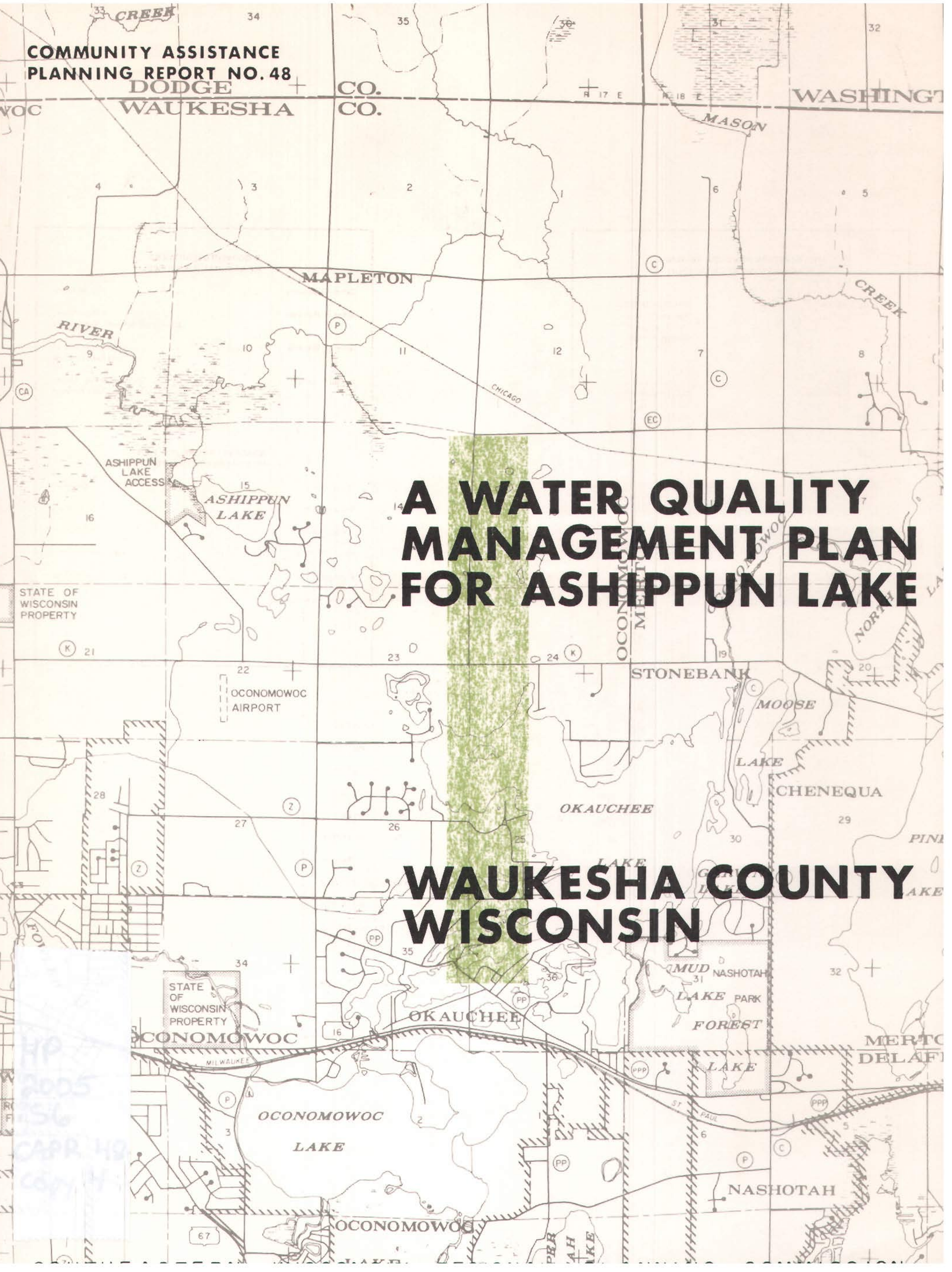
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 48

A WATER QUALITY MANAGEMENT PLAN FOR ASHIPPUN LAKE

WAUKESHA COUNTY WISCONSIN



SOUTHEASTERN WISCONSIN REGIONAL
PLANNING COMMISSION MEMBERS

KENOSHA COUNTY
Leon T. Dreger
Donald E. Mayew
Francis J. Pitts

RACINE COUNTY
Raymond J. Moyer
Earl G. Skagen
Michael W. Wells

MILWAUKEE COUNTY
Irene M. Brown
Richard W. Cutler,
Secretary
Harout O. Sanasarian,
Vice-Chairman

WALWORTH COUNTY
John D. Ames
Anthony F. Balestrieri
Harold H. Kolb

OZAUKEE COUNTY
Allen F. Bruederle
Thomas H. Buestrin
Alfred G. Raetz,
Chairman

WASHINGTON COUNTY
Harold F. Ryan
Thomas J. Sackett
Frank F. Uttech

WAUKESHA COUNTY
Robert F. Hamilton
William D. Rogan,
Treasurer
Paul Vrakas

WISCONSIN DEPARTMENT
OF NATURAL RESOURCES

Carroll D. Besadny . . . . Secretary

James R. Huntoon . . . . Administrator, Division of Resource Management

Oliver D. Williams . . . . Director, Bureau of Inland Lake Renewal

Russell C. Dunst . . . . Deputy Director, Bureau of Inland Lake Renewal

ASHIPPUN LAKE PROTECTION
AND REHABILITATION DISTRICT

Paul J. Ferr . . . . Chairman

Pauline Warzyn . . . . Secretary

Holly Schmidt . . . . Treasurer

Roland L. Merz . . . . County Commissioner

Kenneth Zillmer . . . . Town Commissioner

SOUTHEASTERN WISCONSIN REGIONAL
PLANNING COMMISSION STAFF

Kurt W. Bauer, P.E. . . . . Executive Director

Philip C. Evenson . . . . Assistant Director

John W. Ernst . . . . Data Processing Manager

Leland H. Kreblin . . . . Chief Planning Illustrator

Donald R. Martinson . . . . Chief Transportation Engineer

Frederick J. Patrie . . . . Administrative Officer

Thomas D. Patterson . . . . Chief of Planning Research

Bruce P. Rubin . . . . Chief Land Use Planner

Roland O. Tonn . . . . Chief Community Assistance Planner

Lyman F. Wible, P.E. . . . . Chief Environmental Engineer

Kenneth R. Yunker, P.E. . . . . Chief Special Projects Engineer

Special acknowledgement is due Mr. Robert P. Biebel, P.E., SEWRPC Principal Engineer; Mr. Donald M. Reed, SEWRPC Senior Biologist; Mr. David B. Kendziorski, Former SEWRPC Senior Planner; and James R. D'Antuono, SEWRPC Senior Planner, for their contributions to the preparation of this report.

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 48

A WATER QUALITY MANAGEMENT PLAN FOR ASHIPPUN LAKE
WAUKESHA COUNTY, WISCONSIN

Prepared by the
Southeastern Wisconsin Regional Planning Commission
P. O. Box 769
Old Courthouse
Waukesha, Wisconsin 53187

In Cooperation with the
Wisconsin Department of Natural Resources
Madison, Wisconsin 53707

The preparation of this report was financed in part through a joint planning grant from the U. S. Environmental Protection Agency and the Wisconsin Department of Natural Resources.

January 1982

Inside Region	$4.00
Outside Region	$8.00

(This page intentionally left blank)

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

916 NO. EAST AVENUE • P.O. BOX 769 • WAUKESHA, WISCONSIN 53187 • TELEPHONE (414) 547-6721

Serving the Counties of: KENOSHA
MILWAUKEE
OZAUKEE
RACINE
WALWORTH
WASHINGTON
WAUKESHA

January 24, 1982

TO: All Units and Agencies of Government and Citizen Groups
Involved in Water Quality Management for Ashippun Lake

In 1976 the Southeastern Wisconsin Regional Planning Commission entered into a cooperative agreement with the Wisconsin Department of Natural Resources to study the water quality conditions of Ashippun Lake, identify existing and potential problems related thereto, and propose measures which could be applied to resolve those problems and to protect and enhance the water quality of the lake. The findings and recommendations of that study are presented in this report.

The report describes the physical properties of Ashippun Lake, the quality of its waters, and the conditions affecting that quality, including existing land use and tne present utilization of the lake. All sources of pollution of the lake are identified and, to the extent possible, quantified; and alternative, as well as recommended, means for the abatement of these sources of pollution and for the protection and enhancement of the water quality of the lake are described.

During the preparation of this report, members of the Commission staff met with members of the Ashippun Lake Protection and Rehabilitation District on June 20, 1979 to discuss the recommendations of the study and to receive the comments and suggestions of concerned lakeshore property owners and interested citizens. The findings and recommendations of this report reflect the pertinent comments and suggestions made at that meeting.

The water quality management plan presented herein constitutes a refinement of the areawide water quality management plan adopted by the Regional Planning Commission in July 1979. Accordingly, upon adoption by the local units and agencies of government concerned with water quality management for Ashippun Lake and subsequent adoption by the Regional Planning Commission the plan presented in this report will become an element of the adopted areawide water quality management plan.

The plan presented in this report is believed to provide a sound guide to the making of development decisions concerning the wise management of Ashippun Lake as an aesthetic and recreational asset of immeasurable value. Accordingly, careful consideration and adoption of the plan presented herein by all of the concerned water quality management agencies is respectfully urged. In its continuing role in the coordination of water quality management planning and plan implementation within southeastern Wisconsin, the Regional Planning Commission stands ready to assist the various units and agencies of government concerned in carrying out the recommendations contained in this report.

Respectfully submitted,

Kurt W. Bauer
Executive Director

(This page intentionally left blank)

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

Map		Page

Chapter III

Chapter IV

Chapter V

Chapter VI

Chapter VII

Chapter IX

(This page intentionally left blank)

Chapter I

INTRODUCTION

Thirteen major inland lakes in southeastern Wisconsin were studied under a special program conducted by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Wisconsin Department of Natural Resources, local lake protection and rehabilitation districts and other lake organizations. Eight of the 13 lakes—Eagle Lake, Friess Lake, Lac La Belle, North Lake, Oconomowoc Lake, Pewaukee Lake, Pike Lake, and Wandawega Lake—were studied by the Regional Planning Commission in cooperation with the Bureau of Research, Wisconsin Department of Natural Resources; and four of the lakes—Ashippun Lake, George Lake, Okauchee Lake, and Paddock Lake—were studied by the Regional Planning Commission in cooperation with the respective lake protection and rehabilitation districts and the Wisconsin Department of Natural Resources, Office of Inland Lake Renewal. One of the 13 lakes—Geneva Lake—was studied by the Regional Planning Commission in cooperation with the Geneva Lake Watershed Environmental Agency. The objectives of these studies were to acquire definitive information concerning lake water quality and related land use and land management practices in each lake drainage area; to identify the factors affecting lake water quality, particularly the amount, kind, and temporal distribution of pollutants contributed by the various sources; and to develop recommendations for the abatement of pollution in order to maintain or improve water quality conditions.

On May 20, 1976, the Southeastern Wisconsin Regional Planning Commission entered into a cooperative agreement with the Wisconsin Department of Natural Resources to study Ashippun Lake. The cooperative lake study for Ashippun Lake included the design and conduct of a water quality sampling program to determine existing water quality conditions, and inventories and analyses of pertinent tributary watershed characteristics affecting water quality conditions, including land use and management practices, existing water uses and sources of pollution. The detailed lake water quality sampling program was conducted from December 1976 through November 1977. Some inventory data collected as recently as 1979, however, are incorporated into this report. This report summarizes the results of the sampling program and inventories and provides an evaluation and interpretation of the data collected. From these analyses, feasible alternative actions for the maintenance and enhancement of lake water quality are proposed and evaluated, and water quality management measures are recommended.

Ashippun Lake is an 83-acre lake located entirely within U. S. Public Land Survey Township 8 North, Range 17 East, Section 15, Town of Oconomowoc, in Waukesha County.[1] The lake drains to the Ashippun River via an unnamed outlet stream. Properly managed, the drainage area directly tributary to the lake can contribute to the maintenance of Ashippun Lake as an important asset to the residents of the County and the Region of which the County is an integral part. This report discusses the physical, chemical, and biological characteristics of the lake together with pertinent related characteristics of the tributary drainage area, as well as the feasibility of various water quality management alternatives which may enhance water quality conditions in the lake. Specific management objectives for Ashippun Lake include: 1) providing water quality suitable for recreational use and maintenance of fish and aquatic life, 2) controlling shoreline erosion, 3) reducing the severity of existing nuisance problems due to excessive aquatic plant growths which constrain or preclude intended water uses, and 4) improving opportunities for water-based recreational activities.

The local units of government concerned were asked to review a preliminary draft of this report and comments based upon that review are incorporated into this final report. Accordingly, the lake water quality management plan presented herein should constitute a practical guide for the management of the water quality of Ashippun Lake, and for the management of the land surfaces which drain to this lake.

---

[1] *In SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide, (1968) the area of Ashippun Lake was reported to be 84 acres, as measured from 1956 aerial photographs. Based on 1975 aerial photographs and with the use of computer mapping techniques to measure areas, the area of Ashippun Lake was estimated to be 83 acres.*

(This page intentionally left blank)

Chapter II

PHYSICAL DESCRIPTION

LAKE BASIN AND SHORE CHARACTERISTICS

Ashippun Lake is a head water lake lying within a glacial terminal moraine. As such it has no perennial, channelized, surface water inlets. The lake outlet is tributary to the Ashippun River. Basic hydrographic and morphometric data for Ashippun Lake are presented in Table 1. About 26 percent of the lake area has a water depth of less than 5 feet, 29 percent has a water depth between 5 and 20 feet, and 45 percent of the lake area has a water depth of more than 20 feet. The mean depth is 17 feet and the maximum depth is 35 feet. Ashippun Lake is 0.55 mile long and 0.34 mile wide at its widest point. The major axis of the lake lies in a northwesterly-southeasterly direction. The shoreline of the lake has a length of 1.5 miles, and the shoreline development factor is 1.7. Thus, the lake shoreline is about 1.7 times as long as that of a circular lake of the same area. The lake has a volume of approximately 1,411 acre-feet and a surface area of about 83 acres. The morphometry of the lake basin is illustrated in Map 1. Located immediately downstream of Ashippun Lake is a smaller lake basin with an area of about 12 acres and a maximum depth of less than five feet. The outlet from this smaller lake basin drains to the Ashippun River. Figure 1 presents an aerial photograph of the lake and surrounding shoreline.

The lake bottom is covered by organic detritus, marl, and sand. The predominant bottom substrate along the eastern shore is a combination of marl and organic detritus, with occasional areas of sand. Some of the sand areas are reportedly remnants of sand deposits placed in the lake by riparian landowners. The northern shore bottom is covered by organic detritus with scattered sand areas. The bottom substrate along the southern shore is consistently organic in origin, and the lake bottom along the western shore of the lake is covered by marl.

Shoreline erosion was evident along the eastern and northeastern shores, particularly where riparian landowners have maintained lawns to the water's edge. Some areas with relatively little shore development are, however, also subject to shoreline slumping and erosion.

Table 1

HYDROGRAPHY AND MORPHOMETRY OF ASHIPPUN LAKE: 1975

Parameter	Measurement
Size	
Area of Lake (acres)	83
Area of Direct Tributary Drainage Area (acres)	371
Volume (acre-feet)	1,411
Residence Time[a] (years)	2.3
Shape	
Length of Lake (miles)	0.55
Length of Shoreline (miles)	1.5
Width of Lake (miles)	0.34
Shoreline Development Factor[b]	1.7
Depth	
Percent of Lake Less Than 5 Feet	26
Percent of Lake 5 to 20 Feet	29
Percent of Lake More Than 20 Feet	45
Mean (feet)	17
Maximum (feet)	35

[a] *The "residence time" is estimated as the time period required for the full volume of the lake to be replaced by inflowing waters, during a year of normal precipitation.*

[b] *The shoreline development factor is the ratio of the shoreline length to that of a circular lake of the same area.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

WATERSHED CHARACTERISTICS

The drainage area tributary to Ashippun Lake is 371 acres, or 0.58 square mile, in areal extent, as shown on Map 2. Ashippun Lake has a low watershed-to-lake area ratio of 4.5:1. The lake outlet channel, an unnamed stream, discharges to the Ashippun River about one-half mile downstream of the lake. The Ashippun River exhibits continuous flow and has a resident fish population. The Ashippun River joins the Rock River about seven miles downstream from the confluence with the lake outlet at a point in Jefferson County.

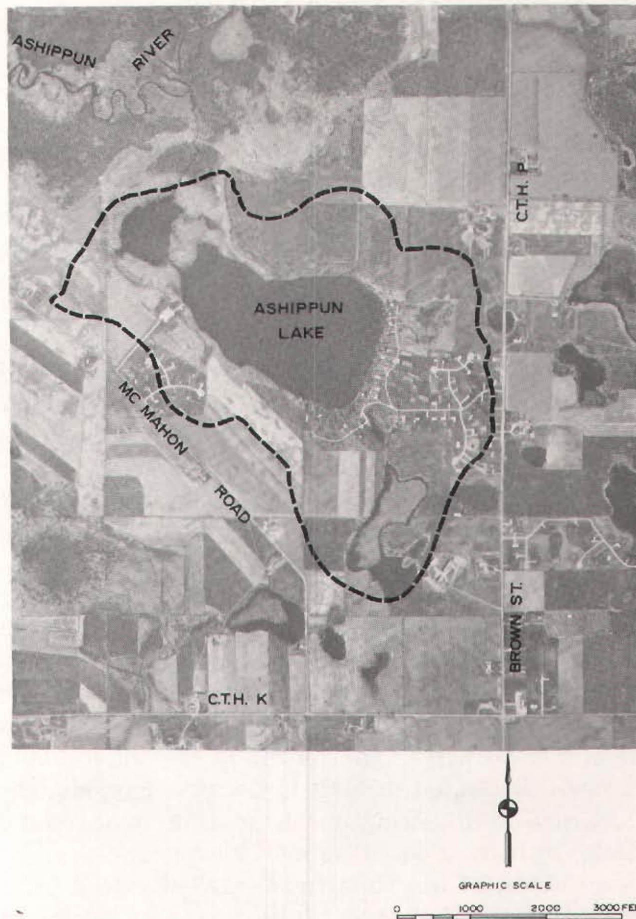
Map 1

HYDROGRAPHY AND MORPHOMETRY OF ASHIPPUN LAKE

Source: Wisconsin Department of Natural Resources.

Figure 1

AERIAL PHOTOGRAPH OF ASHIPPUN LAKE AND SURROUNDING SHORELINE



Source: SEWRPC.

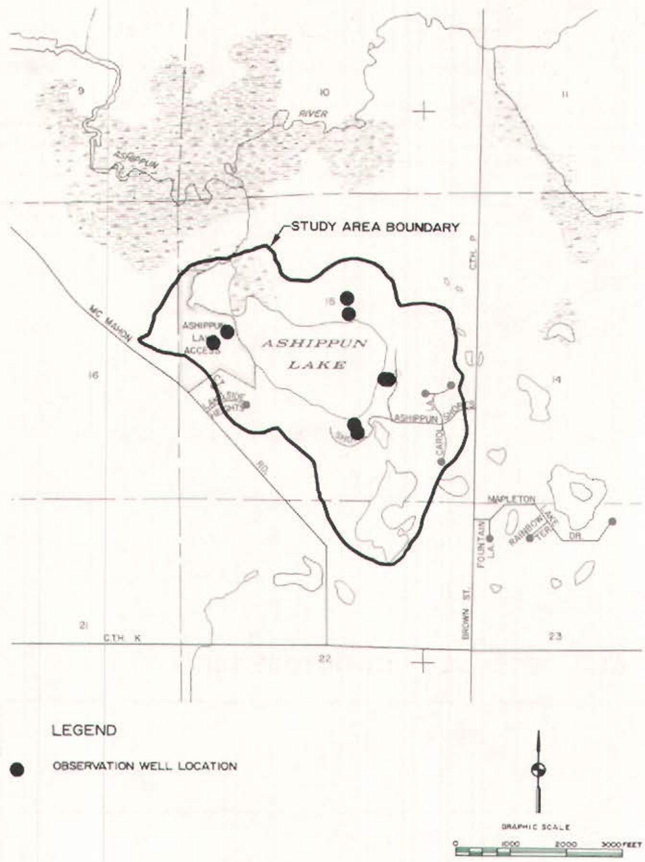
CLIMATE AND HYDROLOGY

Long-term average monthly air temperature and precipitation values for Watertown, Wisconsin, are set forth in Table 2. These averages were taken from official National Oceanic and Atmospheric Administration (NOAA) records. Table 2 also sets forth storm water runoff values derived from U. S. Geological Survey (USGS) flow records for the Rock River at Afton. The mean annual temperature of 47.3°F at Watertown is quite similar to recording locations in southeastern Wisconsin. Mean annual precipitation at Watertown is 31.46 inches. More than half the normal yearly precipitation falls during the growing season, from May to September. Runoff rates are generally low during this period, since evapotranspiration rates are high, vegetative cover is good, and soils are not frozen. Normally, less than 15 percent of the summer precipitation is expressed as surface runoff, but intense summer storms occasionally produce high runoff. Approximately 30 percent of the annual precipitation occurs during the winter or early spring when the ground is frozen, resulting in high surface runoff during those seasons. Impervious areas, such as street surfaces, parking lots, and rooftops, increase the amount of surface runoff and decrease infiltration into the soil.

The 12-month period over which the Ashippun Lake water quality sampling study was carried out—December 1976 through November 1977—was a period of variable temperatures and slightly higher-than-average amounts of precipitation in southeastern Wisconsin, as shown in Table 2. Temperatures were generally below normal during the early winter of 1976, above normal in the spring of 1977, and about normal for the remainder of the

Map 2

DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE AND GROUNDWATER OBSERVATION WELLS



Source: Wisconsin Department of Natural Resources and SEWRPC.

study period. Precipitation for the year as a whole was about 1.86 inches above normal. However, a severe drought occurred in southeastern Wisconsin in the period immediately preceeding, and including the first several months of, the study period. Six of the first seven months of the study period—from December 1976 through June 1977—experienced below normal amounts of precipitation. During the extreme drought conditions of May 1976 through April 1977, precipitation was 11.13 inches below normal at Watertown. Groundwater levels were substantially reduced by this drought, and these reduced groundwater levels were reflected in the below normal flow levels in the Rock River. At Afton, the flow of the Rock River during the study period was only 55 percent of normal. Therefore, while precipitation amounts were slightly higher than normal during the study period, the hydrologic regime of the lake may not have fully recovered from the effects of the preceding drought period.

The water level of Ashippun Lake is primarily determined by the groundwater level and by the amount of precipitation which occurs. As shown in Figure 2, the lake level rose from a low elevation of 868.3 feet above National Geodetic Vertical Datum (NGVD) in early December 1976, to a high elevation of 869.6 feet in mid-April 1977, dropped again to an elevation of 868.3 feet in mid-June 1977, and then rose to an elevation of 869.0 feet during late September 1977.

A water budget for Ashippun Lake was computed from estimated and measured precipitation, evaporation, surface runoff and groundwater inflow, surface outflow, and lake level data and is set forth in Figure 3. For the year of the study, it is estimated that about 174 acre-feet of water, or 28 percent, entered the lake by surface runoff, 233 acre-feet, or 37 percent, entered the lake by direct precipitation on the lake surface, and 217 acre-feet, or 35 percent, entered the lake by groundwater inflow. Losses of 384 acre-feet, or 62 percent, from the lake outlet and 187 acre-feet, or 30 percent, from evaporation were estimated, with a resultant net water gain to the lake of 53 acre-feet, or 8 percent. Groundwater levels and the direction of groundwater movement were observed at five paired observation wells located around the lake, as shown on Map 2. These observations indicated consistent groundwater flows towards the lake around the entire perimeter of the lake, and it was therefore assumed that no significant groundwater outflow occurred.

An abandoned concrete mill dam is located on the Ashippun River in the unincorporated community of Monterey about one and one-half miles downstream of the Ashippun Lake outlet, as shown on Map 3. The so-called Monterey Dam has a normal operating level, as established by Wisconsin Department of Natural Resources requirements of 866.6-867.2 feet NGVD. The level of the dam is controlled by flashboards. Under normal operating conditions, the dam level is 1.1-3.0 feet lower than the elevation of the Ashippun Lake, as measured during the study year. However, some lake residents have expressed concern that during periods of high streamflow and/or when additional flashboards are placed on the Monterey Dam, flow from the Ashippun River enters Ashippun Lake, raising the lake level, thereby accelerating shoreline ero-

Table 2

LONG TERM AND 1976-1977 STUDY YEAR CLIMATOLOGICAL AND RUNOFF DATA FOR THE ASHIPPUN LAKE AREA

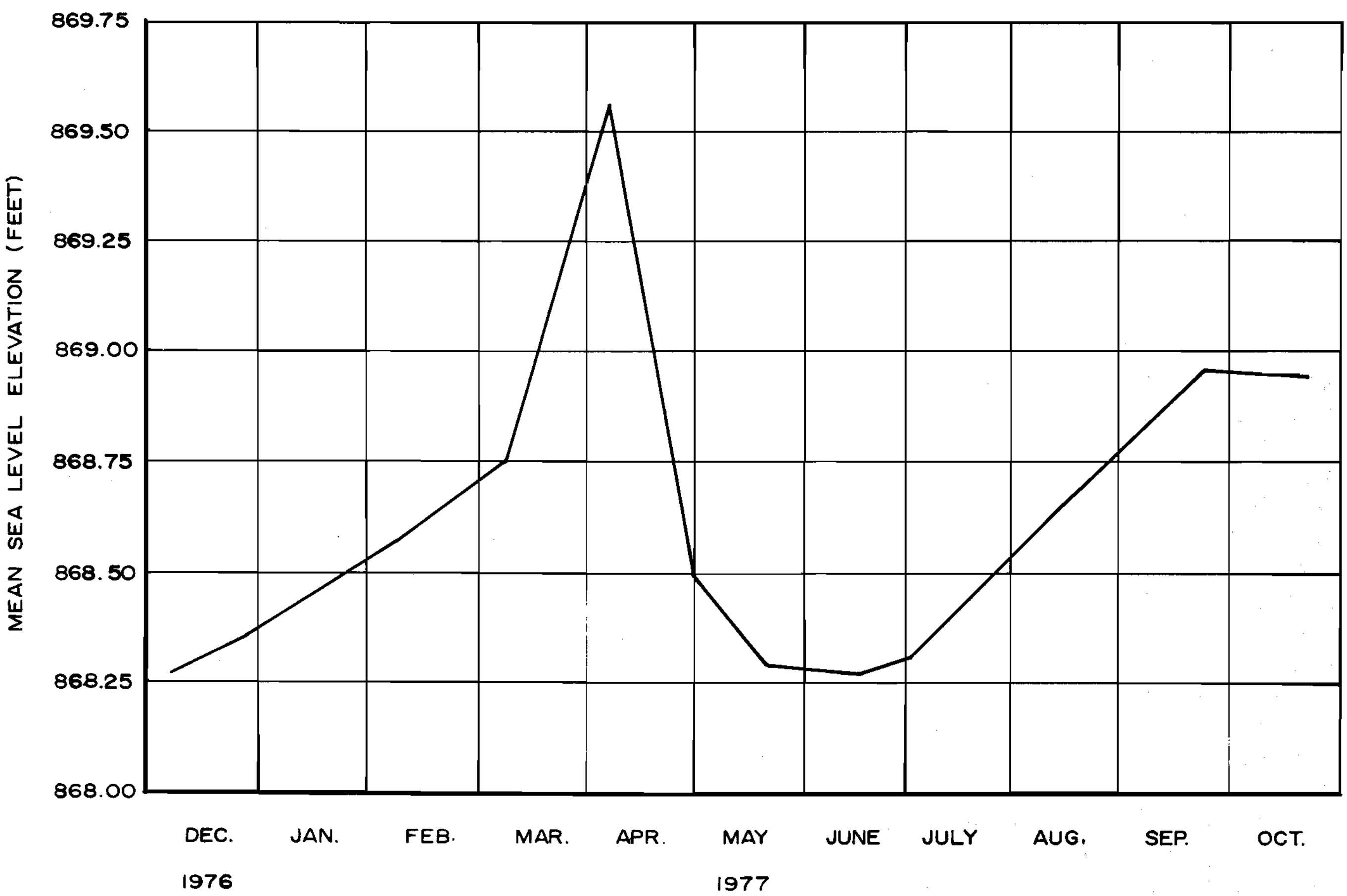
Climatological Data	Long Term Average Monthly Values												
	December	January	February	March	April	May	June	July	August	September	October	November	Annual
Mean monthly air temperature—°F (Watertown) (1890-1975)	24.1	19.5	22.8	32.7	47.6	58.2	67.8	72.2	70.9	62.3	52.4	37.1	47.3
Mean monthly precipitation—inches (Watertown) (1890-1975)	1.64	1.43	1.02	2.18	3.00	3.12	4.05	3.70	3.33	3.78	2.16	2.05	31.46
Mean runoff—inches (Rock River at Afton) (1914-1978). . .	0.46	0.42	0.46	1.14	1.36	0.85	0.56	0.45	0.34	0.37	0.41	0.45	7.27

Climatological Data	Study Period Average Monthly Values												
	1976	1977											
	December	January	February	March	April	May	June	July	August	September	October	November	Annual
Mean monthly air temperature—°F (Watertown)	14.5	5.4	22.0	41.4	53.4	66.8	66.6	75.5	67.7	63.1	49.8	37.1	47.0
Departure from normal monthly mean air temperature—°F (Watertown)	-9.6	-14.1	0.0	8.7	5.8	8.6	-1.2	3.3	-3.2	0.3	-2.6	0.0	-0.29
Precipitation—inches (Watertown)	0.41	0.51	0.85	4.15	2.33	0.94	3.41	7.70	5.15	3.40	2.15	2.32	33.32
Departure from normal precipitation—inches (Watertown)	-1.23	-0.92	-0.17	1.97	-0.67	-2.18	-0.64	4.00	1.82	-0.38	-0.01	0.27	1.86
Runoff—inches (Rock River at Afton)	0.17	0.17	0.15	0.42	0.65	0.22	0.17	0.22	0.43	0.33	0.54	0.53	4.0
Departure from normal runoff—inches (Rock River at Afton)	-0.29	-0.25	-0.31	-0.72	-0.71	-0.63	-0.39	-0.23	0.09	-0.04	0.13	0.08	-3.17

Source: National Oceanic and Atmospheric Administration, U. S. Geological Survey, and SEWRPC.

Figure 2

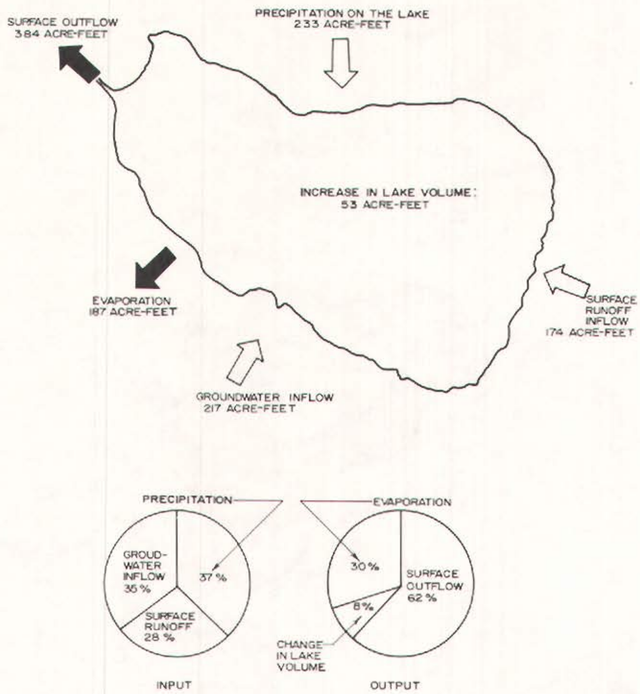
LAKE LEVEL FLUCTUATIONS IN ASHIPPUN LAKE: DECEMBER 1976-OCTOBER 1977



Source: Wisconsin Department of Natural Resources.

Figure 3

HYDROLOGIC BUDGET FOR ASHIPPUN LAKE DECEMBER 1976-OCTOBER 1977

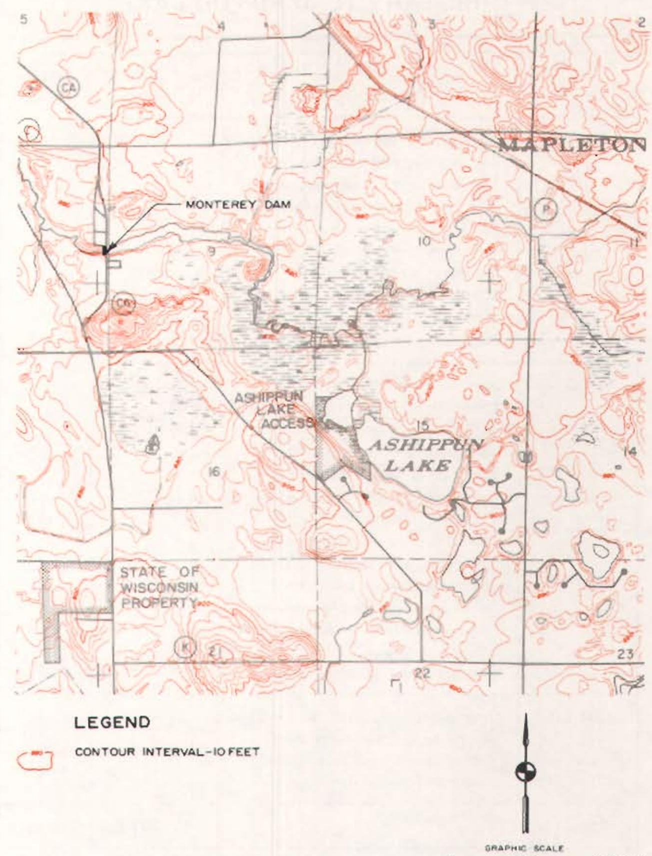


NOTE: DURING THE STUDY YEAR, NO SIGNIFICANT INFLOW TO THE LAKE FROM THE ASHIPPUN RIVER WAS REPORTED. ALTHOUGH NOT REFLECTED IN THIS FIGURE, ON THE AVERAGE, ABOUT 126 ACRE—FEET OF WATER PER YEAR MAY BE CONTRIBUTED TO ASHIPPUN LAKE FROM THE ASHIPPUN RIVER.

Source: SEWRPC.

Map 3

TOPOGRAPHIC MAP SHOWING ASHIPPUN LAKE AND MONTEREY DAM



Source: U. S. Geological Survey

sion, and contributing sediments and nutrients to the lake. During the lake study period, lake level and outlet flow observations made from December 1976 through October 1977, indicated that the flow of water was from Ashippun Lake towards the Ashippun River.

However, analyses conducted by the Regional Planning Commission staff indicate that the Ashippun River could influence the elevation of Ashippun Lake. During normal to low-flow periods, the Monterey Dam does not affect Ashippun Lake water levels, if the dam is operated in accordance with Wisconsin Department of Natural Resources requirements. Because the normal pool level of the Monterey Pool is only one to three feet lower than the normal elevation of Ashippun Lake, during some runoff events the dam—in concert with the natural constrictions in the stream valley—resists the river flow and causes backwater elevations which can induce flow into Ashippun Lake. In an average year, about 126 acre-feet of water may be contributed to Ashippun Lake from the Ashippun River. The water budget shown in Figure 3, which is based on measured data during the study year, does not reflect inflow to the lake from the Ashippun River.

The hydraulic residence time for Ashippun Lake during the study period, which was a year of relatively average precipitation, was approximately 2.3 years. The hydraulic residence time is important in determining the expected response time of the lake to increased or reduced nutrient and other pollutant loadings.

SOIL TYPE AND CONDITIONS

Soil composition, slope, use and management are among the more important factors determining the effect of soils on lake water quality. Major specific soil types were inventoried in the drainage area directly tributary to Ashippun Lake and analyzed in terms of the associated hydrologic characteris-

Table 3

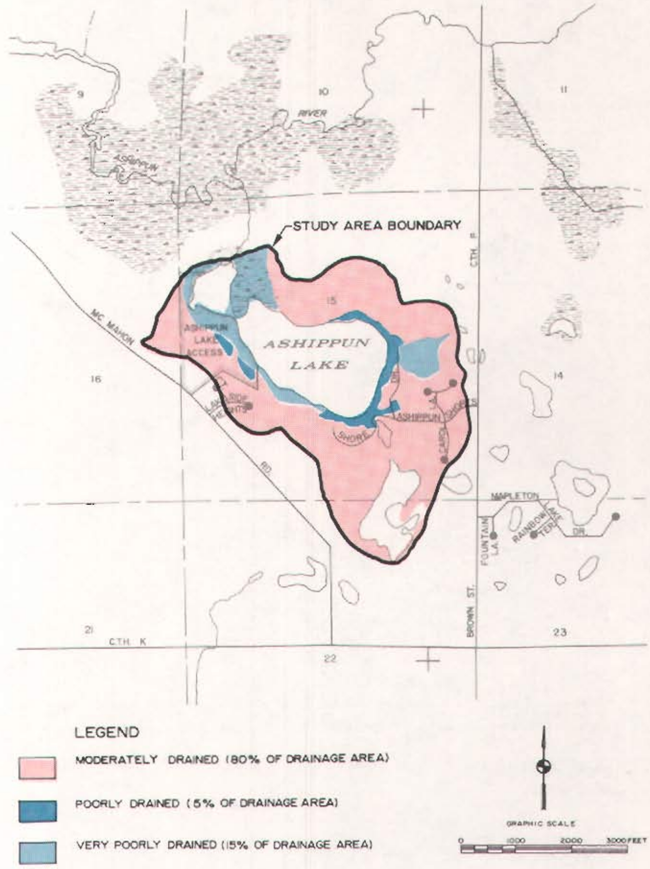
GENERAL HYDROLOGIC SOIL TYPES WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE

Group	Soil Characteristics	Extent (acres)	Percent of Total
A	High infiltration rates Well drained and excessively drained sandy or gravelly soils High rate of water transmission and low runoff potential	None	- -
B	Moderate infiltration rates Moderately well drained Moderately coarse textures Moderate rate of water transmission	293.5	79.1
C	Slow infiltration rates Moderately fine or fine-textured or layers that impede downward movement of water Slow rate of water transmission	22.6	6.1
D	Very low infiltration rates Clay soils with high shrink-swell potential; soils with a high permanent water table; soils with a clay pan or clay layer at or near the surface; shallow soils over nearly impervious substrate Very slow rate of water transmission	54.9	14.8
Made Land	Open pit mining areas, man-made fill areas, dumps and landfills containing widely varying soils and other materials	None	- -
Total		371.0	100.00

Source: SEWRPC.

Map 4

HYDROLOGIC SOIL GROUPS WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE



Source: SEWRPC.

tics. An assessment was made of soil erodibility and soil suitability for use of onsite septic tank sewage disposal systems. These assessments were then used to identify areas of incompatible land use and management.

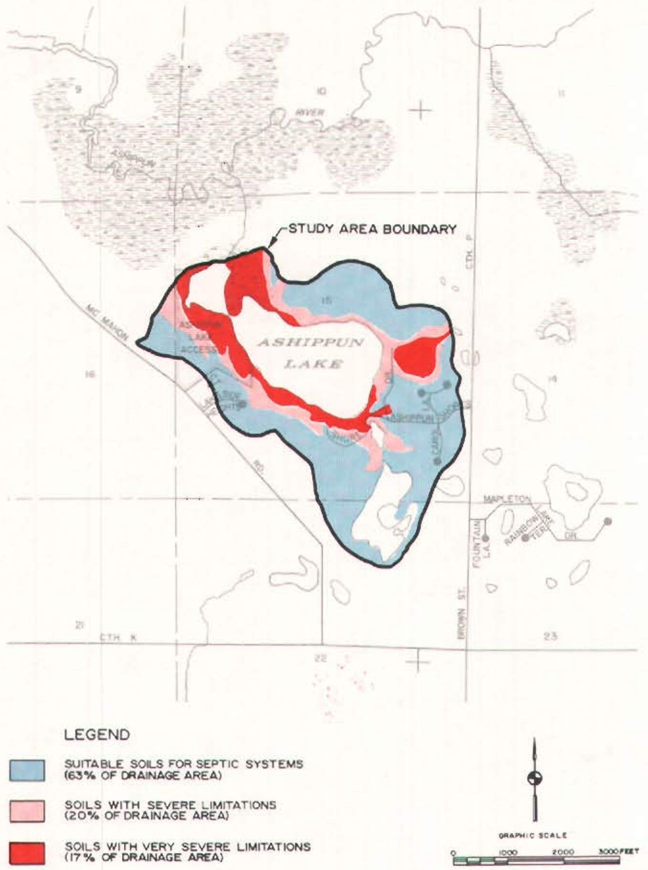
Soil composition, slope and vegetative cover are important factors affecting the rate, amount and quality of storm water runoff. The shape and stability of aggregates of soil particles—expressed as soil structure—influence the permeability, infiltration rate, and erodibility of soils. Slope is important in determining storm water runoff rates and hence susceptibility to erosion.

Soils within the Ashippun Lake watershed can be categorized into three of the four main hydrologic groups and "made land" as indicated in Table 3. The relative proportion of the total area of the Ashippun Lake watershed covered by each of the hydrologic soil groups is: Group A, well drained, none; Group B, moderately drained, 79 percent; Group C, poorly drained, 6 percent; Group D, very poorly drained, 15 percent; and "made land," none. The extent of these soils and their location within the watershed are shown on Map 4. The major specific soil types present within the Ashippun Lake watershed are: Casco loam, Casco-Rodman complex, Fox loam, Fox silt loam, St. Charles silt loam, Sebewa silt loam, Lamartine silt loam, Theresa silt loam, Houghton muck, and marsh soils.

Soils within the direct tributary area were examined for their suitability for septic tank system use. The suitability of soils in the direct drainage area for septic systems on lots of one acre or less in area is

Map 5

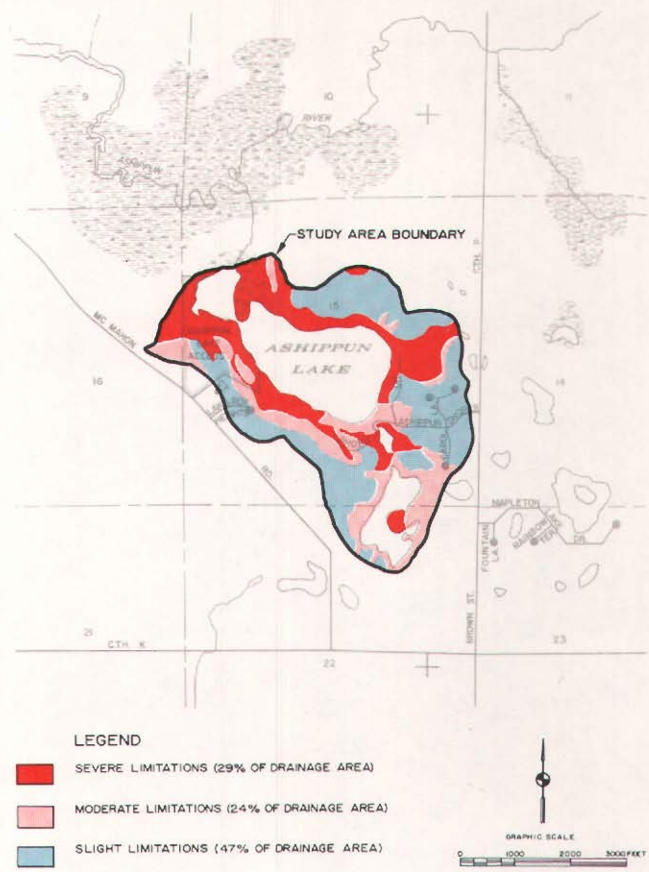
SUITABILITY OF SOILS FOR CONVENTIONAL PRIVATELY OWNED ONSITE SEWAGE DISPOSAL SYSTEMS ON LOTS OF ONE ACRE OR LESS IN SIZE IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE



Source: SEWRPC.

Map 6

SUITABILITY OF SOILS FOR WASTEWATER SLUDGE APPLICATION IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE



Source: SEWRPC.

indicated on Map 5 according to three major groupings: 1) suitable, 2) severely limited, and 3) very severely limited. These soil categories cover 66, 20, and 14 percent of the total watershed area respectively. In the Ashippun Lake drainage area, as of 1975, 21 of the estimated 61 septic systems, or 34 percent, were located on soils having severe or very severe limitations for the use of such systems.

Land uses within the tributary watershed are generally compatible with the soil types, except for the sewage disposal uses noted above. Particularly, residential development within the lake watershed is otherwise generally compatible with the soil characteristics.

Another consideration for watershed management is the suitability of the soils for land application of residual wastewater treatment sludges. The Commission inventory of sewage sludge management practices within the Region indicated that, in 1976, sludge was not routinely applied in the drainage area directly tributary to Ashippun Lake. About 47 percent of the total drainage area is covered by soils rated as having only slight limitations for wastewater sludge application, as shown on Map 6. The remaining 53 percent is covered by soils which have moderate or severe limitations for sludge application; and any application in these areas could be potentially detrimental to stream, lake, or groundwater quality.

(This page intentionally left blank)

Chapter III

HISTORICAL, EXISTING, AND FORECAST LAND USE AND POPULATION

INTRODUCTION

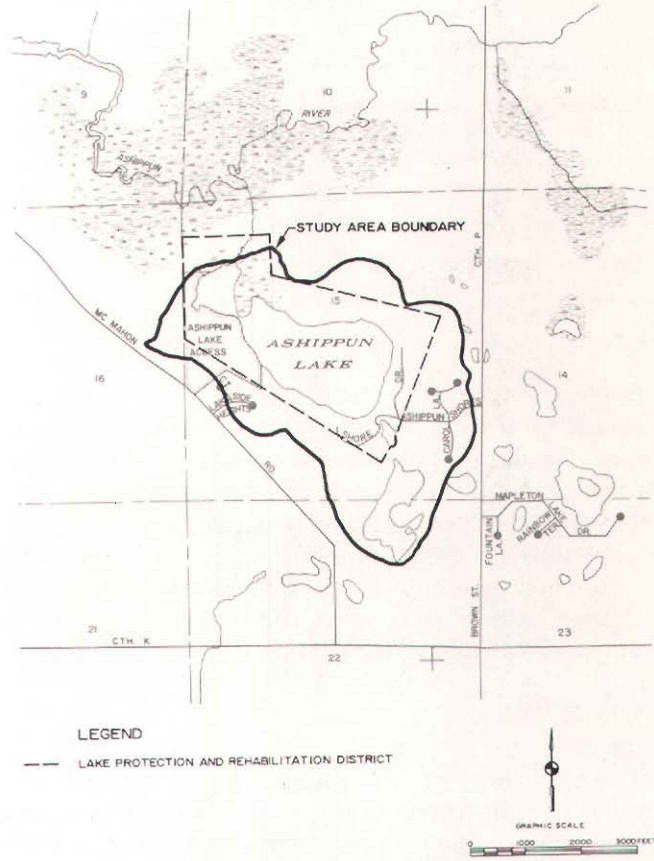
Water pollution problems, and ultimate solutions to those problems, are a function of the human activities within the drainage area of a water body and of the ability of the underlying natural resource base to sustain those activities. This is especially true in an area directly tributary to a lake, because lakes are more susceptible than streams to water quality degradation, and because the degradation is more likely to quickly interfere with desired water uses.

Civil divisions and special purpose units of government are an important factor which must be considered in a water quality management planning effort for a lake, since these local units of government provide the basic structure of the decision-making framework within which intergovernmental environmental problems must be addressed.

The entire drainage area directly tributary to Ashippun Lake is located within the Town of Oconomowoc, Waukesha County, as shown on Map 7. Map 7 indicates that about 0.23 square mile, or 40 percent of the lake drainage area, is within the Ashippun Lake Protection and Rehabilitation District, a special purpose unit of government with responsibilities for lake management.

Map 7

LOCAL GOVERNMENTAL BOUNDARIES IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1975



Source: SEWRPC.

POPULATION

As set forth in Table 4, the resident population of the drainage area tributary to Ashippun Lake has increased steadily since 1950. The 1980 resident population of the drainage area, estimated at about 230 persons, was nearly double the estimated 1950 population level.[1] Population forecasts prepared by the Regional Planning Commission, on the basis of a normative regional land use plan, indicate, as shown in Table 4, that the population of the drainage area tributary to Ashippun Lake should increase slightly by the year 2000. A comparison of historic, existing, and forecast population levels for the Ashippun Lake drainage area, Waukesha County, and the Southeastern Wisconsin Region is set forth in Figure 4. The population growth rate in the Ashippun Lake drainage area since 1950 has been lower than the growth rate for Waukesha County but higher than the growth rate of the Southeastern Wisconsin Region. Forecast population growth in the Ashippun Lake drainage area, however, is at a lower rate than either Waukesha County or the

[1] *1980 population figure is based on preliminary census counts.*

Table 4

HISTORIC AND FORECAST RESIDENT POPULATION OF THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1950-2000

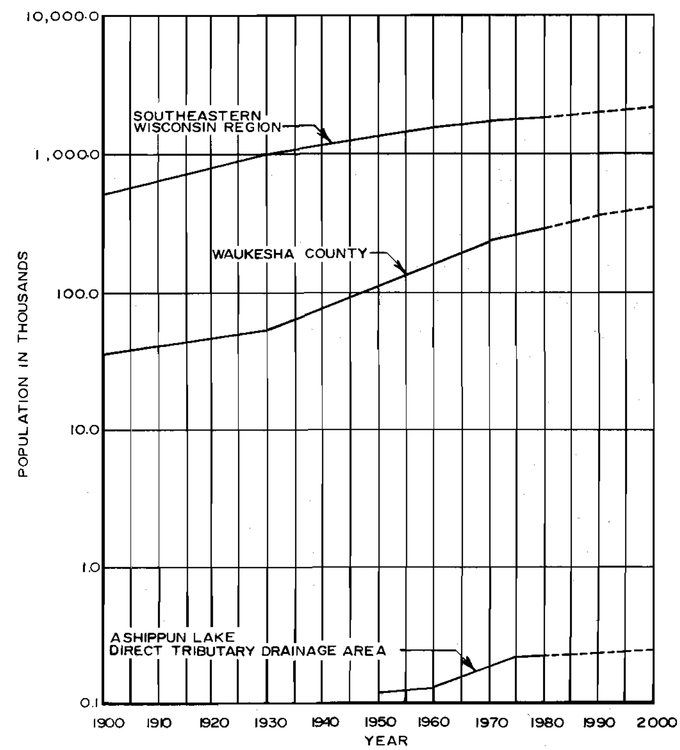
Year	Population
1950	120
1960	130
1970	190
1975	220
1980	230
2000	252

NOTE: 1980 population figure is based on preliminary census counts.

Source: SEWRPC.

Figure 4

COMPARISON OF HISTORICAL, EXISTING AND FORECAST POPULATION TRENDS FOR ASHIPPUN LAKE, WAUKESHA COUNTY AND THE SOUTHEASTERN WISCONSIN REGION



Source: SEWRPC.

Region, since only a slight increase in population is expected within the lake drainage area. This forecast population level, however, may be expected to place a continued stress on the natural resource base of the lake drainage area, and as the population of the County and the Region of which the watershed is an integral part continues to grow and change, water resource demands and use conflicts may be expected to increase.

LAND USE

The type, intensity, and spatial distribution of land uses are important determinants of the resource demands in the lake drainage area. The existing land use pattern can best be understood within the context of its historic development.

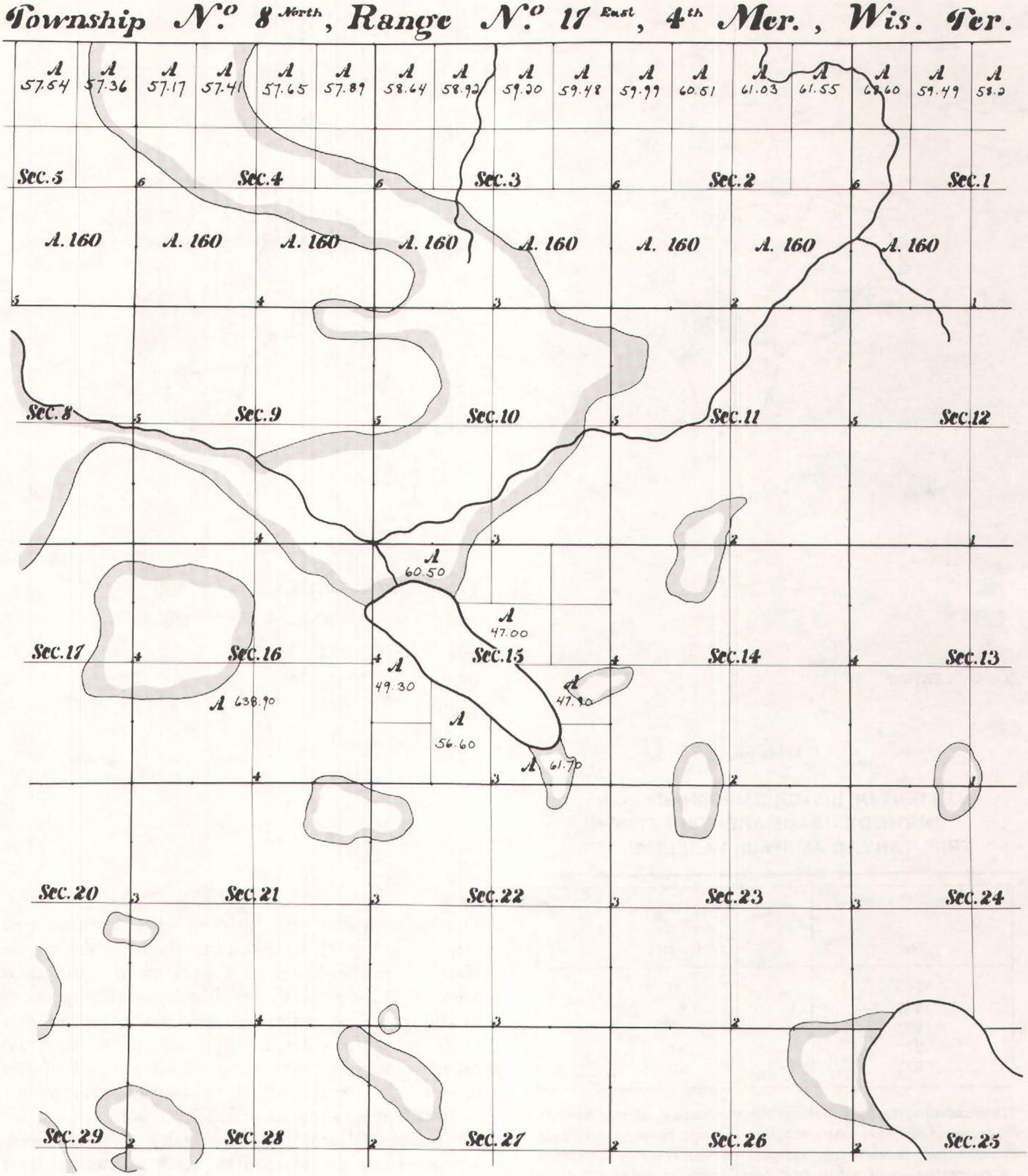
The movement of European settlers into the Southeastern Wisconsin Region began about 1830. Completion of the U. S. Public Land Survey in southeastern Wisconsin in 1836 and subsequent sale of public lands brought a rapid influx of settlers into the area. Map 8 shows the original plat of the U. S. Public Land Survey for the Ashippun Lake area. Rural land division in the drainage area tributary to Ashippun Lake began in the 1830's. Map 9 and Table 5 indicate the historic urban growth pattern in the Ashippun Lake tributary drainage area.[2] Urban development apparently began in the 1940's, with the largest increases in development from 1940 to 1950, and from 1963 to 1975. Prior to, and including 1950, most residential development occurred immediately adjacent to the lake shoreline. Since the mid-1960's, urban development has occurred in the outlying areas away from the lake shoreline itself.

---

[2] *Urban development as defined for the purposes of this discussion includes those areas wherein houses or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of urban land uses. Scattered residential developments were not considered as urban development in this analysis.*

Map 8

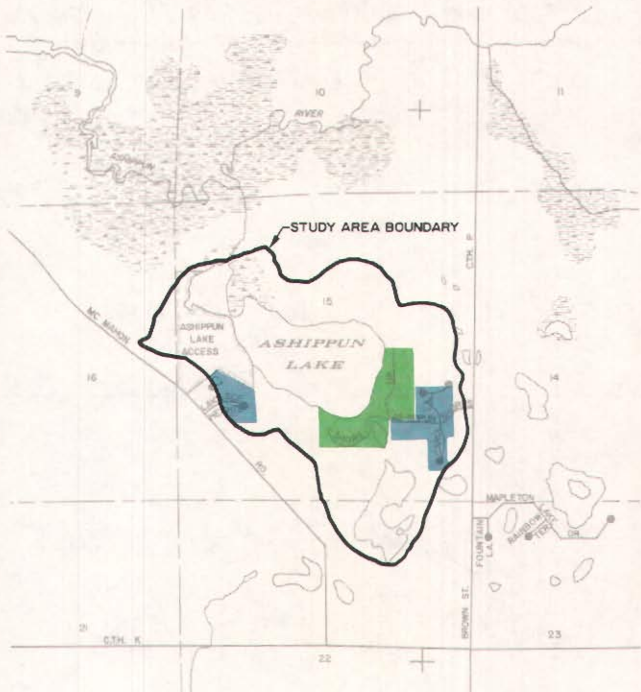
ORIGINAL UNITED STATES PUBLIC LAND SURVEY MAP WHICH INCLUDES THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1836



Source: U. S. Public Land Survey.

Map 9

HISTORIC URBAN GROWTH IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1850-1975



LEGEND

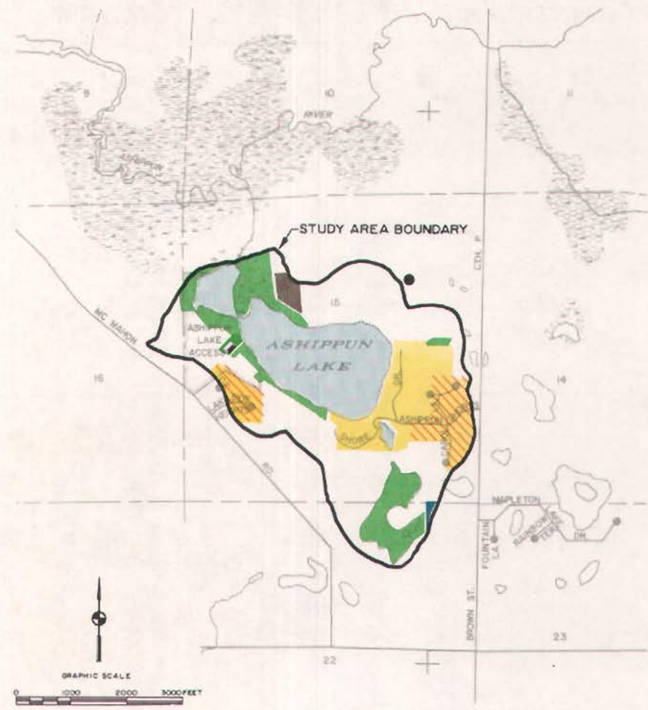
1950

1975

Source: SEWRPC.

Map 10

EXISTING LAND USE IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1975



LEGEND

SUBURBAN DENSITY RESIDENTIAL (0.2-0.6 DWELLING UNITS PER NET RESIDENTIAL ACRE)

LOW DENSITY RESIDENTIAL (0.7-2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)

TRANSPORTATION, COMMUNICATION AND UTILITIES

GOVERNMENT AND INSTITUTION

RECREATION

WETLANDS

WOODLANDS

WATER

AGRICULTURAL AND OTHER OPEN LANDS

LOCATION OF LIVESTOCK OPERATION

Source: SEWRPC.

Table 5

EXTENT OF HISTORIC URBAN GROWTH IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1850-1975

Year	Extent of Urban Development[a] (acres)
1940	- -
1950	45
1963	45
1970	67
1975	80

[a] *Urban development, as defined for the purpose of this analysis, includes those areas wherein houses or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of urban land uses. Scattered residential developments were not considered as urban development.*

Source: SEWRPC.

The existing land use pattern in the drainage area directly tributary to Ashippun Lake is shown on Map 10 and existing land uses are quantified in Table 6. As indicated in Table 6, about 23 percent of the total lake watershed area was in urban land use as of 1975, with the dominant urban land use being residential, consisting of 85 percent of the total area in urban use. All residential development is classified as suburban (0.2-0.6 dwelling unit per net residential area) or low-density (0.7-2.2 dwelling units per net residential acre) residential land use. Over half of the drainage area is in agricultural land use, and woodland areas comprise 1.2 percent of the drainage area. Wetlands and water areas,

Table 6

EXISTING 1975 AND PLANNED 2000 LAND USE WITHIN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE

Land Use Categories	Existing 1975			Planned 2000		
	Acres	Percent of Major Category	Percent of Study Area	Acres	Percent of Major Category	Percent of Study Area
Urban						
Residential						
Suburban Density	40.0	46.9	10.8	40.0	46.9	10.8
Low Density	32.7	38.3	8.8	32.7	38.3	8.8
Residential Subtotal	72.7	85.2	19.6	72.7	85.2	19.6
Commercial	- -	- -	- -	- -	- -	- -
Industrial	- -	- -	- -	- -	- -	- -
Transportation, Utilities, and Communication	10.1	11.9	2.7	10.1	11.9	2.7
Governmental and Institutional	0.9	1.1	0.3	0.9	1.1	0.3
Recreational	1.5	1.8	0.4	1.5	1.8	0.4
Urban Total	85.2	100.0	23.0	85.2	100.0	23.0
Rural						
Agricultural	199.0	69.6	53.7	199.0	69.6	53.7
Water[a]	12.2	4.3	3.3	12.2	4.3	3.3
Wetlands[a]	69.3	24.4	18.7	69.3	24.4	18.7
Woodlands	4.6	1.6	1.2	4.6	1.6	1.2
Other Open Lands	0.3	0.1	0.1	0.3	0.1	0.1
Rural Total	285.4	100.0	77.0	285.4	100.0	77.0
Study Area Total	370.6	- -	100.0	370.6	- -	100.0

[a] *Excludes the surface area of Ashippun Lake.*

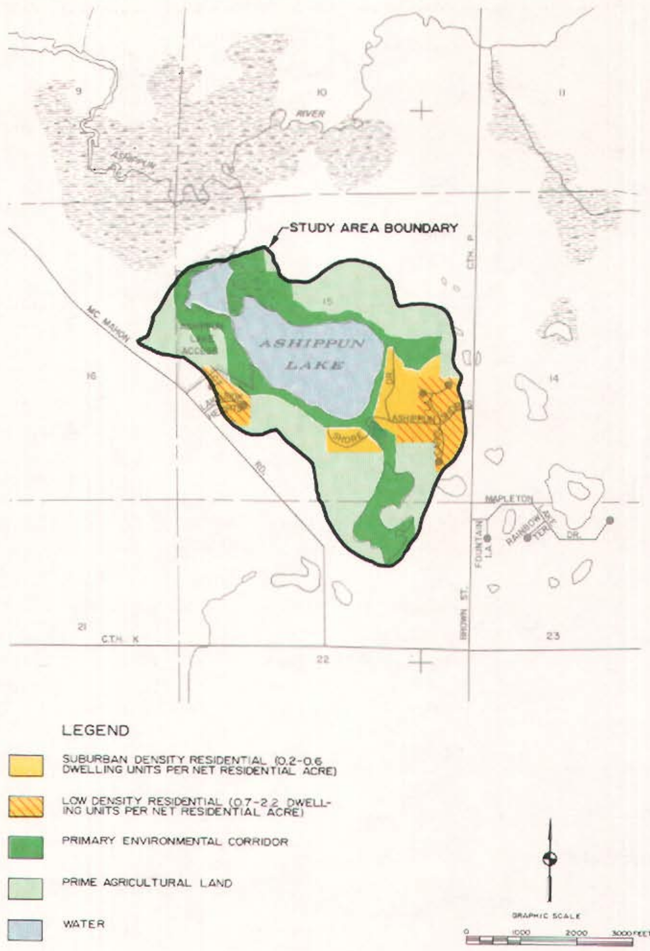
Source: SEWRPC.

excluding the lake itself, account for 22 percent of the total tributary drainage area.

No significant increases in urban development are expected within the lake drainage area by the design year 2000. The year 2000 regional land use plan adopted by the Regional Planning Commission, as set forth in Map 11 and quantified in Table 6, recommends that essentially no new urban development be encouraged to occur in the lake drainage area to the plan design year 2000. All agricultural lands within the lake drainage areas are recommended to be preserved in agricultural use through the design year of the plan. It is recommended that the land immediately surrounding the entire lake, and the wetlands north and south of the lake, be permanently preserved as a primary environmental corridor.

Map 11

GENERALIZED PLANNED LAND USE IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 2000



Source: SEWRPC.

Chapter IV

WATER QUALITY

HISTORICAL DATA

Very little data predating the current study on the water quality and biota of Ashippun Lake are available. Known data sources include miscellaneous Wisconsin Department of Natural Resources file data and reports. Generally, the existing data base on water quality is not sufficient to permit documentation of any long-term trends or changes which may be occurring in the water quality of Ashippun Lake.

PHYSICAL AND CHEMICAL CHARACTERISTICS

The water quality of Ashippun Lake has been monitored periodically from 1973 through 1978. These data were used in the management plan preparation to determine the condition of the lake and to characterize its suitability for recreational use and the support of fish and aquatic life. The primary station for most sampling activities was located at the deepest point in the lake, as shown on Map 12. Monthly temperature and dissolved oxygen profiles taken at this station are shown in Figures 5 through 16. Water temperatures ranged from a minimum of 32°F (0°C) during the winter to a maximum of 78°F (26°C) during the summer.

Complete mixing of the lake is restricted by thermal stratification during the summer, and by ice cover during the winter. Thermal stratification is a result of differential heating of the lake water and of water temperature density relationships. Water is unique among liquids in that it reaches its maximum density—weight per unit volume—at about 39°F. As summer begins, the lake absorbs the sun's energy at the surface. Wind action and, to some extent, internal heat transfer transmit some of this energy to the underlying waters. As the surface of the water is heated by the sun's energy, however, a barrier begins to form between the upper, lighter warmer water and the lower, heavier, colder water as shown in Figure 9. This "barrier" is marked by a sharp temperature gradient known as the metalimnion, or thermocline, which separates the warmer, lighter, upper layer of water—called the epilimnion—from the cooler, heavier, lower layer—called the hypolimnion. Although this barrier is easily crossed by fish, it essentially prohibits the exchange of water between the two layers, a condition which, as will be discussed later, has a great impact on both chemical and biological conditions and activities in the lake. The development of the thermocline, which begins in early summer, reaches its maximum in late summer. This stratification period lasts until the fall, when air temperatures cool the surface water and wind action results in erosion of the thermocline.

As the surface water cools, it becomes heavier, sinking and displacing the warmer water below. The colder water sinks and mixes under wind

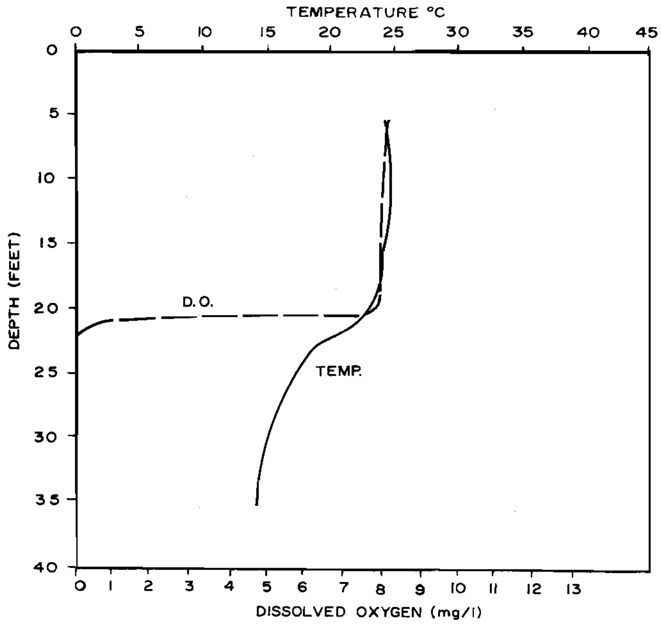
Map 12

PRIMARY WATER QUALITY SAMPLING SITE IN ASHIPPUN LAKE: 1973-1978

Source: SEWRPC.

Figure 5

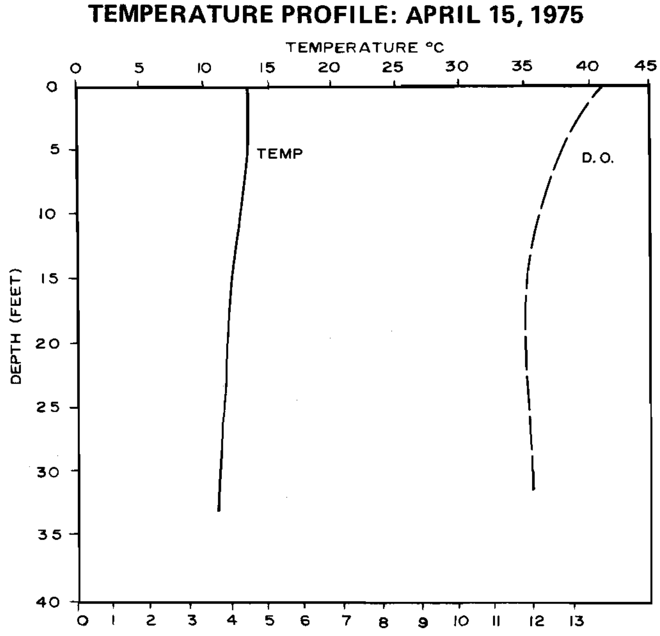
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: SEPTEMBER 12, 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 6

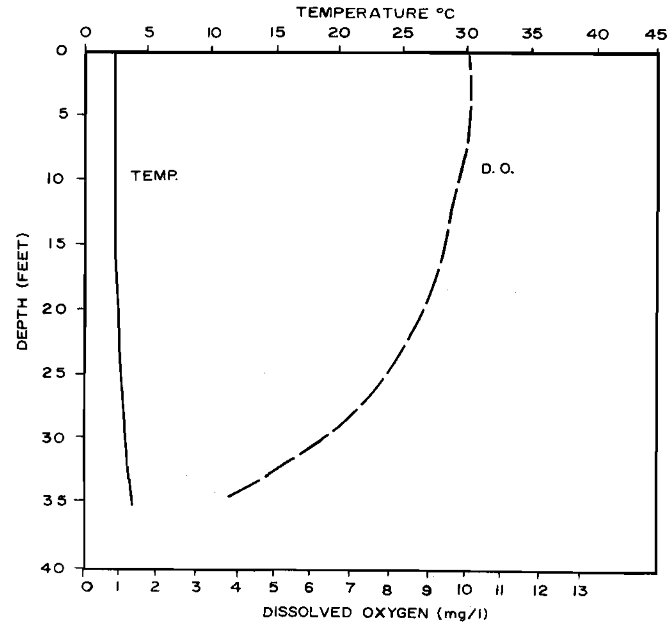
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: APRIL 15, 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 7

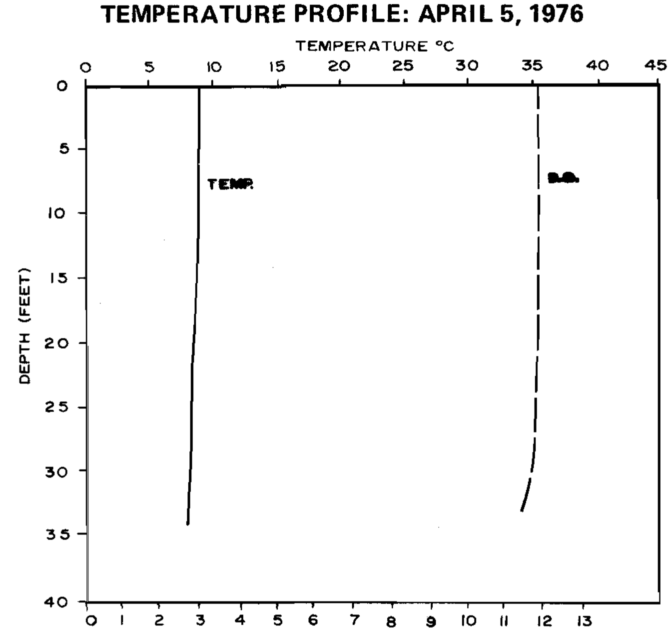
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: FEBRUARY 19, 1976



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 8

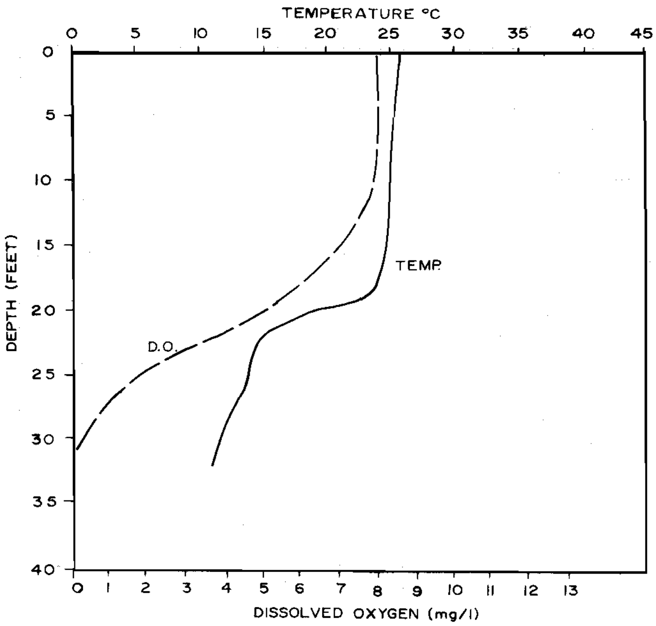
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: APRIL 5, 1976



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 9

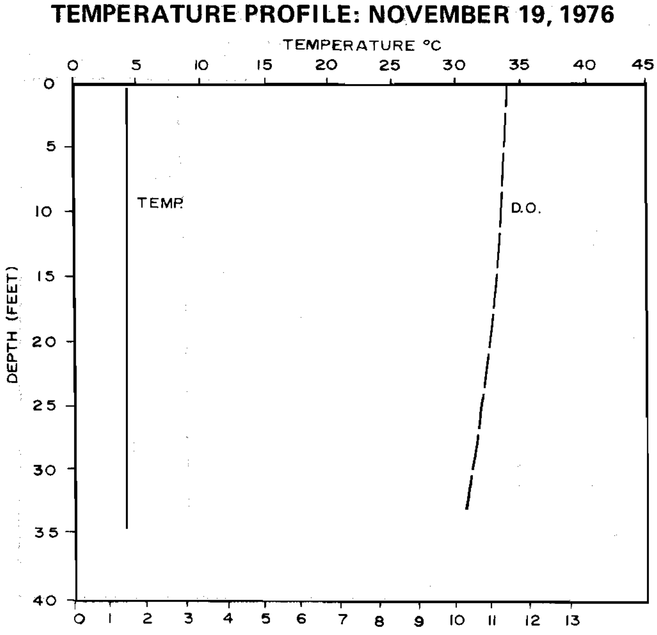
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: JULY 16, 1976



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 10

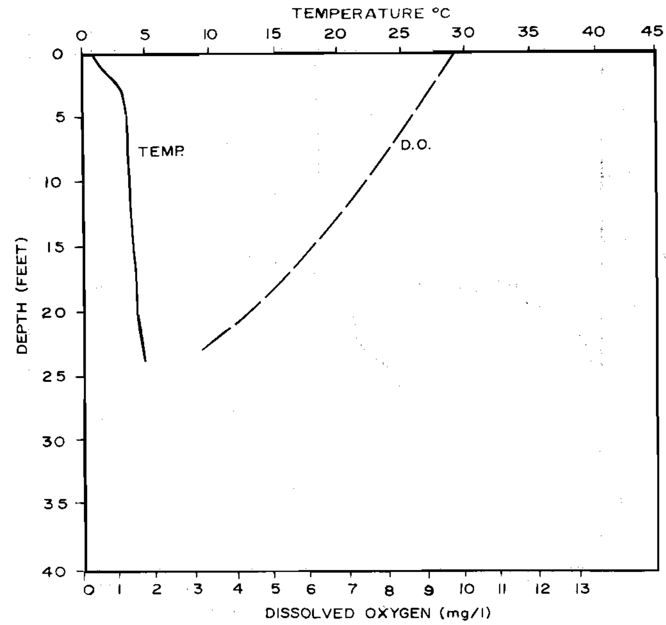
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: NOVEMBER 19, 1976



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 11

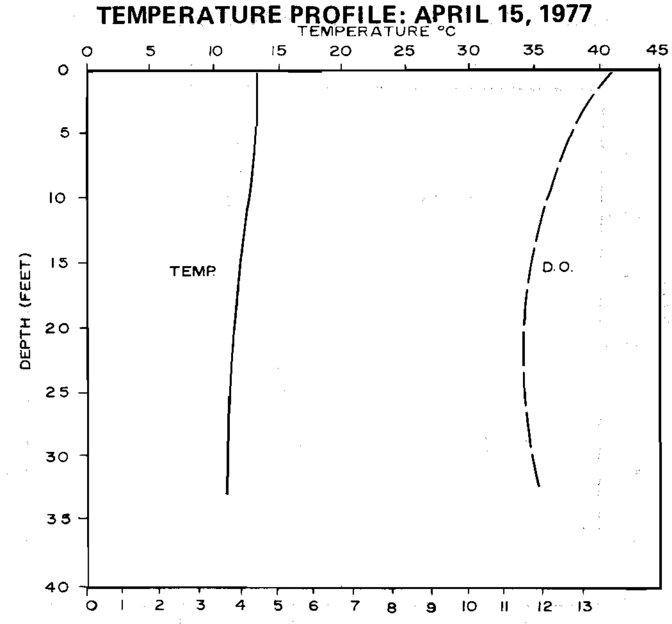
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: JANUARY 24, 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 12

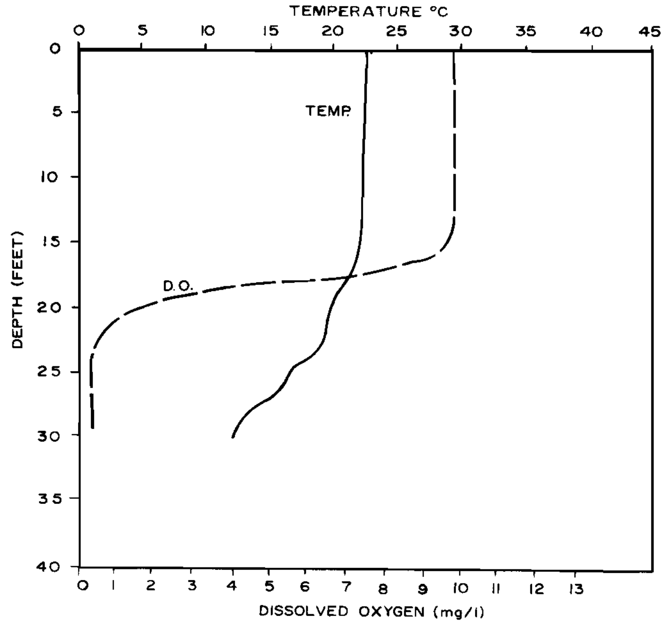
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: APRIL 15, 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 13

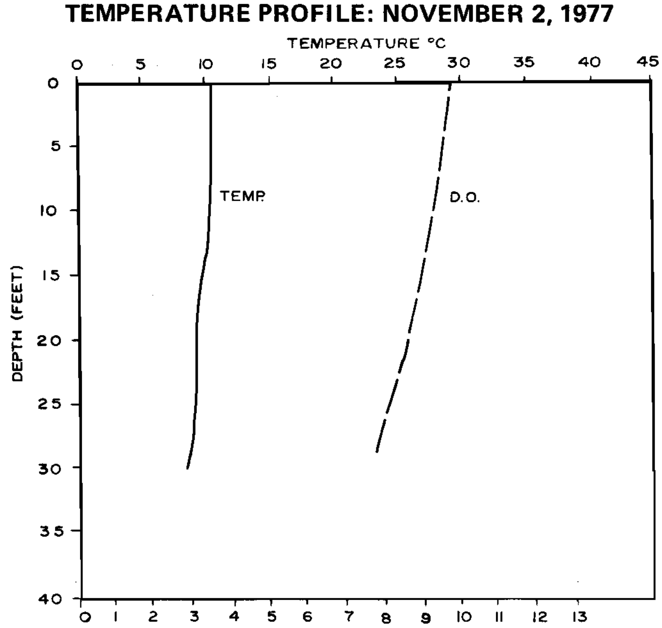
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: SEPTEMBER 1, 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 14

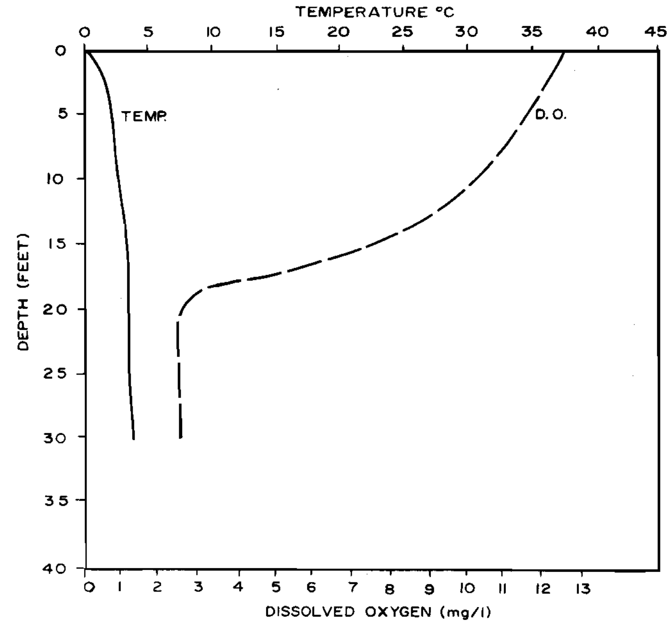
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: NOVEMBER 2, 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 15

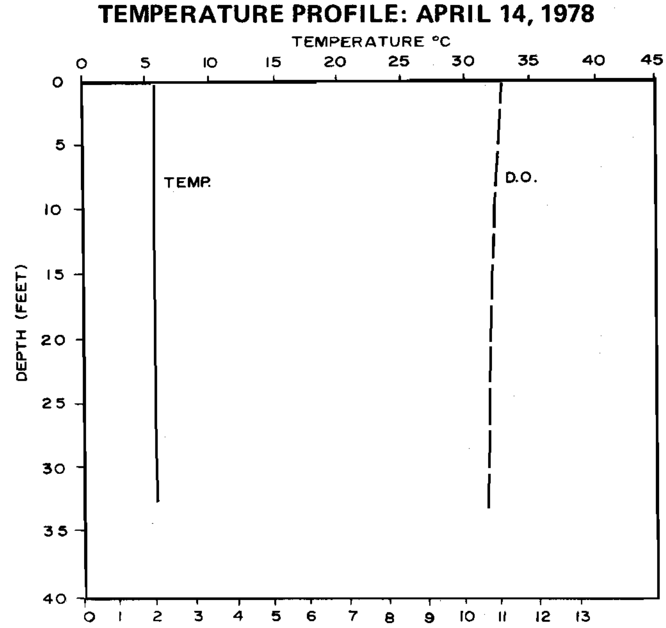
ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: FEBRUARY 8, 1978



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 16

ASHIPPUN LAKE DISSOLVED OXYGEN AND TEMPERATURE PROFILE: APRIL 14, 1978



Source: Wisconsin Department of Natural Resources and SEWRPC.

action to erode the thermocline until the entire column of water is of uniform temperature as shown in Figure 10. This action, which follows summer stratification, is known as fall turnover. When the water temperature drops below 39°F, it again becomes lighter and "floats" near the surface. Eventually, the water near the surface is cooled to 32°F at which time ice begins to form and cover the lake surface, isolating it from the atmosphere for up to four months. On Ashippun Lake, ice cover typically exists from December to early April. As shown in Figure 11, winter stratification occurs as the colder, lighter water and ice remain at the surface, again separated from the relatively warmer, heavier water near the bottom of the lake. The ice shuts the water column off from the atmospheric source of oxygen.

Spring brings a reversal of the process. As the ice thaws and the upper layer of water warms, it becomes more dense and begins to approach the temperature of the warmer, lower water until the entire water column reaches the same temperature. Mixing induced by the wind, continues until the water again reaches 39°F, shown in Figures 6, 8, 12, and 16. This lake season, which follows winter stratification, is referred to as the spring turnover. Beyond this point, the water warms at the surface and again becomes lighter and floats above the colder water. Wind and resulting waves carry, to a limited extent, some of the energy of the warmer, lighter water to lower depths. Thus begins the formation of the thermocline and another summer thermal stratification.

Dissolved oxygen levels are one of the most critical factors affecting a lake ecosystem. In shallow, fertile lakes, winter brings the threat of dissolved oxygen depletion and fish mortality under ice cover. If ice cover is thick and snow cover deep, light penetration is sometimes not sufficient to maintain oxygen-production from the plants in the lake. When plant life dies and decays dissolved oxygen is consumed in the process, resulting in oxygen depletion which kills fish if the supply of dissolved oxygen is not sufficient to meet the total winter demands. This condition, commonly referred to as winterkill, has not been a problem in Ashippun Lake. Dissolved oxygen levels at most depths were adequate for the support of fish and other aquatic life throughout the winter, as shown in Figures 7, 11, and 15.

Dissolved oxygen profiles during summer stratification on Ashippun Lake show total oxygen depletion in the hypolimnion. Beginning in early summer, as the thermocline develops, the lower, colder body of water (hypolimnion) becomes isolated from the upper, warmer layer (epilimnion), cutting off the surface supply of dissolved oxygen to the hypolimnion, while in the epilimnion, atmospheric equilibrum, wind turbulence, wave action, and plant photosynthesis maintain an adequate supply of dissolved oxygen. Gradually, if there is not enough dissolved oxygen to meet the total oxygen demand from decaying material, the dissolved oxygen concentration may be reduced to zero. This oxygen depletion, was observed in Ashippun Lake as shown in Figure 9, and is common for many lakes in southeastern Wisconsin. In July 1976, the dissolved oxygen level at a depth of 32 feet dropped to 0.2 mg/l. This value may cause many species of fish to move upward in the water column, where higher dissolved oxygen concentrations exist. Additional dissolved oxygen measurements were taken during the study year of December 1976 through October 1977. These data, as shown in Figure 17, indicate that a portion of the hypolimnion was completely devoid of oxygen during a period of the summer.

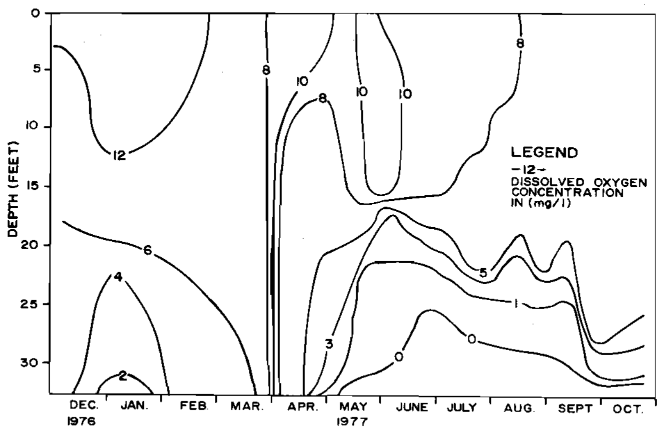
The range of depths within which photosynthetic activity occurs depends to a large extent on the transparency of the water. A Secchi Disc was used to measure water clarity. This is a black and white, 8-inch disc lowered to a depth where it is, just, no longer visible. Water clarity in lakes is typically highly variable. In Ashippun Lake, the Secchi Disc readings ranged from a low of 2.5 feet in mid-February 1978 to a high of 9.3 feet in mid-April 1977, with an average of 5.8 feet as shown in Figure 18. The February reading was taken under snow and ice cover and does not necessarily indicate poor water clarity.

Chlorophyll-a is the major photosynthetic pigment in algae. The amount of chlorophyll-a present is an indicator of the biomass of live algae in the water and its level of concentration is useful in determining the trophic status of lakes and hence the suitability for certain water uses. Chlorophyll-a was measured only once in Ashippun Lake. On November 9, 1976 chlorophyll-a was measured at 28.26 micrograms per liter (µg/l). A single measurement of chlorophyll-a is not adequate for determining the trophic status of a lake.

Water samples collected from Ashippun Lake between 1975 and 1978 were tested for pH (acidity), specific conductance (a measure of the

Figure 17

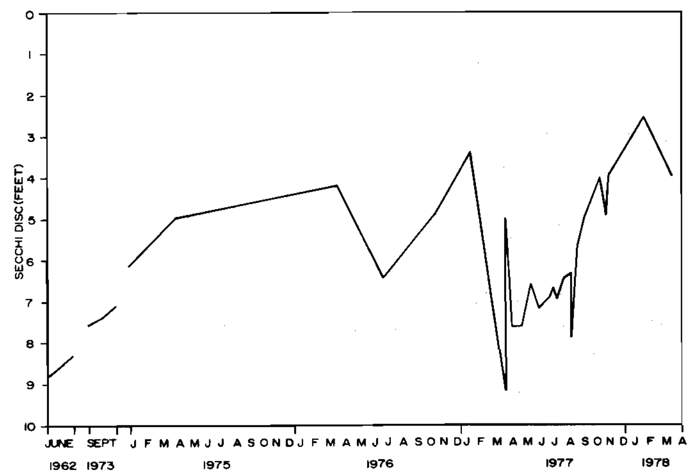
ASHIPPUN LAKE DISSOLVED OXYGEN PROFILE DECEMBER 1976-OCTOBER 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 18

MEASURED SECCHI DISC DEPTHS IN ASHIPPUN LAKE: 1962-1978



Source: Wisconsin Department of Natural Resources and SEWRPC.

amount of dissolved solids), magnesium, sodium, potassium, iron, manganese, sulfate, alkalinity, turbidity, chloride, suspended solids, and different forms of the plant nutrients nitrogen and phosphorus. Ranges and mean values found for these water quality parameters are set forth in Table 7.

Chloride concentrations ranged from 13 to 23 milligrams per liter (mg/l), which is typical of lakes in southeastern Wisconsin. Chloride concentrations are known to be increasing in southeastern Wisconsin lakes and sources of chlorides include road salt, sewage wastes, animal wastes, water softeners, and natural leaching of rock minerals.

Conductivity ranged from 413.5 to 493.0 micromhos/cm, and pH fluctuated between 7.8 and 8.2 standard units. Conductivity is somewhat lower than the average found in most other Waukesha County lakes. The metals data collected is typical of the hard water lakes in the area. Turbidity, another measure of water clarity, is low to moderate throughout the year. Total alkalinity was about average for lakes in Waukesha County.

The nutrients nitrogen and phosphorus, which are necessary for the growth of aquatic plants including algae, have a significant effect on the suitability of lakes for recreational activities. In lakes where supplies of nutrients are limited, plant growth is limited and the lakes are typically clear and classified as oligotrophic. Where abundant supplies of nutrients are available, aquatic plant growth is usually prolific, resulting in nuisance algae blooms and/or excessive macrophyte growth. Lakes experiencing these conditions are unattractive for certain recreational uses.

Phosphorus concentrations in Ashippun Lake were found to exceed the levels believed necessary to support periodic nuisance algae blooms. The recommended water quality standard for recreational use and warmwater fish and aquatic life set forth in the Regional Planning Commission's adopted regional water quality management plan indicates that algae blooms are likely to occur in lakes where the total phosphorus concentration exceeds 0.02 milligram per liter (mg/l) during spring turnover. This is the level considered in the regional plan as needed to limit algae and aquatic plant growth to levels consistent with the recreational, and warmwater fish and aquatic life water use objectives. In Ashippun Lake the mean concentration of total phosphorus was 0.05 mg/l on an annual basis and 0.06 mg/l during spring turnover.

The ratio of total nitrogen to total phosphorus in lake water indicates which nutrient is the factor likely limiting aquatic plant growth in a lake.[1]

---

[1] *M. O. Allum, R. E. Gessner, and T. H. Gokstatter, An Evaluation of the National Eutrophication Data, U. S. Environmental Protection Agency Working Paper No. 900, 1977.*

Table 7

WATER QUALITY CONDITIONS OF ASHIPPUN LAKE: 1975-1978

Water Quality Parameter	Sample Dates (month-day-year)											
	4-15-1975	2-23-1976	4-5-1976	7-16-1976	11-9-1976	1-24-1977	4-15-1977	9-1-1977	11-2-1977	2-8-1978	4-14-1978	Range	Mean
Nitrite and Nitrate Nitrogen	0.13	0.13	0.34	0.04	0.25	0.15	0.13	0.03	0.07	0.23	0.25	0.03-0.34	0.16
Ammonia Nitrogen	0.16	0.38	0.19	0.63	0.09	0.21	0.16	0.35	0.24	0.41	0.46	0.09-0.63	0.30
Organic Nitrogen	0.6	0.57	0.59	1.05	1.18	1.13	0.6	0.65	0.67	0.53	0.7	0.6-1.18	0.75
Total Nitrogen	0.88	1.21	1.28	1.70	1.52	1.50	0.88	1.00	0.98	1.16	1.6	0.88-1.52	1.25
Phosphate Phosphorus	0.008	0.010	0.010	0.010	0.020	0.007	0.008	0.010	0.007	0.039	0.013	0.007-0.039	0.013
Total Phosphorus	0.040	0.030	0.100	0.050	0.080	0.040	0.040	0.050	0.065	0.065	0.070	0.030-0.100	0.050
Calcium	40.5	31.3	46.0	39.3	37.0	29.0	40.5	33.3	37.0	43.0	43.3	29.0-46.0	38.2
Magnesium	36.5	29.7	33.5	34.7	44.0	43.3	36.5	44.0	41.5	40.5	42.8	29.7-44.0	38.8
Sodium	5.5	11.3	17.5	10.0	8.5	24.0	5.5	9.7	7.0	24.5	9.0	5.5-24.5	12.0
Potassium	1.60	6.40	2.00	2.20	2.60	1.07	1.55	1.70	2.40	1.55	1.90	1.07-6.40	2.30
Iron	0.06	0.09	0.11	0.15	0.59	0.35	0.06	0.06	0.06	0.08	0.06	0.06-0.59	0.14
Manganese	0.03	0.08	0.03	0.15	0.27	0.13	0.03	0.24	0.07	0.11	0.09	0.03-0.27	0.11
Conductivity (micromhos/cm)	493.0	424.3	440.0	447.7	426.5	489.0	493.0	462.3	437.5	413.5	459.0	413.5-493	480.5
Sulfate	--	17.3	29.5	9.3	--	--	--	--	--	--	--	9.3-29.5	18.7
Chloride	19.0	13.3	13.0	15.3	16.0	23.0	19.0	20.3	18.5	20.5	21.3	13.0-23.0	18.1
pH (standard units)	7.8	7.9	8.1	8.1	7.8	8.0	7.8	8.2	8.2	8.1	8.0	7.8-8.2	--
Alkalinity	193.0	168.7	202.0	193.3	190.0	208.0	193.0	191.3	200.0	196.0	233.0	168.7-233.0	197.1
Turbidity (formazin units)	2.00	3.20	3.55	2.30	1.85	0.97	2.00	6.70	4.10	2.30	4.40	0.97-6.70	2.94

NOTE: All values reported in mg/l unless otherwise specified.

Source: Wisconsin Department of Natural Resources.

Where the N:P ratio is greater than 14:1, the lake is thought to be phosphorus-limited. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient. As shown in Table 8, in Ashippun Lake the N:P ratio was always equal to or greater than 14:1, except in April 1976, when the ratio was 12.8:1. This indicates that aquatic plant growth in Ashipun Lake is generally limited by phosphorus.

Sediment contributions also have an important effect on the condition of a lake. As the lake bottom is covered by material washed into the lake or by dead aquatic plant remains, valuable benthic habitats are covered, macrophyte substrates are increased, fish spawning areas are covered, and aesthetic nuisances develop. In addition, sediment particles act as a transport mechanism for other pollutants, such as phosphorus, nitrogen, organic substances, pesticides, and heavy metals.

Additional sources of phosphorus to the lake water are not estimated in Table 9 but should be considered in the lake management process. These sources could include livestock operations, and phosphorus released from the bottom sediments. Livestock from a nearby farm, although not housed in the lake watershed, are known to graze along the shoreline and occasionally within the lake itself as shown in Figure 19. Phosphorus contained in the manure from these livestock, as well as disturbance of the bottom sediments and shoreline erosion caused by trampling of the shore, could have significant water quality impacts on the lake. Phosphorus released to the water from the bottom sediments is most likely to occur under anaerobic conditions formed during summer stratification, however, on an annual basis, the bottom sediments probably act as a phosphorus sink as opposed to a phosphorus source. Since the cattle are not permanently located in the direct drainage area, and are subject to annual or seasonal changes in pasturing practices, the associated pollutant load has not been incorporated in the Ashippun Lake nutrient budget estimates.

Table 8

NITROGEN-PHOSPHORUS RATIO FOR ASHIPPUN LAKE: 1975-1978

Sampling Date	Nitrogen (mg/l)	Phosphorus (mg/l)	Nitrogen to Phosphorus Ratio
04-15-75	0.88	0.04	22.0
02-23-76	1.21	0.03	40.3
04-05-76	1.28	0.10	12.8
07-16-76	1.70	0.05	34.0
11-09-76	1.52	0.08	19.0
01-24-77	1.50	0.04	37.5
04-15-77	0.88	0.04	22.0
09-01-77	1.00	0.05	20.0
11-02-77	0.98	0.07	14.0
02-08-78	1.16	0.07	16.6
04-14-78	1.60	0.07	22.9

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 9

ESTIMATED TOTAL PHOSPHORUS LOADS IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1975 AND 2000

Source of Phosphorus	Existing 1975			Anticipated 2000[a]		
	Number	Total Loading (pounds per year)	Percent Distribution	Number	Total Loading (pounds per year)	Percent Distribution
Urban						
Residential Land (acres)	72.7	8	4.3	72.7	8	4.3
Transportation Land (acres)	10.1	6	3.3	10.1	6	3.3
Government and Institution Land (acres)	0.9	1	0.5	0.9	1	0.5
Recreational Land (acres)	1.5	- -	- -	1.5	- -	- -
Onsite Sewage Disposal Systems[b]	21.0	61	32.8	21.0	61	32.8
Rural						
Agricultural Land (acres)	199.0	19	10.2	199.0	19	10.2
Woodlands (acres)	4.6	1	0.5	4.6	1	0.5
Wetlands (acres)	69.3	- -	- -	69.3	- -	- -
Atmospheric Contributions to Open Water (acres)[c]	95.1	48	25.8	95.1	48	25.8
Other Open Land (acres)	0.3	- -	- -	0.3	- -	- -
Groundwater Inflow (acre feet of water per year)	217.0	12	6.5	217.0	12	6.5
Occasional Inflow from the Ashippun River (acre feet of water per year)	126.0	30	16.1	126.0	30	16.1
Total	- -	186	100.0	- -	186	100.0

[a] *Assumes no nonpoint source controls are implemented.*

[b] *Includes only those systems located on soils having severe or very severe limitations for the disposal of septic tank effluent.*

[c] *Includes the area of the lake.*

Source: SEWRPC.

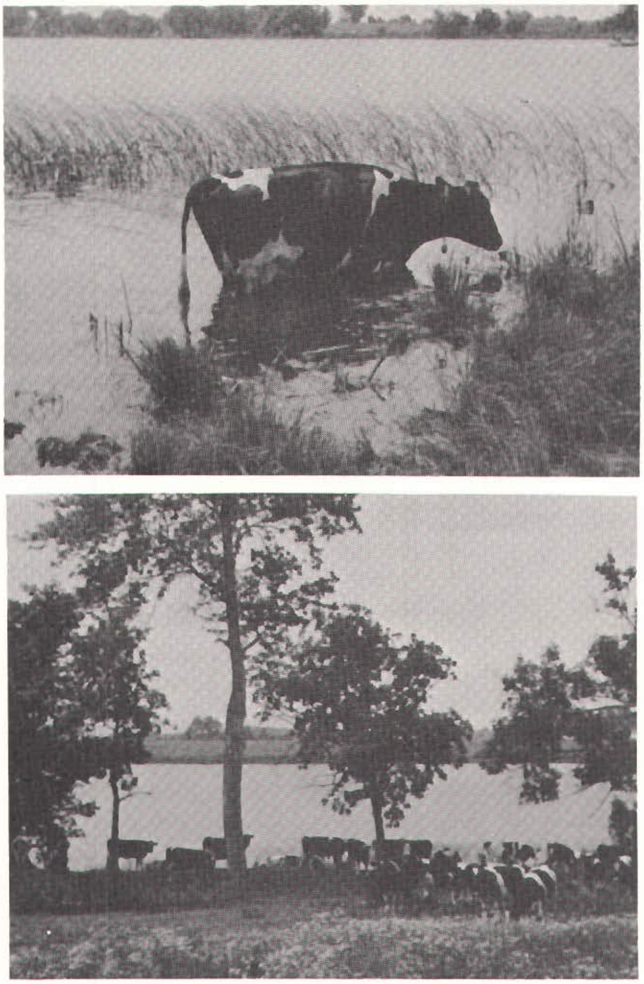
EXISTING AND PROBABLE FUTURE POLLUTION SOURCES AND LOADINGS

Phosphorus has been identified as the factor generally limiting aquatic plant growth in Ashippun Lake and excessive levels of phosphorus in the lake are likely to result in conditions which interfere with the desired use of the lake. Existing and forecast year 2000 phosphorus sources to the lake were identified and quantified using SEWRPC 1975 land use inventory data, planned year 2000 land use data from the Regional Planning Commission's adopted year 2000 land use plan, and the Commission water quality simulation model.

Table 9 sets forth the estimated phosphorus loads to Ashippun Lake under 1975 and anticipated year 2000 conditions, if no nonpoint source controls are implemented in the lake watershed. Land uses and phosphorus loads in the lake watershed are not expected to change significantly under planned year 2000 land use conditions. The estimated annual total phosphorus load to the lake is 186 pounds under both existing and anticipated year 2000 conditions. The major potential source of phosphorus in the lake watershed is septic tank systems, which contribute an estimated 33 percent of the total annual phosphorus load. Direct contributions from the atmosphere via precipitation washout and dry fallout account for about 26 percent of the total phosphorus load. Urban land and rural land runoff contribute about 8 percent, and 11 percent, respectively, of the estimated phosphorus load. In an average year, about 16 percent of the total load may be contributed by occasional back-water inflow from the Ashippun River during high stream flow periods. However, the majority of the phosphorus entering the lake via the Ashippun

Figure 19

LIVESTOCK GRAZING ALONG ASHIPPUN LAKE SHORELINE



Source: SEWRPC.

River would flow back out through the outlet as the high water levels receded. Consequently, it is not anticipated that the majority of the phosphorus entering the lake by high water intrusion would remain in the lake system long enough to have any adverse effects on water quality, algae, and macrophyte growth.

TROPHIC CONDITION RATING

Lakes are commonly classified according to the degree of nutrient enrichment—or trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and aquatic life communities is often correlated to the degree of nutrient enrichment which has occurred. There are three terms usually used to describe the trophic status of a lake: oligotrophic, mesotrophic, and eutrophic.

Oligotrophic lakes are nutrient-poor lakes. These lakes characteristically support relatively few aquatic plants and often do not contain very productive fisheries. Oligotrophic lakes provide excellent opportunities for swimming, boating, and water skiing. Because of the naturally fertile soils and the intensive land use practices employed, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Mesotrophic lakes are moderately fertile lakes which support abundant aquatic plant growths and may support productive fisheries. Nuisance growths of algae and weeds are usually not exhibited by mesotrophic lakes. These lakes provide opportunities for all types of recreational activities, including boating, swimming, fishing, and water skiing. Many lakes in southeastern Wisconsin are mesotrophic.

Eutrophic lakes are nutrient-rich lakes. These lakes often exhibit excessive aquatic weed growths and/or experience frequent algae blooms. If the lakes are shallow, fish winterkills may be common. While portions of these lakes may not be ideal for swimming and boating, many eutrophic lakes support very productive fisheries.

The trophic status of Ashippun Lake was evaluated by the application of three commonly used methods: the Lake Condition Index, the Vollenweider model, and the Trophic State Index.

Uttormark and Wall developed a method for lake classification based on four indicators of eutrophication: dissolved oxygen levels; water clarity (transparency); occurrence of fish winterkills; and recreational use impairment due to algae blooms and/or weed growth. A measure—referred to as a Lake Condition Index—was devised in which "penalty points" were assigned to lakes for undesirable symptoms of water pollution. Thus, if a lake exhibited no undesirable symptoms of eutrophication, it received no points and had a Lake Condition Index of zero. Conversely, a lake with all the undesirable characteristics in the most severe degree had a Lake Condition Index of 23.[2] Under

---

[2] *P. D. Uttormark and J. P. Wall, Lake Classification—A Trophic Characterization of Wisconsin Lakes. EPA Report No. EPA-660/3-75-033, 1975.*

Table 10

LAKE CONDITION INDEX
CALCULATION FOR ASHIPPUN LAKE

Lake Conditions	Lake Condition Index Penalty Points
Dissolved Oxygen Concentrations at Zero During Some Periods in Portions of the Hypolimnion.	4
Average Secchi Disc Reading is About 5 Feet	2
No History of Fish Winterkills.	0
Occasional Blue-Green Algae Blooms and Moderate Weed Growths.	2
Total	8

Source: SEWRPC.

the Uttormark-Wall classification system, Ashippun Lake has a Lake Condition Index of 8—as set forth in Table 10—which is indicative of a mesotrophic lake. This value for Ashippun Lake is higher—that is, more eutrophic—than 12 of the 23 rated lakes in Waukesha County, and higher than 33 of the 66 rated lakes in the seven-county Southeastern Wisconsin Region, as shown in Table 11. Therefore, based on its trophic status, Ashippun Lake is fairly typical of lakes in Waukesha County and in southeastern Wisconsin.

Vollenwider developed a model for predicting the total phosphorus concentration of a lake during spring turnover based on the physical characteristics of the lake, hydrologic data, and phosphorus loading data.[3] The predicted phosphorus concentrations can also be correlated to average summer chlorophyll-a and Secchi Disc (water transparency) levels. Using phosphorus loads estimated by the Commission's water quality simulation model, the Vollenweider model was applied to Ashippun Lake under existing conditions. The model analysis results in a predicted total phosphorus concentration of 0.044 mg/l, or above the applicable SEWRPC phosphorus standard of 0.02 mg/l established for lakes to support recreational use and warmwater fish and aquatic life, as discussed in Chapter VII. An average summer chlorophyll-a concentration of 17.4 µg/l and an average summer Secchi Disc depth of 4.5 feet are also predicted. Based on these data, the lake would be classified as slightly eutrophic. Table 12 compares the predicted phosphorus concentration, chlorophyll-a concentration, and Secchi Disc depth to measured data for Ashippun Lake. The table indicates that the predicted values compare reasonably well with measured values.

A third measure of trophic condition can be achieved by the application of the Trophic State Index (TSI).[4] The Trophic State Index may be computed using total phosphorus, Secchi Disc, and chlorophyll-a measurements to assign a trophic status rating to a lake.

The equations for calculating these three TSI values are:

$$\text{TSI}_{\text{Total Phosphorus}} = 10\left(6 - \left[\frac{\text{Natural log of }\left(\dfrac{40.5}{\text{Total Phosphorus in }\mu g/l}\right)}{\text{Natural log of 2}}\right]\right)$$

$$\text{TSI}_{\text{Secchi Disc}} = 10\left(6 - \left[\frac{\text{Natural log of Secchi Disc in Meters}}{\text{Natural log of 2}}\right]\right)$$

$$\text{TSI}_{\text{Chlorophyll-a}} = 10\left(6 - \left[\frac{\text{2.04-0.68 Natural log of Chlorophyll-a in }\mu g/l}{\text{Natural log of 2}}\right]\right)$$

[3] *R. A. Vollenweider, "Advances in Defining Critical Loading Levels for Phosphorus in Lake Eutrophication," Memorial Institute of Italian Idrobiologica, 33:53-83, 1976.*

[4] *R. E. Carlson, "A Trophic State Index for Lakes," Limnology and Oceanography, 22(2):361:369, 1977.*

Table 11

LAKE CONDITION INDEX OF SELECTED MAJOR LAKES IN SOUTHEASTERN WISCONSIN: 1975

Watershed	Major Lake Name	County	Lake Condition Index[a]	Category
Des Plaines.	Benet and Shangrila	Kenosha	13	very eutrophic
Des Plaines.	Paddock	Kenosha	9	mesotrophic
Fox.	Beulah	Walworth	7	mesotrophic
Fox.	Big Muskego	Waukesha	12	eutrophic
Fox.	Bohners	Racine	6	mesotrophic
Fox.	Booth	Walworth	6	mesotrophic
Fox.	Browns	Racine	8	mesotrophic
Fox.	Buena	Racine	6	mesotrophic
Fox.	Camp	Kenosha	14	very eutrophic
Fox.	Center	Kenosha	6	mesotrophic
Fox.	Como	Walworth	13	very eutrophic
Fox.	Denoon	Waukesha	8	mesotrophic
Fox.	Eagle	Racine	20	very eutrophic
Fox.	Eagle Spring	Waukesha	5	mesotrophic
Fox.	Echo	Racine	6	mesotrophic
Fox.	Elizabeth	Kenosha	6	mesotrophic
Fox.	Geneva	Walworth	5	mesotrophic
Fox.	Green	Walworth	9	mesotrophic
Fox.	Little Muskego	Waukesha	12	eutrophic
Fox.	Long	Racine	17	very eutrophic
Fox.	Lower Phantom	Waukesha	9	mesotrophic
Fox.	Marie	Kenosha	8	mesotrophic
Fox.	Middle	Walworth	7	mesotrophic
Fox.	Mill	Walworth	8	mesotrophic
Fox.	North	Walworth	13	very eutrophic
Fox.	Pell	Walworth	12	eutrophic
Fox.	Pewaukee	Waukesha	13	very eutrophic
Fox.	Pleasant	Walworth	4	oligotrophic
Fox.	Potters	Walworth	12	eutrophic
Fox.	Powers	Kenosha	8	mesotrophic
Fox.	Silver	Kenosha	8	mesotrophic
Fox.	Spring	Waukesha	4	oligotrophic
Fox.	Tichigan	Racine	21	very eutrophic
Fox.	Upper Phantom	Waukesha	6	mesotrophic
Fox.	Wandawega	Walworth	13	very eutrophic
Fox.	Waubeesee	Racine	7	mesotrophic
Fox.	Wind	Racine	7	mesotrophic
Milwaukee	Big Cedar	Washington	5	mesotrophic
Milwaukee	Little Cedar	Washington	5	mesotrophic
Milwaukee	Mud	Ozaukee	10	eutrophic
Rock	Ashippun	Waukesha	8	mesotrophic
Rock	Beaver	Waukesha	7	mesotrophic
Rock	Comus	Walworth	15	very eutrophic
Rock	Delavan	Walworth	14	very eutrophic
Rock	Druid	Washington	6	mesotrophic
Rock	Five	Washington	12	eutrophic
Rock	Friess	Washington	3	oligotrophic
Rock	Golden	Waukesha	8	mesotrophic
Rock	Keesus	Waukesha	8	mesotrophic
Rock	Lac La Belle	Waukesha	10	eutrophic
Rock	Loraine	Walworth	12	eutrophic
Rock	Lower Nemahbin	Waukesha	5	mesotrophic
Rock	Middle Genesee	Waukesha	3	oligotrophic
Rock	Nagawicka	Waukesha	13	very eutrophic

Table 11 (continued)

Watershed	Major Lake Name	County	Lake Condition Index[a]	Category
Rock	North	Waukesha	5	mesotrophic
Rock	Oconomowoc	Waukesha	8	mesotrophic
Rock	Okauchee	Waukesha	5	mesotrophic
Rock	Pike	Washington	3	oligotrophic
Rock	Pine	Waukesha	7	mesotrophic
Rock	Silver	Waukesha	5	mesotrophic
Rock	Tripp	Walworth	6	mesotrophic
Rock	Turtle	Walworth	5	mesotrophic
Rock	Upper Nashotah	Waukesha	4	oligotrophic
Rock	Upper Nemahbin	Waukesha	7	mesotrophic
Rock	Whitewater	Walworth	7	mesotrophic

[a] *Lake Condition Index Trophic Classification*

0 - 1 = very oligotrophic
2 - 4 = oligotrophic
5 - 9 = mesotrophic
10-12 = eutrophic
13-23 = very eutrophic

Source: SEWRPC.

Table 12

COMPARISON OF PREDICTED AND MEASURED TOTAL PHOSPHORUS, CHLOROPHYLL-A, AND SECCHI DISC LEVELS IN ASHIPPUN LAKE

Water Quality Parameter	Predicted[a]	Measured[b]	
		Range	Mean
Total Phosphorus[c] Concentration (mg/l) . .	0.044	0.03-0.10	0.05
Chlorophyll-a[d] Concentration (ug/l) . .	17.4	- -	28.3[e]
Secchi Disc[d] Depth (feet)	4.5	6.3-8.7	7.2

[a] *Based on the Vollenweider (1976) model.*

[b] *Based on measured data from 1975 through 1978.*

[c] *Concentration during spring turnover.*

[d] *Average summer values.*

[e] *Only one chlorophyll-a value, measured during November, was available.*

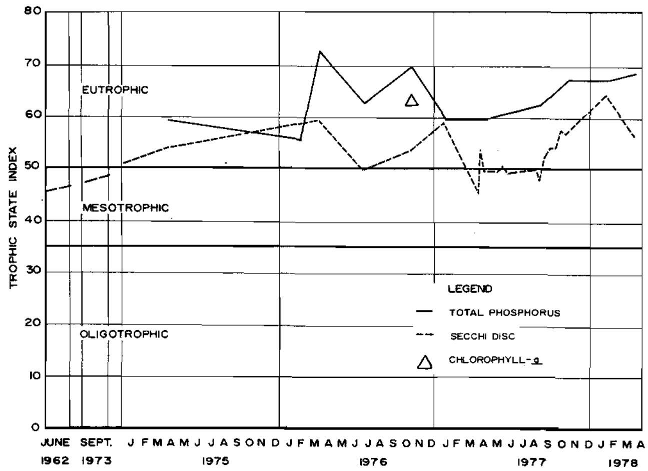
Source: SEWRPC.

TSI ratings of less than 35 are indicative of oligotrophic lakes; ratings of 35 to 50 signify mesotrophic lakes; and eutrophic lakes exhibit ratings higher than 50.

Figure 20 sets forth the TSI calculations for the period of 1962 through 1978 for Ashippun Lake. The values shown on Figure 20 indicate that Ashippun Lake is a eutrophic lake. The values do not indicate any long-term trends in water quality conditions. The trophic state index values on phosphorus concentrations were generally higher than the trophic state index calculations based on Secchi Disc levels or chlorophyll-a levels. About 400 pounds of sodium arsenite were applied during 1953 for aquatic weed control, as discussed in the aquatic plant management section of this report. Much of the applied arsenic was deposited in the bottom sediments and the arsenic may be released from the sediments to the water column during anaerobic conditions. Although the amount of arsenic applied to the lake is relatively small, some arsenic may still have been in the water during the sampling period represented in Figure 20. Since arsenic is colorimetrically equivalent to phosphorus, the normal measurement technique for

Figure 20

TROPHIC STATE INDEX CALCULATIONS
FOR ASHIPPUN LAKE: 1962-1978



Source: SEWRPC.

phosphorus inadvertently also measures arsenic. Because of this interference, some of the phosphorus levels associated with Figure 20 may reflect the presence of arsenic. Studies in Big Cedar Lake, Washington County, have indicated that in the 1960's and early 1970's, arsenic interference resulted in apparent "phosphorus" levels which were at least twice as high as actual levels.[5] However, because of the relatively small amount of arsenic applied to Ashippun Lake, and the extended period of time since those applications were made, arsenic interference with measured phosphorus levels is probably negligible.

---

[5] *Office of Inland Lake Renewal, Wisconsin Department of Natural Resources, Big Cedar Lake, Washington County, Management Alternatives, 1978.*

(This page intentionally left blank)

Chapter V

NATURAL RESOURCE BASE AND RECREATIONAL ACTIVITIES

AQUATIC PLANTS

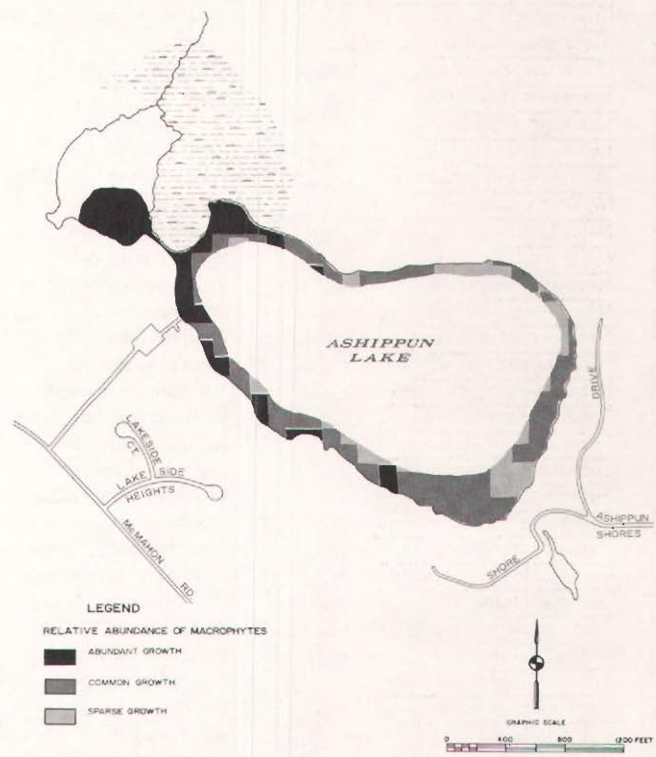
Macrophytes

Aquatic macrophytes play an important role in the ecology of southeastern Wisconsin lakes. Depending on distribution and abundance, they can be either beneficial or a nuisance. Macrophytes growing in the proper locations and in reasonable densities in lakes are an asset because they provide habitat for other forms of aquatic life and may remove nutrients from the water that otherwise could contribute to excessive algae growth. However, aquatic plants may become a nuisance when heavy densities interfere with swimming and boating activities. Many factors, including lake configuration, depth, water clarity, nutrient availability, bottom substrate, wave action, and type and size of fish populations present, determine the distribution and abundance of aquatic macrophytes in a lake.

To document the types, distribution, and relative abundance of aquatic macrophytes in Ashippun Lake, surveys were conducted during the second week of June 1977 and the last week of August 1977. The vegetation was identified and the frequency of occurrence and the relative abundance of each species was noted at 122 sampling locations. Map 13 shows the location of surveyed aquatic macrophytes. The macrophyte species, frequency of occurrence, and relative abundance are listed in Table 13. Illustrations of representative macrophyte species identified in Ashippun Lake are set forth in Appendix A.

Map 13

MACROPHYTE SURVEY OF ASHIPPUN LAKE: JUNE 1977



Source: Wisconsin Department of Natural Resources and SEWRPC.

In general, the macrophyte growth in Ashippun Lake was moderate and diverse. The maximum depth of macrophyte growth was about 17 feet. The dominant macrophytes were coontail (Ceratophyllum demersum), water milfoil (Myriophyllum spicatum), sago pondweed (Potamogeton pectinatus), stonewort (Chara species), and white water lily (Nymphaea tuberosa).

In the near-shore areas with water less than four feet deep, white water lily and water lily (Nuphar variegatum) were abundant; pondweeds and stonewort were common. Water milfoil dominated in water depths from four to ten feet and coontail was abundant in water depths of 10 to 15 feet. Narrowleaf cat-tail (Typha angustifolia) was most abundant in the marsh along the western shoreline near the lake outlet. As often occurs in lakes in southeastern Wisconsin, bushy pondweeds (Najas spp.) and wild celery or eel grass (Vallisneria americana) increased in abundance as the summer progressed, while white stem pondweed (Potamogeton praelongus), floating-leaf pondweed (Potamogeton natans), and stiff water crowfoot (Ranunculus longirostris) decreased in frequency or abundance between June and August.

Table 13

SUMMARY OF MACROPHYTE SURVEYS OF ASHIPPUN LAKE: JUNE AND AUGUST 1977

Macrophyte Species		Percent Frequency of Occurrence[a]		Relative Abundance	
Scientific Name	Common Name	June	August	June	August
Anacharis canadensis	Waterweed	1.7	1.7	Very Sparse	Very Sparse
Carex aquatilis Variety: substricta	Sedge	5.8	2.5	Sparse	Sparse
Ceratophyllum demersum	Coontail	45.5	40.5	Abundant	Abundant
Chara species	Stonewort, or mockgrass	39.7	28.1	Abundant	Common
Eleocharis acicularis	Spike rush	3.3	0.0	Sparse	Absent
Eleocharis calva	Spike rush	4.1	1.7	Sparse	Very Sparse
Equisetum fluviatile	Horsetail	0.8	0.0	Very Sparse	Absent
Heteranthera dubia	Water star grass	9.9	12.4	Sparse	Sparse
Lemna trisulca	Star duckweed	0.8	0.8	Very Sparse	Sparse
Myriophyllum spicatum	Water milfoil	32.2	43.8	Common	Common
Myriophyllum verticillatum	Water milfoil	9.9	0.8	Sparse	Very Sparse
Najas flexilis	Bushy pondweed	3.3	12.4	Common	Sparse
Najas marina	Bushy pondweed	0.8	11.6	Sparse	Common
Nuphar variegatum	Yellow water lily	9.9	8.3	Abundant	Abundant
Nymphaea tuberosa	White water lily	23.1	20.6	Abundant	Abundant
Pontederia cordata	Pickerel weed	11.6	8.3	Sparse	Common
Potamogeton friesii	Fries's pondweed	6.6	0.0	Sparse	Absent
Potamogeton gramineus	Variable pondweed	0.0	4.1	Absent	Common
Potamogeton natans	Floating-leaf pondweed	0.8	0.0	Sparse	Absent
Potamogeton illinoensis	Illinois pondweed	11.6	10.7	Sparse	Common
Potamogeton pectinatus	Sago pondweed	41.3	39.7	Common	Common
Potamogeton praelongus	White-stemmed pondweed	2.5	0.8	Very Sparse	Very Sparse
Potamogeton richardsonii	Clasping-leaf pondweed	0.8	2.5	Very Sparse	Very Sparse
Potamogeton zosteriformis	Flat-stemmed pondweed	6.6	0.8	Sparse	Common
Ranunculus longirostris	Stiff water crowfoot	1.7	0.0	Very Sparse	Absent
Sagittaria latifolia	Arrowhead	5.8	2.5	Sparse	Sparse
Scirpus subterminalis	Water bulrush	0.8	0.8	Abundant	Common
Scirpus validus	Softstem bulrush	16.5	14.1	Common	Common
Sparganium eurycarpum	Bur reed	0.8	0.8	Very Sparse	Very Sparse
Typha angustifolia	Cat-tail	5.0	1.7	Sparse	Sparse
Utricularia species	Bladderwort	10.7	6.6	Abundant	Abundant
Vallisneria americana	Wild celery or eel grass	5.8	13.2	Common	Common
Zizania aquatica Variety: interior	Wild rice	0.8	0.8	Very Sparse	Very Sparse

[a] *The percent frequency of occurrence refers to the percent of the 122 sampling sites in which the plant species was noted.*

Source: Wisconsin Department of Natural Resources.

Heavy growths of coontail are often indicative of a highly fertile lake and bulrushes (Scirpus spp.) often become abundant in shallow areas with very soft organic bottom substrates. Other macrophytes identified in Ashipppun Lake which may produce nuisance conditions include water milfoil, pondweeds, bushy pondweeds, and wild celery or eel grass. Water star grass (Heteranthera dubia), which is common in lakes with dark or turbid water, was also present.

Many species of macrophytes also provide benefits for the lake. Stonewort, cat-tails, wild celery or eel grass, spike rushes (Eleocharis spp.), duckweeds (Lemna spp.), bushy pondweeds, white water lily, pondweeds, bulrushes, and sedges (Carex spp.) provide food, shelter, and/or habitat for wildlife. coontail, stonewort, spike rushes, bushy pondweeds, pondweeds, bulrushes, cat-tails, bladderworts (Utricularia spp.), and wild celery or eel grass provide valuable food and shelter for fish and other aquatic life. White water lily, pickerel weed (Pontederia cordata), yellow water lily, and arrowhead (Sagittaria latifolia) flower throughout most of the summer and add color to a lakeshore.

Algae

Algae are small, generally microscopic plants that are found in all lakes and streams. They occur in a wide variety of forms, in single cells or colonies, and can be either attached or free floating. Algae are primary producers that form the base of the aquatic food chain. Through photosynthesis, they convert energy and nutrients to the compounds necessary to support life in the aquatic system. Oxygen, which is vital to higher forms of life in a lake or stream, is also produced in the photosynthetic process.

Green algae (Chlorophyta) are the most important source of food for zooplankton—microscopic animals—in the lakes of southeastern Wisconsin. Blue-green algae (Cyanophyta) are not ordinarily utilized by zooplankton or fish populations, and may become over-abundant and out of balance with the organisms that feed on them. Population explosions (blooms) of blue-green algae can occur when excessive nutrient supplies are available, optimum sunlight and temperature conditions exist, and there is a lack of competition from other species.

Table 14

ALGAE POPULATIONS IN ASHIPPUN LAKE: APRIL 28, 1978

Species	Algae Type	Relative Abundance
Achnanthes minitissima . . .	Diatom	Rare
Asterionella formosa	Diatom	Present
Chroomonas acuta	Golden brown	Present
Chroomonas coerulea.	Golden brown	Rare
Chroomonas reflexa	Golden brown	Scarce
Cryptomonas ovata	Golden brown	Rare
Cryptomonas species	Golden brown	Rare
Dinobryon species	Yellow-green	Scarce
Erkinia species	Yellow-green	Common
Glenodinium pulvisculus . . .	Dinoflagellate	Present
Golenkinia radiata	Green	Rare
Melosira islandica	Diatom	Rare
Navicula species	Diatom	Present
Oscillatoria prolifica	Bluegreen	Rare
Oscillatoria tenuis.	Bluegreen	Scarce
Scenedesmus quadricauda . .	Green	Rare
Stephanodiscus astrea	Diatom	Rare
Synedra acus.	Diatom	Present
Synedra radians	Diatom	Scarce

Source: Wisconsin Department of Natural Resources.

Algae blooms may reach nuisance proportions in fertile—or eutrophic—lakes, resulting in the accumulation of surface scum or slime. In some cases, heavy concentrations of wind-blown algae accumulate on shorelines, where they die and decompose, causing noxious odors and unsightly conditions. The decaying process of algae consumes oxygen, sometimes depleting available supplies and resulting in fish kills. Also, certain species of decomposing blue-green algae may release toxic materials into the water.

In Ashippun Lake, analyses on the type and abundance of algae were conducted on 14 dates during 1977. In addition, an algal analysis was conducted by the Wisconsin Department of Natural Resources in April 1978, as set forth in Table 14. In 1977, the lowest concentration of algae was recorded in April. The algae populations were greatest from late July to early August, and again in mid-September, with the bluegreen algae Anabaena and Chroococcus being in greatest abundance during this period. The relative abundance of bluegreen algae indicates a potential for algae "bloom" conditions. In April 1978, the dominant algae was the flagellated yellow-green alga Erkinia. Erkinia is a very small alga which is not known to form nuisance conditions. The bluegreen alga Oscillatoria prolifica was also identified in the 1978 survey. Although not dominant, the presence of this alga could potentially signal a decline in water quality. Illustrations of representative algae species identified in Ashippun Lake are set forth in Appendix A.

AQUATIC ANIMALS

Zooplankton

Zooplankton are microscopic animals which inhabit the same environments as phytoplankton (microscopic plants). An important link in the aquatic food chain, zooplankton feed mostly on algae and, in turn, are a food source for fish. The seasonal succession of zooplankton species within Ashippun Lake during the study year was dominated by a spring pulse of Daphnia species and Cyclops species. Population cycles during summer are more variable, being affected by changes in the

Table 15

SPECIES OF FISH CAPTURED
IN ASHIPPUN LAKE: 1952-1975

Common Name	Scientific Name
Black bullhead	Ictalurus melas
Black crappie	Pomoxis nigromaculatus
Bluegill	Lepomis macrochirus
Bowfin	Amia calva
Brown bullhead	Ictalurus nebulosus
Carp	Cyprinus carpio
Common shiner	Notropis cornutus
Golden shiner	Notemigonus crysoleucas
Grass pickerel	Esox americanus vermiculatus
Green sunfish	Lepomis cyanellus
Largemouth bass	Micropterus salmoides
Longnose gar	Lepisosteus osseus
Northern pike	Esox lucius
Pumpkinseed	Lepomis gibbosus
Rock bass	Ambloplites rupestris
Walleye	Stizostedion vitreum vitreum
Warmouth bass	Lepomis gulosus
Yellow bullhead	Ictalurus natalis
Yellow perch	Perca flavescens

Source: Wisconsin Department of Natural Resources.

Table 16

NORTHERN PIKE STOCKING IN ASHIPPUN LAKE

Year	Number	Size
1969	133	9 inches
1970	200,000	Fry
1971	4,500	Fingerlings
1972	74	20 inches
	5,000	Fingerlings
1973	None	- -
1974	None	- -
1975	480	12-30 inches
1976	None	- -
1977	None	- -
1978	None	- -
1979	100,000	Fry

NOTE: A fry is a newly hatched fish; a fingerling is a fish in its first year.

Source: Wisconsin Department of Natural Resources.

food supply and predation by fish and other zooplankton. The density of zooplankton individuals remained low during the summer and into early autumn of 1977, when the study was concluded. Illustrations of representative zooplankton species identified in Ashippun Lake are set forth in Appendix A.

Fish

Ashippun Lake supports a relatively large and diverse fish community. Wisconsin Department of Natural Resources survey reports indicate that from 1952 through 1974, 19 different fish species were captured in the lake, as shown in Table 15. None of these is currently considered to be a rare or endangered species. Illustrations of representative fish species identified in Ashippun Lake are set forth in Appendix A.

According to survey reports in the files of the Wisconsin Department of Natural Resources, the fish populations and consequently, the sport fishing in the lake have changed over the years. In 1952, the fishing was noted to be good for northern pike and fair for bass. It was also noted that no rough fish problems existed. In 1962, an excellent balanced fish community was recorded, including abundant bluegills and relatively few black crappies. By 1969, the black crappies were more abundant than the bluegills and largemouth bass and rock bass were also noted as abundant. In both the 1962 and 1969 surveys, no northern pike were captured. However, the techniques used and timing of these surveys would not be expected to adequately sample northern pike. In 1969, 133 nine-inch northern pike were stocked in Ashippun Lake. As set forth in Table 16, additional northern pike stocking also occurred in 1970, 1971, 1972, 1975, and 1979. No other fish species are known to have been stocked in the lake. In 1973 and 1974, fyke net surveys were conducted, primarily to assess the success of the northern pike stocking program. These surveys indicated that the stocked fish had significantly improved the northern pike population in the lake, and that both stocked and native northern pike populations showed good growth rates. About one-half of the northern pike sampled were stocked fish, and about one-half were native fish. The total fish community was described as "excellent" and "well-balanced," hence, the northern pike stocking apparently has not diminished the quantity or quality of other fish populations.[1] However, reproduction by walleye was apparently poor, and natural reproduction by northern pike appeared limited. Based on these surveys, the Wisconsin Department of Natural Resources fish manager estimated the adult (at least 16 inches long) northern pike population in Ashippun Lake at about two fish per acre.[2] Panfish, especially bluegill and crappie, exhibit good reproduction and good growth rates. No rough fish problems currently exist.

WILDLIFE RESOURCES

Wildlife habitat areas were initially inventoried by the Regional Planning Commission in 1963 and this initial inventory was updated for the Commission in 1970 by the Wisconsin Department of Natural Resources, Bureau of Research. The wildlife habitat areas were classified by the Commission as deer, pheasant, waterfowl, muskrat-mink, songbird, squirrel, or mixed habitat. These designations were applied to help characterize a particular habitat area as meeting the particular requirements of the indicated species. The classification does not imply that the named species is the most important or dominant species in that particular habitat. For example, an area designated as a deer habitat may also provide squirrel and songbird habitat as well.

The five major criteria used to determine the value of these wildlife habitat areas are as follows:

1. Diversity. An area must maintain a high but balanced diversity of species for a temperate climate; this implies that the proper predator-prey (consumer-food) relationships can occur. In addition, a reproductive interdependence must exist.

2. Territorial Requirements. The maintenance of proper spatial relationships among species which allows for a certain minimum population level can only occur if the territorial requirements of each major species within a particular habitat are met.

3. Vegetative Composition and Structure. The composition and structure of vegetation must be such that the required levels for nesting, travel routes, concealment, and protection from weather are met for each of the major species.

4. Location with respect to other wildlife habitat areas. It is very desirable that a wildlife habitat maintain close proximity to other wildlife habitat areas.

5. Disturbance. Minimum levels of disturbance from human activities are necessary.

On the basis of these five criteria, the wildlife habitats in the Ashippun Lake watershed were rated as high, medium, or low quality. The quality ratings used are defined below:

1. High-value wildlife habitat areas contain a good diversity of wildlife, are adequate in size to meet all of the habitat requirements for the species concerned, are generally located in proximity to other wildlife habitat areas, and meet all the other criteria listed above.

2. Medium-value wildlife habitat areas generally lack one of the five aforementioned criteria for a wildlife habitat area.

3. Low-value wildlife habitat areas are remnant in nature in that they generally lack two or more of the five aforementioned criteria for a wildlife habitat area, but may be important if they are located in close proximity to other medium- and/or high-value wildlife habitat areas, if they provide corridors linking higher value wildlife habitat areas, or if they provide the only available range in an area.

As shown on Map 14, the large wetland areas located in the northwest portion of the watershed and southeast portion of the watershed contain approximately 66 acres of high-value waterfowl wildlife habitat. The northwest portion of the Ashippun Lake watershed also contains approximately 13 acres of deer and pheasant wildlife habitat. The remaining six acres of wildlife habitat consist of two small waterfowl and pheasant wildlife habitat areas located in the eastern portion of the watershed.

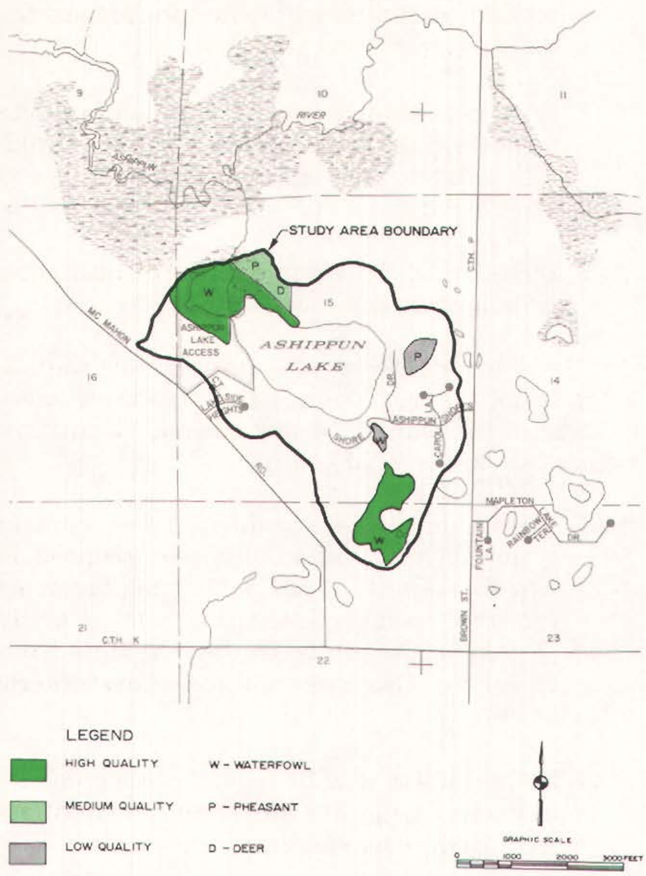
---

[1] *Information provided by Randy Schumacher, DNR Fish Manager, March 20, 1980.*

[2] *Ibid.*

Map 14

WILDLIFE HABITAT IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1980



Source: SEWRPC.

The 40-acre wetland complex located in the northwest portion of the drainage basin contains a significant population of marsh birds. These wetlands are used as feeding areas for the sandhill crane (Grus canadensis) and great blue heron (Ardea herodias) and nesting areas for the black tern (Chlidonias nigra), and American bittern (Botaurus lentiginosus). While not yet classified as rare, threatened, or endangered species, great blue heron and black tern populations are apparently declining in Wisconsin as the result of wetland losses and the loss of suitable nesting habitats. The great blue heron and black tern have both been identified as watch species by the Wisconsin Department of Natural Resources.[3] In addition Forster's tern (Sterna forsteri), endangered in Wisconsin, have been observed as recently as June 28, 1979 feeding in this wetland.

WOODLANDS

Woodlands in southeastern Wisconsin are defined as those areas which contain 17 or more trees per acre which have at least a four-inch diameter at breast height.[4] In addition, the native woodlands are classified as dry, dry-mesic, mesic, wet-mesic, and wet hardwood forests and conifer swamp forests. The latter three woodland classifications are also considered wetlands and for the purposes of this report are discussed in the section on wetlands. The drainage area directly tributary to Ashippun Lake contains one of the six native woodland classifications.

Specifically, as shown on Map 15, the woodland in the Ashippun Lake drainage basin is a southern dry-mesic hardwood forest characterized by northern red oak (Quercus borealis), shagbark hickory (Carya ovata), and red cedar (Juniperus virginiana). Within the Ashippun Lake drainage area, a single 4.6-acre woodland stand is located in the northern portion of the drainage basin. This woodlot has a past history of grazing and selective cutting as indicated by open grown tree crowns, lack of shrubs, and the codominance of red cedar.

WETLANDS

Wetlands in southeastern Wisconsin are classified as deep marsh, shallow marsh, bog, fen, low prairie, southern sedge meadow, fresh (wet) meadow, shrub carr, southern wet and wet-mesic hardwood forest, and conifer swamp. The major wetland communities located in the drainage area directly tributary to Ashippun Lake as shown on Map 15 include fresh (wet) meadow, southern sedge meadow, shrub carr, tamarack swamp, and deep and shallow marsh.

Fresh (wet) meadows are essentially low grass meadows which are dominated by Canada bluejoint grass (Calamagrostis canadensis) and such forbs as marsh (Aster simplex), redstem (Aster puniceus), and New England (Aster Novae-angliae) asters, and giant goldenrod (Solidago gigantea). The fresh (wet) meadows located in the Ashippun Lake drainage

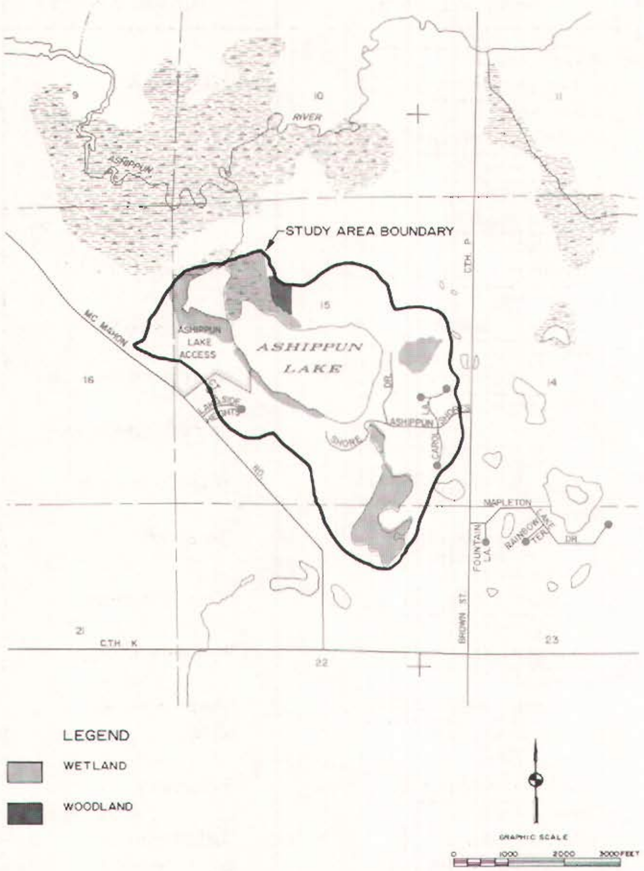
---

[3] *Betty L. Less, The Vanishing Wild: Wisconsin's Endangered Wildlife and Its Habitat, 1979.*

[4] *The diameter at breast height (dbh) is measured at 4.5 feet above the ground.*

Map 15

WETLANDS AND WOODLANDS IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE



Source: SEWRPC.

basin occur along the south lakeshore; in the wetland complex located in the northeast portion of the drainage basin; and in the wetland complexes located in the eastern portion of the watershed. The fresh (wet) meadows are largely associated with the southern sedge meadow and shrub carr wetland types. Many of these wetlands, particularly in the eastern portion of the drainage basin, have been subject to water level changes and excessive runoff from agricultural lands and as a result are dominated by the European strain of reed canary grass (Phalaris arundinacea).

Southern sedge meadows are considered to be stable wetland plant communities that tend to perpetuate themselves if dredging activities and water level changes are prevented. Southern sedge meadows in southeastern Wisconsin are characterized by the tussock sedge (Carex stricta) and to a lesser extent by Canada bluejoint grass. Sedge meadows that are drained or disturbed to some extent typically succeed to shrub carrs. Shrub carrs, in addition to the sedges and grasses found in sedge meadows, contain an abundance of willows (Salix spp.) and red osier dogwood (Cornus stolonifera). In extremely disturbed shrub carrs the willows, red osier dogwoods, and sedges may be replaced by such exotic plants as honeysuckle (Lonicera sp.), buckthorn (Rhamnus sp.), and the very aggressive reed canary grass.

The shallow and deep marsh wetland plant communities are dominated by broadleaf cat-tail (Typha latifolia), lake sedge (Carex lacustris), hardstem bulrush (Scirpus acutus), and softstem bulrush (Scirpus validus). Other common plants occurring in the deep and shallow marshes of the Ashippun Lake drainage basin include arrowhead (Sagittaria latifolia), pickerel weed (Pontederia cordata), white water lily (Nymphaea tuberosa), and yellow pond lily (Nuphar advena). The wetland area located in the northwest portion of the drainage basin contains a very high quality deep and shallow marsh wetland complex. Because of the integrity of this wetland plant community, and the associated southern sedge meadow and fresh (wet) meadow, this wetland has been classified as a natural area of countywide or regional significance.[5] In addition, the large shallow marsh complex located in the southeast quarter of Section 15 and the northeast quarter of Section 22 contains an unusual assemblage of shallow marsh and bog species. This shallow marsh is a floating mat which has been disturbed by water level changes and runoff containing excessive amounts of nutrients from the adjacent agricultural lands. This wetland is dominated by purple loostrife (Lythrum salicaria), marsh fern (Thelypteris palustris), bog cinquefoil (Potentilla palustris), and cotton sedge (Eriophorum angustifolium).

The 5.5-acre wetland located in the northeastern portion of the drainage basin contains a small conifer swamp dominated by tamarack (Larix laricina). In addition, small stands—less than one acre—of wet hardwoods do occur within the Ashippun Lake

---

[5] *Natural Area Inventory: Waukesha County, 1977.*

Table 17

WETLAND SPECIES IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE

Family and Species	Common Name
Equisetaceae	
Equisetum arvense	Common horsetail
Polypodiaceae	
Thelypteris palustris	Marsh fern
Pinaceae	
Larix laricina	Tamarack
Typhaceae	
Typha latifolia	Broadleaf cat-tail
Alismaceae	
Sagittaria latifolia	Arrowhead
Gramineae	
Calamogrostis canadensis	Canada bluejoint grass
Muhlenbergia racemosa	Muhly grass
Phalaris arundinacea[a]	Reed canary grass
Cyperaceae	
Eleocharis spp.	Spike rush
Scirpus validus	Softstem bulrush
Scirpus acutus	Hardstem bulrush
Scirpus atrovirens	Green bulrush
Carex stricta	Tussock sedge
Carex aquatilis	Sedge
Carex lacustris	Lake sedge
Carex sp.	Sedge
Araceae	
Symplocarpus foetidus	Skunk cabbage
Pontederiaceae	
Pontederia cordata	Pickerel weed
Iridaceae	
Iris versicolor	Blue flag
Salicaceae	
Salix nigra	Black willow
Salix discolor	Pussy-willow
Salix spp.	Willow
Ulmaceae	
Ulmus americana	American elm
Urticaceae	
Urtica dioica	Stinging nettle
Polygonaceae	
Rumex orbiculatus	Water dock
Polygonum natans	Smartweed
Nymphaeaceae	
Nuphar advena	Yellow pond lily
Nymphaea tuberosa	White water lily
Ranunculaceae	
Caltha palustris	Marsh marigold
Ranunculus sceleratus	Cursed crowfoot
Aquifoliaceae	
Ilex verticillata	Winterberry
Aceraceae	
Acer saccharinum	Silver maple
Acer negundo	Boxelder
Balsaminaceae	
Impatiens biflora	Jewel-weed
Rhamnaceae	
Rhamnus frangula[a]	European buckthorn
Lythraceae	
Lythrum *salicaria*[a]	Purple loosestrife
Umbelliferae	
Cicuta bulbifera	Water-hemlock
Cornaceae	
Cornus stolonifera	Red osier dogwood
Primulaceae	
Lysimachia thyrsiflora	Tufted loosestrife
Oleaceae	
Fraxinus pennsylvanica	Green ash
Asclepiadaceae	
Asclepias incarnata	Marsh milkweed
Verbenaceae	
Verbena hastata	Blue vervain
Labiatae	
Scutellaria galericulata	Marsh skullcap
Mentha sp.	Mint
Caprifoliaceae	
Sambucus canadensis	Elderberry
Compositae	
Bidens vulgata	Tall beggarticks
Ambrosia trifida	Giant ragweed
Solidaga patula	Swamp goldenrod
Solidago gigantea	Giant goldenrod
Aster puniceus	Redstem aster
Aster junciformis	Bog aster
Eupatorium maculatum	Joe-pye weed
Eupatorium perfoliatum	Boneset

NOTE: Items arranged in taxonomic order.

[a]*Alien or nonnative plant species.*

Source: Waukesha County Park and Planning Commission and SEWRPC.

drainage basin. The dominant trees within these stands include American elm (Ulmus americana), green ash (Fraxinus americana), and Boxelder (Acer negundo). A list of wetland plant species identified in the Ashippun Lake drainage basin are presented in Table 17.

RECREATIONAL USE

Ashippun Lake provides opportunities for a variety of water-based outdoor recreation activities, including boating, fishing, swimming, and nature study. Boating and fishing are the most popular summer

Table 18

PUBLIC ACCESS SITE ON ASHIPPUN LAKE: APRIL 1980

Location	Owner	Type	Area (acres)	Lake Frontage (feet)	Available Car-Trailer Parking Spaces
Town 8 North, Range 17 East Section 15	DNR	Ramp	2	200	40

Source: Wisconsin Department of Natural Resources, Southeast District Office.

outdoor recreation activities on Ashippun Lake. As discussed above, Ashippun Lake provides a high quality habitat for northern pike, largemouth bass, and panfish; an ongoing fish management program is being conducted by the Wisconsin Department of Natural Resources.

Swimming is not a major recreational use activity on Ashippun Lake. Along the eastern shore which has been developed, the shoreline is eroding and the bottom of the lake consists of marl and muck with only scattered deposits of sand. This condition limits swimming opportunities. There are no public beaches on the lake.

Nature study opportunities are provided by the extensive marsh areas on the southern and western shores of Ashippun Lake. Deer, muskrat, pheasant, and limited numbers of ducks use these areas on a year-round basis. Mallards and teal use the lake as a rest stop during the spring and autumn migrations.

A public boat access site, as described in Table 18, provides an opportunity for the general public to participate in water-based outdoor recreation activities. This site consists of a boat launch area which permits the launching and beaching of boats, and includes an area for the parking of automobiles and trailers. The site also includes picnic tables and toilet facilities. The Wisconsin Department of Natural Resources, under guidelines established in the Wisconsin Administrative Code, Chapters NR 1.90 and NR 1.92, and the Regional Planning Commission, under the adopted regional park and open space plan, recommend that at least one public access site open to the general public be provided on all major inland lakes. On Ashippun Lake this recommendation is met by this Wisconsin Department of Natural Resources owned boat access site which also provides parking spaces and car/trailer parking spaces. This public access site is operated by the Waukesha County Park and Planning Commission under an agreement with the State. It is important to note that a majority of the shoreline surrounding Ashippun Lake has been left in open, essentially natural uses with most urban development confined to the eastern shore. This natural shoreline enhances the water quality of the lake by trapping nutrients and sediments contributed from the upstream watershed areas, while also contributing to the high aesthetic value of the lake area.

In general, Ashippun Lake provides opportunities for a variety of outdoor recreation activities in a high-quality setting. In the study year, only a few problems, such as occasional nuisance algae blooms, shoreline erosion, and excessive macrophyte growth were considered to limit the resource value of the lake for water-based outdoor recreation. An outdoor recreational rating technique was developed to summarize the outdoor recreational value of inland lakes. As shown on Table 19, Ashippun Lake scored 53 points out of a possible 72 points, placing it among those lakes in southeastern Wisconsin providing diverse, high quality outdoor recreation opportunities. In order to assure that Ashippun Lake will continue to provide such recreation opportunities, the resource values of the lake must be protected and preserved.

Table 19

RECREATIONAL RATING OF ASHIPPUN LAKE: 1980

Boating:

X	6 Adequate depths (>75 percent of basin 5 feet)		4 Adequate depths (50-75 percent of basin 5' deep)		2 Adequate depths (<50 percent of basin)
	6 Adequate size for extended boating (>1,000 acres)		4 Adequate size for some boating (200-1,000 acres)	X	2 Limit of boating challenge and space (<200 acres)
	6 Good water quality	X	4 Some inhibiting factors such as weedy bays, algae blooms, etc.		2 Overwhelming inhibiting factors such as weed beds throughout

Subtotal: 12

Fishing:

	9 High production	X	6 Medium production		3 Low production
X	9 No problems		6 Modest problems such as infrequent winterkill, small rough fish problems		3 Frequent and overbearing problems such as winter-kill, carp, excessive fertility

Subtotal: 15

Swimming:

	6 Sand or gravel (75 percent or more)		4 Sand or gravel (25-75 percent)	X	2 Sand or gravel (<25 percent)
	6 Clean water	X	4 Moderately clean		2 Turbid or darkly stained
	6 No algae or weed	X	4 Moderate algae or weed problems		2 Frequent algae or weed problems

Subtotal: 10

Aesthetics:

X	6 Existence of 25 percent or more wild shore		4 Less than 25 percent wild shore		2 No wild shore
X	6 Varied landscape		4 Moderately varied landscape		2 Unvaried landscape
	6 Few nuisances such as excessive algae, carp, dumps, etc.	X	4 Moderate nuisance conditions		2 High nuisance conditions

Subtotal: 16

Total Quality Rating: 53 out of a possible 72

Source: Wisconsin Department of Natural Resources and SEWRPC.

Chapter VI

MANAGEMENT AND LEGAL CONSIDERATIONS AFFECTING WATER QUALITY

SEWAGE DISPOSAL

The sanitary and household wastewaters from the estimated 220 persons residing in the drainage area directly tributary to Ashippun Lake, as of 1975, were treated and disposed of through the use of onsite systems. An onsite sewage disposal system may be a conventional septic tank system, a mound system, or a holding tank. As of 1975, 61 septic tank systems and no holding tanks or mound systems were known to exist in the drainage area directly tributary to the lake.

The septic tank system consists of two components: a septic tank proper used to provide partial treatment of the raw wastes—by skimming, settling and anaerobic decomposition, and the soil absorption field for final treatment and disposal of liquid discharged from the septic tank. Both components are installed below the ground surface. The septic tank is a water-tight tank intended to separate floating and settleable solids from the liquid fraction of domestic sewage and to discharge the liquid, together with its burden of dissolved particulate solids, into the biologically active zone of the soil mantle through a subsurface percolation system. The discharge system may be a tile field, a seepage bed or an earth-covered sand filter. Liquid passing through the active soil zone percolates downward until it strikes an impervious layer or the groundwater. Thus, the purpose of the percolation system is to dispose of sewage effluents by utilizing the same natural phenomena which lead to the accumulation of groundwater.

Providing that the system is located, installed, used, and maintained properly, and that there is an adequate depth—four to five feet—of moderately permeable, unsaturated soil below the drainage field, the system should operate with few problems for periods of up to 20 years. However, as previously noted, not all residential areas within the Ashippun Lake direct drainage area are located in areas covered by soils suitable for septic tank use.

Failure of a septic tank system occurs when the soil surrounding the seepage area will no longer accept or properly stabilize the septic tank effluent, when the groundwater rises to levels which will no longer allow for uptake of liquid effluent by the soils, or when age or lack of proper maintenance cause the system to malfunction. Hence, septic system failure may result from installation in soils with severe limitations for system use, improper design or installation of the system, or inadequate maintenance. In many older, improper installations, the septic effluent may not receive the benefit of soil filtration, but rather discharges directly from the septic tank to a drain tile or culvert.

A precise identification of septic tank problems requires a sanitary survey. Sanitary surveys have been conducted in the lake watershed by the Waukesha County Board of Health in 1969 and in 1975. In the 1969 survey, 30 septic tank systems were inspected. Of these, two systems, or 7 percent, were identified as having either substantial State plumbing code violations and/or an obvious discharge of sewage to either the surface or to the groundwater. In 1975, 29 septic tank systems were inspected, with three systems, or 10 percent, noted as having substantial problems. Because of the difficulty in identifying malfunctioning septic tank systems associated with direct sewage discharges—which are not easily observed—and because of the intermittent use of systems by seasonal residents, these types of surveys have historically underestimated the total extent of failing septic tank systems.

There are currently no plans to serve the Ashippun Lake drainage area with sanitary sewers. Although no significant urban development is planned to occur through the year 2000, should such urban development occur, sanitary sewers could become necessary to properly treat the increased sanitary wastes.

EXISTING ZONING REGULATIONS

The Community zoning ordinance represents one of the most important and significant tools available to a local unit of government in directing the proper use of lands within its area of jurisdiction. The zoning ordinance currently in effect within the Town of Oconomowoc is administered jointly by the Town and Waukesha County. The ordinance was initially approved and adopted by Waukesha

County in February 1959, ratified by the Town in April 1959, and was most recently amended in September 1979. A summary of the zoning districts currently available for use in the Town of Oconomowoc is presented in Table 20.

Of the 17 available districts, four districts have been applied within the Ashippun Lake watershed as of 1979: Conservancy (C-1), Agricultural (A-1), Residential (R-2), and Public (P-1). The areas of land placed in each of these four districts, as depicted on the Town of Oconomowoc Zoning Map, dated September 1979, are shown graphically on Map 16 and are quantified in Table 20. It should be noted that residential development is permitted in the Agricultural (A-1) district on a minimum three-acre lot, and in the Residential (R-2) district on a minimum 30,000 square foot lot. As a consequence, about 67 percent of the total watershed area may presently be used for nonfarm residential purposes under the existing ordinance and district map.

In addition to the general Waukesha County zoning ordinance, the Waukesha County Board of Supervisors adopted a Shoreland and Floodland Protection Zoning Ordinance in 1970. This ordinance, prepared pursuant to the requirements of the Wisconsin Water Resource Act of 1965, imposes special land use regulations on all lands located within 1,000 feet of the shoreline of any navigable lake, pond or flowage, and within 300 feet of the shoreline of any navigable river or stream or to the landward side of the floodplain, whichever is greater. The shoreland and floodplain zoning map applicable to the Ashippun Lake watershed was prepared and adopted in 1970 and is shown on Map 17. Where conflicts exist between the two zoning maps in the Town of Oconomowoc, the shoreland/ floodland zoning map supercedes the general zoning map.

The availability of 67 percent of the total area of the watershed for essentially urban and suburban residential use under the existing zoning ordinance encourages the diffusion of urban-type development throughout the watershed in a manner that conflicts with the recommendations contained in the adopted regional land use and water quality management plans. In order to prevent undesirable urban development in the lake watershed, it will be necessary for the Town Board, together with the County, to critically review the County zoning ordinance and accompanying zoning district map for the Ashippun Lake watershed and to amend the ordinance and district map so as to preserve and enhance the existing natural resource base of the watershed. The most pressing needs in this regard are for the creation and sound application of a true, exclusive use agricultural zoning district which prohibits any urban uses.

AQUATIC PLANT MANAGEMENT

Efforts to manage the aquatic plants in Ashippun Lake were first recorded in 1953. Records of aquatic plant management were not maintained prior to 1950. Aquatic plant management for Ashippun Lake can be categorized as macrophyte harvesting, chemical macrophyte control, and chemical algae control.

Macrophyte Harvesting

Macrophyte harvesting is not known to be currently conducted on Ashippun Lake. During 1971 and 1972, macrophyte harvesting was conducted on the lake by the Town of Oconomowoc.[1] The harvesting was reportedly conducted along the eastern and southeastern shore, with about six acres being harvested each year. The collected macrophytes were distributed to farmers, landowners, and greenhouses for use as fertilizer and compost. This limited historical macrophyte harvesting probably had a negligible long-term effect on the lake water quality and the aquatic plant communities.

Chemical Macrophyte Control

Since 1941, the use of chemicals to control aquatic plants has been regulated in Wisconsin. Even prior to this date, chemicals had been used to control aquatic plant growth in lakes and streams. In 1926, sodium arsenite, an agricultural herbicide, was first applied to lakes in Madison, Wisconsin. By the 1930's, sodium arsenite was widely used for aquatic plant control, and no other chemicals were applied in significant amounts to control macrophytes. As indicated in Table 21, the only recorded application of sodium arsenite to Ashippun Lake was in 1953 when 400 pounds of sodium arsenite were applied. Since 88 acres were reportedly treated, the near shore area of the lake must have been treated more than once during 1953. Compared to other lakes in the State which have received applications of sodium arsenite, the 400 pounds used represents a relatively small amount of arsenic.

---

[1] *William Ellis, Town of Oconomowoc Highway Superintendent, Personal Communication, May 12, 1980.*

Table 20

SUMMARY OF EXISTING COMPREHENSIVE ZONING DISTRICTS UNDER THE ADOPTED WAUKESHA COUNTY ZONING ORDINANCE

Zoning District	Permitted Uses		Conditional/Special Uses	Area Regulations			Area Zoned Within Ashippun Lake Watershed (acres)	Percent of Ashippun Lake Watershed
				Minimum Lot Size		Minimum Open Space		
	Principal	Accessory		Area	Average Width			
C-1 Conservancy District	Open space uses	- -	Outdoor recreation facilities, quarrying, refuge disposal sites, fish hatcheries	- -	- -	- -	41	11.1
A-E Exclusive Agricultural District	Open space uses, agricultural uses	- -	Outdoor recreation facilities, quarrying, refuse disposal sites, fish hatcheries	- -	- -	- -	- -	- -
A-1 Agricultural District	Single-family residence, agricultural uses	Garages, barns, home occupations	Airports, gift shops, kennels, churches, cemeteries, fish hatcheries, special agricultural uses, laboratories, mobile home parks, motels and hotels, outdoor theater, planned unit development, outdoor recreation facilities, public buildings, quarrying, refuse disposal sites, restaurants and taverns	3 acres	200 feet	2 acres	84	22.6
A-la Agricultural District	Single-family residence, agricultural uses	Garages, barns, home occupations	Airports, churches, cemeteries, fish hatcheries, special agricultural uses, laboratories, mobile home parks, motels and hotels, outdoor theaters, planned unit development, outdoor recreation facilities, public buildings, quarrying, refuse disposal sites	1 acre	150 feet	20,000 square feet	- -	- -
A-2 Rural Home District	Single-family residence, agricultural uses	Garages, barns, home occupations	Gift shops, churches, cemeteries, fish hatcheries, laboratories, planned unit development, outdoor recreation facilities, public buildings, refuse disposal sites, restaurants and taverns	3 acres	200 feet	2 acres	- -	- -
A-3 Suburban Estate District	Single-family residence, agricultural uses	Garages, barns, home occupations	Gift shops, churches, cemeteries, fish hatcheries, planned unit development, outdoor recreation facilities, public buildings, refuse disposal sites, restaurants and taverns	2 acres	175 feet	75,000 square feet	- -	- -
R-1 Residential District	Single-family residence use	- -	Gift shops, churches, cemeteries, fish hatcheries, motels and hotels, planned unit development, outdoor recreational facilities, public buildings, restaurants and taverns	1 acre	150 feet	30,000 square feet	- -	- -
R-la Residential District	Single-family residence use	- -	Gift shops, churches, cemeteries, fish hatcheries, motels and hotels, planned unit development, outdoor recreational facilities, public buildings, restaurants and taverns	1 acre	150 feet	30,000 square feet	- -	- -

Table 20 (continued)

Zoning District	Permitted Uses		Conditional/Special Uses	Area Regulations			Area Zoned Within Ashippun Lake Watershed (acres)	Percent of Ashippun Lake Watershed
				Minimum Lot Size		Minimum Open Space		
	Principal	Accessory		Area	Average Width			
R-2 Residential District	Single-family residence use	- -	Gift shops, churches, cemeteries, fish hatcheries, motels and hotels, planned unit development, outdoor recreational facilities, public buildings, restaurants and taverns	30,000 square feet	120 feet	25,000 square feet	164	44.3
R-3 Residential District	Single-family residence use	- -	Gift shops, churches, cemeteries, fish hatcheries, motels and hotels, multiple-family dwellings, planned unit development, outdoor recreational facilities, public buildings, restaurants and taverns	20,000 square feet	120 feet	15,000 square feet	- -	- -
P-1 Public District	Recreational, governmental, and institutional uses	- -	Churches, cemeteries, fish hatcheries, laboratories, motels, and hotels, planned unit development, outdoor recreational facilities, public buildings, quarrying, refuse disposal sites	- -	- -	- -	40	10.8
B-1 Restricted District	Single-family, multiple-family, limited retail and service uses	- -	Churches, cemeteries, fish hatcheries, mobile home parks, planned unit development, outdoor recreational facilities, public buildings, refuse disposal sites, restaurants and taverns	20,000 square feet	120 feet	15,000 square feet	- -	- -
B-2 Local Business District	Retail and service, single-family, multiple-family uses	- -	Service stations, kennels, churches, cemeteries, fish hatcheries, drive-in foods, mobile home parks, motels and hotels, multiple-family dwellings, outdoor theater, planned unit development, recreational facilities, public buildings, quarrying, refuse disposal sites	20,000 square feet	120 feet	15,000 square feet	- -	- -
B-3 General Business District	Commercial uses	Single-family residence	Service stations, kennels, churches, cemeteries, fish hatcheries, drive-in foods, mobile home parks, motels and hotels, multiple-family dwellings, outdoor theater, planned unit development, outdoor recreational facilities, public buildings, quarrying, refuse disposal sites	20,000 square feet	120 feet	15,000 square feet	- -	- -
Q-1 Quarrying District	Quarrying, open space, agricultural, single-family residence uses	- -	Churches, cemeteries, fish hatcheries, mobile home parks, motels and hotels, planned unit development, outdoor recreational facilities, public buildings, quarrying, refuse disposal sites	3 acres	200 feet	2 acres	- -	- -

Table 20 (continued)

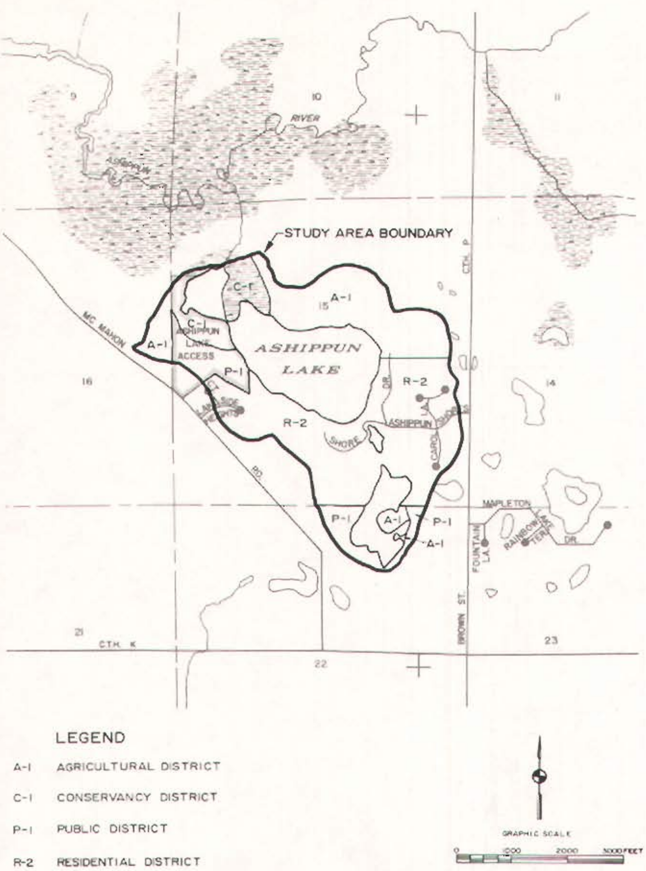
Zoning District	Permitted Uses		Conditional/Special Uses	Area Regulations			Area Zoned Within Ashippun Lake Watershed (acres)	Percent of Ashippun Lake Watershed
				Minimum Lot Size		Minimum Open Space		
	Principal	Accessory		Area	Average Width			
M-1 Limited Industrial District	Commercial, limited industrial (low impact on surrounding residential uses)	Single-family residence	Service stations, kennels, cemeteries, fish hatcheries, drive-in foods, special agricultural uses, laboratories, mobile home parks, motels and hotels, outdoor theaters, planned unit development, outdoor recreational facilities, public buildings, quarrying, refuse disposal sites	1 acre	150 feet	--	--	--
M-2 General Industrial District	Quarrying, industrial, commercial uses	Single-family residence	Service stations, kennels, cemeteries, fish hatcheries, drive-in foods, special agricultural uses, laboratories, mobile home parks, motels and hotels, outdoor theaters, planned unit development, outdoor recreational facilities, public buildings, quarrying, refuse disposal sites	1 acre	150 feet	--	--	--
Total	--	--	--	--	--	--	371[a]	100.0[a]

[a]Includes 42 acres of open water, or 11.3 percent of the drainage area directly tributary to Ashippun Lake.

Source: Waukesha County Park and Planning Commission and SEWRPC.

Map 16

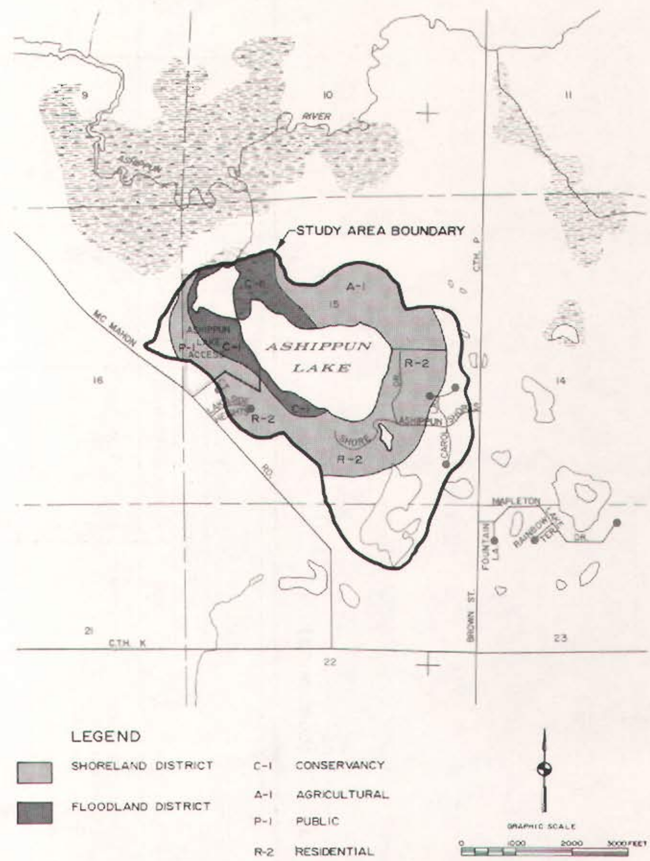
COMPREHENSIVE ZONING DISTRICTS IN THE TOWN OF OCONOMOWOC: 1979



Source: SEWRPC.

Map 17

EXISTING FLOODLANDS AND SHORELAND ZONING DISTRICTS IN THE TOWN OF OCONOMOWOC: 1970



Source: Waukesha County Park and Planning Commission and SEWRPC.

The sodium arsenite was usually sprayed within 200 feet of the shoreline. Treatment typically occurred between mid-June and mid-July. The amount of sodium arsenite used was calculated to result in a concentration of about 10 parts per million sodium arsenite in the treated lake water. Most of the sodium arsenite remained in the water column for less than 120 days. The arsenic residue was naturally converted from a highly toxic trivalent form to a relatively less toxic—and less biologically active—pentavalent form. Much of the arsenic residue was deposited in the lake sediments. Algae, diatoms, and macrophytes have been known to concentrate arsenic in their tissue up to levels exceeding 2,000 micrograms per gram (μg/g) dry weight. However, biomagnification of arsenic through the food chain has not been known to occur. Analyses of fish tissue from some treated lakes by the Wisconsin Department of Natural Resources in 1960 and in 1971 indicated no excessive levels of arsenic.

When it became apparent that arsenic was accumulating in the sediments of treated lakes, the use of sodium arsenite was discontinued in the State in 1969. The application and accumulation of arsenic were concluded to present potential health hazards to human and aquatic life. In drinking water supplies, arsenic is a suspected carcinogen and has been known to cause skin cancer and brain, liver, kidney, and bone marrow damage. Under certain conditions, arsenic may leach to and contaminate the groundwater, especially in sandy soils. The U. S. Environmental Protection Agency drinking water standard for arsenic is 0.05 milligram per liter (mg/l).

Table 21

CHEMICAL CONTROL OF AQUATIC PLANTS IN ASHIPPUN LAKE: 1950-1979

Year	Acres Treated	Algae Control		Macrophyte Control				
		Copper Sulfate	Cutrine or Cutrine-plus	Sodium Arsenite	2, 4-D	Diquat	Endothal	Aquathol
1950	--	--	--	--	--	--	--	--
1951	--	--	--	--	--	--	--	--
1952	--	--	--	--	--	--	--	--
1953	88	--	--	400 pounds	--	--	--	--
1954	--	--	--	--	--	--	--	--
1955	--	--	--	--	--	--	--	--
1956	--	--	--	--	--	--	--	--
1957	--	--	--	--	--	--	--	--
1958	--	--	--	--	--	--	--	--
1959	--	--	--	--	--	--	--	--
1960	--	--	--	--	--	--	--	--
1961	--	--	--	--	--	--	--	--
1962	--	--	--	--	--	--	--	--
1963	--	--	--	--	--	--	--	--
1964	--	--	--	--	--	--	--	--
1965	--	--	--	--	--	--	--	--
1966	--	--	--	--	--	--	--	--
1967	--	--	--	--	--	--	--	--
1968	--	--	--	--	--	--	--	--
1969	--	--	--	--	--	--	--	--
1970	--	--	--	--	--	--	--	--
1971	--	--	--	--	--	--	--	--
1972	4.0	--	--	--	--	4 gallons	--	10 gallons
1973	4.6	--	45 gallons	--	--	--	--	--
1974	4.6	--	36 gallons	--	--	--	--	--
1975	8.2	--	8 gallons	--	14 gallons	--	14 gallons	--
1976	5.6	--	3 gallons	--	90 pounds	--	10 gallons	--
1977	--	--	--	--	--	--	--	--
1978	--	--	--	--	--	--	--	--
1979	5.8	--	12.5 gallons	--	--	--	26 gallons	--
Total	120.8	--	104.5 gallons	400 pounds	14 gallons 90 pounds	4 gallons	50 gallons	10 gallons

Source: Wisconsin Department of Natural Resources

At the relatively low levels of application to Ashippun Lake, it is highly unlikely that arsenic levels in Ashippun Lake are currently excessive. During anaerobic conditions, arsenic may be released from the sediments to the water. In this way, some arsenic continues to be "flushed out" of Ashippun Lake through the outlet. In addition, the arsenic-laden sediments are continually being covered by new sediments. Therefore, the level of arsenic in the water and in the surface sediments can be expected to decrease with the passage of time.

As shown in Table 21, 2, 4-D, Diquat, Endothall, and Aquathol have also been applied to Ashippun Lake to control aquatic macrophytes. All of these chemicals were applied since 1972. All aquatic plant control chemicals used must be approved by the U. S. Environmental Protection Agency and the Wisconsin Department of Natural Resources. The Federal Insecticide, Fungicide, and Rodenticide Act as amended in 1972 requires that all pesticides be registered.

The advantages of chemical use are their relatively low cost and the ease, speed, and convenience of application. Disadvantages associated with chemical control include the following:

1. Although the short-term, lethal effects of chemicals are relatively well known, potential long-term, sublethal effects—especially on fish and fish-food organisms—are relatively unknown.

2. The elimination of macrophytes reduces the competition with algae for light and nutrients. Thus increased algae blooms may develop.

3. Since the plant bodies are not removed from the lake, upon decomposition the nutrients will be released to the water. Decomposition of the plant bodies also consumes dissolved oxygen and increases the potential for fish kills.

4. The elimination of macrophyte beds destroys important cover, food sources, and spawning areas for desired fish species.

5. Adverse impacts on other aquatic organisms may be expected. Diquat has been shown to kill the zooplankton Daphnia (water fleas) and Hyalella (scuds) at the level applied for macrophyte control. Both Daphnia and Hyalella are important fish foods, and Daphnia is a primary food for the young of nearly all fish species.

Chemical Algae Control: Table 21 indicates that Cutrine or Cutrine-plus have been applied since 1973 for algae control. Many of the disadvantages of chemical macrophyte control discussed above apply to chemical algae control as well. In addition, copper, the active ingredient in algicides, may accumulate in the bottom sediments. Excessive levels of copper are toxic to fish and benthic animals.

GOVERNMENTAL AGENCIES WITH WATER QUALITY MANAGEMENT RESPONSIBILITIES

A number of local, state, and federal agencies have water quality management responsibilities for Ashippun Lake. These agencies could include an inland lake protection and rehabilitation district, a town sanitary district, the civil town, the county, the county soil and water conservation district, the Regional Planning Commission, the Wisconsin Department of Natural Resources, the Wisconsin Department of Health and Social Services, the University of Wisconsin-Extension, the U. S. Environmental Protection Agency, the U.S. Department of Agriculture, Soil Conservation Service, and the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service. A brief discussion of the role of these agencies in water quality management follows. A more detailed discussion is presented in Chapter VI, Volume One, SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000.

Inland Lake Protection and Rehabilitation Districts

Inland lake protection and rehabilitation districts are special purpose units of government created pursuant to Chapter 33 of the Wisconsin Statutes. In its initial declaration of intent, the Wisconsin Legislature summarized the underlying philosophy behind the creation of these special purpose districts:

> The legislature finds environmental values, wildlife, public rights in navigable waters, and the public welfare are threatened by the deterioration of public lakes; that the protection and rehabilitation of the public inland lakes of this state are in the best interest of the citizens of this state; that the public health and welfare will be benefited thereby; that the current state effort

to abate water pollution will not undo the eutrophic and other deteriorated conditions of many lakes; and that the positive public duty of this state as trustee of waters requires affirmative steps to protect and enhance this resource and protect environmental values.

Inland lake protection and rehabilitation districts are formed at the local level. The district organizers, who may be any local lake property owners, propose appropriate boundaries encompassing the riparian property and as much of the lake watershed as deemed necessary. Once the district boundary has been so proposed, the organizers must obtain a petition signed by at least 51 percent of the property owners or by the owners of at least 51 percent of the land within the proposed district boundaries. The petition is presented to the county board which holds a hearing after notifying all property owners in the proposed district. Following the hearing, the county board may form an inland lake protection and rehabilitation district.

The lake district has powers to enter into contracts; own property; disburse money; and bond, borrow, and levy special assessments to raise money. Its specific lake management powers include:

1. Study of existing water quality conditions and determine the causes of existing or expected future water quality problems.

2. Control of aquatic macrophytes; algae and swimmer's itch.

3. Implementation of lake rehabilitation techniques, including aeration, diversion, nutrient removal or inactivation, dredging, sediment covering, and drawdown.

4. Construction and operation of water level control structures.

5. Control of nonpoint source pollution.

The districts do not have police powers but may ask counties, towns, villages, or cities to enact ordinances necessary to improve or protect the lake. The governing body of a lake district is a board of commissioners, which consists of:

- Three property owners from within the district, elected by all property owners within the district.

- A county board member who is also a Soil and Water Conservation District supervisor who has been nominated by the Supervisors of the Soil and Water Conservation District and appointed by the County Board.

- A representative of the town, village, or city having the highest assessed evaluation within the district who is appointed by that governing body.

In 1975, a lake protection and rehabilitation district was formed on Ashippun Lake. The District encompasses 162 acres as shown on Map 7 of which 148 acres, or about 91 percent, are within the lake watershed, comprising 40 percent of the total lake watershed area.

Sanitary Districts

Sanitary districts may be created under Section 66.30 of the Wisconsin Statutes to plan, construct, and maintain centralized sanitary sewerage systems. Town sanitary districts have limited authority to construct and maintain storm sewer systems and provide garbage and refuse collection and disposal. Such districts have also been used as an organizational vehicle for lake macrophyte harvesting.

Towns

Towns have authority to undertake a wide variety of activities with respect to the abatement of pollution from both point and nonpoint sources. Towns that contain both urban and rural areas generally have elected to establish separate sanitary and utility districts for the provision of services to urban development, particularly including sanitary sewer and storm water management services. Towns may also undertake stream and lake improvements and watershed protection projects.

Counties

Counties are authorized to engage in soil and water conservation projects, lake and river improvements, property acquisitions, water protection, and solid waste management. In addition, counties may regulate nonpoint source pollution through their planning, zoning, subdivision, building, and health code authorities. Counties are also important to the functioning of the soil and water conservation districts. Not only are such districts fiscally dependent upon county boards, but in effect the districts are governed by a county board committee. In implementation of the areawide water quality management plan, therefore, it would be necessary for county boards and the soil and water conservation districts to work cooperatively.

Soil and Water Conservation Districts

Soil and water conservation districts, as authorized under Section 92.05 of the Wisconsin Statutes, have the authority to develop plans for the conservation of soil and water resources and for the prevention of soil erosion. In addition, the districts have authority to request the County Board of Supervisors to adopt special land use regulations that would implement such plans in unincorporated areas. Such adoption, however, requires a referendum in which a simple majority of the eligible electors who voted and were residents of the area affected approve the proposed regulations. Soil and water conservation districts have the authority to acquire—through eminent domain proceedings—any property or rights therein for watershed protection, soil and water conservation, flood prevention works, and fish and wildlife conservation and recreational works.

Regional Planning Commission

In its role as a coordinating agency for water pollution control activities within southeastern Wisconsin, the Regional Planning Commission utilizes the legally adopted and certified regional plan elements as a basis for review of federal and state grants in aid, discharge permits, and sanitary sewer extensions. The Commission provides technical assistance pertaining to water quality management topics, and further promotes plan implementation through community assistance planning services, as appropriate. In addition, the Commission stands ready to provide a forum for the discussion of intergovernmental issues which may become critical to the orderly and timely implementation of water quality management projects. These indirect plan implementation functions must be distinguished from the plan implementation responsibilities of the other management agencies, through whose direct actions the plans are converted to reality.

Wisconsin Department of Natural Resources

The responsibility for water pollution control in Wisconsin is centered in the Wisconsin Department of Natural Resources. The basic authority and accompanying responsibilities relating to the water pollution control functions of the Department are set forth in Chapter 144 of the Wisconsin Statutes. Under this chapter, the Department is given broad authority to prepare as well as to approve or endorse water quality management plans; to establish water use objectives and supporting water quality standards; to review and approve all plans and specifications for components of sanitary sewerage systems; to conduct research and demonstration projects on sewerage and waste treatment matters; to operate an examining program for the certification of sewage treatment plant operators; to order the installation of centralized sanitary sewerage systems; to review and approve the creation of joint sewerage systems and metropolitan sewerage districts; to regulate water level elevations; and to administer a financial assistance program for the construction of pollution prevention and abatement facilities, or for the application of land management measures. The Wisconsin Statutes also authorize the Department to consider conformance with an approved areawide water quality management plan when reviewing locally proposed sanitary sewer extensions. This permissive authority is in addition to the Department's mandatory review for engineering soundness and for relation to public health and safety.

Under Chapter 147 of the Wisconsin Statutes, the Department is given broad authority to establish and carry out a pollutant discharge elimination program in accordance with the policy guidelines set forth by the U. S. Congress under the Federal Water Pollution Control Act. Pursuant to this authority, the Department has established a waste discharge permit system. No permit may be issued by the Department for any discharge from a point source of pollution that is in conflict with any areawide water quality management plan approved by the Department. Also under this authority, the Department has rule-making powers to establish effluent limitations, water quality-related limitations, performance standards related to classes or categories of pollution, and toxic and pretreatment effluent standards. All permits issued by the Department must include conditions that waste discharges are to meet, in addition to effluent limitations, performance standards, effluent prohibitions, pretreatment standards, and any other limitations needed to meet the adopted water use objectives and supporting water quality standards. As appropriate, the permits may include a timetable for appropriate action on the part of the owner or operator of any point source waste discharge. Although the Department has not established a required elevation for Ashippun Lake itself, the Department does regulate the elevation of the Monterey Dam on the Ashippun River which has hydrologic effects on Ashippun Lake.

Wisconsin Department of Health and Social Services, Division of Health

In performing its functions relating to the maintenance and promotion of public health, the Wisconsin Division of Health is charged with the responsibility of regulating the installation and operation of private septic tank sewage disposal systems. The Division reviews plats of all land subdivisions not served by public sanitary sewerage systems and may object to such plats if onsite sanitary waste disposal facilities are not properly provided for in the plat layout.

University of Wisconsin-Extension

The Extension Service operates on a contractual basis with counties to provide technical and educational assistance within the counties. Of particular importance to implementation of the areawide water quality management plan is the provision of technical assistance by the Extension Service to county soil and water conservation districts, county boards, and county zoning and planning committees. In addition, the Extension Service is well equipped to provide educational services, especially in the areas of nonpoint source pollution and sludge management.

U. S. Environmental Protection Agency

The U. S. Environmental Protection Agency has broad powers under the Federal Water Pollution Control Act to administer federal grants-in-aid for the construction of publicly owned waste treatment works and related sewerage facilities; to promote and fund areawide waste treatment planning and management; to set and enforce water quality standards, including effluent limitations, through the establishment of water use objectives and supporting water quality standards and the conduct of water quality inventories and inspection and monitoring programs; and to establish a national pollutant discharge elimination system. The Environmental Protection Agency, thus, acts as the key federal water pollution control agency and must approve all basin and areawide water quality management plans as certified to it by appropriate state agencies.

U. S. Department of Agriculture,
Soil Conservation Service

The U. S. Department of Agriculture, Soil Conservation Service, administers resource conservation and development projects under Public Law 566 and provides technical and financial assistance, through soil and water conservation districts, to landowners in the planning and construction of measures for land treatment, agricultural water management, and flood prevention, and for public fish, wildlife, and recreational development. The Soil Conservation Service also conducts detailed soils surveys and provides interpretations as a guide to the use of soil survey data in local planning and development. The technical assistance programs of the Soil Conservation Service are of great importance to implementation of the areawide water quality management plan.

U. S. Department of Agriculture,
Agricultural Stabilization and Conservation Service

The U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service, administers the federal Agricultural Conservation Program (ACP), which provides grants to rural landowners in partial support of carrying out approved soil, water, woodland, wildlife, and other conservation practices. These grants are awarded under yearly and long-term assistance programs, providing guaranteed funds for carrying out approved conservation work plans. Grants from the federal Agricultural Conservation Program are important to implementation of the areawide water quality management plan. In addition, the Agricultural Stabilization and Conservation Service has relatively new authority under Section 208(J) of the Federal Water Pollution Control Act to administer a cost-sharing grant program for the purpose of installing and maintaining agricultural measures found needed to control nonpoint source pollution.

Private Action for Water Pollution Control

The foregoing discussion deals exclusively with water quality management by units and agencies of government. Direct action may also be taken, however, by private individuals or organizations to effectively abate water pollution. As shown later in the "Alternative Water Quality Management Measures" chapter, some of the most important, yet least costly, management practices can be readily carried out by individual citizens. In addition, most of the activities of the agencies previously discussed require the cooperation and support of individual citizens and of citizen groups in order to be effectively implemented.

(This page intentionally left blank)

Chapter VII

WATER USE OBJECTIVES AND WATER QUALITY STANDARDS

The Regional Planning Commission adopted areawide water quality management plan, as set forth in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, recommends water use objectives and supporting water quality standards for all major lakes and streams in the Region. The water use objectives recommended for Ashippun Lake are full recreational use and support of a healthy warmwater fishery. The water quality standards which support these objectives are set forth in Table 22. Standards are recommended for temperature, pH, dissolved oxygen, fecal coliform, residual chlorine, un-ionized ammonia nitrogen, and total phosphorus.

The total phosphorus standard of 0.02 milligram per liter (mg/l) applies to lakes during spring turnover, when the lakes are not stratified and maximum vertical mixing is occurring. The achievement of this recommended standard is expected to prevent excessive macrophyte and algae growths in most lakes, although lake rehabilitation techniques may also be required to avoid seasonal problems associated with recycling of phosphorus from the bottom sediments. Excessive total phosphorus levels may stimulate large growths of algae and aquatic macrophytes, which interfere with recreational use. As these plant masses die and decompose, dissolved oxygen depletions may result which also threaten the survival of fish and aquatic life. Although many factors are involved, one pound of phosphorus may produce from 1,000 to 10,000 pounds wet weight of aquatic plant material. Upon the decomposition of this amount of plant material generated from one pound of phosphorus, 100 pounds or more of dissolved oxygen would be consumed.

The phosphorus concentration in the lake is directly related to the phosphorus load contributed to the lake via tributary runoff and atmospheric sources, although some recycling of phosphorus from the lake bottom sediments may also occur. Figure 21 indicates the total phosphorus concentrations

Table 22

RECOMMENDED WATER QUALITY STANDARDS TO SUPPORT RECREATIONAL AND WARMWATER FISH AND AQUATIC LIFE USE

Parameter	Standard
Maximum Temperature	$89^{\circ}F$[a,b]
pH Range	6.0-9.0 standard units
Minimum Dissolved Oxygen	5.0 mg/l[b]
Maximum Fecal Coliform	200/400 MFFCC/100 ml[c]
Maximum Total Residual Chlorine	0.01 mg/l
Maximum Un-ionized Ammonia Nitrogen	0.02 mg/l
Maximum Total Phosphorus	0.02 mg/l[d]
Other	--[e,f]

[a] *There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed $5^{\circ}F$ for streams and $3^{\circ}F$ for lakes.*

[b] *Dissolved oxygen and temperature standards apply to streams and the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inland lakes. Trends in the period of anaerobic conditions in the hypolimnion of stratified inland lakes should be considered important to the maintenance of water quality, however.*

[c] *The membrane filter fecal coliform count per 100 milliliters (MFFCC/100 ml) shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month, nor a monthly geometric mean of 400 per 100 ml in more than 10 percent of all samples during any month.*

[d] *The values presented for lakes are the critical total phosphorus concentrations which apply only during spring when maximum mixing is underway.*

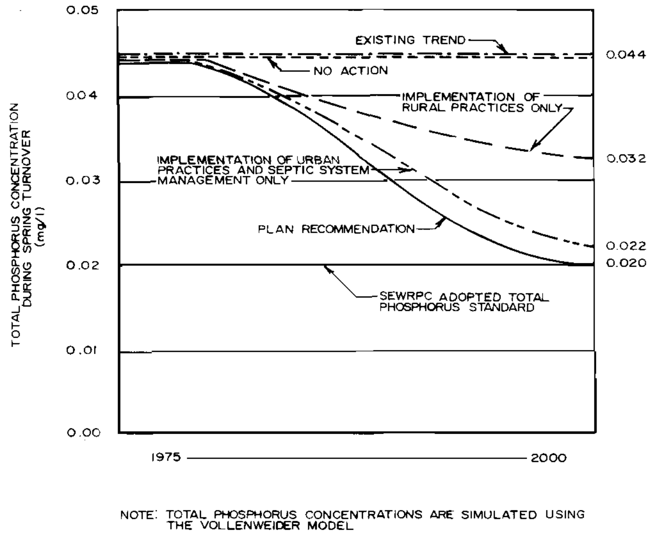
[e] *All waters shall meet the following minimum standards at all times and under all flow conditions: substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the State. Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall not be present in amounts which are acutely harmful to animal, plant, or aquatic life.*

[f] *Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific data base. References to be used in determining the toxicity of a substance shall include, but not be limited to, Quality Criteria for Water, EPA-440/9-76-003, U. S. Environmental Protection Agency, Washington, D. C., 1976, and Water Quality Criteria 1972. EPA R3-73-003, National Academy of Engineering, U. S. Government Printing Office, Washington, D. C., 1974. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, or undefined toxicity to fish and other biota shall be resolved in accordance with the methods specified in Water Quality Criteria 1972 and Standard Methods for the Examination of Water and Wastewater, 14th Edition. American Public Health Association, New York, 1975, or other methods approved by the Department of Natural Resources.*

Source: SEWRPC.

Figure 21

TOTAL PHOSPHORUS LEVELS IN ASHIPPUN LAKE UNDER ALTERNATIVE POLLUTION CONTROL ACTIONS



Source: SEWRPC.

expected to occur during spring turnover under alternative water quality management actions in the lake watershed, as estimated by the Regional Planning Commission's water quality analyses. Failure to implement any management measures in the lake watershed may be expected to result in continued excessive phosphorus levels, and a resulting decrease in water quality and water use potential. Complete implementation of the plan recommendations, including watershed management measures and in-lake management techniques, set forth in this report may be expected to result in the achievement of the phosphorus standard of 0.02 mg/l and subsequently provide water quality suitable for a full range of recreational use opportunities and for support of a healthy warmwater fishery.

Chapter VIII

ALTERNATIVE WATER QUALITY MANAGEMENT MEASURES

INTRODUCTION

Potential measures for water quality management of Ashippun Lake include nonpoint source pollution control and lake rehabilitation techniques. Nonpoint source pollution control consists of the improved management of both urban and rural land uses to reduce pollutants discharged to the lake by direct overland drainage, by drainage through natural or man-made channels, and by groundwater inflow. Lake rehabilitation techniques either directly treat the symptoms of lake eutrophication, or alter the characteristics of the lake basin which may be interfering with the achievement of water use objectives.

NONPOINT SOURCE POLLUTION CONTROL

Nonpoint sources of water pollution include urban sources such as runoff from residential, commercial, industrial, transportation, and recreational land uses, construction activities, and septic tank systems; and rural sources such as runoff from cropland, pasture, and woodland, livestock wastes, and atmospheric contributions.

The water quality analyses presented previously in this report indicated that a reduction in nutrient loads from nonpoint sources in the tributary area would be needed to meet the recommended water use objectives and supporting standards. Alternative nonpoint source control measures are set forth in Table 23. About a 50 percent reduction in nonpoint source loads from the drainage area directly tributary to Ashippun Lake is needed to meet the recommended water use objectives and supporting standards.

LAKE REHABILITATION TECHNIQUES

Although preventing further deterioration in lake water quality conditions, the reduction of nutrient inputs to Ashippun Lake alone may not result in the elimination of existing water quality problems. In mesotrophic or eutrophic lakes, such as Ashippun Lake, and especially in the presence of anaerobic conditions in the hypolimnion, significant amounts of phosphorus may be released from the sediments to the overlying water column. Furthermore, macrophytes may continue to proliferate, rooting in the nutrient-rich bottom sediments, regardless of the nutrient content of the overlying water. Therefore, the desired water quality improvements expected from a reduced nutrient input may be inhibited or prevented by these conditions. If this occurs, or if other characteristics of the lake result in restricted water use potential, the application of lake rehabilitation techniques should be considered.

The applicability of specific lake rehabilitation techniques is highly dependent on lake characteristics. The success of any lake rehabilitation technique can seldom be guaranteed since the state-of-the-art is still in the early stages of development. Because of the relatively high cost of applying most techniques, a cautious approach to implementing lake rehabilitation techniques is recommended. Certain lake rehabilitation techniques should be applied only to lakes in which: 1) nutrient inputs to the lake have been reduced below the critical level; 2) there is a high probability of success; and 3) the possibility of adverse environmental impacts is minimal.

Alternative lake rehabilitation and in-lake management measures discussed below include hypolimnetic aeration, dredging, sediment covering, drawdown, nutrient inactivation, dilution/flushing, selective discharge, macrophyte harvesting, algae harvesting, chemical controls, fish management, shoreline erosion control, and lake water level controls. All costs are presented in January 1980 dollars.

Hypolimnetic Aeration

The purpose of hypolimnetic aeration is to provide oxygen to the hypolimnion of a stratified lake without disrupting the stratification. The hypolimnion of Ashippun Lake underlies about 37 acres, or 45 percent, of the lake area. During the study year about 22 acres, or 59 percent, of the area of the hypolimnion and about 108 acre feet of water, or about 72 percent, of the total volume of the hypolimnion was found to be completely devoid of oxygen during at least a portion of the summer. To provide hypolimnetic aeration, typically the bottom water is airlifted up a vertical tube, with

Table 23

GENERALIZED SUMMARY OF METHODS AND EFFECTIVENESS OF NONPOINT SOURCE WATER POLLUTION ABATEMENT MEASURES

Applicable Land Use	Control Measures[a]	Summary Description[b]	Approximate Percent Reduction of Released Pollutants[c]	Assumptions for Costing Purposes
Urban	Litter and pet waste control ordinance	Prevent the accumulation of litter and pet wastes on streets and residential, commercial, industrial, and recreational areas	2-5	Ordinance administration and enforcement costs are expected to be funded by violation penalties and related revenues
	Improved timing and efficiency of street sweeping, leaf collection and disposal, and catch basin cleaning	Improve the scheduling of these public works activities, modify work habits of personnel, and select equipment to maximize the effectiveness of these existing pollution control measures	2-5	No significant increase in current expenditures is expected
	Management of onsite sewage treatment systems	Regulate septic system installation, monitoring, location, and performance; replace failing systems with new septic systems or alternative treatment facilities; develop alternatives to septic systems; eliminate direct connections to drain tiles or ditches; dispose of septage at sewage treatment facility	10-30	Replace one-half of estimated existing failing septic systems with properly located and installed systems and replace one-half with alternative systems, such as mound systems or holding tanks; all existing and proposed onsite sewage treatment systems are assumed to be properly maintained; assume system life of 25 years. The estimated cost of a septic tank system is $2,300 and the cost of an alternative system is $4,500. The annual maintenance cost of a disposal system is $45. A holding tank would cost $1,300 with an annual operation and maintenance cost of $1,200. However, because septic system management is an existing function necessary for the preservation of public health and the maintenance of drinking water supplies, these costs are not included as part of the areawide water quality maintenance plan
	Increased street sweeping	On the average, sweep all streets in urban areas an equivalent of once or twice a week with vacuum street sweepers; require parking restrictions to permit access to curb areas; sweep all streets at least eight months per year; sweep commercial and industrial areas with greater frequency than residential areas	30-50	Estimate curb miles based on land use, estimated street acreage, and Commission transportation planning standards; assume one street sweeper can sweep 2,000 curb miles per year; assume sweeper life of 10 years; assume residential areas swept once weekly, commercial and industrial areas swept twice weekly. The cost of a vacuum street sweeper is approximately $38,000. The cost of the operation and maintenance of a sweeper is about $10 per curb/mile swept.
	Increased leaf and clippings collection and disposal	Increase the frequency and efficiency of leaf collection procedures in fall; use vacuum cleaners to collect leaves; implement ordinances for leaves, clippings, and other organic debris to be mulched, composted, or bagged for pickup	2-5	Assume one equivalent mature tree per residence plus five trees per acre in recreational areas; 75 pounds of leaves per tree; 20 percent of leaves in urban areas not currently disposed of properly. The cost of the collection of leaves in a vacuum sweeper and disposal is estimated at $25 per ton of leaves

Table 23 (continued)

Applicable Land Use	Control Measures[a]	Summary Description[b]	Approximate Percent Reduction of Released Pollutants[c]	Assumptions for Costing Purposes
Urban (continued)	Increased catch basin cleaning	Increase frequency and efficiency of catch basin cleaning; clean at least twice per year using vacuum cleaners; catch basin installation in new urban development not recommended as a cost-effective practice for water quality improvement	2-5	Determine curb miles for street sweeping; vary percent of urban area served by catch basins by watershed from Commission inventory data; assume density of 10 catch basins per curb mile; clean each basin twice annually by vacuum cleaner. The cost of cleaning a catch basin is approximately $8
	Reduced use of deicing salt	Reduce use of deicing salt on streets; salt only intersections and problem areas; prevent excessive use of sand and other abrasives	Negligible for pollutants addressed in this chapter but helpful for reducing chlorides and associated damage to vegetation	Increased costs, such as for slower transportation movement, are expected to be offset by benefits such as reduced automobile corrosion and damage to vegetation
	Improved street maintenance and refuse collection and disposal	Increase street maintenance and repairs; increase provision of trash receptacles in public areas; improve trash collection schedules; increase cleanup of parks and commercial centers	2-5	Increase current expenditures by approximately 15 percent. The annual cost per person is about $4
	Parking lot storm water temporary storage and treatment measures	Construct gravel-filled trenches, sediment basins, or similar measures to store temporarily the runoff from parking lots, rooftops, and other large impervious areas; if treatment is necessary, use a physical-chemical treatment measure such as screens, dissclved air flotation, or a swirl concentrator	5-10	Design gravel-filled trenches for 24-hour, five year recurrence interval storm; apply to off-street parking acreages. For treatment—assume four-hour detention time. The capital cost of storm water detention and treatment facilities is estimated at $9,000 per acre of parking lot area, with an annual operation and maintenance cost of about $100 per acre.
	Onsite storage—residential	Remove connections to sewer systems; construct onsite storm water storage measures for subdivisions	5-10	Remove roof drains and other connections to sewer system wherever needed; use lawn aeration if applicable; apply dutch drain storage facilities to 15 percent of residences. The capital cost would approximate $200 per house, with an annual maintenance cost of about $10

Table 23 (continued)

Applicable Land Use	Control Measures[a]	Summary Description[b]	Approximate Percent Reduction of Released Pollutants[c]	Assumptions for Costing Purposes
Urban (continued)	Storm water storage—urban	Store storm water runoff from urban land in surface storage basins or, where necessary, subsurface storage basins	10-35	Design all storage facilities for a 1.5 inch of runoff event, which corresponds approximately to a five-year recurrence interval event with a storm event being defined as a period of precipitation with a minimum antecedent and subsequent dry period of from 12 to 24 hours; apply subsurface storage tanks to intensively developed existing urban areas where suitable open land for surface storage is unavailable; design surface storage basins for proposed new urban land, existing urban land not storm sewered, and existing urban land where adequate open space is available at the storm sewer discharge site. The capital cost for storm water storage would range from $1,000-$10,000 per acre of tributary drainage area, with an annual operation and maintenance cost of about $20-$40 per acre
	Storm water treatment	Provide physical-chemical treatment which includes screens, microstrainers, dissolved air flotation, swirl concentrator, or high-rate filtration, and/or disinfection, which may include chlorination, high-rate disinfection, or ozonation to storm water following storage	10-50	To be applied only in combination with storm water storage facilities above; general cost estimates for microstrainer treatment and ozonation were used; same costs were applied to existing urban land and proposed new urban development. Storm water treatment has an estimated capital cost of from $900-$7,000 per acre of tributary drainage area, with an average annual operation and maintenance cost of about $35 per acre
Rural	Conservation practices	Includes such practices as strip cropping, contour plowing, crop rotation, pasture management, critical area protection, grading and terracing, grassed waterways, diversions, wood lot management, fertilization and pesticide management, and chisel tillage	Up to 50	Costs for Soil Conservation Service (SCS)-recommended practices are applied to agricultural and related rural land; the distribution and extent of the various practices were determined from an examination of 56 existing farm plan designs within the Region. The capital cost of conservation practices ranges from $0.30-$14 per acres of rural land, with an average annual operation and maintenance cost of from $2-$4 per rural acre

Table 23 (continued)

Applicable Land Use	Control Measures[a]	Summary Description[b]	Approximate Percent Reduction of Released Pollutants[c]	Assumptions for Costing Purposes
Rural (continued)	Animal waste control system	Construct stream bank fencing and crossovers to prevent access of all livestock to waterways; construct a runoff control system or a manure storage facility, as needed, for major livestock operations; prevent improper applications of manure on frozen ground, near surface drainageways, and on steep slopes; incorporate manure into soil	50-75	Cost estimated per animal unit; animal waste storage (liquid and slurry tank for costing purposes) facilities are recommended for all major animal operations within 500 feet of surface water and located in areas identified as having relatively high potential for severe pollution problems. Runoff control systems recommended for all other major animal operations. It is recognized that dry manure stacking facilities are significantly less expensive than liquid and slurry storage tanks and may be adequate waste storage systems in many instances. The estimated capital cost and average operation and maintenance cost of a runoff control system is $90 per animal unit and $10 per animal unit, respectively. The capital cost of a liquid and slurry storage facility is about $425 per animal unit, with an annual operation and maintenance cost of about $30 per unit. An animal unit is the weight equivalent of a 1,000-pound cow
	Base-of-slope detention storage	Store runoff from agricultural land to allow solids to settle out and reduce peak runoff rates. Berms could be constructed parallel to streams	50-75	Construct a low earthen berm at the base of agricultural fields, along the edge of a floodplain, wetland, or other sensitive area, design for 24-hour, 10-year recurrence interval storm; berm height about four feet. Apply where needed in addition to basic conservation practices; repair berm every 10 years and remove sediment and spread on land. The estimated capital cost of base-of-slope detention storage would be about $250 per tributary acre, with an annual operation and maintenance cost of $10 per acre
	Bench terraces	Construct bench terraces, thereby reducing the need for many other conservation practices on sloping agricultural land	75-90	Apply to all appropriate agricultural lands for a maximum level of pollution control. Utilization of this practice would exclude installation of many basic conservation practices and base-of-slope detention storage. The capital cost of bench terraces is estimated at $625 per acre, with an annual operation and maintenance cost of $45 per acre

Table 23 (continued)

Applicable Land Use	Control Measures[a]	Summary Description[b]	Approximate Percent Reduction of Released Pollutants[c]	Assumptions for Costing Purposes
Urban and Rural	Public education programs	Conduct regional- and county-level public education programs to inform the public and provide technical information on the need for proper land management practices on private land, the recommendations for management programs, and the effects of implemented measures; develop local awareness programs for citizens and public works officials; develop local contact and education efforts	Indeterminate	For first 10 years includes cost of one person, materials, and support for each 25,000 population. Thereafter, the same cost can be applied to for every 50,000 population. The cost of one person, materials, and support is estimated at $33,000 per year
	Construction erosion control practices	Construct temporary sediment basins; install straw bale dikes; use fiber mats, mulching and seeding; install slope drains to stabilize steep slopes; construct temporary diversion swales or berms upslope from the project	20-40	Assume acreage under construction is the average annual incremental increase in urban acreage; apply costs for a typical erosion control program for a construction site. The estimated capital cost and operation and maintenance cost for construction erosion control is $2,200 and $400 per acre under construction, respectively
	Materials storage and runoff control facilities	Enclose industrial storage sites with diversions; divert runoff to acceptable outlet or storage facility; enclose salt piles and other large storage sites in crib and dome structures	5-10	Assume 40 percent of industrial areas are used for storage and to be enclosed by diversions; assume existing salt storage piles enclosed by cribs and dome structures. The estimated capital cost of industrial runoff control is $1,100 per acre of industrial land. Material storage control costs are estimated at $30 per ton of material
	Stream protection measures	Provide vegetative buffer zones along streams to filter direct pollutant runoff to the stream; construct stream bank protection measures, such as rock riprap, brush mats, tree revetment, jacks, and jetted willow poles where needed	5-10	Apply a 50-foot-wide vegetative buffer zone on each side of 15 percent of the stream length; apply stream bank protection measures to 5 percent of the stream length. Vegetative buffer zones are estimated to cost $21,200 per mile of stream, and streambank protection measures cost about $37,000 per stream mile
	Pesticide and fertilizer application restrictions	Match application rate to need; eliminate excessive applications and applications near or into surface water drainageways	0-3	Cost included in public education program
	Critical area protection	Emphasize control of areas bordering lakes and streams; correct obvious erosion and other pollution source problems	Indeterminate	Indeterminate

[a] *Not all control measures are evaluated for each watershed. The characteristics of the watershed, the estimated required level of pollution reduction needed to meet the applicable water quality standards, and other factors will influence the estimation of costs of specific practices for any one watershed. Although the control measures costed represent the recommended practices developed at the regional level on the basis of the best available information, the local implementation process should provide more detailed data and identify more efficient and effective sets of practices to apply to local conditions.*

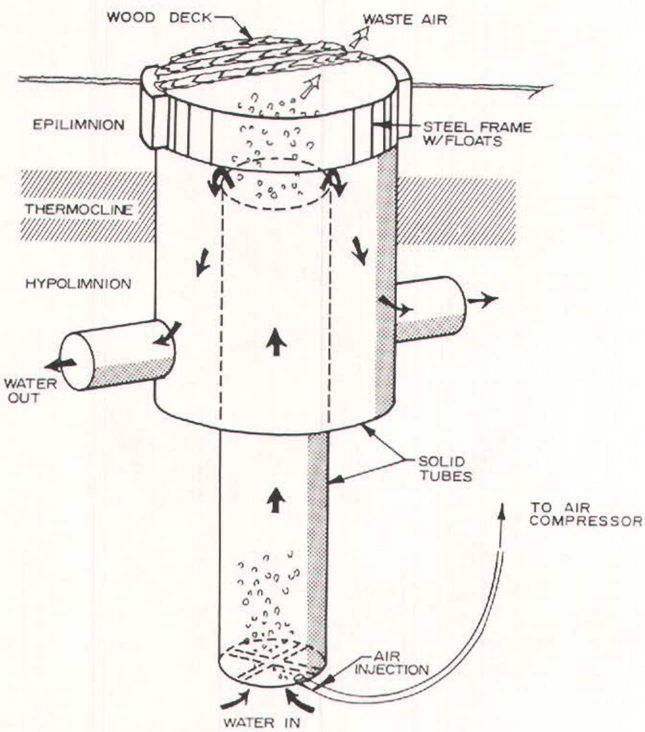
[b] *For a more detailed description of pollution control measures for diffuse sources, see SEWRPC Technical Report No. 18, State of the Art of Water Pollution Control for Southeastern Wisconsin, Volume Three, Urban Storm Water Runoff, and Volume Four, Rural Storm Water Runoff.*

[c] *The approximate effectiveness refers to the estimated amount of pollution produced by the contributing category (urban or rural) that could be expected to be reduced by the implementation of the practice. The effectiveness rates would vary greatly depending on the characteristics of the watershed and individual diffuse sources. It should be further noted that practices can have only a "sequential" effect, since the percent pollution reduction of a second practice can only be applied against the residual pollutant load which is not controlled by the first practice. For example, two practices of 50 percent effectiveness would achieve a theoretical total effectiveness of only 75 percent control of the initial load. Further, the general levels of effectiveness reported in the table are not necessarily the same for all pollutants associated with each source. Some pollutants are transported by dissolving in water and others by attaching to solids in the water; the methods summarized here reflect typical pollutant removal levels.*

Source: SEWRPC.

Figure 22

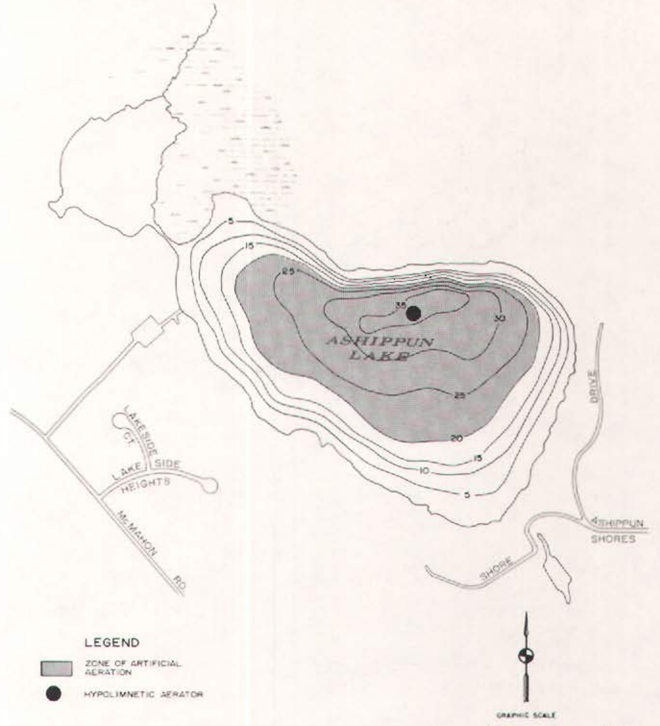
TYPICAL HYPOLIMNETIC AERATION SYSTEM FOR AN INLAND LAKE



Source: A. W. Fast, "The Effects of Artificial Aeration on Lake Ecology," U. S. EPA Water Pollution Control Research Series 16010EXE, 1971.

Map 18

PLAN ALTERNATIVE FOR PLACEMENT OF A HYPOLIMNETIC AERATION SYSTEM IN ASHIPPUN LAKE AND ZONE OF ARTIFICIAL AERATION



Source: SEWRPC.

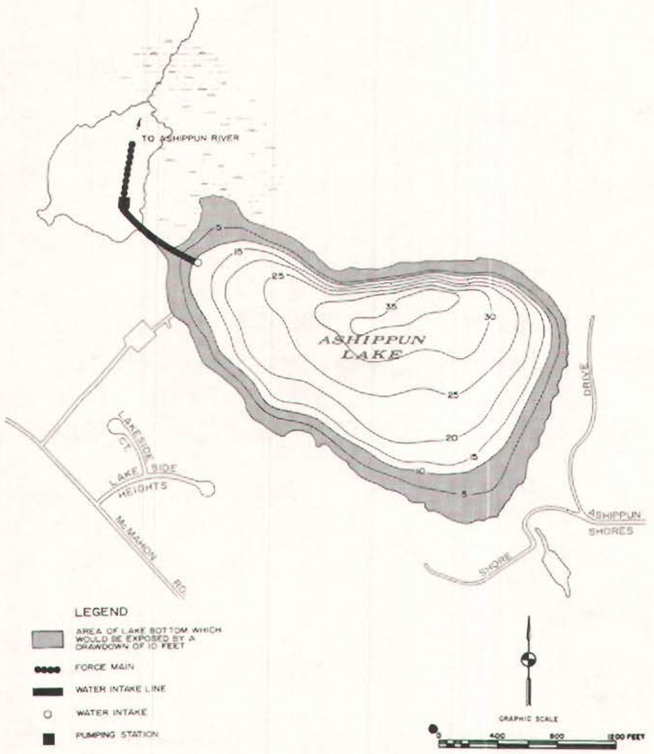
oxygenated water returned to the hypolimnion, as shown in Figure 22 and on Map 18. Aeration of the hypolimnion increases the decomposition of organic matter, and promotes sorption of phosphorus by the hydrous-oxides of iron and manganese present in the lake bottom sediments. The result is that the concentration of phosphorus in the bottom waters may be substantially reduced, and the improved oxygen levels result in increased habitat for fish and aquatic life. Hypolimnetic aeration also provides additional habitat for zooplankton, which can seek refuge from feeding fish during the day in the dark, bottom lake waters, and migrate toward the surface at night to graze on algae. Increased zooplankton populations can effectively reduce certain species of algae. Hypolimnetic aeration in Ashippun Lake would involve a capital cost of about $10,000, with an annual operation and maintenance cost of about $300. It is unlikely that nonpoint source pollution control measures in the lake watershed alone would—at least for some years—substantially improve dissolved oxygen conditions in the hypolimnion. Therefore, hypolimnetic aeration could be implemented even prior to the control of nonpoint pollution sources in order to provide additional and immediate water quality improvement.

Measures for Controlling Sediment Effects on Water Column and Macrophyte Growth

Dredging, sediment covering, and drawdown for sediment consolidation serve either to deepen the lake or to provide bottom sediments which are less likely to release nutrients to the water column or support excessive macrophyte growth. Because of the relatively high cost of these practices, and the temporary disruption to the lake community which occurs when these techniques are implemented on a large scale, these practices are probably warranted only on a very limited-scale basis

Map 19

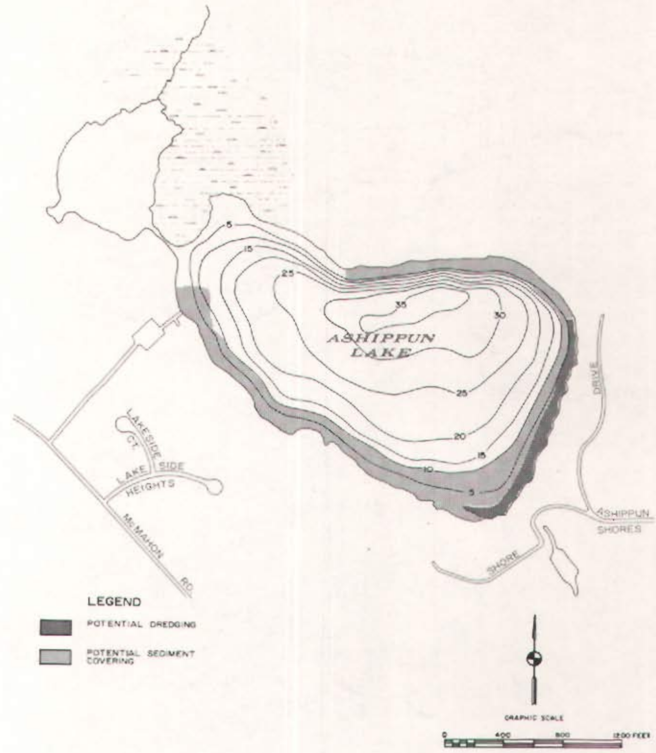
PLAN ALTERNATIVE FOR A 10-FOOT DRAWDOWN AND SEDIMENT CONSOLIDATION FOR ASHIPPUN LAKE



Source: SEWRPC.

Map 20

PLAN ALTERNATIVE FOR LIMITED DREDGING AND SEDIMENT COVERING IN ASHIPPUN LAKE



Source: SEWRPC.

for Ashippun Lake. If actions to reduce inflows are not fully effective in reducing the in-lake nutrient concentration, then additional sediment controls could be considered. Drawdown of the lake level by 10 feet would expose about 27 acres, or 33 percent, of the area of the lake, as shown on Map 19. The pumpage of the necessary 710 acre-feet of water in one month from Ashippun Lake at a rate of 7.3 million gallons per day plus maintenance pumping for an additional three months through a 2,600-foot pipeline 14 inches in diameter would involve a capital cost of about $100,000, with an operation and maintenance cost of about $13,000 for each winter of drawdown. The drawdown would probably increase the depth of the shallow areas by up to one foot and the consolidated sediments could be expected to reduce macrophyte growths. The drawdown would occur over the winter and may need to be periodically repeated. However, following a drawdown of 10 feet, the extensive wetlands bordering the lake along the western and southern shores could slump off into the lake bed and further contribute to floating bog problems. The draining of these wetlands by the drawdown could also have adverse ecological effects on these wetland communities.

Dredging and covering the bottom sediment with sand could be useful on a limited scale to eliminate excessive macrophyte growths in localized areas, such as swimming areas or boat access sites, as shown on Map 20. Dredging with a hydraulic dredge would cost about $3.00 per cubic yard of bottom sediment removed, or about $22,500 to dredge an average of two feet in depth within 60 feet of shore along 1,600 feet of the eastern shore. Prior to actual dredging, the effect of the arsenic residue (from historical sodium arsenite applications) on groundwater quality at the disposal sites would need to be investigated. Because of the small amount of arsenic applied, this factor should not, however, constitute a significant problem at the disposal sites. For areas not dredged which do experience excessive macrophyte growths, sediment covering could be used to provide a bottom substrate less suitable for macrophyte growth and less likely to release phosphorus to the water. Sediment covering would cost about $2,000 per acre, or about $42,000 for the area totaling 21 acres shown on Map 20.

Nutrient Inactivation

The purpose of nutrient inactivation is to 1) change the form of a nutrient to make it unavailable to plants; 2) remove the nutrient from the photic (light-penetrated) zone; and 3) prevent the release or recycling of potentially available nutrients from the lake sediments. Nutrient inactivation of phosphorus, which is usually accomplished by application of aluminum or another metallic salt, can be conducted for the entire lake if nutrients from the epilimnion as well as the hypolimnion are to be removed, or for just the hypolimnion if nutrients from the hypolimnion only are to be removed. Nutrient inactivation is most applicable to lakes which have long hydraulic residence times or in which recycling of phosphorus from the bottom sediments is significant. The hydraulic residence time of Ashippun Lake is relatively long, about 2.3 years, but there is no indication that the amounts of phosphorus being released from the bottom sediments are having significant water quality effects. However, nutrient inactivation may be an effective technique if combined with watershed management practices to reduce external phosphorus loads to the lake. The application of nutrient inactivation to the entire lake would cost about $9,000; application to the hypolimnion would only cost about $4,000. The treatment could need to be repeated periodically.

Dilution/Flushing

Dilution/flushing is intended to alleviate excessive algal growths and associated problems by reducing nutrient levels within a lake through the replacement of nutrient-rich waters with nutrient-poor waters, thereby flushing out phytoplankton and the nutrients contained therein. Lake restoration projects have attempted nutrient dilution by two procedures: 1) pumping water out of the lake, thus permitting the increased inflow of nutrient-poor groundwater; and 2) routing additional quantities of nutrient-poor surface waters into the lake. Dilution/flushing is most applicable for lakes which have very long hydraulic residence times, so that significant natural flushing does not occur, or where the lake has received excessive pollutant loadings which have resulted in a very eutrophic condition. In the latter case, once the pollution source has been removed, dilution/flushing may be effective in reducing the time of water quality improvement in the lake. Ashippun Lake is not a very eutrophic lake and does not have an excessive hydraulic residence time. Therefore, dilution/flushing would not be expected to result in a significant increase in water quality conditions in the lake.

Selective Discharge

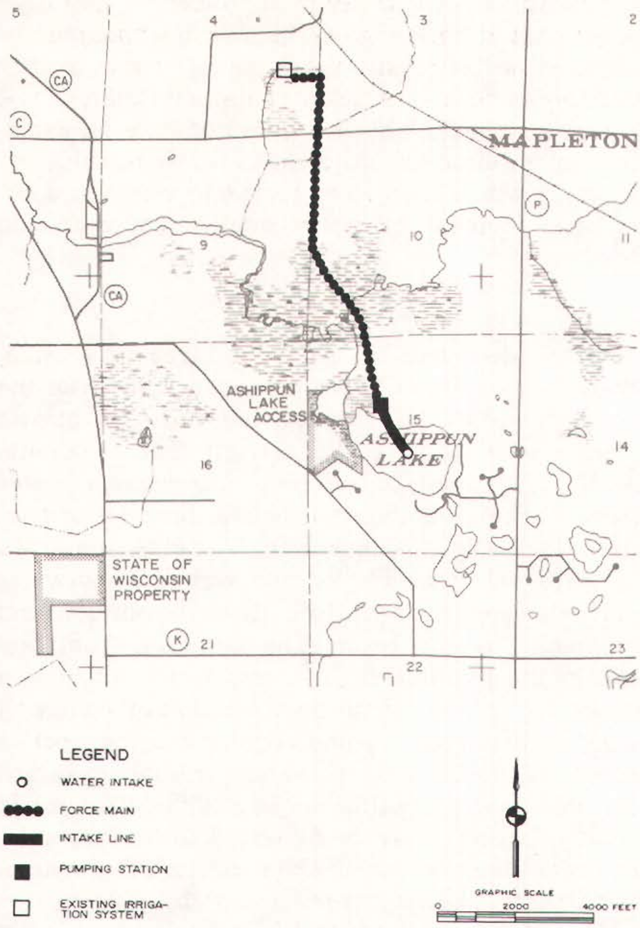
Selective discharge has been employed to substantially improve the dissolved oxygen levels near the bottom and/or to increase the nutrient output from a lake by up to 25 percent. This technique involves releasing anaerobic, nutrient-rich water from the hypolimnion during summer stratification. Typically, the technique is readily employed in lakes with suitable outlet controls, but water may also be pumped from the hypolimnion and discharged downstream. The pumping from one site in the hypolimnion, at the equivalent of two times the volume of the hypolimnion of Ashippun Lake each summer, would require a capital cost of about $240,000 and an average annual operation and maintenance cost of about $20,000. The water quality impacts may be expected to be favorable. In order to avoid causing the adverse effects associated with discharging nutrient-rich, oxygen-poor water into the Ashippun River, the cost assumes discharge to a suitable nearby agricultural irrigation system for surface discharge of the water, as depicted on Map 21. If an irrigation system closer to the lake could be developed, the cost of the project could be substantially reduced. Prior to discharge via the irrigation system, it would be necessary to determine the degree to which the arsenic residues (from historical applications of sodium arsenite for macrophyte control) are released to the lake water during anaerobic conditions, and what effect this arsenic would have on the irrigated vegetation and the underlying groundwater quality.

Aquatic Plant Harvesting

The macrophyte harvesting practices conducted in the past on Ashippun Lake could be reinstituted to provide desired open water areas. Upon implementation of the nonpoint source controls in the watershed, macrophyte growths can be expected to either remain stable or perhaps even decrease in the future. A new harvester suitable for Ashippun Lake

Map 21

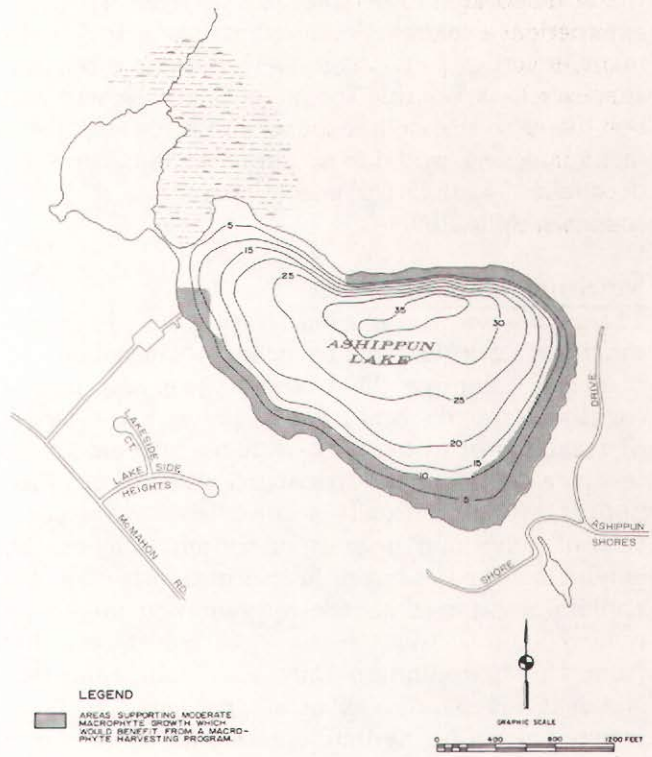
PLAN ALTERNATIVE FOR SELECTED DISCHARGE SYSTEM FOR ASHIPPUN LAKE



Source: *SEWRPC.*

Map 22

PLAN ALTERNATIVE FOR MACROPHYTE HARVESTING FOR ASHIPPUN LAKE



Source: *SEWRPC.*

would cost about $15,000. The annual operation and maintenance cost of a macrophyte harvesting program would be about $3,000. This cost assumes that someone is hired to operate the harvesting equipment. The collected macrophytes would be manually moved from the harvester to either the shore or to a disposal truck. The macrophytes could be disposed of on gardens, fields, or in a dump or landfill. The estimated cost does not include disposal of the macrophytes. As an alternative, a private contractor could be hired to harvest the macrophytes. Costs for harvesting by a contractor would typically be about $150 to $200 per acre harvested, or about $6,900 to $9,200 per year to harvest the area designated on Map 22 twice per year. Normally, these costs would include disposal of the harvested macrophytes. Harvesting about 25 tons of macrophytes per year from the area totaling 23 acres shown on Map 22 would remove about 30 pounds of phosphorus from the lake. Because macrophytes utilize nutrients from the bottom sediments, it is unlikely that all of this phosphorus would contribute to the water quality problems of the lake except the support of the macrophytes themselves. It may be expected, however, that a continuing macrophyte harvesting program would eventually result in a decrease in the accumulation of nutrient- and organically-rich bottom sediments. Such a program as described could be viewed as an intensive, "maximum" use of harvesting techniques; the lake district may determine that fewer acres actually need control of macrophytes.

Algae harvesting has seldom been used for large-scale in-lake applications. The only practical system developed involves filtration of the lake water through a screen system such as a microstrainer.

A pump and microstrainer system designed to treat about one-half of the lake water each summer would require a capital cost of about $80,000 with an annual operation and maintenance cost of about $4,000. In addition to providing aesthetic improvements, harvesting of the algae at this rate could remove an estimated 40 pounds of phosphorus from the lake annually.

Chemical Control of Algae and Macrophytes

Chemical control of algae and macrophytes is currently practiced in Ashippun Lake. Because of the adverse effects of chemical control of aquatic plant growth noted in Chapter VI, chemical control is not recommended, unless other practices—such as harvesting, sediment covering, dredging, or land management practices intended to reduce nutrient levels—prove to be impractical or ineffective. All chemical treatment programs require a permit from the Wisconsin Department of Natural Resources; and treatment of areas over one acre in size requires supervision by DNR staff. Chemical control of both algae and macrophytes at the existing application levels, which treats about six acres each year, involves a cost of about $1,100 per year.

Fish Management

An excellent, well-balanced fish community has been established in Ashippun Lake. Alternative future management efforts identified by the Commission staff in cooperation with the Wisconsin Department of Natural Resources include:

1. Purchase of additional marshland along the western and southern shoreline by the lake district or the Wisconsin Department of Natural Resources (DNR) to preserve the best remaining fish habitat and spawning areas in the lake.

2. Additional stocking of northern pike by the DNR, to maintain or enhance the northern pike population and provide continued game fish resources. Future stocking should be based on the results of fish surveys which evaluate the success of natural reproduction.

3. Stocking of walleye by the DNR to compensate for poor walleye reproduction and to provide additional game fish resources. Walleye stocking could provide improved ice fishing on the lake. However, because walleye compete with largemouth bass for food supplies, the stocking of walleye could adversely affect the native largemouth bass population in the lake.

4. Development of a periodic fish surveillance and management program for Ashippun Lake by the DNR, including a specific schedule for periodic fishery surveys.

5. Conduct a creel census (a survey of sport fishing) by the DNR to determine the composition of the angler catch and the numbers of each species harvested. This information could be correlated to the relative abundance of each species to determine if over-harvesting is taking place.

Shoreline Erosion Control

Shoreline erosion on Ashippun Lake is evident along nearly the entire developed eastern shoreline and along other scattered locations around the lake. This erosion not only interferes with shoreline activities such as swimming, but also results in the retreat of land by sloughing into the lake—as much as one foot per year in some areas, and in the deposition of sediment and nutrients into the lake itself, which contributes to the formation of lake bottom sediments suitable for supporting excessive aquatic plant growth. The shoreline erosion occurring on the eastern shoreline is attributed to the following factors:

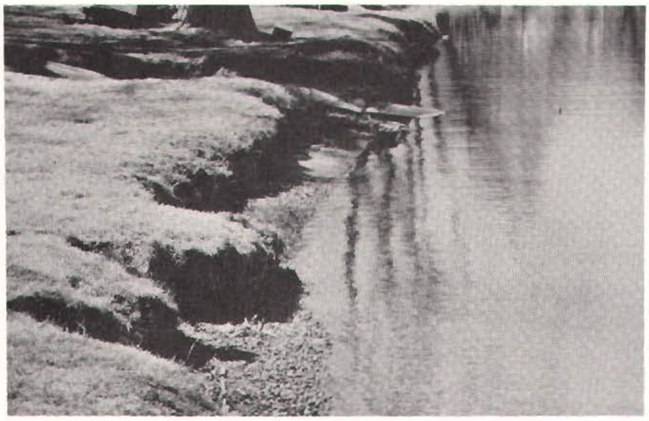
1. Maintenance of lawns to the lake edge has probably increased the rate of shoreline erosion (see Figure 23). The shallow root system of lawn grass fails to sufficiently bind the soil in place and allows undercutting and the filtering of sediment particles through the unstable shore slopes. The lack of vegetation on the water line serves as an indication of active erosion.

2. Wave action is the primary direct cause of shoreline erosion when the lake is not ice-covered. Shoreline erosion by wave action is most evident along the eastern shoreline of lakes in the middle latitudes because of prevailing westerly winds. Under a steady westerly wind of about 20 miles per hour, waves on the eastern shore of Ashippun Lake may be expected to reach a height of about 0.6 foot. Under a steady westerly wind of about 32 miles per hour, waves may be expected to reach a height of about 1.0 foot. The waves undercut the exposed shoreline slopes, resulting in sloughing of the shore land into the lake.

3. High lake levels, caused by fluctuations in the groundwater table, runoff events, and periodic inflow from the Ashippun River,

Figure 23

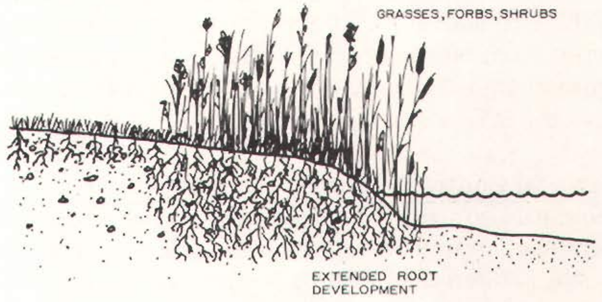
TYPICAL EASTERN SHORELINE OF ASHIPPUN LAKE



Source: SEWRPC.

Figure 24

PLAN ALTERNATIVE FOR SHORELINE EROSION CONTROL: VEGETATIVE BUFFER STRIP



Source: SEWRPC.

may increase shoreline erosion by exposing normally high areas to direct wave action and by saturating normally unsaturated shoreline soils, thereby reducing the adhesiveness of the soil particles.

4. Ice action may be the single most important cause of shoreline erosion on Ashippun Lake. Ashippun Lake is normally ice covered from about early December to early April. Under high lake level elevation conditions, freeze-thaw phenomena may weaken submerged shore slopes. During spring breakup, wind-blown floating ice blocks and fragments can scour the shoreline. During ice cover, thermal expansion of the ice may force a layer of ice up on the shore. These ice-related activities physically scour the shoreline and prevent the establishment of a stable vegetative cover.

Four alternative shoreline erosion control techniques are discussed below: vegetative buffer strips, rock revetments (riprap), wood bulkheads, and gabions. Numerous other techniques, including steel pile bulkheads, concrete walls, and flexible, sand-filled tubes, are also available, but are substantially more costly. The four alternatives considered were selected because they are relatively low-cost measures, because they can be constructed, at least partially, by local lake residents; because most construction materials (i.e. rock, sand, wood) are readily available; because the technique would, in most cases, enable the continued use of the immediate shoreline; and because the measures are visually "natural" or "semi-natural" and should not significantly affect the aesthetic qualities of the lake shoreline. The cost estimates presented below are for the control of about 1,800 feet of eroded shoreline.

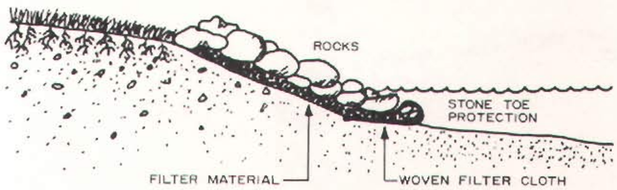
Vegetative Buffer Strips: The simplest, least costly, and most natural method of attempting shoreline erosion control is the provision of a vegetative buffer strip immediately adjacent to the lake (Figure 24). This technique is accomplished by encouraging natural vegetation rather than maintaining lawns within about five feet of the lake shore or by encouraging establishment of emergent aquatic vegetation two to six feet lakeward of the eroding shoreline. Aquatic species such as cat-tails (Typha spp.) and common reed (Phragmites communis), may be suitable in the littoral areas along the eroding eastern shore. Taller grasses invaded initially by weeds, and later by other species of grasses, forbs, and shrubs would occur. Some transplanting or seeding with carefully chosen indigenous plant types could decrease the time period of this succession of plant species. Desired plant species which could be expected to invade the buffer strip or which could be planted include arrowhead (Sagittaria latifolia), cat-tail (Typha species), common reed, (Phragmites communis), water plantain (Alisma plantago aquatica), bur reed (Sparganium eurycarpum), and blue flag (Iris versicolor) in the wetter areas; and touch-me-not

(Impatiens biflora), elderberry (Sambucus canadensis), giant goldenrod (Solidago gigantea), marsh aster (Aster simplex), red stem aster (Aster puniceus), and white cedar (Thuja occidentalis) in the dryer areas. In addition, trees and shrubs such as silver maple (Acer saccharinum), American elm (Ulmus americana), black willow (Salix nigra), and red osier dogwood (Cornus stolonifera) could become established. These plants will develop a more extensive root system than the lawn grass and the above-ground portion of the plants will protect the soil against the erosive forces of rain drops and wave action. A narrow path to the lake could still be maintained in lawn to provide access to the lake for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the lake via direct overland flow. This alternative could involve only a minimal cost. However, there is some doubt as to whether a vegetative buffer strip would fully stabilize the eroding shoreline on Ashippun Lake. The poor stability of the soils, as well as the continuous erosive action of waves and, particularly, of ice, may preclude the establishment of a stable vegetative cover immediately adjacent to the lake.

Rock Revetments: Rock revetment, or riprap, is a highly effective method of shoreline erosion control applicable to many types of erosion problems, especially in areas of low banks and shallow water. The technique, as shown in Figure 25, involves the shaping of the shoreline slope, the placement of a porous filter material—such as sand, gravel, or pebbles—on the slope, and the placement of rocks on top of the filter material to protect the slope against the actions of waves and ice. The advantages of a rock revetment are that the structure is highly flexible and not weakened by slight movements caused by settling or ice expansion; it can be constructed in stages, often with the labor being done by the local residents; and it requires little or no maintenance. The disadvantages of a rock revetment are that it is often improperly constructed, which results in failure; it limits the use of the immediate shoreline in that the rough, irregular rock surfaces are unsuitable for walking; a large amount of filter material and rocks would need to be transported to the lake shore; and excavation and shaping of the shore slope would cause temporary disruptions and contribute sediment to the lake. A rock revetment constructed along the entire 1,800 feet of eroding shoreline by a private contractor would involve a total capital cost of about $36,000, or about $20.00 per lineal foot. By providing labor and some materials, lake residents could reduce this cost by up to 50 percent.

Figure 25

PLAN ALTERNATIVE FOR SHORELINE EROSION CONTROL: ROCK REVETMENT

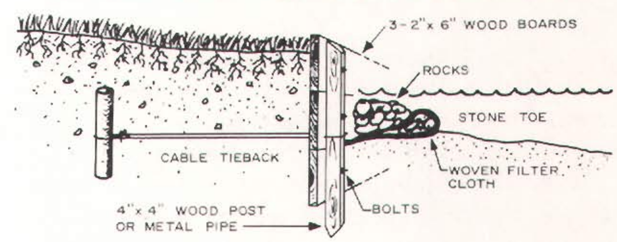


TOTAL COST: $36,000.00 COST PER LINEAL FOOT: $20.00

Source: SEWRPC.

Figure 26

PLAN ALTERNATIVE FOR SHORELINE EROSION CONTROL: WOODEN BULKHEAD



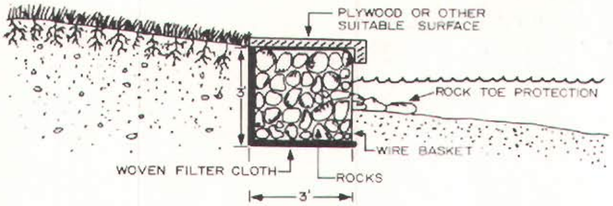
TOTAL COST: $11,000.00 COST PER LINEAL FOOT: $6.00

Source: SEWRPC.

Wooden Bulkhead: A wooden bulkhead, as shown in Figure 26, prevents the sliding of land or slope failure, and provides protection against wave action, and to a lesser extent ice action. A series of boards would be bolted to posts or pipes partially sunken into the soil at the water line. A stone toe would be provided on the lake-side to protect against undercutting. A sunken cable tieback to an anchored "deadman" would prevent the bulkhead from slipping towards the lake. Advantages of a wooden bulkhead are that it provides substantial protection and maintains the shoreline in a fixed position; it requires low maintenance; and the materials are readily available. Bulkheads may be considered less visually appealing than rock revetments by some; they are less flexible and more susceptible to ice damage; and repair of a bulkhead is considerably more difficult and expensive than repair of rock revetment. A wooden bulkhead for the entire eroding shoreline installed by a private contractor would involve a total capi-

Figure 27

PLAN ALTERNATIVE FOR SHORELINE EROSION CONTROL: GABIONS



TOTAL COST: $54,000.00 COST PER LINEAL FOOT: $30.00

Source: SEWRPC.

tal cost of about $11,000, or about $6.00 per lineal foot. As with rock revetments, the provision of labor and some materials by local residents could substantially reduce this cost.

Gabions: A gabion is simply a steel wire mesh basket filled with rocks. Gabions are commercially available in a variety of sizes and they are constructed and filled with rocks at the site of placement. A single gabion three feet high and sunken into the soil to about one-half its height could be expected to adequately protect the shoreline of Ashippun Lake, as shown in Figure 27. An underlying filter cloth would prevent pumping of finer sized particles which can cause excessive movement and severe settling of the gabion. A rock toe would be provided to prevent undercutting. The top surface of the gabion could be covered with plywood or other suitable surface to maximize the use of the shoreline. The advantages of gabions are that they are flexible and easily repaired, relatively easy to construct, and would be extremely effective against ice movement. Gabions often become covered with vegetation, which adds to their visual appeal. The disadvantages of gabions are their relatively high cost, the potential for the damage and breaking of the wire mesh, and the considerable excavation needed to implant the gabions. Gabions have been successfully used to control streambank erosion in southeastern Wisconsin. Gabions installed by a private contractor along the entire 1,800 feet of eroding shoreline would cost about $54,000, or about $30.00 per linear foot. If labor and some materials could be provided by local residents, this cost could also be substantially reduced.

Lake Water Level Control

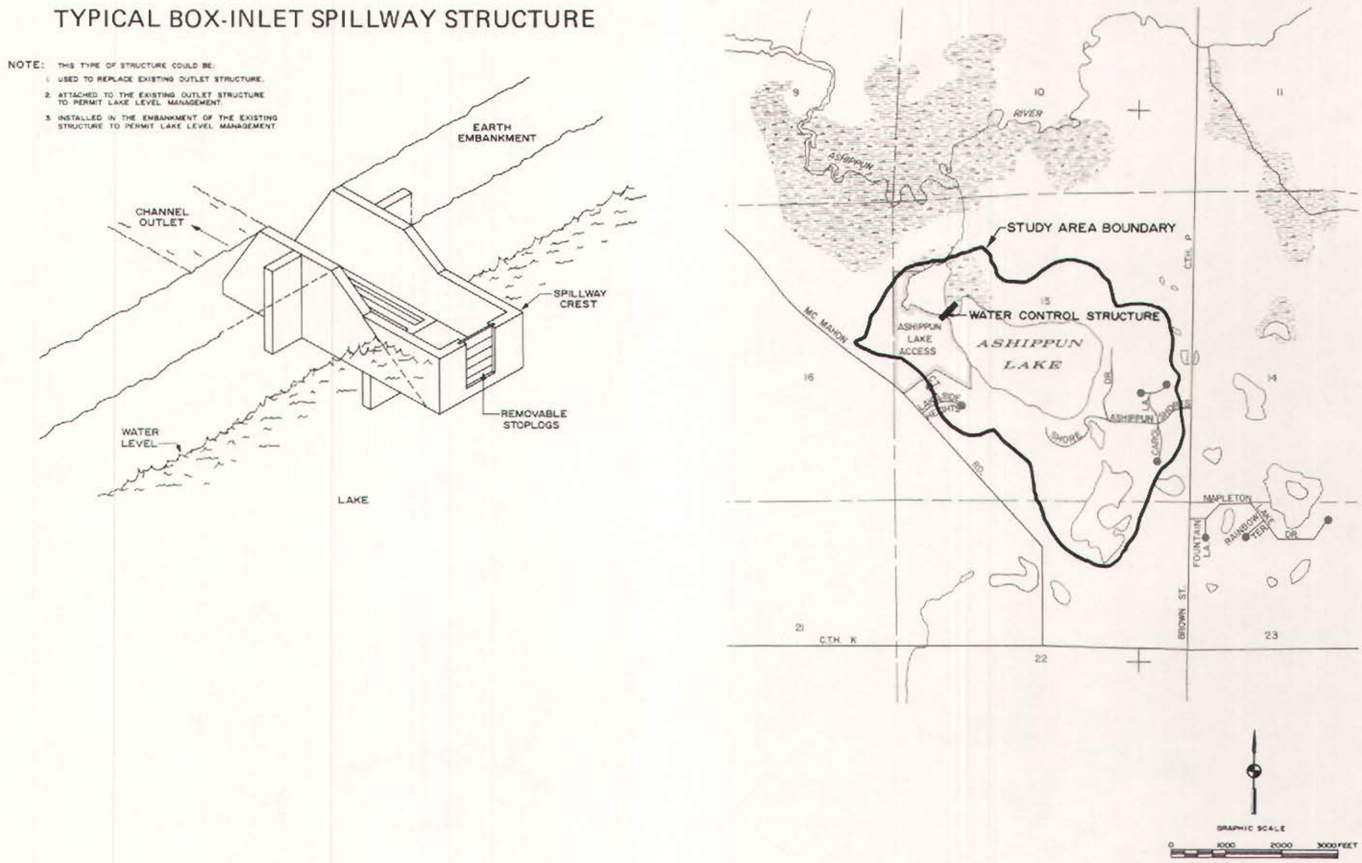
On the average, it is estimated that about 126 acre-feet of water each year, containing about 30 pounds of phosphorus, may be contributed to Ashippun Lake from the Ashippun River. Two alternatives could be identified which would alleviate this condition: alteration of the Monterey Dam; or the construction of a water control structure between the basin of Ashippun Lake and the small lake basin located immediately downstream.

Alteration of the Monterey Dam: During high flow periods, the Monterey Dam raises the level of the Ashippun River beyond that which would occur if the dam did not exist. This can be alleviated somewhat by permanently removing all the flashboards on the dam. This would reduce the Monterey Lake pool elevation by two feet to a maximum of about 865.2 feet National Geodetic Vertical Datum (NGVD) during normal flow periods and substantially increase the hydraulic conveyance capacity of the dam during high flow events. This would result in decreased flood stages on the Ashippun River near Ashippun Lake, thus reducing the amount of river flow into the lake. The flashboards would need to be removed only during high flow conditions, but because of the poor operating condition of the dam, as a practical matter, it would probably be necessary for the boards to be permanently removed or for the dam to be repaired. Permanent removal of the flashboards would entail no cost, but the depth of the Monterey impoundment would be reduced by two feet.

Water Control Structure: A water control structure could be constructed downstream of the main lake basin, as shown on Map 23. The structure could be operated to prevent flow of Ashippun River water, sediment, and nutrients into Ashippun Lake during high flow periods. Stop logs or flashboards would be inserted during high flow periods and removed after the river recedes. While this would impede river flow into the lake, the lake level still would rise during storm events because the lake outlet would block discharge of local surface water and groundwater entering the lake. This increase in elevation, however, would be less than the increase caused by backwater from the river. A water control structure would involve a total capital cost of about $2,500 assuming that no filling would be required on the isthmus between the two lake basins.

Map 23

PLAN ALTERNATIVE FOR WATER CONTROL STRUCTURE ON ASHIPPUN LAKE



Source: SEWRPC.

(This page intentionally left blank)

Chapter IX

RECOMMENDED PLAN

INTRODUCTION

This chapter, building on the land use, land and water management, biological and water quality inventory findings, pollution source analyses, land use and population forecasts, and alternative water quality management plan evaluations, presents a recommended management plan and its projected costs for Ashippun Lake. The plan sets forth the recommended means for: 1) providing water quality suitable for the maintenance of fish and other aquatic life; 2) controlling shoreline erosion; 3) reducing the severity of existing nuisance problems due to excessive weed growths which constrain or preclude intended water uses; and 4) improving opportunities for water-based recreational activities. The primary water-based recreational activities on the lake are fishing, swimming, and pleasure boating. An analysis of the status and condition of these recreational activities revealed that the lake supports a viable warm water fishery, but swimming opportunities are hampered to a certain extent by excessive shoreline erosion. Consequently, a portion of the recommended management plan and the alternatives are directed more toward improving swimming opportunities and to a lesser degree toward the maintenance and improvement of other uses. The development of plan recommendations was based upon an evaluation of many tangible and intangible factors bearing upon water pollution control—with primary emphasis, however, upon the degree to which the water use objectives are met, and upon the cost-effectiveness of recommended measures. The plan development process involved review of preliminary drafts of the recommended plan by the Ashippun Lake Protection and Rehabilitation District.[1]

---

[1] *Preliminary drafts submitted to Mr. Paul J. Ferr, Chairman; Mrs. Pauline Warzyn, Secretary; Mr. William Houle, Treasurer; Ronald Grace, Town of Oconomowoc Commissioner; and Roland L. Merz, Waukesha County Commissioner; Ashippun Lake Protection and Rehabilitation District.*

LAND USE

A fundamental and basic element of sound water quality management for Ashippun Lake is sound land use in the tributary watershed. The type and location of future urban and rural land uses in the watershed will determine to a large degree the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for various forms of land management; and ultimately, the water quality of the lake.

The basis for the land use recommendations set forth in this report is the adopted regional land use plan, as set forth in SEWRPC Planning Report No. 25, A Regional Land Use Plan and A Regional Transportation Plan for Southeastern Wisconsin: 2000. The regional land use plan recommends—as set forth in Map 11—that no significant additional urban land use development be encouraged to occur in the lake watershed through the year 2000.

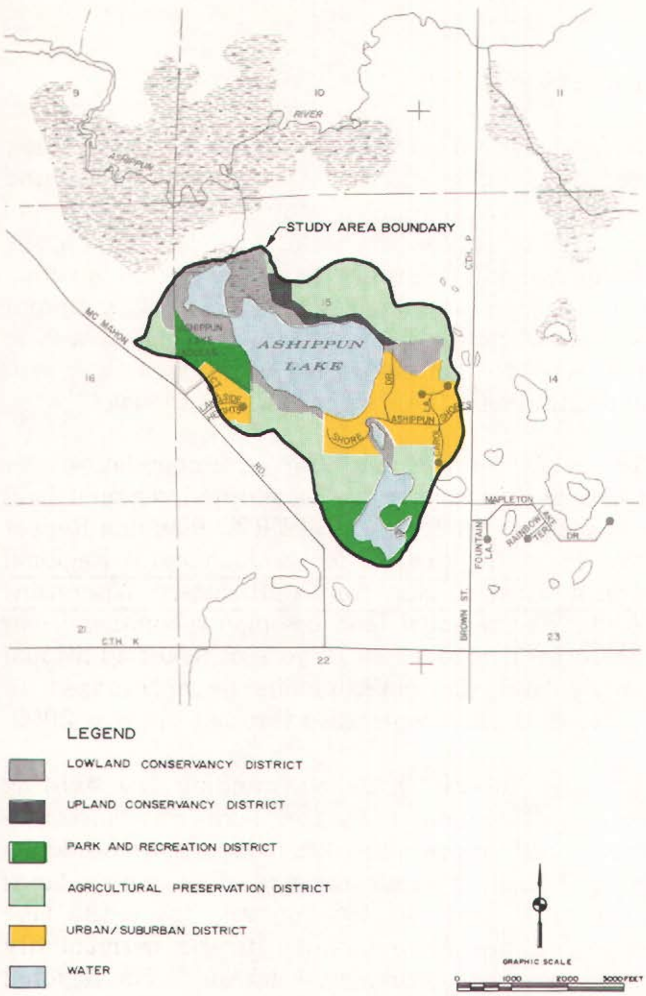
The agricultural lands surrounding the existing urban development in the lake watershed are designated prime agricultural land and should be preserved in agricultural use. The marsh lands north and south of the lake and the entire lake shoreline are recommended to be permanently preserved as environmental corridor. The regional land use plan can be an effective tool for water quality protection only if local action is taken to adopt and implement the plan. The Town of Oconomowoc and the County of Waukesha have authority for local land use planning in the Ashippun Lake watershed.

ZONING ORDINANCE MODIFICATIONS

As noted in Chapter V, an abundance of valuable natural resource base features are located within the Ashippun Lake watershed. In order for the existing zoning ordinance to be an effective tool for the preservation of these natural resource features, as recommended in the water quality management plan for Ashippun Lake, certain modifications to the ordinance are required. As previously noted, the Town Board, together with Waukesha County, should critically review the existing zoning ordinance and accompanying

Map 24

PROPOSED ZONING DISTRICTS FOR THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE



Source: SEWRPC.

zoning district map of the Town and amend and modify the ordinance and district map as necessary to better preserve and enhance the existing natural resource base of the Town. As a point of departure for such revisions, the following zoning districts should be considered for inclusion in any modification of the existing zoning ordinance and district map. The areas of land in the Ashippun drainage area to be placed in the proposed zoning districts are shown on Map 24, and are compared with existing zoning practices in Table 24.

Lowland Conservancy District

This district could be used to preserve, protect, and enhance the lakes, streams, and wetland areas of the Town. No new urban development would be permitted in this district. The existing County C-1 Conservancy District is adequate in this respect and can be used. It is proposed that 54 acres, or about 15 percent of the drainage area, be included in a Lowland Conservancy District.

Under the existing zoning ordinance administered within the direct drainage area, approximately 41 acres, or 76 percent, of the 54 acres are zoned conservancy; 6 acres, or 11 percent, are included in residential districts; 4 acres, or 7 percent, are included in agricultural districts; and the remaining 3 acres, or 6 percent, are included in public districts.

Upland Conservancy District

This district could be used to conserve and enhance the significant woodlands, related scenic areas, and marginal farmlands, while at the same time allowing for rural estate residential development that maintains the rural character of this portion of the Town. This district would provide for a minimum lot size of five acres and would place limits on the removal of natural vegetation and on the number of domestic animals permitted. An Upland Conservancy District should be included in the county zoning ordinance as a new zoning district. It is proposed that nine acres, or about 2 percent of the drainage area, be included in this new district. Under the existing zoning ordinance, the nine acres are currently included in an Agricultural District (A-1).

Agricultural Preservation District

This district could be used to preserve and enhance lands historically used for agricultural purposes. The zoning district provides for a minimum parcel size of 35 acres in order to preserve workable farm units, and prohibits further intrusion of urban land uses. Conditional agricultural and agricultural-related industrial uses, such as a cheese factory, food processing plant, or agricultural supply center, would be permitted in this district. This district would be included in the county zoning ordinance as a new zoning district. It is proposed that 146 acres, or about 39 percent of the drainage area, be included in this new district. Under the existing zoning ordinance administered within the direct drainage area, 71 acres, or 49 percent, are included in an agricultural district and 75 acres, or 51 percent, are included in residential districts.

Residential District

This district is used to preserve and protect residential areas within a physical environment that is healthy, safe, convenient, and attractive. The only

Table 24

SUMMARY OF PROPOSED ZONING MODIFICATIONS IN THE DRAINAGE AREA DIRECTLY TRIBUTARY TO ASHIPPUN LAKE: 1979

Proposed Zoning Districts	Existing Zoning Classifications (acres)				Total Acres	Percent of Direct Drainage Area
	General Conservancy (C-1)	Agricultural (A-1)	Residential (R-1)	Public (P-1)		
Lowland Conservancy	41	4	6	3	54	14.6
Upland Conservancy	- -	9	- -	- -	9	2.4
Agricultural Preservation District	- -	71	75	- -	146	39.3
Residential District	- -	- -	83	- -	83	22.4
Park and Recreation District	- -	- -	- -	37	37	10.0
Total	41	84	164	40	371[a]	100[a]

[a] *Includes 42 acres of open water, or 11.3 percent, of the drainage area directly tributary to Ashippun Lake.*

Source: SEWRPC.

residential district applied within the Ashippun Lake watershed is the R-2 Residential District, which provides for single-family residences with a minimum lot size of 30,000 square feet. It is proposed that 83 acres, or about 22 percent of the direct drainage area, be included in this new district. Under the existing zoning ordinance administered within the direct drainage area, the 83 acres are currently zoned residential (R-2).

Park and Recreation District

This district could be used to properly zone existing recreation land uses in the direct drainage area and to protect them from possible encroachment by other less desirable or incompatible land uses. This category would prohibit the conversion of a private recreational site to urban or other incompatible uses without Town and County approval. This district would be included in the county zoning ordinance as a new zoning district and would necessitate the modification of the P-1 Public District presently included in the existing ordinance. Thus, only existing and proposed public and private park and outdoor recreation sites would be placed in the park and recreation district, while governmental and institutional land uses in the Town could be retained in the existing P-1 Public District. It is proposed that 37 acres, or 10 percent of the direct drainage area be included in this new district. Under the existing zoning ordinance administered within the direct drainage area, the 37 acres are currently zoned in public districts (P-1).

NONPOINT SOURCE POLLUTION CONTROL AND LAKE MANAGEMENT

The water quality management plan for Ashippun Lake must address methods for reducing the nutrient loading to the lake from nonpoint sources, and techniques for lake rehabilitation. As described below, the implementation of nonpoint source controls and in-lake management measures requires urban nonpoint source control practices, agricultural land management practices, increased regulation of some land management activities, and technical and financial assistance from state and federal units of government.

Ashippun Lake Protection and Rehabilitation District

It is recommended that the Ashippun Lake Protection and Rehabilitation District formed under the provisions of Chapter 33, Wisconsin Statutes, serve as the lead agency in the continued study and management of Ashippun Lake. In addition to its important role in the implementation of specific management measures, it is recommended that the district coordinate the plan implementation activities of local and state agencies and private citizens.

It is also recommended that the lake district conduct a continuing in-lake quality sampling program to assess the effects of implemented lake management measures. This sampling program would consist at least of measurements of soluble phosphorus, total phosphorus, nitrite- and nitrate-nitrogen, ammonia nitrogen, organic nitrogen, chorophyll-a, and water clarity and the development of tempera-

Table 25

LOCAL GOVERNMENTAL MANAGEMENT AGENCIES AND RESPONSIBILITIES FOR URBAN NONPOINT SOURCE WATER POLLUTION CONTROL

Urban Nonpoint Source Management Agency	Local Land Use Planning	Undertake Septic System Management Program	Review Public Works Maintenance Practices	Conduct Educational and Informational Program	Provide Technical Assistance	Provide Fiscal Support to Soil and Water Conservation District
Waukesha County.	X	--	--	X	--	X
Waukesha County Board of Health . .	--	X	--	X	--	--
Waukesha County Soil and Water Conservation District	--	--	--	--	X	--
Ashippun Lake Protection and Rehabilitation District	--	--	X	X	--	--

Source: SEWRPC.

ture and dissolved oxygen profiles at least twice during the summer and once each spring turnover. These data should be obtained at the deepest point in the lake. Lake freeze-up and thaw dates, as well as snow cover conditions should be recorded annually. Such a data collection program would have an estimated cost of about $300 per year. Surveys of fish, macrophytes, algae, and other biota should be conducted periodically by or with the technical assistance of the Wisconsin Department of Natural Resources.

Urban Nonpoint Source Pollution Controls

The implementation of nonpoint source controls in urban areas requires the efforts of Waukesha County, the Waukesha County Board of Health, the Waukesha County Soil and Water Conservation District, and the Ashippun Lake Protection and Rehabilitation District. The recommended responsibilities of each of these governmental agencies—consistent with their legal authorities under existing state and federal laws—are summarized in Table 25.

Septic Tank System Management Program: The basic objective of a septic tank system management program would be to ensure the proper installation, operation, and maintenance of existing septic tank systems, and of any such new systems that may be required to serve existing urban development in the Ashippun Lake drainage area.

A septic tank system management program is recommended to consist of at least the following actions:

1. The revision and expansion of the Waukesha County Sanitary Ordinance to include regulation of the operation and maintenance of onsite sewage disposal systems, including septic tanks, holding tanks, and "mound" systems or other systems approved by the applicable State regulations.

2. The establishment through such sanitary ordinances of a regular program of inspection of onsite sewage disposal systems. Such a program would include an in the field visual inspection of each onsite sewage disposal system by trained individuals. The purpose of the inspection would be to identify any malfunctioning sewage disposal systems. Such an inspection program could extend to the testing of individual systems through the injection of dye, particularly in those cases where onsite systems are suspected of discharging directly to the lake. It is envisioned that each system would be inspected once every five years, and that the Waukesha County Board of Health would thereby inspect one-fifth of all such systems annually. The inspection program would result, as necessary, in the issuance of orders to abate improper practices and take appropriate corrective measures.

3. The conduct of an educational program whereby homeowners would be advised of the rules and regulations governing onsite sewage disposal systems and be encouraged to undertake preventive maintenance measures.

Development and Implementation of Detailed Urban Land Management Practices: The design of urban nonpoint source pollution abatement practices should be a highly localized, detailed, and individualized effort requiring, as it does, highly specific knowledge of the physical, managerial, social, and fiscal considerations that affect the local landowners concerned. Accordingly, it is recommended that the Ashippun Lake Protection and Rehabilitation District work with property owners to develop the land management practices recommended herein, for an approximate 25 percent reduction in urban nonpoint source pollution.

It is recommended that the lake district identify the specific sources of nonpoint source pollution within the urban areas of the direct drainage area, and develop programs to implement measures to control these specific sources. Specifically, it is recommended that the lake district inventory and assess the existing land management practices, determine the extent and location of the problem areas, define and recommend applicable pollution control measures, estimate the effectiveness and costs of these control measures, and develop a program for implementing and financing the recommended control measures. It is recommended that urban nonpoint source control measures implemented in the Ashippun Lake drainage area include a public education program to provide information on the relationship of land management practices to water quality; the proper collection and disposal of leaves, grass clippings, and other vegetative debris; the proper use of fertilizers, pesticides, and other lawn care measures; the appropriate management of near-shore areas; the adequate maintenance of storm water drainage ditches; the proper disposal of litter and pet wastes; and other measures as locally identified. It is recommended that an identification of specific residential land management practices beneficial to water quality be prepared and distributed to property owners with the assistance of the University of Wisconsin-Extension Service. It is further recommended that the Lake District seek technical assistance in the preparation and implementation of the detailed practices from the Waukesha County Soil and Water Conservation District, and seek further assistance in the form of public educational and information programs from the Waukesha County office of the University of Wisconsin-Extension Service.

Rural Nonpoint Source Pollution Controls

The implementation of nonpoint source pollution controls in rural areas requires the efforts of the Ashippun Lake Protection and Rehabilitation District, Waukesha County, and the Waukesha County Soil and Water Conservation District. The recommended responsibilities of each governmental agency are set forth in Table 26.

Like urban nonpoint source pollution abatement practices, the design of rural nonpoint source pollution abatement practices should be a highly localized, detailed, and individualized effort as it requires highly specific knowledge of the physical, managerial, social, and fiscal considerations that particularly affect the farmers and rural landowners concerned.

Accordingly, it is recommended that the County Soil and Water Conservation District in cooperation with the Lake Protection and Rehabilitation District undertake the design of detailed practices for rural land conservation on each farm in the watershed. It is recommended that the lake district be the lead agency in the preparation of such detailed practices, and, as such, formally request that the soil and water conservation district conduct a detailed assessment of the potential for agricultural nonpoint source pollution in the lake watershed including estimates of soil loss, and recommend specific abatement measures for each identified source. It is also recommended that the cost and effectiveness of each practice be estimated. Agricultural nonpoint source abatement measures which may be appropriate for use in the Ashippun Lake watershed include crop rotation, conservation tillage, grassed waterways, diversions, terraces, contour strip-cropping, and livestock fencing. It is envisioned that the Lake Protection and Rehabilitation District would—through an intergovernmental memorandum of understanding—cooperate with the County Soil and Water Conservation District in the necessary detailed planning.

Following the selection of detailed practices for the abatement of nonpoint source pollution in rural areas, it is recommended that the management agencies take appropriate steps to install the practices. This would include the establishment of public educational programs by the Lake District in cooperation with the University of Wisconsin-Extension Service, continued work with the farm operators, and the undertaking of actions to protect critical areas from erosion. It is further recommended that the Waukesha County Soil and Water Conservation District provide all necessary technical assistance in installing the practices.

Table 26

LOCAL GOVERNMENTAL MANAGEMENT AGENCIES AND RESPONSIBILITIES FOR RURAL NONPOINT SOURCE WATER POLLUTION CONTROL

Rural Nonpoint Source Management Agency	Local Land Use Planning	Develop and Implement Detailed Plan for Rural Practices	Conduct Educational and Informational Program	Provide Technical Assistance	Provide Fiscal Support to Soil and Water Conservation District
Waukesha County	X	--	X	--	X
Waukesha County Soil and Water Conservation District	--	X	--	X	--
Ashippun Lake Protection and Rehabilitation District	--	X	X	--	X

Source: SEWRPC.

LAKE REHABILITATION TECHNIQUES

The selection of lake rehabilitation techniques must consider local circumstances and lake management objectives. The implementation of lake rehabilitation techniques is best carried out by the proposed Ashippun Lake Protection and Rehabilitation District. Additional technical assistance from the Wisconsin Department of Natural Resources, Office of Inland Lake Renewal, will be required prior to actual implementation of a rehabilitation technique.

To control excessive growth of macrophytes in Ashippun Lake and to provide improved opportunities for recreational use improvement, it is recommended that the Ashippun Lake Protection and Rehabilitation District implement a macrophyte harvesting program. It is recommended that the area shown on Map 22 be harvested with a mechanical weed harvester about two or three times per year initially. In future years, the area to be harvested and schedule of harvesting can be better defined to provide the most cost-effective use of a harvester. A relatively small harvester, which would be suitable for Ashippun Lake, could cut one to two acres per day and up to five feet deep. The benefits of macrophyte harvesting are that it is a reasonably economical practice, approximating the annual cost of herbicide usage; it removes plant material and nutrients from the lake; it is effective against existing problem species in Ashippun Lake such as water milfoil; and it is a highly flexible practice, in that control efforts can be directed to the most severe problem areas at any specific time. Harvesting would not significantly interfere with the recreational use of the lake, and, if properly used, would not damage fish spawning areas. The harvesting operations and collection and disposal of the removed plant material would have a significant labor requirement.

It is recommended that shoreline erosion along the eastern shore be controlled by the construction of a rock revetment—or riprap. This technique is a very effective means of shoreline erosion control and would provide an adequate barrier to shoreline damage from both wave- and ice-action. Aesthetically, a properly designed rock revetment, as depicted in Figure 24, could maintain the "natural" shore appearance of Ashippun Lake. It is recommended that smooth, rounded rocks be used in the construction of the revetment to maximize access to shallow water areas for swimming. Because there are only scattered sand bottom substrates, swimming is limited in Ashippun Lake. It is important that this project be undertaken along the entire area where erosion problems exist—principally the developed segment of the eastern shore—to provide consistency in the protection and stability of the shoreline. Separately designed and constructed shoreline erosion control projects by individual landowners would not be as effective or as visually pleasing.

Other types of structural shoreline protection measures, such as concrete grass pavers, would also be suitable and could be considered when evaluating local costs and property owner preferences.

A vegetative buffer strip or a wood bulkhead may not provide sufficient protection against ice-action on the shoreline. They are therefore not recommended. Gabions would technically provide sufficient protection against both wave- and ice-action but are more expensive to construct than a rock revetment and, if damaged, are more difficult and expensive to repair.

Lake water level control—either by altering the Monterey Dam or by installing a water control structure at the lake outlet—is not recommended. Control of inflow to the lake from the Ashippun River would not significantly reduce ice damage to the shoreline; and the shoreline protection measures (rock revetment) recommended to protect against ice damage would also provide sufficient protection against wave action to the extent it is accelerated by higher lake levels induced by the high streamflow events on the River. The phosphorus load contributed to the lake via inflow from the Ashippun River accounts for about 16 percent of the existing total phosphorus load. This phosphorus load contributed from the Ashippun River is not expected to preclude the achievement of the recommended water quality standards.

To manage the fishery resources in Ashippun Lake, it is recommended that the Wisconsin Department of Natural Resources consider purchasing additional wetlands contiguous to existing State-owned land. The Department fish manager should identify the highest quality habitat and spawning areas to be protected. The Wisconsin Department of Natural Resources can more effectively protect and manage these areas than can the Lake District. It is recommended that the Department continue in the management of the northern pike fishery, including stocking as necessary. It is recommended that the Department conduct a creel census to evaluate the angler catch and determine if over-harvesting of some species is occurring. It is also recommended that the Department establish a periodic fish surveillance and sampling program for Ashippun Lake. Under such a program, whereby a specific schedule for periodic fishery surveys would be established, the Department would be able to assess and evaluate long-term trends in the total fishery resource of the lake, not just a specific game fish species. The stocking of walleye in Ashippun Lake to improve the game fish resources is not recommended due to potentially adverse effects on the largemouth bass population. The primary reason that carp have not reached excessive numbers in Ashippun Lake is probably that the balanced populations of game fish are effective predators on the carp fry. The continued management of the fishery resources and the maintenance of the balanced game fish populations will ensure that carp populations are controlled in the future.

Hypolimnetic aeration is not recommended for Ashippun Lake at this time. The water quality problems which hypolimnetic aeration alleviates—an anaerobic hypolimnion, nutrient release from bottom sediments, and excessive algae growths—have not been identified as severe water quality problems affecting the beneficial use of Ashippun Lake. Therefore while hypolimnetic aeration is generally applicable to Ashippun Lake, the existing water quality problems do not appear to warrant its application.

Other methods of controlling excessive aquatic macrophyte growths, such as dredging, sediment covering, and drawdown, are technically feasible for Ashippun Lake. However, these techniques are not recommended because, while they have substantially higher costs than harvesting, they are not expected to provide substantial additional water quality or water use benefits. The benefits of covering the sediments with plastic sheeting, sand, or other suitable material could be short-lived if additional organic matter is deposited upon these new sediments. Dredging would be effective only where the depth of dredging exceeded the depth of light penetration. Hence, the near-shore areas would not exhibit a substantial reduction in macrophytes. In most areas, the substrate exposed by dredging would not be less suitable for continued macrophyte growth; reportedly only a few scattered sand areas are located along the eastern shore. Drawdown, while consolidating the sediments and providing a slight increase in depth, would not, in itself, be expected to provide the level of macrophyte control achieved by a properly operated harvesting program. Furthermore, the lake would require more than one year to refill to normal levels following drawdown and additional slumping of the wetland shores could occur.

Nutrient inactivation and selective discharge are not recommended because, while reducing the nutrient levels in the water, these techniques would not significantly reduce aquatic macrophyte levels in the lake. However, if, upon the control of macrophytes, algae blooms become more severe due to reduced competition for nutrients and light, nutrient inactivation should be reconsidered as a means of reducing this algae growth.

Table 27

ESTIMATED COST OF RECOMMENDED WATER QUALITY AND LAKE MANAGEMENT MEASURES FOR ASHIPPUN LAKE

Water Quality or Lake Management Measure[b]	Capital[a]		Average Annual Operation and Maintenance[a]		Total Average Annual[a]	
	Total	Local Public Sector	Total	Local Public Sector	Total	Local Public Sector
Septic Tank System Management[c] . . .	$ --	$ --	$ --	$ --	$ --	$ --
Rural Land Management	100	--	500	--	500	--
Urban Land Management	100	100	100	100	100	100
Watershed Management Subtotal	200	100	600	100	600	100
Aquatic Macrophyte Harvesting[d]	30,000	30,000	3,000	3,000	4,400	4,400
Rock Revetment (riprap)[e]	36,000	14,400	100	100	1,700	700
Fish Management[f]	--	--	--	--	--	--
Water Quality Sampling Program	--	--	300	300	300	300
In-Lake Management Subtotal	66,000	44,400	3,400	3,400	6,400	5,400
Total	$66,200	$44,500	$4,000	$3,500	$7,000	$5,500

[a] *All costs expressed in January 1980 dollars.*

[b] *Land use plan element costs are not presented.*

[c] *The proper maintenance and replacement of the remaining septic tank systems is recommended to help improve the water quality of Ashippun Lake. However, because septic tank systems management is an existing function necessary for the preservation of public health and the maintenance of drinking water supplies, this cost is not included in the water quality management plan. The estimated expenditures for septic system management in the Ashippun Lake drainage basin include a capital cost over the period of 1980-2000 of $112,500, an average annual operation and maintenance cost of $2,400 and a total average annual cost of $7,800.*

[d] *It was assumed that a harvester suitable for Ashippun Lake would cost about $15,000 and have an average life of 10 years. Therefore, two harvesters would need to be purchased during the 20-year plan period.*

[e] *It was assumed that 60 percent of the capital costs for rock revetment would be provided by state and federal funds under the Wisconsin inland lake protection and rehabilitation program.*

[f] *Costs for fish management will be borne by the Wisconsin Department of Natural Resources.*

Source: SEWRPC.

Because of the environmental hazards and unknown ecological consequences of the use of chemicals to control algae and aquatic macrophytes, the application of this practice is not recommended for Ashippun Lake. Furthermore, the deposit of the dead plant material upon the lake bottom releases additional nutrients to the water and only serves to further contribute to the build-up of organic matter with associated macrophyte growth and reduced depth conditions. The use of chemicals is recommended only as a last resort when other plant management alternatives are not feasible. For Ashippun Lake, there are environmentally sound alternative methods of aquatic plant control which are feasible and cost-effective.

Cost Analysis

Generalized cost estimates—in 1980 dollars—for recommended nonpoint source controls in the Ashippun Lake watershed and in-lake management techniques are set forth in Table 27. Most of the watershed management cost is associated with soil conservation practices on rural land. The in-lake management costs range from a total average annual

Table 28

AVAILABLE STATE AND FEDERAL COST-SHARING FOR IMPLEMENTATION OF THE RECOMMENDED ASHIPPUN LAKE WATER QUALITY MANAGEMENT PLAN

Water Quality or Lake Management Measure	Estimated Total Cost 1980-2000		Anticipated Percent State or Federal Cost Share	State or Federal Cost-Share Program
	Capital	Annual Operation and Maintenance		
Rural Land Management Practices[a]	$ 100	$ 500	50-75 percent of capital cost, none for operation and maintenance	Federal Agricultural Conservation Program (ACP) administered by the USDA Agricultural Stabilization and Conservation Service (ASCS) and the Soil Conservation Service (SCS)
Urban Land Management Practices[a]	100	100	None	- -
Aquatic Macrophyte Harvesting	30,000	3,000	None	- -
Rock Revetment	36,000	100	60 percent of capital cost, none for operation and maintenance	Department of Natural Resources, Inland Lake Rehabilitation Program
Fish Management	- -	- -	- -	Costs will be borne by the Wisconsin Department of Natural Resources
Water Quality Sampling Program	- -	300	None	- -

[a] *Cost sharing and technical assistance for nonpoint source controls could also be applied for as a local priority project under the Wisconsin Fund Nonpoint Source Pollution Abatement Program administered by the Wisconsin Department of Natural Resources.*

Source: SEWRPC.

cost of $300 for a water quality sampling program to an annual cost of $4,400 for macrophyte harvesting. The total capital cost of the recommended plan is $66,200 with an average annual operation and maintenance cost of $4,000 and a total annual cost of $7,000. Of these totals, $44,500, or 67 percent of the capital cost; $3,500, or 87.5 percent of the annual operation and maintenance cost; and $5,500, or 78.5 percent of the total annual cost would be borne by the local public sector, primarily the Ashippun Lake Protection and Rehabilitation District. The remaining costs would be provided by individual property owners or by state or federal cost-share funds. Table 28 sets forth the estimated costs of the plan expected to be provided by state or federal cost-share programs. Based on the estimated 1985 population of the lake watershed, the total average annual cost—$7,000—would be about $100 for each household in the lake watershed, or about $30 per resident. The average annual public sector cost—5,500—would be about $80 for each household or about $23 for each lake drainage area resident. If only the Lake District residents are considered, the average annual local public sector cost would be about $56 per person or $190 per household.

(This page intentionally left blank)

Chapter X

SUMMARY

The preparation of a water quality management plan for Ashippun Lake was a cooperative effort of the Southeastern Wisconsin Regional Planning Commission and the Wisconsin Department of Natural Resources. The lake study included the design and conduct of a water quality sampling program—conducted from December 1976 through November 1977—and the inventory and analysis of land use, watershed characteristics, natural resource base, recreational use, and existing management practices. The objectives of the plan were to provide water quality in Ashippun Lake suitable for recreational use and warmwater fish and aquatic life, to reduce the severity of existing nuisance conditions caused by excessive weed growth, to control shoreline erosion, and to improve opportunities for water-based recreational activities.

Ashippun Lake is located entirely within U. S. Public Land Survey Township 8 North, Range 17 East, Section 15, in Waukesha County. The lake has a surface area of 83 acres, a maximum depth of 35 feet and a mean depth of 17 feet. The lake outlet drains to the Ashippun River. The lake has a direct drainage area of about 371 acres, or about 0.6 square mile, which lies entirely within the Town of Oconomowoc. As of 1980, the resident population of the direct tributary drainage area to the lake was estimated by the Commission to be 230 persons.

The type, intensity, and spatial distribution of land uses are important factors determining resource demand in the direct tributary drainage area. As of 1975, approximately 85 acres, or 23 percent of the 371-acre directly tributary drainage area, was in urban land use, with the dominant urban land use—73 acres, or about 86 percent—in residential use. The remaining urban land uses—commercial, industrial, government and institutional, transportation, communication, utilities, recreation—constituted about 12 acres, or 3 percent of the Ashippun Lake direct drainage area. Approximately 285 acres, or 77 percent of the directly tributary drainage area, was in rural land use, with the dominant rural land use—199 acres, or 70 percent—in agricultural use. Woodlands and open lands comprised about 5 acres, or 2 percent of the rural land area. Wetlands and surface water, excluding the surface area of Ashippun Lake, accounted for 81 acres, or 28 percent of the rural land area.

As of 1975, the sanitary and household wastewaters from the estimated 220 persons residing in the direct tributary drainage area to the lake, were treated and disposed of through the use of onsite disposal systems. There are approximately 61 septic tank systems in the direct tributary drainage area—21 of which were located in areas covered by soils having severe or very severe limitations for the use of such systems. No holding tanks or mound systems were known to exist, as of 1975, in the directly tributary drainage area.

For the year of study, it is estimated that approximately 624 acre-feet of water entered the lake. Of this total, about 233 acre-feet, or 37 percent, was contributed by direct precipitation on the lake surface, about 217 acre-feet, or 35 percent, was contributed by groundwater inflow, and about 174 acre-feet, or 28 percent, was contributed by surface runoff. Of the total water output from Ashippun Lake, about 384 acre-feet, or 62 percent, was discharged via the lake outlet and 187 acre-feet, or 30 percent, was evaporated from the surface of the lake. In addition, there was a net gain in lake level as a consequence of the 53 acre-feet, or 8 percent increase in lake storage.

Monthly temperature and dissolved oxygen profiles indicate that complete mixing of Ashippun Lake is restricted during the summer by thermal stratification. The data indicate that Ashippun Lake, like other mesotrophic or eutrophic lakes in southeastern Wisconsin, experiences oxygen depletion in the hypolimnion or bottom water layer. Oxygen depletion in the hypolimnion may increase the release of phosphorus from the bottom sediments and cause fish to migrate upward in the water column where higher dissolved oxygen concentrations exist. Water clarity, as measured by a Secchi Disc, ranged from about 2.5 feet to 9.3 feet, with an average Secchi Disc depth of 5.8 feet in Ashippun Lake.

Ashippun Lake supports a relatively large and diverse fish community. Wisconsin Department of Natural Resources survey reports indicated that from 1952 through 1975, 19 different fish species were surveyed in the lake. No threatened or endangered fish species were found in the lake.

The Regional Planning Commission recommended water quality standard for recreational use and warmwater fish and other aquatic life indicates that nuisance aquatic growth is likely to occur in lakes where the total phosphorus concentration exceeds 0.02 milligram per liter (mg/l) during the spring turnover. In Ashippun Lake, the mean concentration of total phosphorus during spring turnover was about 0.06 mg/l, which indicates that the potential for nuisance aquatic plant growths exists in the lake.

In general, the aquatic plant growth in Ashippun Lake was moderate and diverse. Populations of blue-green algae in the lake indicated a potential for bloom conditions. However, as previously noted, accumulations of algae in nuisance "bloom" conditions was not observed.

It is estimated that under the existing conditions, as of 1975, the total phosphous load to Ashippun Lake during an average year would be approximately 186 pounds per year. Of this total, 61 pounds, or about 33 percent, was estimated to be contributed by onsite sewage disposal systems. In addition, direct atmospheric fallout was estimated to contribute 48 pounds, or about 26 percent, of the total. The remaining land uses in the Ashippun Lake direct drainage area—residential, agricultural, government and institutional, transportation, recreational and agricultural lands, and woodlands, other open land—together with groundwater inflow, and occasional inflow from the Ashippun River—contributed an estimated 77 pounds, or about 41 percent, of the phosphorus load to the lake.

Based on the study data, Ashippun Lake is classified as mesotrophic, a term describing moderately fertile lakes which may support abundant aquatic plant growth and may support productive fisheries. Nuisance growths of algae and weeds may occasionally be exhibited by mesotrophic lakes.

According to the adopted Commission land use plan, the population of Ashippun Lake direct tributary drainage area is expected to increase by about 10 percent, or approximately 22 residents, by the year 2000. As a result, no significant increases in urban development are expected within the lake drainage area by the year 2000. All prime agricultural lands, totaling 170 acres, within the lake drainage area are recommended to be preserved in agricultural use through the design year of the plan. It is recommended that the surface area of the lake and land immediately surrounding the entire lake, and the wetlands north and south of the lake totaling 196 acres be permanently preserved as a primary environmental corridor.

The Commission estimated that under anticipated year 2000 conditions, the total phosphorus load to the lake would remain at about 186 pounds per year. The major source of phosphorus in the lake drainage area would be onsite septic tank systems, which would contribute about 61 pounds, or 33 percent, of the estimated phosphorus load to the lake each year.

Management measures required to meet the water use objectives for Ashippun Lake must address the nonpoint source pollution controls needed. Commission estimates indicated that there would need to be a reduction of 50 percent in nonpoint source phosphorus loads from the direct tributary drainage area in order to meet the recommended water use objectives and supporting standards. Nonpoint source control measures, as discussed in Chapter IX, consist of improved management of both urban and rural land uses to reduce pollutant discharges to the lake by direct overland drainage, by drainage from natural or man-made channels, and by groundwater inflow. These actions would be designed to reduce the in-lake concentration of total phosphorus in Ashippun Lake during the spring turnover to the Commission recommended standard of 0.02 milligram per liter (mg/l).

Alternative lake rehabilitation and in-lake management techniques were evaluated to examine the feasibility of conducting an in-lake management program. Techniques assessed included hypolimnetic aeration, dredging, sediment covering, drawdown, nutrient inactivation, dilution and flushing, selective discharge, lake water level control, macrophyte harvesting, algae harvesting, chemical controls, and fish management. In addition, methods to alleviate shoreline erosion along the eastern shore of the lake were also evaluated.

As a result of these analyses, the Commission recommended that the Ashippun Lake Protection and Rehabilitation District implement a macrophyte harvesting program. Also, it was recommended that the shoreline erosion along the eastern shore be controlled by the construction of a rock revetment or other structural improvements. The Commission also recommended that the Wisconsin Department of Natural Resources consider purchasing additional wetlands contiguous to existing state-owned land and continue management of the northern pike fishery, including stocking as necessary. The Department should also conduct a creel census and periodic fishery surveys to evaluate the angler catch and determine if over-harvesting of some species is occurring. Finally, the Ashippun Lake Protection and Rehabilitation District should implement a continuing in-lake water quality monitoring program.

In summary, the water quality management recommendations for Ashippun Lake were developed within the framework of the adopted regional water quality management plan and include:

1. The development and implementation of local land use plans in conformance with the Commission's adopted regional land use plan.

2. The implementation of nonpoint source controls in both urban and rural areas, including a public education program, improved public works activities, improved urban "housekeeping" practices, improved agricultural management, and technical and financial assistance from state and federal units of government.

3. The revision and expansion of the Waukesha County Sanitary Ordinance to address the operation, maintenance, and inspection of onsite sewage disposal systems.

4. The implementation of macrophyte harvesting, fish management, a rock revetment along the eastern shore to control shoreline erosion, and a water quality sampling program.

Implementation of the recommended nonpoint source controls in the drainage area directly tributary to Ashippun Lake and in-lake management would entail a total capital cost of about $66,200 with an average annual operation and maintenance cost of about $4,000 and a total average annual cost of $7,000 over a 20-year plan period. About 54 percent of the capital cost of watershed management is associated with control of erosion from the eroding eastern shoreline, with 60 percent of this construction erosion control cost being borne by the private sector. The in-lake management costs include a total average annual cost of $300 for an in-lake water quality monitoring program. Based on the estimated 1985 population of the direct tributary drainage area to the lake, the total average annual cost—$7,000—would be about $100 for each household in the lake watershed, or about $30 per resident. The average annual local public sector cost of the recommended plan is about $5,500, or about $80 for each household in the lake watershed, or about $23 per resident. If only the lake district residents are considered, the average annual local public sector cost would be about $56 per person, or $190 per household.

Ashippun Lake is a valuable natural resource in the Southeastern Wisconsin Region. There is a delicate, complex relationship between the water quality conditions of a lake and the land uses within the direct tributary drainage area of the lake. Projected increases in population, urbanization, income, leisure time, and individual mobility forecast for the Region will result in additional pressure for development in the direct drainage area of lakes in southeastern Wisconsin and for water-based recreation on the lakes themselves. Without the adoption and administration of an effective water quality management program for Ashippun Lake, based upon comprehensive water quality management and related land use plans, the water quality protection needed to maintain conditions in Ashippun Lake suitable for recreational use and for maintenance of fish and other aquatic life will not be provided.

(This page intentionally left blank)

APPENDICES

(This page intentionally left blank)

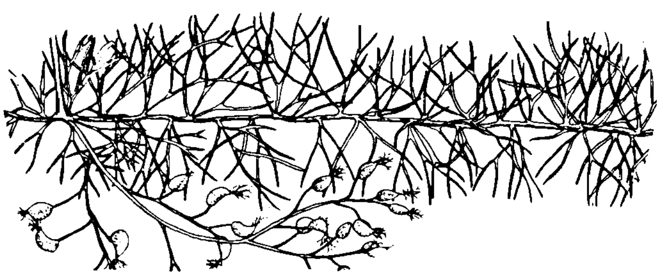
Appendix A

ILLUSTRATIONS OF REPRESENTATIVE BIOTA IN ASHIPPUN LAKE

Appendix A-1

REPRESENTATIVE MACROPHYTES FOUND IN SOUTHEASTERN WISCONSIN LAKES

BLADDERWORT (Utricularia sp.)

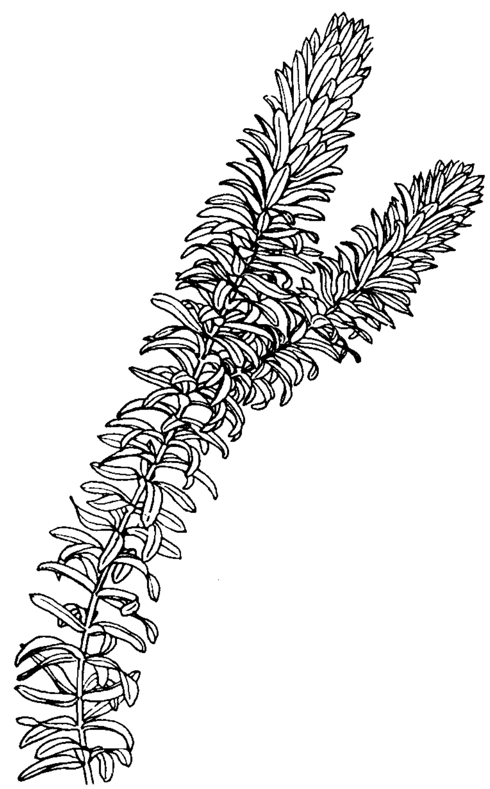


Bladderwort is a carnivorous plant which occurs in shallow ponds and lakes or on wet soils. The small bladders are traps which catch tiny animal life, particularly crustaceans. Bladderwort provides some food and cover for fish. It is never abundant enough to become a nuisance.

BUSHY PONDWEED (Najas flexilis)

Bushy pondweed is a common species in ponds, small lakes, and slow-moving streams in southeastern Wisconsin. It provides food and cover for fish. Bushy pondweed may become a nuisance during late summer in some lakes.

COMMON WATERWEED (Anacharis canadensis)



Common waterweed is a submerged plant which usually occurs in hard water. It provides cover for many small aquatic organisms which serve as food for the fish population. Waterweed is an aggressive plant and may suppress the growth of other aquatic plants.

COONTAIL (Ceratophyllum demersum)

Coontail is a submerged plant which prefers hard water. It supplies cover for shrimp and young fish and supports insects which are valuable as fish food. A heavy growth of coontail is an indication of very fertile lake conditions.

CURLY LEAF PONDWEED (Potamogeton crispus)

Curly leaf pondweed is an introduced plant species which does well in hard or brackish water which is usually polluted. However, curly leaf pondweed does provide good food, shelter, and shade for fish and is valuable for early spawning fish.

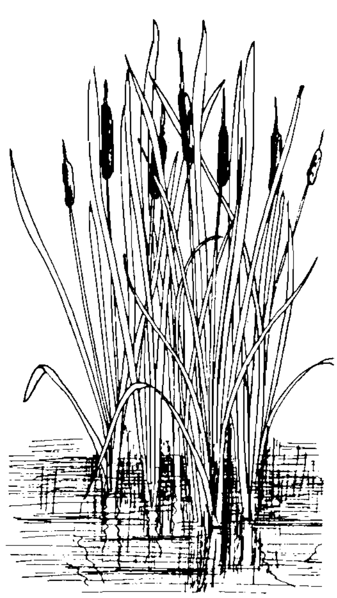
FLOATING LEAF PONDWEED (Potamogeton natans)

Floating leaf pondweed has leaves which float on the surface with the rest of the plant submerged. It provides food and shelter for fish and other aquatic species.

LARGE LEAF PONDWEED (Potamogeton amplifolius)

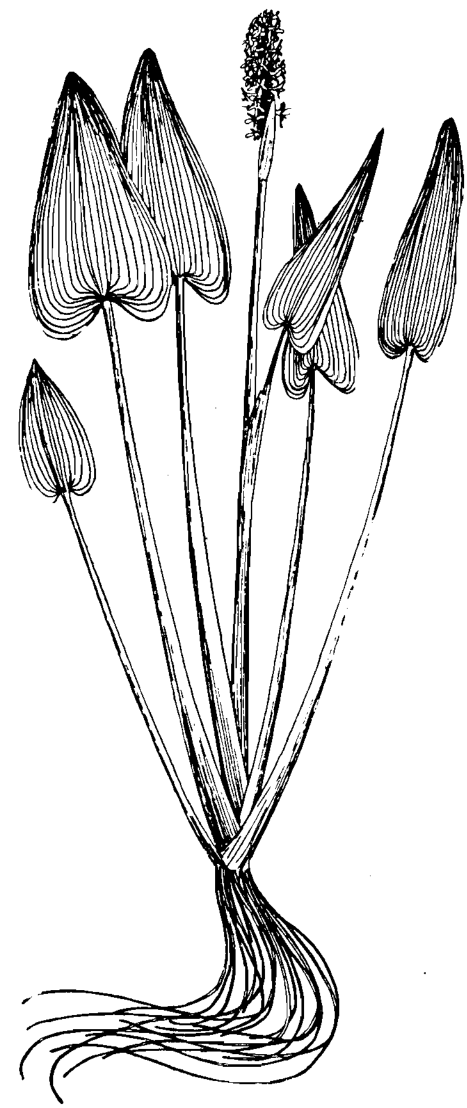
Large leaf pondweed is usually found in relatively hard water. Submersed, it supports insects and provides a good food supply for fish.

NARROW-LEAVED CATTAIL (Typha angustifolia)



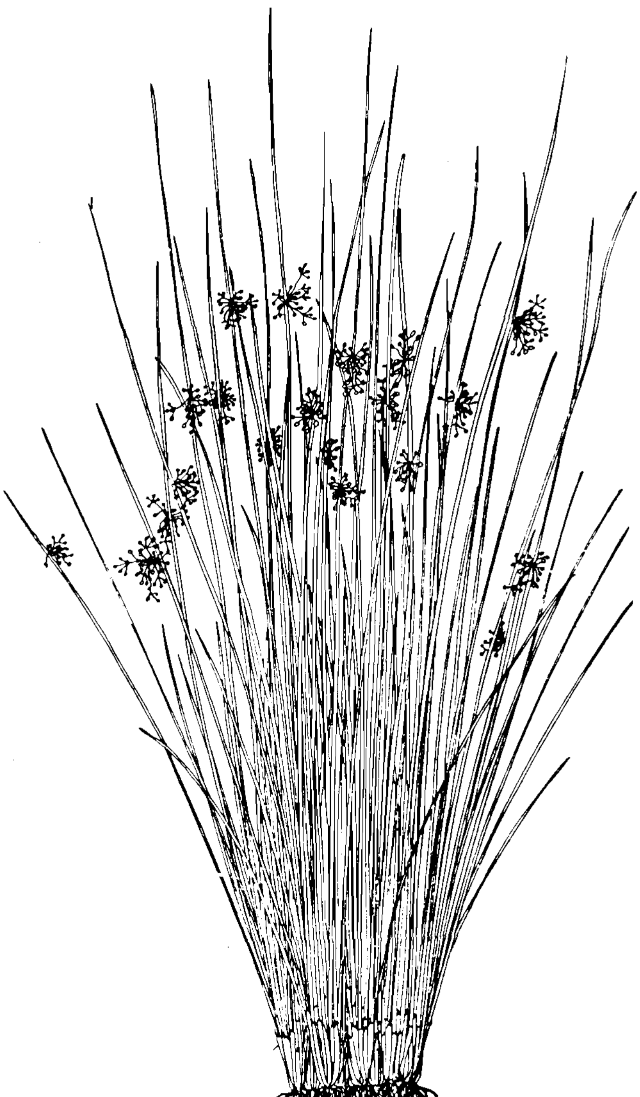
Narrow-leaved cattail may appear in almost any wet place. It is used as a spawning area for sunfish and shelter for various species of young fish, as well as a variety of other forms of wildlife. Cattails often occur in dense stands and therefore may become a nuisance.

PICKEREL WEED (Pontederia cordata)



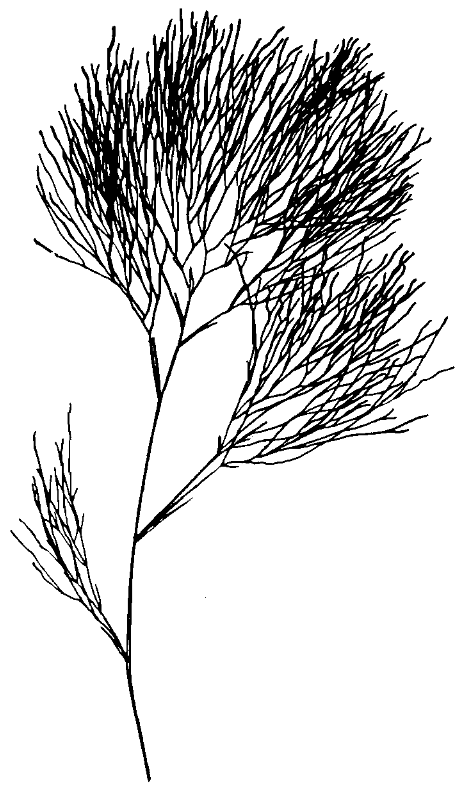
Pickerel weed is common in shallow water with muddy shores. It provides shade and shelter for fish but has only slight value as food and cover. Pickerel weed usually is not abundant enough to be a nuisance.

RUSH (*Juncus* sp.)



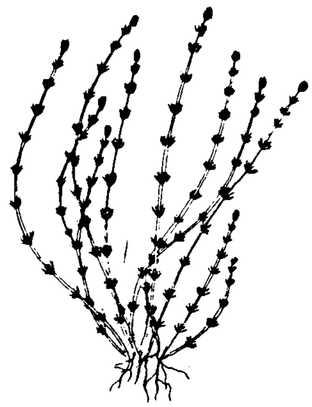
Rushes are an emergent aquatic plant with a widespread habitat which ranges from wet meadows and lakeshores to shallow pools. Thick growths of rushes often form spawning grounds for rock bass, bluegills, and other sunfish.

SAGO PONDWEED (*Potamogeton pectinatus*)



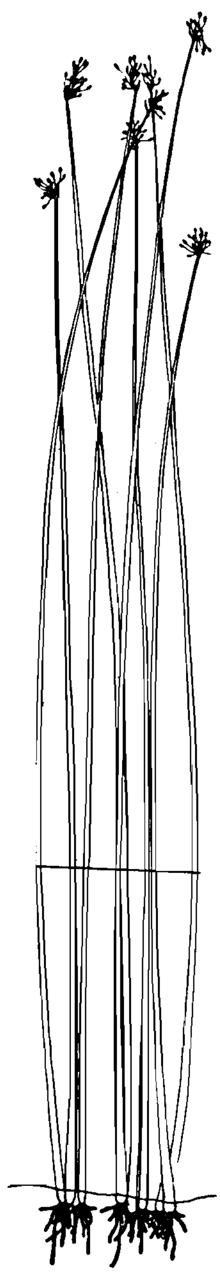
Sago pondweed is found in hard or brackish water of lakes and slow-flowing streams. Sago pondweed provides food and shelter for young trout and other fish.

STONEWORT (*Chara aspera*)



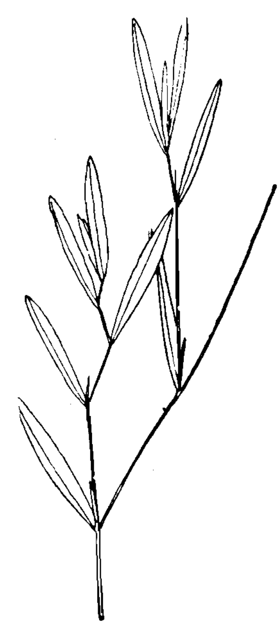
Stonewort is a type of algae which usually occurs in hard water. It provides fair cover for fish and produces excellent food for young trout, large and small mouth bass, and black bass.

SOFTSTEM BULRUSH (*Scirpus validus*)



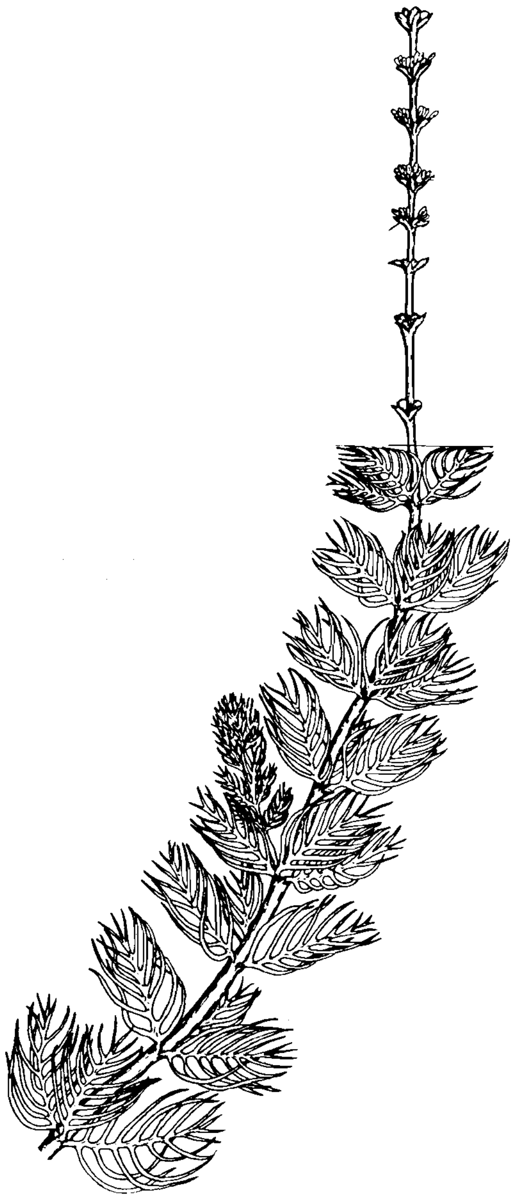
Softstem bulrush is an emergent aquatic species. It supports insects and provides food for young fish and many species of waterfowl.

VARIABLE PONDWEED (*Potamogeton gramineus*)



Variable pondweed is a submergent species. However, it will occasionally grow on muddy shores. Variable pondweed provides food and cover for fish.

WATER MILFOIL (Myriophyllum exalbescens)



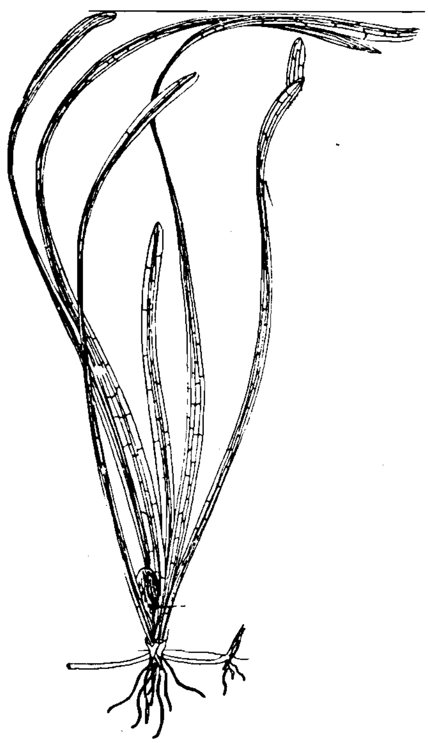
Water milfoil is a submergent plant which may cause extensive weed problems in lakes and streams. However, when not overabundant, water milfoil provides cover for fish and is a valuable food source for many forms of aquatic life.

WATER SMARTWEED (Polygonum natans)

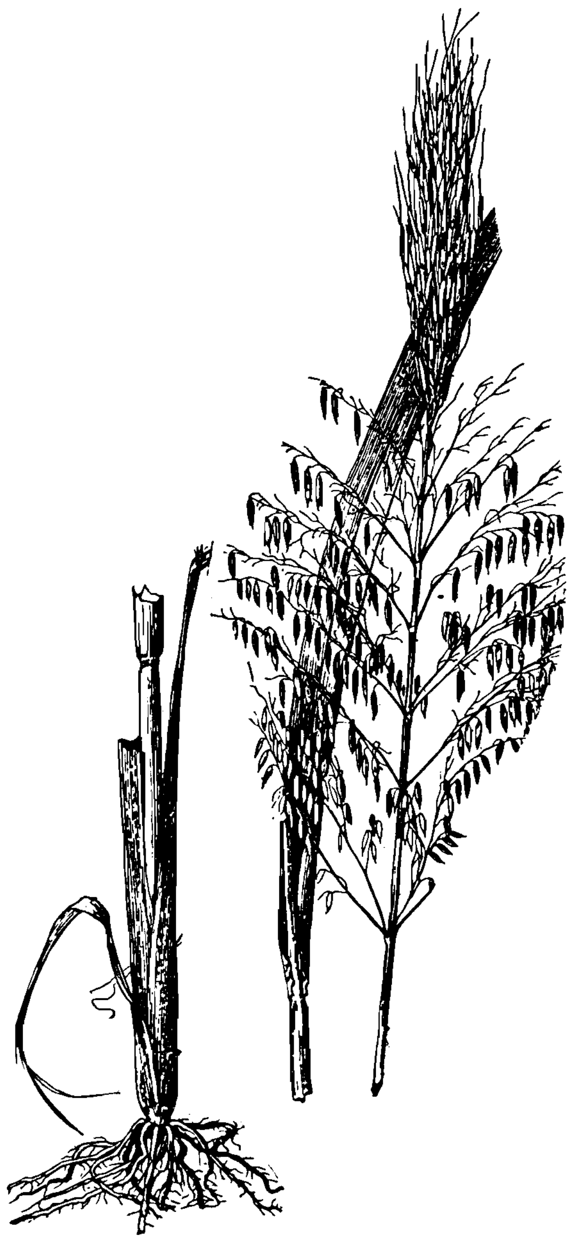
Water smartweed is found along the shoreline of shallow water. It provides food and cover for fish and wildlife. Water smartweed is never abundant enough to cause aquatic nuisance problems.

WILD RICE (Zizania aquatica)

WILD CELERY OR EEL GRASS (Vallisneria americana)

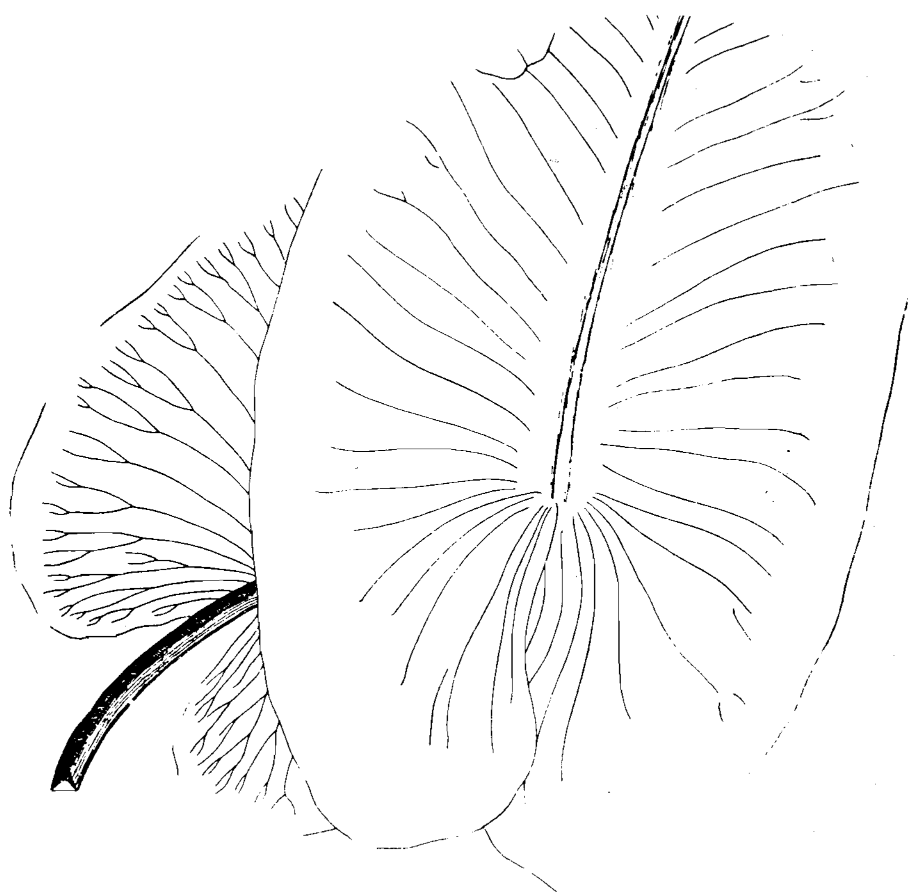


Eel grass is a submersed plant which provides shade, shelter, and food for fish. It supports insects and is a valuable food source for waterfowl. Sometimes forming dense growths, eel grass may be undesirable in swimming areas.



Wild rice is a valuable emergent aquatic grass. Wild rice prefers clean water with low turbidity during the growing season. Wild rice is an annual grass with seeds that depend on sufficient light penetration in spring and early summer for germination. Wild rice is an important food source for many species of fish and waterfowl. It is also a food source for humans.

YELLOW WATER LILY (Nuphar variegatum)



Yellow water lily and white water lily are found in shallow portions of lakes and ponds. The leaves float on the surface of the water and algae and insects often grow under the leaves. Yellow and white water lilies provide shade and shelter for fish but may cause problems because of the extensiveness of their beds in shallow portions of lakes.

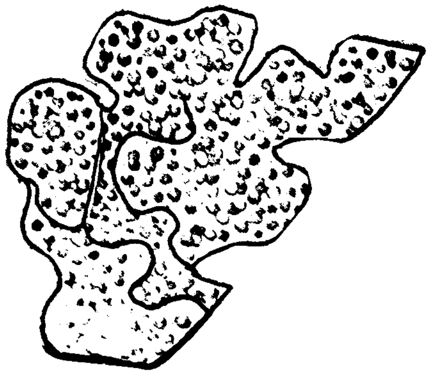
Appendix A-2

REPRESENTATIVE PHYTOPLANKTON FOUND IN SOUTHEASTERN WISCONSIN LAKES

Anabaena

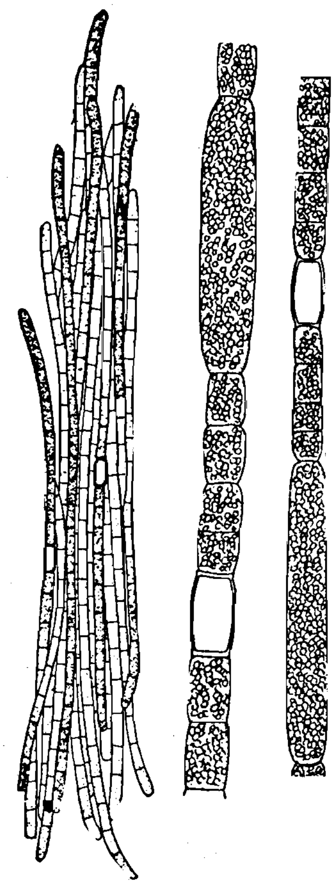
There are many individual species of the bluegreen algae, Anabaena. Some species are solitary while others form aggregated masses of indefinite shape. Anabaena seldom cause disagreeable conditions in lakes and reservoirs when they bloom, as they remain suspended throughout the water column and do not form surface scums. However, some species of Anabaena have been known to cause toxic water supplies which have caused animal fatalities.

Anacystis



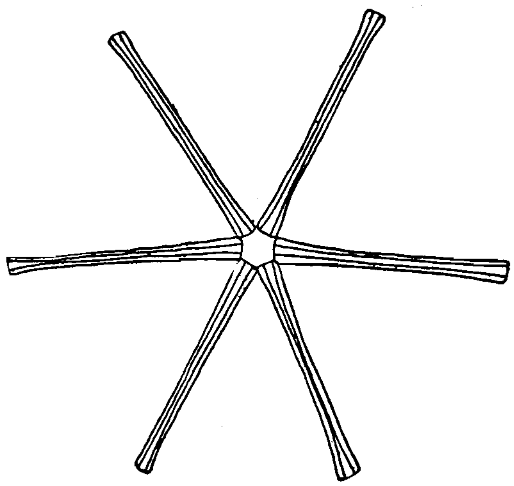
Anacystis is a loose colony of small spherical bluegreen algae cells contained in a gelatinous mass. The colony floats in the water column and is visible to the naked eye. Like Anabaena, Anacystis have been known to cause toxic water supplies.

Aphanizomenon



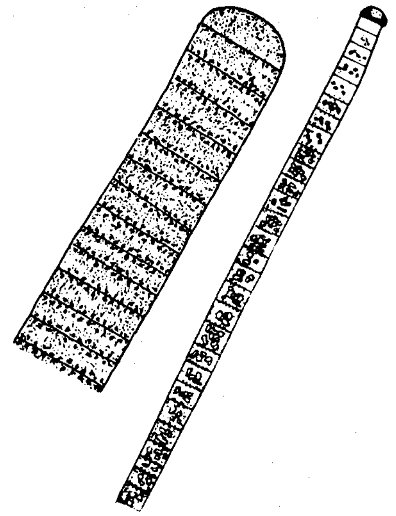
Individual cells of Aphanizomenon form strands which lie parallel in bundles and often occur so abundantly that the water appears to be filled with bits of chopped grass. The individual cells contain air spaces which give the plants great bouyancy. This accounts for the abundant growths of this bluegreen algae becoming concentrated on or near the surface where floating scum results. Dense growths may lead directly or indirectly to the death of fish through oxygen depletion or the secretion of toxins.

Asterionella



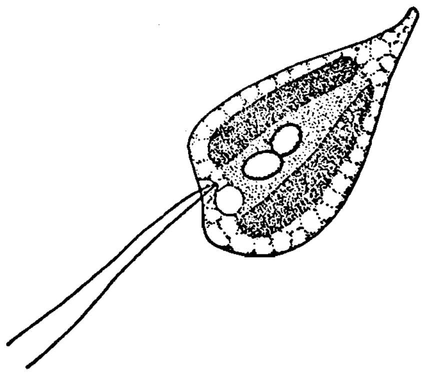
The diatom, Asterionella, usually occurs as a member of lake plankton. It prefers hard-water lakes and is readily identified by the spoke-like arrangement of the rectangular arms about a common center. Asterionella may be so abundant that lake water used for domestic water supplies may have a fishy taste.

Oscillatoria



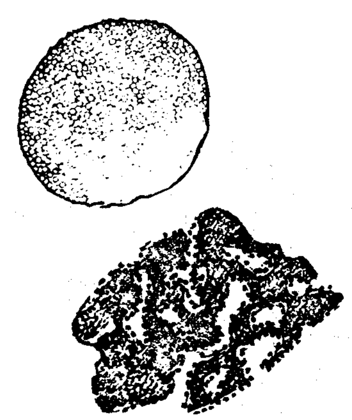
Oscillatoria is a filamentous bluegreen algae that grows in dense darkly colored clumps or mats. A characteristic of this bluegreen algae is the active oscillating movement for which it is named.

Dinobryon



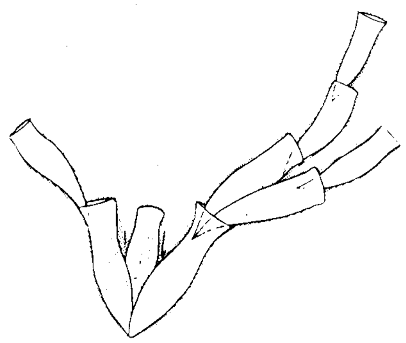
Dinobryon typically inhabit hard water lakes and, under certain conditions, may bloom. Dinobryon may produce disagreeable odors and tastes in domestic water supplies.

Microcystis



The cells of Microcystis, a bluegreen algae, are closely compacted and irregularly arranged in colonies enclosed in mucilage. Where some species of Microcystis occur, the habitat is completely dominated by this algae to the exclusion of all other forms of algae. Dense growths of Microcystis may cause oxygen depletion or secrete toxins which cause fish kills.

YELLOW GREEN ALGAE (Chrysophyta)



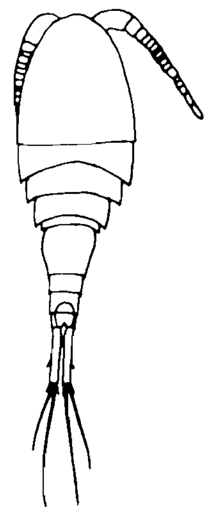
Many freshwater Chrysophyta are restricted to cold brooks, especially mountain streams, springs, and lakes duirng cool seasons. Most thrive in water relatively free of pollution.

(This page intentionally left blank)

Appendix A-3

A FORM OF ZOOPLANKTON FOUND IN SOUTHEASTERN WISCONSIN LAKES

COPEPODS (Diacyclops thomasi)



A common example of copepods found in permanent bodies of water of all types from shallow ponds and marshes to lakes is Diacyclops thomasi. The adults are predaceous on other zooplankton and can injure fish fry.

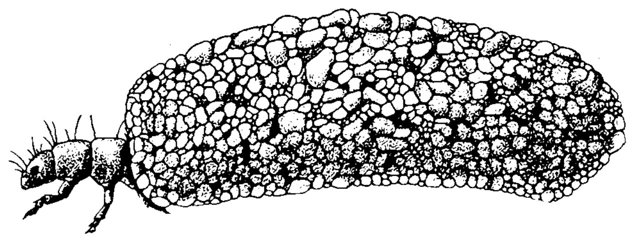
(This page intentionally left blank)

Appendix A-4

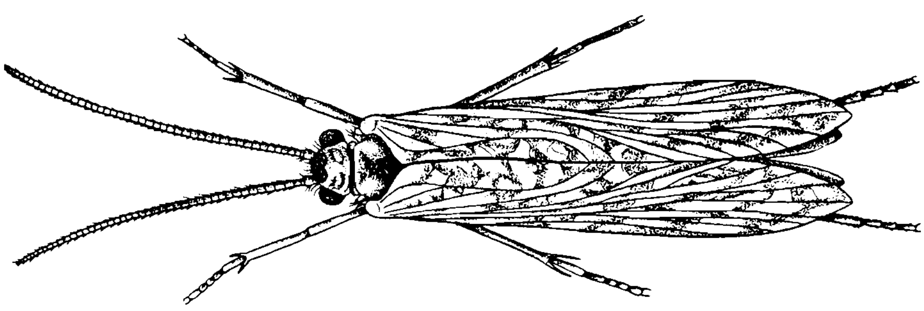
A FORM OF BENTHIC OR BOTTOM DWELLING ORGANISM FOUND IN SOUTHEASTERN WISCONSIN LAKES

CADDISFLIES (*Trichoptera*)

Caddisfly Larvae and Case



Adult Caddisfly



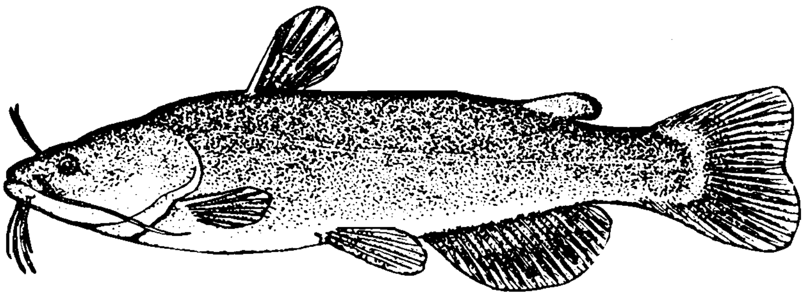
Caddisflies are found in most types of freshwater habitat, including streams, spring seepages, rivers, lakes, marshes, and temporary pools. Their tolerance to organic pollution varies widely, with some species being quite tolerant. Caddisflies are a food source for many species of fish.

(This page intentionally left blank)

Appendix A-5

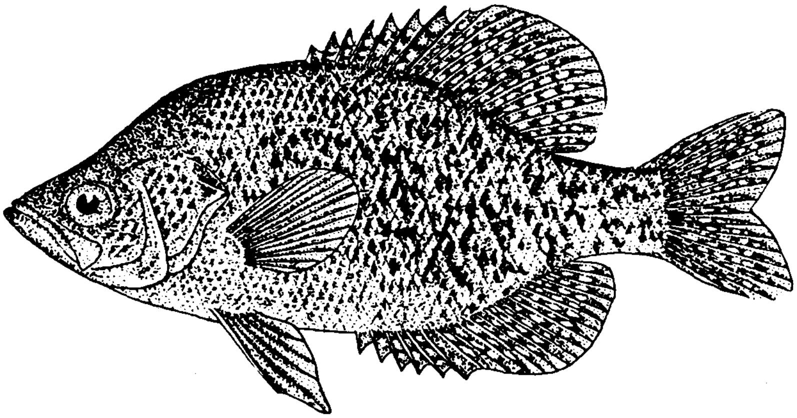
REPRESENTATIVE FISH SPECIES FOUND IN SOUTHEASTERN WISCONSIN LAKES

BLACK BULLHEAD (Ictalurus melas)



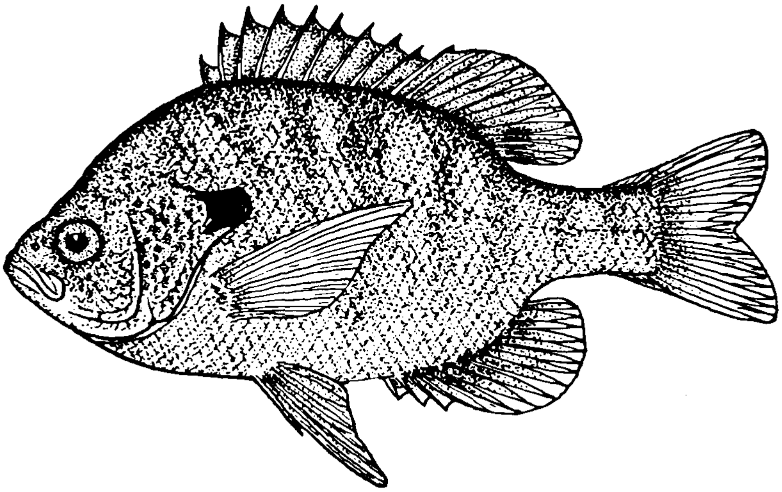
The black bullhead is common in shallow lakes and muddy streams. It nests in shallow water on either a sand or mud bottom. Bullheads are scavengers and will eat whatever food is available, such as minnows, leeches, crayfish, and amphipods.

BLACK CRAPPIE (Pomoxis nigromaculatus)



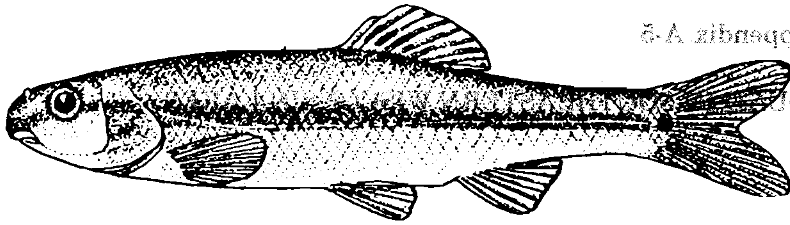
The black crappie prefers large streams and medium-sized lakes. It nests in water between three and six feet deep with a somewhat muddy bottom. Crappies feed on aquatic insects, small crustaceans, minnows, and other small fish.

BLUEGILL (Lepomis macrochirus)



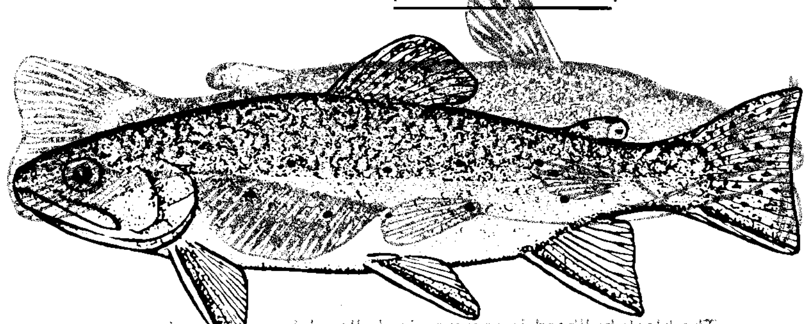
The bluegill is found in nearly all clear water lakes and streams. It nests in *shallow areas with sandy bottoms; nests are often crowded* together. Bluegills feed on small aquatic insects, worms, snails, and amphipods.

BLUNTNOSE MINNOW (Pimephales notatus)



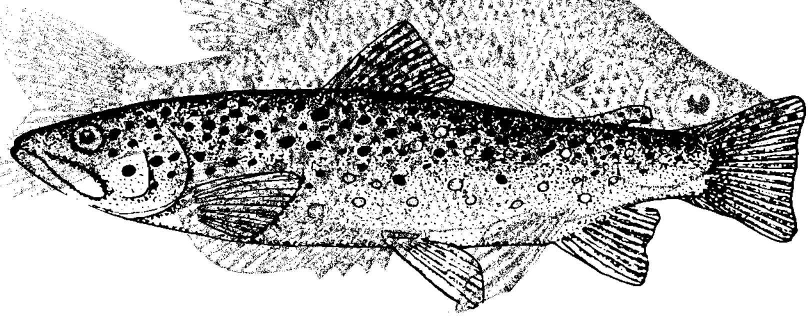
The bluntnose minnow is common in lakes and streams, but not in large rivers. The nest is built under an object, such as a rock or log. Bluntnose minnows feed mainly on algae.

BROOK TROUT (Salvelinus fontinalis)



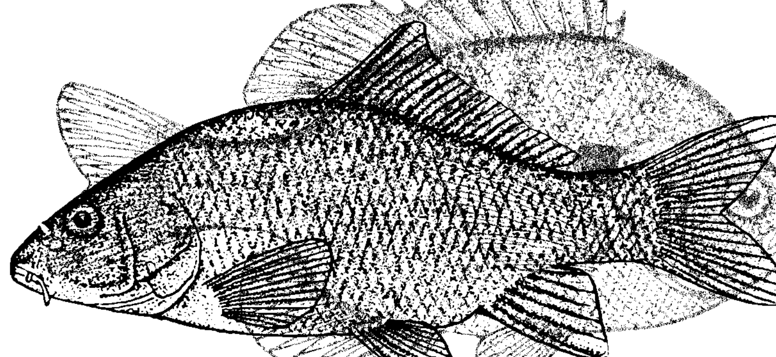
The brook trout, a native species in southeastern Wisconsin, prefers clear brooks and rivers in which the mean annual temperature rarely exceeds 50°F. The nest or redd is built on gravel bottoms in shallow riffle areas. Brook trout feed on adult aquatic insects and their larvae.

BROWN TROUT (Salmo trutta)



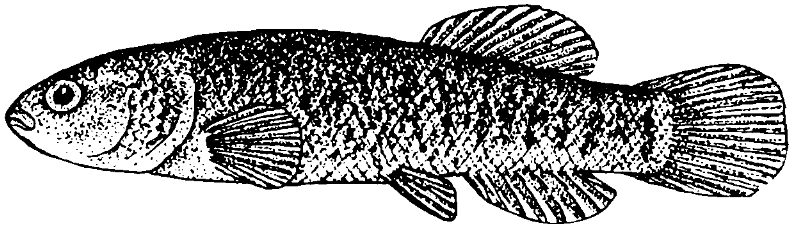
The brown trout is an introduced trout species which has become common in cold water streams. Nests or redds are built on sand and gravel bars at the mouths of tributaries. Young brown trout feed on small crustaceans and aquatic insects. Adults eat small fish, snails, crayfish, and terrestrial insects.

CARP (Cyprinus carpio)



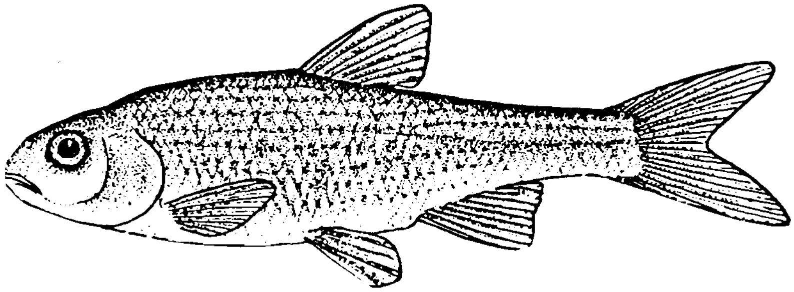
The carp is an introduced species which is tolerant of low dissolved oxygen conditions and prefers warm waters, with shallow mud-bottom lakes. Carp eat a wide variety of food. The uprooting of vegetation during feeding results in suspension of bottom sediments into the water column and a loss of aquatic plant beds which other fish species depend on.

CENTRAL MUDMINNOW (Umbra limi)



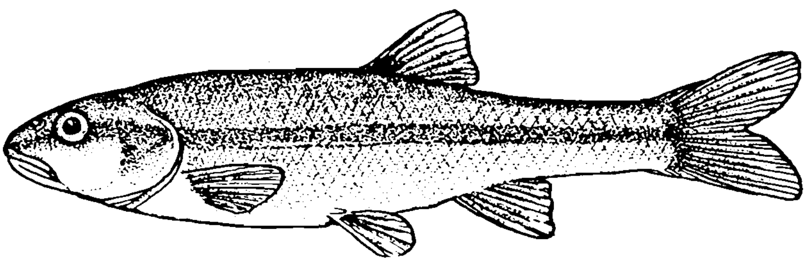
The central mudminnow prefers bog habitats, ditches, and streams with mud bottoms supporting dense aquatic vegetation. Spawning occurs in late spring and early summer. Mudminnows feed on insects, small crustaceans, and worms.

COMMON SHINER (Notropis cornutus)



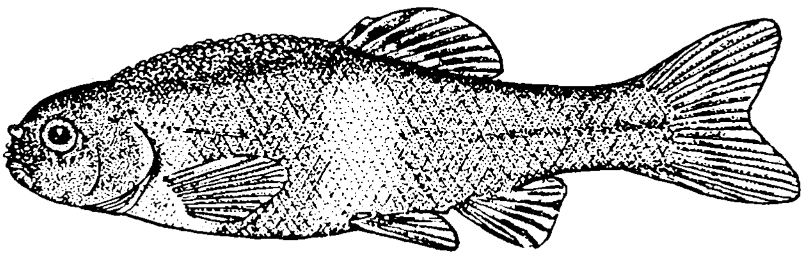
The common shiner occurs in habitats ranging from intermittent streams to large rivers and lakes. Common shiners are a forage fish that have value as a food source for game species. Shiners feed on small insects, crustaceans, and some algae.

CREEK CHUB (Semotilus atromaculatus)



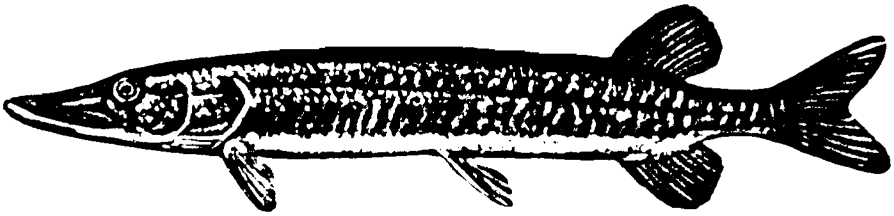
The creek chub prefers small streams and rivers but occasionally is found in lakes and large rivers. Creek chubs are quite common in beaver dam pools and may compete with trout for food. Chubs feed on all types of insects, amphipods, vegetation, and other, smaller fish.

FATHEAD MINNOW (Pimphales promelas)



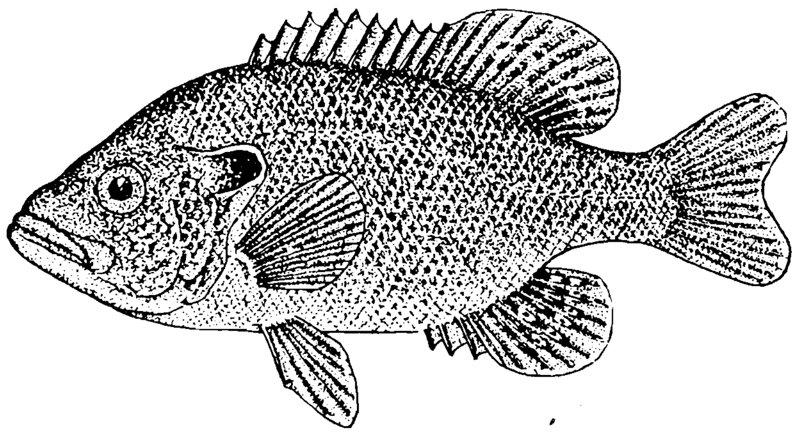
The fathead minnow prefers shallow lakes, ponds, and ditches. Nests are built on the underside of sticks, boards, and rocks in water between 3 and 12 inches deep. The fathead minnow can withstand very low oxygen conditions and, therefore, are very tolerant to pollution. Young fathead minnows feed on algae, while adults feed on a variety of aquatic insects, worms, and plants. The fathead minnow is a forage species and serves as a food source for many types of game fish.

GRASS PICKERAL (Esox americanus vermiculatus)



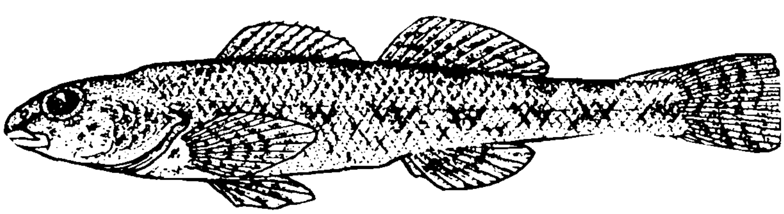
The grass pickerel is common in weedy portions of lakes and rivers. Pickerels are predators and as such feed almost exclusively on other fish. Grass pickerel are too small to have much value as a game fish.

GREEN SUNFISH (Lepomis cyanellus)



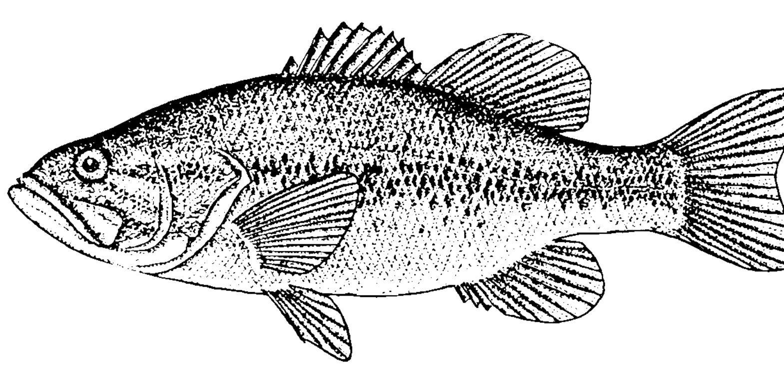
The green sunfish prefers small, shallow lakes and is common in creeks. Green sunfish feed on aquatic insects and any flying insects that happen to fall into the water. Large numbers of stunted adults may occur in some lakes and as such may decrease the viability of the existing fishery.

JOHNNY DARTER (Etheostoma nigrum)



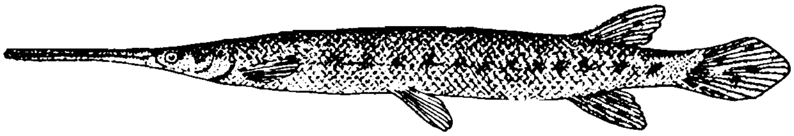
The johnny darter occurs in relatively clean lakes and streams. Nests are built under sticks and stones. The johnny darter feeds on algae and small, immature insects.

LARGEMOUTH BASS (Micropterus salmoides)



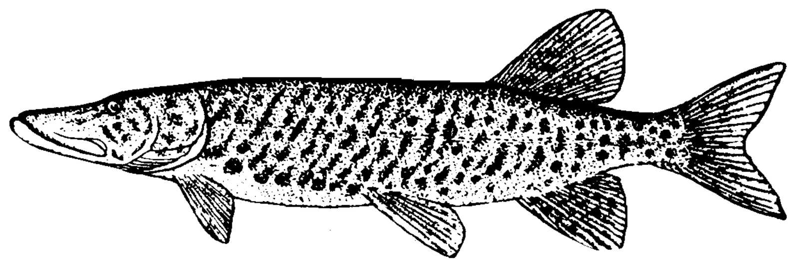
The largemouth bass prefers small- to medium-sized hardwater lakes with clear water, sandy shores, and marginal weed beds. The largemouth bass is carnivorous and as an adult feeds on perch, minnows, and small sunfish.

LONGNOSE GAR (Lepisosteus osseus)



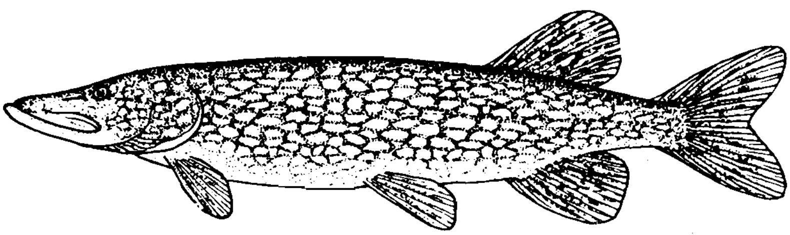
The longnose gar is a warmwater fish that often can tolerate surface waters which are too polluted for other species. Gars feed on game and forage fish and in some instances may alter fish populations enough to damage a fishery resource.

MUSKELLUNGE (Esox masquinongy)



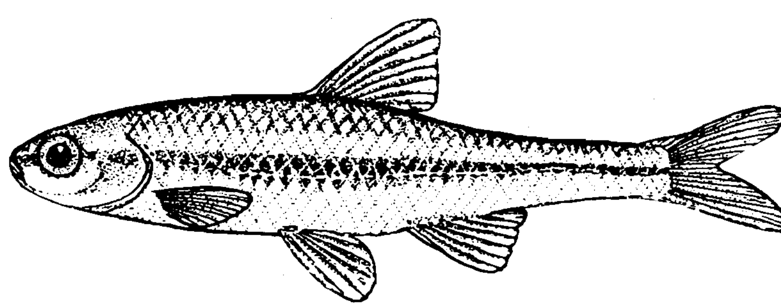
The muskellunge is common in lakes but is seldom abundant because it requires a large area of water to supply enough food for its voracious appetite. Spawning occurs in early May in tributary streams and shallow lake channels. Muskellunge are strictly carnivorous, feeding primarily on perch and suckers. A hydrid strain (tiger muskie) is stocked in many lakes in southeastern Wisconsin.

NORTHERN PIKE (Esox lucius)



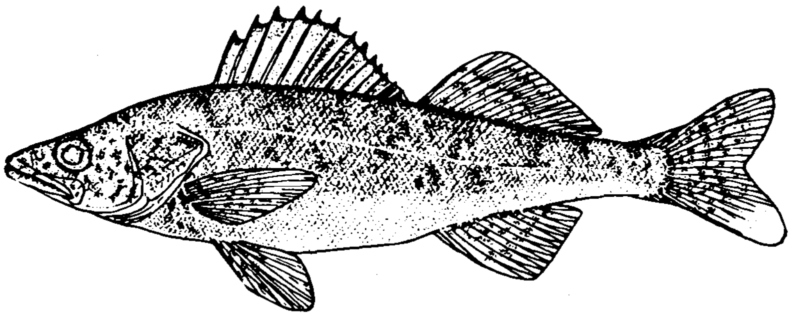
The northern pike is common in southeastern Wisconsin lakes. It feeds on a variety of fish, including perch, small suckers, sunfish, and even smaller northern pike. Spawning occurs immediately after the ice melts in April or early May in wetlands adjacent to lakes and streams.

PUGNOSE SHINER (Notropis anogenus)



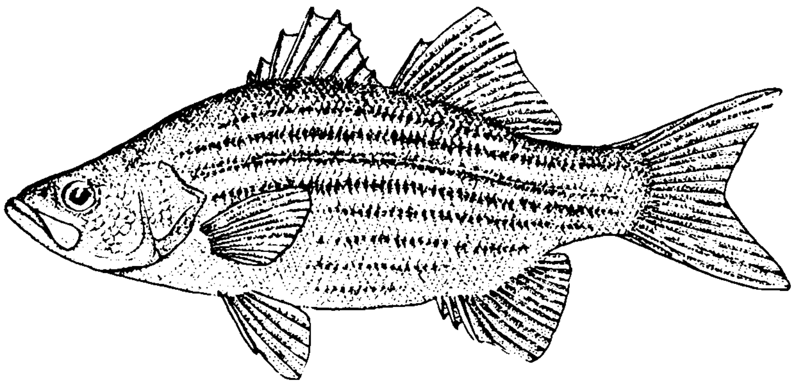
The pugnose shiner is threatened in Wisconsin. This small fish—up to two inches in length—prefers weedy waters in streams and lakes. Little is known about its life history as it is one of the rarest shiners. Changes by man in streams, rivers, and lakes have been responsible for its disappearance and resulting inclusion on the threatened species list in Wisconsin.

WALLEYE (Stizostedion vitreum vitreum)



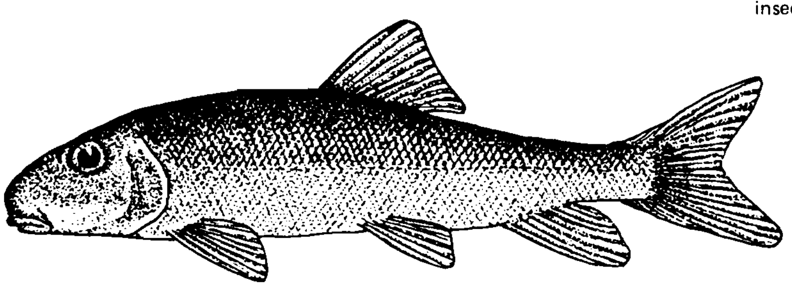
The walleye prefers clean and moderately warm to cold lakes and rivers. Spawning occurs in early spring on sand bars and shoals. Walleye feed on small minnows, small bullheads, and leeches. Walleye are a very desirable game fish.

WHITE BASS (Morone chrysops)



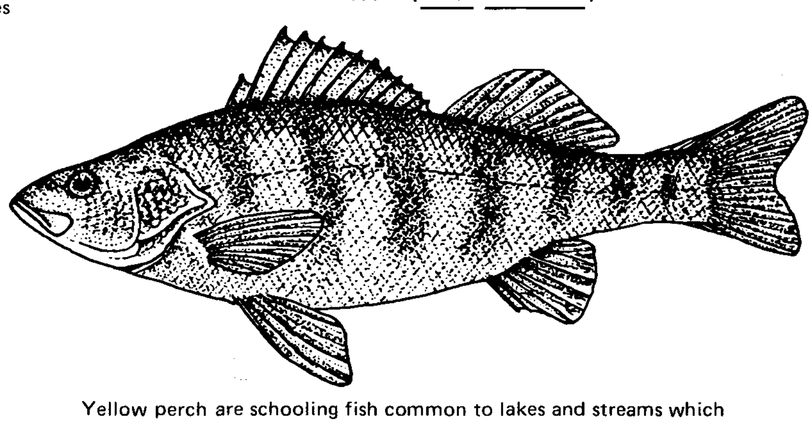
The white bass occurs in large rivers and connected lakes. White bass usually travel in large schools near the surface. Eggs are scattered randomly on shallow bars and gravelly reefs. White bass feed on insects and small fish.

WHITE SUCKER (Catostomus commersoni)



The white sucker occurs in almost every permanent body of fresh water, from small streams to large lakes. White suckers have an important role in cleaning lakes and streams. White suckers are a forage species and serve as a food source for many other species of fish.

YELLOW PERCH (Perca flavescens)



Yellow perch are schooling fish common to lakes and streams which do not experience winter kills. Eggs are deposited in a gelatinous, ribbonlike bank over submerged aquatic plants or branches. Perch are predaceous and feed on minnows, aquatic insects, crayfish, leeches, and snails. In addition, perch may compete with other game fish for food and space if populations get too large.