# *Wisconsin Lake Planning Grant Report*

## *Half Moon Lake*
## *Polk County, Wisconsin*

*Prepared for*
*Half Moon Lake Protection and*
*Rehabilitation District*

*June 1994*

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HALF MOON LAKE

PLANNING GRANT REPORT

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## 1.0 INTRODUCTION

Half Moon Lake in Polk County, Wisconsin is located in a part of the State known as the Balsam Branch of the Apple River Watershed. Because of the importance of the area as a State resource, the Balsam Branch has recently been designated as a Priority Watershed by the Wisconsin Department of Natural Resources (WDNR) . The following Half Moon Lake Planning Grant Project was initiated by the Half Moon Lake Protection and Rehabilitation District (HMLPRD) to investigate the current condition of the lake, and identify potential projects for protection of the lake. The Lake Planning Grant Program provides funding for lake specific projects through the WDNR.

The purpose of this project is 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. Lake management should be considered as an endless responsibility requiring planning, knowledge, and flexibility in dealing with the issues affecting the lake. Much of the information in this report is technical in nature, and does not specifically address an existing problem. It does, however, provide information about the lake and watershed that will help the HMLPRD make informed decisions about lake management issues.

The goal of the Half Moon Lake Planning Grant project is to provide the HMLPRD with the background information necessary to make decisions about the management of Half Moon Lake, and to provide guidance on the issues affecting the function and value of the lake. The management plan portion of the report is intended to become a part of the long term management of the lake by the HMLPRD, and subject to periodic modification and updating. If properly maintained, the plan will provide long term guidance for future managers of the HMLPRD. It is hoped that this plan will promote thoughtful planning and a succession of consistent management philosophies for Half Moon Lake.

## 1.1 Half Moon Lake

Half Moon Lake is located in Polk County, Wisconsin, approximately 3 miles northeast of the town of Balsam Lake. The watershed contributing to Half Moon Lake is presented in Figure 1, and the morphometry of the lake is shown in Figure 2 and presented in Table 1. There are two main stream inflows to the lake, Harder Creek entering the lake on the north and a smaller stream entering through the Tamarack Bay area on the west side of the lake. Water levels are controlled by an outlet structure on the southern shore of the lake which discharges to Harder Creek, and ultimately to Balsam Lake.

The lake is classified by the WDNR as drainage lake with common abundances of northern pike, walleye, and largemouth bass. According to the WDNR, one or more species of fish in Half Moon Lake have been tested for mercury concerns, and presently no consumption advisory exists for the fish in the lake.

A public park with a swimming beach and public access is located at the west end of the lake. Approximately 197 seasonal and permanent residences are located on the lake. Based on previous studies of the lake, approximately 10 percent of the residences are permanent and the remainder seasonal. The current uses of the Half Moon Lake include fishing, boating, waterskiing, and jet skiing.

TABLE 1

HALF MOON LAKE MORPHOLOGY[1]

| | |
|---|---|
| Lake Surface Area | 579 acres (234 ha) |
| Maximum Depth | 60 feet (18 m) |
| Mean Depth | 25 feet (7.6 m) |
| Volume | 14,750 acre-feet (18.19 $hm^3$) |

[1] Values reported by Wisconsin DNR

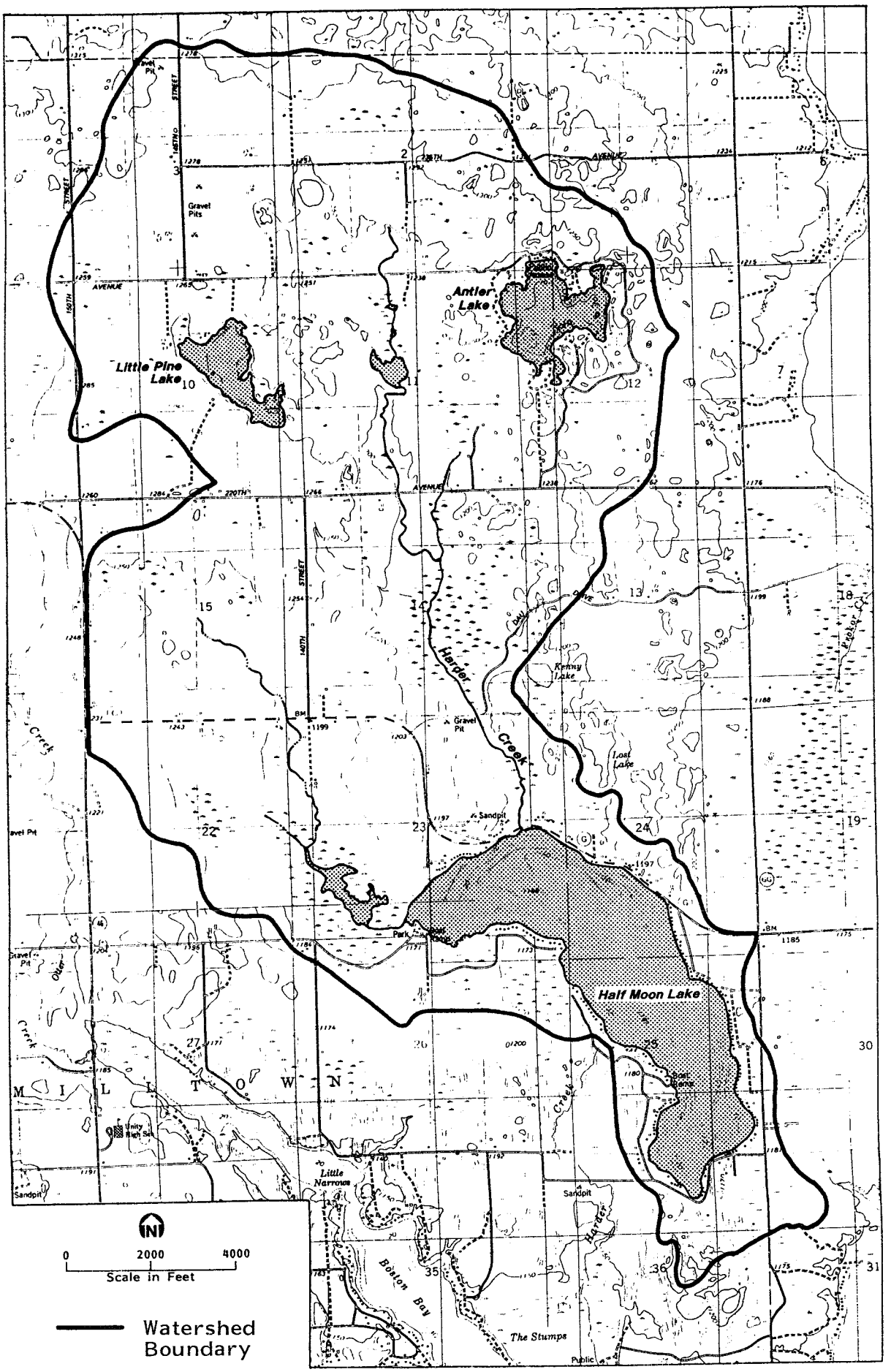



FIGURE 1

HALF MOON LAKE WATERSHED

# HALF MOON LAKE




FIGURE 2

## 2.0 WATERSHED INVENTORY

A lake's watershed is often the main source of dissolved minerals, nutrients, and suspended solids to that lake. The amount and composition of material carried into the lake is highly dependent on the following watershed components: geology, soil composition, land use and topography, and vegetative cover. The information gathered on each during the watershed inventory of Half Moon Lake is discussed in the following sections.

### 2.1 Surficial Geology

The watershed geology is important for several reasons. Direction and amount of groundwater flow is influenced by the bedrock geology. Rock weathering will contribute to the concentrations of dissolved minerals in both groundwater and surface water flow. Stability of the bedrock may affect erosion rates and suspended solids concentrations in streams tributary to the lake.

The Half Moon Lake watershed is located in a geologic setting of glacial drift resting unconformably on Cambrian age sandstones which overlay Precambrian rock of various compositions. The glacial drift consists of till and outwash deposits. Till deposits are deposited directly by glaciers without being reworked by meltwater flowing away from the glacier. Till deposits tend to have various sizes of sediment intermixed and are unlayered. Outwash deposits are deposited by the meltwater flowing away from the glacier as it melts and recedes. Outwash deposits tend to be stratified by sediment size. The glacial drift deposits in the Half Moon Lake watershed area generally consist of ground moraine tills deposited from the bottom of the glacier as it melted and receded and end moraine tills deposited at the farthest reach of the glacier before it started melting and receded. The ground moraine tills are comprised of unstratified clay, silt, sand, gravel and boulders. The end moraine tills are comprised of unstratified clay, silt, sand, gravel, and boulders and lessor amounts of stratified sand and gravel. Scattered areas across the watershed are covered with outwash deposits comprised of stratified sand and gravel. The glacial deposits range in thickness from approximately 100 to 150 feet across the watershed.

The uppermost bedrock units found under the glacial drift deposits are the Cambrian sandstones including the Jordan Sandstone, the St. Lawrence Formation, and the Franconia, Galvesville, Eau Claire, and Mount Simon Sandstones. The Cambrian age rocks rest on Precambrian basaltic lava flows, sedimentary sandstones and shales, and igneous and metamorphic crystalline rocks.

## 2.2 Soils

The soil composition in the lake's watershed is important, especially in regards to onsite waste disposal (septic systems). The effective operation of a septic system depends on the efficiency of the waste treatment provided by the surrounding soil. The soil should stabilize the septic system discharge water so it can be evaporated or used by vegetation; the soil should also adsorb and remove most of the phosphorus in the discharge water. The type of soil, the slope of the soil, and the proximity of the soil layer to groundwater will all affect the soil treatment of septic tank discharge water.

The soils identified across the Half Moon Lake watershed area are of three major types: the Amery-Santiago-Magnor (covering approximately 75% of the watershed), the Antigo-Rosholt (covering approximately 10% of the watershed), and the Rosholt-Cromwell-Menahga (covering approximately 15% of the watershed) (U.S.D.A, 1979).

The Amery-Santiago-Magnor is generally found in the region north and east of Half Moon Lake and south of Little Pine and Antler Lakes. This soil unit is generally level to very hilly, well drained, and composed of loamy and silty soils laying on glacial till.

The Antigo-Rosholt soil unit is generally found west of Half Moon Lake and north of Little Pine and Antler Lakes. The Antigo-Rosholt soil unit is comprised of nearly level to sloping, well drained silty and loamy soils that developed on outwash deposits.

The Rosholt-Cromwell-Menahga soil unit is generally found immediately north, west, and south of Half Moon Lake near the shores of the lake. The soil unit is a level to very hilly, well to excessively drained, loamy and sandy soil unit that developed on outwash deposits.

According to the soil survey of Polk County, Wisconsin (U.S.D.A., 1979) the general septic system performance is moderate to poor in the soil units found in the Half Moon Lake watershed due to the slope, wetness, and slow percolation of the soil.

## 2.3 Land Cover

The vegetative cover of a lake's watershed is important for several reasons. Established vegetation will prevent soil erosion by protecting the soil cover from impact, and by stabilizing the soil

with a root structure. According to the Wisconsin DNR, the erosion rate from unprotected disturbed soils may be a thousand times greater than that from soils protected by a mature forest (WDNR, 1980). Eroded soils entering a lake may increase the suspended solids concentrations, nutrient concentrations, and water turbidity, and decrease water clarity; the eroded soils may also negatively affect the fishery by disturbing spawning habitat. Vegetation will also reduce the amount of runoff from the watershed by moisture uptake through root systems. Vegetative buffer strips near the lake shore may remove nutrients from the direct watershed runoff.

The original vegetation in the Half Moon Lake watershed consisted of mixed coniferous-deciduous forests (maple, birch, white pine, red pine), deciduous forests (maple, basswood, oak), and wetland vegetation (cedar, black spruce, tamarack) (Finley, 1976). Approximately 25 percent of the watershed has been converted to agricultural cropland, and over 10 percent has been converted to pasture or open land, or developed. The fraction of the remaining watershed area altered by land clearing and logging is not known. Currently the greatest disturbance of vegetative cover in the Half Moon Lake watershed is due to agriculture and construction projects.

## 2.4 Land Use

Water runoff from various land uses will contain disparate amounts of phosphorus, which is related to the fraction of impervious surface (hard surface or paved), the degree of soil disturbance, and specific activities (e.g. fertilizer use, animal grazing, car and truck traffic) associated with a particular land use. Statistical analysis of field data by numerous researchers has resulted in the calculation of export coefficients - the annual amount of phosphorus predicted to runoff from a specific land area, usually in units of pounds per acre. When minimal field data is available, the land use breakdown for a watershed and appropriate export coefficients can be used to predict the phosphorus load to the lake from the watershed.

Land use in the Half Moon Lake watershed was determined using Agricultural Stabilization and Soil Conservation Service (ASCS) aerial photos for 1992 and 1986 - 1988, as well as U.S.G.S. topographic quadrangle maps. The following land use categories were used in the analysis: woodland, marsh/wetland, open space, row crop, non-row crop, farmyard/feedlot, and pasture. Open space was defined as non-agricultural fields, while pasture was defined as land areas used for livestock grazing.

The land use analysis is presented in Table 2. The watershed is mainly undeveloped, except for the lakeshore. Woodland, wetland, and open space cover 74 percent of the watershed, while 26 percent of the watershed is used for agriculture. Figure 3 shows the location of all active farms within the watershed identified by the Polk County Land Conservation District.

Land use within the Half Moon Lake watershed was also estimated in 1980 by the Wisconsin DNR; the Little Pine and Antler Lake subwatersheds were not included in their analysis. They estimated the 5,100 acre watershed was approximately 62 percent agricultural, and 38 percent forests and wetlands. Since the land use classifications in that study were not clearly defined, it is difficult to compare the DNR land use determination with that of this study.

## 2.5 Watershed Topography

The topography of the watershed will affect the rate of runoff to the lake. Hilly terrain with steep grades will produce more runoff at higher velocity flow than gently sloping or flat terrain. Low-lying depressions, such as wetlands and ponds, may store and moderate the runoff flow.

The Half Moon Lake watershed topography is typical of glacially-scoured terrain, with gently rolling hills, many pot-hole wetlands, and kettle lakes. The maximum elevation within the watershed is 1300 m.s.l., while the elevation of Half Moon Lake is about 1166 m.s.l. (according to 1983 U.S.G.S. topographic maps Luck, Wisconsin, and Balsam Lake, Wisconsin).

# TABLE 2
## HALF MOON LAKE WATERSHED AREAS AND LAND USE BREAKDOWN

| SUBWATERSHED | TOTAL AREA (ACRES) | WOODS (ACRES) | MARSH (ACRES) | OPEN[1] (ACRES) | ROW CROP (ACRES) | CROP (ACRES) | FARMYARD[2] (ACRES) | PASTURE[1] (ACRES) | URBAN LAKESHORE (ACRES) |
|---|---|---|---|---|---|---|---|---|---|
| Little Pine | 544.2 | 123.4 | 104.8 | 43.9 | 207.9 | 59.2 | 5.1 | 0.0 | 0.0 |
| Antler | 511.9 | 192.5 | 313.1 | 0.0 | 6.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Harder Creek | 2470.9 | 595.2 | 1206.0 | 234.2 | 303.7 | 131.9 | 0.0 | 0.0 | 0.0 |
| Tamarack | 1332.3 | 91.5 | 471.2 | 164.6 | 469.2 | 116.9 | 9.6 | 9.3 | 0.0 |
| Direct | 845.3 | 518.5 | 111.2 | 47.9 | 104.4 | 1.7 | 8.6 | 53.0 | 150.0 |
| TOTAL | 5704.6 | 1521.0 | 2206.2 | 490.7 | 1091.5 | 309.7 | 23.3 | 62.3 | 150.0 |

1 Open area defined as non-agricultural, non-forest, vegetated area
Pasture defined as land used for cattle grazing.

2 Farmyard defined as agricultural impervious/impacted area including buildings, driveways, barns, feedlots, etc. All feedlots in Half Moon Lake Watershed were classified as non-critical by 1993 Balsam Branch Priority Watershed Project. See Section 4.3.2, page 31.

## 3.0 HYDROLOGIC INVENTORY

Nutrients, dissolved minerals, and suspended solids are typically transported to a lake by surface water runoff, groundwater flow, or direct precipitation. A hydrologic inventory was done on the Half Moon Lake watershed in order to determine routes and quantity of surface runoff, amount and direction of groundwater flow, and amount of precipitation. Wetlands, lakes, and ponds in the watershed were also identified, and water quality data was tabulated. The following sections discuss the various components of the hydrologic inventory carried out during this study; supplementary information and reference materials have been provided to the HMLPRD as a separate file for future reference.

### 3.1 Drainage Divides

Drainage divides are used to separate the watershed into subwatersheds. While watershed refers to the entire land area which ultimately drains to a lake, subwatershed refers to a portion of the watershed which drains to the lake by the same route, such as through a creek.

Drainage divides were determined using Luck, Wisconsin and Balsam Lake, Wisconsin U.S.G.S. topographic quadrangle maps. The Half Moon Lake watershed consists of 6,400 acres (5,700 acres excluding lake surface areas). Six subwatershed areas were identified, and are shown in Figure 3. The watersheds of Little Pine Lake and Antler Lake were not included in the original watershed delineation since no surface outlets from those lakes flow to Half Moon Lake. However, those areas were included in the Half Moon Lake watershed delineation completed by the Wisconsin DNR as part of the Balsam Branch Priority Watershed Project. To be consistent, those areas have been included in the watershed delineation used in this study.

### 3.2 Rainfall

The amount of surface runoff to a lake is directly related to the amount of precipitation falling on the watershed. Since the amount of precipitation typically varies from year to year, the amount of surface runoff to lake will vary annually, as well.

Precipitation data was obtained from the Wisconsin State Climatologist's Office for the nearest precipitation gage station, which is approximately five miles from Half Moon Lake at Luck, Wisconsin.

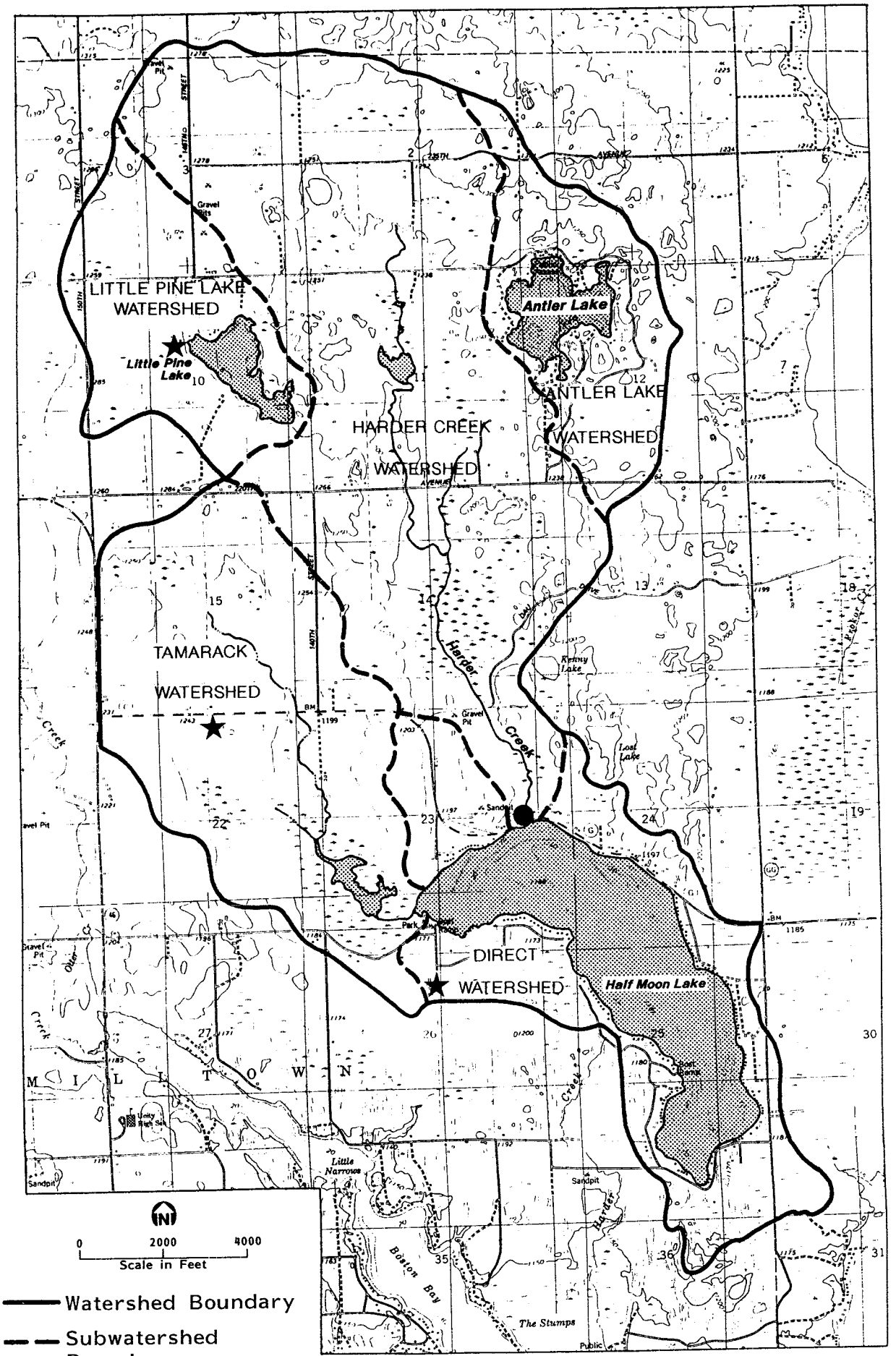



FIGURE 3

HALF MOON LAKE SUBWATERSHEDS

The long term annual average for the station (based on data collected from 1961 - 1990) is 31.12 inches; the total precipitation measured at the Luck station during 1993 was 33.08 inches. Therefore, the Lake Planning Grant study was carried out during a period of greater than normal precipitation.

## 3.3 Wetlands

Wetlands in a watershed affect the water quality and quantity of surface water runoff entering a lake in several ways. Wetlands provide water storage during snowmelt or periods of high rainfall, when high runoff flows occur. As runoff is stored in wetland areas, downstream flows are moderated. Therefore, damage often associated with high stream flows, such as streambank erosion, loss of vegetation, and elevated suspended solids loads, are reduced. Wetlands may also improve runoff water quality by providing water storage. Suspended solids particles are settled out, and phosphorus is removed by microbial, algal, and aquatic plant uptake. Wetlands located along the lakeshore provide critical habitat for fish spawning and waterfowl nesting.

Wetlands in the Half Moon Lake watershed were identified using U.S.G.S. topographic maps, A.S.C.S. aerial photography, and Wisconsin DNR wetland inventory maps. Approximately 39 percent of the watershed area is covered by wetlands, most of which are associated with the Harder Creek and Tamarack Creek subwatersheds. The wetlands directly associated with Harder and Tamarack Creeks are classified as forested or scrub, with deciduous (leaved) and coniferous (needled) tree cover, palustrine (marsh-like) soil conditions, and several areas of open water with emergent plant vegetation. The Harder Creek subwatershed is also dotted with wetlands smaller than 5 acres, with a few areas of open water with floating vegetation. The Half Moon Lake direct subwatershed also contains several large wetlands, and numerous small wetlands smaller than 5 acres. Several of the large wetlands in the direct subwatershed are directly associated with the lake shoreline.

## 3.4 Drainage Systems

Drainage systems are rivers, creeks, and streams which drain from the watershed to the lake via channelized flow. Large portions of the watershed may be drained by a single stream; the channelized flow will accelerate watershed runoff, and resulting flows may be too rapid to allow suspended particles to settle out before reaching the lake. During periods of high runoff, lake levels may be affected from stream inflow. Large portions of the nutrient load to a lake may also enter through drainage systems.

Two drainage systems flow into Half Moon Lake via tributary creeks. Harder Creek enters the lake on the north shore, while Tamarack Creek enters the lake at the northwest end. Harder Creek drains approximately 2,500 acres; approximately 50 percent of the drainage area is wetland, while 18 percent is agricultural. Tamarack Creek drains approximately 1,300 acres, of which 7 percent is wetland, and 47 percent is agricultural. Harder Creek is the only surface outlet in Half Moon Lake; it exits the lake on the southwest shore, and ultimately flows to Balsam Lake.

## 3.5 Groundwater

The amount and direction of groundwater flow to a lake can influence the water quality of a lake. Groundwater inflow can make up a large portion of water flowing to a lake each year; depending on the surrounding geology, the groundwater inflow can transport significant amounts of dissolved minerals to the lake. Groundwater contaminated by septic systems or fertilizers may transport nutrients to the lake, as well.

Groundwater flow characteristics were not determined as part of this planning grant study. However, as part of a feasibility study conducted during the late 1970's, the Wisconsin Department of Natural Resources determined the local groundwater flow pattern around Half Moon Lake through the installation of monitoring wells (WDNR, 1980). In general, the DNR found that the groundwater was flowing into the lake along the north shore, and out of the lake along the east and west shores of the southern two-thirds of the lake basin. The DNR estimated the groundwater inflow to the lake as 0.4 cubic feet per second (cfs), and the outflow as 3.4 cfs. The average phosphorus concentration in the monitoring wells was 0.03 mg/L, which is higher than observed phosphorus concentrations in Half Moon Lake.

## 3.6 Lakes

Tributary lakes are small lakes and ponds that ultimately drain to a downstream lake; the tributary lakes are included in the downstream lake's watershed. The tributary lakes and ponds usually improve the water quality of the watershed runoff before it reaches the main lake by settling out suspended solids and particulate phosphorus.

The Wisconsin DNR has determined that the Half Moon Lake watershed contains two small tributary lakes - Little Pine Lake, and Antler Lake. Little Pine Lake has a surface area of 61 acres, and

a maximum depth of approximately 10 feet. Antler Lake has a surface area of 101 acres, and a maximum depth of approximately 22 feet. Even though these lakes are included in the Half Moon Lake watershed, neither has a surface outlet which flows directly to the lake. Therefore, the outflow from these lakes probably has minimal effect on the water quality of Half Moon Lake.

Several small unnamed ponds also lie within the Half Moon Lake watershed. Most of these are within wetland areas associated with Harder and Tamarack Creeks.

## 3.7 Water Quality Data

In-lake water quality data for Half Moon Lake were not collected as part of this planning grant study. However, during 1993 the Wisconsin DNR collected lake water samples for laboratory analysis as part of the Balsam Branch Priority Watershed Project. Samples were collected during April, June, July, and September. Lake water quality data was also collected during several past studies of the lake, which are outlined in Table 3. Historical phosphorus and chlorophyll a concentrations were measured during 1982, 1986, 1987, and 1988; secchi disc transparency data was also collected those years, as well as during 1977. Phosphorus data generated during the late 1970's by an independent laboratory was found by the DNR to be in error, and was not used in this study. The 1993 and the historical data are presented and discussed in subsequent sections.

## 3.8 1993 Flow Monitoring

The Harder Creek watershed is the largest contributing area to Half Moon Lake, and is the source of most surface water inflows to the lake. As a part of this Lake Planning Grant project, flow monitoring of Harder Creek was conducted between May 7 and October 1, 1993. An automatic flow meter was installed at the outlet of Harder Creek to the lake. This flow meter measured the rate of flow into the lake on a fifteen minute basis during the monitoring period. Daily total inflows measured at this site are summarized in Appendix A, and presented in Figure 4. In addition to measuring the flow rate of Harder Creek, several grab samples were collected to provide an indication of the water quality of Harder Creek which were analyzed for total phosphorus, total ammonia, organic nitrogen, total Kjeldahl nitrogen, nitrate+nitrite nitrogen, and total suspended solids.

Flow monitoring data collected during this period indicate that the wetlands, lakes and other storage areas within the watershed significantly reduce the volume of water entering the lake. During

# TABLE 3

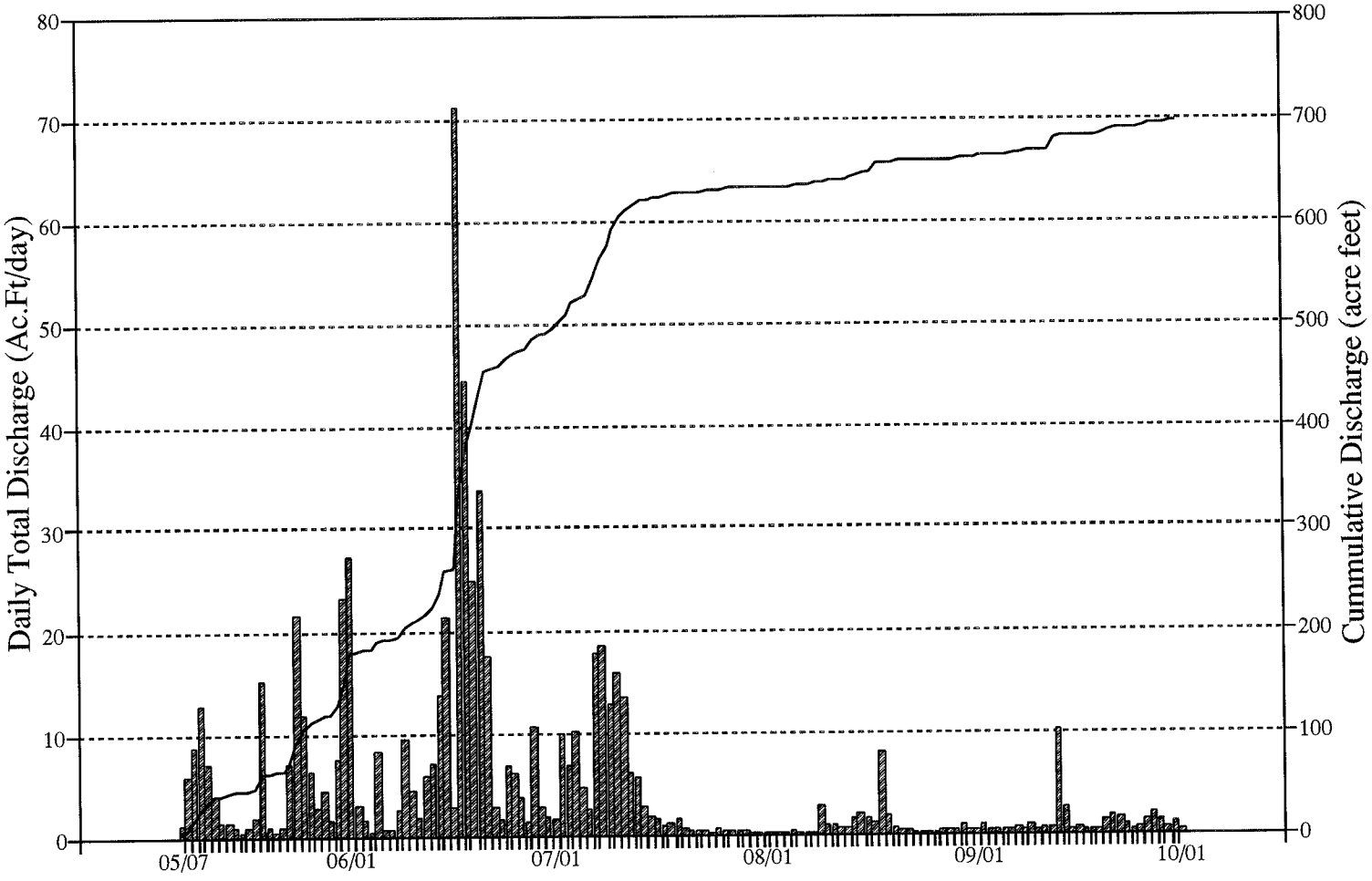
## SOURCES OF HISTORICAL DATA FOR HALF MOON LAKE

| YEAR | SOURCE | PURPOSE OF STUDY |
|---|---|---|
| 1977 | Environmental Research Assessments/Wisconsin DNR | Feasibility Study |
| 1982 | Serco | Not Available |
| 1986 | Instrumental Resource, Inc. | Hypolimnetic Aeration Study |
| 1987 | Wisconsin DNR | Ecoregion Study |
| 1988 | Wisconsin DNR | Ecoregion Study |
| 1993 | Wisconsin DNR | Balsam Branch Priority Watershed |

FIGURE 4

# Half Moon Lake - Polk County, Wisconsin

## Harder Creek Inflow: May-September 1993



May, June and July, frequent rainstorms produced increases in flow in proportion to the size of the storm event. The months of August and September were very dry, and little flow was observed in Harder Creek. It is assumed that the dry weather allowed for the depletion of storage within the watershed, and runoff was retained in the watershed rather than discharged to the lake.

Beaver dams upstream of the monitoring station created problems in determining the runoff yield from the watershed. Periodically during the year the beaver dams were removed and the stored water behind the dams released to the lake. This situation produced increased flows at the monitoring station that were not related to rainfall events. The highest flows to the lake resulted from the removal of the dams; because of this situation the total volume of water flowing to the lake was higher than would be expected from natural conditions.

Based on a watershed area for Harder Creek of 2471 acres, the yield of runoff during this period was calculated to be 3.4 inches. The U.S.G.S. reports the longterm average yield over the same period for the Apple River near St. Croix Falls to be 3.82 inches (U.S.G.S. 1991). As previously stated, 1993 was a wet year with annual precipitation approximately 6% above average. The measured inflows to the lake were approximately 15% lower then would be expected based on long term averages in this area. The lakes, wetlands, beaver ponds in the watershed are responsible for the reduced inflows.

A summary of water quality samples collected during this project are presented in Table 4.

TABLE 4

HARDER CREEK WATER QUALITY ANALYSIS

| DATE | AMMONIA (mg/L as N) | NITRATE + NITRITE (mg/L as N) | TOTAL KJELDAHL NITROGEN (mg/L as N) | TOTAL PHOSPHORUS (mg/L) | TOTAL SOLIDS (mg/L) | TOTAL SUSPENDED SOLIDS (mg/L) |
|---|---|---|---|---|---|---|
| 06/15/93 | 0.050 | <0.007 | 1.1 | 0.186 | 156 | 9 |
| 06/30/93 | 0.052 | 0.033 | 1.2 | 0.095 | 148 | <2 |
| 09/13/93 | 0.176 | 0.117 | 1.0 | 0.122 | 166 | 4 |
| 04/18/94 | 0.068 | 0.076 | 0.6 | 0.055 | 100 | 2 |
| Spring, 1994 | Collected, laboratory results not received | | | | | |
| Spring, 1994 | Collected, laboratory results not received | | | | | |



B:\TAB4.TAB\JXL

## 4.0 DATA ANALYSIS

Data collected for this project provides insight to the condition of water quality in Half Moon Lake, and the factors influencing the lake. The reported condition of the lake is compared with historic data for Half Moon Lake, the water quality of nearby lakes, and estimates of nutrient loadings to the lake. These comparisons will be used to determine whether water quality problems exist in Half Moon Lake, and the possible cause of these problems.

### 4.1 Present Trophic Status of Half Moon Lake

The 1993 phosphorus, chlorophyll a, and transparency data are shown in Figure 5. Chlorophyll a concentration was highest during June and September, and was lowest during August. This is unusual, since in lakes similar to Half Moon the chlorophyll a concentrations are highest in August, due to blue-green algae blooms. The water transparency was highest during August, coinciding with the low chlorophyll a concentrations. The total phosphorus in Half Moon Lake remained fairly constant throughout the monitoring period.

One method of expressing a lake's degree of eutrophication is by calculating a Trophic State Index (Carlson, 1977) from measured water quality parameters. A TSI value can be calculated based on either total phosphorus concentrations, Secchi disc transparencies, or chlorophyll a concentrations. It describes the relationship between these physical/chemical/biological water quality parameters and the productivity of the lake. Four trophic stats designations used for lakes are given below with corresponding approximate TSI value ranges:

Oligotrophic -- [$20 \leq TSI \leq 38$} clear, low productivity lakes,

Mesotrophic -- [$38 < TSI \leq 50$] intermediate productivity lakes,

Eutrophic -- [$50 < TSI \leq 62$] high productivity lakes,

Hypereutrophic -- [$62 < TSI \leq 80$] extremely productive lakes which are highly eutrophic, disturbed and unstable (i.e., fluctuating in their water quality on a daily and seasonal scale, producing gases, and toxic substances, experiencing periodic anoxia and fish kills, etc.).

The seasonal mean Trophic State Index calculated for Half Moon Lake was 40 for total phosphorus, 43 for transparency, and 51 for chlorophyll a, which corresponds to a trophic classification of oligotrophic-mesotrophic for total phosphorus, eutrophic-mesotrophic for chlorophyll a, and mesotrophic for water transparency. Trophic State Indices calculated from historical data are shown in Figure 6.

FIGURE 5

# Half Moon Lake
## 1993 Water Quality Data

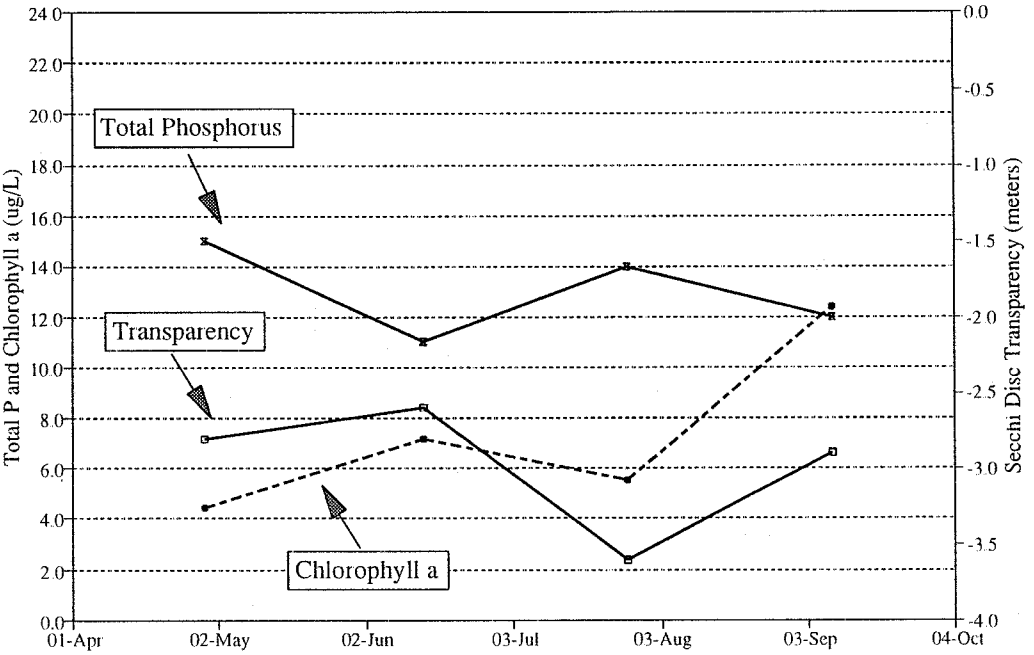
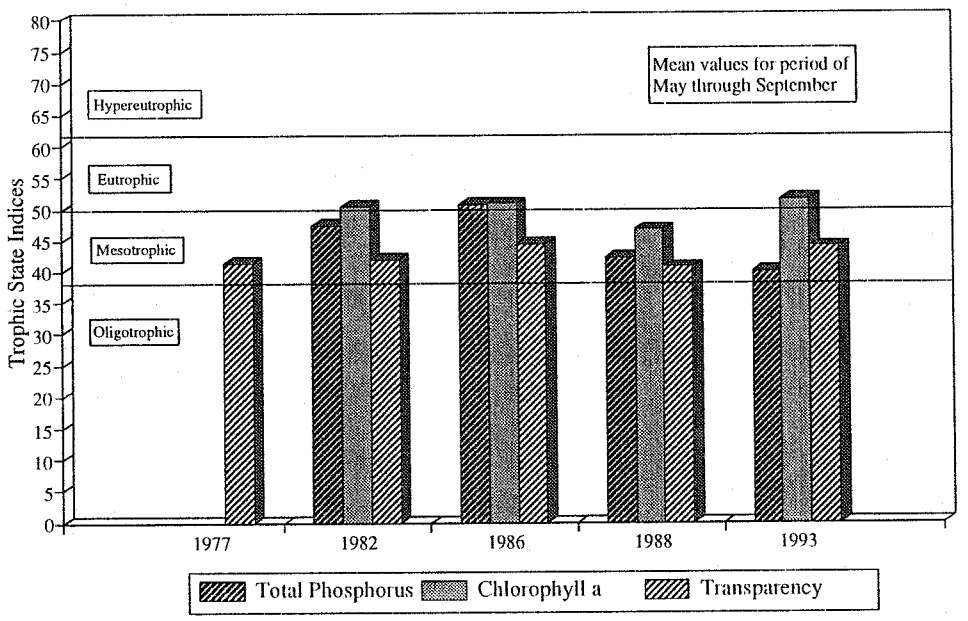



FIGURE 6

# Half Moon Lake
## Historical Trophic State Indices



The indices calculated from these three parameters are generally in close agreement; however in this case the trophic state index for chlorophyll a is significantly higher than for the other two parameters. This discrepancy may be due to the algal species present in the lake, since the amount of chlorophyll a found in algae does tend to vary with species. However, algal speciation was not determined as part of this study, nor the DNR study. In the initial evaluation of the 1993 lake data by the DNR for the Balsam Branch Priority Watershed Project, Half Moon Lake was classified as eutrophic (based on the chlorophyll a concentrations).

Data were also collected by the DNR at various lake depths. The dissolved oxygen and total phosphorus data for July, 1993 are shown in Figures 7 and 8. The dissolved oxygen concentration was extremely low below 9 meters; the near-bottom total phosphorus concentration was extremely high (approximately 0.19 mg/L). The high total phosphorus concentration was probably due to internal phosphorus release from the lake sediments. Similar concentrations in hypolimnetic dissolved oxygen and total phosphorus were also reported in several of the other past studies of Half Moon Lake.

The Wisconsin DNR (1980) found that the dissolved oxygen concentrations throughout the lake during winter were sufficient to support the fishery, but that during the summer months, the dissolved oxygen concentration was extremely low below 6 meters. During 1988, the DNR found the near-bottom dissolved oxygen was depleted by July; during August of that year, the lake was anoxic (devoid of oxygen) below 9 meters, with a near-bottom total phosphorus concentration of 0.35 mg/L. Sediment phosphorus release occurs from chemical changes in the sediments resulting from oxygen depletion in the bottom of the lake. In addition to changes in the chemistry of the bottom portion of the lake, these conditions reduce the available habitat for fish and other aquatic organisms.

If the lake remains strongly stratified during the summer, the internal phosphorus load would more likely impact the autumn and spring water quality. Additional field data would be necessary to completely evaluate the effects of internal phosphorus load on Half Moon Lake. However, cursory analysis of available data indicates that the effect of internal phosphorus load on the summer water quality is probably minimal. The current water quality of Half Moon Lake is very good, and compares well with other area lakes. This indicates that impacts from the watershed are probably minimal.

FIGURE 7

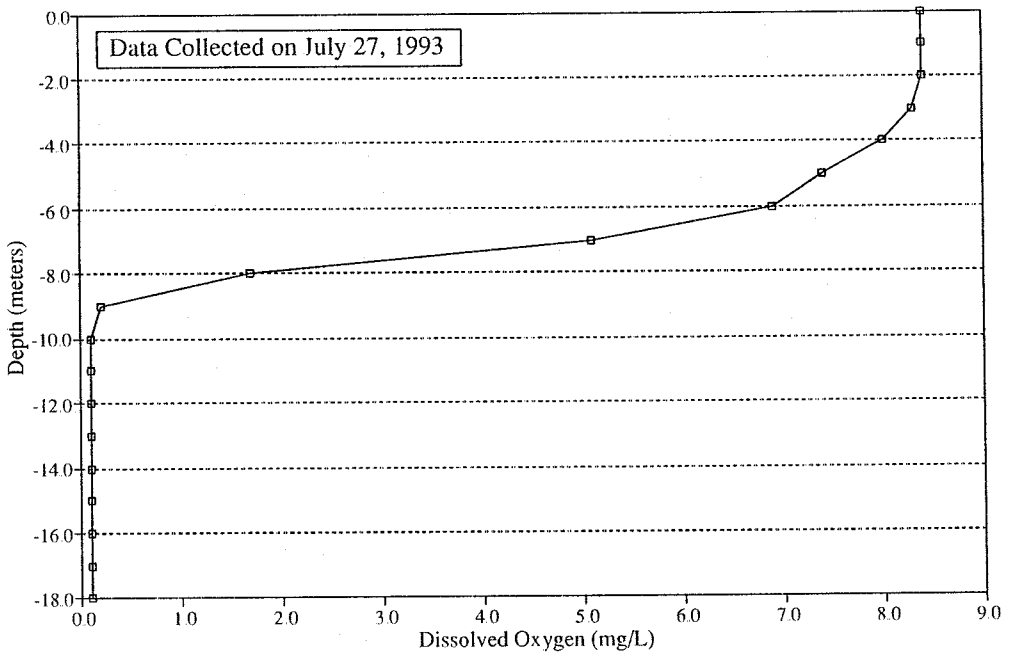
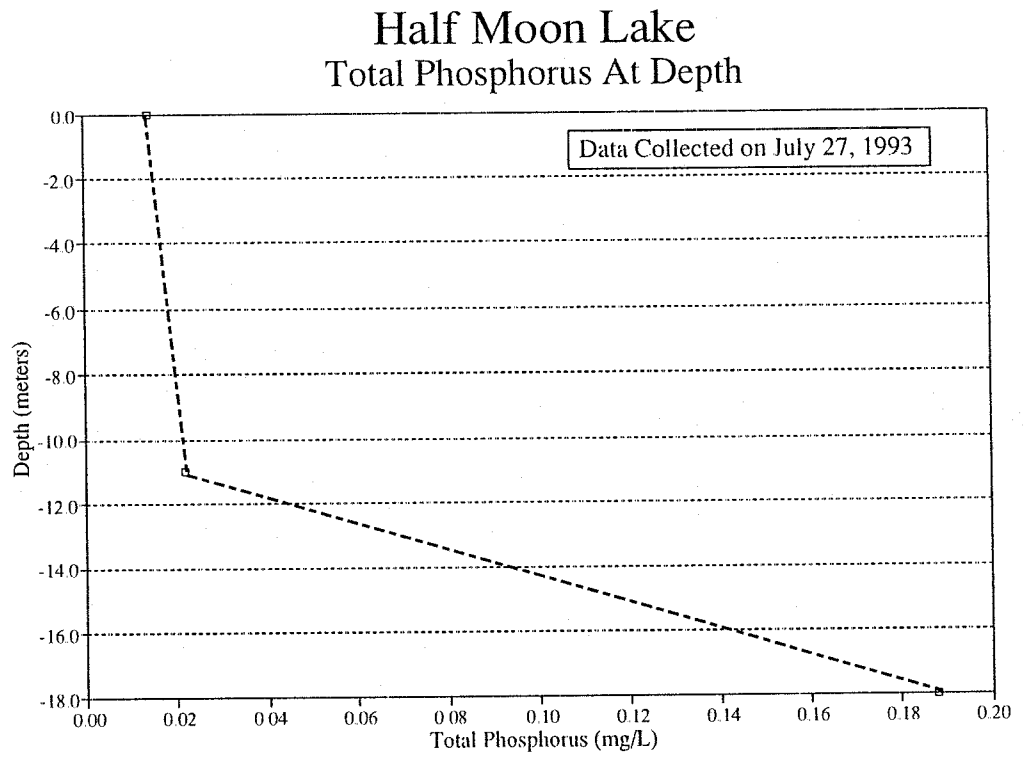



FIGURE 8



## 4.2 Apparent Trends in Half Moon Lake

There is insufficient historical water quality data available for trend analysis by typical statistical methods. No conclusive trends in water quality degradation or improvement could be detected from visual inspection of the trophic state indices for the available data set (Figure 6). Some annual variation in water quality was apparent in the data; however this was most likely due to climatic effects, such as variations in precipitation or temperature, rather than actual changes in water quality.

## 4.3 Analysis

### 4.3.1 Hydrologic Budget

The hydrologic budget for Half Moon Lake has been estimated for 1993 based on the information collected for this project. The hydrologic budget provides a method of determining the sources of water entering the lake on an annual basis. Meteorologic conditions create year to year variations in the hydrologic budget, but the estimated budget helps identify the most significant sources of water, and pollutants, to the lake. The following section describes the methods used to estimate the hydrologic budget for Half Moon Lake.

Hydrologic Budget Equation

The Hydrologic Budget Equation for Half Moon Lake is given as:

$$\Delta S = Q_{in} + P - Q_{out} - Ev +/- GW$$

where:

| | | |
|---|---|---|
| $\Delta S$ | = | Change in water volume of Half Moon Lake |
| $Q_{in}$ | = | Sum of the surface water inflows to Half Moon Lake |
| P | = | Direct precipitation on the lake surface |
| $Q_{out}$ | = | Surface water outflow from Half Moon Lake |
| Ev | = | Direct evaporation from the lake surface |
| GW | = | Net groundwater flows to and from the lake |

$\Delta S$ - The change in water volume stored in Half Moon Lake is determined from the lake surface elevation. During 1993, the water level in the lake fluctuated approximately 0.5 feet during the monitoring period. For the annual hydrologic budget it was assumed that the change in storage was zero for the water year October 1, 1992 to September 30, 1993.

$Q_{in}$ - The surface water inflows were determined by two methods, by using the measured inflow data collected for this project, and by use of long term average runoff yields for the area measured by the United States Geologic Survey (USGS). The measured inflows from Harder Creek were used to compute runoff yields specific to Half Moon Lake during the

monitoring period. These yields were applied to the entire Harder Creek Watershed to estimate the inflows from May through October. The inflows to the lake during the remainder of the year were estimated by applying USGS long term monthly average runoff yields measured for the Apple River Basin to the Half Moon Lake Watershed.

P - Direct Precipitation on the lake was determined by applying the daily total precipitation measured at Luck Wisconsin by the Wisconsin State Climatologists office. Luck is approximately seven miles northeast of Half Moon Lake.

$Q_{out}$- Outflow from Half Moon Lake was determined by calculating the discharge from lake levels during the monitoring period, and using discharges measured by the USGS during 1988 for the remainder of the year. Comparison of 1988 outflows with calculated discharges from 1993 monitoring records indicate similar total discharges during the period.

Ev - Evaporation for Half Moon Lake was determined from the Meyer Evaporation Formula (Meyer, 1947). The Meyer equation uses climatological data to estimate the evaporation from lake surfaces.

GW - Groundwater flows into Half Moon Lake in certain areas, and out of the lake in other areas. The net groundwater flow is calculated as the groundwater inflows minus the groundwater outflows. Since this is very difficult to measure, the net groundwater flow to Half Moon Lake is estimated as the residual of the hydrologic budget equation.

The hydrologic budget for Half Moon Lake is presented in Table 4. The surface water inflows to the lake are presented by subwatershed in Table 5. This table indicates that more than 50 percent of the annual surface water inflows to Half Moon Lake enter through Harder Creek. The next most significant inflow to the lake is the Tamarack subwatershed. Table 4 indicates that two thirds of the water entering Half Moon Lake is surface water inflows from the watershed. As stated in Section 3.8, the inflows from Harder Creek are reduced by wetlands and other ponding in the watershed. If these areas are altered, changes in the volume of water entering Half Moon Lake and the resulting water quality of the lake would be expected.

# TABLE 5

## HALF MOON LAKE

## 1993 WATER YEAR HYDROLOGIC BUDGET

| | VOLUME (ac-ft) | % TOTAL | AVERAGE RATE (cfs) |
|---|---|---|---|
| INFLOWS | | | |
| Surface Inflows | 2900 | 65.9% | 4.01 |
| Direct Precipitation | 1500 | 34.1% | 2.07 |
| Total Inflow | 4400 | | |
| OUTFLOWS | | | |
| Surface Outflow | 1600 | 36.4% | 2.21 |
| Direct Evaporation | 1200 | 27.3% | 1.66 |
| Net Groundwater | 1600 | 36.4% | 2.21 |
| Total Outflow | 4400 | | |
| Inflow - Outflow = | | 0 | |

# TABLE 6
# HALF MOON LAKE WATERSHED

| | | RUNOFF (BY SUBWATERSHED) (ac-ft) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MONTH | RUNOFF YIELD (in) | LITTLE PINE 544.2 (ac) | ANTLER LAKE 511.9 (ac) | HARDER CREEK 2470.9 (ac) | HARDER CREEK TOTAL 3527 (ac) | TAMARACK 1332.3 (ac) | DIRECT 845.3 (ac) | TOTAL 5704.6 (ac) |
| October | 0.33 | 14.8 | 13.9 | 67.1 | 95.7 | 36.2 | 22.9 | 154.8 |
| November | 0.41 | 18.6 | 17.5 | 84.4 | 120.4 | 45.5 | 28.9 | 194.8 |
| December | 0.34 | 15.6 | 14.6 | 70.6 | 100.8 | 38.1 | 24.2 | 163.0 |
| January | 0.38 | 17.4 | 16.3 | 78.9 | 112.6 | 42.5 | 27.0 | 182.2 |
| February | 0.34 | 15.3 | 14.4 | 69.5 | 99.2 | 37.5 | 23.8 | 160.4 |
| March | 0.94 | 42.6 | 40.0 | 193.3 | 275.9 | 104.2 | 66.1 | 446.3 |
| April | 0.57 | 26.1 | 24.5 | 118.4 | 168.9 | 63.8 | 40.5 | 273.2 |
| May | 0.84 | -- | -- | 95.1 | 95.1 | 93.4 | 59.2 | 247.7 |
| June | 1.04 | -- | -- | 461.4 | 461.4 | 115.5 | 73.3 | 650.2 |
| July | 0.60 | -- | -- | 65.9 | 65.9 | 66.2 | 42.0 | 174.0 |
| August | 0.85 | -- | -- | 4.1 | 4.1 | 94.2 | 59.8 | 158.1 |
| September | 0.49 | -- | -- | 4.2 | 4.2 | 54.3 | 34.5 | 93.0 |
| TOTAL | 7.13 | 150 | 141 | 1313 | 1604 | 791 | 502 | 2898 |
| | | 5.2% | 4.9% | 45.3% | 55.4% | 27.3% | 17.3% | 100.0% |



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4.3.2 Nutrient Budget

The 1993 phosphorus budget calculated for Half Moon Lake is listed in Table 7. The phosphorus budgets calculated by the Wisconsin DNR for 1980 (as part of feasibility study) and for 1993 (as part of Balsam Branch Priority Watershed Project) are also included in the table for comparison.

The watershed loading was calculated by Barr Engineering in two different ways - from field data collected for the project and from land use / export coefficients. The first method utilized the 1993 surface water runoff volume (calculated as part of the hydrologic budget for this study) and the mean in-stream phosphorus concentration measured in Harder Creek during 1993. It was assumed that all runoff from the watershed had phosphorus concentrations similar to those in the creek. The second method utilized the land use analysis and the following export coefficients: forest - 0.206 kg/ha/yr (Reckhow et. al., 1980); mixed agriculture - 0.91 kg/ha/yr (Reckhow et. al., 1980); open space - 0.12 kg/ha/yr (Walker, 1985). Phosphorus removal due to upstream wetland retention was not included in the calculation.

The atmospheric phosphorus deposition rate used was 0.56 kg/ha/year (0.5 lb/acre/year) based on a range of reported values from 0.1 to 1.0 kg/ha/year (Tetra Tech, 1982). The phosphorus contribution from groundwater inflow used in the budget was estimated by the Wisconsin DNR (1980) from monitoring well data. The phosphorus contribution from septic systems was estimated according to Reckhow et. al. (1980), was based on a soil retention coefficient of 0.8 and an estimated nutrient load from the household to the septic system of 1.0 kg/capita-year (Reckhow et. al., 1980). Of the approximately 197 septic systems and outhouses in the direct watershed, it was assumed that 10 percent were associated with year-round residences, that 90 percent were associated with seasonal residences, and that the average occupancy was 3 persons per dwelling.

The groundwater monitoring done by the Wisconsin DNR in 1980 showed that the net groundwater flow was into the lake on the north shore, and out of the lake around the remainder of the shoreline. The WDNR has based their septic system loading on only that portion of the watershed were the net inflow was towards the lake. The phosphorus loading from septic systems estimated by Barr Engineering includes the entire direct watershed, since the direction of groundwater flow can vary periodically throughout the year.

# TABLE 7

## HALF MOON LAKE PHOSPHORUS BUDGET

| SOURCE CONTRIBUTION | BARR ENGINEERING COMPANY 1993 BASED ON FIELD DATA (kg/yr) | | BARR ENGINEERING COMPANY 1993 BASED ON EXPORT COEFF. (kg/yr) | | WDNR (1980) (kg/yr) | | WDNR (1993) (kg/yr) | |
|---|---|---|---|---|---|---|---|---|
| Watershed Loading | | | | | | | | |
| Harder Creek | 265 | (39.1%) | 370 | (38.6%) | -- | | -- | |
| Tamarack Creek | 131 | (19.3%) | 278 | (29.0%) | -- | | -- | |
| Direct Watershed | 83 | (12.2%) | 111 | (11.6%) | -- | | -- | |
| Total | 479[1] | (70.6%) | 759[2] | (79.2%) | 460 | (78.4%) | 430[3] | (78.9%) |
| Atmospheric Loading | 131[4] | (19.3%) | 131[4] | (13.7%) | 72 | (12.3%) | 82 | (15.0%) |
| Groundwater[5] | 27 | (4.0%) | 27 | (2.8%) | 27 | (4.6%) | 27 | (5.0%) |
| Septic Systems | 41[6] | (6.0%) | 41[6] | (4.3%) | 28 | (4.8%) | 6 | (1.1%) |
| TOTAL | 678 | | 958 | | 587 | | 545 | |

1 Calculated from surface water runoff volume and mean 1993 in-stream phosphorus concentration.

2 Calculated from land use and export coefficients.

3 Includes upstream phosphorus retention of 157.4 kg.

4 Calculated from loading rate of 0.56 kg/ha/yr (Tetra Tech, 1982).

5 Determined by WDNR, 1980.

6 Calculated according to Reckhow et. al., 1980.



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As can be seen from Table 6, surface water runoff from the watershed transports the majority (approximately 71 - 79 percent) of the phosphorus to the lake. The amount of phosphorus transported from the watershed is a function of the land use activities, the number of wetlands and ponds, and the soils and geology upstream of the lake. Typically, the phosphorus load from the watershed estimated from field data and the load estimated from export coefficients are in fairly close agreement; however, in this case there is a discrepancy between the two estimates. The estimate based on export coefficients is probably too large, since it does not account for the retention and removal of phosphorus in the upstream wetlands.

Part of the watershed phosphorus load in agricultural areas may be due to animal feedlots. Runoff from animal feedlots can be extremely high in phosphorus, depending on the number of animals and the size of the feedlot. Three operational farms are located in the Half Moon Lake watershed; one of these is located in the direct watershed (Figure 3). Each of the feedlots in the Half Moon Lake watershed were inspected and classified as part of the Balsam Branch Priority Watershed Project.

In each case, the impact of the existing feedlots were classified as non-critical; therefore, the potential contributions from feedlots were not specifically included in the 1993 phosphorus budget. The actual methodology for evaluating these farms was not made available for this report by the Polk County Land Conservation District. We believe this classification is not based on the present, or potential, impact of these farms to Half Moon Lake, but rather based on their importance to the goals and objectives of the Balsam Branch Project in general. However, the farm located south of the lake, in the direct watershed, has undergone changes over the past few years. This farm currently includes only a few head of young steer; several years ago, it included a dairy herd of approximately 150 - 200 head of cattle. At that time, the feedlot probably had a greater impact on the phosphorus load to the lake, and future changes at this site should be monitored closely.

The contributions from the atmosphere, groundwater, and septic systems are also included in the phosphorus budget. Atmospheric phosphorus is usually transported via dust particles, and is deposited to the lake either during rain or snow events, or as dry precipitation. Since atmospheric transport can occur over large distances, it is difficult to control the phosphorus load from atmospheric deposition. The phosphorus contribution to Half Moon Lake from groundwater and septic systems was estimated to be a fairly insignificant part of the budget.

The contribution estimated for the septic systems may be quite different than the actual conditions, since each septic system situated around the lake was not inspected during this study. Septic systems become less effective with age, and older septic systems may not have been built to modern standards. It is unlikely that phosphorus from faulty septic systems will ever have a significant impact on the lake, especially when compared to the watershed load. However, faulty septic systems can impact the lakeshore property owners in another way, through the contamination of drinking water by microbes, parasites, and other disease-carrying organisms.

The internal phosphorus load (from sediment-release of phosphorus) was not included in the nutrient budget. Chemistry data from lake monitoring has shown that phosphorus is released from the Half Moon Lake sediments during the summer months. However, the lake remains strongly stratified throughout the summer, so the internal phosphorus load remains sequestered in the hypolimnion (lake bottom water) during the summer, and is not available for algal growth. The internal phosphorus load may cause increased algal growth in the fall, after the lake mixes, but this was not observed during this study.

### 4.3.3 Mass Balance Models

Mass balance modeling is a method of estimating the impact of the watershed on the water quality of the lake. Several empirical relationships between phosphorus loading, the total mass of phosphorus entering a lake from the watershed, and resulting water quality have been developed in recent years. The purpose of the mass balance modeling used for this study is to estimate the current impact of the watershed on the lake, and to predict estimated improvements to the lake from feasible management alternatives, if appropriate.

Numerous models have been developed which use lake morphometry, lake outflow, and phosphorus load to predict in-lake phosphorus concentration, chlorophyll a concentration, and secchi disc transparency. The phosphorus load estimated during this study was applied to several of these models, using the Wisconsin DNR program "Trophic". The results are listed in Table 7. In each case, the predicted in-lake concentration is higher than what was actually observed in Half Moon Lake. There are several reasons for this discrepancy.

The watershed phosphorus load estimation may be higher than actual, since each Harder Creek grab sample was collected by volunteers coincidently with the removal of an upstream beaver dam. The

# TABLE 8

## HALF MOON LAKE MASS BALANCE MODELS

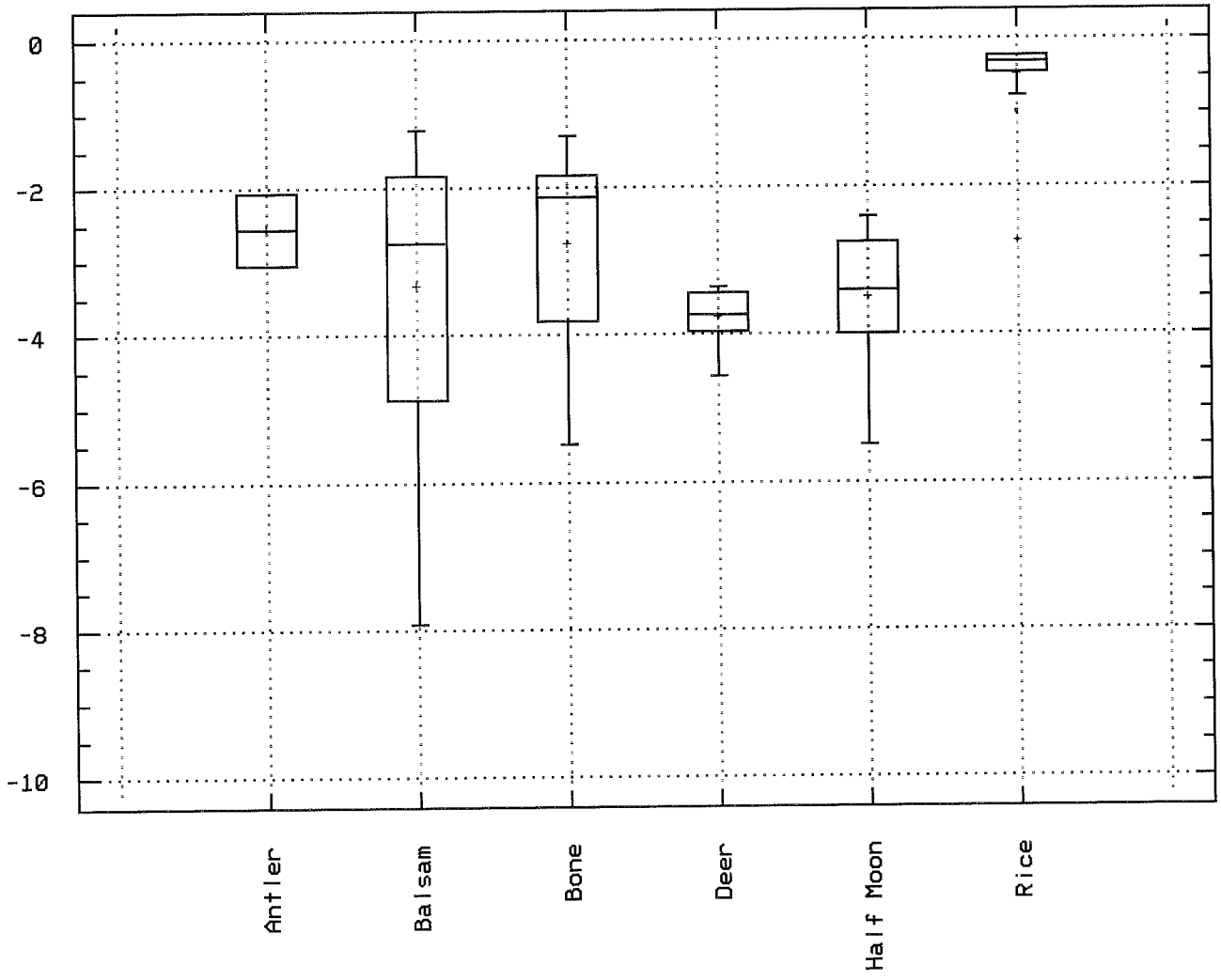
| MODEL | PREDICTED SPRING PHOSPHORUS ($\mu$g/L) | PREDICTED SUMMER CHLOROPHYLL a ($\mu$g/L) | PREDICTED SUMMER SECCHI TRANSPARENCY (Meters) |
|---|---|---|---|
| Dillon and Rigler (1974) | 31 | 11 | 1.7 |
| Vollenweider (1975) | 27 | 8 | 1.9 |
| Canfield and Bachman (1979) | 39 | 15 | 1.5 |
| Reckhow et. al. (1980) | 23 | 7 | 2.1 |
| 1993 Field Measurements | 15 | 8.4[1] | 3.0[1] |

[1] Mean value for June-September

FIGURE 9

Half Moon Lake

Secchi Transparency Comparison



resulting high flows may have entrained phosphorus and suspended solids. Portions of the nutrient budget calculated from statistical coefficients, such as septic system and atmospheric loads, are only estimates, and may differ from the actual loads.

The measured Secchi transparencies for Half Moon Lake were compared to the reported transparencies for several other lakes in Polk County. Figure 9 is a Box and Whisker plot which shows the range of recorded Secchi readings together with the average and median value for each lake. The Box covers the middle 50 percent of the readings, and the whiskers indicate the readings above and below the box range. As can be seen from Figure 9, the transparency of Half Moon Lake is higher than most of its neighboring lakes, with the exception of Deer Lake. The average Secchi transparency of Half Moon, Balsam and Deer are similar, but Balsam Lake transparencies are much more variable than the others. This comparison is based on a limited data set obtained form the WDNR computerized bulletin board, and the data has not been verified.

## 4.4 Data Analysis Conclusions

Based on the data analysis conducted for this project, the following conclusions have been made:

- **Half Moon Lake currently has good water quality, and no trends are suggested by historical water quality data for the lake. This conclusion is contrary to previous reports.**

- **Compared to other lakes in the area, Half Moon Lake has very similar water quality conditions. This indicates that the impact of the watershed on the lake is probably minimal, and the condition of the lake may be difficult to improve.**

- **In-lake water quality data indicate that internal loading to the lake from bottom sediments may be significant. This condition may create other problems besides water quality impairment such as habitat reductions for fish and other aquatic organisms.**

- **Based on the hydrologic and nutrient budgets prepared for the lake, and mass balance modeling of in-lake water quality, the lake appears to be in better condition than would be expected from the watershed landuse. We believe the existing wetland areas upstream of the lake are responsible for existing good water quality of the lake.**

- **Management efforts of the HMLPRD should be directed to protection of the present condition of the lake through watershed planning and management.**

# 5.0 POLICIES AND IMPLEMENTATION RECOMMENDATIONS

This section describes the policies of the Half Moon Lake Protection and Rehabilitation District and recommendations to satisfy those policies. The purpose of this section is to provide guidelines for dealing with issues related to management of the lake, and to provide consistency in the application of these guidelines among present and future board members of the HMLPRD. The following sections are subject to periodic review and modification, and should reflect the opinion of the majority of the Half Moon Lake community.

It is recommended that the Half Moon Lake Protection and Rehabilitation District form a policy committee to be responsible for the maintenance and further development of the positions of the HMLPRD. As existing policies are modified, or new policies added, the policy committee would amend this section to reflect the changes.

The policies and related recommendations involve the following topics:

5.1 Half Moon Lake Protection and Restoration District

5.2 Lake Water Quality

5.3 Exotic Species in the Lake and watershed

5.4 Wetland Protection

5.5 Lake Access

5.6 Lake Use and Public Safety

5.7 Fisheries Management

5.8 Septic Systems

Appendix A includes the agencies and contacts currently responsible for each of the management of each listed topic. This information will provide the HMLPRD with a starting point for changing current policies, or dealing with specific problems related to Half Moon Lake or the surrounding watershed.

## 5.1. Half Moon Lake Protection and Rehabilitation District

*Policy Statement:*

> ***The Half Moon Lake Protection and Rehabilitation District will continue working towards total management of Half Moon Lake and the surrounding watershed for the purpose of maintaining the high quality of the lake, and the long term enjoyment of the resource.***

The present condition of Half Moon Lake is due to the current landuse in the watershed, and the nature of undeveloped areas above the lake. The HMLPRD will use its influence and authority to prevent undesirable changes around the lake, and within the watershed to prevent the degradation of the quality of the lake.

Table 9 lists all available programs providing funding for improvement of current conditions of the lake, or protection of the lake from future changes through lake and watershed management activities. As projects are identified by the HMLPRD for implementation, these sources can be contacted for potential funding, and support.

## Table 9

## SUMMARY OF FEDERAL/STATE LAKE AND LAND MANAGEMENT PROGRAMS

| PROGRAM | AVAILABLE FUNDING | DESCRIPTION | CONTACT |
|---|---|---|---|
| Lake Management Planning Grant Program | Maximum State Share is $10,000<br>25 Percent Local Share Required | Provides funds for conducting lake and watershed studies with the ultimate goal of lake protection or rehabilitation. | Dan Ryan<br>DNR Northwest District<br>Box 309<br>Spooner, WI 54801<br>(715) 635-4073 |
| Lake Management Protection Grant Program | Maximum State Share is $100,000<br>50 Percent Local Share Required | Provides funds to carry out lake protection through:<br>1. the purchase of property which may contribute to the protection of the lake.<br>2. the restoration of a wetland which will prevent degradation of the lake.<br>3. the development of local regulations which will prevent degradation of the lake. | Dan Ryan<br>DNR Northwest District<br>Box 309<br>Spooner, WI 54801<br>(715) 635-4073 |
| Recreational Boating Facilities Program | 50 Percent<br>Cost Share | Provides funds for development of recreational boating facilities and includes the acquisition of capital equipment necessary to cut and remove nuisance aquatic plants. | Phil Wallace<br>DNR Northwest District<br>Box 309<br>Spooner, WI 54801<br>(715) 635-4159 |
| Wisconsin Fund: Private Sewage System Replacement and Rehabilitation Grant Program | Cost Share; Maximum Grant is $7,000 | Provides grants for replacement of failing septic systems for residences occupied at least 51 percent time. Priority is given to systems discharging sewage to surface water and groundwater. | Cate Gimse - Owen<br>DILHR<br>P.O. Box 7969<br>Madison, WI 53707<br>(608) 266-7319 |
| Forest Stewardship Incentive Program | 25 Percent Local Share<br>Maximum Grant is $10,000 | Provides funds to owners of 10 contiguous acres of land for enhancement of wildlife habitats, soil and water protection, and reforestation efforts. | Phil Stromberg or Dan Bailey<br>DNR Bureau of Forestry<br>P.O. Box 51<br>Webster, WI 54893<br>(715) 866-8201<br>(715) 349-2158 |

## Table 9 - Continued

## SUMMARY OF FEDERAL/STATE LAKE AND LAND MANAGEMENT PROGRAMS

| PROGRAM | AVAILABLE FUNDING | DESCRIPTION | CONTACT |
|---|---|---|---|
| Water Bank Program | Variable | Ten year lease to protect wetlands and adjacent upland acres. | Polk USDA<br>Agricultural Stabilization<br>& Conservation Service (ASCS)<br>Center Building<br>P.O. Box 306<br>Balsam Lake, WI 54810<br>(715) 485-3138 |
| Agricultural Conservation Program (ACP) | Variable | Cost share program for protection of agricultural lands and waters. Cost share practices include sediment retention structures, stream protection, animal waste control. | Polk USDA<br>Agricultural Stabilization<br>& Conservation Service (ASCS)<br>Center Building<br>P.O. Box 306<br>Balsam Lake, WI 54810<br>(715) 485-3138 |
| Wetlands Reserve Program | Variable | Ten year lease to preserve wetlands; cost sharing is available for wetland restoration. | Polk USDA<br>Agricultural Stabilization<br>& Conservation Service (ASCS)<br>Center Building<br>P.O. Box 306<br>Balsam Lake, WI 54810<br>(715) 485-3138 |
| Small Watershed Program | Variable | Cost sharing and technical help for fish and wildlife habitat improvement and wetland conservation. | Polk USDA<br>Agricultural Stabilization<br>& Conservation Service (ASCS)<br>Center Building<br>P.O. Box 306<br>Balsam Lake, WI 54810<br>(715) 485-3138 |

## Table 9 - Continued

## SUMMARY OF FEDERAL/STATE LAKE AND LAND MANAGEMENT PROGRAMS

| PROGRAM | AVAILABLE FUNDING | DESCRIPTION | CONTACT |
|---|---|---|---|
| Pheasants Forever | Variable | Provides cost share grants for establishment of vegetation and filter strips for wildlife nesting habitat. | Duane Riley<br>Pheasants Forever<br>Indianhead Chapter<br>216 Lake Street<br>Amery, WI 54001<br>(715) 268-8908 |
| Partners for Wildlife | 100 Percent | Provides funding for restoration of drained or modified wetlands and grasslands. | Mike Johnson<br>DNR-Northwest District<br>Box 537<br>Balsam Lake, WI 54810<br>(715) 485-3136 |
| Wetland Acquisition | Variable | U.S. Fish and Wildlife Service occasionally purchases high quality wetlands and associated uplands. Wetlands are managed for waterfowl production. | Steve Delehanty<br>U.S. F.W.S.<br>St. Croix Wetland Management District<br>146 West Second Street<br>New Richmond, WI 54017<br>(715) 246-7784 |
| Wetland Easement | Variable | Perpetual easement to protect and conserve privately owned wetlands for wildlife habitat. | Steve Delehanty<br>U.S. F.W.S.<br>St. Croix Wetland Management District<br>146 West Second Street<br>New Richmond, WI 54017<br>(715) 246-7784 |
| Upland Easement | Variable | Long-term easement to protect and conserve privately owned wetlands and associated uplands to provide buffer strip and nesting area for waterfowl. | Steve Delehanty<br>U.S. F.W.S.<br>St. Croix Wetland Management District<br>146 West Second Street<br>New Richmond, WI 54017<br>(715) 246-7784 |

## 5.2 Lake Water Quality

***Policy Statement:***

> ***The Half Moon Lake Protection and Rehabilitation District will work to achieve and maintain "non-degradation" of the water quality of Half Moon Lake.***

Degradation of the lake's water quality can be minimized if steps are taken now to limit the impact of existing and future development. The following recommendations are given to help achieve the District's goal of non-degradation for Half Moon Lake:

1. Lake Water Quality Monitoring
2. Watershed Best Management Practices
3. Public Education Programs

### 5.2.1 Recommendation: Continue and Expand a Regular and Consistent Program of Lake Water Quality Monitoring

An ongoing water quality monitoring program is recommended to help understand the interacting physical, chemical, and biological processes that control lake water quality. Such a program will indicate if a water quality problem is developing in Half Moon Lake and will help the HMLPRD to determine if the goal of non-degradation is being met.

The monitoring program should include yearly sampling of in-lake water quality parameters beginning at spring overturn, and five additional times during the summer. The sampling should provide the information necessary to establish a baseline to which future lake conditions can be compared, and to identify water quality problems as they develop. The parameters included in the in-lake monitoring program should be nutrients, temperature, dissolved oxygen, specific conductance, pH, phytoplankton (algae), zooplankton, macrophytes (aquatic weeds), and Secchi disc water transparency.

In addition to the in-lake sampling, lake inflow rates and water quality sampling should be continued similar to sampling completed for this report. This information will enable an estimate of the amount of nutrients entering the lake from the watershed and identify changes in the inflow concentrations as the watershed becomes developed. All information collected during monitoring should be incorporated into an annual report for future use and comparison and should also be included in the Wisconsin Lakes database.

### 5.2.2 Recommendation: Adopt and Enforce Watershed Best Management Practices

These standards should be adopted for shoreland areas and throughout the watershed. The following are recommended Best Management Practices (BMPs) for the Half Moon Lake Watershed. There are many other BMPs which are not discussed here but which may serve to improve stormwater runoff quality. When feasible, these additional BMPs should also be used to protect the quality of Half Moon Lake.

a. Wetland Treatment

Wetland treatment involves passing runoff through a natural or constructed wetland to remove or treat pollutants. The Half Moon Lake Watershed contains numerous wetlands that could serve this purpose.

Wetland treatment is very effective in removing sediment and pollutants from stormwater runoff (such as trace metals, nutrients, hydrocarbons, oxygen-demanding substances, and bacteria). During the growing season, wetlands can also be effective for removing dissolved nutrients as well as those adsorbed to sediment (MPCA, 1989).

The effectiveness of wetland treatment in removing pollutants depends on the physical characteristics of the system, such as the ratio of wetland size to watershed size, runoff residence time in the wetland, and water budget. In general, as the wetland to watershed ratio increases, the average runoff residence time increases, and the effectiveness of the wetland for pollutant removal also increases. The effectiveness of wetlands for removing nutrients also depends heavily on the season. During the summer, when biological activity is maximized, nutrient uptake is the greatest (Nichols, 1983; Brown, 1985).

Although wetlands are effective for removing pollutants, certain drawbacks limit their use as a best management practice. For example, environmental damage may be done to natural wetlands, and a large land area is required for constructed wetlands.

The HMLPRD policy is to protect and preserve the wetlands in the Half Moon Lake Watershed. The HMLPRD requests that Milltown Township, Polk County, and the State of Wisconsin use their respective jurisdictional authorities to protect and preserve wetlands in the Half Moon Lake shoreland area and in the entire watershed. This policy is discussed further in Section 5.4 of this Plan.

b. Fertilizer Management

The Half Moon Lake Protection and Rehabilitation District believes that the application of fertilizer on lakeshore property is unnecessary, and should not be recommended. However without regulation to this effect, individual property owners will have the generally responsibility for this decision. The following guidelines are presented for the management of fertilizer application to minimize the impact of this activity on the lake when necessary.

Fertilizer management involves control of the rate, timing, and method of fertilizer application in developed areas so that plant nutrient needs are met while also minimizing the chance of surface water pollution. This practice is directed at control of phosphorus and other nutrient runoff from landscaped areas.

Significant nutrient loads can result from over-application or inappropriate application of lawn fertilizer in developed areas. Restricting the amount of fertilizer applied to the quantity needed for plant growth will minimize the potential for surface water and groundwater contamination. Although it is difficult to quantify the benefits, proper fertilizer management will reduce the likelihood of this material entering the lake.

The Half Moon Lake Protection and Rehabilitation District requests that the Milltown Township and Polk County adopt more specific ordinances regarding the use of fertilizer in residential areas than given in the State rules.

A public education program recommended in Section 5.2.4 can also help reduce the impact of urban landscaping practices on the water quality of Half Moon Lake through voluntary cooperation of residents in the watershed.

c. Erosion and Sediment Control

Erosion in drainageways, and from land disturbed by construction activity, is a potential source of pollutants to Half Moon Lake. Some erosion does occur naturally, but as development occurs, drainageway erosion may increase due to the higher rates of runoff. Land disturbed by construction activity usually does not have vegetation to protect it from the forces of erosion, and therefore sediment and nutrients leave the site, enter drainageways, and may ultimately enter Half Moon Lake.

Specifically, the HMLPRD encourages Polk County, and Milltown Township to implement the following requirements for erosion and sediment control within the Half Moon Lake Watershed:

- Drainageway erosion that causes net degradation of the watercourse or destruction of properties adjacent to the watercourse shall be stabilized. Streambank stabilization and streambed control measures that are site-specific shall be used to control erosion.

- Slopes susceptible to severe erosion from runoff shall be maintained in a natural state or stabilized to minimize erosion potential. Slopes subject to moderate erosion shall be managed to minimize erosion.

- Land use adjacent to watercourses shall be regulated to allow for the reasonably expected natural behavior of streams.

- Altering the natural course and meandering of streams is discouraged, except when foreseeable erosion threatens to damage structures, utilities, or natural amenities, or threatens to impair the drainage system.

- Effective energy dissipation devices shall be constructed at point discharges of stormwater into open channels, lakes, ponds, and detention basins to prevent bank, channel, and shoreline erosion.

- The drainage systems and erosion control features for new developments shall be constructed and made operational as quickly as possible during the initial phases of construction.

- Erosion control plans are required for all land development and construction work disturbing one or more acres of vegetation. These plans shall include at least the following information:

  - copy of preliminary plat to scale 1′ = 100″ or 1′ = 50″
  - existing and proposed contours at 2-foot intervals
  - existing vegetation
  - property boundaries and lot lines
  - drainage areas, direction of flow, and overflow pathways that act as secondary conveyors during runoff events
  - soil types and boundaries
  - elevations of lot corners, wetlands, storm sewer inlets and outlets, and the lowest and first floor elevations of proposed structures
  - the grade of streets and parking lots

- proposed erosion and sediment control features
- site restoration and timing during construction (soil should be exposed for as little time as feasible; where topsoil is removed, restoration shall include at least 4 inches of soil of a nutrient quality at least equal to that in-place prior to development
- critical erosion areas
- limits of clearing and grading
- locations of utilities

- Enforcement of the erosion and sediment control plan shall include inspections of construction sites as follows:

  - pre-construction site inspection to verify conditions on the plan
  - inspection during or immediately following the initial installation of sediment controls
  - inspection following severe rainstorms to check for damaged controls
  - inspection prior to seeding deadlines, particularly in the fall
  - final inspection of nearly-complete projects to ensure that any temporary measures have been removed and that the site has been restored

- Permits required for construction activity through the National Pollutant Discharge Elimination System (NPDES) program must be obtained and enforced where applicable throughout the Half Moon Lake watershed.

d. Agricultural Use Standards

Use of fertilizer, pesticides, or animal wastes within the watershed must be done in such a way as to minimize impact on the lake by proper application.

Non-point source runoff from agricultural lands outside Half Moon Lake's watershed is not regulated by any government agency, but the Polk County Soil and Water Conservation District works with farmers to implement best management practices in an effort to reduce erosion and resulting water pollution. This participation in the non-point source pollution control programs is voluntary. The HMLPRD should monitor future changes in legislation related to agricultural activity and water quality, particularly the NPDES program.

The HMLPRD also encourages farmers in the Half Moon Lake Watershed to adopt agricultural best management practices, and to work with the Polk County Land Conservation District to reduce the impact of agricultural activities on Half Moon Lake and other downstream resources.

### 5.2.3 Recommendation: Public Information and Education Program

A public information and education program should be implemented by the HMLPRD to teach residents in the Half Moon Lake Watershed how to protect and improve the quality of the lake. The HMLPRD education program should include distribution of fliers to all residents in the watershed and placement of advertisements in the local newspaper. Information could also be disseminated through organizations such as local schools, Girl Scouts and Boy Scouts, and other local service clubs.

Voluntary participation of watershed residents in a "good housekeeping" program can help reduce the amount of phosphorus entering the lake. Table 10 lists suggestions that should be included in a public education campaign geared to homeowners in the Half Moon Lake Watershed. These suggestions were gathered from several sources including: the Bassett Creek Water Management Commission; Colbert, 1991; and "Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota" (MPCA, 1989).

The Wisconsin Department of Natural Resources together with the University of Wisconsin-Extension (608-262-3346) publishes similar educational information through the Wisconsin Non-point Source Water Pollution Abatement Program. Each regulatory agency responsible for implementing or enforcing BMP's in the watershed may have specific sources for the design of these practices. Many other sources of information exist for BMP's including the United States Environmental Protection Agency, and the United States Department of Agriculture Soil Conservation Service.

Table 10

## Public Education Program
## Suggested "Good Housekeeping" Practices

1. Erosion Control at Construction Sites

On new construction sites, homeowners should take steps to establish turfgrass as soon as conditions permit. On steeply sloping banks, sod should always be secured through proper staking; where seed is used, siltation fences should be installed to prevent erosion of soil and/or siltation into streets and storm drains. For further information on seeding or sodding methods, contact the Polk County Soil and Water Conservation District.

2. Fertilization

a. On existing lawns, soil testing is the first step toward efficient lawn care. Soil testing kits are available through the University of Minnesota's Soil Testing Laboratory at (612) 625-3101. Test results may indicate that phosphorus or other nutrients are already in adequate supply in your soil. If this is the case, fertilization rates can be cut back while still maintaining a green and healthy lawn.

b. When purchasing a low-phosphorus fertilizer, carefully review the analysis on the outside of the fertilizer bag. Three large numbers will usually appear indicating the percentages of nitrogen (N), phosphorus (P), and potassium (K). Select a fertilizer with a phosphorus content of less than 3 percent.

c. When fertilizing your lawn, avoid sprays or drift of the pellets onto hard-surface areas, such as driveways, sidewalks, and roads. In addition, any fertilizer spilled on hard surfaces should be promptly cleaned up. This will lessen the chance of rain or lawn irrigation washing the fertilizer directly into the stormwater drainage system.

d. Never apply fertilizer to frozen ground.

e. Water your lawn after fertilizing, but not so heavily as to allow water to run off into road drainage systems or lakes.

f. Be careful not to deposit fertilizer in the water when applying fertilizer near the lake or drainage system.

g. When using pesticides, consider spot-spraying problem areas rather than full lawn treatments. Chemical runoff can be further reduced by spraying just once a year in the fall, when pesticides are most effective.

## Public Education Program
## Suggested "Good Housekeeping" Practices

3. Mowing and Mulching

a. Grass kept at a height of 2 to 2½ inches can withstand heat stress better than close-clipped grass. This higher mowing height encourages deeper rooting and there is less need for frequent watering and fertilization. In addition, grass kept at a greater height tends to shade broad-leaved weeds, giving your lawn a competitive edge over dandelions and other weeds.

b. Whenever possible, avoid using a grass catcher when mowing your lawn. Research has shown that leaving clippings on your lawn is equal to approximately one fertilizer application per year. As the clippings decompose, they release valuable sources of nutrients to the lawn.

c. When mowing, direct the discharge chute of your mower toward the interior of your lawn. This will avoid depositing the clippings directly onto the street where they can be washed into the storm drains. As grass clippings (organic material) decompose in a water body, they release high levels of phosphorus and nitrogen, which further encourages plant and algae growth.

d. Whenever leaves or grass clippings are collected from a lawn, they should never be deposited in or adjacent to nearby water bodies. Rather, compost piles should be established and maintained far enough from the water's edge to avoid leaching into the lake or drainage system.

e. Use compost instead of fertilizer for enriching home gardens. Not only is compost environmentally more sound, it also provides a long-lasting source of organic nutrients for vegetables and flowers.

f. Wherever possible, homeowners should leave an 8- to 10-foot wide unmaintained buffer around the edges of the lake and ponds in the watershed. This area of taller grass and plant growth may intercept and absorb a large portion of nutrient runoff before it reaches the water.

g. In low-traffic areas of your lawn (where neighboring properties will not be affected), consider the establishment of non-maintained prairie grasses, wildflowers, or mulch beds. Creation of "natural areas" in the home landscape encourages songbirds and wildlife while reducing the amount of lawn requiring fertilization.

Table 10 Continued

## Public Education Program
## Suggested "Good Housekeeping" Practices

4. Waste Management

a. Residents should be cautious in their disposal of household chemicals and waste. Motor oil should never be drained directly onto the street. Similarly, liquid chemicals, such as pesticides, paints, or solvents, should never be dumped onto the lawn or into street gutters. Rather, they should be disposed of in accordance with produce label instructions. Phosphorus-free detergents should also be used when washing vehicles on driveways or in the street.

b. Property owners, with septic systems near lakes or ponds, are urged to take the following precautions:

- Have the system checked every two years and pumped when necessary
- Use non-phosphate detergents
- Employ water conservation techniques
- Minimize use of garbage disposals
- Keep solvents, plastics, paper diapers, etc. out of the system

c. In developed areas, citizens should clean up after their pets. Animal feces are a significant factor in water pollution as they contribute a high nutrient level and a high coliform count to the water.

## 5.3 Exotic Plant and Animal Species in the Lake and Watershed

***Policy Statement:***

***The HMLPRD will work to prevent the introduction of deleterious exotic plant and animal species into Half Moon Lake.***

The introduction of plant and animal species that are not native to the region can cause extensive damage to the lake. For some of these species, there may not be a natural enemy to control their population.

The aquatic weed Eurasian Watermilfoil (*Myriophyllum spicatum*) has become a major water quality concern for Wisconsin lakes. Eurasian Watermilfoil has no natural enemies or controls. Consequently, it has become a noxious weed and is present in many lakes. It has spread rapidly because of its ability to regenerate from small fragments. Dense growths of milfoil pose a hazard to navigation and are an aesthetic nuisance along beaches. Therefore, its presence in other Wisconsin and Minnesota lakes is a threat to Half Moon Lake, which could become infested by plant fragments carried on boats and boat trailers. Other exotic species of concern to Half Moon Lake include zebra mussels, purple loosestrife, and others.

It is the HMLPRD goal to prevent the introduction of exotic species into the lake. Because Eurasian Watermilfoil is of current concern, the management recommendations are aimed to meet this goal as it pertains to Eurasian Watermilfoil.

### 5.3.1 Recommendation: Public Information and Education Program

A program should be implemented by the HMLPRD to inform and educate the public about Eurasian Watermilfoil. The following should be included in the program:

a. Signs should posted at all access areas instructing boaters to clean boats and trailers of all weeds before entering the lake and upon leaving the lake to prevent the spread of Eurasian Watermilfoil and other exotic species of concern.

b. Informational brochures should be distributed to the public.

c. Feature articles about exotic plants and animals should be published in a local paper.

### 5.3.2 Recommendation: Boat Inspection

Fragments of Eurasian Watermilfoil are transported from lake to lake on boats and trailers. New plants grow from these small pieces and it can quickly infest lakes, although milfoil has a hard time getting established in lakes with a healthy population of native plants.

The HMLPRD can help prevent the introduction of Eurasian Watermilfoil into Half Moon Lake by inspecting watercraft entering and exiting the lake via the public access. Inspectors should ensure all aquatic plants are removed from trailers, boats, motors/propellers, and anchors of craft launching into or leaving Half Moon Lake. Special care should be taken to see that aquatic plants are removed from the wet wells of trailered boats, the board boxes of sailboats, and the interiors of car-top boats and canoes. Inspectors should concentrate their activities on weekends (especially

holidays) when lake use is greatest. They should also attempt to educate boaters about the dangers of Eurasian Watermilfoil during their inspections.

It is recommended that volunteers from the HMLPRD or other lake associations perform the inspections under the direction of the Polk County Sheriff's Department.

### 5.3.3 Recommendation: Early Identification by Inspection and Observation

If the presence of Eurasian Watermilfoil in a lake is detected early, it may be possible to eradicate it chemically. It is important, therefore, that the HMLPRD be vigilant in identifying milfoil infestations. An aquatic plant survey should be conducted on a regular basis by a professional limnologist trained to recognize Eurasian Watermilfoil. This annual survey could be part of the District's water quality monitoring program. Additionally, the HMLPRD should educate its members to identify Eurasian Watermilfoil and encourage them to report the presence of this or any other suspicious-looking aquatic weeds to the HMLPRD and the WDNR.

## 5.4 Wetland Protection

*Policy Statement:*

> ***The HMLPRD will adopt procedures and support programs, ordinances, and regulations that protect and preserve the wetlands within the Half Moon Lake Watershed.***

Wetlands are recognized as an important part of the natural resources of the Half Moon Lake area. They perform natural functions like flood storage and water quality enhancement that make them invaluable (Sather and Smith, 1984).

The functional values of wetlands are the basis for establishing a policy of wetland protection. Preserving the natural functions of wetlands protects the public health, safety, and general welfare of the community. These functional values are usually referenced in the "Statement of Purpose" section of zoning ordinances and include the following:

- Provide habitat for fish and wildlife
- Store water during times of flood and slowly release it to downstream areas, thereby lowering flood peaks
- Reduce flood flows and the velocity of flood waters, thereby reducing erosion and allowing flood waters to release more sediment
- Protect water bodies from sediments, nutrients, and other natural and man-made pollutants
- Provide open space for recreational and visual enjoyment
- Provide educational opportunities for nature observation and scientific study
- Provide areas for groundwater recharge
- Protect shorelines from erosive wave action

The wetland function that is most beneficial to Half Moon Lake is the protection of water quality from sediment, nutrients, and other natural and man-made pollutants. The reduction of flood flows and flood velocities is also beneficial to the lake by reducing erosion along drainageways that lead to the lake. The other wetland functions listed would benefit residents and lake visitors by increasing recreation opportunities, and enhancing wildlife in the Half Moon Lake Watershed.

The HMLPRD should, at a minimum, work together with Milltown Township, Polk County, and WDNR to help manage wetlands for water quality protection and flood control since these functions directly benefit the lake. The following recommendations are given to help protect wetlands in the Half Moon Lake Watershed.

### 5.4.1 Recommendation: Prepare and Maintain a Complete Wetland Inventory within the Half Moon Lake Watershed

The Half Moon Lake Protection and Rehabilitation District should prepare an inventory of wetlands within the Half Moon Lake Watershed. The inventory will identify wetlands in the watershed and wetlands that have already been drained. There are programs available for the restoration of drained wetlands. As part of the inventory, each wetland should be classified and delineated accurately on a map, and its elevation should be determined. An elevation provides a definable reference of the wetland boundary.

### 5.4.2 Recommendation: Prepare Wetland Protection and Management Ordinances

Neither Milltown Township nor Polk County has a policy for protecting wetlands. The HMLPRD requests that the Township and County adopt wetland ordinances for the protection and management of the wetlands within their communities and especially for those wetlands identified in the Half Moon Lake Watershed.

### 5.4.3 Recommendation: Review and Respond to All Public Notices on the Corps Permitting Process

The HMLPRD should request to be added to the distribution list to receive public notices on any proposed activity that may impact wetlands in the Half Moon Lake Watershed and require a Section 404 permit from the U.S. Army Corps of Engineers. This notice informs public agencies and private parties of the proposed activity and solicits comments and information necessary to evaluate the probable impact on the public interest.

Section 404 of the Clean Water Act requires the Corps to regulate, in accordance with guidelines developed by the Environmental Protection Agency, the discharge of dredged or fill material into waters of the United States, including wetlands. Activities affecting wetlands for which Section 404 permits may be required include but are not limited to:

- Placement of fill material
- Ditching activities when the excavated material is sidecast
- Levee and dike construction
- Land clearing involving relocation of soil material
- Land leveling
- Most road construction
- Dam construction

### 5.4.4 Recommendation: Notify Owners and Intervene in Cases of Non-Permit Wetland Filling

The HMLPRD should encourage the residents of the Half Moon Lake Watershed to notify the HMLPRD of any suspected wetland filling within the watershed. If there is evidence of unpermitted filling, the HMLPRD should then notify the WDNR and the Enforcement Section of the U.S. Army Corps of Engineers, which regulates wetlands under Section 404.

### 5.4.5 Recommendation: Create and Maintain a Public Information Program

The HMLPRD requests that the Township and Polk County to notify persons proposing or carrying out filling or other development activity in protected waters that their activity may require permit from the Wisconsin Department of Natural Resources. The Township and County should also be encouraged to maintain a copy of the National Wetland Inventory (NWI) map and notify persons proposing or carrying out filling or other development activity in areas identified as wetlands on the NWI map that their activity may require a Section 404 permit from the Corps of Engineers.

Local officials and residents in the watershed should be informed of available programs that may give technical or financial assistance for protecting, enhancing, or restoring wetlands in the Half Moon Lake Watershed.

### 5.4.6 Recommendation: Encouraging Owners to Restore Drained Wetlands

Some wetlands in the agricultural areas around Half Moon Lake may have been drained to provide additional farmland, although none were identified as a part of this study. These wetlands can be restored through programs administered by the U.S. Fish and Wildlife Service and the Polk County Soil and Water Conservation District. The Fish and Wildlife Service restores wetlands on private land with funds from the Private Lands Challenge Grant Program, which matches donations from private individuals and conservation programs. The Polk County SWCD also restores wetlands in cooperation with Ducks Unlimited.

The HMLPRD should identify drained wetlands within the Half Moon Lake Watershed and encourage the private landowners, the Fish and Wildlife Service, and the Polk County SWCD to implement wetland restoration projects.

## 5.5 Lake Access

***Policy Statement:***

> ***The HMLPRD will work together with other public agencies and lakeshore owners to provide for a balance between the public benefit derived from use of Half Moon Lake and protection of the lake and lake users.***

Half Moon Lake is a major public resource and adequate access is needed for the public to use the lake. However, public access must also be controlled to protect the water quality of the lake, the public safety for boaters and swimmers, and the rights of lakeshore owners. Access can be controlled by the limiting car-trailer parking at public access points and by limiting shoreland development as it impacts riparian lake access.

### 5.5.1 Recommendation: Access Availability and Control of Lake Access Improvements

Because of the lake's popularity, lake accesses should be provided in accordance with WDNR guidelines while minimizing the disturbance to residences near the lake access areas. The HMLPRD encourages Polk County and the Milltown Township to have their shoreland ordinances require adequate parking, sanitary facilities, buffer zones between access points and neighboring residences, and provisions for maintenance of the lake accesses.

## 5.6 Lake Use and Public Safety

***Policy Statement:***

***The HMLPRD will promote lake user satisfaction while maintaining the level and type of lake uses that assure public safety.***

### 5.6.1 Recommendation: Coordinate and Lead Discussions with Appropriate Agencies to Create Solutions When Public Safety Issues Arise

The Half Moon Lake Protection and Rehabilitation District recognizes that as the area around Half Moon Lake develops (and the lake attracts more boaters), there will be increased recreational lake use with public safety becoming of greater concern. When problems are identified, the HMLPRD should work with the Milltown Township, Polk County, and the WDNR to identify solutions to those problems. Law enforcement should be provided by the Polk County Sheriff's Department.

## 5.7 Fisheries Management

***Policy Statement:***

***The HMLPRD will take actions required to protect and enhance fish habitats within Half Moon Lake.***

Fishing is a popular use of the Half Moon Lake. The HMLPRD should encourage the protection and enhancement of the fish habitat within the lake. The following are recommendations to promote this policy.

5.7.1 Recommendation: Work with the WDNR to Continue Fish Stocking Programs

5.7.2 Recommendation: Work with the WDNR to Control Rough Fish Populations

5.7.3 Recommendation: Act as Coordinator/Facilitator Between Agencies When Fisheries Issues Arise

When and if fisheries issues are identified, the HMLPRD should work with Milltown Township, Polk County, the WDNR, and/or other appropriate private organizations or governmental agencies to implement the HMLPRD's fisheries policy.

## 5.8 Septic Systems

***Policy Statement:***

> ***The HMLPRD promotes the proper construction, maintenance and operation of individual septic systems located adjacent to Half Moon Lake.***

The septic systems of property owners adjacent to Half Moon Lake should be up to current codes for septic systems, and maintained on a regular basis to minimize the impact of these systems on Half Moon Lake. The HMLPRD should work with the Polk County Department of Health to identify substandard and problem systems, and work with individual property owners to upgrade these systems.

5.8.1 Recommendation: Conduct a survey of existing systems to identify substandard systems

5.8.2 Recommendation: Require substandard system upgrades as a requirement of property transfer

The HMLPRD should work with Polk County to enact regulations requiring property owners to certify and upgrade septic systems as a part of the sale of lakeshore property.

5.8.2 Recommendation: Sanitary District expansion or creation

If the opportunity for Half Moon Lake to be included in an existing, or proposed, sanitary district, the HMLPRD should support the annexing of Half Moon Lake into the district.

## 6.0 MANAGEMENT ALTERNATIVES AND STRATEGIES FOR HARDER CREEK

The Harder Creek watershed is the largest subwatershed contributing to Half Moon Lake. The HMLPRD has identified the Harder Creek area as a primary concern for water quality management efforts. The following section outlines the possible alternatives for management of the watershed, and a recommendation of options to be pursued by the HMLPRD. The Harder Creek watershed is minimally developed, and few problems were discovered as a part of the work on this project. Because of this, the emphasis of the feasibility assessment for the Harder Creek area is directed toward the protection of the area from future development. The recommendations of this section are intended to provide guide for the HMLPRD to follow to help protect the currently good water quality of Half Moon Lake.

### 6.1 Management Alternatives

The alternatives presented in the following section have been presented in order of the cost of implementation expected to be incurred by the HMLPRD. All possible options have been identified, and recommendations have been selected as a result of discussions with the HMLPRD.

Low or No Cost Option

#### 6.1.1 Ag Land Management through Polk County Land Conservation District

Agricultural development of the watershed is a potential threat to the water quality of Half Moon Lake. Two possible situations exist: first, land currently not in production could be developed for either crops or livestock, and secondly lands in CRP or other programs could be returned to production.

The Polk County Land Conservation District is involved in agricultural activities in the watershed, and in the Balsam Branch Project. Goals and concerns about agricultural activities should be discussed with the Land Conservation District, and long term communications should be established to track proposed changes, and to form alliances with the Land Conservation District in future agricultural issues. The Land Conservation District will be important in terms of problem resolution in working with the agricultural community.

BMP's and management - Each active farm in the Half Moon Lake Watershed should be evaluated for impacts specific to Half Moon Lake. Best management practices (BMP's) should be identified and implemented for all areas associated with livestock and crop production on each farm. Particular areas of concern in

these areas include the management of animal wastes, tillage practices, drain tile systems, CRP land especially in highly erodible soil areas (HEL).

This work will include the negotiation of participation with each landowner, procurement of funding, cost effectiveness analysis of each proposed BMP, design and implementation of each option, monitoring of compliance, and maintenance of all BMP's.

Regulation, Local, State, NPDES - Agricultural activities have been historically exempt from water quality legislation, but this is changing. As legislation is changed to include these areas, the HMLPRD should work with the regulatory agencies to ensure compliance within the watershed

### 6.1.2 Ground Truthing of Watershed for Easily Fixed Problems

No apparent point source problems were observed in the Harder Creek Watershed. Since most of this work was completed from aerial photographs and other records, site inspection of the watershed may provide additional insight on site specific problems that have not been identified in this report. As problems are identified, the appropriate authority would be contacted to approach the land owner. Potential problems that may be observed include:

Septic Systems
Ag Practices and management
Illicit dumping

### 6.1.3 Education of Watershed Residents

Many potential water quality problems result from a lack of understanding by residents within the watershed. Day to day activities that result from long term habits may create unintentional impacts that can be simply corrected by providing educational information to the residents of the watershed. Several methods of raising the water quality awareness of the public are available, which include:

Regular newsletter
Radio messages
Informational signs at areas of concern
Public meetings and social functions

### 6.1.4 Organization of Watershed Development Steering Committee

Often adversarial relationships develop between lakeshore owners and residents of associated watershed over issues of responsibility for lake and stream water quality. A possible solution for preventing this type of problem is to organize a steering committee to involve the watershed residents in the issues of the HMLPRD, and the lakeshore owners in the development of the watershed. This committee will facilitate the exchange of concerns between all residents interested in the lake and watershed, and will provide a vehicle to resolve conflicts.

Moderate to High Cost Options

### 6.1.5 Buffer Strip Easements

Buffer strips are areas of natural, or managed, vegetation between improved areas of the watershed and the streams entering the lake. Buffer strips provide minimal treatment of stormwater runoff prior to entering streams or lakes, and are especially important in areas where livestock have access to the stream. The process of obtaining buffer strip easements/agreements would include negotiation of agreement, delineation of buffer strip boundaries, determination of compensation, and enforcement of buffer strip agreements.

### 6.1.6 Water Quality Structures

Construction of water quality structures at roadways along Harder Creek may provide treatment to stormwater entering Half Moon Lake. These structures would increase the ponding within the watershed, and prevent floating debris from reaching the lake. If installed, each structure would require periodic maintenance for proper operation, and the higher water levels in watershed may require modifications to each roadway crossing. The construction of these structures may be infeasible due to WDNR regulations on navigation and fishery issues. This would effectively create sedimentation basins at each structure.

The process of constructing these structures would include obtaining permits, survey and design of each structure, and the construction and maintenance of each site.

6.1.7 Regulation of Land use Activity within Watershed through Permitting/BMP's

6.1.8 Regulation of Future Development of Watershed through Permitting/BMP's

The Half Moon Lake Protection and Rehabilitation District may pursue the development and adoption of local regulation of development and commercial activity within the watershed. The primary difficulty with this option is related to the number of individuals, organizations, and regulatory bodies involved in the adoption of these rules. The process would include the identification of activities of concern and the associated regulatory agency, and lobbying for the adoption the desired goal through laws, ordinances, permitting of specific activities, and long term planning for the watershed. The activities of concern may included agriculture, livestock production, logging, and other industrial activities.

High Cost Options

6.1.9 Land Purchase

The portion of Harder Creek closest to Half Moon Lake covers a very large area of heavily wooded undeveloped wetlands. This area may be responsible for the presently good water quality of the lake, and if preserved, may continue to protect the lake from non-point pollution for years. A high cost option for the long term management of water quality would involve the purchase of approximately 500 to 1000 acres of land along Harder Creek, and the subsequent donation of this area to the WDNR as a perpetual natural area for wildlife management, and water quality protection. This would involve the negotiation of the land purchase, the negotiation of the donation to the WDNR, and a long term management plan for this area.

6.1.10 Stabilization of Harder Creek Stream Bank

Stream bank erosion increases the amount of sediment, and nutrients, that are discharged from a stream. No specific areas of erosion were observed as a part of this work, but a closer field survey of Harder Creek through the watershed may produce areas of substantial impact. The HMLPRD may consider looking for these particular areas, and implementing erosion control methods where appropriate. This work would include the negotiation of rights to address these problems, and the design of remedial actions appropriate for each site, and the actual implementation of improvements.

### 6.1.11 Treatment of Inflows

Two methods of affecting water quality in streams are presently being used, the prevention of non-point pollution from entering the stream through watershed management efforts, and the removal of pollutants from stream water through chemical, physical, or biological treatment of all, or part, of the inflows. This option would involve the design of a sophisticated treatment facility, and the long term operation and maintenance of the facility. Although technically feasible, the construction and operation of a treatment plant may be financially unattractive at this time.

## 7.0 OTHER HALF MOON LAKE ALTERNATIVES

The purpose of this project was to concentrate on the management options available for Harder Creek. However, there are options that should be considered for the entire watershed, and within Half Moon Lake specifically. The final recommendation of this report is to pursue the second and final WDNR Lake Planning Grant for the Half Moon Lake. Suggested topics for the next project include:

Septic Tank Survey and Alternative Study

The HMLPRD could conduct a survey of the septic systems around Half Moon Lake to determine the condition of the existing systems, and to better estimate the impact of these systems on the lake. The feasible alternatives for septic systems could be included with this study including a cost benefit analysis of upgrading all non-conforming systems, annexing of Half Moon Lake to a Sanitary District, and any other potential alternatives.

Macrophyte Survey and Management Plan

The HMLPRD could begin a regular macrophyte survey program. This program would identify the existing types and abundances of aquatic plants in the lake, and determine changes in populations, locations, and species throughout the lake.

Long Term Lake Monitoring Program

The HMLPRD could begin a regular long term in-lake sampling program for Half Moon Lake. This sampling program would provide information of changes or trends in the water quality of the lake over time. The long term sampling program could be completed together with the present WDNR sampling, or covering years not included in the WDNR program.

Shoreline Stabilization Study and Implementation

Shoreline erosion has been a recent problem for some Half Moon Lake residents. The HMLPRD could undertake a study of the problem areas, and design remedial actions for the protection of sensitive areas around the lake.

Lake Level Operating Plan

The proper water level of Half Moon Lake has been questioned during the current study. Water levels were especially high during this period, and shoreline erosion was observed. The

HMLPRD could conduct a study of the current outlet structure from the lake, impacts of high water conditions, and prepare a long term water level management plan for the lake.

Implementation of Planning Grant Project Recommendations

The HMLPRD could implement one or more of the recommendations of this report through the Planning Grant program, or assist in the implementation of recommendations of the Balsam Branch Priority Watershed project.

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Wisconsin DNR, 1980.

# Appendix A

## HALF MOON LAKE PROTECTION AND REHABILITATION DISTRICT

1. General Information of Lake Associations in Wisconsin
   UW-Extension Lakes Management Program
   (715) 346-2116

## WATER QUALITY

1. General info, planning grant information, data analysis,
   Wisconsin DNR - Northwest District Office
   Dan Ryan: (715) 635-2101

2. Aquatic Pesticide Application Permits
   Wisconsin DNR - Northwest District Office
   Frank Koshere: (715) 635-4072

3. Non-Aquatic Pesticide Applications:
   Regulations; Enforcement; Complaints of Pesticide Misuse.
   Department of Agriculture, Trade and Consumer Protection
   Karen Fenster: (608) 266-9502
   Enforcement: (608) 266-2295

4. Land Use Management, Neutral Technical Assistance
   Polk County Land Conservation Office
   Jeff Timmons: (715) 485-3725

5. Balsam Branch Priority Watershed Project
   Jeff Timmons: (715) 485-3725

## EXOTIC SPECIES IN LAKES

1. Eurasian Water Milfoil

   General Questions:
   Wisconsin DNR
   Northwest District Office
   Frank Koshere: (715) 635-4072

2. Inspection/Enforcement

   General Questions:
   Wisconsin DNR
   Northwest District Office
   Frank Koshere: (715) 635-4072

## WETLAND PROTECTION

1. General Information Review of Wetland Maps, Assistance with Wetland Boundary Determinations
   Polk County Zoning
   (715) 485-3161

2. Application forms, review of wetland maps, wetland boundary determinations, general information
   Wisconsin DNR - Northwest District Office
   (715) 822-3590

3. Federal Regulations/Permitting
   U.S. Army Corps of Engineers
   (612) 220-0375

4. To Report Unpermitted Filling of Wetlands
   U.S. Army Corps of Engineers - Compliance Section
   (612) 290-0375

5. Protection: Management of Agricultural Wetlands
   Polk County ASCS Office
   (715) 485-3138

## LAKE USE AND PUBLIC SAFETY

1. Wisconsin Boating Regulations
   Boating Safety, Education, Enforcement
   Wisconsin DNR - Northwest District office
   Bart Halverson: (715) 635-4112

2. Local Boating Ordinances
   Milltown Town Chair
   Bruce Christianson: (715) 825-3596
   Wisconsin DNR - Northwest District Office
   Bart Halverson: (715) 635-4112

3. To Report Boating Violations

   a. Polk County Boat Patrol/Polk County Sheriff Office
      (715) 485-3151
   b. Wisconsin DNR Tip Line
      1-800-TIP-WDNR

FISHERIES MANAGEMENT

1. General information, regulations, stocking, general fisheries management
   Wisconsin DNR - Northwest District Office
   Rick Corclius: (715) 537-5046

LAKE LEVEL MANAGEMENT

1. Regulations, Permits for Lake Outlet Alternations
   Wisconsin DNR - Northwest District Office
   Ed Slaminski: (715) 822-3590

2. Maintenance of Outlet Structure
   Lake Level Control
   Milltown Town Chair
   Bruce Christianson: (715) 825-3596

SEPTIC SYSTEM MANAGEMENT

1. Permits, general information, complaints on failing systems
   Polk County Zoning Office
   Gary Spanel: (715) 485-3161

2. State Regulations, General Information
   Department of Industry, Labor, & Human Relations
   Dave Russell: (608) 266-3815

SHORELINE DEVELOPMENT

1. Permits for shoreline riprapping, installation of piers, etc. below the ordinary high water mark
   Wisconsin DNR - Northwest District Office
   Ed Slaminski: (715) 822-3590

2. General information, permits for filling, grading, lagooning, dredging, and excavating within 1,000 feet of ordinary high water mark of lake shore; removal of shore cover; shoreland wetlands
   Polk County Zoning
   Gary Spanel: (715) 485-3161

UPLAND DEVELOPMENT

1. General Information, building permits, lot requirements, land use districts.
   Polk County Zoning Office
   Gary Spanel: (715) 485-3161

2. Construction Site Erosion Control, Inspection of Building Sites, Department of Industry, Labor, and Human Relations.
   Robin Zentner: (608) 267-5113

3. Forest management, logging concerns,
   Polk County Forestry Department
   Mike Gringer: (715) 485-3136

4. Management, inspection of erodible farmland
   Soil Conservation Service
   Don Meyer: (715) 485-3340

MACROPHYTE MANAGEMENT

1. General Information, permitting
   Wisconsin DNR - Northwest District Office
   Frank Koshere: (715) 635-4072