2003 SUMMARY REPORT
of
FAIRFIELD MARSH

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Fairfield Marsh is a 33-acre shallow water marsh that lies within both Avon and Lake Villa Townships. The marsh has a maximum depth of 4.5 feet and an estimated mean depth of 2.25 feet. Although the Village of Round Lake Heights owns a small parcel of the marsh, the majority is privately owned. At this time, there is no public access to the marsh. A subdivision to the northwest drains into a detention pond that flows into Fairfield Marsh.

Aerial photography from 1939 shows Fairfield Marsh was farmland at the time. Clogged farm tiles allowed water to collect in this low area to form the present marsh. In late July of 2003, a tile broke open, allowing water to exit the marsh at a rapid rate. The water elevation dropped by a total of 3.77 feet from the June sampling date to the August sampling date. In late August, the tile was located and plugged temporarily. In November 2003, the temporary plug was removed and the tile permanently disabled. The water level increased gradually, and as of April 2004, was close to the initial elevation measured in May 2003.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured each month from May-September 2003. Because of the chemical changes experienced by the marsh after the water loss in July, some of the parameter results in May, June and July are markedly different than those of August and September.
In comparison to lakes throughout Lake County, Fairfield Marsh had poor water quality both before and after the water loss occurred. Total Kjeldahl nitrogen, total phosphorus, total suspended solids, total volatile solids concentrations and water clarity were worse than the Lake County medians. The high total suspended solids concentrations resulted in low Secchi disk readings, which were one foot or less throughout the season. Water clarity, total Kjeldahl nitrogen, total suspended solids and total volatile solids concentrations collected after water loss had occurred ranked as the worst in our 1999-2003 database. Much of this was a result of sediment disturbance, the nutrient release from this disturbed sediment and a subsequent algae bloom, the latter two of which may not have occurred with this intensity if the water level had remained stable throughout the season. Another reason is that the nutrients and solids were concentrated in a smaller volume of water as evaporation occurred after the initial water loss. The water column in Fairfield Marsh was completely mixed and dissolved oxygen levels were high during the 2003 sampling season.

The aquatic plants in Fairfield Marsh were sampled only in May and June. The water loss prevented us from sampling for the remainder of the season. They were scattered and few, with only four species observed. One species found, Eurasian water milfoil is an exotic, invasive plant. The plants that were observed usually were coated with sediment, which many submersed aquatic species do not tolerate well.

Although 44% of the shoreline of Fairfield Marsh is developed, much of it is considered as buffer, prairie and wetland types. No area of the shoreline was eroding. Invasive shoreline plant species were noticed along 27% of the shoreline. A good mix of songbirds and waterfowl were seen using the marsh. Forster’s terns, an Illinois endangered species were also noted.

LAKE IDENTIFICATION AND LOCATION

Fairfield Marsh is a 33-acre manmade shallow water marsh in north central Lake County (T45 R10E Sections 18 and 7), with a maximum depth of 4.5 feet. The marsh has an average estimated depth of 2.25 feet, with an estimated volume of 74.4 acre-feet. The length of shoreline is 1.77 miles. Most of the marsh lies within unincorporated Lake County near the Village of Round Lake Heights. With the exception of one small parcel owned by the village, the marsh privately owned by several individuals. Fairfield Marsh flows into a small tributary that leads to Eagle Creek, which flows into Long Lake. Long Lake eventually flows into Squaw Creek and to the Fox River/Chain O'Lakes.

The watershed feeding Fairfield Marsh is small, consisting of approximately 142 acres, 33 acres of which is Fairfield Marsh itself (Figure 1). The watershed to lake ratio is approximately 4:1, which is relatively small and may help prevent serious water quality problems that often accompany a larger watershed to lake ratio. A small watershed is generally beneficial for lakes, and the quality of the stormwater entering a lake depends on the land uses within that watershed. Developed land can deliver more pollutants such as sediment and nutrients than undeveloped areas such as prairies or forests. The largest percent of land that drains into the Fairfield Marsh is categorized as residential, which comprises approximately 30% of the total watershed. Residential land can be a source of nutrients and sediment to lakes. The next two largest land uses (not including the marsh) are forest/grasslands at 13.4% and open space at 10.6% of the total watershed. These land uses are important within a watershed as they absorb rainfall and filter stormwater before it enters a body of water.

INSERT FIGURE 1. WATERSHED

INSERT FIGURE 2. LAND USE

BRIEF HISTORY OF FAIRFIELD MARSH

Aerial photography from 1939 shows Fairfield Marsh was farmland at the time. This area may have been a marsh prior to the tile installation in the 1920's. Local information indicates that after the farming practices stopped in the early 1980's, the tiles eventually clogged, which allowed water to collect in this low area to form the present marsh. In late July of 2003, the tile broke open, allowing water to exit the marsh at a catastrophic rate. According to local residents, this occurred about five days prior to our scheduled July sampling date. The water level had dropped approximately 1.5 feet from June to July, even though 5.4 inches of rain had fallen in the area in the month of July. The water elevation dropped by a total of 3.77 feet from the June sampling date to the August sampling date. On August 29, the tile was located and plugged temporarily until further information could be collected about the hydrology of the area in order to create a more permanent solution to the water loss. During November 20 and 21, 2003, the tile was relocated, crushed and backfilled with compacted clay in four locations in order for it to be effectively disabled. The temporary plug was removed. The overflow swale was graded to an elevation specified by Lake County Stormwater Management Agency to allow the marsh to regain the historic water elevation. The area where this work was done was seeded and blanketed with natural vegetation. The water level has been gradually increasing again in the marsh, and in early April 2004, was about 4 inches lower than the initial elevation we recorded in May 2003.

No management activities have been conducted within the marsh. A large portion is owned by Neumann Homes, a developer that is currently constructing the Chesapeake Trails Subdivision on the northeast side of the marsh. After the final phase of construction, the portion of the marsh they own will be dedicated to the homeowner's association. However, the Village of Round Lake Heights will be responsible for maintenance of this area.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Fairfield Marsh has no public access for swimming or fishing uses. People living on the west side of the marsh use it for aesthetic purposes, and one property owner has used the marsh for educational purposes for grade school children.

LIMNOLOGICAL DATA - WATER QUALITY

Water samples were collected each month, from May through September 2003, at the deepest location (Figure 3), and were analyzed for a variety of water quality parameters (See Appendix B for methodology). Due to the significant water loss during July and August, data in this report will be compared before and after the water loss occurred.

Fairfield Marsh did not thermally stratify during May-September, 2003. The shallow water column was continually mixed by wind, wave and carp action. Because of this mixing, dissolved oxygen (DO) was high throughout this system for the entire season. The DO

INSERT FIG. 3 SAMPLING POINT

concentrations from July through September were nearly double the May and June concentrations. During August and September, a heavy algae bloom was in progress, which resulted in a large amount of daytime DO production in the remaining amount of water, which was less than two feet deep. This situation may be quite different a night, however, when the algae respires, a process that uses oxygen. It's possible that the DO concentrations could have been very low at this time, which would have caused oxygen stress on the remaining fish in the marsh.

Two important nutrients for algae growth, nitrogen and phosphorus, were in very high concentrations in Fairfield Marsh, both before and after water loss had occurred. Total phosphorus (TP) averaged 0.180 mg/L during May-July 2003, which is about three times higher than the Lake County TP median of 0.059 mg/L. After the water loss had occurred, the TP concentrations jumped to 0.540 mg/L and 0.552 mg/L in August and September, respectively, resulting in an intense algae bloom during these months. Generally, nuisance algae blooms, such as what was seen on Fairfield Marsh, can occur with TP concentrations of only 0.05 mg/L. Another reason phosphorus concentrations are so high is that the nutrients and solids were concentrated in a smaller volume of water after the water loss.

TP also can be used in determining the trophic state index (TSI), which classifies lakes according to the overall level of nutrient enrichment. The TSI uses phosphorus levels, chlorophyll *a* (algae biomass) levels and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. Using the total phosphorus concentration, the TSI score can be calculated. The score falls within the range of one of four categories: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Mesotrophic and oligotrophic lakes are those with low nutrient levels. These are very clear lakes, with little or no plant and/or algae growth. Most lakes in Lake County are nutrient rich, and are classified as eutrophic, with a TSI score of 50 or greater. These lakes are productive lakes in terms of aquatic plants and/or algae and fish. Hypereutrophic lakes are those that have excessive nutrients, with nuisance algae growth reminiscent of "pea soup" and have a TSI score greater than 70. The TSI of Fairfield Marsh in terms of its phosphorus concentrations during 2003 was hypereutrophic, with a TSI score of 87.7. The marsh ranked 127th out of 130 Lake County lakes based on average total phosphorus concentrations of lakes studied since 1999. If TP results were used only from May through July, the marsh would still be hypereutrophic, with a ranking near 116th out of 130 Lake County lakes. Although the overall assessment of water quality in Fairfield Marsh is very poor, it is not unusual given the morphology and origin of this body of water. This area was farmed for decades, and the marsh formed in the 1980's over very rich, fertilized farm soil that has probably been releasing phosphorus and nitrogen into the water column since the water level began to rise. Of the 16 lowest ranking lakes for total phosphorus concentrations in Lake County (Table 2, Appendix A), all but one are very shallow systems, five are marshes and eight are "flow through" systems that are fed by poor quality streams.

The other nutrient critical for algae growth is nitrogen. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen. In Fairfield Marsh, TKN concentrations averaged 2.82 mg/L from May - July 2003, which is more than two times higher than the Lake County TKN median of 1.22 mg/L. After water loss had occurred, and the late summer algae bloom peaked, TKN concentrations soared to 7.8 mg/L and 10.3 mg/L in August and September, respectively. The September result is the highest TKN concentration recorded in our 1999-2003 database. The total seasonal average is over four times higher than the Lake County median. During August and September, the intense algae bloom in progress was probably the major source of TKN, since this nitrogen type is typically bound up in algal cells. Wind, wave and carp action also resuspends nutrient laden sediment into the water column from the bottom. This was very likely during these last two months because the marsh was less than two feet deep. Another reason is that the nutrients and solids were concentrated in a smaller volume of water. Other sources for nitrogen are numerous, and include rain, fertilizer, the atmosphere and other non-point sources, and can be difficult to pinpoint, and virtually impossible to control.

The ratio of total nitrogen to total phosphorus (TN:TP) indicates if the amount of phosphorus or nitrogen would limit algae and/or plant growth in the lake. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. Most lakes in Lake County are limited by phosphorus. Although Fairfield Marsh is still limited by phosphorus, with a seasonal TN:TP ratio of 16:1, this system has an overabundance of both nutrients, contributing to the algae bloom seen in late summer.

Although algae was in abundance and was a partial reason for poor water clarity in Fairfield Marsh, sediment also played a role. Water clarity is usually the first thing people notice about any body of water, and typifies the overall water quality. A large amount of material in the water column can decrease water clarity as well as inhibit successful predation by sight-feeding fish, such as bass and pike, or settle out and smother fish eggs. High turbidity caused by sediment or algae can shade out aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as habitat for many fish species and stabilization of lake bottom sediments.

The water clarity in Fairfield Marsh during 2003 was poor, both before and after the marsh experienced the water loss. The readings averaged 1.11 feet deep during May through July, and 0.36 feet deep in August-September, with all readings well below than the Lake County median of 3.41 feet. The reading taken in September of 0.33 feet was the poorest clarity measurement in our 1999-2003 database. The poor water clarity was due to the high concentrations of total suspended solids (TSS) in the water column throughout the season. TSS are composed of nonvolatile suspended solids (NVSS), non-organic materials such as clay or sediment particles, and volatile suspended solids (VSS) such as algae and other organic matter. The average TSS concentration in the marsh from May – July was 34.7 mg/L, over four times the Lake County median of 7.5 mg/L. The August-September data were much worse, with results of 139 mg/L and 165 mg/L, respectively. Both algae and sediment were suspended in very shallow water during these months. In Fairfield Marsh, the calculated NVSS concentrations comprised the majority of the TSS throughout the season. Therefore, although algae was abundant in the water, sediment is the major component of TSS that caused the low water clarity. Wind and wave action and carp activity are all factors that resuspend sediment into the water column, especially in shallow systems such as this one.

The Illinois Environmental Protection Agency (IEPA) has indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as phosphorus concentrations, water clarity and aquatic plant coverage. Fairfield Marsh partially supports aquatic life according to these guidelines. Although the marsh isn't used for in-lake recreational uses or for swimming, the low water clarity, high phosphorus concentrations and high NVSS concentrations placed the marsh in the nonsupport category for these uses. The marsh falls into the nonsupport category for overall use.

Conductivity is a measurement of water's ability to conduct electricity via total dissolved solids (TDS), which are dissolved minerals (i.e., chlorides) or salts in the water column. Because of the use of road salts, lakes with residential and/or urban land uses are often noted to have higher conductivity readings and higher total dissolved solids concentrations than lakes that are not surrounded by development. Stormwater runoff from impervious surfaces such as asphalt and concrete can deliver high concentrations of these salts to nearby lakes and ponds. Conductivity is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. The Lake County average conductivity reading of water near the surface is 0.7907 mS/cm. During 2003, the conductivity levels in Fairfield Marsh averaged 1.1091 mS/cm. Although we do not have historical conductivity or TDS data before the Chesapeake Trails subdivision was built, the marsh receives some stormwater from the detention basin that drains a portion of this subdivision. This could be one source for these minerals and salts.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

We randomly sampled locations in Fairfield Marsh in May and June for aquatic plants. After the water loss, we could not access the entire marsh to look for plants. Four aquatic species were identified, and shoreline plants were also recorded. Table 3 lists the plants that were identified by their common and scientific names. Table 4 in Appendix A lists the plant species and the frequency in which they were found.

Aquatic plants were only found in a few sample sites. Eurasian water milfoil (EWM) was found most often, in 33% of the sample sites. The other species, sago pondweed, coontail and duckweed, were found in just a handful of sites. To support a healthy fishery, the Illinois Department of Natural Resources (IDNR) suggests that aquatic plants cover approximately 20% to 40% of the lake bottom. In Fairfield Marsh, the aquatic plants covered less than 1% of the bottom, offering little in terms of food, shelter and nursery habitat for aquatic life. Light levels were measured at one-foot intervals from the water surface to the lake bottom. When light intensity falls below 1% of the level at the water surface, plants are no longer able to grow. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. During 2003, the 1% light level in Fairfield Marsh did reach the bottom in May, but only to about two feet deep in June. Even so, few aquatic plants were present. The plants that were observed usually were coated with sediment, which many submersed aquatic species do not tolerate well. Also, in some areas, such as part of the west shore, the substrate is rocky or very hard, which is difficult for plants to grow in.

Floristic quality index is a measurement designed to evaluate the closeness of the flora (plants species) of an area to that with undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long term floristic trends, and 4) monitor habitat restoration efforts. Each floating and submersed aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). These numbers are then used to calculate the floristic quality index (FQI). A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake, and better plant diversity. Nonnative species are included in the FQI calculations for Lake County lakes. The FQI scores of 86 lakes measured from 2000 through 2003 ranges from 0 to 37.2, with an average of 14.7. Fairfield Marsh has a floristic quality of 7.5, indicating a lower than average aquatic plant diversity.

Table 3. Aquatic and shoreline plants on Fairfield Marsh, May – September 2003.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna* sp.
Eurasian Water Milfoil	*Myriophyllum spicatum*
Sago Pondweed	*Stuckinia pectinatus*
Shoreline Plants	
Velvet Leaf^	*Abutilon theophrasti*
Teasel^	*Dipsacus sylvestris*
Purple Loosestrife^	*Lythrum salicaria*
Reed Canary Grass^	*Phalaris arundinacea*
Common Reed^	*Phragmites australis*
Smartweed	*Polygonum* sp.
Cattail	*Typha* sp.
Wild Grape	*Vitus* sp.
Trees/Shrubs	
Silver Maple	*Acer saccharinum*
Willow	*Salix* spp.
Buckthorn^	*Rhamnus* sp.

^Exotic species

Of note was the discovery of the milfoil weevil (*Euhrychiopsis lecontei*) in the marsh in June. This very tiny insect serves as a biological control for EWM, and when present in large enough numbers, can cause significant damage to milfoil beds. Although EWM is not considered to be in nuisance populations in Fairfield Marsh at this time, the possibility exists that this species could expand in the marsh. If the EWM does expand, the weevils may play an important role in the control of this plant because there are no other plant management techniques being employed in the marsh. The reasons for weevil success or failure in controlling EWM are still being researched and there are no definite answers at this time. Research has shown that approximately 1-2 weevils per stem are needed in order to see significant damage and decline of a EWM bed.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

In October 2003, we assessed the shoreline of Fairfield Marsh. See Appendix B for a discussion of the methods used. About 56% of the shoreline is classified as undeveloped. Figure 2 shows the three shoreline types: buffer (59% of the total shoreline), wetland (31% of the total shoreline) and lawn (11 % of the total shoreline). Typically, buffer and wetland shoreline types protect the shoreline from erosion and provide good quality wildlife habitat. Shorelines with manicured lawns to the water's edge can erode because the short root system of turfgrass does not withstand eroding forces such as wave action and fluctuating water levels. No erosion was noted along the shoreline at this time. Although the areas with manicured lawns are not eroding now, the owners of these parcels should still consider installing buffer strips with native plants to further enhance the surrounding wildlife habitat. Exotic shoreline plant species are present along approximately 27% of the shoreline (Figure 3). These included purple loosestrife, reed canary grass, common reed, and buckthorn shrubs. These species are especially detrimental, as they can crowd out native, beneficial plants used by wildlife. Their removal is recommended.

INSERT FIGURE 4, SHORELINE TYPES

INSERT FIGURE 5, INVASIVES

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Table 5 lists the wildlife species observed at Fairfield Marsh. An excellent variety of birds were noted during 2003, including the Forster's tern, an Illinois endangered species. Juvenile Forster terns were noted, indicating that these birds were probably nesting in the area. A good mix of songbird species were observed on and around the marsh throughout the summer, also. The marsh offers good habitat along its shoreline with the buffer and wetland plants, which are better than manicured lawn in terms of habitat quality. However, some shoreline plants are invasive exotic species, which can compromise wildlife habitat. This shoreline could offer even better habitat quality if these plants were removed and replaced with native vegetation. Table 6 in Appendix A lists beneficial, native plant species that are commonly used for shoreline plantings.

Residents were concerned that the habitat as a whole may degrade because the marsh suffered such an extensive water loss. However, in early April of 2004, the water level had increased to within 4 inches of the May 2003 water level. Residents have also noted several species of migratory waterfowl have been using the area in spring of 2004. The water loss also resulted in the deaths of several hundred fish such as bluegill and crappie. Some fish were flushed out of the system as the water drained from the marsh. Others were victims of hunting egrets and herons, which were able to grab them easily as they were isolated in pockets of shallow water. Some carp were also lost, although this is a positive aspect, since carp were a problem previously in the marsh.

Table 5. Wildlife species observed on Fairfield Marsh, May – September 2003.

Birds	
Pied-billed Grebe	*Podilymbus podiceps*
Double-crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Forster's Tern*	*Sterna forsteri*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Mourning Dove	*Zenaida macroura*
Common Flicker	*Colaptes auratus*
Eastern Kingbird	*Tyrannus tyrannus*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*

Table 5. Wildlife species observed on Fairfield Marsh, May – September 2003, cont'd.

Marsh Wren	*Cistothorus palustris*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Northern Oriole	*Icterus galbula*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*
Mammals	
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
White-tailed Deer	*Odocoileus virginianus*
Amphibians	
Green Frog	*Rana clamitans melanota*
Reptiles	
Painted Turtle	*Chrysemys picta*
Eastern Spiny Softshell Turtle	*Apalone spinifera*
Mussels	
Fatmucket	*Lampsilis siliquoidea*

* Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Poor Water Clarity*

  Fairfield Marsh suffers from poor water clarity that is caused by the high total suspended solids in the water, most of which is sediment. Wind, wave and carp action add to the solids in the water by disturbing the bottom. Another contributor to the total suspended solids in the water was the algae that bloomed in August and September.

- *High Nutrient Concentrations*

  Fairfield Marsh has high nutrient concentrations. Total phosphorus concentrations over the season averaged more than five times higher than the Lake County median, and total Kjeldahl nitrogen was over four times higher than the Lake County median. Some nutrient inputs may also be entering from the Chesapeake Trail subdivision, via its detention basins. Nutrients were also concentrated in the marsh later in the season after the water loss.

- *Lack of Aquatic Plants*

  The marsh has few aquatic plants, and a low diversity of plant species. This results in a lack of habitat for aquatic life. The root systems of aquatic plants can also assist in stabilizing the sediment, making it less likely that it will be resuspended into the water column from wind and wave action. Emergent species would be the type of plants to begin with in establishing native species.

- *Invasive Shoreline Plant Species*

  Exotic shoreline plant species grew along approximately 27% of the shoreline. These included purple loosestrife, reed canary grass, common reed, and buckthorn shrubs. These species are especially detrimental, as they can crowd out native, beneficial plants used by wildlife.

- *Carp*

  Before the water loss, carp were thriving in the marsh, and were one factor in resuspending the bottom sediment, which resulted in poor water clarity. The poor water clarity and suspended sediment are two more factors that were probably repressing the growth of some native plants. Without the carp, there is the possibility that a native seed bank could begin to grow again. The removal of carp can allow aquatic plants to grow and help further stabilize the sediment. The challenge would lie in that if aquatic plants do begin to establish themselves, Eurasian water milfoil could be the dominant plant, which could create another management issue. However, in the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), can be negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), 2.022 gal/AF is required. In waters with high turbidity such as Fairfield Marsh, the ppm may have to be higher. The volume of the marsh is estimated at 76.2 acre/feet. The minimum amount needed for the marsh is approximately (76.2 acft) x (2.022 gal/acft) = 154 gallons. The cost per gallon ranges from $50-75, which would total $7700-11550.

POTENTIAL OBJECTIVES FOR FAIRFIELD MARSH MANAGEMENT PLAN

I. Eliminate or Control Exotic Species
II. Control Excessive Numbers of Carp
III. Reestablish Native Vegetation

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Eliminate or Control Exotic Species

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

Purple loosestrife is responsible for the “sea of purple” seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants, its roots exude a chemical that discourages other plant growth, and it is quick to become established on disturbed soils. Reed canary grass is an aggressive plant species that was introduced as a shoreline stabilizer. It is found on lakeshores, stream banks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

The 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, but its removal early on is best. 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.

At Fairfield Marsh, the presence of aggressive exotic shoreline plant species occurred most notably along the western shoreline. The exotic species are listed in Table 3 and include buckthorn shrubs, reed canary grass, common reed, and purple loosestrife.

Option 1: No Action

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics whenever possible. Table 6 in Appendix A lists several native plants that can replace these invasive species.

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 affected.

Costs

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

Option 2: Biological Control

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

Recently two leaf beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils, one a root-feeder (*Hylobius transversovittatus*) and one a flower-feeder (*Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on the leaves, roots, or flowers of purple loosestrife, eventually weakening and killing the plant or, in the case of the flower-feeder, prevent seeding. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly reduce plant densities. The insects are host specific, meaning that they will attack no other plant but purple loosestrife. Currently, the beetles have proven to be most effective and are available for purchase. There are no designated stocking rate recommendations, since using bio-control insects are seen as an inoculation and it may take 3-5 years for beetle populations to increase to levels that will cause significant damage. Depending on the size of the infested area, it may take 1,000 or more adult beetles per acre to cause significant damage.

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

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

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

Costs
The New York Department of Natural Resources at Cornell University (email: bb22@cornell.edu, 607-255-5314, or visit the website: www.invasiveplants.net) sells overwintering adult leaf beetles (which will lay eggs the year of release) for $1 per beetle and new generation leaf beetles (which will lay eggs beginning the following year) at $0.25 per beetle. The root beetles are sold for $5 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (INHS; 217-333-6846). The INHS also conducts a workshop each spring at Volo Bog for individuals and groups interested in learning how to rear their own beetles.

Option 3: Control by Hand
Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass,

can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth is common. 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.

<u>Option 4: Herbicide Treatment</u>

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 impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides 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 an herbicide-soaked device. Trees are normally treated by cutting off a ring of bark around the trunk (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

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

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

Costs
Two common herbicides, triclopyr (sold as Garlon ™) and glyphosate (sold as Rodeo®, Round-up™, Eagre™, or AquaPro™), are sold in 2.5 gallon jugs, and cost approximately $200 and $350, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. A girdling tool costs about $150.

Objective II: Control Excessive Numbers of Carp

A frequent problem that plagues many of the lakes in the County is the presence of common carp (*Cyprinus carpio*). Common carp were first introduced into the United States from Europe in the early 1870's, and were first introduced into Illinois river systems in 1885 to improve commercial fishing. The carp eventually made their way into many inland lakes and are now so widespread that many people do not realize that they are not native to the U.S.

Carp prefer warm waters in lakes, streams, ponds, and sloughs that contain high levels of organic matter. This is indicative of many lakes in Lake County. Carp feed on insect larvae, crustaceans, mollusks, and even small fish by rooting through the sediment. Immature carp feed mainly on small crustaceans. Because their feeding habits cause a variety of water quality problems, carp are very undesirable in lakes. Rooting around for food causes resuspension of sediment and nutrients, which can both lead to increased turbidity. Additionally, spawning, which occurs near shore in shallow water, can occur from late April until June. The spawning activities of carp can be violent, further contributing to turbidity problems. Adult carp can lay between 100,000 –500,000 eggs, which hatch in 5-8 days. Initial growth is rapid with young growing 4 ¾" to 5" in the first year. Adults normally range in size from 1-10 lbs., with some as large as 60 lbs. Average carp lifespan is 7-10 years, but they may live up to 15 years.

There are several techniques to remove carp from a lake. However, rarely does any technique completely eradicate carp from a lake. Commonly, once a lake has carp, it has carp forever. However, it is up to the management entity to dictate how big the problem is allowed to become. Rotenone is the only reliable piscicide (fish poison) on the market at this time, but it kills all fish that is comes into contact with. Currently, there is a rotenone laced baiting system that can selectively remove carp. While the process is a step in the right direction, several factors still need to be worked out in order for it to be a viable alternative to the whole lake treatment. Until this baiting technique is further developed and produces consistent results, we do not recommended it at this time.

Option 1: No Action

By following a no action management approach, nothing would be done to control the carp population of the lake. Populations will continue to expand and reach epidemic proportions if they do not already exist.

Pros

There are very few positive aspects to following a no action plan for excessive carp populations. The only real advantage would be the money saved by taking no action.

Cons

There are many negative aspects to a no action management plan for carp management. The feeding habits of carp cause most of the associated problems. As carp feed they root around in the lake sediment. This causes resuspension of sediment and nutrients. Increased nutrient levels can lead to increased algal blooms, which, combined with resuspended sediment, lead to increased turbidity (reduced clarity). As a result there is a decrease in light penetration, negatively impacting aquatic plants. Additionally, the rooting action of the carp causes the direct disruption of aquatic plants. Loss of aquatic plants can further aggravate sediment and nutrient loads in the water column due to loss of sediment stabilization provided by the plants. Additionally, the fishery of the lake may decline and/or become stunted due to predation issues related to decreased water clarity and loss of habitat. Other wildlife, such as waterfowl, which commonly forage on aquatic plants and fish, would also be negatively impacted by the decrease in vegetation.

The loss of aquatic plants and an increase in algae will drastically impair recreational use of the lake. Swimming could be adversely affected due to the increased likelihood of algal blooms. Swimmers may become entangled in large mats of filamentous algae, and blooms of planktonic species, such as blue-green algae, can produce harmful toxins and noxious odors. Fishing would also be negatively affected due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer from an increase in unsightly algal blooms, having an unwanted effect on property values.

Costs
There is no cost associated with the no action option.

<u>Option 2: Rotenone</u>
Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into CO_2 and H_2O) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone. However, some organisms are effected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. More sensitive nonfish species include frogs and mollusks but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption. Additionally, warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

Rotenone is available in 5% and 2.5% concentrations. Both concentrations are available as synergized formulations. The synergist (piperonal butoxide) is an additive that inhibits fish detoxification of rotenone, making the rotenone more effective. Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunately, concentrations to remove undesirable fish, such as carp, bullhead and green sunfish, are high enough to kill more desirable species such as bass, bluegill, crappie, walleye, and northern pike. Therefore, it is difficult to selectively remove undesirable fish while leaving desirable ones. Typically, rotenone is used at concentrations from 2 ppm (parts per million) – 12 ppm. For removal of undesirable fish (carp, bullhead and green sunfish) in lakes with alkalinities in the range found in Lake County, the target concentration should be 6 ppm. Sometimes concentrations will need to be increased based on high alkalinity and/or high turbidity. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are <50^{o}F. Under these conditions, rotenone is not as toxic as in warmer waters but it breaks down slower and provides a longer exposure time. If treatments are done in warmer weather they should be done before spawn or after hatch as fish eggs are highly tolerant to rotenone.

Rotenone rarely kills every fish (normally 99-100% effective). Some fish can escape removal and additional rotenone treatments need to occur about every 10 years. At this point in time, carp populations will have become reestablished due to reintroduction and reproduction by fish that were not removed during previous treatment. To ensure the best results, precautions can be taken to assure a higher longevity. These precautions include banning live bait fishing (minnows bought from bait stores can contain carp) and making sure every part of the lake is treated (i.e., cattails, inlets, and harbored shallow areas). Restocking of desirable fish species may occur about 30-50 days after treatment when the rotenone concentrations have dropped to sub-lethal levels. Since it is best to treat in the fall, restocking may not be possible until the following spring. To use rotenone in a body of water over 6 acres a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois, as it is a restricted use pesticide. If this method is considered, the water elevation should become stabilized in Fairfield Marsh in order to calculate the proper dosage.

Pros

Rotenone is one of the only ways to effectively remove undesirable fish species. This allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. By removing carp, sediment will be left largely undisturbed. This will allow aquatic plants to grow and help further stabilize the sediment. As a result of decreased carp activity and increased aquatic plant coverage, fewer nutrients will be resuspended, greatly reducing the likelihood of nuisance algae blooms and associated dissolved oxygen problems. Additionally, reestablishment of aquatic plants will have other positive effects on lake health and water quality, increases in fish habitat and food source availability for wildlife such as waterfowl.

Cons

In the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), are also negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. Furthermore, the IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species. Another drawback to rotenone is the cost. Since the whole lake is treated and costs per gallon range from \$50.00 - \$75.00, total costs can quickly add up. This can be offset with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

Costs

As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), 2.022 gal/AF is required. An estimate for the minimum amount needed for Fairfield Marsh is given below.

(Lake volume in Acre Feet)(2.022 gallons) = Gallons needed to treat lake
(76.2 acft) x (2.022 gal/acft) = 154 gallons.

(Gallons needed)(Cost/gallon*) = Total cost

*Cost/gallon = $50-75 range
The cost per gallon ranges from $50-75, which would total $7700-11550.

The dosage for Fairfield Marsh may need to be higher, since in waters with high turbidity and/or planktonic algae blooms, the ppm may need to be increased. An IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

Objective III: Reestablish Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control. 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 if using submersed aquatic plants. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis. Since turbidity is high in Fairfield Marsh, emergent species would be the best to start with instead of submersed plants.

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

Pros

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

Cons

There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control.

However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant is used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 6 in Appendix A for plant pricing. Costs will be higher if a consultant/nursery is contracted for design and labor. Additional costs will include herbivory protection materials such as metal posts and protective wire mesh (chicken wire).