IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE I
LAKE MANAGEMENT PLAN
MARY LAKE
LANGLADE COUNTY, WISCONSIN

REPORT TO:
Mary Lake Protection and Rehabilitation District

June, 1993

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SUMMARY

Mary Lake is a small (156 acres) natural **drainage lake**[1] (Mary Creek inlet and outlet) located on the border between Langlade and Oconto Counties, Wisconsin. Existing excellent water quality is attributable to spring inputs (to Mary Creek and Lake) and an undisturbed forested watershed almost completely within the Nicolet National Forest.

Nutrient levels are at or below those typical for the ecoregion (which are low compared to other regions); nutrient inflow to the system from the extended or immediately adjacent watershed does not appear to be significant. Transparency is such that light is able to penetrate to the entire lake bottom most of the time. Trophic State Index ratings typified **oligotrophic** to early **mesotrophic** conditions.

Lake level, a major concern of Mary Lake riparian landowners, is controlled by a series of beaver dams on the outlet stream. Water levels for the period 1989 - 1992 varied almost two feet; this variability is aesthetically, and probably ecologically, significant given an average lake depth of only five feet. Levels appeared to drop significantly when natural or human activities affected the dams. Levels did not exceed the Ordinary High Water Mark, but fell below the recommended minimum level (available staff gage readings) several times during the period.

Recreational use of Mary Lake is reported to be light. The lake receives most use during Summer months, mainly in non-consumptive activities such as viewing nature, wildlife watching, fishing and swimming/sunbathing. More aggressive activities such as water and jet skiing and sailing were less popular.

Riparian sanitary systems were reported to be adequately maintained. On-site water sampling near suspected failing systems suggested that the systems were operating adequately.

Management objectives and recommendations were designed to increase the knowledge of Mary Lake, track trends and control lake levels:

* 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 supplement the relatively small amount of information available. **Secchi depth** monitoring should be continued along with lake level readings. Rainfall data should be recorded as practical to supplement this data. Event testing of areas of concern may be implemented.

* Efforts should be made to verify the level of the current gage. Also, reassessment of the Ordinary High Water Mark (OHWM) and the recommended minimum level for the Mary Lake resource seems necessary. Lake level fluctuation, which can reduce spawning success, cause flooding and disrupt plant growth in and around the lake should be controlled. Installation of a beaver pipe may help to alleviate this problem.

* Public access to the lake may be improved, particularly since public access via the private ramp has been discontinued. A ramp on the north shore of the lake was installed years ago but has since deteriorated.

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

INTRODUCTION

Mary Lake is located primarily in the Town of Wolf River in east-central Langlade County, Wisconsin, and extends into the Towns of Townsend and Doty, Oconto County. Mary Lake is a natural drainage lake with a permanent inlet (Mary Creek) and a permanent outlet (also Mary Creek). Groundwater from a forested watershed is the major source of inflow to Mary Lake and Creek.

The Mary Lake Protection and Rehabilitation District (MLPRD) was formed in 1989 to provide leadership and coordination of lake preservation and educational activities pertinent to Mary Lake. Major concerns of the MLPRD in development of a lake management plan included fluctuating water levels and general water quality maintenance. Currently, the MLPRD has two elected commissioners and about 30 voting members. Representatives from the Town of Wolf River and Langlade County also serve as commissioners.

The MLPRD, in 1991, decided to pursue development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. The MLPRD 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 1991:

- determine lake water quality and track trends,
- identify impacts to water quality based on lake levels,
- identify potential nonpoint source loads to the lake,
- increase awareness of lake property owners of lake problems and establish a base of support for lake management efforts.

A meeting of the Advisory Committee (comprised of representatives from MLPRD, IPS and WDNR) was scheduled but cancelled due to an illness related absence of the field biologist. In lieu of scheduling another full Committee meeting, input relative to program guidance and direction was solicited and received from each Committee member.

DESCRIPTION OF AREA

Mary Lake (T33N R14E S36) is a drainage lake located in the Nicolet National Forest on the border of Langlade and Oconto Counties, Wisconsin (Figure 1). The Mary Lake watershed is predominantly forested with wooded residential areas bordering the southeast corner of the lake.

The general topography of Langlade County is related to glacial activity. Land topography in the general area is level to steeply sloping; topography immediately adjacent to the basin varies from level to moderately steep. Major soil types in the Mary Lake area are well drained Antigo silt loams on 2-15 percent slopes (North), well drained Pence sandy loams on 2-45 percent slopes (North and West) and Vilas loamy sands on 0-6 percent slopes (South and East). Soil permeability is moderate (Antigo) to rapid (Vilas) and runoff is slow (Vilas) to rapid (Pence) (4).

Mary Lake has a surface area of 156 acres, a maximum depth of about 10 feet, an average depth of 5 feet and a volume of 780 acre-feet (5). Over 30% of the lake surface area is less than three feet deep and light usually penetrates to the entire lake bottom. Mary Lake water level is controlled by beaver dams on the outlet stream. The **fetch** is 0.6 miles (southwest-northeast orientation) and the width is 0.5 miles (northwest-southeast)

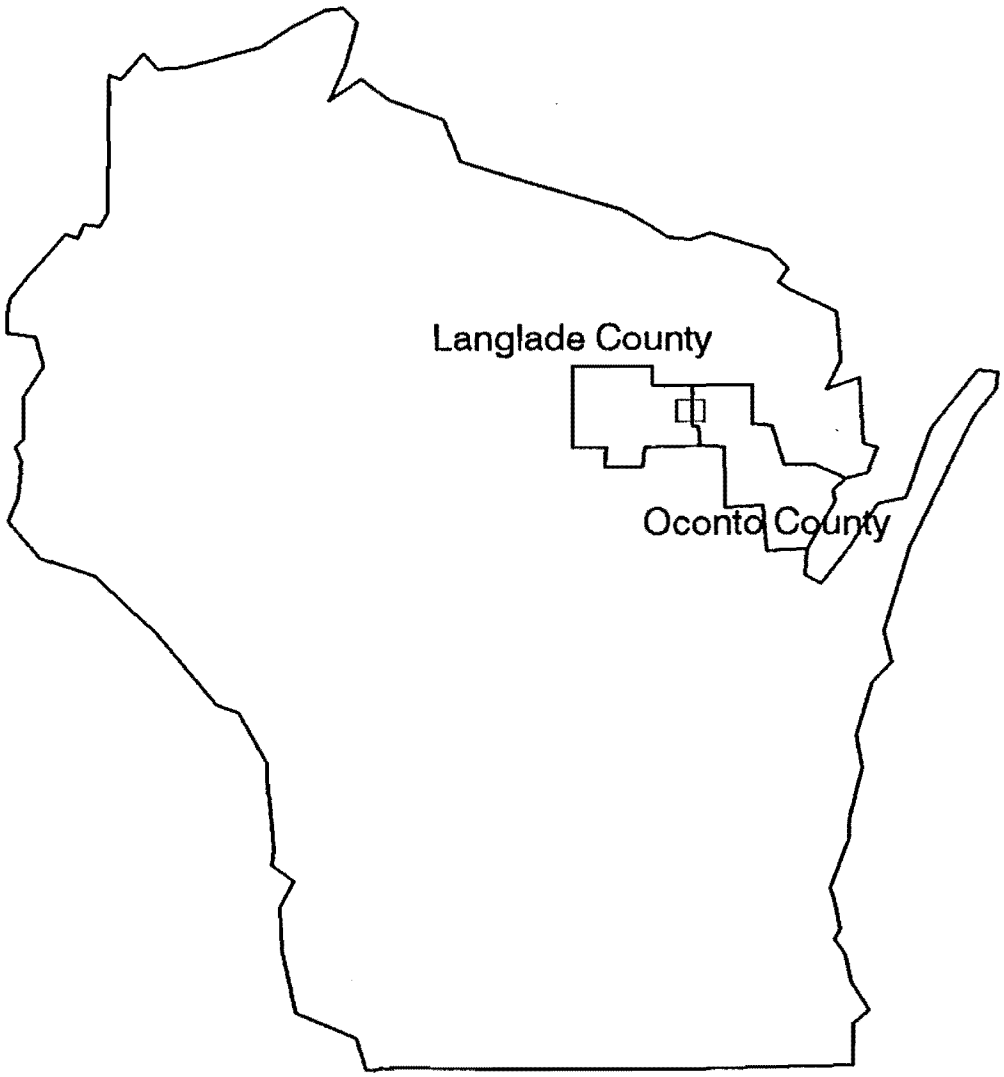

Figure 1. Location Map, Mary Lake, Langlade County, WI.

orientation. Mary Lake has 1.95 miles of shore and is nearly circular with a **shoreline development factor** of 1.25 (6).

The watershed is about 3000 acres and almost completely forest; about 10 homes border the lake. The watershed to lake ratio is about 19.2 to 1 which means that 19.2 times more land than lake surface area drains to the lake. **Residence time** was not available for Mary Lake but back-calculations (using linear regression equations) against the watershed to lake ratio estimated the residence time to be 0.45 (7) to 1.02 years (8).

Predominant **littoral** substrates include **marl** (50%), sand (20%), gravel (20%) and muck (10%) (6). Mary Lake fish species include largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), white sucker (Catostomus commersoni), johnny darter (Etheostoma nigrum) and golden shiner (Notemigonus crysoleucas) (6).

Public access, classified as wilderness in public ownership (5), is available on the north shore, but the landing has not been recently improved and generally restricts users to carry-in access. A private campground had provided boat ramp access to the public in recent years but has since closed to all but seasonal campers (Pers. comm. MLPRD).

METHODS

FIELD PROGRAM

Water samples were taken at Stations 1701 (deepest point) on January 29, April 30, July 6 and September 16, 1992; Stations 1702 (Mary Creek inlet) or 1703 (Mary Creek outlet) were sampled April 30, July 6 and September 16, 1992 (Table 1, Figure 2). Station 1701 was sampled three feet below the surface (designated "S") and three feet above bottom (designated "B"); Mary Creek stations were sampled at mid-depth (designated "M").

Physicochemical parameters measured in the field were Secchi depth, water temperature, pH, dissolved oxygen (DO), and conductivity. Field measurements were taken using a standard Secchi disk and a Hydrolab Surveyor II multiparameter meter; the Hydrolab unit was calibrated prior and subsequent to daily use.

Water samples for laboratory analyses were taken with a Kemmerer water bottle. Samples were labelled, preserved if necessary, and packed on ice in the field; samples were delivered by overnight carrier to the laboratory. All laboratory analyses were conducted at the State Laboratory of Hygiene (Madison, WI) using WDNR or APHA (9) methods. Winter water quality parameters determined by the laboratory included total Kjeldahl nitrogen,

Table 1. Sample Station Descriptions, Mary Lake, 1992.

WATER QUALITY

Regular Monitoring Sites

Site	Latitude/Longitude	Depth
1701	45° 17' 35" 88° 41' 04"	10.0 ft.
1702	45° 17' 33" 88° 41' 27"	1.0 ft.
1703	45° 17' 24" 88° 41' 28"	1.0 ft.

Event Monitoring Sites

Site	Description
17E1	Overland flow from campground area near boat landing on south shore
17E2	Overland flow from public access area on north shore

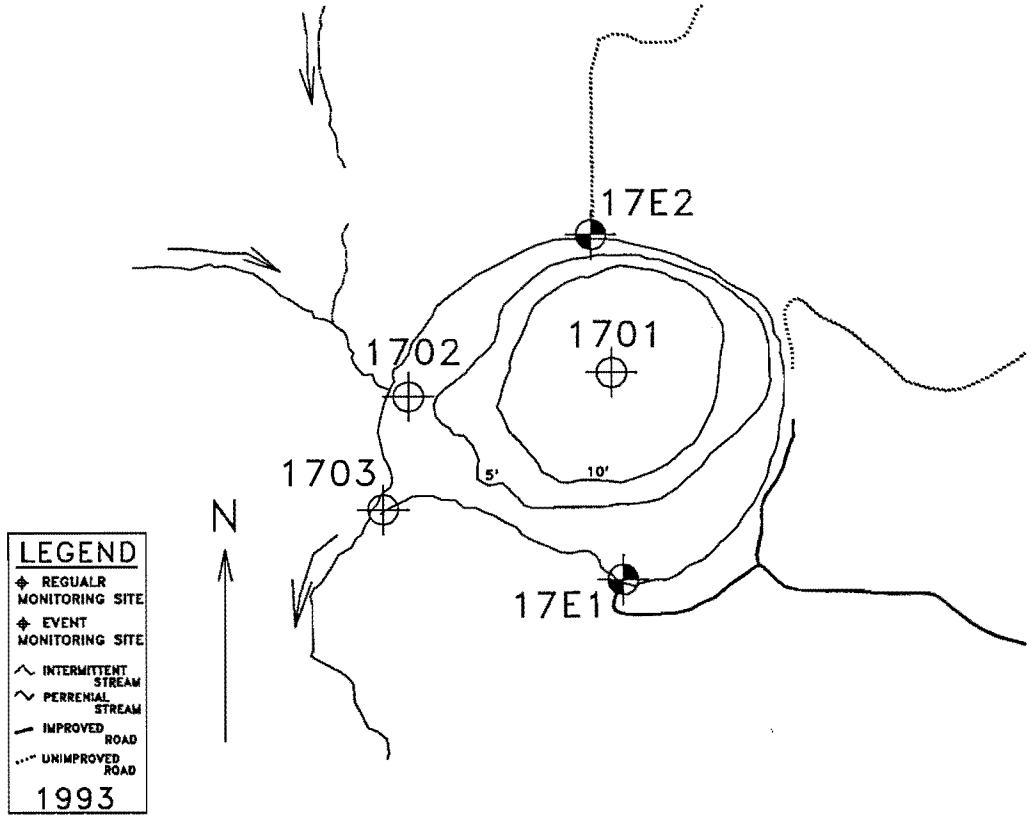

Figure 2. Sample Station Locations, Mary Lake, Langlade County, WI, 1992.

ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus. Spring parameters included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus, and **chlorophyll a**. Summer and late Summer laboratory analyses included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus, dissolved phosphorus, and chlorophyll a.

Event samples [surface runoff during or after a major (about 1 inch) rain event] were taken by MLPRD on September 14, 1992 at Sites 17E1 and 17E2 (Table 1, Figure 2). Samples were analyzed for total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

OTHER

Recreational Use and Sanitary System Surveys

Surveys were distributed to the MLPRD members to gather information about the Mary Lake resource, recreational uses and sanitary systems.

Water Quality Information

Additional lake information was retrieved from the WDNR Surface Water Inventory (6), MLPRD water quality data and from the WDNR

Wisconsin Lakes publication (5). Additional information was retrieved through the WDNR WI LAKES Bulletin Board System.

Land Use Information

Details of zoning and specific land uses were obtained from the United States Soil Conservation Service soil maps (4), aerial photographs, and United States Geological Survey quadrangle maps. This information, when considered questionable or out-dated, was confirmed by field reconnaissance.

Ordinance information was obtained from the Langlade and Oconto County Zoning Ordinances and the Oconto County Soil Erosion Control Plan.

Public Involvement Program

Public involvement activities were coordinated with the lake management planning process and are outlined in Appendix I.

FIELD DATA DISCUSSION

Mary Lake is a natural lake, as opposed to an impoundment or dammed riverine system. Physicochemical parameters of natural lakes tend toward dynamic equilibrium (seasonally variable but relatively consistent within that framework over the long-term) as defined by basin morphometry and watershed characteristics.

Land use in the Mary Lake watershed is primarily forested (over 2,900 acres) with a small wooded residential and wetland areas (about 40 acres each; Figure 3). Forested areas are relatively undisturbed areas of the Nicolet National Forest.

Mary Lake is, by definition, a drainage lake because it has a permanent inlet and outlet stream; the primary source of water is groundwater inflow to Mary Creek and Mary Lake proper. Lake level is controlled primarily by a series of beaver dams on the Mary Creek outlet. The downstream gradient was determined (on May 16, 1993) to be about 0.48% (0.48ft/100ft) from the lake level (80.91 feet) to the unimpounded water level below the third beaver dam (77.29 feet). Water level in Mary Lake fluctuates as a result of natural or human alteration of the beaver dams.

Staff gauge readings by MLPRD indicated wide fluctuations in water level for the period 1989 - 1992 (Figure 4). Water levels

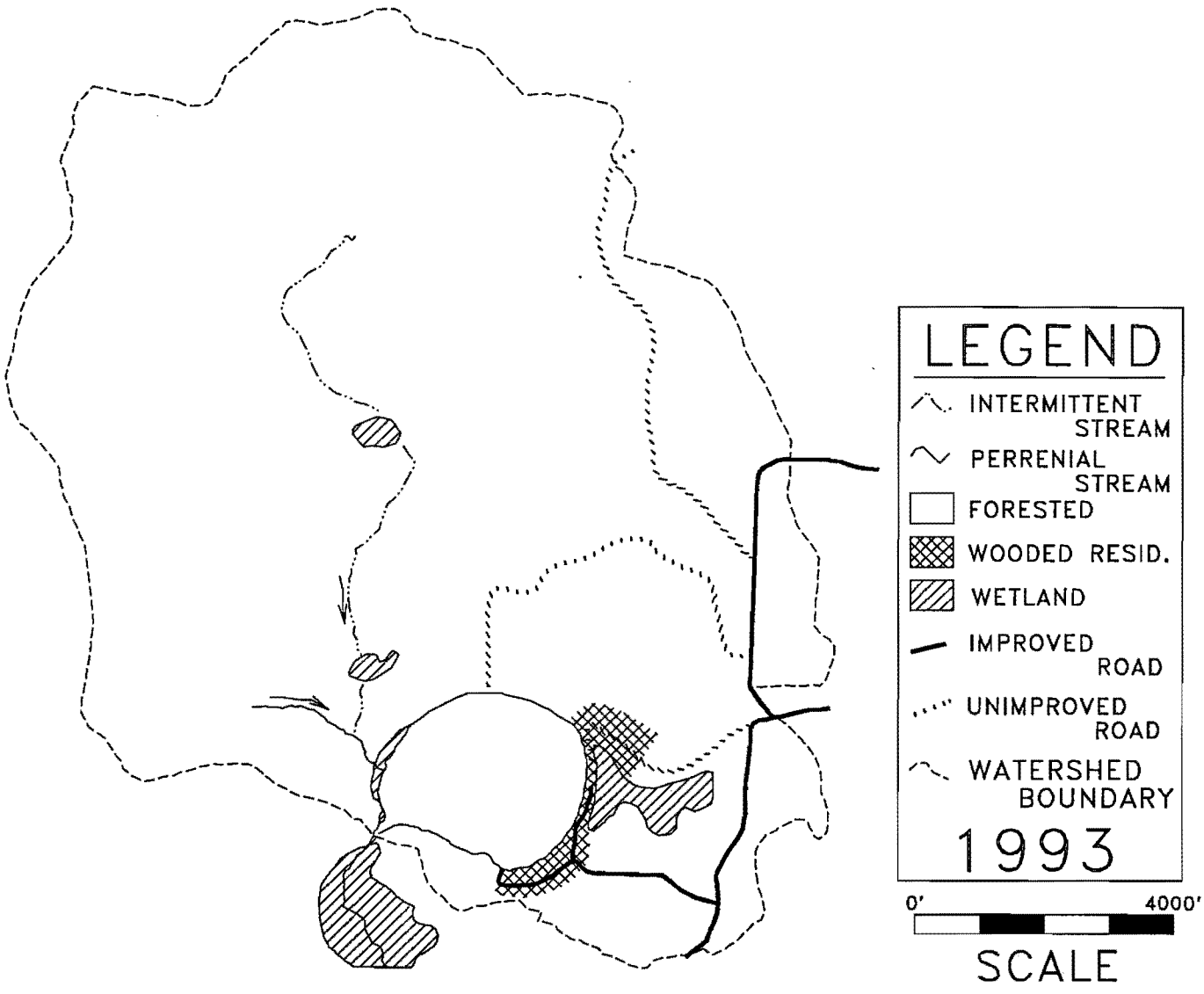

Figure 3. Land Uses in the Mary Lake Watershed, 1992.

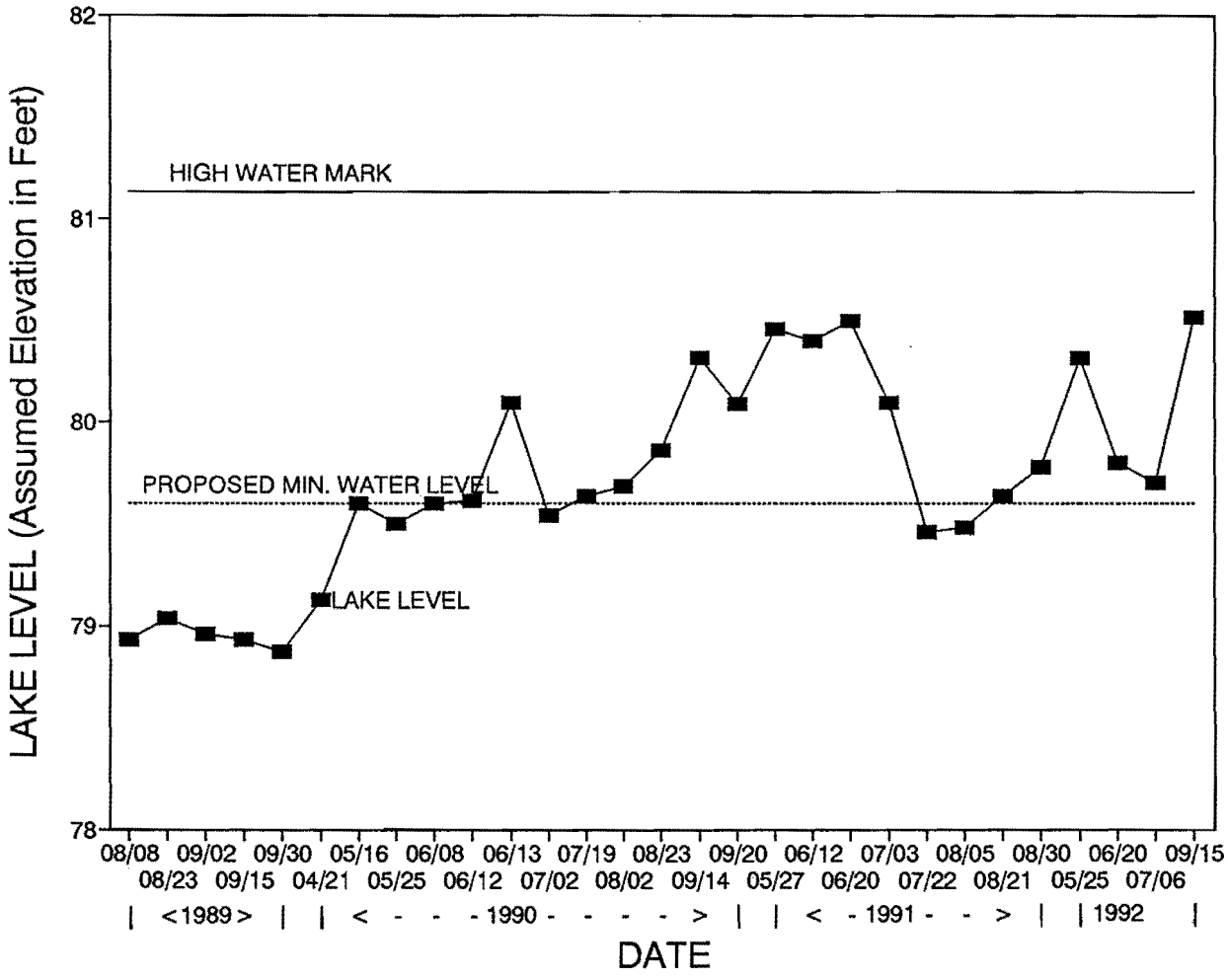

Figure 4. Mary Lake Water Level History, 1989 - 1992.

reached a maximum (for the existing dam structure) on September 15, 1992 (as evident by water flowing over the beaver dam). This level (assumed elevation of 80.52) is still below the Ordinary High Water Mark (81.13 feet, assumed elevation) observed by the WDNR in 1987. In addition, staff gage levels (determined July 16, 1993) differed by almost 0.75 feet from WDNR water level records. Optimum water levels for fish and wildlife habitat and food production were determined to be between 79.55 and 81.13 (assumed elevations, Pers. comm. WDNR).

Even highest water levels, erosion did not appear to be significant; populations of cattails (Typha spp.) and rushes (Scirpus spp.) around the lake perimeter appear to minimize erosion potential. Highest water levels, however, did cause ponding and flooding of a crawl space in at least one residence on the east shore. Water levels are unstable and have dropped below the minimum water level recommended by the WDNR.

Phosphorus is often the limiting major nutrient in **algal** and plant production in lakes. In-lake surface total phosphorus (Station 1701) during 1992 monitoring ranged from 0.004 to 0.013 mg/l (parts per million) with a mean value of 0.008 mg/l (Table 2). Inlet total phosphorus (Station 1702) ranged from 0.017 to 0.020 mg/l (mean = 0.019 mg/l) and outlet total phosphorus ranged from 0.014 to 0.016 mg/l (average = 0.015) (Tables 3 and 4).

Table 2. Water Quality Parameters, Station 1701 (Deepest Point), Mary Lake, 1992.

PARAMETER	SAMPLE[1]	01/29/92	04/30/92	07/06/92	09/16/92
Secchi (feet)		NR[2]	>10.0	>9.5	>9.2
Cloud Cover (%)		100	50	5	100
Temperature (°C)	S	3.80	9.91	18.19	17.30
	B	4.16	9.86	18.02	17.20
pH (S.U.)	S	7.18	8.26	8.68	8.72
	B	7.31	8.21	8.65	8.70
D.O. (mg/l)	S	7.58	12.78	9.49	10.30
	B	7.38	12.71	9.42	10.14
Conductivity (μmhos/cm)	S	245	183	184	174
	B	246	182	184	174
Laboratory pH (S.U.)	S	NR	8.34	NR	NR
	B	NR	8.22	NR	NR
Total Alkalinity (mg/l)	S	NR	102	NR	NR
	B	NR	102	NR	NR
Total Kjeldahl N (mg/l)	S	0.9	0.4	0.5	0.3
	B	1.0	0.4	0.4	0.3
Ammonia Nitrogen (mg/l)	S	0.538	0.233	0.044	0.006
	B	0.558	0.223	0.039	0.008
NO_2 + NO_3 Nitrogen (mg/l)	S	0.017	0.064	ND[3]	ND
	B	0.035	0.064	0.007	ND
Total Nitrogen (mg/l)	S	0.917	0.464	0.500	0.300
	B	1.035	0.464	0.407	0.300
Total Phosphorus (mg/l)	S	0.004	<0.02	0.013	0.008
	B	0.014	<0.02	0.012	0.009
Diss. Phosphorus (mg/l)	S	0.002	0.002	0.002	ND
	B	0.002	0.002	0.002	0.002
N/P Ratio	S	229.3	>23.2	38.5	37.5
	B	73.9	>23.2	33.9	33.3
Chlorophyll a (μg/l)	S	NR	1[4]	3	3.02[4]

[1] S = Near Surface; B = Near Bottom; [2] NR = No Reading; [3] ND = Not Detectable; [4] = Results Approximate

Table 3. Water Quality Parameters, Station 1702 (Mary Creek Inlet), Mary Lake, 1992.

PARAMETER	SAMPLE[1]	04/30/92	07/06/92	09/16/92
Secchi (feet)		>1.0	>1.0	>1.0
Cloud Cover (%)		50	5	100
Temperature (°C)	M	8.21	11.70	12.24
pH (S.U.)	M	7.63	8.54	7.05
D.O. (mg/l)	M	8.44	7.70	8.15
Conductivity (µmhos/cm)	M	197	227	213
Laboratory pH (S.U.)	M	8.04	NR[2]	NR
Total Alkalinity (mg/l)	M	108	NR	NR
Total Kjeldahl N (mg/l)	M	0.3	0.3	0.2
Ammonia Nitrogen (mg/l)	M	0.017	0.037	0.034
NO_2 + NO_3 Nitrogen(mg/l)	M	0.127	0.109	0.155
Total Nitrogen (mg/l)	M	0.427	0.409	0.355
Total Phosphorus (mg/l)	M	<0.020	0.020	0.017
Diss. Phosphorus (mg/l)	M	0.007	0.008	0.009
N/P Ratio	M	>21.4	20.5	20.9
Chlorophyll a (µg/l)	M	3	5	1.33[3]

[1] M = Mid-Depth; [2] NR = No Reading; [3] = Results Approximate

Table 4. Water Quality Parameters, Station 1703 (Mary Creek Outlet), Mary Lake, 1992.

PARAMETER	SAMPLE[1]	07/06/92	09/16/92
Secchi (feet)		>1.0	>1.0
Cloud Cover (%)		5	100
Temperature (°C)	M	18.14	17.08
pH (S.U.)	M	8.50	8.52
D.O. (mg/l)	M	7.14	9.11
Conductivity (μmhos/cm)	M	186	178
Laboratory pH (S.U.)	M	NR[2]	NR
Total Alkalinity (mg/l)	M	NR	NR
Total Kjeldahl N (mg/l)	M	0.4	0.3
Ammonia Nitrogen (mg/l)	M	0.026	0.013
NO_2 + NO_3 Nitrogen(mg/l)	M	ND[3]	0.009
Total Nitrogen (mg/l)	M	0.400	0.309
Total Phosphorus (mg/l)	M	0.016	0.014
Diss. Phosphorus (mg/l)	M	0.002	0.002
N/P Ratio	M	25.0	22.1
Chlorophyll a (μg/l)	M	5	4.15[4]

[1] M = Mid-Depth; [2] NR = No Reading; [3] ND = Not Detectable; [4] = Results Approximate

Total nitrogen is highly variable among lakes and is best compared on a relative or trend scale within the same lake. Total nitrogen levels were similar (0.300 mg/l to 0.500 mg/l) among the three sample sites during the open water seasons; higher levels (0.917 mg/l and 1.035 mg/l) were observed in-lake under ice-covered conditions. Surface **N/P ratios** greater than 15 indicated Mary Lake to be phosphorus limited during 1992.

In-lake Summer surface phosphorus levels during 1992 (0.008 and 0.013 mg/l) were, according to a recent compilation of Summer total phosphorus levels in upper midwestern lakes (10), typical (0.010 - 0.014 mg/l) for the region in which Mary Lake is located. Levels were lower than a survey of lakes in the northwest region (0.019 mg/l) and for natural lakes (0.025 mg/l) in Wisconsin (7). Event monitoring indicated a slightly higher level of total phosphorus (0.037 mg/l) in surface runoff from the public access site on the north shore at Station 17E2 (Table 5).

Other indicators of lake **eutrophication** status include light penetration and algal production. Numerous summarative indices have been developed, based on a combination of these and other parameters, to assess or monitor lake eutrophication or aging. The Trophic State Index (TSI) developed by Carlson (11) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indices, application is generally most appropriate on a

Table 5. Event Water Quality Parameters, Mary Lake, September 14, 1992.

PARAMETER	UNITS	STATION 17E1	STATION 17E2
Total Kjeldahl N	mg/l	0.4	0.5
Ammonia Nitrogen	mg/l	ND[1]	0.010
NO_2+NO_3 Nitrogen	mg/l	ND	0.017
Total Nitrogen	mg/l	0.400	0.517
Total Phosphorus	mg/l	0.011	0.037
Diss. Phosphorus	mg/l	ND	ND
Suspended Solids	mg/l	NS[2]	NS

[1] ND = Not Detectable
[2] NS = No Sample Collected

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).

Low total phosphorus and chlorophyll a TSI values for Mary Lake were typical of oligotrophic to early mesotrophic conditions (Figure 5). Secchi depth TSI values (not including values to bottom) were typical of a mesotrophic classification. No discernable trends were evident from current and historic data.

Recreational use surveys were distributed to the entire MLPRD membership to solicit opinions and attitudes. Despite follow-up

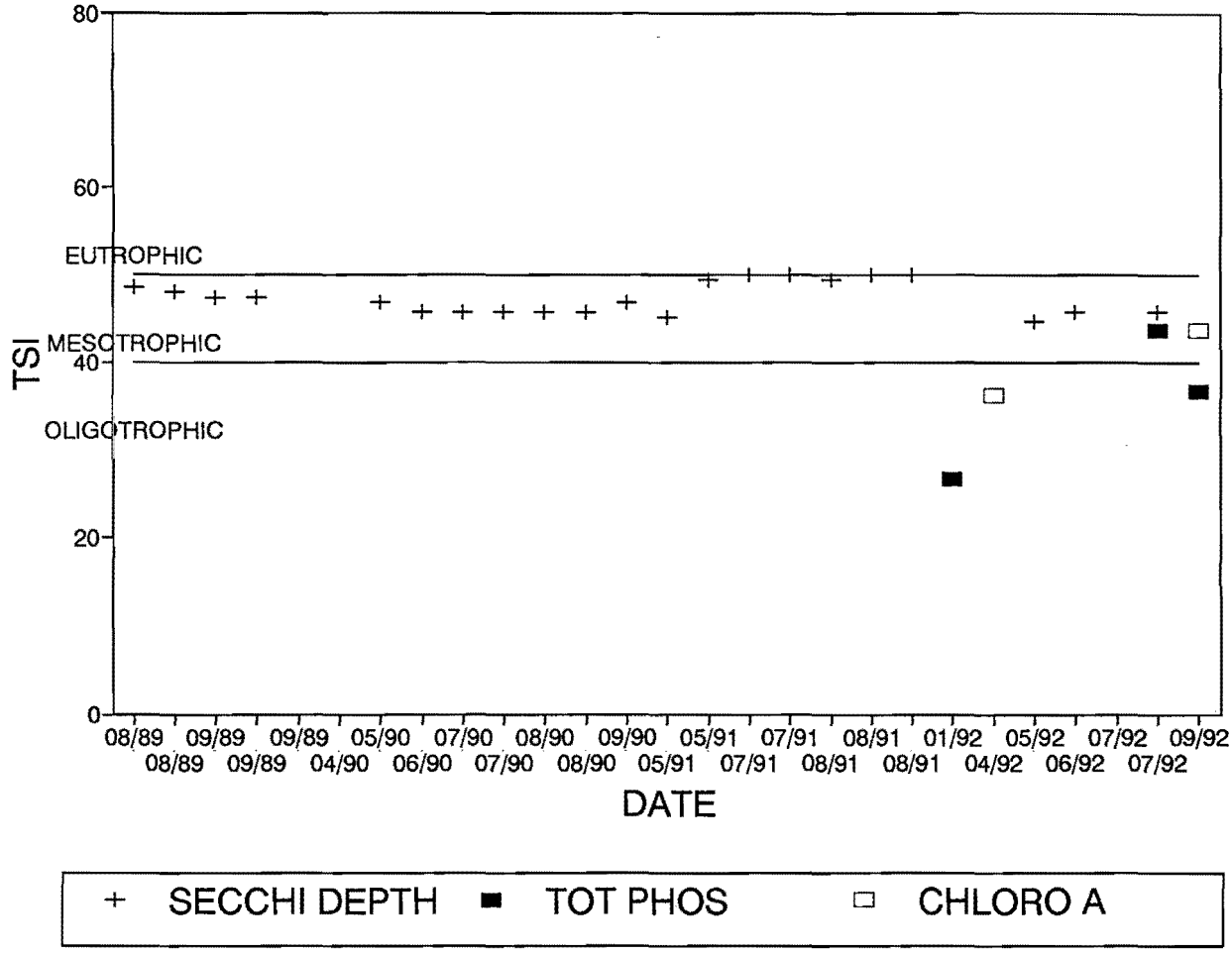

Figure 5. Trophic State Index for Secchi Depth, Total Phosphorus and Chlorophyll a, Mary Lake, Langlade County, WI.

reminders to respond, only about 50% (15 of about 30) of the surveys were returned (Sample survey, Appendix II).

Greatest use by respondents and families was indicated during Summer months (June to August), followed by Fall, Spring and Winter, respectively (Figure 6; Appendix III). One respondent indicated renting their unit (four weeks per Summer); use by families/relation of landowners was minimal (total for all surveys: nine weeks during Summer, one week during Fall, and none in Winter or Spring).

A total of 27 watercraft were reported for the lake, 12 of which were motorboats with less than 25 horsepower motors (Figure 7; Appendix III); five each of canoes and row/paddle boats and two sailboats were also reported. There were no reported motorboats greater than 25 horsepower or personalized watercraft (jet skis). Respondents reported allowing four other watercraft (all motorboats with <25 horsepower) to be kept on their property.

The most popular reported activity on Mary Lake was viewing natural beauty and bird and wildlife watching, with 73% and 71% (respectively) of the respondents participating frequently (Figure 8; Appendix III). Fishing was next popular (47% frequently), followed by swimming/sunbathing (43% frequently). No respondents reported waterskiing or jet skiing on Mary Lake.

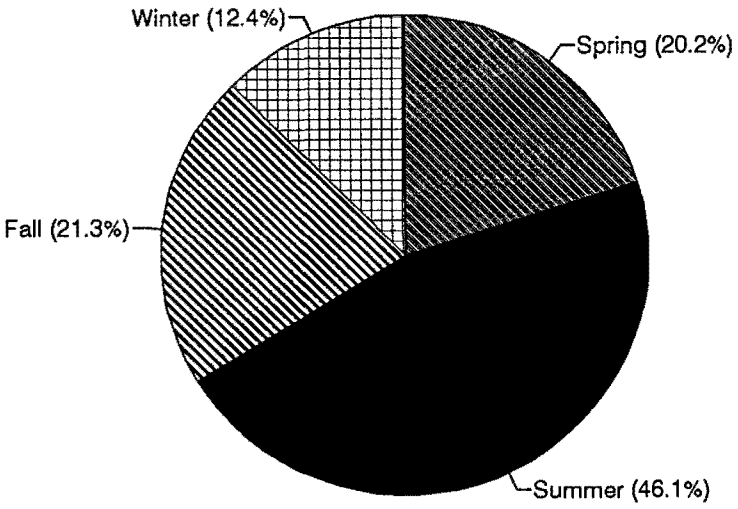

Figure 6. Seasonal Use for Mary Lake, Langlade County, WI.

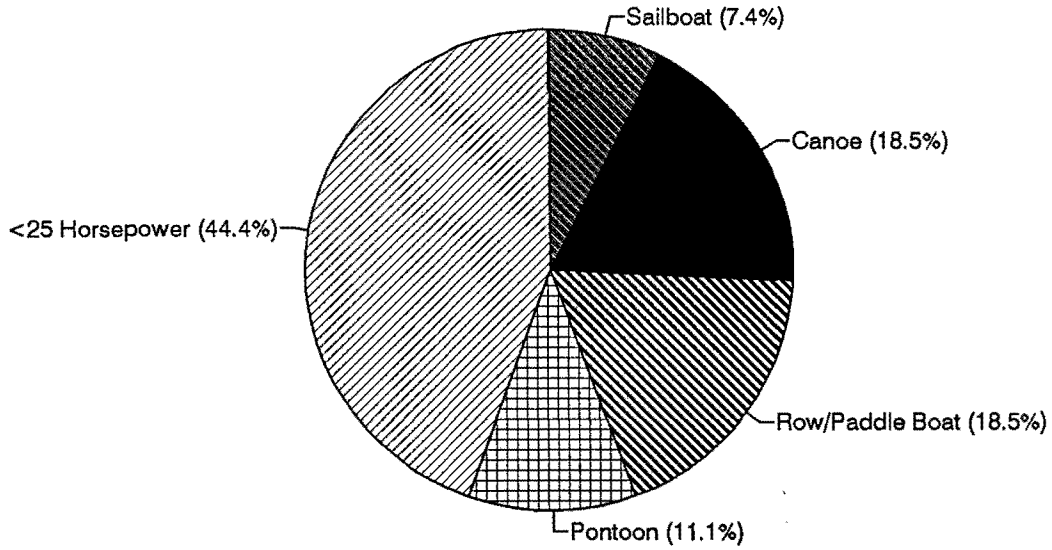

Figure 7. Most Commonly Reported Watercraft Types, Mary Lake, Langlade County, WI.

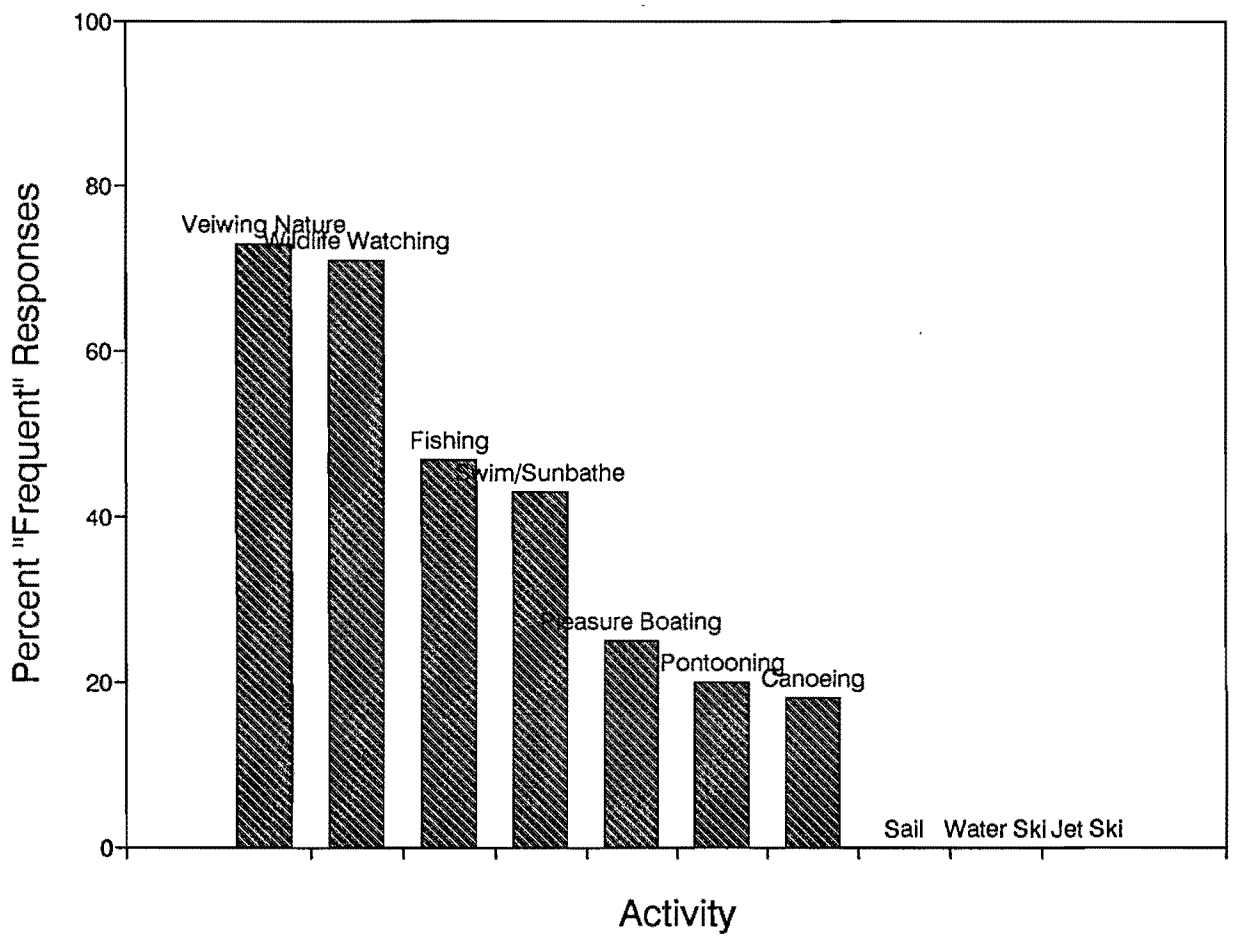

Figure 8. Most Popular Activities (for Survey Respondents), Mary Lake, Langlade County, WI.

Cross-country skiing was the most popular Winter activity (58% frequently or occasionally).

Nearly all respondents launched their watercraft from a private launch (93%); one respondent (7%) used the public boat ramp. Eighty-six percent of the respondents strongly agreed or agreed (43% each), however, that there was adequate public access to Mary Lake.

Survey data indicated that there was not a crowding problem on Mary Lake. Seventy-one percent of the respondents disagreed with the statement "There are too many watercraft on Mary Lake". The majority (80%) didn't think that regulations needed to be enacted and enforced. Sixty-four percent disagreed (57%) or strongly disagreed (7%) with limiting the number of watercraft. Most agreed that there is adequate water safety enforcement [weekdays (73%), weekends (62%), and holidays (54%)] on Mary Lake.

Surveys were distributed to MLPRD members only, but a significant number of people rented seasonal sites at a private campground on Mary Lake. In 1992, about 30 sites were rented and may have accounted for as much recreational use as MLPRD members.

General public recreational use was most likely minimal in 1992 for Mary Lake. The private campground had allowed unrestricted

public access in previous years, but was closed (and locked) to all but seasonal campers in 1992. Several complaints were registered with local officials about the lack of access to the lake during 1992.

In the past, sanitary systems have been suspected of contributing nutrients and bacteria to the Mary Lake system. A sanitary system survey (questionnaire) was distributed to the MLPRD membership (Sample Survey, Appendix IV) to establish what types of systems were present and to raise the awareness of landowners concerning sanitary systems. About one-third (11 of about 30) were completed and returned.

All but one system (sand filter system) reported were conventional septic/drain fields; the average system was installed in 1980 (range 1970-1992) and has a 720 gallon septic tank (range 250-1,000 gallons). Respondents reported the average drain field was about 500 feet from the lake shore (range 90-2,000 feet) and 62 feet above shore elevation (the range was 7-120 feet and appears erroneous). Soils between the drain field and the lake shore were reported to be generally sand (Appendix V).

The average housing unit was occupied by about three persons for about 123 days per year (two permanent residents). No problems

with sanitary systems were reported in the survey. Systems were serviced by a professional an average of once every two years (based on five respondents); six systems (of 11 surveyed) were reported serviced in 1992.

Previous on-site surveys have shown fecal coliform readings well below acceptable levels. A sanitary survey, i.e., visual inspection of the shoreline and collection of water samples (analyzed for fecal coliform bacteria) directly in front of suspected faulty septic systems, conducted by WDNR on August 4, 1982 (10 samples) indicated a maximum of 60 organisms per 100 milliliters. A similar survey (15 samples) conducted on July 21, 1987, indicated a maximum of 70 per 100 milliliters with seven readings registering below 10 per 100 ml. The upper acceptable limit (for Wisconsin recreational water standards) is 400 organisms per 100 ml; raw sewage typically contains 500,000 organisms per 100 ml (Pers. comm. WDNR).

BASELINE CONCLUSIONS

- Mary Lake is a natural drainage lake with a relatively small, forested watershed and excellent water quality. Nutrient levels are low and typical of those found in the largely forested ecoregion in which Mary Lake is located; nutrient inflow doesn't appear to be significant. Transparency is such that light is able to penetrate to the entire lake bottom most of the time. Aquatic plants are mostly near-shore emergents and appear to positively affect the resource. Plant densities are low and probably related to predominantly sandy substrates, low nutrient levels and, possibly, fluctuating water levels.

- Water level fluctuation is considered a problem by many Mary Lake residents. Water levels from 1989 to present have varied about two feet, i.e., 78.88 - 80.52 ft staff gage readings. Fluctuations are primarily caused by natural and human effects (creation, removal, disturbance) on beaver dams in the Mary Creek outlet. Water levels have fallen below the recommended minimum for the lake, and highest water levels (even though below the OHWM) have resulted in flooding problems for at least one resident.

- Recreational use peaks in Summer months with the most popular activities being nature/wildlife watching, fishing and swimming/sunbathing. There were no reported watercraft with engines larger than 25 horsepower. Recreational use conflicts, e.g., overcrowding, were not identified and are apparently not a concern at this time.

- Limited response to the sanitary survey indicated that sanitary systems are mostly conventional septic/drain field systems which are adequately maintained. Two previous on-site surveys have indicated fecal coliform counts well below the maximum allowable level.

- Current access to the lake exists privately, at the campground ramp (with roadside parking for several vehicles and trailers) on the south shore, and at an older, sometimes impassable public ramp (with very limited parking for vehicles and trailers) on the north shore. Recommended minimum public access for lakes 100 to 499 acres is one or more access sites which in total provide 1 car-trailer unit per 30 open water acres but no less than 5 units for lakes of 100 to 150 open water acres (as outlined in the ss. NR 1.90 and 1.93 of the Wisconsin Administrative Code).

MANAGEMENT ALTERNATIVES DISCUSSION

Recreational use of Mary Lake is light and water quality is excellent and related to a predominantly forest watershed. Maintenance of excellent water quality through riparian land management and control of water level fluctuations should be emphasized.

WATER QUALITY

Because of the extensive forested and "wild" watershed and small lake surface area, shoreline land practices can have a significant influence on Mary Lake water quality. Land owner diligence should be strongly emphasized and encouraged to reduce the effects of sediment and nutrient runoff from these, the only disturbed areas of the watershed. Common sense approaches are relatively easy and can be very effective in minimizing inputs.

Yard practices can minimize both nutrient and sediment inputs. Fertilizers should be used sparingly, if at all. If used, the land owner should use phosphate-free fertilizers and apply small amounts more often instead of large amounts at one or two times. Composting yard wastes away from the lake can reduce nutrient inputs to the lake. If leaves are burned, it should be done in an area where the ash cannot wash directly into the lake.

Creation of a buffer strip with diverse plants at least 20 feet wide immediately adjacent to the lake can control wave erosion, trap soil eroded from the land above, increase infiltration (to filter nutrients and soil particles), and shade areas of the lake to reduce macrophyte growth (especially on south shores) and provide fish cover. Placement of a low berm in this area can enhance effectiveness of the buffer strip by further retarding runoff during rainfalls. A buffer zone not only protects lake water quality, but creates habitat for wildlife and provides privacy.

Informational sources for land owners with questions regarding land management practices are summarized in Appendix VI.

WATER LEVELS

Limited macrophyte growth, shoreline erosion and reduced fish spawning and hatching success have been attributed to fluctuating water levels. Water level variation is a natural occurrence in Mary Lake, but fluctuations should be minimized to the extent practical to protect fish and wildlife habitat and to improve aesthetics and access.

Currently, water level is read from a ruler lowered to a cinder block flush with the lake bottom. This block was established on

July 10, 1990 after ice had affected the previous gage (near the private launch). There is local concern that lake level readings from the new gage may not be comparable with those from the previous gage and that the Ordinary High Water Mark and recommended minimum levels may not be correctly defined by the recently established gage. Efforts should be made to verify the existing lake level gage height (and equalize values from the previous gauge) and to reassess the Ordinary High Water Mark and the recommended minimum water levels for Mary Lake.

Construction of a dam on the outlet creek could help to control levels on the lake. A stop-log type dam would allow high water over the dam and retain levels lower than the set level. Dam construction would be complicated by the wide outlet stream area, flow-through via the surrounding wetlands, beaver damming, and acquisition of permission of all landowners in the potentially inundated area. Construction costs of such a dam would be very high and may not be justified in such a "wild" setting.

A beaver pipe type water level control has adequately minimized water level fluctuations in similar situations (12), regardless of beaver dam height. This relatively inexpensive method allows beaver populations to maintain the dam while a PVC pipe (with mesh covered and perforated ends to prevent clogging) through the structure allows high water to flow through.

MANAGEMENT RECOMMENDATIONS

Management objectives for Mary Lake should emphasize maintenance of a water level beneficial to the ecology and recreation use of the lake and continued water quality monitoring.

Subsequent to verification/calibration of the staff gage, the Ordinary High Water Mark and the recommended minimum water levels for Mary Lake should be reassessed and established. Gage level measurements by WDNR and IPS varied by about 0.75 feet and flooding occurred at levels below acceptable levels. Lake level may be maintained by utilizing a "beaver pipe" in the upstream-most beaver dam on the Mary Creek outlet. This method is inexpensive (about $100) and can be implemented easily (12) but may be maintenance intensive dependent upon design and installation. It should be pursued and effectiveness assessed before more costly options are considered.

A proposed staff gage installation on the outlet stream does not appear to be warranted at this time. Beaver have (subsequent to this study) created additional dams upstream and gage measurements would most likely be ineffective. Also, a gage is already located on the lake, but steps should be taken to verify its elevation for comparison of historic and more current lake level data.

Lake level and Secchi depth readings should be continued to document the effectiveness of the beaver pipe installation. Routine water quality sampling to monitor trends and further event sampling in areas of concern should be continued. Event sampling of the Mary Creek inlet may yield information of nutrient flushing from the forested and undisturbed watershed. Rainfall characteristics should also be recorded with event data. According to newly revised minimum public access standards, Mary Lake should provide one ramp with at least 5 car-trailer units. Enhanced access for Mary Lake could be accomplished by contracting with the private provider of access (a minimum of five years) or by updating the existing public access on the north shore (or both).

IMPLEMENTATION

The success of any lake management plan relates directly to the ability of the association/district to obtain funds and regulatory approval necessary to implement the plan. The MLPRD is a lake district (as specified under Chapter 33, Wisconsin Statutes) and has specific legal and financial powers (to adopt ordinances or levy taxes or special assessments) to meet plan objectives.

The Mary Lake watershed is located within the political jurisdictions of the Towns of Wolf River and Townsend, Counties of Langlade and Oconto, and the State of Wisconsin. These units have the power to regulate land uses and land use practices. Sources of local information and assistance are outlined in Appendix VI. Langlade County ordinances and plans possibly pertinent to the Mary Lake plan are summarized in Appendix VII.

Potential sources of funding are listed in Appendix VIII.

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