2000 SUMMARY REPORT

of

LAKE FAIRVIEW

Lake County, Illinois

Prepared by the

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

Michael D. Adam
Mary C. Colwell
Joseph Marencik
Mark A. Pfister

July 2001

TABLE OF CONTENTS

LAKE IDENTIFICATION AND LOCATION

Lake Fairview (T44N, R9E, Section 35) is a manmade impoundment located in Wauconda Township, east of state highway 59, near the village of Wauconda. It is part of the Tower Lake drainage in the Fox River Watershed. No major creeks, rivers, or tributaries flow into Lake Fairview. Water from the lake eventually flows into Tower Lake and ultimately into the Fox River. The sole outlet is a culvert located on the southeastern corner of the lake.

Lake Fairview encompasses approximately 20.5 acres and has a shoreline length of 0.8 miles. A maximum depth of 10.5 feet was measured at the southeastern corner of the lake near the outlet in April, 2000. Although no bathymetric (depth contour) map for Lake Fairview exists, a mean depth and volume was estimated based on data from lakes with known depths and volumes. Mean depth was obtained by multiplying the maximum depth by 0.5. Volume was obtained by multiplying the mean depth by the lake surface area. Based on these calculations, Lake Fairview has an estimated mean depth of 5.25 feet and an estimated volume of 107.6 acre-feet. Lake elevation is approximately 760 feet above sea level.

BRIEF HISTORY OF LAKE FAIRVIEW

Lake Fairview was created in 1969 under the supervision of the United States Department of Agriculture, Soil Conservation Service. An earth-mound dammed the previous wetland to create this lake. Historically, the maximum depth was 12 feet deep. It is privately owned and managed by the residents on the lake. Parcel maps show 15 individuals own the lake bottom, and of these, three own >80% of the bottom. A distinguishing characteristic of Lake Fairview is a large dead tree that stands in the middle of the lake.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Lake Fairview has no public assess. The lake is used solely by the homeowners and their guests. Only non-motorized boats are allowed on the lake. Fishing is allowed on a catch-and-release basis. Several homeowners have piers and beaches. Wildlife viewing and general aesthetics are popular activities. Several homeowners have wood duck nesting boxes mounted along the shoreline. The surrounding land uses consist primarily of residential housing, mixed with some agricultural and light industry.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken once a month, May through September 2000, at the deep-hole location near the lake's center. See Appendix A for water sampling methods used.

Lake Fairview's water quality is similar to many lakes in Lake County (Table 1). Most of the water quality parameters measured were near the averages of other Lake County lakes that the Health Department has monitored. Several important findings were noted.

Secchi disk readings fluctuated during the season. Low readings in July (3.12 feet) and September (3.25 feet) can be attributed, in part, to the large planktonic algal blooms seen in those months. The high May reading (7.51 feet) can be attributed, in part, to the curlyleaf pondweed that was present. By July, once the curlyleaf died-off, algae was able to dominate, and thus the lower Secchi readings. In August, the increased growth of aquatic plants (particularly coontail) in the lake most likely contributed to the Secchi reading of 8.04 feet, even though a minor algae bloom was occurring.

Lake Fairview began to weakly thermally stratify in August, but by September water and ambient (air) temperatures dropped, eliminating any temperature gradient that began to form. Although Lake Fairview did not stratify during 2000, anoxic conditions (< 1 mg/L of dissolved oxygen, DO) existed in May (8 foot depth) and in August (6, 7, and 8 foot depths). Low DO conditions that may be stressful to fish (generally < 5.0 mg/L) existed throughout the water column in July and August. Good DO conditions (> 5.0 mg/L) existed at all other depths during the season. Overall, poor DO conditions were not a problem on Lake Fairview in 2000, but the potential for problems do exist, since the lake is shallow and experiences significant algal blooms. If severe algal blooms occur, decomposition of plants and algae could reduce oxygen levels enough to cause fishkills. Anoxic conditions can also cause nutrient release from the sediment making them available for additional plant and algae growth.

Algal blooms contributed to high Total Suspended Solids (TSS) that reduced water clarity. This correlates with the lower Secchi disk readings described above. Additional support for this is found in the seasonal average of 3.6 mg/L for Non-Volatile Suspended Solids (NVSS), that is, the inorganic solids found in the water sample. This value is low, compared to many other lakes in the county, indicating that much of the TSS is made up of organic compounds like algae.

High ammonia nitrogen (NH_3-N) concentrations in the 3-foot water sample and deep water sample in August probably resulted from the release of nitrogen due to warmer ambient (air) and water temperatures, low DO concentrations, and the decomposition of plant and algae material. Ammonia nitrogen is released under anoxic conditions, which existed in May and August. Since Lake Fairview did not stratify in 2000, ammonia nitrogen could freely move throughout the water column. In contrast, lakes that stratify in the summer usually exhibit higher ammonia concentrations in the deep water sample

since the temperature gradient acts as a barrier and prevents ammonia and other nutrients from mixing throughout the water column. This continues until the gradient has been dissipated (spring and/or fall turnover). The high ammonia values likely contributed to the algal blooms during the summer since algae readily utilize this nutrient.

Water levels on Lake Fairview remained stable, but gradually increased over the season. The lowest levels were found in May, highest levels in September. The total water level increase from May to September was only 0.24 feet. Fluctuating water levels were not an issue on Lake Fairview in 2000, however, residents indicated that 2000 was an abnormal year. Normally the water levels drop throughout the summer by as much as a foot or more from levels seen in 2000. Lakes with stable water levels potentially have less shoreline erosion problems. Lower water volumes may have negative impacts on the lake. Low DO conditions, as seen in July and August 2000, may become problematic under lower water volumes. Additionally, lower water volume may allow nuisance aquatic plant beds to expand.

The average ratio between nitrogen and phosphorus for Lake Fairview was 22:1, indicating a phosphorus-limited system. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) which are more difficult to control than sources of phosphorus. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

However, although Lake Fairview is phosphorus-limited, it still had excessive amounts of phosphorus. The numerous blue-green algal blooms on Lake Fairview during 2000 verify this condition. The average total phosphorus value of the oxic (oxygenated) sample near the surface (0.072 mg/L) was higher than the county average (0.066 mg/L). These high values are indicative of man-made lakes in the Midwest. High levels of phosphorus in Lake Fairview can be the result of both internal and external sources. Due to the lake's origin (a damming of a wet depression area), high levels of phosphorus may have already been present when the area was flooded (thus, an internal source). External events, like runoff from rain events are another source. A significant source may come from lawn fertilizer, which is usually high in phosphorus. Some manufactures are making low (<5%) to no phosphorus formulations which should be used by lake homeowners.

Rain events probably contributed additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. Rain occurred within 48 hours prior to water sampling in May (0.78 inches recorded at the Stormwater Management Commission rain gauge in Wauconda), June (0.34 inches), and September (0.49 inches).

Based on data collected in 2000, standard classification indices compiled by the Illinois Environmental Protection Agency were used to determine the current condition of Lake Fairview. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic

(extremely nutrient-rich productive). This index is calculated using total phosphorus values obtained at or near the surface. The TSI for Lake Fairview classified it as a eutrophic lake. Eutrophic lakes are the most common types of lakes throughout the Midwest, and they are particularly common among man-made lakes. In Lake Fairview, the aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. However, due to high nutrient levels (particularly phosphorus) and poor water clarity, the swimming and recreation use indices showed a partial impairment of these activities. The Health Department did not test for bacteria or other harmful pathogens on Lake Fairview in 2000.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Lake Fairview were assessed monthly from May through September 2000 (see Appendix A for methods). Eight aquatic plant species, one macro-algae, and several emergent shoreline plants were found (see Table 2, below). The average plant sample depth was 6.6 feet. Plants were found scattered throughout the lake and at the maximum lake depth of 10.5 feet. Most aquatic vegetation did not reach the water surface, with the exception of white water lily and duckweed, which naturally occur there.

Small pondweed, curlyleaf pondweed, and coontail were the three most common aquatic plants found (Table 3). Significant patterns were noted. Curlyleaf pondweed was the dominate plant in May (found in 95% of samples), but consisted of only 27% of samples in June and eventually 0% in September. Conversely, coontail was not present in May, but by July comprised 40% of the samples. These results are typical for lakes with curlyleaf pondweed and coontail. Curlyleaf is an early-season plant, which peaks in May/June and naturally dies back by July. Coontail typically increases as the summer progresses. Small pondweed was present throughout the season.

Readings at the water quality sampling point indicated that the 1% light level (the point where plants cannot photosynthesize) fluctuated slightly over the season. Light penetration was deepest in May (9% at 6.3 feet, the light meter depth when the Hydrolab DataSonde® 4a was at the lake bottom) and most shallow in July and September (1% at 5.2 feet). Plants were found at the deepest part of the lake, 10.5 feet in June indicating that enough light had reached the lake bottom. Based on this data, vegetative coverage of the lake bottom could theoretically be 100% during the season with the exception of July and September when adequate light levels were reduced. Algal blooms most likely contributed to the decreased water clarity and light penetration in July and September.

Lake Fairview did not have a significant aquatic plant problem at the lake surface in 2000. However, several homeowners reportedly treat isolated areas of the lake each year with herbicides and algaecides in late-spring/early-summer. Aquatic plants are good for the lake since they compete with algae for nutrients and help improve water clarity by holding sediment. It is recommended that approximately 25 – 40 % of the lake be

covered with plants. Algae was noted throughout the sampling period and significant blue-green planktonic algal blooms were noted in July, August, and September.

Two exotic aquatic plant species were found in the lake: curlyleaf pondweed and Eurasian water milfoil. Both plants are not significant problems at this time. However, these aquatic plants can cause severe problems, quickly dominating a lake if the right conditions exist. Careful monitoring of the lake's vegetation should be conducted to prevent their spread.

Table 2. Obligate hydrophitic plants on Lake Fairview, May - September 2000.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Curlyleaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Small Pondweed	*Potamogeton pusillus*
Sago Pondweed	*Stuckenia pectinatus*
Small Duckweed	*Lemna minor*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Northern Water Milfoil	*Myriophyllum sibiricum*
White Water Lily	*Nymphaea tuberosa*
Macro Algae	
Chara/Nitella	*Chara* sp./*Nitella* sp.
Shoreline Plants	
Spikerush	*Eleocharis* sp.
Reed Canary Grass	*Phalaris arundinacea*
Swamp Smartweed	*Polygonum coccineum*
Common Arrowhead	*Sagittaria latifolia*
Cattail	*Typha* sp.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in May 2000 to determine the condition of the lake shoreline (see Appendix A for methods). Of particular interest was the condition of the shoreline at the water/land interface. Lake Fairview is approximately 75% developed,

25% undeveloped. All development is in the form of private lots. Undeveloped shoreline consists of segments along the northeastern and eastern sections of the lake, which includes the earthen dam, and a small wetland area on the western shoreline.

Of the developed shoreline, 69% had some form of a buffer strip at the water's edge. However, the quality of the buffer strips were, in most cases, lacking. Most buffer strips were minimal in width and consisted of either unmowed turfgrass or reed canary grass, an exotic. The remaining 31% of developed shoreline was mowed turfgrass lawn to the water's edge (22%), beach (7.5%), and rock rip-rap (1.5%). Improvement of the shoreline on most of the lots is recommended.

Erosion does not appear to be a problem at this time. Slight erosion was noted at a couple of locations, but was not severe enough to warrant immediate remediation. However, each property owner should periodically check the shoreline for erosion problems.

Exotic species, specifically reed canary grass and buckthorn, were found along much of the shoreline of Lake Fairview. However, no purple loosestrife was found. Control of these and other exotics should be part of the lake's overall management plan.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

The only known fish management action taken on Lake Fairview was in 1970, when the Illinois Department of Natural Resources stocked 1,500 largemouth bass (*Micropterus salmoides*) and 3,500 bluegill (*Lepomis macrochirus*) fingerlings into the lake. No fish surveys were completed by the Lake County Health Department during 2000.

Good wildlife populations, primarily birds, were found on and around Lake Fairview (see Table 4, below). Current habitat is fair to good. Many of the birds noted were seen along the northeast shoreline. The small grove of trees in that bay supported several songbird species as well as a suspected green heron nest site. The adjacent grassland supported several songbird species including bobolinks, an increasingly rare prairie bird. Another noteworthy bird was the osprey, spotted over the lake in May, June, July, and September. Ospreys are classified as endangered in Illinois. No osprey nest was noted. However, the lake is < 2 miles from the Fox River and several larger lakes, and thus ospreys most likely use Lake Fairview to hunt fish.

No effort was made to document nests of birds. Some of the species listed below were likely migrating through the area. Although several wood duck boxes are located around the lake, no wood ducks were noted. A lake resident indicated that some were present early in the spring.

Habitat improvement is needed around the lake for non-waterfowl species, such as songbirds, reptiles, and amphibians.

Table 4. Wildlife species observed on Lake Fairview, May – September, 2000.

Birds

Double-Crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Great Egret	*Casmerodius albus*
Osprey*	*Pandion haliaetus*
Red-tailed Hawk	*Buteo jamaicensis*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Zenaida macroura*
Belted Kingfisher	*Megaceryle alcyon*
Downy Woodpecker	*Picoides pubescens*
Common Flicker	*Colaptes auratus*
Eastern Kingbird	*Tyrannus verticalis*
Least Flycatcher	*Empidonax minimus*
Barn Swallow	*Hirundo rustica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-Capped Chickadee	*Poecile atricapillus*
White-Breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Gray-cheeked Thrush	*Catharus minimus*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Tennessee Warbler	*Vermivora peregrina*
Common Yellowthroat	*Geothlypis trichas*
Wilson's Warbler	*Wilsonia pusilla*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Bobolink	*Dolichonyx oryzivorus*
Eastern Meadowlark	*Sturnella magna*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Indigo Bunting	*Passerina cyanea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*

Mammals and Amphibians	
None noted	
Reptiles	
Painted Turtle	*Chrysemys picta*
Insects	
Dragonfly species Cicada	
*Endangered species in Illinois	

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a 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. Currently, no such map exists for Lake Fairview.

- *Excess nitrogen and phosphorus*

  Water samples indicated high levels of phosphorus in Lake Fairview throughout the season. Ammonia nitrogen was high in August. These nutrients significantly contribute to excess algal growth. Reduction of nutrients (particularly phosphorus) in the lake is recommended.

- *Blue-green algae blooms*

  Blue-green planktonic algal blooms were observed in July, August, and September. Blooms resulted in poor Secchi disk visibility and noxious odors in July and September. Blooms are the result of excess nutrients (particularly phosphorus) in the lake and limited aquatic plant growth.

- *Lack of a comprehensive aquatic plant management plan*

  While Lake Fairview did not have an aquatic plant problem at the lake surface in 2000, in part due to herbicide treatments by individual residents, a comprehensive

management plan is needed. Plant coverage on Lake Fairview theoretically could be 100%, depending on light levels. A healthy lake should have 25 – 40 % plant coverage. Coordination among lake residents is critical. A comprehensive plan will assist in determining the appropriate timing and concentrations of plant or algae treatments.

- *Minimal shoreline vegetation*

  Turfgrass mowed to the water's edge was found on 22% of the lots. Although buffer strips were found on 69% of the lots, most consisted of poor stands of exotic reed canary grass or unmowed turfgrass. Buffer strips were also minimal in width. Revegetation of shorelines with buffer strips of native vegetation is recommended for most lots on the lake.

  Cost-share and technical assistance for the protection, restoration, and enhancement of aquatic resources with secondary benefits to wildlife habitats in the Fox River Watershed (this includes Lake Fairview) is available from the Lake County Soil and Water Conservation District (847-223-1056). Cost-share payments for all eligible practices are at a rate of 75%. Two deadline dates, March 15 and August 15, 2001 currently exist.

- *Presence of exotic species*

  Reed canary grass was noted along much of the shoreline. Buckthorn was also present. Currently, these exotics do not pose a problem, but they should be kept in check to prevent their spread. Residents have done a good job of excluding purple loosestrife from the shorelines. This should continue.

- *Canada Geese*

  Numerous Canada geese were seen around Lake Fairview. Residents have identified geese as a problem. A plan to address this problem should be implemented.

- *Improve wildlife habitat*

  While numerous birds were noted, additional nesting habitat (both artificial and natural) could be made available for non-waterfowl species. In addition, limited habitat exists for other wildlife species, particularly reptiles (i.e., turtles) and amphibians.

POTENTIAL OBJECTIVES FOR THE LAKE FAIRVIEW MANAGEMENT PLAN

I. Bathymetric Map
II. Aquatic Plant and Algae Management
III. Enhance Shoreline Vegetation
IV. Control Exotic Plant Species
V. Control of Canada Geese
VI. Enhance Wildlife Habitat Conditions

ALTERNATIVES 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 lakes in Lake County do have a bathymetric map, but they are frequently old, outdated and do not accurately represent the current features of the lake.

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 and Algae Management

All aquatic plant and algae 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 and algae management plan should not be rushed. A plan 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 and algae management plan to achieve long term success, follow up is critical. A good 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 or algae have 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 or algae 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 and algae management options that are not covered below as they are not very effective, or are too experimental to be widely used.

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 excessive algal growth. Normally, excessive algae growth is a sign of larger problems such as 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 excessive algal growth involves treating the factors that cause the excessive growth not the algae it self. Long term solutions to excessive algae 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.

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 and algae from becoming problematic. With a no action plan in a lake with non-native nuisance species, nothing would be done to control the aquatic plant and algae population of the lake regardless of the type and extent of the problem. Nuisance vegetation and algae 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 curlyleaf 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 (*Myriophyllum spicatum*) and coontail (*Ceratophyllum demersum*), which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's surface. 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 plant and algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation and algae control were eventually needed, the cost would be substantially higher than if the no action option was followed. Another benefit of this option would be the lack of environmental manipulation. Under this option, no chemicals, mechanical altercation, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. Expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants kept "weedy" plants and algae 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 due to plant uptake and sediment stabilization. However, the occurrence of filamentous algae may increase 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. This will also impact fish populations. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced

predation. Predation will decrease due to the difficulty of finding prey in the dense stands of vegetation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species such as some blue-green algae. Blue-green algae can also produced 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 vegetation and algae, 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. 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 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. Dead plant and algae 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 algal blooms and an overall increase of the internal nutrient load to the lake. 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 mats of plant and algae. Swimming could also become increasingly difficult due to thick vegetation or algae 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 or algae 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.

Option 2: Aquatic Herbicides and Algaecides

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products can not be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of

any negative effects on human health, wildlife, and the environment. Aquatic herbicides are not allowed to be environmentally persistent, bioaccumulate, or have any bioavailability. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e. low wind speed).

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

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

Algaecides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algaecides 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 affective. Algaecides 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 algaecides are mainly used

on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algaecides, 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 algaecides 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 algaecide. When applying an algaecide 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 algaecides should never be done in extremely hot weather (>90^{o}F). This will help lessen the likelihood of an oxygen crash and resulting fishkills. When possible, treatments should be made as early in the season as possible. 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.

Because Lake Fairview has poor water clarity, chemical treatment of algae, if needed, should be done with a chelated copper product like Cutrine Plus®. Copper sulfate is not as effective in turbid waters since it binds with particles in the water more easily than chelated copper.

In Lake Fairview, coontail, curlyleaf pondweed and small pondweed were the most common plants found. If these plants are problematic, spot-treatment with a contact herbicide such as diquat is recommended. If a contact herbicide is used, it is important to use it in spot treatments, and not an entire lake treatment. Treating the entire lake with a contact herbicide will cause a large die-off of plants, which will decrease dissolved oxygen (DO) levels in the lake. In Lake Fairview, which already has moderately low DO levels, this could decrease DO to a point where a fishkill occurs. While a systemic herbicide like floridone (i.e., Sonar™) is more effective at long-term control of plants like coontail, it can be non-selective, killing beneficial plants as well as the target species.

Pros

When used properly, aquatic herbicides and algaecides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide and algaecides 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 watermilfoil but allow desirable plants such as the pondweeds to remain. This removes the problematic vegetation and allows native and more desirable plants to remain and flourish with minimal manipulation.

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

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

Cons

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

By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. In many instances, over use of copper is leading to selection of species tolerant to copper. 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. Additionally, excessive use of copper products can lead to a build up of copper in lake sediments. This can cause problems for actives such as dredging. Due to large amount of copper in the sediments, special permits and disposal methods would have to be utilized.

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 (such as sunlight), 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 water milfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation can lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fisheries can have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl and other wildlife. Additionally, some herbicides have use restrictions regarding their use in relation to fish, swimming, irrigation, etc.

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

Costs

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 and algae management plan. However, without a bathymetric map it is difficult to calculate the proper amount of chemicals needed for treatment. For example, treatment of Lake Fairview with chelated copper is dependent on the lake's acre-feet. Based on the estimate of 107.6 acre-feet, treating with chelated copper would cost $2,000-5,000. As stated previously, copper treatments should be done in spot-treatments, not lake-wide. To spot treat the lake with a contact herbicide like Reward® would cost approximately $425 per surface acre. To treat 60% of the lake (to achieve 40% plant coverage assuming the lake was 100% covered with plants) would cost approximately $5,200. If herbicides are necessary, spot treatments in problematic areas are recommended. This will reduce costs and prevent significant dissolved oxygen depletion.

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, which 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 unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds, 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 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 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. This

would likely be true for Lake Fairview. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. While most of Lake County's lakes are in this safe range, Lake Fairview had a pH reading above 9 in May. 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

Calculating the cost of an alum treatment is complex. On Lake Fairview such a treatment would cost at least $5,000, depending on several factors. These costs could be reduced with a partial draw-down of the lake. Tests need to be completed in order to determine the appropriateness and degree of alum needed. Treatments should only be conducted in the spring or fall.

Option 4: Hand Removal

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

Pros

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

Cons

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. Another drawback is possible nonselective

removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plant and algae are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable vegetation and/or disrupt valuable habitat (fish spawning beds).

Costs

Plant and algae 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 5: Reestablishing Native Aquatic Vegetation

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 minimum, 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 5 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

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

Cons

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

Costs

See Table 5 for pricing. Actual costs will vary depending on the type and amount of vegetation that needs to be purchased and planted.

Objective III: Enhance Shoreline Vegetation

An effective method of controlling shoreline erosion and enhance shoreline vegetation is to create a buffer strip with existing or native vegetation. At this time, Lake Fairview does not have an erosion problem. However, revegetation of much of the shoreline is recommended. The information below will be helpful in both enhancing current shoreline vegetation and improving erosion control should it arise.

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. Table 5 gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., muskrats) by placing a wire cage over the plants for at least one year.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or 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 Table 5 should be considered for native plantings.

Pros

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Occasional high mowing (1-2 times per year) for specific plants or physically removing other weedy species may be needed.

The buffer strip will stabilize the soil with its deep root structure and help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae and "weedy" aquatic plants. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff.

Another benefit of a buffer strip is potential flood control protection. Buffer strips may slow the velocity of flood waters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. Many plants can survive after being under water for several days, even weeks, while turfgrass is intolerant of wet conditions and usually dies after several days under water. This contributes to increased maintenance costs, since the turfgrass has to be either replanted or replaced with sod. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of

particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

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

Cons

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

Costs

If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. 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.

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.

Cost-share and technical assistance for the protection, restoration, and enhancement of aquatic resources with secondary benefits to wildlife habitats in

the Fox River Watershed (including Lake Fairview) is available from the Lake County Soil and Water Conservation District (847-223-1056). Cost-share payments for all eligible practices are at a rate of 75%. Two deadline dates, March 15 and August 15, 2001 currently exist.

Objective IV: Control Exotic Plant Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus 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. Exotic aquatic plants are addressed in the **Objective II: Aquatic Plant and Algae Management** section above.

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million per plant), and high seed germination rate, purple loosestrife spreads quickly. No purple loosestrife was found on Lake Fairview. 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. Buckthorn and reed canary grass were found around Lake Fairview. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

Presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

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

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 5 lists several native plants that can be planted along shorelines.

Cons

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

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

Costs

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

Option 2: Control by Hand

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

Pros

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

Cons

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

Costs

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

Option 3: Herbicide Treatment

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.

Glyphosate (sold as Rodeo® or Round-up™) can be used to treat reed canary grass, purple loosestrife, and buckthorn. Triclopyr (sold as Garlon®) is also effective at treating buckthorn and purple loosestrife. Both Round-up™ and Garlon® can be toxic to fish and thus, should not be used near water.

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

Glyphosate (sold as Rodeo® or Round-up™) costs $65/gallon. Garlon® costs approximately $100/gallon. Only Rodeo® is licensed for use near water. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting devise, 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 V: Control Canada Geese (*Branta canadensis*)

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

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

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

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

Pros

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

Cons

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present

(many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

Costs

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

Option 2: Removal

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

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

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

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

Pros

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

Cons

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

Costs

A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $33.00 for the 2000-2001 hunting season. For depredation permits, there is a $25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

Option 3: Dispersal/Repellent Techniques

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

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

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

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

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

Pros

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

Cons

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

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

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

Costs

Costs for the propane cannons are approximately $660 ($360 for the cannon, $300 for a timer), not including the propane tank. The cost of ReJeX-iT® is $70/gallon, GooseChase™ is $92/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 4: Exclusion

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

Pros

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

Cons

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

Costs

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

Option 5: Habitat Alteration

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To

achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. Table 5 has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

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

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

Pros

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

Cons

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

Costs

If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

Option 6: Do Not Feed Waterfowl!

There are few "good things", if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the "foods" (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustom to hand feeding may become aggressive toward other geese or even the people feeding the geese.

Costs

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

Reference

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

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 variety of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

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

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

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

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

Pros

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

Cons

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

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

Costs

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

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Table 5 for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

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

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

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

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

Cost-share and technical assistance for the protection, restoration, and enhancement of aquatic resources with secondary benefits to wildlife habitats in the Fox River Watershed (including Lake Fairview) is available from the Lake County Soil and Water Conservation District (847-223-1056). Cost-share payments for all eligible practices are at a rate of 75%. Two deadline dates, March 15 and August 15, 2001 currently exist.

Pros

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

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

Cons

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

Costs

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

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 5 should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

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

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

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

Pros

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

treatments or use of electrical “bug zappers” that have limited effect on nuisance insects.

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

Cons

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks. Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake’s nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may 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 were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

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

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

Cons

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

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

Costs

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

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.

Water quality table.

Epilimnion

DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/18/00	3	102	1.21	<0.1	<0.05	0.051	0.02	464	1.6	456	129	7.51	0.7553	9.24	7.5
6/22/00	3	125	1.17	<0.1	0.051	0.073	0.006	454	4.9	476	124	5.25	0.7883	8.69	7.8
7/20/00	3	129	1.3	0.19	0.053	0.087	0.008	428	5.8	457	132	3.12	0.758	8.26	4.6
8/24/00	3	134	1.8	0.395	0.05	0.066	<0.005	466	3.7	480	118	8.04	0.8076	8.18	4.5
9/21/00	3	140	1.86	<0.1	<0.05	0.085	<0.005	436	8.4	475	129	3.25	0.8098	8.49	7.3
	Average	126	1.47	0.293[k]	0.051[k]	0.072	0.011[k]	449	4.9	469	126	5.43	0.7838	8.57	6.3

Hypolimnion

DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/18/00	6	103	1.25	<0.1	<0.05	0.079	0.022	450	2.9	460	130	NA	0.7575	9.15	6.4
6/22/00	7	125	1.24	<0.1	0.051	0.068	0.01	440	4.6	479	124	NA	0.7894	8.65	7.3
7/20/00	6	130	1.5	0.194	0.06	0.077	0.006	431	5.8	469	121	NA	0.7596	8.24	4.3
8/24/00	6	134	1.7	0.476	<0.05	0.059	0.006	454	3.5	506	149	NA	0.8096	7.71	0.3
9/21/00	6	139	2	<0.1	<0.05	0.085	<0.005	436	8	477	134	NA	0.8096	8.48	7.2
	Average	126	1.54	0.335[k]	0.056[k]	0.074	0.011[k]	442	5	478	132	NA	0.7851	8.45	5.1

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L

SECCHI = Secchi Disk Depth, Ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

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

Table 3. 2000 seasonal and monthly occurrence of aquatic plants in Lake Fairview.

Seasonal Summary 5/18/00-9/19/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	9	24	25	1	3	1	1	49	19	3
% Occurrence	11%	29%	30%	1%	4%	1%	1%	60%	23%	4%

Monthly Summary 5/18/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	1	0	19	0	0	0	0	11	2	0
% Occurrence	5%	0%	95%	0%	0%	0%	0%	55%	10%	0%

6/20/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	3	3	4	0	1	0	1	13	3	3
% Occurrence	20%	20%	27%	0%	7%	0%	7%	87%	20%	20%

7/12/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	1	8	1	1	0	1	0	15	9	0
% Occurrence	5%	40%	5%	5%	0%	5%	0%	75%	45%	0%

8/22/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	3	7	1	0	1	0	0	5	3	0
% Occurrence	25%	58%	8%	0%	8%	0%	0%	42%	25%	0%

9/19/00	Chara/Nitella	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Water Milfoil	Northern Water Milfoil	Sago Pondweed	Small Pondweed	White Water Lilly	Unknown
Num. of Sites	1	6	0	0	1	0	0	4	2	0
% Occurrence	10%	60%	0%	0%	10%	0%	0%	40%	20%	0%

Plant Sampling Point Statistics

Average Sample Depth	6.6 feet
Min. Sample Depth	1.5 feet
Max Sample Depth	10.5 feet
Max Plant Depth	10.5 feet
Total # of Samples	82

Native plant table

Terrestrial-Dry soil	Seeding Rate	Seed Price	Planting Rate	Price/Plant
Big Bluestem Grass (*Andropogon gerardii*)	10-25b lbs/acre	$20/lb	NA	$4-5
Bluejoint Grass (*Calamagrostis canadensis*)	2 lbs/acre	$2-4/oz	NA	$4-5
Little Bluestem Grass (*Andropogon scoparius*)	10-25 lbs/acre	$20/lb	NA	$4-5
Prairie Cord Grass (*Spartina pectinata*)	0.25-1.0 lbs/acre	$2-3/oz	250-500/acre	$2-4
Switch Grass (*Panicum virgatum*)	0.5-2.0 lbs./acre	$6-7/oz	NA	$1-5
Terrestrial-Wet Soil	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Blue Flag (*Iris versicolor*)	NA	$10/oz	1000/acre	$0.60-1.50
Blue Vervain (*Verbena hastata*)	NA	$6/oz	500-1000/acre	$0.80-1.00
Blunt Spike Rush (*Eleocharis obtusa*)	NA	$30/oz	500-1000/acre	$0.50-1.00
Boneset (*Eupatorium perfoliatum*)	0.006-0.25 lbs./acre	$6-7/oz	500-700/acre	$1.00
Water Horsetail (*Equisetum fluviatile*)	NA	NA	1000/acre	$0.50
Joe-Pye-Weed (*Eupatorium maculatum*)	NA	$8/oz	500-700/acre	$0.50-1.00
Sweet Flag (*Acorus calamus*)	NA	$10/oz	250/acre	$0.50-1.00
Wild Rice (*Zizania aquatica*)	NA	$5.00/lb	1000/acre	$0.50-0.20
1"-1.5' Deep	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Arrow Arum (*Peltandra virginica*)	NA	$4-5/oz	1000/acre	$0.40-1.00
Bottle Brush Sedge (*Carex comosa*)	0.12-0.19 lbs./acre	$6-8/oz	NA	NA
Chairmakers Rush (*Scirpus americanus*)	0.06-0.25 lbs/acre	$8-15/oz	1000/acre	$0.25-0.85
Common Arrowhead (*Sagittaria latifolia*)	0.06-0.125 lbs/acre	$15-16/oz	1000/acre	$0.60-1.25
Common Burreed (*Sparganium euycapum*)	0.06-0.25 lbs/acre	$10-15/oz	1000/acre	$0.22-0.50
Common Cattail (*Typha latifolia*)	0.06-0.5 lbs/acre	$3-15/oz	1000/acre	$0.40-1.00
Hardstem Bulrush (*Scirpus acutus*)	0.06-0.25 lbs/acre	$8-15/oz	1000/acre	$0.25-0.50
Pensylvania Smartweed (*Polygonum pensylvanicum*)	0.06-0.25 lbs/acre	$5/oz	NA	NA
River Bulrush (*Scirpus fluviatilis*)	0.06-0.25 lbs/acre	$5/oz	NA	NA
Soft Rush (*Juncus effusus*)	0.06-0.125 lbs/acre	$15-16/oz	$4-5	$0.25-0.90
Softstem Bulrush (*Scirpus validus*)	NA	$20/oz	1000/acre	$0.25-0.90
Water Plantain (*Alisma subcordatum*)	0.06-0.25 lbs/acre	$10-15/oz	1000/acre	$0.25-0.85
Water Smartweed (*Polygonum fluitans*)	0.06-0.5 lbs/acre	$3-25/oz	1000/acre	$0.35-0.50
White Water Buttercup (*Ranunculus longirostris*)	NA	NA	500/acre	$0.40-0.50
Yellow Water Buttercup (*Ranunculus flabellaris*)	NA	NA	500/acre	$0.70-1.51
1.5'-3' Deep	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Watersheild (*Brasenia schreberi*)	NA	NA	1000/acre	$0.65-1.49
White Water Lily (*Nymphaea tuberosa*)	NA	NA	200/acre	$0.30-0.40
Yellow Water Lily (*Nuphar advena*)	NA	NA	200/acre	$3.75
3'-8' Deep	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Elodea (*Elodea canadensis*)	NA	NA	1000/acre	$0.25-0.51
Large-leaved Pondweed (*Potamogeton amplifolius*)	NA	NA	1000/acre	$0.25-0.51
Richardson's Pondweed (*Potamogeton richardsonii*)	NA	NA	250lbs/acre	$2/lb
Sago Pondweed (*Potamogeton pectinatus*)	NA	NA	1000/acre	$0.35-0.50
Vallisineria, Eel Grass (*Vallisineria*	NA	NA	1000/acre	$0.40-0.75

americana)				
Water Stargrass (*Zosterella dubia*)	NA	$4.00/lb	1000/acre	$0.25-0.50
Trees and Shrubs	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Bur Oak (*Quercus macrocarpa*)	NA	NA	NA	$5-6
Buttonbush (*Cephalanthus occidentalis*)	NA	NA	NA	$6-7
Red Osier Dogwood (*Cornus stolonifera*)	NA	$9/oz	NA	$2-5
White Oak (*Quercus alb*a)	NA	$5-8/oz	NA	$6-7
Seed Mixes	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Forb and Grass Seed Mix	500 square ft	$20-60	NA	NA
Forb and Grass Seed Mix	1000 square ft	$66-108	NA	NA

Figure 1.

Appendix A. Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were generally at the deepest point in the lake (see sample site map), three feet below the surface, and approximately two feet off the bottom. Samples were collected with a horizontal or vertical Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. TestAmerica Incorporated, an environmental services lab, analyzed samples collected for total Kjeldahl nitrogen (TKN). The Health Department lab analyzed all other samples. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Total Kjeldahl nitrogen was analyzed by method 351.2 from the Methods for Chemical Analyses of Water and Wastes (EPA 600 Series). Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every foot until reaching the bottom in lakes $\leq$ 15 feet deep, and every two feet in lakes >15 feet.

Plant Sampling

Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At random locations in the littoral zone, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, any plants on the rake were identified and recorded. Plants that were not found on the rake but were occularly seen in the immediate vicinity of the boat at the time of sampling, were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation. Approximate locations of each point were drawn on an aerial photo of the lake. Locations of the plant edge were also identified and marked on the aerial photo. The plant edge was defined as the area where aquatic plants presence dissipated, typically toward the deeper portions of the lake. The number of sample locations was contingent upon lake surface area, area of littoral zone, and presence and distribution of plants.

Shoreline Assessment

To assess the current condition of each lake's shoreline, a shoreline assessment was completed in 2000. This survey was conducted with the use of a boat, aerial photos, and county parcel maps. The shoreline along the land/water interface on each parcel was observed from a boat and various parameters were assessed (Table A2). Shorelines were first identified as developed or undeveloped. The type of shoreline was then determined and length of each type was recorded based on the parcel map or was occularly estimated. In addition, several other parameters were measured including: the extent of shoreline vegetation, the degree of slope and erosion, and the presence of inlets, recreational structures (including boats, canoes, jetskis, boat ramps, piers, boat lifts, swimming platforms, etc.), aerators, irrigation pumps, water control structures, invasive vegetation, beaver activity, and deadfall (trees or shrubs lying in the water).

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

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

Wildlife Assessment

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

Table A1. Analytical Methods Used for Water Quality Parameters.

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

Table A2. Shoreline Type Categories and Assessment.

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