Wisconsin Lake Planning Grant Report

Half Moon Lake

Polk County, Wisconsin

Prepared for

Half Moon Lake Protection & Rehabilitation District

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HALF MOON LAKE
PLANNING GRANT REPORT
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HALF MOON LAKE
LAKE PLANNING GRANT REPORT

I.0 INTRODUCTION

This second study of Half Moon Lake in Polk County, Wisconsin, was commissioned by the electors of the Half Moon Lake Protection and Rehabilitation District at their annual meeting held on August 24, I996. The study is part of a long range plan to preserve the quality of the water in the lake and to preserve and enhance the unique characteristics of the area.

1.1 EARLIER STUDY

The earlier study (I994) had been commissioned to investigate the condition of the lake and identify potential projects for protection of the lake. The purpose of the project was to compile all available information about Half Moon Lake, to inventory the hydrologic properties of the watershed, to analyze and assess the current condition of the lake water quality, to determine the feasibility of management options within the Harder Creek watershed and to prepare a guide for the management of the lake through policy statements, objectives and management principles. The conclusion reached from the study was that the quality of the water was very good and had not materially changed during the period when reports on testing were available. The report identified the primary sources of the water coming into the lake as being from Harder Creek, Tamarack Bay and the general runoff from lands around the lake, and reported no identifiable sources of pollution other than nonpoint sources from the agricultural lands surrounding the lake. The study focused on measuring the amount of phosphorus presently concentrated in the lake and the amount of phosphorus coming into the lake. Phosphorus is the ingredient that generally causes the excessive growth of algae in a body of water.

I.2 RECOMMENDATION FROM I994 STUDY

A recommendation from the I994 study was that efforts be made to preserve the wetlands around the lake and especially the Harder Creek area which supplies over half of the water flowing into Half Moon Lake.

I.3 PROJECT SCOPE AND DESCRIPTION OF DELIVERABLES

The Half Moon Lake Protection and Rehabilitation District is developing a long range plan for the protection/acquisition of critical wetlands in the Half Moon Lake watershed. This study was undertaken to do the following:

a. Prepare an analysis and evaluation of the four principal wetlands in the watershed which are adjacent to Harder Creek, Tamarack Bay, Nelson Bay and Baldwin Bay.
b. Determine the relationship of the four areas to the total lake ecosystem.
c. Prepare an analysis of the wetland laws and their relationship to the lake district goals.
d. Determine the best protection alternatives including financing and funding alternatives.
e. Determine a reasonable time line for the installation or utilization of protection alternatives that will provide protection to the wetland areas.

1.4 REASON FOR STUDY

A big share of the surface water draining into Half Moon Lake comes through Harder Creek and through the watershed area surrounding Tamarack Bay. These areas may be vulnerable to run off from surrounding areas in the future if they are not protected. Harder Creek is also affected by a township road that is subject to flooding caused by beaver dams. Wetlands adjacent to Harder Creek are critical to the filtration of water before it enters the lake. There are unique areas of peatland (bog and fen) which need to be preserved for aesthetic reasons. Areas of peatland are found in Tamarack Bay, Nelson Bay and Baldwin Bay. There are also aquatic plant beds in the lake which are important spawning areas for fish that need to be protected.

1.5 PURPOSES OF STUDY

Subsequent to the Meeting of the electors at which this Study was authorized, the Board provided to the electors a statement setting out the purposes of the Study. It stated as follows:

Purposes:

1. To analyze the wetland areas surrounding the lake.

    a. Determine legal descriptions and size
    b. Determine the ownership of each tract
    c. Determine their function in relation to the lake
    d. Determine their assessed value for tax purposes and their market value.
    e. Determine in terms of priority which are most important in preserving lake quality.

2. To prepare an analysis of the current federal, state, county and township laws that affect the use of the wetland areas.

    a. Review zoning laws
    b. Review federal and state wetland laws
    c. Determine accessibility of wetland area and practicality of development
    d. Determine what can reasonably be expected to occur if no action is taken by the lake district

3. To determine best method of protecting the wetland areas

    a. By acquisition of fee title
    b. By acquisition of conservation easements
    c. Study effect of real estate taxation on parcels encumbered by conservation easements
    d. Determine what governmental body should hold title to the ownership rights in the wetland areas (state, county, township or lake district)

4. To determine what would be a reasonable time line for acquiring the property rights

    a. When the property becomes available
    b. Make a concerted effort to acquire the lands over the next years by purchase
    c. Use of condemnation

5. To determine available financing to acquire wetlands

   a. Use of district funds raised through taxation
   b. State, federal and local programs that have funds available

2.0 PARTICIPANTS IN THE STUDY

The following persons and agencies participated in this study and in the preparation of this report:

a. Robert Bursik, biologist, who spent time in the field studying the fauna and flora in the 4 wetland areas and spent time preparing this report.

b. Officer Ed Slaminski of the Department of Natural Resources who walked the areas and provided input as to the shoreline delineation in the areas of Nelson Bay, Baldwin Bay and Tamarack Bay.

c. Gary Spaniel, Zoning Administrator for Polk County.

d. Members of the Board of Commissioners. Members of the board walked the areas under study, attended conferences and reviewed laws on the subjects of zoning and wetland laws, attended conferences on the subject of conservation easements and reviewed information provided by non-profit conservancy organizations in relation to acquisition of conservancy easements, conferred with representatives of Polk County Parks Board, Polk County Land Conservation Department and the Polk County Zoning office, reviewed tax laws related to tax benefits from gifting of land to governmental or non-profit organizations, secured photos and maps of the area from the Polk County Land Information Office, secured property owners' records from the Polk County Treasurer's office and the Polk County Recorder's office and helped in the writing of this report.

3.0 OVERVIEW OF WETLAND AREAS UNDER STUDY

This study has focused on four wetland areas around the lake, three of which adjoin the lake and one which adjoins Harder creek. Three of the wetland areas, Tamarack Bay, Nelson Bay and Baldwin Bay, include floating peatland that are particularly unique and worthy of protection. The four wetlands are identified on Figure A as follows:

Wetland 1 - Harder Creek Bottomland. This includes the portion of Harder Creek extending north from Half Moon Lake to Dau road, a distance of one-fourth of a mile. The area under study includes the creek bed and the adjoining bottomlands affected by the creek.

Wetland 2 - Tamarack Bay. This includes the open body of water and the surrounding wetlands west of the main body of Half Moon Lake which is connected by a small channel not generally passable by boats larger than canoes. There are areas of floating peatland immediately surrounding Tamarack Bay similar to those in Nelson Bay and Baldwin Bay. These floating habitats are below the ordinary high water marks(OHWM) and are part of the lake. Non-floating peatland and marsh wetlands adjacent to and above the OHWM are simply classified as wetlands. Jurisdictional wetland is an area with a water table at, near or slightly above the soil surface for significant (generally 2 weeks or longer) period during the growing season. (Army Corps of Engineers, I987).

Wetland 3 - Nelson Bay. This includes the area of the lake known locally as Nelson Bay. It has been named after the Nelson family because ownership of the land along the shoreline has been in the Nelson family for over l00 years. It is currently owned by two daughters in the Nelson family. There is an area of floating peatland immediately adjacent to the lake which is below the OHWM and thus part of the lake and an extensive fixed peatland area adjacent to and above the OHWM which is jurisdictional wetland but is not part of the lake.

Wetland 4 - Baldwin Bay. This includes the area of the lake known locally as Baldwin Bay because it has been in the Baldwin family for many years. There is an area of floating peatland which is below the OHWM and thus part of the lake and a wetland area adjacent to and above the OHWM.

4.0 WETLAND EVALUATION IN THE HALF MOON LAKE WATERSHED

4.1 INTRODUCTION

Field investigations on the plant community composition and functional values of four wetlands in the Half Moon Lake, Polk County, Wisconsin watershed were carried out between October 1996 and September 1997 for the Half Moon Lake Protection and Rehabilitation District. Robert Bursik was the principle field investigator and report writer. Field assistance was provided at various times by David Butler, Sherm Gardner, Steve McMahon, and Cheryl Bursik.

The purposes of this study were several-fold:

a. Identify the biotic attributes of each area, with particular reference to the plant communities and their functional aesthetic, recreational, and wildlife habitat values.

b. Delineate the watershed of each of the wetlands of interest.

c. Identify land use within each wetland watershed that could adversely affect the water quality of Half Moon Lake.

d. Ascertain the importance of each wetland area for attenuating nutrients and sediments that would otherwise enter Half Moon Lake.

e. Identify interpretive interests and potential of each site. Note possible affects, if any, of making the areas available to public uses such as hiking and wildlife viewing along interpretive trails or boardwalks.

f. Outline areas surrounding these wetlands that should be considered in acquiring easments or fee title for the purposes of protecting, maintaining, and improving the water quality of Half Moon Lake.

4.2 STUDY SITE DESCRIPTION AND BACKGROUND

The Half Moon Lake watershed is approximately 5,624 acres in size. Land use data and water quality and habitat recommendations are available from a 1996 water quality appraisal prepared by the Wisconsin Department of Natural Resources (WDNR) and the Balsam Branch Priority Watershed Plan prepared by the Polk County Land Conservation Department. The following information is summarized from these reports. The watershed consists of: 1,856 acres (33%) are agricultural land

(Photo 1A and 1B), 1,538 acres (27%) are forested (Photo 2), 1,591 acres (28%) are wetland (Photo 3), and 638 acres (11%) are in residential development (Photo 4). There is an intermittent stream that enters Tamarack Bay from the northwest (Tamarack Creek) and one permanent inlet, Harder Creek, that enters the north edge of the lake. Harder Creek exits the south end of the lake and feeds Balsam Lake to the south.

The water quality of the lake is considered good, although algal blooms are frequent in the early summer (Photo 5; 1997 algal bloom in Tamarack Bay). The lake supports a quality walleye, largemouth bass, and panfish fishery. Northern pike are present, but not particularly common.

WDNR (1996) has made recommendations to reduce phosphorus loads coming into Half Moon Lake and enhance fish and wildlife habitat. Phosphorus is the limiting nutrient to algae and plant growth in lakes and streams. Increased phosphorus concentration causes increased algae and aquatic plant growth. According to WDNR lake models for phosphorus, agricultural land contributes the most per hectare (0.5 kg P/ ha/yr) for a total of 390.2 kg/yr in Half Moon Lake. Forested areas contribute 0.1 kg/ha/yr for a total of 102.4 kg/yr. Wetlands contribute only 0.05 kg/ha/yr for a total of 8.5 kg/yr, and residential land contributes 0.4 kg/ha/yr for a total phosphorus load contribution to Half Moon Lake of 92.4 kg/year. Agricultural land and residental land cover only 44% of the watershed and yet they contribute a combined 81% (484 kg/yr) of the incoming phosphorus from the surrounding watershed, while wetlands and forested lands, which cover 56% of the watershed, contribute only 19% (110kg/yr) of the total phosphorus (WDNR 1996).

The Balsam Branch Priority Watershed Plan recommends reducing phosphorus inputs from shoreline development through practices such as using porous paving materials for roads and driveways, upgrading and maintaining waste disposal systems, using low or zero phosphorus fertilizers on lawns and gardens, and planting/restoring shoreland habitat buffer strips . Restoring shoreland buffer strips will also assist in the enhancement of fisheries and wildlife habitat goal laid out by the watershed plan. Additionally, the plan recommends restoring wetlands, and enhancing wetland and grassland habitats within the watershed, both of which would serve to meet both recommended goals. Finally, the plan suggests protecting existing wetlands within the Half Moon Lake watershed to protect water quality from further degradation due to development within and adjacent to these wetlands. This study relates to this last recommendation.

Four priority wetlands immediately adjacent to Half Moon Lake and its two inlets were surveyed. The plant communities supported in each wetland, the functional values of each site, and the role that each plays in maintaining and protecting the water quality of Half Moon Lake were investigated and are described below. Also discussed is the current level of jurisdictional protection offered to each of these sites.

4.3 WETLAND AND UPLAND BUFFERS - WHY HAVE THEM?

When considering establishment of wetland buffer strips or the purchase of wetland and upland buffers to protect or improve water quality of a lake, stream, or river; several questions surely arise. What is the value of wetland and upland buffers around lakes and streams? Do they actually serve to protect or improve water quality? If so, are the costs worth it? Do these buffers have other values for recreation, education, aesthetics, or wildlife habitat? All these questions should be addressed before an agency or private group such as a Lake Protection District or Lake Association engages in such a potentially costly endeavor. Because this report concerns evaluating wetland sites for future acquisition considerations, a review of the literature on the subject was conducted.

Lake ecosystems are sensitive. Changes in lake biota can often be observed following changes in factors such as nutrient concentrations in amounts as low as one or a few parts per million. Lakes are the bowels of the landscape, receiveing water from creeks or rivers and from surface runoff that was not absorbed by adjacent upland or wetland soils. Runoff entering a lake contains more than water; it also carryies sediments and nutrients that can have profound effects on the lake ecosystem and its important attributes such as fisheries, water clarity, and quantity of aquatic plant growth. Land use practices that contribute sediments and nutrients (particularly agriculture and housing developments), therefore will negatively impact water quality of a lake, such as Half Moon Lake, while naturally vegetated forest, grassland, and wetland buffers around the lake and tributary creeks will decrease or prevent sediment and nutrient inputs.

Buffer strips, naturally vegetated (untilled and preferably ungrazed or lightly grazed) uplands and/or wetlands along lakes, streams, and rivers, can play a vital role in slowing the flow of water toward a surface water body, catching sediments, and taking up nutrients such as phosphorus before they get into the surface water. By attenuating the nutrients and sediments, buffer strips effectively improve or maintain water quality of rivers, lakes, and streams. At the same time buffer strips are an important habitat for many terrestrial, aquatic, and wetland plant and animals species that depend on such habitats through all or part of their life cycles (Barling and Moore 1994).

The width of a buffer strip required to protect water quality can vary. Several studies have indicated that naturally vegetated areas 75 to 100 feet wide can effectively protect a stream from excessive sedimentation and nutrient runoff from uplands while decreasing the potential for stream bed erosion, all of which degrade downstream water quality (Cormack 1949; Erman and others 1977). Borg and others (1988) found that reducing the width of a buffer strip from 200 to 100 meters or 100 to 50 meters had little, if any effects on water quality. Total removal of the buffer strip to the edge of the creek, however, led to changes in the creek channel and to algae blooms in downstream lakes and ponds. Castelle and others (1994) in an exhaustive review of the literature regarding buffer strips concluded that a 15 meter (50 feet) wide naturally vegetated buffer is the minimum size required to assure protection of water quality in lakes, streams, and wetlands, although they found the ideal width for sediment removal to be nearly 75 feet and the ideal width for nutrient (phosphorus) removal to be approximately 100 feet.

Numerous studies have suggested that naturally vegetated buffer strips effectively remove sediments from incoming water. Sediment trapping usually occurs in the first 20 feet of the buffer strip with large-sized sand and silt particles settling out first and smaller clay particles being more slowly trapped (i.e., further into the buffer strip) (Barfield and others 1977; Barfield and others 1979; Hayes and Hairiston 1983). The fact that most of the incoming phosphorus is tied up in clay particles (the last to settle out) indicates that adequately wide buffer strips must be maintained to assure phosphorus attenuation (Barling and Moore 1994). Clearing of wetland vegetation along lakes, rivers, and creeks for residential or agricultural development greatly lowers the threshold needed to cause catastrophic change in water quality while increasing the severity of effects when the occasional torrential rainstorm or rapid snow melt occurs (Barling and Moore 1994). Other values of buffers include moderation of stormwater runoff which decreases the rate of flow, thereby increasing the rate of infiltration of sediments and nutrients (Broderson 1973).

Naturally vegetated plant communities adjacent to lakes and creeks can trap nutrients either by filtering them out or by uptake of the nutrients such as phosphorus by plants (Madison and others 1992). Madison and others (1992) along with other studies have documented significant nutrient

reductions in lakes and creeks by naturally vegetated buffer strips as narrow as 15 meters (approximately 50 feet) wide. Vanderholm and Dickey (1979) found that much wider buffer strips were required to attenuate nutrients and manure coming off of feed lots where slopes were steeper.

Buffer strips along creeks and rivers can effectively moderate water temperatures along the edge. A number of species require such temperature moderation for survival (Barton and others 1985). Habitat diversity is also maintained where well-vegetated buffers are in place adjacent to rivers, creeks, and lakes. Many species depend on naturally vegetated uplands adjacent to aquatic areas to complete their life cycles. Examples include many amphibians (frogs, toads, salamanders) osprey, and wood ducks. Naturally vegetated habitats along aquatic ecosystems are also critical for the movement of wildlife species from one area to another, particularly where the adjacent uplands are characterized by heavy urban or agricultural development (Castelle and others 1994).

Land purchases or acquisition of conservation easements can protect wetland areas adjacent to Half Moon Lake from development or from impact by detrimental land use activities in adjacent uplands. Gaining control of land through purchase or easement could allow the Half Moon Lake Protection and Rehabilitation District to restore wetlands in the watershed, take highly erodable agricultural land out of production, or prevent grazing or land clearing in the vegetated corridors along Half Moon Lake and its tributaries. These are worth-while undertakings to assure the long-term protection of the lake's water quality.

4.4 WETLAND DESCRIPTIONS

Wetland 1 - Harder Creek Bottomland

Harder Creek enters Half Moon Lake from the north in the SE 1/4 of section 23, T35N, R17W. It exits Half Moon Lake in the SW 1/4 of section 25, T35N, R17W (Figure 1; Photo 6 & 7). Harder Creek has the largest subwatershed of Half Moon Lake, covering nearly 2500 acres. More than half of the lake's water comes from Harder Creek, making watershed protection along the creek a priority for water quality protection (Barr Engineering 1994). Vegetation along the lower 0.3 mile of Harder Creek was surveyed in October 1996 and July 1997 from Dau Road (in the north) to the outlet in Half Moon Lake. Richard McClain owns the northern half (40 acres) of the land that was surveyed and Richard Kaiser the southern half (40 acres).

The Wisconsin Wetland Inventory (WWI) classifies the bottomlands (low areas along the creek that are prone to flooding and characterized by wetland vegetation) along this stretch of Harder Creek as T3/8K - deciduous and conifer forested swamp on wet soils. This classification applies to only approximatly 50% of the bottomlands. The other half of the bottomlands are covered by persistent graminoid marsh (E3K in the WWI classification) dominated by grasses and grass-like plant species such as sedges and rushes, over mineral to mucky soils that are saturated to shallowly inundated.

Photo 8 shows the mosaic of communities found in the Harder Creek bottomlands with the graminoid (grasses and grass-like plants) marsh community dominating the frequently flooded creek margins while the wet margins adjacent to the upland forests are characterized by black ash (*Fraxinus nigra*) and tag alder (*Alnus rugosa*) swamp with a few patches of tamarack (*Larix laricina*). At the time of the Wisconsin Wetland Inventory for this area (early 1980s), the entire bottomland was forested swamp. Beaver activity in the interim has killed many of the trees and favored the graminoid marsh vegetation (see Photo 9 to see the many dead, standing trees throughout the graminoid marsh).

The wettest marsh zone, which occurs immediately adjacent to the creek channel, is covered by dense stands of reed canary grass (*Phalaris arundinacea*), rice cut grass (*Leersia oryzoides* - Photo 10), arrowhead (*Sagittaria latifolia* - Photo 11), jewelweed (*Impatiens biflora* - Photo 12), beggarticks (*Bidens* spp.), blue joint reedgrass (*Calamagrostis canadensis*), several sedge species (*Carex lacustris, C. crinita, C. utriculata*), narrow leaf cattail (*Typha angustifolia* - Photo 13) and soft stem bulrush (*Scirpus validus*) (see Photo 14 for a view of this habitat). Possibly the showiest species found in the Harder Creek bottomland, purple fringed orchid (*Habenaria psychodes*, Photo 15) occurs on sand and gravel bars along the creek. Its occurrence in the area is infrequent, however, it is not considered rare in the state. White water lilies (*Nymphaea odorata*), yellow water lilies (*Nuphar variegatum*), pondweeds (*Potamogeton* spp.), and other aquatic plants are growing in sluggish stretches of the creek (Photo 16).

The permanently to frequently inundated marsh immediately adjacent to the creek grades into a seasonally flooded marsh zone that is characterized by stands of reed canary grass (*Phalaris arundinacea*), lake sedge (*Carex lacustris*), tussock sedge (*Carex stricta*), blue joint reedgrass (*Calamagrostis canadensis*), jewelweed (*Impatiens biflora*), and stinging nettle (*Urtica dioica*) (Photo 17). Much of this community is growing beneath dead trees of black ash and tamarack, which died when the area was ponded by a beaver dam.

The seasonally flooded marsh grades into swamp that is characterized by black ash (*Fraxinus nigra*), willows (mostly *Salix exigua*); tag alder (*Alnus rugosa*), and meadowsweet (*Spiraea alba*). The understory beneath the trees and shrubs is diverse and includes various sedges and several ferns (lady fern - *Athyrium felix-femina*; interrupted fern - *Osmunda claytonii*; and cinnamon fern - *Osmunda cinnamomea*) (Photo 18). Prior to beaver damming and flooding of this lower reach of Harder Creek, forested swamp dominated most of the bottomlands. In the absence of prolonged flooding, it will likely again cover most of the areas now dominated by persistent graminoid marsh.

Beaver are still active along the lower stretch of the creek. One large beaver dam exists approximately 200 yards upstream from the mouth on Half Moon Lake on the Kaiser property. Photo 19 shows the pond created upstream from the beaver dam. Beaver ponds like this slow the flow of water and allow settlement of sediments and attenuation of nutrients by aquatic plants. Despite the seemingly destructive nature of beaver damming and flooding (which kills trees), it likely has had a positive impact on lake water quality, at least in the short term. Remnants of another dam were found further north on the McClain property.

The uplands immediately adjacent to the Harder Creek bottomlands are primarily forested. Dominant tree species vary depending on the age of the stand and include bur oak (*Quercus macrocarpa*), sugar maple (*Acer saccharum*), paper birch (*Betula papyrifera*), trembling aspen or popple (*Populus tremuloides*), big tooth aspen (*Populus grandidentata*), black cherry (*Prunus serotina*), green ash (*Fraxinus pennsylvanica*), and white pine (*Pinus strobus*).

More than 10 acres of the McClain property (the northern 40 acre piece) are formerly cultivated and pastured fields that are now in the early stages of old field succession (Photo 20). The fields are dominated by pasture grasses, including timothy (*Phleum pratense*) Kentucky bluegrass (*Poa pratensis*), and redtop (*Agrostis stolonifera*). Other common species include goldenrod (*Solidago* spp.), yarrow (*Achillea millefolium*), milkweed (*Asclepias syracia*), and dandelion (*Taraxacum officionale*). Scattered trees can be seen throughout the fields along with patches of various shrubs,

indicating that recolonization of the open fields by forest species is well under way. The slopes and soil types found in these fields make them highly erodable and ill-suited to regular tillage (Soil Survey of Polk County1979).

The uplands on the east side of the Kaiser property are covered by oak forest. On the west side, the bottomland ends abruptly with a steep slope that is covered by scattered trees and shurbs. Open pasture and cultivated fields begin at the top of the slope and extend to the west. Much of the lower west side of Harder Creek including part of the open field at the top of the slope, the steep slope, and the narrow fringe of wet bottomland to edge of the creek is part of a sheep pasture. As is the case with the uplands adjacent to the McClain property, some of the farmed and pastured uplands adjacent to the creek on the Kaiser property are considered highly erodable by the Natural Resources Conservation Service.

Functional Values

Plant growth in wetlands is extremetly luxuriant due to the inflow of nutrients from adjacent uplands and an abundance of water (Tester 1995). The high productivity and high diversity of plant species and communities found in wetlands, in turn, harbor a wide array of animal species that are supported directly or indirectly by the wetland plants. It has been estimated that more than 900 plant and animal species in the United States spend a significant portion of the life cycles in wetlands (Willard 1979). Wetlands are a prime habitat for recreational development for wildlife viewing, photography, hunting, and fishing because they support a disproportionally high percentage of wildlife species, making wildlife viewing experiences more fruitful than in most upland communities. Despite this, recreational opportunities in wetlands are usually very limited. This is certainly the case in Polk County.

The mosaic of graminoid marsh and tree and shrub-dominated swamp along the surveyed stretch of Harder Creek provides an excellent mix of forage and cover for a broad diversity of wildlife species. Many of the dominant marsh sedges and grasses are heavy seed producers. During spring when much of the habitat is flooded, migrating waterfowl species will feed heavily on last season's seed crop (Fassett 1957). Most of the dominant graminoids in the marsh community are persistent, meaning the previous season's dead stems will remain standing through the winter, providing critical nesting and foraging cover for migrating waterfowl in the spring. Harder Creek also offers a combination of flowing stream channel areas with rock or gravel substrate along with sluggish margins with sandy or mucky substrate that supports floating, submergent, and emergent aquatic plant species. Different species of waterfowl prefer these different habitats.

Abundant chubs, minnows, and shiners were observed and panfish, northern pike, and largemouth bass would be expected to occur in small numbers throughout this stretch of Harder Creek. Although no sign was observed, the combined habitat and fish production of the creek make this stretch very good river otter habitat. Beaver and muskrat were observed as were other water-dependent species such as kingfishers. The bottomlands are alive with woodpecker activity due to the abundance of standing snags (dead trees), which provide foraging and nesting habitat. The woody shrubs and trees dominating the swamp habitats are browse for white tail deer, while the creek provides access to water. Harder Creek also provides a corridor for wildlife to move between the relatively wild upper regions of Harder Creek, which are covered by broad wetland complexes and adjacent forests, and the relatively developed regions around Half Moon Lake.

Plant diversity is high in the Harder Creek bottomland communities. More than 75 species were documented in the area (see Appendix 1). Many of the herbaceous species are particularly showy, including purple fringed orchid (Photo 15), joe pye weed (*Eupatorium maculosum* - Photo 21), boneset (*Eupatorium perfoliatum* - Photo 22), and swamp milkweed (*Asclepias incarnata* - Photo 23), which are among the most prized species for viewing by wildflower enthusiasts.

Access to bottomland marsh and swamp habitats along hiking trails in the area is very limited in Polk County. Of the four wetland sites surveyed for this study, this is the easiest one for developing trails because wooden or plastic boardwalks would not be necessary throughout the entire area. Trails through the Harder Creek bottomlands could be used by hikers, birders, wildlife and wildflower enthusiasts, hunters, and skiers. Access to these wetland communities would make these trails attractive to local school teachers for class field trips. Because the surrounding forests are very diverse in composition, interpretive trails could highlight the ecology of forests of the region as well as the characteristics of the bottomlands.

Water Quality Protection Values

According to the Barr Engineering Report (1994), Harder Creek provides most of the surface flow entering Half Moon Lake. Flow data taken from Harder Creek indicated that existing wetlands, lakes, and beaver ponds are effective at slowing the runoff into Half Moon Lake, thereby protecting water quality. Alterations to these habitats (or adjacent uplands) that increased the rate of flow into the lake would be expected to adversely impact lake water quality (Barr Engineering 1994). Because of the proximity to Half Moon Lake, the two properties surveyed are critical to the water quality of the lake and their eventual acquisition should be considered a priority. Because of the steep nature of the slopes in surrounding uplands, any agricultural activity, including grazing or tilling are likely to add nutrients and sediments to Harder Creek and Half Moon Lake. For this reason, aquisition options should consider not only the bottomland communities along Harder Creek, but also the adjacent uplands.

Acquisition Considerations and Potential

The wetland communities along Harder Creek themselves are protected from filling and draining under section 404 of the Clean Water Act and by various local and state ordinances. Jurisdiction of wetland uses at the local, state, and federal level are discussed in Section 7. Any legal development in wetlands requires a permit that is reviewed by the US Army Corps of Engineers (at the federal level), and/or by the Wisconsin DNR (at the state level). A recent reinterpretation of Section 404 of the Clean Water Act requires that agricultural activities, which involve draining, ditching, or filling wetlands be permitted by the United States Department of Agriculture Natural Resources Conservation Service (NRCS; formerly the Soil Conservation Service). WDNR also oversees wetland permits on agricultural lands. Although farmers must acquire a permit to drain or ditch a wetland for agricultural conversion, the permit is generally granted. Agricultural conversion of wetlands has been discouraged by making farmers ineligable for various other subsidies if they drain wetlands. Redraining and reditching of prior converted wetlands, which were drained or ditched in the past, but which occasionally must be redrained or reditched, is usually allowed without penalty, however. It is unknown whether there are prior converted wetlands on either of these properties.

In summary formal jurisdictional protection of creekbottom communities like those occuring along Harder Creek are tenuous at best, and impacts may legally be permitted either by the Army Corps of Engineers, Wisconsin Department of Natural Resources, the NRCS, or Polk County on agricultural

lands. The best way of protecting these sites and therefore protecting the water quality of Half Moon Lake is to consider outright purchase of the properties or to pursue easements that will effectively limit land use activities to those that will not impact Half Moon Lake's water quality. Ideally the steep uplands adjacent to the bottomland areas should be left in forest or planted to forest tree or native prairie species. Logging activities should be discouraged in the steep forested uplands within the drainage or done in a selective manner only during the winter when soil impacts would be avoided. Pursuing acquisition and easments of bottomlands and adjacent uplands further upstream from the two surveyed sites is also advisable. There was a considerable amount of logging activity occurring further upstream (along Dau Road) during the summer of 1997.

Some of the agricultural land on the Kaiser property and perhaps the fields on the McClain property would be eligible for the NRCS Crop Reserve Program (CRP), which pays farmers to take crop lands out of production and put them into native prairie or forest. Another program that may apply to some of the agricultural or former agricultural lands within the drainage is the Wetlands Reserve Program of the NRCS. This program pays farmers to undo drainage and ditching systems in prior converted wetlands thereby restoring the original hydrology and hastening the return of the native plant communities. According to the Polk County Land Conservation Department, a number of wetlands within the Harder Creek drainage have already been restored under this program. The role of the Half Moon Lake Protection District could be either to encourage land owners to pursue these options and facilitate the process for them or to pursue these programs after acquiring the properties.

Wetland and bog area 2 - Tamarack Bay

Tamarack Bay is actually a small lake, approximately 20 acres in size, connected to the west end of Half Moon Lake via a narrow stream channel that is navigable by canoe. It is located in the SW 1/4 of section 23, T35N, R17W. The open-water portion has been classified by the WWI as E4/A2H - wet meadow with nonpersistent vegetation (i.e., vegetation that does not remain erect or standing throughout the winter)/ floating aquatic vegetation in standing water. Tamarack Bay varies in depth from one to perhaps five feet and is completely covered by floating and rooted aquatic plants. The open water (Photo 24) has only scattered patches of emergent (coming out of the water) plants, primarily the annual grass, wild rice (*Zizania aquatica*). The vast majority of the open water is covered by floating plants, including yellow and white water lilies, floating pondweed (*Potamogeton natans*), and the free-floating (non-rooted) aquatic duckweeds (*Wolfia punctata; Lemna minor; Spirodela polyrhiza*; Photo 25). In early July, 1997, dense floating rafts of filamentous algae and cyanobacteria (blue-green algae) intermingled with the duckweeds throughout most of Tamarack Bay (Photo 24). By late July, much of the algae had died back and the duckweeds had also begun to senesce (Photo 26). Underlying this floating green mass is a dense stand of submergent aquatic flowering plants, including coontail (*Ceratophyllum demersum*); several pondweed species (including cabbageweed - *Potamogeton amplifolius; P. epihydrus; P. robbinsii, P. gramineum,* and others); waterweed (*Elodea canadensis*); water buttercup (*Ranunculus aquatilis*); and northern milfoil (*Myriophyllum sibericum*). No Eurasian milfoil (*Myriophyllum spicatum*) was observed.

The wetlands surrounding Tamrack Bay are primarily peatlands; i.e., wetlands occurring on peat soil consisting of dead plant remains. The peatland communities surrounding the bay range from bogs, which are extremely nutrient-poor and dominated by sphagnum or peat mosses (Photo 27) with relatively few, scattered trees, shrubs, or herbaceous flowering plants (Photo 28), to more nutrient-rich fens, which range from poor fens to intermediate fens, to rich fens. Poor fens are similar to bogs but with more dense growth of graminoids (grasses and grass-like flowering plants such as sedges and rushes), shrubs and trees over the top of sphagnum moss mats. Rich fens are more nutrient

rich and are dominated by graminoids (particularly sedges; Photo 29), shrubs and trees, without the solid mats of sphagnum moss. Intermediate fens are codominated by sphagnum mosses and sedges, shrubs, and certain tree species.

The peatland communities surrounding Tamarack Bay occur in several zones which differ based on water level and the dominant plant species. The margins of the lake consist of unstable, floating mats of intermediate fen vegetation which are dominated by graminoids (grass-like plants), wetland forbs (broad-leaved herbaceous flowering plants such as blue flag iris and swamp milkweed), and shrubs; with sphagnum moss covering the mats in most areas (Photo 30). Section 5 discusses the jurisdiction of these floating plant communities. Because they are below the ordinary high water mark, they are considered part of the lake and are given the same legal protections and restrictions as to their exploitation as the open water of the lake. The dominant plants of this zone include broad and narrow leaf cattail, various sedges (*Carex rostrata, C. utriculata* - Photo 29; *Carex comosa* - Photo 31;and *C. lasiocarpa*), spikerush (*Eleocharis palustris*), blue joint reedgrass, jewelweed (Photo 12), swamp milkweed (Photo 23); and tag alder. This floating intermediate fen extends from the lake edge, inland 25 to 100 yards.

Further inland from the floating fringe, the peatland remains quaking, unstable, and characterized by intermediate fen species, but it is dominated by tamarack, tag alder, bog cranberry (*Vaccinium macrocarpon* - Photo 32), sphagnum moss, bog birch (*Betula pumila* - Photo 33), and several sedges (*Carex* spp.). This zone is approximately 100 yards wide. It gives way on the upland side to tamarack, black ash and tag alder swamp on stable (not quaking) peaty to mineral soil. The swamp vegetation continues to the upland boundary on all sides of the wetland. The wetlands that are not floating are above OHWM and are protected under section 404 of the Clean Water Act. Activities in these portions of the wetland illegal unless permitted by the agencies discussed above.

Upstream along the Tamarack Creek inlet from the northwest end of Tamarack Bay, the soil of the adjacent wetland is more mineral in composition and the margins of the stream are dominated by dense stands of reed canary grass on relatively stable mineral to peaty soil (Photo 34). The reed canary grass marsh extends about 25 yards from the edge of the creek channel where it grades into a forested swamp dominated by black ash, tamarack, and tag alder.

Functional Values

Tamarack Bay contains a nice diversity of aquatic and wetland plant species (see Appendix 1) and aquatic and wetland plant communities, which are favored by a number of different wildlife species. A wide diversity of waterfowl, including mallard ducks and teal use the duckweeds, coontail, and pondweeds as a food source (Fassett 1957). Additionally, the dense stands of persistent graminoids that dominate the margins of the bay provide prime nesting cover in the spring for these and other waterfowl species, including the common loon. The bay is very important for spawning and rearing a variety of fish species. Dense schools of small to relatively nice-sized sunfish and a few crappies were observed throughout the bay. Small to large largemouth bass were common throughout, and northern pike were also observed. Because of the shallow nature of the bay, most of these fish are probably only seasonal residents in the bay and migrate to Half Moon Lake during the fall, winter, and early spring. Muskrat, beaver, bald eagle, great blue heron, painted and snapping turtles were all observed while surveying Tamarack Bay. The adjacent forested and shrub-dominated swamp provide heavy browse for white tail deer. Deer sign was abundant throughout the wetland, particularly in the swampy margins with more stable substrate. A variety of song birds were also noted. More than 75 species of aquatic and wetland plant species were observed in the bay. Of particular interest to wildflower enthusiasts are showy species like swamp milkweed and bristly

sedge, as well as edible species such as bog cranberry and wild rice. Chippewa Indians, as recently as the middle of the 20th century gathered bog cranberries in the fen and bog habitats surrounding Half Moon Lake.

The potential for developing boardwalk trails through the Tamarack Bay wetlands (accessed from adjacent roads) for interpretive hiking trails, and sportsman access for fishing and perhaps hunting is great. The swamp and fen communities surrounding the bay are relatively homogeneous so there would be little trouble in placing the trail (boardwalk). Access through the wetlands to the lake could provide people with a unique look at an undeveloped and relatively pristine shallow lake/wetland ecosystem. As elucidated above, wildlife viewing in the bay is exceptional. The quaking fen communities are very unique and intruiging and access to such habitats along boardwalks or trails are very limited to nonexistent in Polk County. Due to the quaking, unstable nature of most of the wetland communities surrounding Tamarack Bay, floating boardwalks would be necessary to provide access by foot. These could easily be made handicapped accessible as well.

Water Quality Protection Values

It is clear when driving around the margins of this wetland complex and looking at aerial photographs that most of the uplands adjacent to Tamarack Bay are either regularly tilled and row-cropped or they are part of a pasture rotation (see Photos 1A and 1B). Tamarack Creek flows intermittently and feeds into the northwest end of Tamarack Bay. Areas along the lower reach of the creek are mainly cropped or pastured to the edge. Some of this crop and pasture land has been classified as Highly Erodable Land by the NRCS. Some of the agricultural land on the east side of the creek, south of Highway G is considered highly erodable and is currently enrolled in the NRCS Crop Reserve Program (CRP). A large field in the northwest 1/4 of section 22, west of the intermittent inlet stream and to the northeast of the western lobe of the Tamarack Bay swamp is considered highly erodable and is not currently enrolled in the CRP program. Crop lands in the western half of section 22 and the southern portion of section 22 are, for the most part not classified as highly erodable and are currently being row-cropped.

Tamarack Bay is receiving large loads of nutrients (phosphorus) based on the extent of the algal/duckweed bloom observed in 1997, probably from Tamarack Creek, which enters the northern end of the bay (Photo 34). Next to Harder Creek, Tamarack Creek is the largest subwatershed for Half Moon Lake (Barr Engineering Report 1994). It is difficult to determine whether the nutrient inflow that is fueling the algae and duckweed bloom is due to "natural" geology and hydrology in the drainage, or if the current inflow of nutrients are due to cultural activities, including agricultural. The swamp and fen wetlands surrounding the bay on all sides are a minimum of 400 yards wide. In all likelihood, any nutrients coming in the form of surface or subsurface groundwater flow from those sides would be attenuated by these wetland communities (see the Why Have Buffers section above). Once nutrients enter the wetland in the swampy margins, the gradient is nearly flat and the water flow toward the bay is extemely sluggish, allowing for plenty of time for uptake of nutrients by the plants. For this reason, it seems most likely that the majority of the phosphorus feeding the algal bloom is coming in from Tamarack Creek. Further study, of course would be required to pinpoint the source for sure.

The clearly eutrophic nature of Tamarack Bay and the fact that the stream between Tamarack Bay and Half Moon Lake is very sluggish and slow-moving, makes it appear as though the retention time of the water in the bay may be such that most of the nutrients are attenuated before the water is released into Half Moon Lake. Algae and duckweed growth decreased significantly from Tamarack Bay through the channel and into Half Moon Lake. Wave action also increased precipitously along

"make or become thin"

that gradient and may have served to disperse the algae and duckweed in Half Moon Lake. Because there is an observable flow from the Tamarack Bay outlet toward Half Moon Lake, it is safe to assume that the Tamarack Creek/Bay subwatershed is a significant source of phosphorus in the lake.

Other impacts of the Tamarack Bay algal bloom on the lake may be less apparent. During early July, 1997 the density of sunfish and bass spawning beds and surface activity of fish decreased greatly in portions of the bay choked with the surface growth of filamentous algae and duckweeds compared with areas with only submerged or floating aquatic plants such as water lilies. Consequently, this nutrient inflow may have an important effect on the Half Moon Lake fishery because it creates the excessively eutrophic conditions in Tamarack Bay, which negatively impacts the spawning of important fish species.

Acquisition Considerations and Potential

The value of the floating and fixed wetland communities surrounding Tamrack Bay for attenuating nutrients and sediments and providing valuable wildlife habitat is great. Any proposed draining or filling activity in the fixed peatland and swamp wetlands that cover the outer portions of the Tamarack Bay wetland complex would be reviewed and permitted by ACOE, NRCS, WDNR, and Polk County as discussed above. Most of the peatland communities surrounding the open water of Tamarack Bay are below typical high water level of the lake (as evidenced by the fact that they are actually floating or quaking mats of vegetation over open water or over extremely soupy muck) and as such are protected under Wisconsin State and Federal laws as part of a navigable waterway, which puts them under the jurisdiction of the state, rather than the private landowners, who can have title to *land*, but not to areas below normal high water mark of a navigable waterway. Consequently, they are afforded the same legal protection as open water and alterations of the habitat for housing or other habitat-altering activities would be illegal. Perhaps one-third of the wetlands adjacent to the open water of Tamarack Bay are these quaking peatlands floating over open water. It is important to note, however, that illegal activity out of ignorance or disregard for water rights and clean water laws is always a threat to such sites and impacts in the swamp communities on stable substrate (which are above the high water level) could legally be permitted and would have a negative impact on the water quality of Tamarack Bay and subsequently on the main portion of Half Moon Lake.

The black ash and tamarack swamp forests that ring the upland margin of the wetlands of Tamarack Bay may be legally logged by property owners because they occur on fixed substrate above the ordinary high water mark. The value of the timber (and the likelihood of logging) and the impact that it might have water quality protection and wildlife habitat quality is unknown. If the logging were done with minimal soil compaction and erosion, (i.e., in the winter) the impact on runoff quality feeding Tamarack Bay would be probably be minimal.

Perhaps of greatest immediate concern in this subwatershed is land use along Tamarack Creek. Although Tamarack Creek is shown as an intermittent stream on topographic maps and aerial photos, it was found to be navigable in a canoe for more than 300 feet up the channel in July 1997. On aerial photos it shows up as a nearly permanent waterway from its mouth on the northwest end of Tamarack Bay until just south of Highway G, which is approximately 0.6 mile north of the north end of Tamarack Bay. The channel is obscure at Highway G and was difficult to locate in July and August, 1997 from the road. If one were to look for it during the spring runoff period, however, it would be readily apparent. During peak flows of snow melt periods, high levels of phosphorus and sediment can enter the system. Tamarack Creek forks just south of Highway G and the two branches continue north of Highway G approximately 0.3 mile into the extreme southeastern 1/4 of

section 15 of T35N, R17W. Agricultural land use in the upper reaches of this tributary probably contributes a significant amount of the phosphorus that powers the algae bloom and aquatic plant growth in Tamarack Bay (see Photos 1A and 1B). It is in this area that land acquisitons and other efforts (pursuit of easements) could have a positive impact on water quality entering Tamarack Bay and ultimately Half Moon Lake.

According to the Polk County Land Conservation Department in Balsam Lake, several wetlands within the Tamarack Creek subwatershed have been restored. Three are in the extreme northwestern 1/4 of section 23 and 11 restored wetlands are in the SW 1/4 of section 14, although the wetlands in section 14 may actually be in the Harder Creek watershed (discussed previously). According to PCLCD, a number of drained wetlands in the Tamarack Creek watershed remain unrestored, however. These are all south of Highway G very near or within the intermittent stream channel in sections 23 and 24. Wetland drainage hastens runoff from uplands into surface water sources. Wetlands, under natural conditions receive and hold water and slow the rate of runoff into surface sources. This slowed rate of runoff also allows time for attenuation of sediments and nutrients in the wetland instead of allowing them into the surface water source (Tester 1995). If there is amplification of nutrient loads above those considered "natural" coming into Tamarack Bay, it is likely due to these drained wetlands and due to land use in the uplands adjacent to the intermittent creek channel, particularly cultivation (row-cropping, fertilizing, etc.) and cattle grazing, both of which can add significant amounts of nutrients and sediments in a stream. Any wetland restoration along Tamarack Creek would surely contribute positively to the water quality of Tamarack Bay and all of Half Moon Lake.

Land acquisition or pursuit of easements to restore wetlands or change land uses deemed harmful may best be sought in this area to protect the water quality of Half Moon Lake. Immediate results could come from letting the property owner know about the highly erodable classification of the large field in the northwest 1/4 of section 22, which runs up to the edge of the creek, and the eligibility of this land for the CRP program of the NRCS. Enrollment periods for CRP vary. Land owners should contact the NRCS office in Balsam Lake for details. Likewise, the wetlands that have yet to be restored along Tamarack Creek may be eligible for restoration under the Wetlands Reserve Program of the NRCS, although this is seldom applied in this area. More often wetland restoration is coordinated by WDNR under the North American Waterfowl Conservation Act. The DNR office in Balsam Lake should be contacted for details and information on eligibility for this program.

Wetland and bog area 3 - Nelson Bay

The Nelson Bay wetland complex is located on the southwest end of Half Moon Lake, just to the east of the public beach and boat launch in the extreme southern portion of the southeast 1/4 of section 23, T35N, R17W. The WWI classifies the area as T2K, which is conifer swamp on wet soil. It occurs both north and south of 200th Avenue. South of the road is a black spruce muskeg (poor fen) dominated by black spruce (*Picea mariana*), and tamarack with an understory characterized by several shrub species, including blueberry (*Vaccinium angustifolium*), labrador tea (*Ledum groenlandicum* - Photo 35), leather leaf (*Chamaedaphne calyculata* - Photo 35), tag alder, and catberry (*Nemopanthus mucronatus*); with a solid mat of sphagnum moss, soft leaf sedge, and three fruit sedge (*Carex disperma* and *C. trisperma*) beneath. This community is very homogeneous in composition. Of interest in this habitat is the moccasin flower (*Cypripedium acaule*, no picture). It is a showy member of the orchid family with a single large pink flower topping each stem. It is so showy, in fact, that it is designated the State Flowering Plant of Minnesota. Further south the black spruce muskeg grades into a black ash, alder, and sedge swamp before hitting upland. This swamp is very similar to the swamp habitats encountered in Tamarack Bay and along Harder Creek.

North of 200th Avenue is a continuation of the wetland south of the road that extends all the way to Half Moon Lake (300 ft). It has been classified as T2K along the road and S1/E2H toward the lake by WWI. S1 is scrub shrub characterized by deciduous shrubs such as alder, bog birch, leatherleaf, and labrador tea. E2H is wet meadow dominated by persistent graminoids. The entire area is covered by peatland ranging from rich fen near the road to poor fen and true bog in the center to intermediate fen on very unstable floating mats along the lake margin. Sphagnum moss is dominant throughout this portion of the Nelson Bay wetland, except in the zone just north of 200th Avenue.

The narrow band of swamp just north of 200th Avenue occurs on stable muck soil and is dominated by tamarack, black ash, tag alder, winterberry (*Ilex verticillata*), catberry, balsam willow (*Salix pyrifolia*) paper birch (*Betula papyrifera*), and red maple (*Acer rubrum*) with an understory dominated by lake sedge (*Carex lacustris* - Photo 36), water sedge (*C. aquatilis*), tussock sedge, and ferns, including regal fern (*Osmunda regalis* - Photo 37), one of the most beautiful and unusual native ferns.

The swamp quickly grades into a quaking bog zone dominated by sphagnum moss, slender sedge (*Carex lasiocarpa* - Photo 38), starry sedge (*Carex muricata* - Photo 39), stunted tamarack and black spruce, leather leaf, and bog rosemary (*Andromeda polifolia* - Photo 40) (see Photo 41 for a broader view of the habitat). The vast majority of the wetland area north of 200th Ave. is floating peatland over water and is legally considered part of Half Moon Lake. Photos 42-44 give a closer look at this habitat and demonstrate what makes it a true bog. Photo 42 shows a stunted tamarack with a hummock of sphagnum moss growing around it. Notice how easy it is to see the sphagnum due to the sparse growth of the grass-like sedge stems and the few scattered shrubs. Photo 43 is a closeup of one of the sphagnum moss hummocks at the base of a stunted tamarack tree, which clearly shows how dominant the sphagnum moss is and how scattered in occurrance the sedges and shrubs are. Photo 44 moves in even closer to show how much sphagnum there is for every sedge and shrub stem. This habitat also harbors three of the most beautiful orchid species found in Wisconsin. Snakemouth (*Pogonia ophioglossoides* - Photos 45 and 46) has a single terminal flower with a couple of oval leaves on the stem. Grass pink orchid (*Calopogon pulchellus* - Photos 47 and 48) has several showy pink flowers at the top of 18 inch tall stems. Perhaps less striking, but more intuiging due to its rarity is the ragged fringed orchid (*Habenaria lacera* - Photos 49-52), which is considered a rare species in the state of Wisconsin by the Department of Natural Resources Natural Heritage Program. No more than 200 stems of snakemouth and grass pink orchid were seen and only approximately 10 stems of ragged fringed orchid were documented. All of these orchid species are restricted to bog and fen habitats in the region.

The bog community forms a doughnut around a central, lower area that occurs on an even more unstable quaking mat that is covered by shallow standing water (see Photo 53) which is characterized by rich fen vegetation. Slender sedge, bog cranberry, steeple bush (*Spiraea tomentosa*), podgrass (*Scheuchzeria palustris*), bog willow (*Salix pedicellaris*), mud sedge (*Carex limosa*), and beaked sedge are common to prominent and sphagnum moss is lacking in this zone. This community supports several carnivorous plants. These plants are adapted to life in nutrient poor bogs and fens by having mechanisms to trap and digest insects for nutrients such as nitrogen and phosphorus, which are very scarce in peatland soils.

The most showy of the carnivorous plants is the pitcher plant (*Sarracenia purpurea* - Photos 53 and 54). The leaves of the pitcher plant are modified into pitchers, which contain a slurry of digestive enzymes. Small, creeping insects are attracted by sugary secretions that are found from the bottom to the top of the outside of the pitcher. Once they reach the top, they look down and see many more nectaries, which prompts them to take the plunge. Once in the pitcher, of course, there is no

escape, due to sharp, down-pointed hairs and slick pitcher sides. The flowers, seen in the foreground of Photo 54, taken at Baldwin Bay are large, bizzare, and beautiful. Pitcher plants occur in the rich fen as well as adjacent intermediate fen and poor fen, though they seldom occur in bog communities.

Photo 53 shows one of the other carnivorous plant species lurking in the shallow waters of this rich fen, intermediate sundew (*Drosera intermedia*). Photo 55 is a closeup of this species. Sundews have glandular red hairs on the edges of the modified leaf blade. Sugary secretions form at the tip of these hairs. Insects and other creepy-crawly critters are attracted to these secretions. Besides being sugary, they are also sticky. Once stuck, the insect struggles and becomes more stuck. Digestive enzymes are then secreted from the leaf blade and the critter is digested for the nutrients it contains. Round leaf sundew (*Drosera rotundifolia* - Photo 56), with rounded leaf blades, is also found in the rich to poor fen habitats at Nelson Bay. Both species have small, white, five-petaled flowers that begin showing up in late July.

The least conspicuous carnivorous plant species in the rich fen area is the least bladderwort (*Utricularia minor* - Photos 57 and 58). The bladderworts are aquatic species, growing submerged in shallow waters of fen habitats. Photo 57 shows the small, highly dissected green leaves along the submerged stems, as well as the insect-trapping structures (see the lower right of Photo 57), which are semi-transparent traps that possess hair triggers. These are positioned underwater and when a small aquatic insect swims by and trips the hair triggers, a vacuum is created as the trap opens, sucking the animal in, where it is digested by a slury of enzymes. Photo 58 shows the dainty little yellow flowers of the bladderwort, which appear on shoots that emerge above the surface of the shallow fen waters.

The lake-edge vegetation is quite different from the rich fen/bog complex at Nelson Bay described above. It is quite extensive; probably about 25 yards wide on average. It is best classified as intermediate fen due to the nearly continuous cover of sphagnum mosses beneath the lush growth of several shrubs, including tag alder, bog birch and leatherleaf; sedges including beaked and bristly sedge, cattails; and several fern species (Photo 59). Water channels (see Photo 59) run through this mat from the lake to the edge of the bog/rich fen area. This mat is floating and is much thinner and less stable (more quaking) than the mat that supports the bog and rich fen vegetation further back from the edge of the lake. Steve McMahon noted that we were able to get closer to the lake edge than he had ever gotten before (probably because spring drought had dropped water levels, stabilizing the mat enough to support our weight - Photo 60).

Functional Values

Nelson Bay offers an opportunity to experience the full range of peatland communties from rich fen to sphagnum-dominated, extremely nutrient-poor bog. Peatland plants are uniquely adapted to growing in their own dead remains (Tester 1995). Because peatlands support so many unique plants and they often occur on floating mats over open water, they are some of the most intriguing and awe-inspiring habitats in the region or anywhere else. Peatlands are primarily found in northern latitudes which were recently (geologically speaking) scoured by continental glaciers. In the depressions left behind by the glaciers only 11,000 years ago, peatland communities have formed. Wisconsin and Minnesota are at the southern edge of peatland distribution in North America. Further north in Canada and extreme northern Minnesota, where glaciation was more intense, unbroken expanses of peatlands form in flat, poorly drained areas that cover many square miles. In this area, peatlands are scattered and localized in distribution.

In addition to the unique plant species, peatlands also provide a home for many animal species which are also uniquely adapted to these habitats. Others may prefer peatlands for nesting or foraging at certain times of the year. Shrews and voles are common rodents of peatlands. The water shrew has stiff hairs on its hind feet that aid in swimming. Southern bog lemmings prefer black spruce and tamarack swamp habitats (Tester 1995). Sandhill cranes often nest in peatlands due to the isolation of these habitats from human development and activities. Two native warblers prefer peatlands for nesting - the Connecticut and palm warblers. Both build nests of fine sedge stems at the top of sphagnum hummocks in tamarack and spruce forests (see Photo 43). Other bird species including the great gray owl, yellow rail, LeConte's sparrow, Lincoln's sparrow, savannah sparrow, ruby-crowned kinglets, gray jay, Swainson's thrush, and the Tennessee, Nashville, yellow-rumped, and Cape May warblers are common in open to forested peatland habitats (Tester 1995). Geese are also known to settle into open bogs with large stands of cranberries and graze heavily on the nutritious berries. Many insects, including the bog fritillary butterfly are restricted to peatland habitats throughout their range of occurrance.

Between the showy orchids, carnivorous plants, and many bird species uniquely adapted to peatland habitats, the recreational and educational potential in these areas is enormous. Such opportunities, largely limited by lack of access, are absent in this region. If this area is acquired by the Half Moon Lake Protection and Rehabilitation District, the development of some type of floating interpretive trails through the Nelson Bay floating peatland communities is strongly recommended. Cost-sharing opportunities with various organizations, including WDNR and others are often available for such a project.

Water Quality Protection Values

The wetland communities of Nelson Bay play an important role in buffering Half Moon Lake from nutrient and sediment runoff, particularly from the agricultural lands bordering the wetland to the west. To the south the wetland is bordered by a rather extensive forested area that occurs on soils ill-suited to agriculture (Soil Survey of Polk County 1979). There is no surface flow (creek) running from the adjacent uplands through the Nelson Bay wetland, so incoming water is either in the form of sheet surface runoff or subsurface (groundwater) flow. In such sites, as much as 80% of incoming phosphorus can be absorbed by a relatively narrow band of forested swamp or marsh adjacent to a waterway, as long as the water remains sheet runoff, rather than rill, stream, channel, or ditch runoff (see the **Why Have Buffers** discussion above). It is assumed, therefore that the vegetation in the Nelson Bay wetland complex, effectively attenuates all or most of the sediments and nutrients before the water enters the lake. The subwatershed of Nelson Bay (the upland that provides runoff to the area) is much smaller than the previous two wetlands discussed (Harder Creek and Tamarack Bay), and its role, therefore, in protecting the water quality of Half Moon Lake is less (though it should not be considered insignificant) (Barr Engineering 1994). If the Nelson Bay wetlands remain undisturbed, they will continue to effectively buffer Half Moon Lake.

Acquisition Considerations and Potential

Any legal development within the stable (fixed) wetland communities in Nelson Bay, particularly south of 200th Avenue would require a permit (under Section 404 of the Clean Water Act) and realistically, such development is unlikely, due to the saturated peaty nature of the soil. Most of the wetland communities north of 200th Avenue occur on floating mats over open water, which makes them part of the open water of Half Moon Lake, and therefore they are legally protected from development. The black spruce swamp south of 200th Ave. could be logged, although the stunted trees would have very little value. Land use in adjacent uplands could affect this site. Tilled fields

are adjacent to the west side of the wetland. Forested uplands border the Nelson Bay wetlands to the south and east. Logging in these forested uplands, depending on the method employed could impact the quality and quantity of water coming into wetlands.

Unlike the previously discussed sites, Nelson Bay receives only surface sheet runoff and groundwater recharge from its watershed, not from a creek (Barr Engineering 1994). The wetlands of Nelson Bay likely attenuate the vast majority of nutrients and sediments in the incoming waters. Therefore, if the only question regarding whether to acquire property is based on its direct effect on Half Moon Lake's water quality, then it may be best to consider acquisition of the fixed wetland areas, particularly south of 200th Ave. only, rather than any of the adjacent uplands. Changing land use in the uplands, such as clearcut logging with considerable soil disturbance, or housing developments could contribute more nutrients to the wetland, perhaps affecting the composition of the peatland plant communities, but this would not compromise the wetland's capacity to attenuate these additional nutrients and prevent them from reaching the lake.

Wetland and bog area 4 - Baldwin Bay

The Baldwin Bay wetland is located in the northwest 1/4 of section 25, T35N, R17W, just to the east of Nelson Bay on the southwestern end of Half Moon Lake. Like Nelson Bay, it occurs immediately adjacent to Half Moon Lake and has quaking margins covered by fen vegetation. The quaking margins grade into a black muskeg on stable, wet peat that extends back from the lake more than 0.25 mile. The uplands surrounding the site are primarily private forest lands with soils ill-suited to agriculture due to their steep, rocky nature (Soil Survey of Polk County 1979).

The WWI classification for the Baldwin Bay wetland is T2K, forested swamp dominated by conifers. This is accurate for all but the two to three acres next to the lake. Tag alder and tamarack dominate the lake-edge zone (Photo 61) with an understory that includes several ferns, some sphagnum moss, and one of the showiest native wildflowers, blue flag iris (*Iris shrevii* - Photo 62). This zone is only approximately 15 feet wide and is relatively stable, though noticeably quaking. Behind it is an open intermediate to poor fen with solid to sparse sphagnum moss cover throughout. Much of it is dominated by bog cranberry, leatherleaf, and labrador tea (Photos 32 and 35) while other areas are covered by stands of several sedges, including poor-fruit sedge (*Carex oligosperma* - Photo 63), lake sedge (Photo 36), beaked sedge (Photo 64), arrow sedge (*Dulichium arundinaceum* - Photo 64), poor sedge (*Carex paupercula* - Photo 64), slender sedge, and cattails. Two of the more showy constituents in this community are bog candles (*Lysimachia terrestris* - Photo 65) and marsh cinquefoil (*Potentilla palustris* - Photo 66). Round leaf sundew and pitcher plants are also found in this habitat. This zone is quaking but relatively stable.

The black spruce muskeg is dominated by black spruce with some scattered patches of tamarack, and black ash. Tag alder is also common but the herbaceous understory is very depauperate because the canopy is so thick, limiting light penetration to the surface. Sphagnum moss is common, as are two sedges, fine-leaf sedge (*Carex disperma*) and three-fruit sedge (*Carex trisperma*), cinnamon and interrupted ferns, and sensitive fern (*Onoclea sensibilis*).

Functional Values

Because of the similarity of Baldwin Bay wetland to the Nelson Bay wetland, please see the functional values section for Nelson Bay. Due to more difficult access of this site, however, the construction of boardwalks or interpretive trails of any type in this habitat is not recommended, if it could instead be pursued in the Nelson Bay wetland.

Water Quality Protection Values

Baldwin Bog is well-buffered from agricutural or urban lands. The majority of its watershed to the west and south is forested (based on analysis of aerial photos, not based on ground surveys). There is no surface flow (creek) running from the adjacent uplands through the Baldwin Bay wetland, so the water feeding into the site from surrounding uplands is either in the form of surface sheet runoff or subsurface (groundwater) flow. Given the flat and extensive nature of the wetland communities, they are clearly adequate, by themselves, to attenuate the vast majority of incoming sediments and nutrients before they reach the lake. The subwatershed of Baldwin Bay is smaller than Tamarack Bay or Harder Creek and similar in size to the Nelson Bay subwatershed. According to the Barr Engineering Report (1994), the watershed of this site is connected with that of Nelson Bay. As with Nelson Bay, the presence of these intact peatland communities are effectively buffering the lake from further inputs of nutrients and sediments. If these communities are disturbed in some way, the buffering capacity of the site will be compromised and the water quality of Half Moon Lake could decline as a result.

Acquisition Considerations and Potential

The two to three acre non-forested fen community that occurs on a floating peat mat next to Half Moon Lake in Baldwin Bay is considered part of the lake because it is below the ordinary high water mark and is therefore legally protected from development as part of the lake. Any legal development within the Baldwin Bay wetland that occurs on stable soil would require a permit (under Section 404 of the Clean Water Act) and realistically, such development is unlikely because of the waterlogged nature of the peat soils. The black spruce could be logged, although the stunted trees would have very little value. Land use in adjacent uplands could affect the vegetation within the site. Logging, for example, in the forested uplands to the south and west of the wetland communities could increase incoming nutrients and sediments, though based on the literature review, in a site that is as broad and flat as this site, the vast majority of the sediments and nutrients would be filtered out or taken up by plants with in the first 15 meters of wetland adjacent to the upland. Further toward the lake, the vegetation would be virtually unaffected and the water quality of Half Moon Lake would still probably remain unaffected.

Baldwin Bay, like Nelson Bay is receiving only surface sheet runoff and groundwater from its surrounding watershed, not from a creek. The wetland communities alone at Nelson Bay are likely adequate to attenuate the vast majority of nutrients and sediments in the incoming water before they could reach the lake. Therefore, if the only question regarding whether to acquire property is based on its direct effect on Half Moon Lake's water quality, then it would be prudent to focus efforts on acquiring only the wetland communities that are above ordinary high water mark because these alone will protect the lake from water quality degrading activities that could occur in adjacent uplands. Different land use in the uplands, such as clearcut logging with considerable soil disturbance, could contribute more nutrients to the wetland, perhaps affecting the composition of the peatland plant communities, but this would not compromise the wetland's capacity to attenuate these additional nutrients prior to them reaching Half Moon Lake.

4.5. SUMMARY OF FUNCTIONAL VALUES AND ACQUISITION RECOMMENDATIONS

The four inventoried sites are high quality wetland ecosystems that provide water quality protection for Half Moon Lake, important wildlife habitat and biodiversity values (plant and animal species diversity and plant community diversity), and great potential for recreational hiking trail development. Laws protecting these sites will be discussed further in later portions of this document. The integrity of these statutes may be compromised in the future. Under current conditions, filling and draining could be permitted in some portions of these wetlands. Additionally, activities in adjacent uplands that could negatively impact runoff into these sites and ultimately into Half Moon Lake, are far less restricted. Consequently, acquisition of fee title to the wetlands above OHWM and the important adjacent uplands appears to be the best way of protecting the sites and their important functional values. What follows is a priority list for consideration.

Functional Value - Water Quality Protection

1. Harder Creek Bottomlands and adjacent uplands. This subwatershed is most critical because it contributes more than half of Half Moon Lake's water. Habitat degradation in the bottomlands along Harder Creek or the adjacent uplands will adversely impact runoff into the lake.

2. Tamarack Bay Wetlands - This is the second most important subwatershed for contributing Half Moon Lake's surface water. Particularly critical are the agricultural lands upstream from Tamarack Bay along Tamarack Creek. Land use along Tamarack Creek likely accounts for the nutrients that fuel the summer algal bloom in the bay. Acquisition of these lands and habitat restoration will positively affect runoff feeding Tamarack Bay.

3. Nelson Bay and Baldwin Bay - These sites have a relatively small surrounding watershed and no surface water source. They are sufficiently broad to buffer the lake from most water quality impacts that could arise from land use in the adjacent uplands. If the integrity of these sites is altered or degraded somehow directly, however, their water quality protecting values could significantly diminish.

Functional Value - Wildlife Habitat and Biodiversity Protection

1. Tamarack Bay Wetland - Tamarack Bay itself supports an impresive diversity of aquatic flowering plants and algae. The wetlands include a wide diversity of plant communities including floating and fixed peatlands, marsh, and swamp. The site is large, intact and very pristine with a wilderness-type atmosphere. Bald eagles, loons, great blue herons, and other animal species abound in the bay.

2 Nelson Bay Wetland - Although not as diverse in animal wildlife species, the peatland community and species diversity supported at this site are exceptional. I have explored many peatland complexes in Minnesota and Wisconsin, but have seldom seen sites with so many orchids or the plant species diversity, in general, found in this site.

3. Harder Creek Bottomlands - This area is exceptional for animal wildlife species habitat and is a critical corridor for the movement of wildlife. The plant communities are high in quality but happen to be quite common in the area. Forest quality and diversity in uplands adjacent to the bottomlands also appeared exceptional. Ranking this below Nelson Bay may be more of a reflection of the author's bias toward plants than his ability to be objective.

4. Baldwin Bay Wetland - This site is smaller, with less peatland community and species diversity than the Nelson Bay Wetland. The vast majority of the site is covered by an extensive, homogeneous black spruce muskeg, which does not support a wide diversity of plant or animal species.

Functional Value - Recreational Development

1. Nelson Bay Wetland - Accessibility and presence of high quality peatland habitats are the biggest attraction here. Concerns with developing this site include limiting the impact that floating walkways would have on the orchid populations and the peatland communities in general. Careful trail placement, in other words, would be a very important consideration.

2. Tamarack Bay Wetland - The extensive nature of the wetland communities and the wildlife viewing potential make this area particularly attractive for the development of some floating boardwalks. Access may be slightly more difficult than at Nelson Bay but proper siting of the trail and floating boardwalks will be less difficult. Providing access to the remote and peaceful open water of Tamarack Bay would be an added benefit.

3. Harder Creek Bottomlands - Access to the area would be relatively easy off of Dau Road. The plant communities found here are more common and perhaps of less interest as a consequence than at the previous two sites, although wildlife viewing potential is high and trails can access adjacent upland forests in addition to the bottomland communities. Fewer boadwalks would be required on the trail, making it less costly to develop this site vs. the previous two.

4. Baldwin Bay Wetland. This site is probably too small to develop. It makes much more sense to do it in Tamarack Bay or Nelson Bay to provide access to the same type of plant communities.

4.6 LITERATURE CITED

Army Corps of Engineers. 1987. Wetland Delineation Manual. Department of the Defense, Washington, D.C.

Barfield, B.J., E.W. Tollner, and J.C. Hayes. 1977. Prediction of sediment transport in grassed media. Paper No. 77-2023, American Society of Agricultural Engineers, St. Joseph, MI.

Barfield, B.J., E.W. Tollner, and J.C. Hayes. 1979. Filtration of sediment by simulated vegetation I. Steady-state flow with homogeneous sediment. Transaction of the American Society of Agricultural Engineers 22: 540-548.

Barling, R.D. and I.D. Moore. 1994. Role of buffer strips in management of waterway pollution: a review. Environmental Management 18:543-558.

Barr Engineering Company. 1994. Wisconsin Lake Planning Grant Report prepared for Half Moon Lake Protection and Rehabilitation District.

Barton, D.R., W.D. Taylor, and R.M. Biette. 1985. Dimensions of riparian buffer strips required to maintain trout habitat in southern Ontario streams. North American Journal of Fisheries Managtement 5:364-378.

Borg, H., A. Hordacre, and F. Bartini. 1988. Effects of logging in stream and river buffers on watercourses and water quality in the southern forest of Western Australia. Australian Forestry 51: 98-105.

Broderson, J.M. 1973. Sizing buffer strips to maintain water quality. M.S. Thesis, University of Washington, Seattle, WA.

Castelle, A.J., A.W. Johnson, and C. Conolly. 1994. Wetland and stream buffer size requirements - a review. Journal of Environmental Quality. 23: 878-882.

Cormack, R.G.H. 1949. A study of trout streamside cover in logged-over and undisturbed virgin spruce woods. Canadian Journal of Forest Research 27:78-95.

Erman, D.C., J.D. Newbol, and K.B. Roby. 1977. Evaluation of streamside bufferstrips for protecting aquatic organisms. Technical Completion Report No. 165. California Water Resources Center, California.

Fassett, N.C. 1957. A manual of aquatic plants. University of Wisconsin Press, Madison, WI.

Hayes, J.C. and J.E. Hairston. 1983. Modelling the long-term effectiveness of vegetative filters on on-site sediment controls. Paper No. 83-2081. American Society of Agricultural Engineers, St. Joseph, MI.

Madison, C.E., R.L. Blevins, W.W. Frye, and B.J. Barfield. 1992. Tillage and grass filter strip effects upon sediment and chemical losses. p. 331. in Agronomy Abstracts. Madison, WI.

Naiman, R.J., H. Decomps, J. Pastor, and C.A. Johnston. The potential importance of boundaries to fluvial ecosystems. J. North American Benthological Society. 7: 289-306.

Wisconsin Department of Natural Resources. 1996. Half Moon Lake subwatershed. p. 57-61 in Balsam Branch Watershed Appraisal. available at Polk County Land Conservation Department, Balsam Lake, WI.

Natural Resources Conservation Service (Formerly Soil Conservation Service). 1979. Soil Survey of Polk County, Wisconsin. United States Department of Agriculture.

Tester, J. 1995. Minnesota's Natural Heritage: an ecological perspective. University of Minnesota Press, Minneapolis, MN.

Vanderholm, D.H. and E.C. Dickey. 1978. American Society of Agricultural Engineers Paper 78-2570, Winter Meeting, Chicago, IL; St. Joseph, MI.

Willard, D.E. 1979. Support for birds and mammals. Abstract of paper presented at National Symposium on Wetlands, November 7-9, 1978 at Lake Buena Vista, Florida.

5.0 SHORELINE DELINEATION

In the course of the study a question arose as to a delineation of the boundary between the lake and private property, particularly in the area of the floating peatlands. The question was addressed to Officer Ed Slaminski of the DNR, the Water Management Specialist for the Half Moon Lake area.

His response came in a letter dated September 23, 1997, addressed to David Butler, Chairman of the Board of Commissioners. A copy of the letter is attached as Figure B. After surveying the floating peatlands, he concluded that "most of the bog part of the wetlands were below the ordinary high water mark of the lake, these areas are subject to the same protection as the main part of the lake." The attached Figure C is a map of the 3 bays showing the approximate area of the shoreline. No attempt has been made to lay out an exact definition of the Ordinary High Water Mark (OHWM) in the areas. This boundary could, however, be rather easily defined by the author.

This lead to a further inquiry into the laws that determine what is private property and what is public property. The following statements have been taken from Wisconsin Department of Natural Resources publications WZ-004 92 REV LP WZ 003 92 and WZ-003 96 Rev. The publications are titled "Public or Private ? I - Navigability" and "Public or Private ? II - The Ordinary High Water Mark"

The dividing line between public and private ownership of land on natural lakes is determined by the Ordinary High Water Mark (OHWM). The citizens of Wisconsin own the beds of natural lakes, which are held in trust for them by the State. The riparian (waterfront) landowners own the land above the OHWM. This includes areas classified as jurisdictional wetlands, activities in which are regulated and permitted only through the Army Corps of Engineers and the Wisconsin DNR, despite the fact that they are part of the private property of waterfront land owners. On streams, the riparian landowner owns the bed to the center of the stream, but the public has the right to use the water for activities such as canoeing and fishing. The Department of Natural Resources (DNR) and the U.S. Army Corps of Engineers have the authority to require permits or plan approvals for activities in public waterway below the OHWM.

The OHWM is the point on the bank or shore where the water is present often enough so that the lake or stream bed begins to look different from the upland. The mark may be indicated by change in vegetation or other easily recognizable characteristics. The Wisconsin DNR field staff locate the OHWM through on-site studies of physical and biological conditions at the shoreline. The principal indicator is the change from water plants to land or wetland plants.

What does this mean to a citizen? As long as one keeps their feet wet, they may walk along the shore, swim or boat in any navigable lake or stream. You need not worry about the location of the OHWM as long as you stay in the water. In the case of a period of low water, the riparian owner has exclusive use of the exposed bed until the water returns.

Navigability determines whether a waterway is public or private. Navigable lakes and streams are public waterways. Because they are public, one can use navigable waterways for boating, hunting, fishing, swimming or other recreational activities provided public access is available. There is no strip of public ownership along public waterways.

At first, rivers and streams which were meandered (surveyed) and declared navigable by U.S. government surveyors were considered navigable under territorial and early state law. Using these surveys, courts determined the navigability of lakes although the statutes did not specifically define lake navigability until much later. Even when meandering was declared as the basis for navigability, the courts held many non-meandered lakes to be navigable. As water uses changed, a new definition of navigability was adopted by the legislature. A lake or stream was considered navigable if it was "navigable-in-fact for any purpose whatever. Since the early 1900's the courts have clarified what was meant by "navigable-in-fact for any purpose whatsoever". Navigation for recreation

purposes and enjoyment of scenic beauty was declared to be a right entitled to protection. State v. Bleck, 114 Wis. 2d 454 (1983). Streams do not need to be navigable at normal levels but only on a regular recurring basis, such as during spring rains.

6.0. OWNERS OF THE WETLANDS

The record owners of the four wetland areas are shown on the attached Map D. Ownership information was obtained from the public records at the Polk County Court House.

7.0 ZONING AND WETLAND RESTRICTIONS

As a part of the study the Board has tried to contemplate the pressures a growing population will put on the areas around the lake. As agricultural use of the land in the area is reduced there will be a greater demand for residential and industrial use. The Polk County Land Conservation Department reports that the number of farms in Polk County has diminished significally in the last number of years. The immediate affect on the lake of less agricultural use will be positive as fewer agricultural chemicals are applied to the areas with less runoff into the lake. However, as more residential and industrial development occur and the demand for space around the lake increases, new problems will arise that may have adverse affects on the lake. As noted in Section 5, phosphorus contribution of residental land is roughly equivalent to agricultural land although residential development is generally concentrated on a relatively small percentage of land.

One of the issues under review is whether the current zoning and wetland laws have the power to properly restrict the use of land around the lake that can adversely affect lake quality. The following summary of the present zoning and wetland laws and regulations are taken from a letter from Gary Spanel, the Polk County Zoning Administrator and from other governmental published material.

On June 1, 1967, the Polk County Shoreland Protection Zoning Ordinance went into effect. This ordinance was the result of a legislative mandate. Prior to June 1, 1967, the legislators passed a law that required the Department of Natural Resources to promulgate rules that would protect the shore lands of the state. These rules are now known as NR 115 of the Wisconsin Administrative Rules. It was from these rules that Polk County created its Shoreland Protection Ordinance.

The legislators passed a law that required the counties to regulate all land within 1000 feet of navigable lakes, ponds or flowages, and 300 feet from navigable rivers or streams or to the landward side of a floodplain, whichever is greater. The administrative rule, NR 115, established the minimum regulations within these areas. The rule stated that the counties were to regulate the following: lot sizes, building setbacks, tree removal, filling and grading, nonconforming uses and subdivisions. Later, the law and the rule were changed to include the regulations of some of the wetlands within the areas described above. In 1983, Polk County revised this shoreland ordinance to include the regulations of these wetlands. Counties must meet or exceed the minimum state standards to protect water resource values such as natural beauty, water quality, recreation and navigation, fish and wildlife.

Today, the zoning office, which is located in the courthouse in Balsam Lake, Wisconsin, is responsible to administer and enforce the Polk County Shoreland Protection Zoning Ordinance. The purpose of this ordinance is to protect water quality and protect the spawning ground for fish and other aquatic life, to preserve the aesthetic quality of the lakes and rivers and to promote public health and safety. This is all done by the following zoning regulations:

a. Setback. The ordinance requires a minimum setback of 75' from the ordinary high water mark for all structures except boathouses, or a lesser setback where existing development has established a pattern of a lesser setback. It also sets a minimum setback for all structures from public roads.

b. Lot size. Minimum lot size is addressed in the ordinance. Lot sizes vary depending on the dates they were created and the availability of public sewer.

c. Regulation of shore cover. The ordinance regulates the removal of trees and shrubbery within the first 35 feet of the shoreline. This is done to maintain aesthetic quality and to maintain a buffer to trap some of the sediment that will be released by the disturbed area during construction. Trees and shrubs provide wildlife habitat, shade for fish and a natural buffer that helps protect the lake from erosion and sedimentation during heavy rains. Manicured lawns seldom provide this protection. If fertilized, heavy rains can carry nutrients directly into the lake. The cumulative effect of many lawns along a lake shore can adversely affect water quality, fish, wildlife and aesthetics.

d. Filling and grading. The ordinance prohibits large amounts of landscaping on shoreland properties because of the impact on water quality. In some cases, the ordinance prohibits one from grading or filling anything at all.

e. Septic systems and wells. The ordinance regulates the location and construction of septic systems and wells.

f. Exceptions. Boathouses, boat hoists, piers and walkways necessary to reach the shoreline are usually exceptions to the setback requirement. Boathouses must meet specific construction standards, may be used only for storing boats and related equipment and cannot be built on the bed of a waterway. A permit is required and construction standards may be prescribed if excavation of land sloping to the water is required. Boathouse construction may be prohibited if erosion cannot be avoided due to slope or soil type. Piers and walkways can be constructed to provide access to the shoreline, but they may not be enlarged to include decks.

7.I ZONING DISTRICTS

The zoning ordinance provides that land within the l000 feet area from a lake or 300 feet area from a stream shall be divided into two districts, a Wetland District and a General Purpose District.

a. Wetland districts. The areas of land within l000 feet of a lake or 300 feet of a stream which have been designated by the Department of Natural Resources as wetland, are included in this district. The ordinance establishes specific uses which are allowed within these wetlands and prohibits certain uses.

b. General purpose district. All areas of land within l000 feet of a lake or 300 feet of a stream which have not been designated as wetlands come within the general purpose district. It is on land within this district that development near the lake is taking place. Uses are permitted for such things as follows: Single family dwellings, accessory buildings, farming, farm buildings, bridges, home occupations, travel trailer and mobile home parks, multi-family dwellings, resorts, specialty shops, sporting goods stores, institutions of educational nature, dinner clubs, taverns, private clubs, motels, hotels and condominiums.

c. Disricts around the shores of Half Moon Lake. Most of the shore line areas around Half Moon Lake fall within the general purpose district. The wetland areas adjacent to the shores, however, come within the wetland district and fall within the more restrictive provisions of the ordinance.

7.2 OTHER WETLAND REGULATIONS

In addition to the Polk County Shoreland Protection Zoning Ordinance which governs the use and alteration of wetlands within 1000 feet of a lake and 300 feet of a stream, there are other state and federal laws that deal with the regulation of wetlands outside of these areas that are not covered by the shoreland ordinance. Maps are available from the county which delineate the areas classified as wetland. The wetland map of the area around Half Moon Lake is attached as Map B.

7.3 BENEFITS OF WETLAND AREAS

Wetlands are not the wastelands they were once thought of. The following are some of their benefits:

a. Wetlands filter nutrients and sediments out of water, keeping our lakes and streams clean.

b. Wetlands reduce flood damage by storing runoff from heavy rains or snow melt.

c. Wetlands are spawning and nursery areas for fish such as northern pike.

d. Wetlands are home to waterfowl, songbirds, pheasants, furbearers and a number of rare or endangered animal and plant species.

e. Wetlands buffer adjacent uplands against wave and current erosion.

f. Wetlands are scenic and often the only open spaces in urban areas.

7.4 ALLOWED USES OF WETLANDS

Management of the wetland areas at the state level is under the jurisdiction of the Department of Natural Resources (DNR) and at the federal level the jurisdiction of the U.S. Army Corps of Engineers. Copies of state and federal wetland inventory maps can be purchased from the Geologic and Natural History Survey.

There are certain uses allowed in wetland areas such as the following:

a. Recreation such as hunting, fishing, trapping and hiking.

b. Forestry, including limited water level manipulation and some road construction.

c. Harvesting wild crops.

d. Pasturing livestock, including fence construction.

e. Agricultural cultivation, including maintenance of existing drainage systems.

f. Some limited construction of small buildings needed to support open space or wetland preservation uses.

g. Pier, dock and walkway construction.

h. Development of parks, recreation areas; and fish and wildlife habitat improvement projects.

I. Limited utility construction.

j. Limited road construction for farming and forestry.

k. Limited railroad construction.

Generally draining, dredging, filling or flooding aren't permitted in wetlands. Under certain conditions where these activities are associated with permitted uses they may be allowed to a limited extent. For example, farmers may cultivate crops within shoreland wetlands as long as they don't drain, dredge, fill or flood the wetland.

Sometimes an area may have wetland features but none of the values of wetlands listed earlier. If the owner of a wetland area believes this to be the case, he or she may file a petition with the local zoning office to rezone the area or remove it form the wetland district. After the petition is received, the zoning agency, after a hearing, can recommend a change to the local council or board and the council or board can rezone the area on the recommendation of the zoning agency and DNR.

7.5 Laws and Rules

Authority and minimum standards for wetland management are found in:

Counties - Section 59.97I, Statutes; Chapter NR II5, Administrative Code

Cities - Section 62.2w3I, Statutes; Chapter NR II7, Administrative Code

Villages - Section 6I.35I, Statutes; Chapter NR II7, Administrative Code

Mapping - Section 23.32, Statutes

General - Section I44.26, Statutes

The issue for the Lake District to decide is whether it can rely entirely on the zoning and wetland laws to protect the wetlands or whether it needs to be more assertive and take some action to acquire either fee title ownership or easements in the wetlands . There will always be a concern that as pressures are placed on political bodies to relax the laws to allow for more development, land use regulations may be relaxed and the lakes may be at risk. Experience has shown that wetland laws have changed dramatically toward protecting rather than destroying these areas once considered useless. A change back to providing less restrictions as demand increases for useable land is always possible.

8.0 PIERS AND WALKWAYS IN THE WETLAND AND FLOATING PEATLAND

Under State law, a "pier" is a structure extending into navigable waters from the shore with water on both sides, built or maintained for the purpose of providing a berth for watercraft or for loading or unloading cargo or passengers onto or from watercraft. Such a structure may include a boat shelter (or lift station) which is removed seasonally. Wis. Stats. Sec.30.0l(5).

The right of a riparian property owner to place a pier on the bed of a navigable waterway is subject to three general limitations. Under common law, riparian rights are limited by a rule of "reasonableness". Piers may only be placed within the riparian property owner's "riparian zone". The placement of piers is subject to state and local ordinances. Most piers are placed without permits pursuant to Sec.30.13 of the Wisconsin Statutes. Sec.30.l2 authorizes the issuance of permits for docks not authorized by Sec. 30.l3 provided the pier will not (l) materially obstruct navigation, (2) reduce the effective flood flow capacity of a stream, or (3) be detrimental to the public interest. The Department has promulgated an administrative rule, NR 327 Wis. Adm. Code, in order to ensure that its interpretation of these two statutes is consistent. The Department standards generally permit a riparian owner to place a pier from the shoreline to the line of navigation or to a "pierhead line". A pierhead line is a line established by local ordinance to limit the length of piers. The standards require that piers not "interfere" with public rights or the rights of other riparian owners. Important considerations include the length and width of the proposed pier, the depth of the water and vegetation at the site, the presence of fish and wildlife habitat, the water quality of the lake and other factors.

The Department's guidelines also address the "reasonable use" issue which concerns the number of moorings. Generally, the Department interprets the law to require that a permit be issued for any pier which provides more than 2 boat berths for the first 50 feet of shoreline and l boat berth for each additional 50 feet of shoreline owned. The determination of such a permit will be based on an analysis of the expected impact of the pier on navigation, fish and wildlife habitat, natural scenic beauty and other public rights in water and on its effect on the rights of other riparian owners. This determination may include consideration of the "cumulative effect' that would result if other structures of piers or structures of the kind proposed were to be constructed on the water body.

The law in Wisconsin also limits the placement of piers in public waters to "riparian owners". Holding an easement over land adjacent to the lake is not enough. The meaning of "riparian owner" has been a subject of recent legislation and case law in the State. Although they have an interest in property that extends down to the lakeshore, holders of easements are not riparian owners. As a result, the Wisconsin Courts have held that a pier may not be placed by a person who holds an easement to a lake or river shore. There is an exception where the easement was recorded before December 3l, l986.

Local governments also have authority to regulate piers.

The issue has not been addressed as to whether the owners of the property adjacent to the shore line in the three bays under study would have the right to build walkways extending from a buildable site on higher ground through the wetlands to the OWHM and then through the bog vegetation below the OWHM to provide access from the building site to the open water in the lake. This raises a very serious issue which needs to be addressed. If the wetlands above the OWHM and the bogs below the OWHM could be laced with walkways every 50 to 75 feet to provide access from the higher ground, there could result in serious obstructions to others who want to explore the bogs from the open water portion of the lake and walk along the lake shore. There could also be serious damage

to the bogs if such walkways were installed and used without proper thought given to the integrity of the area. There is nothing to indicate the present owners of the shorelines in the bays have any such intentions in mind. In fact they have been very jealous about preserving the integrity of the bogs. Planning for the future, however, as part of a long range plan, would dictate that this issue be explored further.

9.0 DREDGING AND CUTTING WEEDS

The supervision of dredging or cutting weeds in the lake and alteration of water flow in a stream are under the supervision of the Wisconsin DNR. Cutting of weeds around the area of a dock which is considered necessary for ordinary use of the area is allowed provided the weeds are not cut below a reasonable distance from the lake bottom. Dredging of the lake bottom is not allowed. It is assumed in the cutting of weeds that the roots will not be disturbed and the weeds will grow back. Jurisdiction for the supervision of these activities by the DNR is found in Wisconsin Statutes 30.l2 and 30.l25. Minnesota currently applies the cutting and dredging laws differently than the state of Wisconsin, so experience with one state is not necessarily precedent for the other state.

10.0 ACQUIRING OWNERSHIP OF WETLANDS

One of the possibilities for protecting the wetlands is to acquire the critical areas of land adjoining the lake and Harder Creek so that the areas can be protected perpetually without the need to rely on zoning and wetland laws. Properties may be acquired through purchase of fee title which means the full ownership of the property is acquired. Or in the alternative, a property owner can retain fee title, but grant an easement such as a conservation easement which restricts the land from development. If properly drafted, an easement may be able to give the lake district the protection it needs to oversee the use of the property and to protect it from adverse development.

Contacts have been made with Wisconsin land conservancy groups, the Wisconsin DNR and Polk County about holding title to any areas acquired. Fee title to the properties or easements could also be held in the Lake District. In a typical case, a property owner would decide that an area of property should be set aside for preservation and not be developed for residential or industrial purposes. They could sell or donate their entire fee title interest in the property or they could grant a conservation easement to the Lake District or some other designated governmental body or nonprofit conservancy group. The specific purposes for which the property may be used would be stated in the transfer documents. The entity accepting the fee title or easement would be responsible for overseeing the property and enforcing the restrictions placed in the document.

11.0 REAL ESTATE TAX RAMIFICATIONS OF A CONSERVATION EASEMENT

If a property owner conveys a conservation easement, the value of the remaining property is reduced so the subsequent real estate tax on the property should be reduced. The exact amount of the reduction is determined by the assessor. The assessor determines the value of the property remaining after it has been subjected to a conservation easement. The property owner usually still retains the right to possess the property, but agrees the property will never be used for development. There has been discussion in the legislature for extending this law to give more real estate tax benefit to landowners who are willing to subject their property to a conservation easement. Resistance has come from the school districts who are sensitive to a reduction in the tax base.

12.0 VALUES OF THE PROPERTIES IN THE 4 AREAS

The original plan for the study was to acquire market values of the properties in the 4 areas under study. It has been decided, however, that the cost of obtaining appraisals could not be justified as no sales of the lands are currently contemplated. The assessed market values of the properties for real estate tax purposes are of record in the Polk County Treasurer's office and can be readily obtained if needed.

13.0 FUNDING THE PURCHASE OF PROPERTY

Matching grants are available from the State of Wisconsin for use in acquiring land that is needed by the Lake District for lake preservation purposes. The state will provide 75% in matching funds for acquisition of property. The Half Moon Lake District would cover the other 25% through property tax levies. Loans are available to the Lake District from a state agency at low interest rates to finance the District's share of the cost if the District does not have ample funds on hand when property becomes available for purchase.

14.0 ACQUIRING PROPERTY THROUGH CONTRIBUTIONS

It may be that interested persons may desire to donate critical areas of wetland or may purchase wetlands and donate the land to the Half Moon Lake Protection and Rehabilitation District or some other governmental agency or a nonprofit conservancy group. There are numerous income tax benefits and estate and gift tax benefits available to contributors who may be interested in making such gifts. Owners of the wetland areas no doubt paid little for the property. If sold, the increase in value would be subject to income tax. If given away, a deduction for income tax purposes is allowed based on the market value of the property given away. No one pays a tax on the increase in value. This is the government's way of encouraging gifts to charities and governmental agencies. Charitable gifting of property with appreciated value is one of the most beneficial forms of charitable giving.

Property gifted by will or trust at the time of death reduces estate taxes. It may be that certain owners would like to pass on the wetland areas to their family but create a legacy by leaving a conservation easement to the lake district.

In determining the value of a gifted easement for income, gift or estate tax purposes, an appraisal is made of the wetland area before the easement and the wetland area after the easement. The difference in these two values is the value of the easement for tax purposes.

15.0 HALF MOON LAKE ALTERNATIVES

15.I UTILIZING ZONING ORDINANCES AND WETLAND REGULATIONS

Until opportunities arise for the acquisition of fee title or conservation easements in the 4 principal wetland areas, the Board of Commissioners should be alert to activities in the areas that might compromise the quality of the lake and the Board should be ready and willing to fully utilize the powers available under the zoning ordinances and the wetland regulations.

15.2 POLK COUNTY COMPREHENSIVE LAND USE PLAN

The Board of Supervisors of Polk County are pursuing the development of a long term comprehensive land use plan. The Board of the Half Moon District should be actively involved in the development of that plan with input on the best possible uses of the wetland areas around the lake.

15.3 RESTORATION OF WETLAND AREAS

The Balsam Branch Watershed District has inventoried current and former wetland areas within the Half Moon Lake watershed. Funds are available to assist landowners in restoring these areas to wetland classification. An effort should be made to encourage the restoration of as many wetland areas as possible.

15.4 CREATION OF WALKING PATHS

There may be wetland areas around the lake that could be opened up for public use without compromising the integrity of the areas. Further investigation could be made into whether it would be appropriate to open up some of the wetland areas for the creation of walking paths. This would require permission from the owners, acquisition of the fee title to the properties or the acquisition of easements which would allow for public access.

15.5 ACQUISITION OF PROPERTY

When property becomes available for purchase, consideration should be given to purchasing fee title or conservation easements in wetland areas around the lake that are determined to be of vital interest in preserving the quality of the lake. Although zoning ordinances and wetland regulations give current protection, in the long run acquiring vulnerable areas will be of the most long lasting benefit to the lake.

This study should be made available to owners of the vital wetland areas around the lake so that they will be aware of the desire of the Board to acquire some or all of the property if property becomes available by sale or by gift.

15.6 EDUCATION OF PROPERTY OWNERS

The Board should continue in its efforts to education landowners around the lake to the importance of buffer strips, shoreline preservation, good septic systems and other practices that preserve the quality of the lake and to be on the lookout for practices that are harmful to the lake.

16.0 - FIGURE A

SOUTH ⟷ NORTH

16.0 – FIGURE 5

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
William H. Smith, District Director

Cumberland Area Headquarters
1341 2nd Ave., PO Box 397
Cumberland, WI 54829
TELEPHONE 715-822-3590
FAX 715-822-3592

September 23, 1997

File: Half Moon Lake

MR DAVID BUTLER
RICHFIELD BANK & TRUST BLDG
SUITE 526
6625 LYNDALE AVE S
RICHFIELD MN 55423

Dear Mr. Butler:

Thank you for the tour of the wetland bog areas attached to Half Moon Lake. As you know, these areas are extremely valuable habitat areas as well as containing a very diverse flora and fauna community.

Anytime a lake contains these large bog/wetland communities the lake as a whole benefits from the many functional values of these areas.

As we discussed, most of the bog part of the wetlands were below the ordinary high water mark of the lake, these areas are subject to the same protection as the main part of the lake. The more wooded wetland areas are more likely above the OHWM but will also be protected. It may be in the lake district's best interest to try and purchase these areas, so they will be protected forever.

Again, thank you and if you have any questions, please call me at 715-822-3590.

Sincerely,

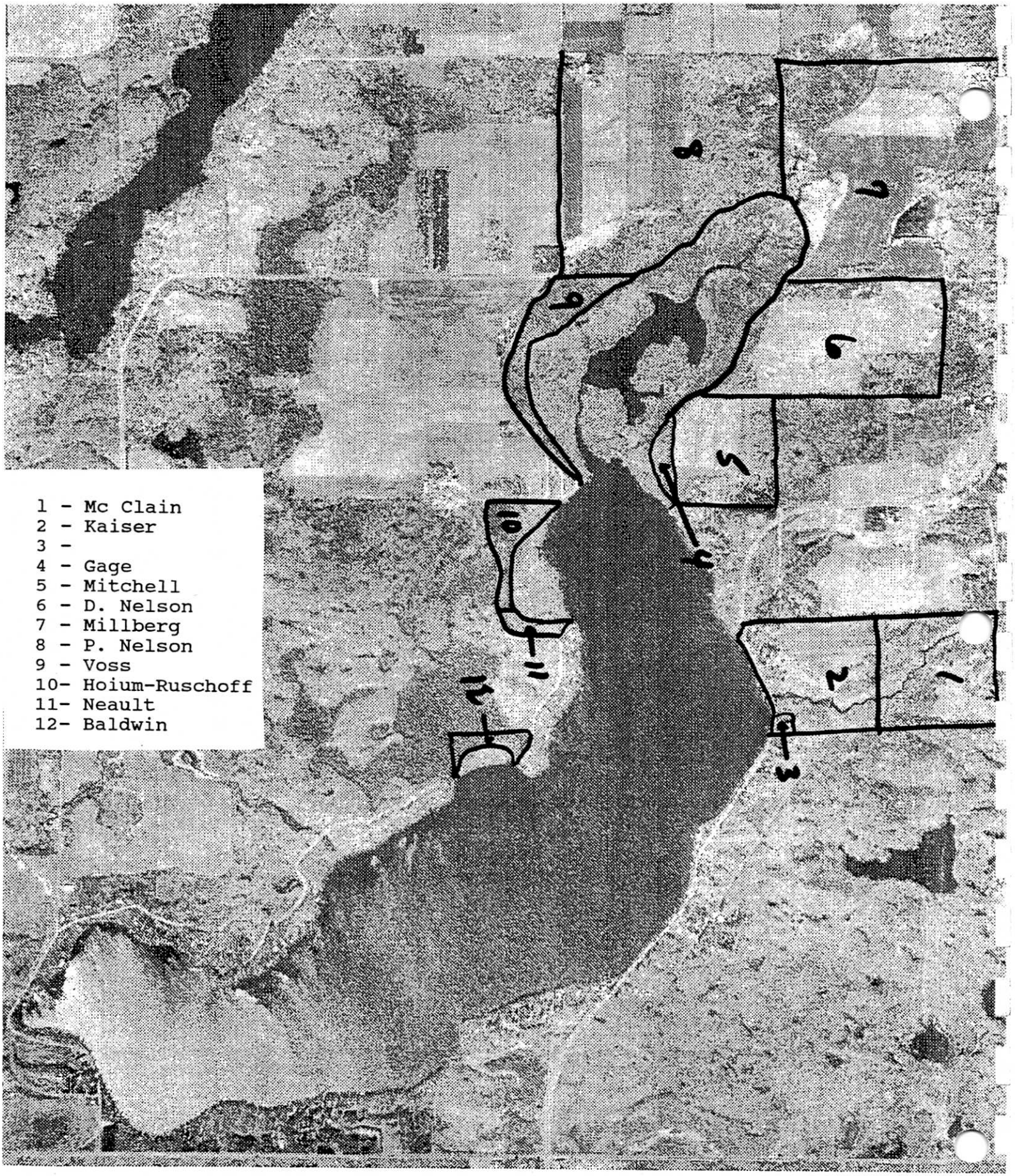
Ed Slaminski
Water Management Specialist

EMS:dh
c:\ems\wr970215

16.0 - FIGURE C

SOUTH ⟷ NORTH

16.0 - FIGURE D SOUTH ⟷ NORTH



17.0 APPENDICES

17.1 LIST OF PLANT SPECIES FOUND IN FOUR SURVEYED WETLANDS IN THE HALF MON LAKE BASIN

Abies balsamea - balsam fir
Acer negundo - box elder
Acer rubrum - red maple
Acer saccharinum - silver maple
Acer saccharum - sugar maple
Adiantum pedatum - maidenhair fern
Agrostis alba - redtop
Agrostis scabra - rough bentgrass
Alisma plantago-aquatica - water plantain
Alnus rugosa - tag alder
Alopecurus aequalis - short-awn foxttail
Alopecurus pratensis - meadow foxtail
Andropogon gerardii - big bluestem
Angelica atropurpurea - purple stem angelica
Aronia prunifolia - chokeberry
Asclepias incarnata - swamp milkweed
Aster macrophyllus - big leaf aster
Aster novae-angliae - New England aster
Aster puniceus - swamp aster
Aster simplex - panicled aster
Aster umbellatus - flat top aster
Athyrium felix-femina - lady fern
Betula alleghaniensis - yellow birch
Betula papyrifera
Betula pumila - bog birch
Bidens cernua - nodding beggarticks
Bidens tripartita - three lobe beggarticks
Boehmeria cylindria - false nettle
Brasenia schreberi - water shield
Bromus ciliatus - fringed brome
Calamagrostis canadensis - blue joint reedgrass
Calopogon pulchellus - grass pink orchid
Caltha palustris - marsh marigold
Carex arcta - northern clustered sedge
Carex aquatilis - water sedge
Carex bebbii - Bebb sedge
Carex brunnescens - brownish sedge
Carex buxbaumii - Buxbaum sedge
Carex canescens - hoary sedge
Carex chordorrhiza - string-root sedge
Carex comosa - bottlebrush sedge
Carex crawfordii - Crawford sedge
Carex crinita - caterpillar sedge
Carex diandra - lesser panicled sedge
Carex disperma - soft-leaf sedge

Carex interior - inland sedge
Carex intumescens - bladder sedge
Carex lacustris - lake sedge
Carex lanuginosa - wooly sedge
Carex lasiocarpa - slender sedge
Carex leptalea - bristly stalk sedge
Carex limosa - mud sedge
Carexmuricata - starry sedge
Carex oligosperma - poor fruit sedge
Carex paupercula - poor sedge
Carex retrorsa - retrorse sedge
Carex rostrata - beaked sedge
Carex stipata - saw-beak sedge
Carex stricta - tussock sedge
Carex trisperma - three-seed sedge
Carex utriculata - inflated sedge
Carex vesicaria - inflated sedge
Carex vulpinoidea - fox sedge
Ceratophyllum demersum - coontail
Chamaedaphne calyculata - leatherleaf
Cicuta bulbifera - bulb-bearing water hemlock
Cicuta maculata - spotted water hemlock
Cirsium arvense - creeping thistle
Clintonia borealis - blue beadlily
Cornus canadensis - bunchberry
Cornus racemosa - gray dogwood
Cornus stolonifera - red osier dogwood
Corylus americana - american hazel
Corylus cornuta - beaked hazel
Drosera intermedia - intermediate sundew
Drosera rotundifolia - round leaf sundew
Dryopteris cristata - crested shield fern
Dryopteris spinulosa - spiny woodfern
Dulichium arundinaceum - arrow sedge
Eleocharis acicularis - least spikerush
Eleocharis ovata - ovate spikerush
Eleocharis palustris - creeping spikerush
Elodea canadensis - waterweed
Equisetum fluviatile - water horsetail
Eriophorum spissum - hare's tail
Eriophorum viridi-carinatum - green keel cottongrass
Eupatorium maculatum - Joe pye weed
Eupatorium perfoliatum - boneset
Fraxinus nigra - black ash
Fraxinus pennsylvanicus - green ash
Gaultheria hispidula - creeping snowberry
Glyceria borealis - floating manna grass
Glyceria canadensis - rattlesnake manna grass
Glyceria maxima - giant manna grass
Glyceria striata - fowl manna grass

Gratiola neglecta - clammy hedge hyssop
Habenaria lacera - ragged fringed orchid
Habenaria psychodes - purple fringed orchid
Ilex verticillata - winterberry
Impatiens biflora - jewelweed
Iris shrevii - blue flag iris
Juncus effusus - soft rush
Juncus tenuis - path rush
Kalmia polifolia - bog laurel
Laportea canadensis - Canada wood nettle
Larix laricina - tamarack
Ledum groenlandicum - Labrador tea
Leersia oryzoides - rice cutgrass
Lemna minor - least duckweed
Lemna trisulca- star duckweed
Lycopus americanus - american bugleweed
Lycopus uniflorus - bog bugelweed
Lysimachia ciliata - fringed loosestrife
Lysimachia terrestris - bog candles
Lysimachia thyrsiflora - tufted loosestrife
Lythrum salicaria - purple loosestrife
Mentha arvense - field mint
Menyanthes trifoliata - bog bean
Mimulus ringens - monkey-flower
Myosotis laxa - bay forget-me-not
Myriophyllum verticillatum
Najas flexilis - slender naiad
Nuphar variegatum - yellow water lily
Nymphaea odorata - white water lily
Onoclea sensibilis - sensitive fern
Osmunda cinnamomea - cinnamon fern
Osmunda claytoniana - interrupted fern
Osmunda regalis - regal fern
Phalaris arundinacea - reed canary grass
Phragmites australis - common reed
Picea mariana - black spruce
Pilea pumila - clear weed
Pinus strobus - eastern white pine
Plantago major - common plantain
Poa compressa - Canada bluegrass
Poa palustris - fowl bluegrass
Poa pratensis - Kentucky bluegrass
Pogonia ophioglossoides - snakemouth orchid
Polygonum amphibium - water smartweed
Polygonum aviculare - prostrate knotweed
Polygonum hydropiperoides - swamp smartweed
Polygonum lapathifolium - willow smartweed
Polygonum pennsylvanicum - Pennsylvania smartweed
Polygonum persicaria - lady's thumb
Pontederia cordata - pickerel weed

Populus balsamifera - balsam poplar
Populus tremuloides - trembling aspen
Potamogeton amplifolius - cabbageweed
Potamogeton epihydrus - ribbon-leaf pondweed
Potamogeton fresii - fries's pondweed
Potamogeton natans - floating pondweed
Potamogeton pectinatus - sago pondweed
Potamogeton richardsonii - Richardson's pondweed
Potamogeton robbinsii - Robbin's pondweed
Potentilla norvegica - Norwegian cinquefoil
Potentilla palustris - marsh cinquefoil
Ranunculus aquatilis - water buttercup
Ranunculus pennsylvanicus - Pennsylvania buttercup
Ribes americanum - wild black currant
Ribes glandulosum - skunk currant
Rubus allegheniensis - blackberry
Rubus idaeus - red raspberry
Rubus pubescens - dwarf blackberry
Rumex crispus - crispy dock
Rumex orbiculatus - great water dock
Sagittaria latifolia - wapeto
Salix bebbiana - Bebb willow
Salix discolor - pussy willow
Salix lucida - shining leaf willow
Salix nigra - black willow
Salix pedicellaris - bog willow
Salix pyrifolia - balsam willow
Sarracenia purpurea - pitcher plant
Scheuchzeria palustris - pod grass
Scirpus acutus - hard stem bulrush
Scirpus atrovirens - cloaked bulrush
Scirpus cyperinus - wool grass
Scirpus microcarpus - small fruit bulrush
Scirpus validus - soft stem bulrush
Sium suave - water parsnip
Solidago canadensis - Canada goldenrod
Solidago gigantea - giant goldenrod
Sparganium chlorocarpum - green burreed
Sparganium eurycarpum - giant burreed
Spartina pectinata - prairie cordgrass
Sphagnum spp. - sphagnum or peat moss
Spiraea alba - meadowsweet
Spiraea tomentosa - steeplebush
Spirodela polyrhiza - greater duckweed
Stachys palustris - hedge nettle
Thalictrum dasycarpum - purple meadowrue
Thelypteris thelipteroides - marsh fern
Triadenum fraseri - marsh St. John's wort
Typha angustifolia - narrow leaf cattail
Typha latifolia - broad leaf cattail

Ulmus americana - american elm
Ulmus rubra - slippery elm
Utricularia intermedia - intermediate bladderwort
Utricularia minor - least bladderwort
Utricularia vulgaris - common bladderwort
Vaccinium angustifolium - blueberry
Vaccinium macrocarpon - large cranberry
Vaccinium myrtilloides - velvet leaf blueberry
Vaccinium oxycoccos - small cranberry
Verbena hastata - blue vervain
Viburnum trilobum - high bush cranberry
Viola cucullata - marsh blue violet
Wolfia punctata - wolfia

nicled aster - 1, 2, 3, 6, 7
Aster umbellatus - flat top aster - 1, 2, 3, 6, 7
Athyriu a e s *f*

17.2 HALF MOON LAKE PHOTOS

Photo 1A Typical row-cropping agriculture in the Tamarack Creek subwatershed of Half Moon Lake.

Photo 1B Pastured agricultural land in the Tamarack Creek subwatershed of Half Moon Lake.

Photo 2 Upland forested land in the Harder Creek subwatershed of Half Moon Lake.

Photo 3 Marsh wetland in the Harder Creek subwatershed of Half Moon Lake.

Photo 4 Residential development along the north shore of Half Moon Lake.

Photo 5 Algae bloom in Tamarack Bay, July 1997.

Photo 6 The Harder Creek inlet on the north shore of Half Moon Lake.

Photo 7 Half Moon Lake viewed from the Harder Creek inlet on the north shore of Half Moon Lake.

Photo 8 The mosaic of wetland communities in the frequently flooded bottomlands along Harder Creek. Grass and sedge marsh occur in the foreground immediately adjacent to the creek bed. The wet but less-frequently flooded bottomland margins adjacent to upland forest are dominated by tamarack (Larix laricina), black ash (Fraxinus nigra), green ash (Fraxinus pennsylvanicus), and tag alder (Alnus rugosa) swamp.

Photo 9 Harder Creek bottomlands viewed from Dau Road facing south. The different marsh zones along the creek are apparent in the photo as are the numerous dead trees (snags) recently killed by beaver flooding. Bottomland margins at the edges of the photo are dominated by ash and tag alder swamp.

Photo 10 Rice cut grass (Leersia oryzoides) along the margins of Harder Creek.

Photo 11 The arrowhead-shaped leaf blades and white flowers of arrowhead (Sagittaria latifolia) growing with sedges and rice cut grass in the shallow margins of Harder Creek.

Photo 12 Jewelweed (Impatiens biflora) growing in the marsh vegetation along the banks of Harder Creek.

Photo 13 Narrow-leaf cattail (Typha angustifolia) growing in the shallow margins of Harder Creek and in scattered shallow depressions throughout the bottomlands.

Photo 14 Harder Creek channel with grass and sedge-dominated (graminoid) marsh along the margins which also support numerous dead snags of ash, tamarack, and red maple (Acer rubrum), killed by recent beaver flooding.

Photo 15 Purple fringed orchid (Habenaria psychodes) growing on wet sand and gravel bars in the marsh on the edge of Harder Creek.

Photo 16 White water lily (Nymphaea odorata) growing in sluggish stretches of Harder Creek.

Photo 17 The reed canary grass (Phalaris arundinacea), blue joint reedgrass (Calamagrostis canadensis), and sedge (Carex lacustris and C. stricta) seasonally flooded marsh adjacent to the Harder Creek channel. The dead trees in this marsh indicate that it was recently ponded by beaver damming on the creek.

Photo 18 The black ash (Fraxinus nigra), red maple (Acer rubrum), and tag alder (Alnus rugosa) swamp along Harder Creek with an understory dominated by sedges and several fern species.

Photo 19 The pond created by a beaver dam on Harder Creek approximately 200 yards upstream from the inlet on Half Moon Lake.

Photo 20 Formerly tilled and pastured fields on the McClain property adjacent to Harder Creek; now in the early stages of old field succession.

Photo 21 Joe-pye weed (Eupatorium maculosum) growing in the marsh habitats along Harder Creek. Note: these flowers are just in bud; when open they are much more spectacular.

Photo 22 Boneset (Eupatorium perfoliatum) growing in the marsh habitats along Harder Creek.

Photo 23 Swamp milkweed (Asclepias incarnata) growing in marsh communities along Harder Creek.

Photo 24 View of Tamarack Bay showing the large floating leaves of white (Nymphaea odorata) and yellow water lily (Nuphar variegatum) and the dense growth of the free-floating duckweeds (Lemna minor, Spirodela polyrhiza, and Wolfia punctata).

Photo 25 Closeup of the three duckweed species that cover most of Tamarack Bay. The largest stems with the reddish edge are greater duckweed (Spirodela polyrhiza), the medium sized ones are of least duckweed (Lemna minor) and the smallest ones are from wolfia (Wolfia punctata) These are the smallest flowering plants in the world, they are not algae.

Photo 26 Tamarack Bay, July 1997 showing the algae/duckweed bloom as it began to die back.

Photo 27 Sphagnum or peat moss (Sphagnum spp.), which dominates the floating and fixed peatland habitats in Tamarack Bay, Nelson Bay, Baldwin Bay, and elsewhere around Half Moon Lake.

Photo 28 The floating peatland (bog) habitat at Nelson Bay. The mat is floating over water and is dominated by sphagnum moss, sedges, shrubs such as leather leaf (Chamadaphne calyculata), Labrador tea (Ledum groenlandicum), and bog rosemary (Andromeda polifolia), and scattered clumps of black spruce (Picea mariana), and

tamarack (Larix laricina) trees. All of this type of habitat is legally considered part of the lake because it is below the ordinary high water mark. It is therefore protected from development.

Photo 29 Two dominant sedges of the floating peatland habitats around Half Moon Lake; beaked sedge (Carex rostrata) on the bottom and inflated sedge (Carex utriculata) on top.

Photo 30 Very unstable floating peatland on the margins of Nelson Bay dominated by fen vegetation, including sphagnum moss, sedges, cattails, tag alder, leather leaf, and tamarack.

Photo 31 Bristly sedge (Carex comosa) one of the most showy lake edge species growing along the margins of Half Moon Lake, both on the floating peatlands, and on the stable margins covered with mineral soil.

Photo 32 Bog cranberry (Vaccinium macrocarpon), characteristic of the poor fen and bog floating peatland habitats surrounding Half Moon Lake.

Photo 33 Bog birch (Betula pumila), a characteristic species of poor and intermediate fen floating peatland habitats surrounding Half Moon Lake.

Photo 34 Reed canary grass marsh along the edge of the Tamarack Creek inlet on the north end of Tamarack Bay.

Photo 35 Two heath family shrubs that dominate the floating and fixed peatland habitats around Half Moon Lake: Labrador tea (Ledum groenlandicum) on the left and leatherleaf (Chamaedaphne calyculata) on the right.

Photo 36 Lake sedge (Carex lacustris), a dominant sedge species of marsh and rich fen peatland habitats of Half Moon Lake.

Photo 37 Regal fern (Osmunda regalis), which occurs in swamp wetlands (tree dominated on mineral soil) around Half Moon Lake.

Photo 38 Slender sedge (Carex lasiocarpa), a common species of floating and fixed fen and bog peatland habitats surrounding Half Moon Lake.

Photo 39 Starry sedge (Carex muricata), a species of floating and fixed fen peatland habitats surrounding Half Moon Lake.

Photo 40 Bog rosemary (Andromeda polifolia), a common shrub species of floating poor fen and bog habitats around Half Moon Lake.

Photo 41 Floating bog habitat in the Nelson Bay wetland on Half Moon Lake. True bog habitat differs from fen peatlands by being covered by a solid mat of sphagnum moss with only scattered sedges, stunted tamaracks, and bog shrubs like Labrador tea and bog rosemary. The whole area pictured is floating over open water. The mat may range from one to several meters thick. Because of its floating nature, it is below the ordinary high water mark and is therefore considered part of the lake and is afforded the same legal protection from development as the open water portions of the lake.

Photo 42 Closeup of the floating bog peatland in Nelson Bay showing sphagnum moss hummocks around the base of the stunted tamarack trees. A tree this size (about six feet tall) can often be nearly 100 years old due to their slow growth in the nutrient poor soil conditions of a floating bog.

Photo 43 A closer look at the sphagnum hummocks surrounding the stunted tamarack trees on the floating bog peatland in the Nelson Bay wetland on Half Moon Lake.

Photo 44 An ant's eye view of the sphagnum dominated floating bog peatland in the Nelson Bay wetland. Notice the complete coverage of the habitat by sphagnum moss while sedge and shrub stems are very scattered in occurrence.

Photo 45 Snakemouth orchid (Pogonia ophioglossoides) growing on the floating bog habitat in the Nelson Bay wetland.

Photo 46 Snakemouth orchid in the floating bog of the Nelson Bay wetland.

Photo 47 Grass pink orchid (Calopogon pulchelus) in the floating bog peatland in the Nelson Bay wetland.

Photo 48 Closeup of grass pink orchid.

Photo 49 Habitat of the ragged fringed orchid (Habenaria lacera), a Wisconsin State Rare species, which grows on the floating bog peatland in the Nelson Bay wetland.

Photo 50 Ragged fringed orchid in bud, early July 1997.

Photo 51 Ragged fringed orchid in flower, late July 1997.

Photo 52 Closeup of ragged fringed orchid, late July 1997.

Photo 53 The insect-trapping modified leaves of the pitcher plant (Sarracenia purpurea), which is common in the floating fen and bog peatland habitats surrounding Half Moon Lake.

Photo 54 The beautiful large, purple flowers of the pitcher plant (in the foreground) in the floating bog peatland in Baldwin Bay.

Photo 55 Closeup of intermediate sundew (Drosera intermedia), showing its insect-trapping leaves, growing with pitcher plant in the shallow water of the floating fen vegetation zone in the Nelson Bay wetland.

Photo 56 Round leaf sundew (Drosera rotundifolia) with its insect-trapping leaves, growing in the rich to poor fen vegetation zones on the floating peatland in the Nelson Bay wetland.

Photo 57 The stems, highly dissected leaves, and insect-trapping bladders of the least bladderwort (Utricularia minor), an aquatic carnivorous plant that occurs in the shallow water on the surface of the floating peatland in the Nelson Bay wetland.

Photo 58 The emergent flowering stems of the least bladderwort.

Photo 59 The highly unstable floating mat near the edge of Half Moon Lake in Nelson Bay. It is dominated by intermediate fen vegetation and is traversed by many channels that are connected to Half Moon Lake.

Photo 60 The highly unstable floating mat edge in Nelson Bay looking northeast into Half Moon Lake.

Photo 61 The tag alder-dominated swamp zone adjacent to Half Moon Lake in the Baldwin Bay wetland.

Photo 62 Blue flag iris (Iris shrevii), a common species on the margins of the floating peatlands surrouding Half Moon Lake.

Photo 63 Poor fruit sedge (Carex oligosperma), which grows in poor and intermediate fen zones on the floating peatland mat in the Baldwin Bay wetland.

Photo 64 Three characteristic sedges of the floating fen petland habitats in Baldwin Bay. Left to right are inflated sedge (Carex utriculata), arrow sedge (Dulichium arundinaceum), and poor sedge (Carex paupercula),

Photo 65 Bog candles (Lysimachia terrestis) in the fen habitats in the Baldwin Bay wetland.

Photo 66 The fragrant maroon flowers of marsh cinquefoil (Potentilla palustris) growing on the floating fen peatlands in the Baldwin Bay wetland.