

IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE I
PLEASANT LAKE MANAGEMENT PLAN
WAUSHARA COUNTY, WISCONSIN

REPORT TO:
PLEASANT LAKE IMPROVEMENT CORPORATION

October, 1996

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

LIST OF TABLES iii

LIST OF FIGURES iv

LIST OF APPENDIXES v

GLOSSARY OF TERMS vi

SUMMARY 1

INTRODUCTION 2

DESCRIPTION OF AREA 4

METHODS 7

 Watershed Characteristics 7

 Water Quality Monitoring 7

 Event Monitoring 9

 Staff Gage 10

 Recreational Use 10

 Public Involvement Program 10

 Land Use Information 11

 Exotic Species 11

FIELD DATA DISCUSSION 12

 Watershed Characteristics 12

 Water Quality 12

 Event Monitoring 18

 Recreational Use 20

 Exotic Species 24

BASELINE CONCLUSIONS 26

MANAGEMENT RECOMMENDATIONS 29

LIST OF REFERENCES 33

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LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Sampling Station Descriptions, Pleasant Lake, 1994 - 1995	8
2	Water Quality Parameters, Station 2201 Pleasant Lake, January, 1994 - August, 1995	16
3	Event Nitrogen and Phosphorus Parameters (in milligrams per liter), Pleasant Lake, Waushara County, 1994 - 1995	19
4	Comparison of Recreational Use Parameters, Pleasant Lake, Waushara County, WI	21
5	Percent of "Strongly Agree" and "Agree" Responses, Pleasant Lake, Waushara County, WI	23

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Location Map, Pleasant Lake, Waushara County, WI	5
2	Sample Station Location, Pleasant Lake, Waushara County, WI, 1994 - 1995	8
3	Watershed Land Slopes, Pleasant Lake, Waushara County, WI	14
4	Watershed Cover Types, Pleasant Lake, Waushara County, WI	15
5	Open/Agricultural Areas on Sand Soils with less than 5% Land Slope, Pleasant Lake, Waushara County, WI	15
6	Total Phosphorus Trends for Pleasant Lake, 1994 - 1995	17
7	Total Nitrogen Trends for Pleasant Lake, 1994 - 1995	17
8	Trophic State Index For Secchi Depth, Total Phosphorus and Chlorophyll <u>a</u> , Pleasant Lake, Waushara County, WI, 1994 - 1995	20
9	Seasonal Use For Pleasant Lake, Waushara County, WI	21
10	Most Commonly Reported Watercraft Types, Pleasant Lake, Waushara County, WI, 1995	22

LIST OF APPENDIXES

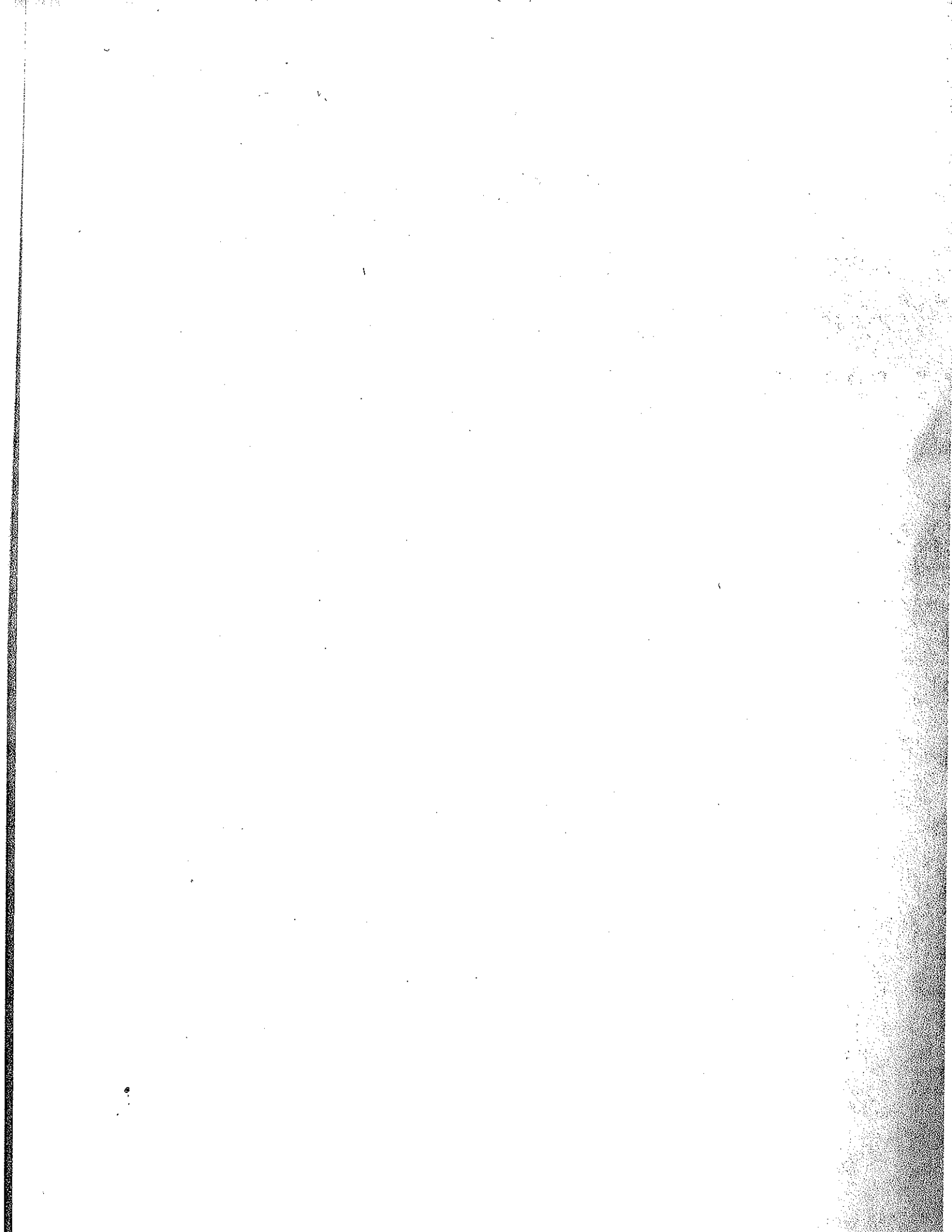
<u>Appendix</u>		<u>Page</u>
I	Recreational Use Survey Results, Pleasant Lake Management Plan	35
II	Summary of Public Involvement Activities, Pleasant Lake Management Plan	45
III	Sources of Information and Assistance, Pleasant Lake, Waushara County, WI	46
IV	Review of Best Management Practices (BMP's)	49
V	Summary of Pertinent Waushara County Ordinances and Plans	59
VI	Potential Funding Sources for Plan Implementation	62

GLOSSARY OF TERMS (1, 2, 3)

<u>Best Management Practices (BMP's)</u>	Land use practices to control the interactive processes of erosion, runoff and nutrient or pesticide inflows.
<u>Chlorophyll a</u>	Green pigment present in all green plant life and needed in photosynthesis. The amount present in lake water is related to the amount of algae and is therefore used as an indicator of water quality.
<u>Conductivity</u>	Determined by measuring the conductance, which is the ratio of current to voltage, of a conductivity cell immersed in the solution of interest.
<u>Ecoregion</u>	An area delineated in order to make comparisons between and within certain geographic areas of the state. The five lake region boundaries were chosen to group lakes of similar nature, provide sufficient number of lakes and lake types to provide for adequate statistical analysis, and separate lakes on the basis of regional means.
<u>Eutrophication</u>	The process of lake aging or enrichment with nutrients, generally with associated increases in algae or weeds. The extent to which this process has progressed is described by trophic status terms, e.g., oligotrophic, mesotrophic, or eutrophic.
<u>Littoral</u>	The shallow area of a lake from the shore to the depth where light no longer penetrates to the bottom.
<u>Macrophyte</u>	Commonly referred to as lake "weeds", actually aquatic vascular plants that grow either floating, emergent or submergent in a body of water.
<u>Mesotrophic</u>	A lake of intermediate photosynthetic activity and transparency.
<u>N/P Ratio</u>	Total nitrogen divided by the total phosphorus found in a water sample. A value greater than 15 indicates phosphorus to be limiting primary production.

GLOSSARY OF TERMS
(Continued)

- Oligotrophic A lake of low plant productivity and high transparency.
- Physicochemical Pertaining to physical and/or chemical characteristics.
- Primary production The energy captured by plants in photosynthesis. Gross primary production measures the amount of energy stored as organic materials, as well as that used in respiration by the plant. Net production includes only the amount stored.
- Residence Time Commonly called the hydraulic residence time. The amount of time required to completely replace the lake's current volume of water with an equal volume of "new" water.
- Riparian A landowner whose land lies on the shore of a particular body of water.
- Secchi Depth A measure of optical water clarity as determined by lowering a weighted Secchi disk (20 cm in diameter) into a body of water to a point where it is no longer visible.
- Seepage Lake A lake with no permanent inlet or outlet and with adjacent land groundwater and precipitation inputs as major sources of water.



SUMMARY

Pleasant Lake is a small (126 acres) natural seepage lake¹ primarily located in Waushara County with a slight southeast portion of the lake located in Marquette County. As a heavily used recreational resource and high aesthetic quality, it is perceived that Pleasant Lake may encounter an acceleration of nutrient (eutrophication) problems.

The majority of Pleasant Lake's watershed can be characterized as forested with more steeply sloped areas being common. Open or agricultural areas of nearly level sandy soils are also present but not as abundant within the watershed.

Water quality, when rated according to Trophic State Index, was **oligotrophic** to **mesotrophic** for total phosphorus and **chlorophyll a**, and oligotrophic for **Secchi depth**. Pleasant Lake, however, has a very narrow littoral zone which limits the amount of rooted aquatic plants (macrophytes) and allows nutrients to be available for algal growth. Pleasant Lake nutrient levels were low in comparison to most seepage lakes. Event sampling indicated the public boat landing area on the north shore as an area of concern each for phosphorus and nitrogen.

Management objectives should target continued monitoring, better definition and reduction of surface runoff (where possible and practical), riparian education/awareness of land use practice effects on water quality and potential use conflicts:

- Areas of concern should be assessed for nutrient and sediment contributions to surface and groundwaters. **Riparian** landowner education and awareness regarding yard practices should be emphasized and measures implemented where appropriate and practical.
- Water quality monitoring should be continued to track trends and develop an accurate nutrient budget. **Secchi depth** monitoring should be continued along with lake level readings. Rainfall data should be recorded as practical to supplement this data.
- A DNR fishery survey should be completed in the next five years to determine the status of fish populations.
- An exotic species watch group should be encouraged to monitor or remove exotic species when encountered. Members should coordinate with the WDNR Exotic Species Program and inform the PLIC membership and public on the hazards of exotic species as they relate to Pleasant Lake.
- Areas defined as "sensitive areas" should be designated accordingly to help protect and preserve the resource.

¹ Text terms in bold print defined in glossary (pp. vi-vii)

INTRODUCTION

Pleasant Lake is a small, hard water seepage lake located in southwest Waushara County, Wisconsin, with a small portion of the lake located in Marquette County, Wisconsin. Pleasant Lake is characterized by good water quality with littoral bottom materials comprised of primarily sand and marl. The lake basin is a fairly deep; roughly fifty percent of its area is greater than 20 feet deep. Groundwater from a primarily forested watershed is the major source of inflow to Pleasant Lake.

The Pleasant Lake Improvement Corporation (PLIC) was formed in the early to mid 1940's to provide leadership and coordination of lake preservation and educational activities pertinent to Pleasant Lake. Currently, the PLIC has nine elected board members and about 130 members overall (4). Major concerns of the PLIC in development of a lake management plan included fluctuating water levels, general water quality maintenance and excessive recreational use.

The PLIC, in 1993, decided to pursue development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. The PLIC officers selected IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin as its consultant to assist with

development of the plan. A grant application, incorporating required or recommended program components and the following objectives, was prepared, submitted, and approved in October 1993:

- assessment of current water quality in Pleasant Lake and implementation of a monitoring strategy to track trends,
- conduct recreational use survey of landowners,
- review of historic information,
- identify environmentally sensitive areas in need of protection.

This report summarizes and presents conclusions based on Phase I management planning efforts for Lake Management Plan, Pleasant Lake, Waushara County, Wisconsin. Specific physical properties of the resource, preliminary methods, and other introductory and technical information are described or discussed in text.

DESCRIPTION OF AREA

Pleasant Lake (T18N R8E S33) is a natural 126 acre seepage lake (i.e., with no permanent inlet or outlet) located primarily in the Town of Coloma (North) and Springfield (South), in Waushara County, Wisconsin (Figure 1). Pleasant Lake has a moderately deep basin with a maximum depth of about 30 feet, a mean depth of 15 feet and a volume of 1890 acre-feet (5). Like other seepage lakes, Pleasant Lake has a long residence time, a comparatively small watershed and commonly reflects groundwater level and rainfall patterns.

Physicochemical characteristics of natural lakes tend toward a state of dynamic equilibrium (e.g., seasonally variable but relatively consistent within the framework over the long-term) as defined by basin morphometry and watershed characteristics. Area, soil and cover types, slopes and land uses all directly and indirectly influence the Pleasant Lake resource.

Major soil types near Pleasant Lake are excessively drained Coloma loamy sands on 2-12 percent slopes, Okee loamy sand on 2-12 percent slopes, Boyer loamy sand on 6-12 percent slopes and Plainfield sand on 6-30 percent slopes (6). Permeability is moderate to rapid and the soils are generally unsuited for septic systems because of steep slope (Okee) or inability to filter septate (Boyer, Coloma, Plainfield).

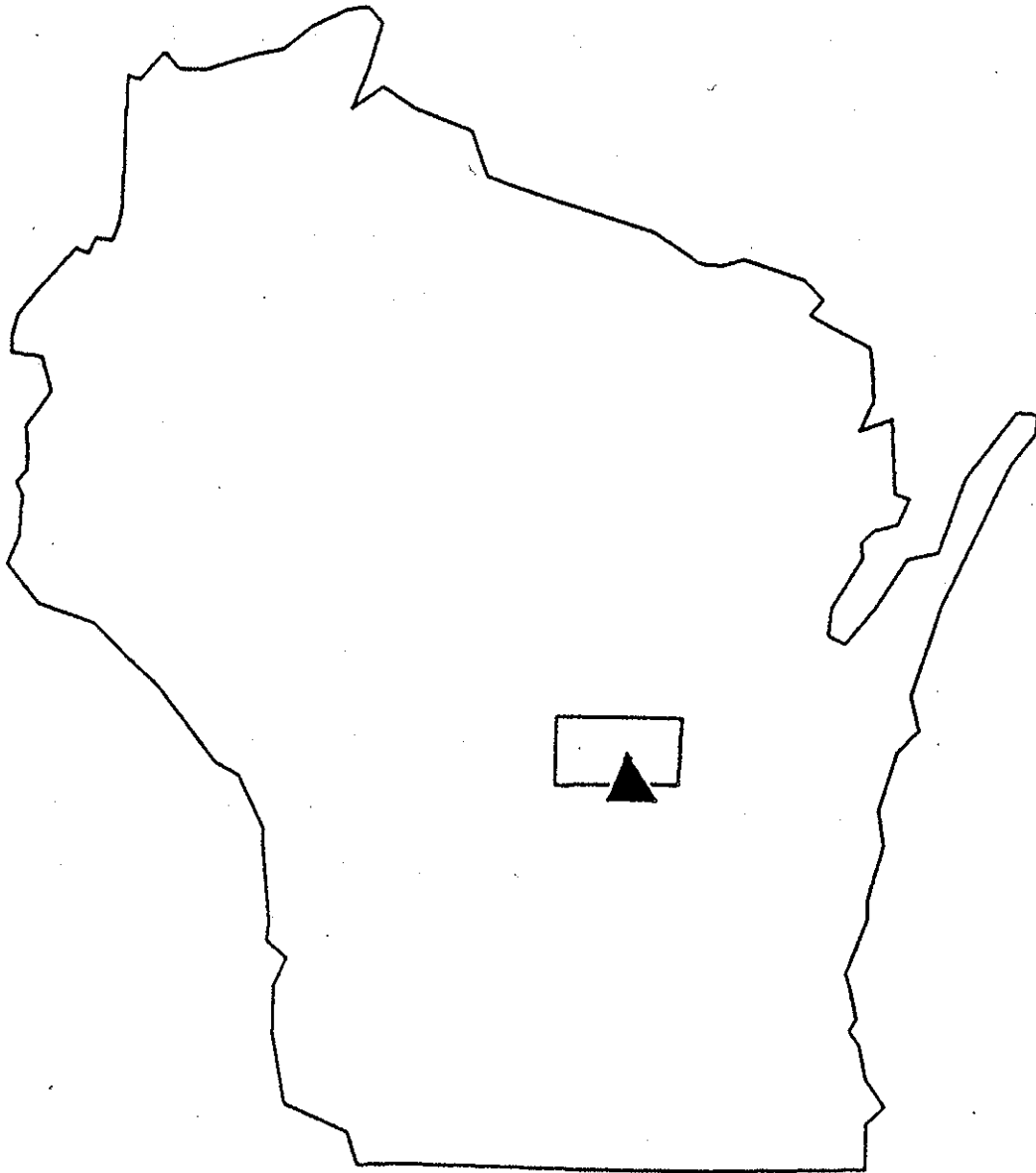


Figure 1. Location Map, Pleasant Lake, Waushara County, WI.

Public lake access is available at two locations. A paved boat ramp, with available parking, is maintained by Waushara County on the north shore, and an unpaved boat ramp in Marquette County on the southwest shore.

Pleasant Lake supports fish species including northern pike (Esox lucius), yellow perch (Perca flavescens), largemouth bass (Micropterus salmoides), rock bass (Ambloplites rupestris), bluegill (Lepomis macrochirus), black crappie (Pomoxis nigromaculatus), pumpkinseed (Lepomis gibbosus), black bullhead (Ictalurus melas), white sucker (Catostomus commersoni) and warmouth bass (Lepomis gulosus) (5). The most recent Wisconsin Department of Natural Resources fish survey (conducted June 13, 1960) indicated a very good fish population but unsuccessful northern pike hatches several years prior (7). Also, there is a significant number of ducks, coots, Canada geese, loons, great blue herons and a number of other waterfowl species that use the lake during annual migration.

METHODS

Watershed Characteristics

Watershed information was entered into the AGNPS (Agricultural NonPoint Source) computerized modeling program (8). The AGNPS program is commonly used for intense watershed analysis. Because of large informational needs for analysis, the program was used as a mapping tool for the Pleasant Lake project.

Parameters entered into the 192 cell (cell = 10 acres) database included soil type, slope, flow and cover type information. Cover type and flow information was taken from the United States Geological Survey 7.5' quadrangles for the area (9); soils information was taken from the Waushara County Soils Survey (6). A weighted average was assigned for slope and other numeric data while absolute information (cover and soil type) was recorded as the category with the greatest area for the cell.

Water Quality Monitoring

Pleasant Lake water samples were taken from Station 2201 (deepest point) during January, May, June, July, and September, 1994 and March, May, June, July, and August, 1995 (Table 1, Figure 2). Samples were taken from three feet below the surface (designated "S") and three feet above bottom (designated "B").

Table 1. Sampling Station Descriptions, Pleasant Lake, 1994 - 1995.

REGULAR MONITORING

<u>Site</u>	<u>Depth</u>
2201	30 feet

EVENT MONITORING

<u>Site</u>	<u>Description</u>
22E1	Overland flow - near boat landing on north shore of Lake.
22E2	Sample collected near boat landing
22E3	Sample collected near boat landing
22E4	Sample collected near boat landing after 3 hours of rain.

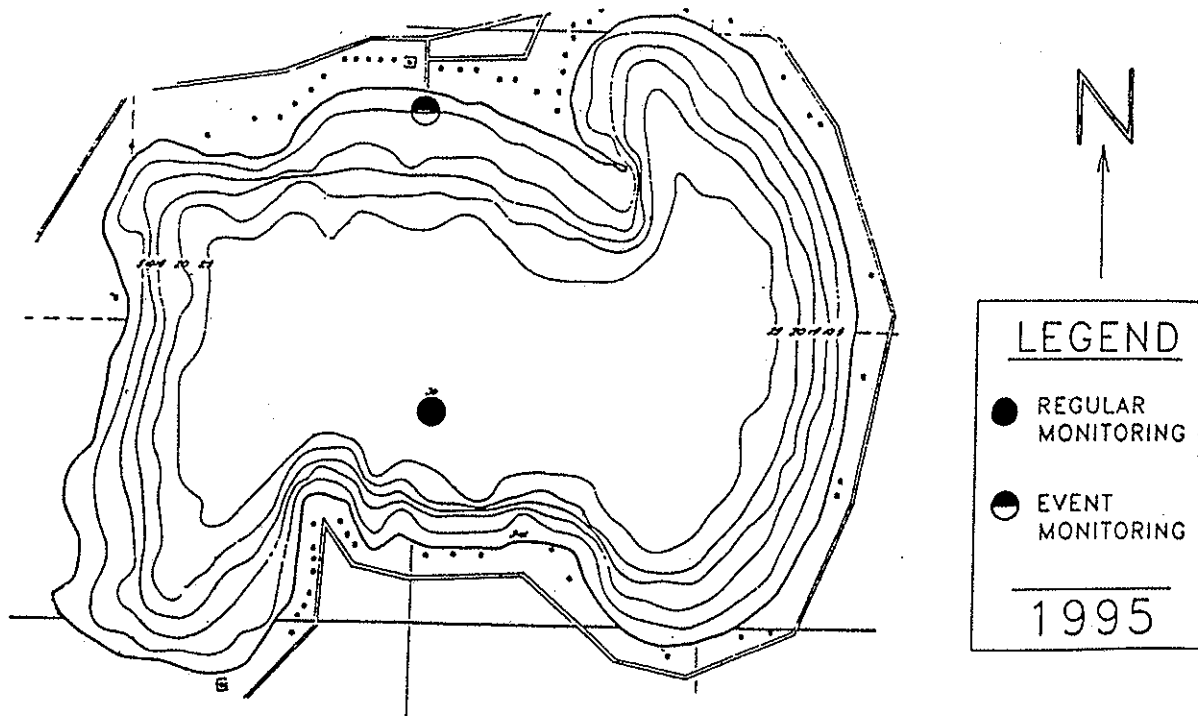


Figure 2. Sample Station Location, Pleasant Lake, Waushara

Secchi depth, water temperature, pH, dissolved oxygen (DO), and conductivity were measured in the field. Field measurements were taken using a standard Secchi disk and a Hydrolab Surveyor II; Hydrolab data were adjusted for meter drift based on calibration prior to and subsequent to daily use (manufacturers recommended procedure).

Water samples were taken for laboratory analyses with a Kemmerer water bottle. Samples were labeled, preserved if necessary, and packed on ice in the field; samples were delivered via overnight carrier to the State Laboratory of Hygiene (Madison, WI) for analysis using WDNR or APHA (10) methods. Spring parameters determined by the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus, total solids and chlorophyll a. Summer and late Summer laboratory analyses included total phosphorus, dissolved phosphorus and chlorophyll a.

Event Monitoring

In addition to regular monitoring sites, an event sampling site was established (Figure 2) to help assess the extent of nutrient inflow. The event sample site was located at the public boat access. Samples were collected by members of the PLIC (with IPS instruction) on June 5, June 28, July 4, August 3, and August 18, 1994.

Staff Gage

Measurement of changes in lake level, and determination of water flow into and out of a lake, can help assess the annual nutrient, organic matter, and sediment loads to a lake. A staff gage was constructed and positioned in the lake to record water levels associated to groundwater inflow and seasonal variations in the local water table. The enamel staff gage was purchased with funds provided by the PLIC and positioned in the lake by IPS on June 15, 1995.

Recreational Use

A recreational use survey of the PLIC membership was conducted to obtain property and lake use, water use opinions and demographics information. About 100 questionnaires were distributed (one per household) by PLIC neighborhood volunteers. A sample survey questionnaire is included in Appendix I.

Public Involvement Program

Public involvement activities were coordinated to inform and educate the PLIC about lake management and specifics regarding the Pleasant Lake resource. Activities included news releases, IPS newsletters, meeting attendance and presentations to the PLIC. A summary of public involvement activities is outlined in Appendix II.

Land Use Information

Details of zoning and specific land uses were obtained from the United States Soil Conservation Services soil maps (6), aerial photographs, United States Geological Survey quadrangle maps and the Waushara County Land Conservation Department. This information, when considered questionable or out-dated, was confirmed by field reconnaissance.

Exotic Species

Visual observation [including a full shoreline cruise and in-lake observations (raking)] were made throughout the Phase I period to document the occurrence of exotic species. Target species included Eurasian Water Milfoil (*Myriophyllum spicatum*), Purple Loosestrife (*Lythrum salicaria*) and Zebra Mussels (*Dreissena polymorpha*).

FIELD DATA DISCUSSION

Watershed Characteristics

Water quality in Pleasant Lake is influenced by watershed characteristics. Watershed area, soil and cover types, slopes and land uses all directly and indirectly influence the Pleasant Lake resource.

AGNPS program results for the Pleasant Lake watershed:

- Slopes - 0-5% (770 acres, 43%), 5.1-10% (710 acres, 39%), 10.1-15% (240 acres, 13%), 15.1-17% (90 acres, 5%) (Figure 3).
- Cover types - forested (1180 acres, 65%), open/agricultural (630 acres, 35%) (Figure 4).

Areas of concern include sand soils with nearly level slope (0 - 5%) which are prone to rapid infiltration with greater potential for groundwater contamination (Figure 5).

Water Quality Monitoring

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. Pleasant Lake surface total phosphorus levels (ave. = 0.009, median = 0.008, σ = 0.004 mg/l)

(Table 2, Figure 6) were well below expected levels for seepage lakes (ave. = 0.021, median = 0.015, σ = 0.028 mg/l), drainage lakes (ave. = 0.040, median = 0.025, σ = 0.064) and lakes in the central region of Wisconsin (ave. = 0.020, median = 0.012, σ = 0.021) (11). NOTE: Some total phosphorus data are indicated to have exceeded the recommended holding time before analysis. A study has shown, however, that phosphorus data remains accurate for samples analyzed well after the 28 day holding time (12).

Surface total nitrogen levels were lower (ave. = 0.370, median = 0.380, σ = 0.035) (Table 2, Figure 7) than expected levels for seepage lakes (ave. = 0.760, median = 0.640, σ = 0.570), drainage lakes (ave. = 0.950, median = 0.830, σ = 0.550), and lakes in the central region of Wisconsin (ave. = 0.720, median 0.690, σ = 0.310) (11). Surface N/P ratios greater than 15 indicated Pleasant Lake to be phosphorus limited during 1994 - 1995 Phase I activities.

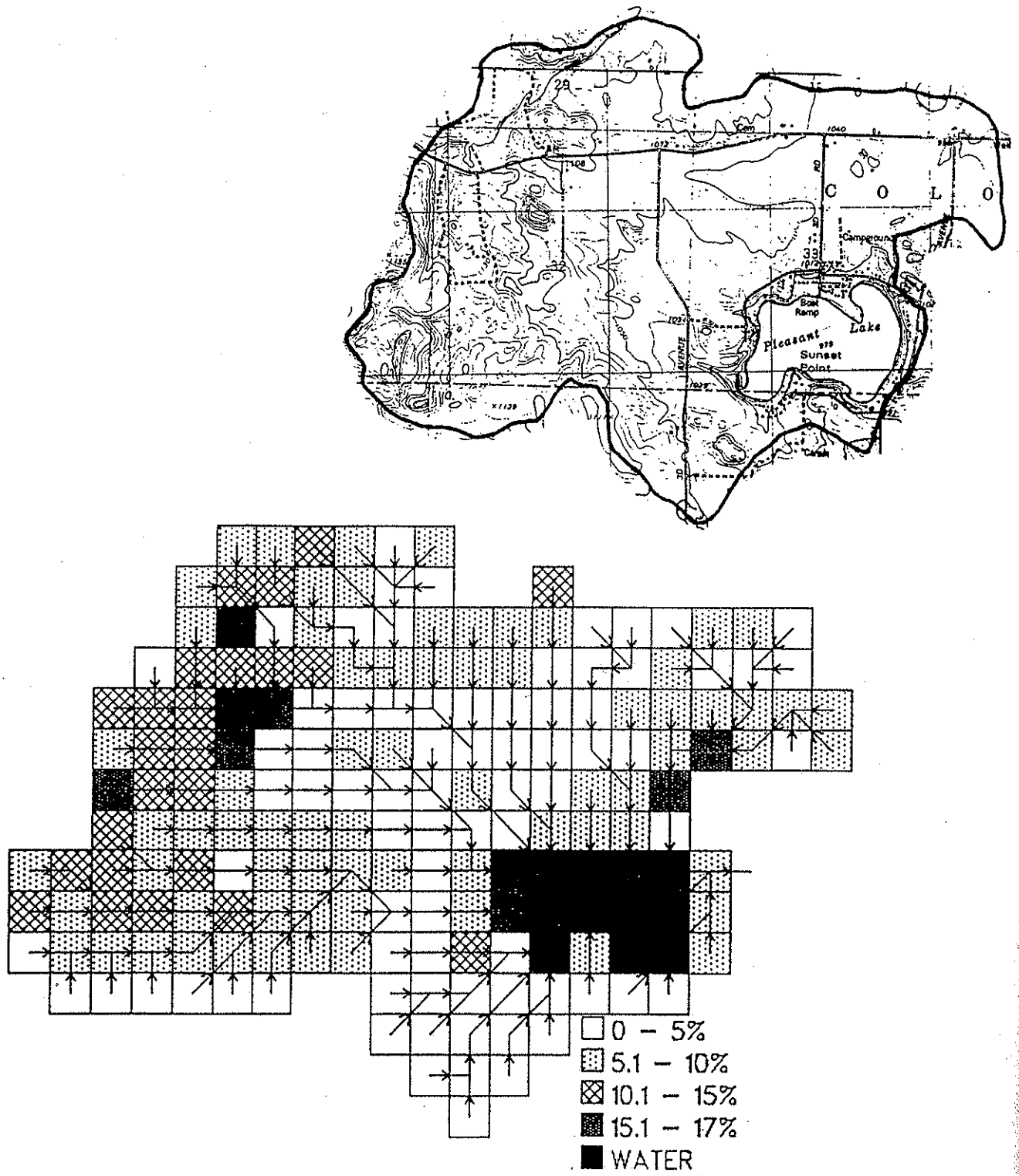


Figure 3. Watershed Land Slopes, Pleasant Lake, Waushara County, WI.

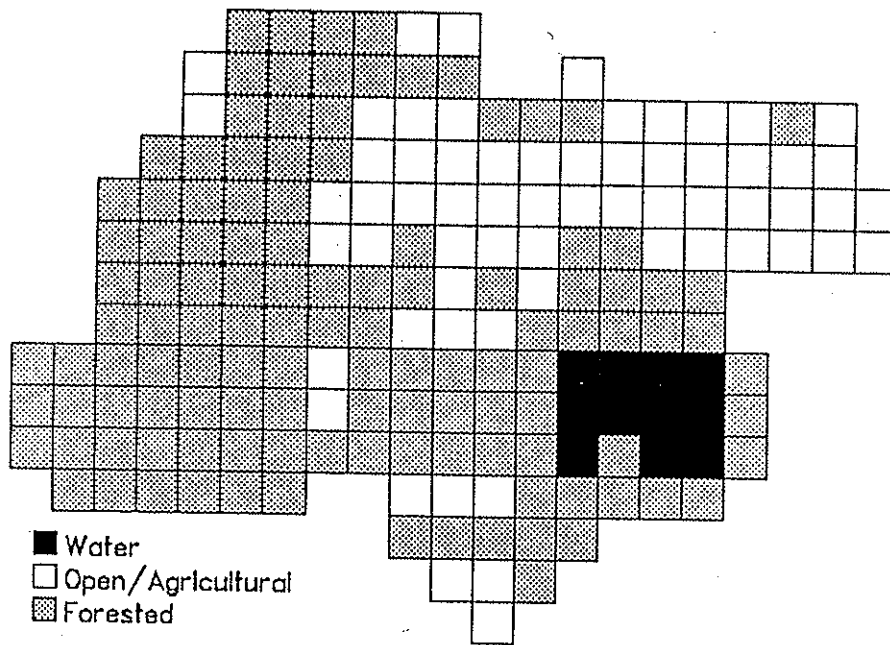


Figure 4. Watershed Cover Types, Pleasant Lake, Waushara County, WI.

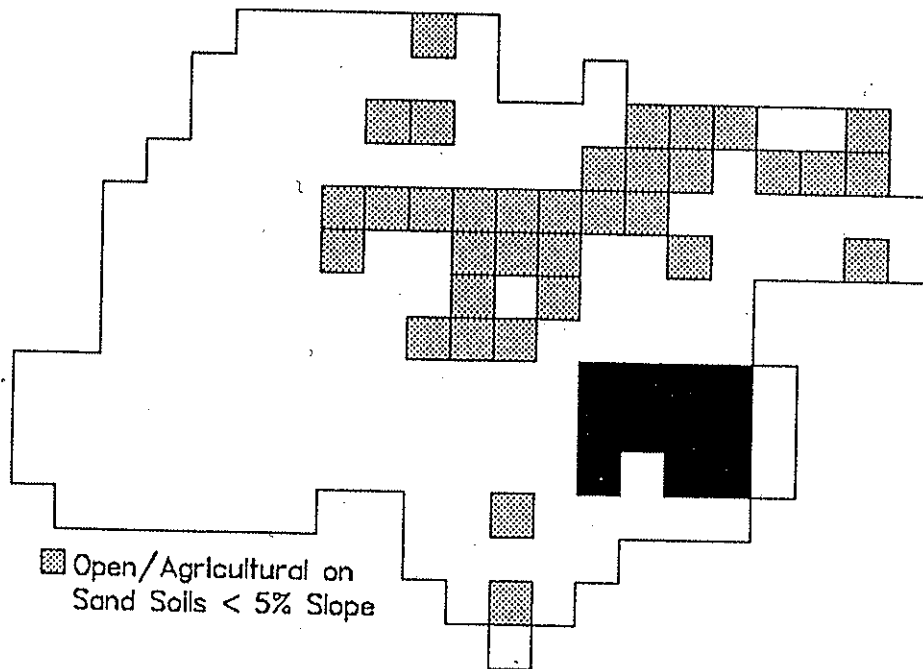


Figure 5. Open/Agricultural Areas on Sand Soils with less than 5% Land Slope, Pleasant Lake, Waushara County, WI.

Table 2. Water Quality Parameters, Station 2201, Pleasant Lake, January, 1994 - August, 1995.

PARAMETER	SAMPLE ¹	DATE									
		01/31/94	05/09/94	06/28/94	07/27/94	09/07/94	03/01/95	05/15/95	06/15/95	07/25/95	08/22/95
Secchi (feet)		NR ²	21.2	8.3	20.7	10.8	NR	16.5	19.4	11.6	12.3
Cloud Cover (percent)		0	0	70	50	30	0	0	0	5	0
Temperature (degrees Celsius)	S	4.13	13.22	24.91	23.33	20.19	5.28	12.96	21.09	25.82	25.43
	B	4.71	13.08	19.52	22.77	19.95	4.99	11.41	17.62	22.82	23.98
pH (surface units)	S	7.18	8.29	8.18	8.03	7.69	NR	8.83	8.43	9.08	8.18
	B	6.57	7.93	8.10	7.73	7.67	8.31	8.43	7.92	8.42	7.16
D.O. (mg/l)	S	12.68	11.34	9.06	7.75	7.05	NR	11.37	10.02	8.42	7.31
	B	7.72	11.43	NR	5.11	6.83	NR	11.21	7.91	7.71	2.47
Conductivity (umhos/cm)	S	257	248	224	232	215	255	243	237	236	238
	B	269	248	235	246	215	259	245	252	270	286
Laboratory pH (surface units)	S	NR	8.40	NR	NR	NR	NR	8.66	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Alkalinity (mg/l)	S	NR	134	NR	NR	NR	NR	125	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Solids (mg/l)	S	NR	162	NR	NR	NR	NR	156	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	S	NR	0.2	NR	NR	NR	NR	0.3	0.4	NR	0.4
	B	NR	0.4	NR	NR	NR	NR	0.6	0.4	NR	NR
Ammonia Nitrogen (mg/l)	S	NR	0.061	NR	NR	NR	NR	ND ³	ND	NR	ND
	B	NR	0.054	NR	NR	NR	NR	ND	0.042	NR	NR
NO ₂ + NO ₃ Nit. (mg/l)	S	NR	0.129	NR	NR	NR	NR	0.053	ND	NR	ND
	B	NR	0.068	NR	NR	NR	NR	0.038	ND	NR	NR
Total Nitrogen (mg/l)	S	NR	0.329	NR	NR	NR	NR	0.353	0.4	NR	0.4
	B	NR	0.454	NR	NR	NR	NR	0.638	0.4	NR	NR
Total Phosphorus (mg/l)	S	<0.004	0.009	0.010	0.007 ⁴	0.017 ⁴	0.007	0.008	ND	0.008	0.009
	B	0.006	0.009	0.012	0.007 ⁴	0.011 ⁴	0.010	0.035	ND	0.011	0.015
Dissolved Phos. (mg/l)	S	ND	ND	0.002	0.003	ND	NR	ND	ND	ND	0.004
	B	ND	ND	ND	ND	ND	NR	ND	0.002	ND	0.005
Nit./Phos Ratio	S	--	36.6	--	--	--	--	44.12	--	--	44.4
	B	--	50.4	--	--	--	--	18.23	--	--	--
Chlorophyll a (ug/l)	S	NR	3.94	3.16	2.37	4.01	NR	4.5	2.3	0.35	3.2

¹ S = surface, B = bottom; ² NR = no reading; ³ ND = not detectable; ⁴ holding time exceeded by SLOH

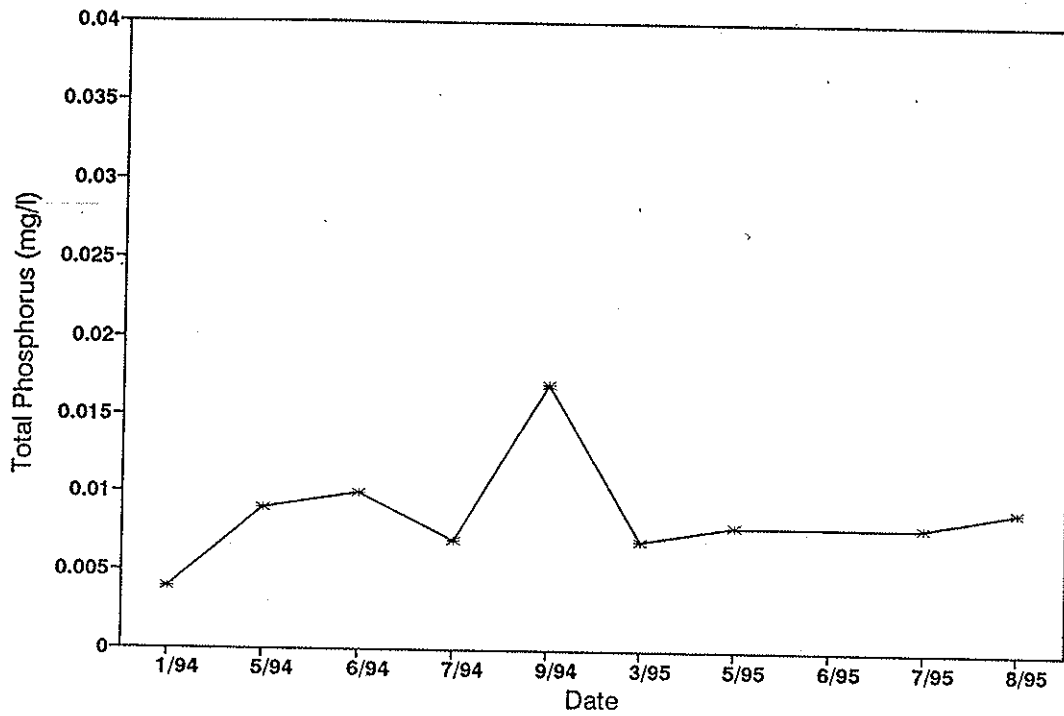


Figure 6. Total Phosphorus Trends for Pleasant Lake, 1994 - 1995.

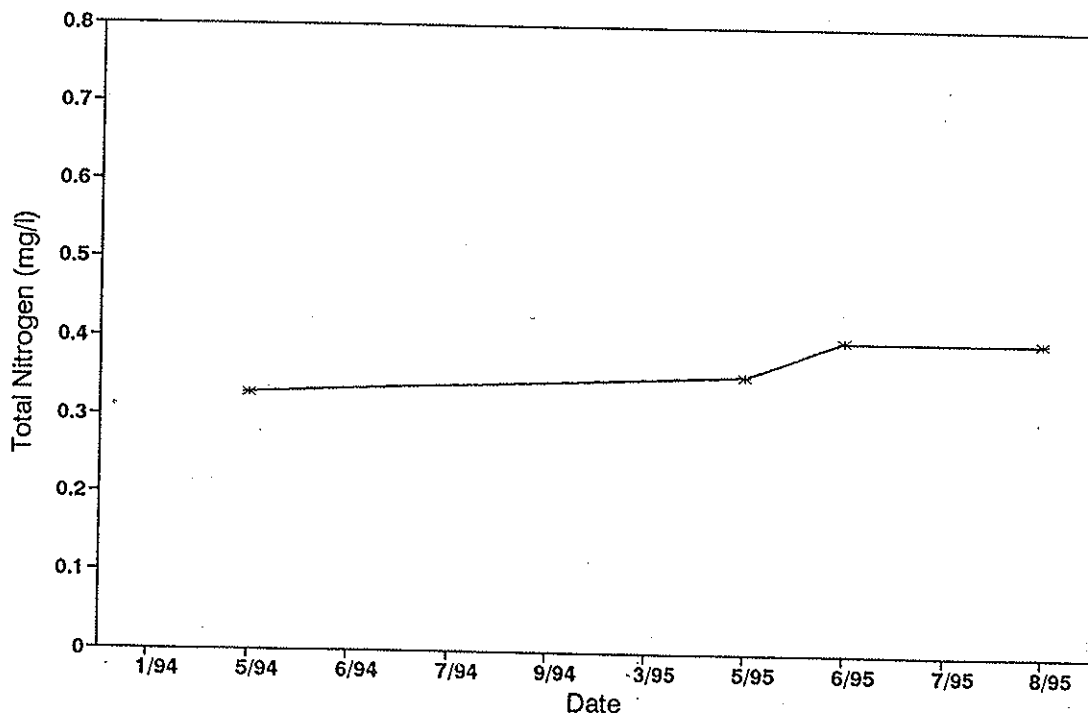


Figure 7. Total Nitrogen Trends for Pleasant Lake, 1994 - 1995.

Event Monitoring

Event monitoring (near public boat landing) indicated significantly higher total phosphorus levels compared with the in-lake site (Table 3). The average event total phosphorus level was 0.387 mg/l (median 0.066, $\sigma = 0.033$); highest total phosphorus was observed August 3, 1994.

Higher than expected total nitrogen levels were also observed during event monitoring (Table 3). Total nitrogen levels ranged from 0.407 to 1.698 mg/l with an average of 0.888 mg/l for all in-lake samples collected. The extreme level (12.306 mg/l) of total nitrogen was collected on August 3, 1994, as surface runoff prior to entering lake.

Other indicators of lake eutrophication status include light penetration and algal production. Numerous summative indicies have been developed, based on combination of these and other parameters, to assess or monitor lake eutrophication or aging. The Trophic State Index (TSI) developed by Carlson (13) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indicies, application is generally most appropriate on a relative and trend monitoring basis. This particular index does not account for natural, regional variability in total phosphorus levels nor in Secchi transparency reduction unrelated to algal growth (e.g. that associated with color).

Table 3. Event Nitrogen and Phosphorus Parameters (in milligrams per liter), Pleasant Lake, Waushara County, 1994 - 1995.

DATE	PARAMETER	
<u>06-05-94</u> 22E1	TKN	0.4
	NH ₄ -N	0.018
	NO ₂ +NO ₃ -N	0.007
	Tot. N	0.407
	Tot. P	0.007
	Diss. P	ND
<u>06-28-94</u> 22E2	TKN	0.9
	NH ₄ -N	0.036
	NO ₂ +NO ₃ -N	0.029
	Tot. N	0.929
	Tot. P	0.050
	Diss. P	ND ¹
<u>07-04-94</u> 22E3	TKN	0.5
	NH ₄ -N	0.043
	NO ₂ +NO ₃ -N	0.019
	Tot. N	0.519
	Tot. P	0.066
	Diss. P	0.007
<u>08-03-94</u> 22E1 ²	TKN	11.47 ³
	NH ₄ -N	0.621
	NO ₂ +NO ₃ -N	0.836
	Tot. N	12.306
	Tot. P	1.71 ³
	Diss. P	0.075
<u>08-18-94</u> 22E4	TKN	1.26 ³
	NH ₄ -N	0.853
	NO ₂ +NO ₃ -N	0.438
	Tot. N	1.698
	Tot. P	0.103 ³
	Diss. P	0.015

¹ ND = not detectable; ² lake access runoff; not a lake sample; ³ holding time exceeded by SLOH

Low total phosphorus and chlorophyll a TSI values for Pleasant Lake were typical of oligotrophic to mesotrophic conditions with early indications of eutrophic conditions. Low Secchi depth TSI values were typical of a oligotrophic classification (Figure 8).

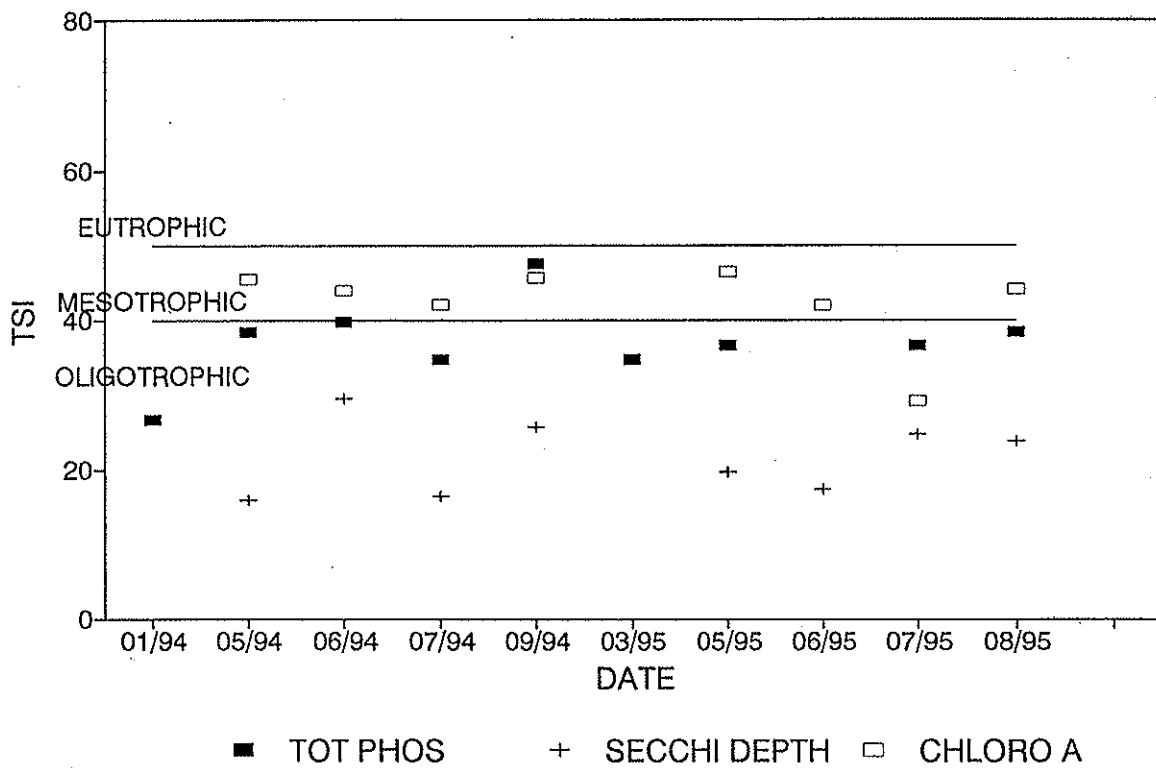


Figure 8. Trophic State Index for Secchi Depth, Total Phosphorus and Chlorophyll a, Pleasant Lake, Waushara County, WI, 1994 - 1995.

Recreational Use

About 12% of all Pleasant Lake respondents indicated they were permanent residents. Average occupancy for all respondents was 5.7 weeks (Table 4); seasonal residents averaged 7.3 months. Occupancy was greatest during summer (Figure 9).

Table 4. Comparison of Recreational Use Parameters, Pleasant Lake, Waushara County, WI.

Parameter	
Average weekly occupancy	5.7
Average number of watercraft (per response)	2.5
Average number of adults (per respondent household)	2.4
Average number of children 12 - 18 years old (per respondent household)	0.2
Average number of children less than 12 years old (per respondent household)	0.6
Percent of respondents leaving comments	46

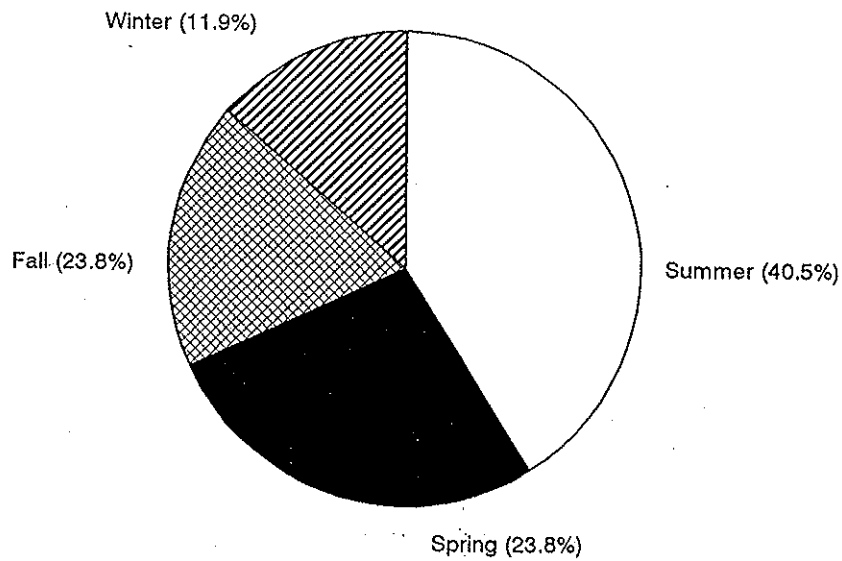


Figure 9. Seasonal Use for Pleasant Lake, Waushara County, WI.

Respondents indicated a total of 262 watercraft with an average of 2.5 per household. Most common watercraft types (in order) were row/paddle boats, boats with greater than 25 horsepower motors, boats with less than 25 horsepower motors and canoes or kayaks (Figure 10).

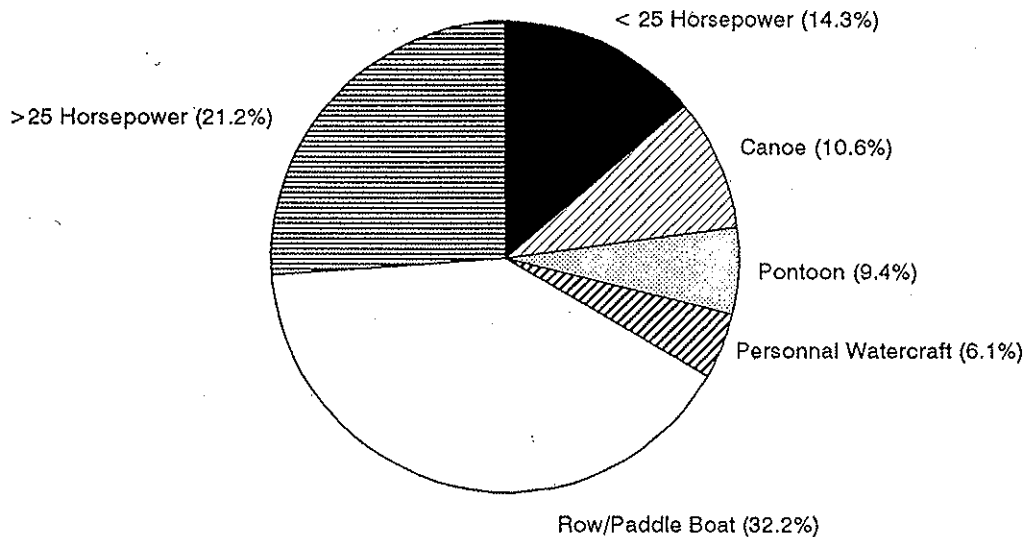


Figure 10. Most Commonly Reported Watercraft Types, Pleasant Lake, Waushara County, WI, 1995.

Pleasant Lake resident respondents agreed (71% "strongly agree" or "agree" responses) there are too many watercraft [primarily on weekends and holidays (Appendix II)] and that the number of watercraft cause safety problems (71%) [primary cause identified as non-resident watercraft (68%)] and diminish user enjoyment (Table 5).

Table 5. Percentage of "Strongly Agree" and "Agree" Responses, Pleasant Lake, Waushara County, WI.

Opinion	
There are too many watercraft on Pleasant Lake	71
The current number of watercraft causes safety problems	71
There is adequate water safety enforcement:	
weekdays	67
weekends	32
holidays	29
The current number of watercraft diminishes aesthetics:	
weekdays	24
weekends	57
holidays	67
The causes of water safety problems:	
private residential watercraft	22
non-residential watercraft	68
other	10
Additional water use regulations need to be enacted and enforced	45
There should be limits set on the number of watercraft	52
There is adequate public boater access to Pleasant Lake	96
There should be a public swimming beach on Pleasant Lake	35

They agreed there was adequate water safety enforcement on weekdays (67%); considerably fewer agreed for weekends (32%) and holidays (29%). Overall consensus was somewhat against the enactment of more ordinances (55% "strongly disagree" or "disagree" responses) and nearly evenly split on the need for limiting boat numbers (52% "strongly agree" or "agree" responses).

Respondents agreed (96% "strongly agree" or "agree" responses) there is adequate public boater access to Pleasant Lake and generally disagreed (65%) there should be a public swimming beach. They also agreed that during peak use (holidays) the current number of water craft diminish the ability to enjoy Pleasant Lake aesthetics (67%); fewer agreed for weekends (57%) and weekdays (24%) (Appendix II).

Exotic Species

Eurasian Water Milfoil was not observed in Pleasant Lake (aquatic plant observations, 1994 - 1995). There were also no observations of Zebra Mussels or Purple Loosestrife plants.

Eurasian Milfoil plants possess leaves with 12-15 pairs of leaflets and red tinged stems and shoots (characteristics normally associated with Eurasian Milfoil). Eurasian Milfoil, when present, can spread quickly, and is known to occur at

nuisance levels (14) and often displaces more desirable native vegetation and can alter plant and animal assemblages within a lake. Milfoils are able to reproduce by seeds, winter buds, and by fragmentation (15). If Eurasian milfoil becomes established, care must be taken to remove all cut plants when harvesting to avoid introduction of the plant to previously unpopulated areas.

Purple loosestrife is an exotic plant with a bright purple flower, originally propagated in the United States by the horticulture industry for flower gardens. It blooms late June to July and produces seeds soon after. The plant is able to outcompete native wetland vegetation and modify entire plant (and thus animal) assemblages.

Zebra mussels look like small clams with a yellowish and/or brownish "D"-shaped shell, usually with alternating dark and light bands of color. Most are under an inch long and usually grow in clusters containing numerous individuals and are generally found in shallow (6 to 30 feet deep), algae-rich water. They are the only freshwater mollusk that firmly attaches itself to solid objects, including rocks, boat hulls, etc.

BASELINE CONCLUSIONS

Watershed Characteristics

Areas of concern for the watershed include a combination of steep shorelines, sandy soils with low slopes and particular areas which provide ecological importance in preserving the resource.

As part of the Phase I elements ecologically sensitive areas were identified. "Sensitive areas" designation is described in Chapter NR 107 of the Wisconsin Administrative Code. In Section 107.05 (3(i)) it is stated that "Sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water". The southwest bay (Turtle Bay) and south shoreline provide important spawning and feeding grounds for the lake's fishery. The sand and gravel bar which extends from the north shore also provides an important panfish nesting area.

Water Quality

Regular water quality monitoring in Pleasant Lake during Phase I indicated good to very good water quality. Surface total phosphorus levels generally exhibited weak and variable seasonal trends. Total nitrogen levels tended to be slightly higher, as a

whole, and the limited amount of data did not suggest seasonal trends. Good water quality appears to be related to a combination of substantial groundwater inflow and a primarily wooded watershed. In-lake phosphorus levels were near or below levels expected for stratified lakes, lakes in the central region of Wisconsin and lakes in the ecoregion in which Pleasant Lake is located.

Nutrient inputs (and probably sediment) from the immediate watershed appear significant as higher levels of nitrogen and phosphorus were observed entering the lake via the public access area on the north shore of the lake.

Recreational Use

Pleasant Lake respondents generally agreed watercraft use is high and that the current number of watercraft cause safety problems. They also indicated that water safety enforcement was adequate during weekdays, but considerably fewer agreed during weekend or holiday periods of heavy recreational use. Respondents were evenly split as to limiting the number of watercraft and slightly less agreeable to additional use regulations being enacted and enforced. Respondents also tended to agree the current number of watercraft diminishes the ability to enjoy aesthetics from the water or shore during holidays. There was relatively low interest in establishment of a public swimming beach on Pleasant Lake.

Water quality protection and recreational use conflict minimization appear to be of most concern in future management objectives for Pleasant Lake.

Exotic Species

There were no observations of, Eurasian Water Milfoil, Purple Loosestrife or Zebra Mussels in Pleasant Lake. Purple Loosestrife and Eurasian Water Milfoil have become widely distributed in Wisconsin and are agents of habitat alteration and degradation.

MANAGEMENT RECOMMENDATIONS

Watershed: Management of Pleasant Lake should concentrate on better definition and reduction of nutrient inputs, via runoff to the lake. Nutrient input may be controlled to an extent by riparian land owners, but measured levels entering the lake from the extended watershed are somewhat excessive (on an event basis).

Pleasant Lake is significantly influenced by groundwater and receives surface water inflow from the watershed. Residential landowners should be made aware of the potential effects of watershed uses on their resource and can also use Best Management Practices (BMP's) to control nutrients and sediment entering Pleasant Lake. Buffer stripping, composting yard wastes, fertilizer management and slope contouring are just a few practices that can be adopted to slow and absorb overland runoff. Also, "clear-cutting" on steep slopes should be avoided. A number of informational sources regarding land management are outlined in Appendix III.

It is recommended that the Pleasant Lake Association request that the "sensitive areas" be designated accordingly, as defined by Chapter NR 107 of the Wisconsin Administrative Code. It is important that these areas (i.e., Turtle Bay, Sunset Point) be protected to help preserve the Pleasant Lake resource.

Water Quality: Water quality in Pleasant Lake is currently very good but routine sampling to monitor trends and further event sampling should be continued. More extensive monitoring of the public boat access (north shore) should better define the magnitude and timing of nutrient inputs to the lake. Re-routing surface runoff to a vegetative area would help filter out nutrients and sediment prior to entering the lake and should be pursued with county assistance. Self-help secchi monitoring should be continued; rainfall monitoring should be initiated.

The Pleasant Lake fishery should be assessed in the next five years to determine the status of the fishery. An aquatic plant survey should also be implemented in order to correctly identify macrophyte communities and their densities.

Agricultural/open land owners could then implement a number of Best Management Practices (BMP's) through development of a soil and nutrient conservation plan. BMP's are sometimes costly but are often common sense approaches based on awareness of land usage. Adoption of BMP's is especially important on open, sloping, tilled, tilled and fertilized lands. Some pertinent BMP's are outlined in Appendix IV.

Recreational Use: Pleasant Lake recreational use survey results suggest that use, during summer weekends and holidays, is at or near saturation levels and that most perceive the problems

related to non-resident and private watercraft. There does not appear, however, to be a clear concensus that additional regulations are desirable to address the situation. The PLIC, then, should form a committee, or enlist some outside assistance, to address direct education or prevention measures to attempt minimization of use conflicts; these may include

- Brochures, for visitors at access points, emphasizing "water use ethics" along with information on, access points and applicable regulations and ordinances,
- Development of waste disposal facilities for boaters,
- Initiation of a reasonable ramp fee at boat landing (north shore) with the money collected directed toward access maintenance or lake management/protection activities, and
- Riparian landowners education about pertinent ordinances (dock design/size, boat numbers per pier, building near lakeshores, near-lake improvements, etc.).

Exotic Species: The three exotic species of most concern are currently not established in Pleasant Lake.

- An exotic species watch group should be organized to monitor exotic species (i.e., Purple Loosestrife, Zebra Mussels and

Eurasian Water Milfoil) within the resource. Members should coordinate with the WDNR Exotic Species Program and inform the PLIC membership and public on the hazards of exotic species as they relate to Pleasant Lake.

Public Involvement: Informational and educational programs for the PLIC membership and public should be continued. Meetings, presentations and/or newsletters should continue to include information on groundwater and surface water quality, recreational use issues and the spread or control of exotic species.

Local townships, Waushara County and the State of Wisconsin, should take a cooperative effort in protection of the Pleasant Lake resource by the regulation of land uses and land use practices. Counties should communicate to the PLIC any variances that are granted in order for the PLIC to be more aware of changes within the watershed and the possible long-term effect to water quality. Efforts should continue to pursue cost-share funding (Lake Protection Grant) to implement long term conservation practices and preserve/protect important ecological areas.

Waushara County ordinances and plans possibly pertinent to Pleasant Lake are summarized in Appendix V. Potential sources of funding are listed in Appendix VI.

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APPENDIX I
 SAMPLE RECREATIONAL USE SURVEY
 Pleasant Lake Management Plan

RESIDENT RECREATIONAL USE SURVEY
 Pleasant Lake Improvement Corporation

The Pleasant Lake Improvement Corporation (PLIC) is leading a coordinated effort to develop a Comprehensive Lake Management Plan for Pleasant Lake. One of the major work efforts for this first phase (of a potentially three-phased program) involves getting a better idea of the recreational use and general attitudes toward Pleasant Lake management. (Note: Household is here defined as your Pleasant Lake residence)

Please take the time to complete this questionnaire. After you have completed the questionnaire please mail to PLIC treasurer Lynn Templeton or bring it with you to the PLIC meeting on Saturday, May 28, 1994 at the Coloma Community Center at 10 a.m.

All replies are confidential. Please do not sign your name to the survey. Only through your help can we develop a successful, comprehensive plan! The results of the survey will be available at a later date. We thank you for your cooperation!

PROPERTY USE

1. What year did you purchase your property on Pleasant Lake? _____
 N= 99; Ave= 1974; Range= 1915-1994
2. Is your Pleasant Lake residence your primary residence?
 If not, where is your primary residence? _____
 N= 93; Primary= 11 (City, County, State)

(IF YOU DO NOT HAVE A DWELLING ON YOUR PROPERTY, GO TO #6.)

3. How many weeks per season do you occupy your dwelling on Pleasant Lake?
 Spring ____ Summer ____ Fall ____ Winter ____
 (Mar-May) (Jun-Aug) (Sep-Nov) (Dec-Feb)
 Ave= 5.4 Ave= 9.2 Ave= 5.4 Ave= 2.7
 Range= 0-13 Range= 0-21 Range= 0-13 Range= 0-13
4. Do you rent out your dwelling? (Please check (x) your response below.)
 a. Yes 4 b. No 94
 c. If yes, how many weeks per season?
 Spring ____ Summer ____ Fall ____ Winter ____
 (Mar-May) (Jun-Aug) (Sep-Nov) (Dec-Feb)
 Ave= 0.35 Ave= 0.66 Ave= 0.34 Ave= 0.34
 Range= 0-13 Range= 0-13 Range= 0-13 Range= 0-13
5. Do you let others use your dwelling? (Please check (x) you response below)
 a. Yes 37 b. No 61
 c. If yes, how many weeks per season?
 Spring ____ Summer ____ Fall ____ Winter ____
 (Mar-May) (Jun-Aug) (Sep-Nov) (Dec-Feb)
 Ave= 0.25 Ave= 1.4 Ave= 0.44 Ave= 0.08
 Range= 0-2 Range= 0-12 Range= 0-8 Range= 0-2

APPENDIX I
(continued)

WATER USE

6. Please identify the type and number of watercraft/horsepower (HP) you own.

N= 262

<u>Watercraft Type</u>	<u>Number</u>	<u>Watercraft</u>	<u>Number</u>
a. sailboat	<u>0</u>	f. Motor boat 26-50 HP	<u>14</u>
b. canoe or kayak	<u>26</u>	g. motor boat over 51 HP	<u>52</u>
c. row boat/ paddleboat (no motor)	<u>79</u>	h. personalized watercraft, i.e jet ski	<u>15</u>
d. pontoon boat	<u>23</u>	i. other, please list	<u>1</u>
e. motor boat less than 25 HP	<u>35</u>	<u>sailboarding</u>	<u> </u>

7. Do you allow others to keep water craft on your property? (Please check (x) your response below.)

a. Yes 12 b. No 87

c. If yes, please identify the type/horsepower of the water craft.

<u>Watercraft Type</u>	<u>Number</u>	<u>Watercraft</u>	<u>Number</u>
a. sailboat	<u>0</u>	f. Motor boat 26-50 HP	<u>3</u>
b. canoe or kayak	<u>4</u>	g. motor boat over 51 HP	<u>5</u>
c. row boat/ paddleboat (no motor)	<u>3</u>	h. personalized watercraft, i.e jet ski	<u>0</u>
d. pontoon boat	<u>1</u>	i. other, please list	<u>0</u>
e. motor boat less than 25 HP	<u>2</u>	<u> </u>	<u> </u>
		<u> </u>	<u> </u>

APPENDIX I
(continued)

(FOR QUESTIONS 8, 9 AND 10, THE TERM "PLEASURE BOATING" REFERS TO THE USE OF THE BOAT FOR RIDING AND SIGHTSEEING ONLY - NOT FOR FISHING OR WATER SKIING. "PONTOONING" REFERS TO PLEASURE BOATING USING A PONTOON.)

8. Please indicate how you spend YOUR time on Pleasant Lake. Please check (x) the amount of water use for each surface water use category.

Surface Water Use	Amount of Time Spent*			
	Frequently	Occasionally	Seldom	Never
a. Sailing	2	8	10	45
b. Canoeing	4	8	18	35
c. Pleasure Boating	42	29	11	4
d. Personal Water Craft (i.e., Jet Ski)	8	5	2	46
e. Water Skiing	25	30	9	13
f. Fishing	37	30	10	8
g. Swimming & Sunbathing	57	24	4	1
h. Pontooning	20	2	1	42
i. Bird Watching/ Wildlife Watching	26	23	20	16
j. Viewing Nature	26	24	11	12
k. Other - please specify		SCUBA		

- *Frequently = at least 1 time per week.
 Occasionally = at least 1 time per month.
 Seldom = 3-4 times a year.

APPENDIX I
(continued)

9. Please indicate how OTHER ADULTS (18 and over) in your household spend their time on Pleasant Lake.

Amount of Time Spent*

Surface Water Use	Frequently	Occasionally	Seldom	Never
a. Sailing	2	5	5	47
b. Canoeing	3	7	15	35
c. Pleasure Boating	30	28	13	4
d. Personal Water Craft (i.e., Jet Ski)	7	3	2	45
e. Water Skiing	30	26	7	10
f. Fishing	27	26	13	8
g. Swimming & Sunbathing	53	24	4	1
h. Pontooning	13	7	4	38
i. Bird Watching/ Wildlife Watching	21	15	14	19
j. Viewing Nature	24	16	12	16
k. Other - please specify				

- * Frequently = at least 1 time per week.
 Occasionally = at least 1 time per month.
 Seldom = 3-4 times a year.