Bone Lake Management Plan

Phase I: Water Quality Study of Bone Lake

Phase II: Hydrologic and Phosphorus Budgets

June 1997

Prepared for
Bone Lake Management District

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Prepared by
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with Assistance from:
Bone Lake Management District
Polk County Land Conservation Department
Wisconsin Department of Natural Resources

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Executive Summary

The results of a 1993 survey of Bone Lake property owners indicated many respondents favored the development of a long-term management plan for the lake. The District began the process of completion of the Bone Lake Management Plan during 1996. A data collection program was completed to investigate the current condition of the lake. The program involved the collection of several types of data, including:

- Lake water quality data
- Inflow/outflow water quality data
- Flow data
- Precipitation data
- Lake level data
- Watershed land use information

Data collected during 1996 were evaluated to determine the lake's current water quality. During the early part of the summer, the lake exhibited excellent water quality. However, the lake's water quality deteriorated throughout the summer. Excessive algal blooms during August and September reduced the lake's water transparency to a level considered undesirable for recreational users. The lake's water quality problems result from excess phosphorus concentrations in the upper layers of the lake. Phosphorus is a nutrient used by algae for food. Algae are microscopic plants growing in the lake. Higher than expected yields of algae from the available phosphorus further exacerbated the lake's water quality problems.

Analysis of the lake's watershed, its inflows, and its outflows was completed in 1997 to determine the sources of phosphorus to the lake. The analysis included the completion of annualized hydrologic (i.e., water) and phosphorus budgets. The budgets indicate about half the phosphorus load (i.e., 48 percent) is caused by runoff from the lake's watershed. Internal loading (i.e., recycled phosphorus from the lake's sediments) comprises approximately 21 percent of the annual load. The remaining load consists of contributions from septic systems (about 5 percent), atmospheric deposition (i.e., dry deposition and direct rainfall on the lake surface, which cleans the air of its phosphorus, and contributes 18 percent of the annual load), and groundwater (about 8 percent).

The District has now completed two of the three phases which comprise the lake's management plan preparation. The District next intends to complete the third phase of the project, the completion of a lake management plan. Data from the first two phases will be used to determine a feasible management plan for the lake. Because the lake exhibits undesirable algal blooms during the summer, the plan's focus will be the improvement of the lake's water quality to the greatest extent possible. The plan will also address the issue of protection of the lake's water quality to prevent further degradation.

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1.0 Introduction

Bone Lake in Polk County, Wisconsin has a reputation as one of the better muskellunge lakes in the state. However, the lake is very fertile and has been experiencing problems with dense algal blooms and extensive weed beds for more than 20 years. The local people were concerned about the lake and formed the Bone Lake Management District in 1975 under Chapter 33, Wisconsin Statutes. They requested and received technical assistance from the Office of Inland Lake Renewal, who conducted a one-year data collection program during 1977 through 1978. A report, entitled *"Feasibility Study Results, Management Alternatives,"* was issued during 1980. The study concluded that Bone Lake was a eutrophic body of water and ample nutrients were present to support an abundant aquatic "crop" of algae. The study concluded that significant quantities of phosphorus were being supplied to the algae from an inlake recycling mechanism. Alum treatment of the lake was recommended to reduce inlake phosphorus levels. Other management alternatives that were recommended included conducting macrophyte harvesting on selected areas, protecting the watershed and insuring the correction of existing inadequate shoreline disposal systems.

WDNR Fish Management and Water Resources personnel have cooperated with the Bone Lake organization to control the lake's algae and macrophyte problems while protecting the lake's critical areas. Management of the lake's algal blooms has been supported by the WDNR through the issuance of annual algicide permits to allow copper sulfate treatments of Bone Lake each summer. A survey to document aquatic plant "sensitive area" sites on the lake was conducted in 1988 and 1989. Eleven sites on Bone Lake were designated as sensitive areas because they provide valuable spawning, feeding, and nursery areas for fish populations, waterfowl, and other aquatic life (see Appendix F). Specific aquatic management recommendations were made. The WDNR uses the recommendations as a basis for decisions regarding macrophyte control permits (i.e., herbicide treatment or harvesting of macrophytes).

From 1989 through the present, a volunteer from Bone Lake has collected water transparency data through the WDNR "Self-Help" program. The data show a decline in the lake's water transparency throughout the summer as algal blooms increase. The data suggest the lake is eutrophic and that nutrients increase throughout the summer. In recent years, the Bone Lake Management District has been treating the lake with copper sulfate to manage its dense algal blooms. The lake has generally been treated with algicide weekly throughout each summer.

During 1993, a survey among property owners was completed to define concerns and desired actions to deal with riparian concerns. Many respondents favored a strengthening of the lake district and the development of a long-term management plan for the lake. Consequently, the Bone Lake Management District initiated a three-phase project to develop a management plan. The three phases of the project include:

- **Phase I**—Collection of data
- **Phase II**—Preparation of annualized hydrologic and phosphorus budgets for existing watershed land use conditions
- **Phase III**—Preparation of the lake management plan.

1.1 Report Coverage

This report discusses the methodology, results, and conclusions from Phases I and II of the lake management plan development. The report will answer the following two questions that apply to properly managing lakes:

1. What is the general condition of the lake?
2. Are there problems evident in the water quality?

To answer the first question, this report begins with descriptions of the watershed, the lake, methods of data collection and analysis. The results of water quality monitoring are then summarized in tables, figures, and accompanying descriptions.

To answer the second question, water quality data are analyzed and compared to established water quality standards for lakes.

A third and final question will be answered in the Phase III project, development of a lake management plan:

3. What are the most effective solutions to the lake's water quality problems?

Hydrologic and phosphorus budgets were prepared in preparation for the Phase III project, and are discussed in this report.

A background information section is also included in the report. Section 2.0 covers general concepts in lake water quality.

2.0 General Concepts in Lake Water Quality

There are many concepts and terminology that are necessary to describe and evaluate a lake's water quality. This section is a brief discussion of those concepts, divided into the following topics:

- Eutrophication
- Trophic states
- Limiting nutrients
- Nutrient recycling and internal loading
- Stratification

To learn more about these five topics, one can refer to any text on limnology (the science of lakes and streams).

2.1 Eutrophication

Eutrophication, or lake degradation, is the accumulation of sediments and nutrients in lakes. As a lake naturally becomes more fertile, algae and weed growth increases. The increasing biological production and sediment inflow from the lake's watershed eventually fill the lake's basin. Over a period of many years, the lake successively becomes a pond, a marsh and, ultimately, a terrestrial site. This process of eutrophication is natural and results from the normal environmental forces that influence a lake. Cultural eutrophication, however, is an acceleration of the natural process caused by human activities. Nutrient and sediment inputs (i.e., loadings) from wastewater treatment plants, septic tanks, and stormwater runoff can far exceed the natural inputs to the lake. The accelerated rate of water quality degradation caused by these pollutants results in unpleasant consequences. These include profuse and unsightly growths of algae (algal blooms) and/or the proliferation of rooted aquatic weeds (macrophytes).

2.2 Trophic States

Not all lakes are at the same stage of eutrophication; therefore, criteria have been established to evaluate the nutrient "status" of lakes. Trophic state indices (TSIs) are calculated for lakes on the basis of total phosphorus, chlorophyll *a* concentrations, and Secchi disc transparencies. A TSI value is obtained from any one of these three parameters. TSI values range upward from zero, describing the condition of the lake in terms of its trophic status (i.e., its degree of fertility). Four trophic status designations for lakes are listed below with corresponding TSI value ranges:

1. ***Oligotrophic* – [TSI ≤ 37]** Clear, low productivity lakes with total phosphorus concentrations less than or equal to 10 µg/L.

2. ***Mesotrophic* – [38 ≤ TSI ≤ 50]** Intermediate productivity lakes with total phosphorus concentrations greater than 10 µg/L, but less than 25 µg/L.

3. ***Eutrophic* – [51 ≤ TSI ≤ 63]** High productivity lakes generally having 25 to 60 µg/L total phosphorus.

4. ***Hypereutrophic* – [64 ≤ TSI]** Extremely productive lakes which are highly eutrophic, disturbed and unstable (i.e., fluctuating in their water quality on a daily and seasonal scale, producing gases, off-flavor, and toxic substances, experiencing periodic anoxia and fish kills, etc.) with total phosphorus concentrations above 60 µg/L.

Determining the trophic status of a lake is an important step in diagnosing water quality problems. Trophic status indicates the severity of a lake's algal growth problems and the degree of change needed to meet its recreational goals. Additional information, however, is needed to determine the cause of algal growth and a means of reducing it.

2.3 Limiting Nutrients

The quantity or biomass of algae in a lake is usually limited by the water's concentration of an essential element or nutrient—the "limiting nutrient." (For rooted aquatic plants, the nutrients are derived from the sediments.) The limiting nutrient concept is a widely applied principle in ecology and in the study of eutrophication. It is based on the idea that plants require many nutrients to grow, but the nutrient with the lowest availability, relative to the amount needed by the plant, will limit plant growth. It follows then, that identifying the limiting nutrient will point the way to controlling algal growth.

Nitrogen (N) and phosphorus (P) are generally the two growth-limiting nutrients for algae in most natural waters. Analysis of the nutrient content of lake water and algae provides ratios of N:P. By comparing the ratio in water to the ratio in the algae, one can estimate whether a particular nutrient may be limiting. Algal growth is generally phosphorus-limited in waters with N:P ratios greater than 12. Laboratory experiments (bioassays) can demonstrate which nutrient is limiting by growing the algae in lake water with various concentrations of nutrients added. Bioassays, as well as fertilization of in-situ enclosures and whole-lake experiments, have repeatedly demonstrated that phosphorus is usually the nutrient that limits algal growth in fresh waters. Reducing phosphorus in a lake, therefore, is required to reduce algal abundance and improve water transparency. Failure to reduce phosphorus concentrations will allow the process of eutrophication to continue at an accelerated rate.

2.4 Nutrient Recycling and Internal Loading

Phosphorus enters a lake from either runoff from the watershed or direct atmospheric deposition. It would, therefore, seem reasonable that phosphorus in a lake can decrease by reducing these external loads of phosphorus to the lake. All lakes, however, accumulate phosphorus (and other nutrients) in the sediments from the settling of particles and dead organisms. In some lakes this reservoir of phosphorus can be reintroduced in the lake water and become available again for plant uptake. This resuspension or dissolution of nutrients from the sediments to the lake water is known as "internal loading." The relative amounts of phosphorus coming from internal and external loads vary with each lake. Phosphorus released from internal loading can be estimated from depth profiles (measurements from surface to bottom) of dissolved oxygen and phosphorus concentrations.

2.5 Stratification

The process of internal loading is dependent on the amount of organic material in the sediments and the depth-temperature pattern, or "thermal stratification," of a lake. Thermal stratification profoundly influences a lake's chemistry and biology. When the ice melts and air temperature warms in spring, lakes generally progress from being completely mixed to stratified with only an upper warm well-mixed layer of water (epilimnion), and cold temperatures in a bottom layer (hypolimnion). Because of the density differences between the lighter warm water and the heavier cold water, stratification in a lake can become very resistant to mixing. When this occurs, generally in mid-summer, oxygen from the air cannot reach the bottom lake water and, if the lake sediments have sufficient organic matter, biological activity can deplete the remaining oxygen in the hypolimnion. The epilimnion can remain well-oxygenated, while the water above the sediments in the hypolimnion becomes completely devoid of dissolved oxygen (anoxic). Complete loss of oxygen changes the chemical conditions in the water and allows phosphorus that had remained bound to the sediments to reenter the lake water.

As the summer progresses, phosphorus concentrations in the hypolimnion can continue to rise until oxygen is again introduced (recycled). Dissolved oxygen concentration will increase if the lake sufficiently mixes to disrupt the thermal stratification. Phosphorus in the hypolimnion is generally not available for plant uptake because there is not sufficient light penetration to the hypolimnion to allow for growth of algae. The phosphorus, therefore, remains trapped and unavailable to the plants until the lake is completely mixed. In shallow lakes this can occur throughout the summer, with sufficient wind energy (polymixis). In deeper lakes, however, only extremely high wind energy is sufficient to destratify a lake during the summer and complete mixing only occurs in the spring and fall (dimixis). Cooling air temperature in the fall reduces the epilimnion water temperature, and consequently increases the density of water in the epilimnion. As the epilimnion water density approaches the density of the hypolimnion water very little energy is needed to cause complete mixing of the lake. When this fall mixing occurs, phosphorus that has built up in the hypolimnion is mixed with the epilimnion water and becomes available for plant growth.

3.0 Basin Characteristics

Bone Lake, in Polk County, Wisconsin, covers an area of approximately 1,781 acres. The lake consists of two basins (Figure 1). However, because the basins are not separated from one another, the lake is perceived as consisting of a single basin. The north basin is the deepest, with a maximum depth of 43 feet. The south basin has a maximum depth of 32 feet. The lake has a mean depth of almost 22 feet, and the lake's water volume is approximately 38,499 acre-feet. Because Bone Lake has a long fetch (exposure to winds), it is subject to intermittent mixing during the summer though it is considered a relatively deep lake. Evidence of mixing was observed during a 1978 study of the lake when the lake's bottom temperature was 70 degrees Fahrenheit during mid-August (WDNR 1980).

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Figure 1 Bone Lake Sampling Stations

4.0 Methods

4.1 Lake Water Quality Data Collection

In 1996, a representative lake sampling station was selected for each of the two basins. Sampling Stations 1 and 2 were located in Bone Lake's north and south basins, respectively (Figure 1). Biweekly water samples were collected during June and July and weekly samples were collected from August through mid-September. A total of nine water quality parameters was measured at the two Bone Lake sampling stations. Table 1 lists the water quality parameters, and specifies when and at what depths samples or measurements were collected. Dissolved oxygen, temperature, specific conductance and Secchi disc transparency were measured in the field; whereas, water samples were analyzed in the laboratory for total phosphorus, total dissolved phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and chlorophyll *a*. A survey of macrophyte coverage was completed during August. Although a June survey was scheduled to be completed by a Bone Lake volunteer, the survey was not completed because of unexpected scheduling problems. During the August survey, twelve transects were established at representative locations (see Figure 2) and the maximum depth of macrophyte growth was determined at each transect.

4.2 Sediment/Phosphorus Release Experiment

The areal phosphorus release rate of Bone Lake sediments under anoxic conditions was determined using lake sediment cores incubated in the laboratory. Following is a description of the sediment collection and experimental procedure.

Four sediment samples were collected from Station 1 (see Figure 1) using a piston coring apparatus. The sediment cores were then transported to the laboratory and extruded into clear PVC tubes of 4-inch-inside diameter. Two of the four microcosms consisted of approximately 6 inches of extruded lake sediment overlaid by 3 liters of lake water in 2-foot tall microcosms, and capped with 1-inch mineral oil seals. The remaining two microcosms consisted of approximately 6 inches of extruded lake sediment overlaid by nearly 6 liters of lake water in 3-foot tall microcosms, and capped with 1-inch mineral oil seals.

Table 1 Bone Lake Water Quality Parameters

Parameters	Depth (meters)	6/10	6/24	7/9	7/23	8/6	8/13	8/19	8/26	9/3	9/10
Dissolved Oxygen	Surface to bottom profile	X	X	X	X	X	X	X	X	X	X
Temperature	Surface to bottom profile	X	X	X	X	X	X	X	X	X	X
Specific Conductance	Surface to bottom profile	X	X	X	X	X	X	X	X	X	X
Chlorophyll a	0-2	X	X	X	X	X	X	X	X	X	X
Psych. Disc	—	X	X	X	X	X	X	X	X	X	X
Total Phosphorus	0-2	X		X		X		X		X	
Total Dissolved Phosphorus	Surface				X		X		X		X
Total Dissolved Phosphorus	1.5 M to bottom profile	X	X	X	X	X	X	X	X	X	X
Total Kjeldahl Nitrogen	0-2	X		X		X		X		X	
Nitrate + Nitrite Nitrogen	0-2	X		X		X		X		X	

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Figure 2 Bone Lake Macrophyte Sampling Stations

Each microcosm was allowed to go anaerobic after its mineral oil seal was added. The microcosms were then mixed continuously using a magnetic stirring apparatus which propelled a Teflon stirring bar positioned 8 inches above the sediment/water interface. The slowly revolving stirring bar served to keep the water layer completely mixed without suspending sediment particles. The microcosms were then incubated in a darkened chamber at 70 degrees Fahrenheit for a period of 22 days. Small water samples were extracted daily from each microcosm through a sampling port at mid-depth in the water column. The concentrations of total phosphorus in each sample were analyzed and cumulative total phosphorus mass was plotted against days of incubation to determine sediment phosphorus release rates using linear regression techniques.

4.3 Inflow/Outflow Monitoring Methods

Grab samples were collected from two surface water inflow locations, from a spring inflow location, and from the lake's outflow (see Figure 1) during each lake sample event. All samples were analyzed for total phosphorus. Discharge was also generally measured. Discharge from the spring was measured by filling a one gallon container and recording the filling time. The "Floating Object" method of discharge measurement was used for surface water stations. Following is a description of the "Floating Object" method:

1. A stretch of stream about 100 feet long with fairly even gradient and flow was selected. The average width and depth of the stream were determined.

2. The time in seconds required for an orange to traverse the length of the flow station was measured. The process was repeated five times and an average of the five trials was taken.

3. Discharge was computed in the following manner:

$$Q = \frac{(W x D x L)\ a}{T}$$

Where: "Q" = rate of flow in cubic feet per second (cfs)
"W" = average width of the stream in feet
"D" = average depth in feet

"a" = a constant for stream bottom type where a = 0.8 if stream bottom is rough and strewn with rocks, rubble and coarse gravel and a = 0.9 if strewn bottom is smooth, mud, sand, or bedrock

"L" = length of the stream over which speed of floating orange was measured

"T" = time in seconds required for the orange to traverse the measured distance

4.4 Evaluation of the Tributary Watershed

The Bone Lake watershed was divided into nine subwatersheds which include the tributary watershed lakes and wetlands, as well as the remaining areas draining directly to each of the lake basins (see Figure 3). Table 2 shows the watershed areas for each of the nine subwatersheds. The Station #1 and #2 subwatersheds drain directly to the lake, while the remaining subwatersheds contribute flow from upstream lakes or wetlands. The Station #1 and #2 subwatersheds comprise approximately 40 percent of the total watershed area.

Table 2 Bone Lake Subwatershed Areas

	Watershed Area (acres)
Station #1	1,809
Station #2	3,036
Inflow #2	1,208
Prokor Creek	1,285
Hunting Grounds	777
Bone Lake Point	1,520
East Inflow	669
Northeast Inflow	630
Vincent Lake	1,043
Total Watershed Area	11,977

Evaluation of watershed land use within each section of the Bone Lake tributary watershed was completed using aerial photographs supplied by the Polk County Land Conservation Department. The evaluation consisted of a determination of watershed land use within each subwatershed. Specifically, acres of cropland, forest land, Conservation Reserve Program (CRP) land, and residential land uses were determined.

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Figure 3 Bone Lake Subwatershed Area Percentages

4.5 Hydrologic Budget Determination

Rain gages accurate to within 1/100th of an inch were installed at one location within Bone Lake's watershed and read daily by volunteers during the ice free period, to determine daily precipitation amounts. Measurements were made between April and September 1996. Data from the Village of Luck was included, and the measurements from the two gages were used to determine the average precipitation over the watershed. The data from the Village of Luck was also used during the winter months to determine total precipitation amounts for the unmonitored periods.

Evaporation from the lake water surface area and surface runoff from the lake's watershed, during the study period, was estimated using the Meyer Watershed Model (Molsather et al., 1977), which incorporates methods developed by Adolph Meyer (1947). This method uses average monthly temperature, wind speed, and relative humidity to predict monthly evaporation from water surfaces. Monthly temperature, wind speeds, and humidity used for input in the Meyer Watershed Model were taken from 1996 data from the Minneapolis/St. Paul International Airport National Weather Service station. Average daily temperature readings from the Minneapolis/St. Paul airport and average daily and total monthly precipitation from the study area were used as input for predicting surface runoff in the model.

Two staff gages were installed and read on a daily basis during the period May 7 through November 14. The staff gage readings and floating orange flow measurements, taken at the lake outlet, were used to develop an outlet rating curve for the lake. The outlet rating curve is a statistical relationship which enables prediction of the flow from the lake outlet, based on the observed lake levels. The staff gage readings and outlet rating curve were used to determine daily lake volume changes and average lake outflow volumes.

A hydrologic (water) budget for Bone Lake, based on the 1995–96 water year (October 1, 1995 through September 30, 1996), was determined by measuring or estimating the important components of the budget The important components of the budget include:

- Precipitation
- Surface Runoff
- Lake Outflow
- Evaporation
- Groundwater Flow
- Change in Lake Storage

Due to the limited scope of the project, the net groundwater flow (inflow minus outflow) had to be estimated from the calibration simulation performed with the WATBUD model. The WATBUD model, developed by the Minnesota Department of Natural Resources, allows for the automatic adjustment of coefficients that will provide the best fit between the observed and simulated lake levels. Net groundwater flow (seepage) for the monitored period was determined by allowing the WATBUD model to solve the water balance equation as presented below:

$$GW = OF + EVAP - P - RO +/- S$$

Where:

GW	=	Net Groundwater Flow (Groundwater Inflow minus Groundwater Outflow)
OF	=	Lake Outflow
EVAP	=	Evaporation from the Lake's Surface
P	=	Direct Precipitation on the Lake's Surface
RO	=	Watershed Runoff
S	=	Change in Lake Storage

The period between May and November 1996 was used for the calibration simulation since precipitation, change in storage and the remaining parameters were either known or could be estimated. Groundwater inflow and outflow were estimated, based on the net groundwater flow determination, the surrounding soil types, and the groundwater potentiometric map published by the Wisconsin Geological and Natural History Survey (1990). The groundwater potentiometric map was superimposed with the watershed map and soil types to estimate the area of the lake that experiences groundwater inflow and outflow, and to determine the hydraulic conductivities of each area contributing groundwater flow.

The annual yield of surface water runoff from the Bone Lake watershed was determined by dividing the predicted watershed runoff volumes by the watershed area to compute a yield value expressed in inches of water. The runoff yield was divided by the total precipitation for the monitored period. The resultant number represents the runoff coefficient for the watershed.

4.6 Phosphorus Budget and Lake Water Quality Mass Balance Model

Numerous researchers have demonstrated the relationship between phosphorus loads, water loads and lake basin characteristics to the observed in-lake total phosphorus concentration. The relationship was used to verify the annual phosphorus load into Bone Lake based on average surface phosphorus concentrations, the lake's hydrologic budget, and lake basin characteristics. The relationship has many forms. The equation used for Bone Lake was adapted from one developed by Dillon and Rigler (1974), modified by Nurnberg (1984) and has the form of:

$$P = \frac{L_A (1 - R_P)}{Q_S} + \frac{L_I}{Q_S}$$

Where:

P = is the mean phosphorus concentration

L_A = amount of phosphorus added per unit surface area of lake from all sources except from the internal load of the lake

R_P = the coefficient which describes the total amount of phosphorus retained by the sediments each year

= $15/(18+Q_s)$

Q_S = the outflow of the lake divided by its surface area

L_I = mass of phosphorus added to the lake from internal loading

For Bone Lake, all variables of the equation were measured or could be estimated based on data collected during the study. This equation was added to the Wisconsin Lake Model Spreadsheet (WILMS) (Panuska and Wilson, 1994) and compared with the other predictive lake water quality equations already present in WILMS.

The overall Bone Lake phosphorus budget was determined using the tributary water quality data and corresponding watershed runoff volumes to determine phosphorus export coefficients for each of the subwatershed areas containing tributary lakes or wetlands. These data were combined with the export rates for each of the phosphorus input sources (or land uses) within the direct subwatersheds (Station #1 and #2) to estimate the total loads to each of the lake's basins. The phosphorus budget for Bone Lake was determined by measuring or estimating the important components of the budget. The important components of the budget include:

- Watershed Surface Runoff from Forested, Cropland, Residential, and Pasture/CRP Land Uses
- Internal Loading
- Atmospheric Wet and Dry Deposition on the Lake Surface
- Septic System Loading

- Monitored Tributaries
- Groundwater

The watershed surface runoff component was estimated using an annual phosphorus export coefficient for each land use type within the direct subwatersheds. An annual phosphorus export coefficient of 0.07 lbs/ac/yr was used for the forested portions of the subwatersheds. This value closely corresponds with the most likely default coefficient in the WILMS model (Panuska and Wilson, 1994), and that observed by Singer and Rust (1974). The cropland phosphorus export coefficient of 0.31 lbs/ac/yr, used in this analysis, agrees well with that observed by others (Burwell et al., 1975; Alberts et al., 1978). The residential phosphorus export coefficient of 0.45 lbs/ac/yr corresponds with other published data (Landon, 1977; Bannerman et al., 1983). Finally, Harms et al. (1974) obtained a phosphorus export coefficient of 0.22 lbs/ac/yr, which corresponds well with the 0.18 lbs/ac/yr used for the pasture/CRP land use within the direct subwatersheds.

Internal loading (L_I in the above equation) was estimated for each of the lake basins using the total phosphorus data from the lake's water column. The summer internal load, for each basin, is the product of the fraction of hypolimnetic phosphorus released to the surface waters, the sediment phosphorus release rate, the fraction of the lake basin surface area experiencing anoxia, and the duration of hypolimnetic anoxia. The 1996 dissolved oxygen profiles of each basin were used to estimate the duration of anoxia (D.O. <0.5 mg/L). The fraction of each lake basin's total surface area experiencing anoxia was based on the depths of the observed summer anoxia and the morphometry of each basin. The average sediment total phosphorus release rate of 1.0 mg/m^2/day was estimated using the total phosphorus data from the lake's water column. This sediment release rate is lower than the release rates determined from the sediment phosphorus release experiment (approximately 6 mg/m^2/day) conducted as part of this study, but agrees well with the observed increase of total phosphorus over the anoxic portion of the hypolimnetic waters of each basin during the summer of 1996. Finally, the fraction of hypolimnetic total phosphorus released to the surface waters was estimated to facilitate the calibration of the lake mass balance model. For the calibrated model, this fraction ranged from 0.69 to 0.80 for each basin. This release fraction agrees with that observed by Nurnberg and Peters (1984).

An atmospheric wet and dry deposition rate of 0.22 lbs/ac/yr, which agrees well with the most likely export coefficient in the WILMS model (Panuska and Wilson, 1994) and others (Richardson and Merva, 1976; Eisenreich et al., 1977), was applied to the surface area of Bone Lake. The groundwater flow component of the phosphorus budget was determined using the inflow volume from the hydrologic budget and an average groundwater total phosphorus concentration of 0.020 mg/L, based on nearby sampling data published by the Wisconsin Geological and Natural History Survey (1990). The watershed runoff component from the tributary subwatersheds was estimated using the export coefficients determined from the measured inflow concentrations and estimated runoff from each of the monitored watersheds. The Prokor Creek and Inflow #2 subwatershed total phosphorus export coefficients were 0.026 and 0.108 kg/ha/yr, respectively. The measured Prokor Creek export coefficient is significantly less than published values for other subwatersheds with similar land uses, and may reflect the nutrient removal capacity of the large wetland directly upstream of the outfall.

Phosphorus export rate computations, used in the WILMS model and published by the U.S. EPA for septic systems, were used to estimate an annual load from drain fields. The equation used for Bone Lake estimated the septic system load as follows:

$$\text{Total Septic System Load (kg/yr)} = Ec_{st} * \text{\# of capita-years} * (1-SR)$$

Where:

Ec_{st}	=	export coefficient to septic tank systems (0.5 kg/capita/yr)
cap.-yrs.	=	# of people occupying a dwelling each year
	=	(# of permanent residents/dwelling)*(permanent dwellings) + (# of seasonal residents/dwelling)*(days/yr)*(seasonal dwellings)
SR	=	weighted soil retention coefficient (88 for most likely value used in model)

The Bone Lake property owners survey results were used to determine the number of septic systems within each of the two lake basin areas and the total number of septic systems for both permanent and seasonal residences. The most likely soil retention coefficients of 90 and 40 were chosen for properly and improperly functioning systems, respectively. Five percent of the septic systems were assumed to be improperly functioning, yielding a weighted soil retention coefficient of 88. Each permanent and seasonal dwelling unit was assumed to have three and five residents, respectively, on average. The seasonal dwelling units were assumed to have been occupied 100 days per year. Finally, the USGS Quad Maps were used in conjunction with the number septic systems within each township to assign the number of dwellings adjacent to each of the two lake basins of Bone Lake. The ratio of permanent to seasonal residences was kept the same as the total for each basin. The assumptions made regarding the septic system inputs agree well with the estimates made for Balsam Lake in Polk County, Wisconsin (Bursik, 1996).

4.7 Bone Lake Survey

The Bone Lake District intended to complete a survey to evaluate water use conflicts, fishing conflicts, and boating conflicts. However, the District determined that survey results from its 1993 survey provided sufficient information regarding the issue of lake usage. The 1993 survey was sent to a total of 435 property owners on Bone Lake with the June newsletter. A total of 142 property owners completed and returned the survey, which is a 36 percent return rate. Survey questions solicited information regarding lake usage, water quality perceptions, and lake management desires of riparian owners.

5.0 Results and Discussion

5.1 Compiled Data

Water quality data acquired by the 1996 monitoring program are compiled in Appendices A through E. Appendix A presents the tabulated in-lake water quality data for each lake station. Selected water quality parameters from Appendix A are analyzed and summarized in the discussion below. Appendix B contains the tabulated inflow/outflow measurements of total phosphorus. From these results, the flux of phosphorus from the watershed was calculated and used to calibrate the phosphorus mass balance model. Lake level data used to determine changes in lake volume are shown in Appendix C. Appendix D contains the precipitation data collected by a Bone Lake volunteer and the City of Luck. Appendix E presents the results of the sediment/ phosphorus release experiment.

5.2 Seasonal Patterns in 1996 Water Quality Conditions

5.2.1 Phosphorus

Phosphorus is the plant nutrient that most often limits the growth of algae. Phosphorus-rich lake water indicates a lake has the potential for abundant algal growth, which can lead to lower water transparency and a decline in hypolimnetic oxygen levels in a lake.

Total phosphorus data collected from Bone Lake during 1996 were within the mesotrophic (i.e., moderate amount of nutrients) category during the late spring and early summer period and the eutrophic (i.e., nutrient-rich) category during the late summer period (Figure 4). The two basins exhibited similar phosphorus concentrations during the growing season. The average epilimnetic (i.e., surface waters—upper 6 feet) summer phosphorus concentrations at Stations 1 and 2 were 0.028 mg/L and 0.023 mg/L, respectively.

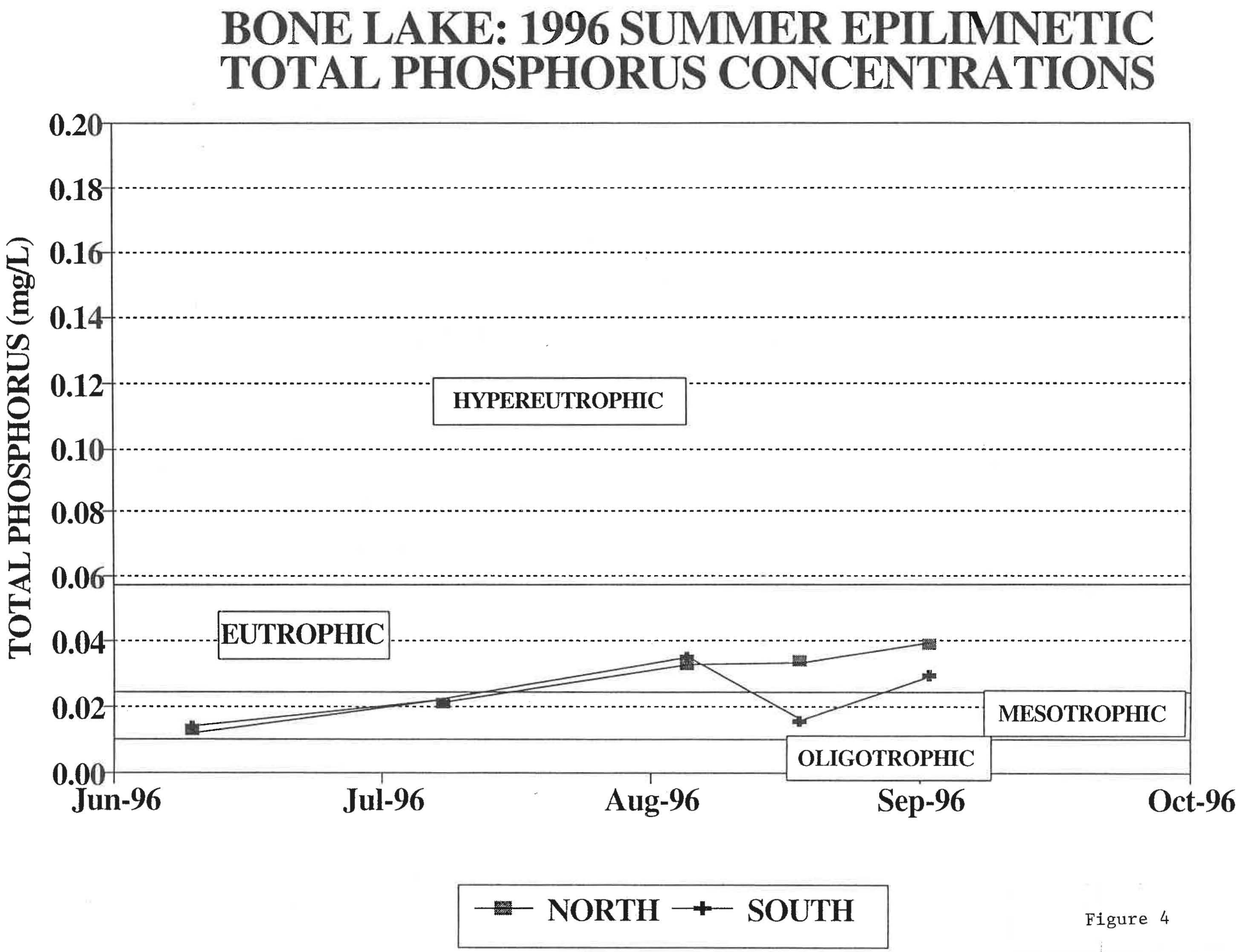

BONE LAKE: 1996 SUMMER EPILIMNETIC
TOTAL PHOSPHORUS CONCENTRATIONS
TOTAL PHOSPHORUS (mg/L)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HYPEREUTROPHIC
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
NORTH
SOUTH

Figure 4

5.2.2 Chlorophyll *a*

Chlorophyll a is a measure of algal abundance within a lake. High chlorophyll a concentrations indicate excessive algal abundance (i.e., algal blooms), which can lead to recreational use impairment.

The 1996 Bone Lake chlorophyll *a* data indicate that both basins experienced algal blooms during most of the summer despite regular algicide treatments of portions of the lake (Figure 5). Stations 1 and 2 had moderate chlorophyll *a* concentrations during the late spring period; however, algal abundance increased rapidly, resulting in extremely high algal biomass throughout the summer period. Similar chlorophyll concentrations were observed in the two basins during the late spring and early summer period; however, the north basin (i.e., Station 1) exhibited higher chlorophyll concentrations than the south basin during the late summer period. Summer average epilimnetic (i.e., surface waters—upper 6 feet) chlorophyll *a* concentrations at Stations 1 and 2 were 32.4 and 23.8 µg/L, respectively. The seasonal pattern of chlorophyll *a* concentrations was similar to phosphorus concentrations in the two basins, confirming that the lake's algal growth is directly related to phosphorus levels. The chlorophyll data indicate a relatively high yield of algal biomass resulted from the lake's available phosphorus.

5.2.3 Secchi Disc Transparency

Secchi disc transparency is a measure of water clarity. Perceptions and expectations of people using a lake are generally correlated with water clarity. Results of a survey completed by the Metropolitan Council (Osgood, 1989) revealed the following relationship between a lake's recreational use impairment and Secchi disc transparencies:

- *Moderate to severe use-impairment occurs at Secchi disc transparencies less than 1 meter (3.3 feet).*
- *Moderate impairment occurs at Secchi disc transparencies of 1 to 2 meters.*
- *Minimal impairment occurs at Secchi disc transparencies of 2 to 4 meters.*
- *No impairment occurs at Secchi disc transparencies greater than 4 meters*

BONE LAKE: 1996 SUMMER EPILIMNETIC CHLOROPHYLL CONCENTRATIONS

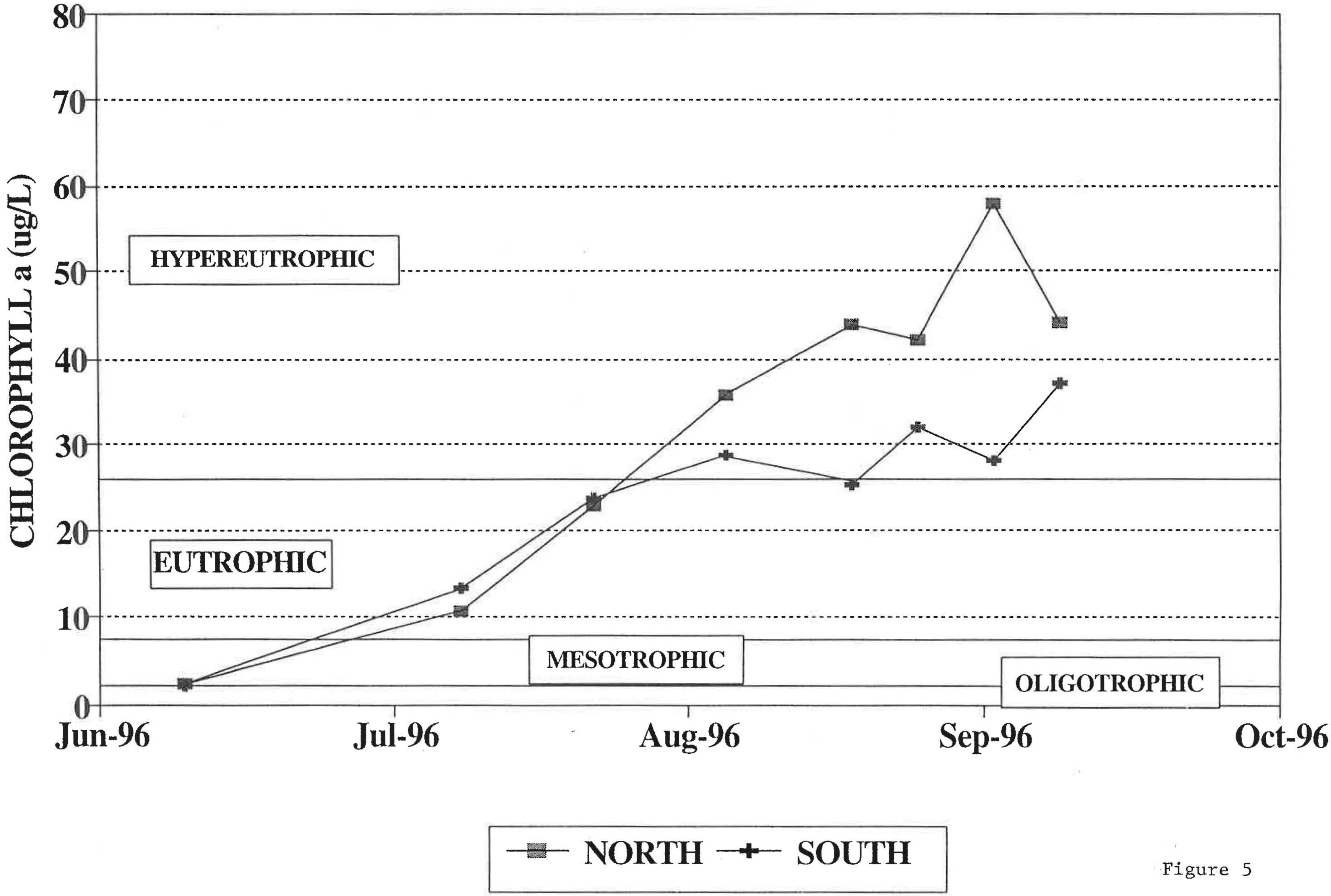


Figure 5

Secchi disc measurements in Bone Lake generally mirrored phosphorus and chlorophyll *a* concentrations (Figure 6). Transparency was good during the late spring and early summer period, but declined sharply throughout the summer. The seasonal patterns clearly show that the lake's water transparency is largely determined by algal abundance. For Stations 1 and 2, use-impairment appears to have been minimal during the early summer period and became moderate to severe during the late summer. Based on the Metropolitan Council study, the 1996 average summer Secchi disc transparencies in the two basins of Bone Lake (1.7 and 1.8 meters, respectively) indicate that Bone Lake generally experiences moderate recreational use-impairment. The use impairment occurred, however, despite frequent algicide treatments of portions of the lake.

5.2.4 Temperature, Dissolved Oxygen, Specific Conductance, and Phosphorus Isopleth Diagrams

Isopleth diagrams represent the change in a parameter relative to depth and time. For a given time period, vertical isopleths indicate complete mixing and horizontal isopleths indicate stratification.

Isopleth diagrams are useful for showing patterns with depth and time when sufficient depth profile data are available. Isopleth diagrams of temperature, dissolved oxygen, total phosphorus, and specific conductance were prepared for both basins. The temperature isopleth diagrams (Figures 7 and 8) indicate both basins of Bone Lake were stratified throughout the sampling period. The lake has a long fetch (exposure to the wind) and mixing could have occurred. The basin could have completely mixed during periods between sample events and restratified, giving the appearance of stratification throughout the sample period in the isopleth diagram.

The dissolved oxygen isopleth (Figures 9 and 10) diagrams show dissolved oxygen concentrations near the lake bottom were near zero throughout the sampling period because of oxygen depletion from the bottom waters. This reduces the available habitat for organisms (e.g., fish and zooplankton). A dissolved oxygen concentration of 5.0 mg/L is considered the minimum desirable level for fish. Oxygen concentrations of 5 mg/L or larger were observed from the lake's surface to the 6- to 8-foot depths at the north basin (i.e., Station 1) and from the lake's surface to the 5- to 7-meter depths at the south basin (Station 2). The differences in the depth at which the 5.0 mg/L oxygen concentration was found in the two basins was believed to be caused by differences in maximum depth (i.e., maximum depth of the north basin was 43 feet and the maximum depth of the south basin was 32 feet).

BONE LAKE: 1996 SECCHI DISC TRANSPARENCIES

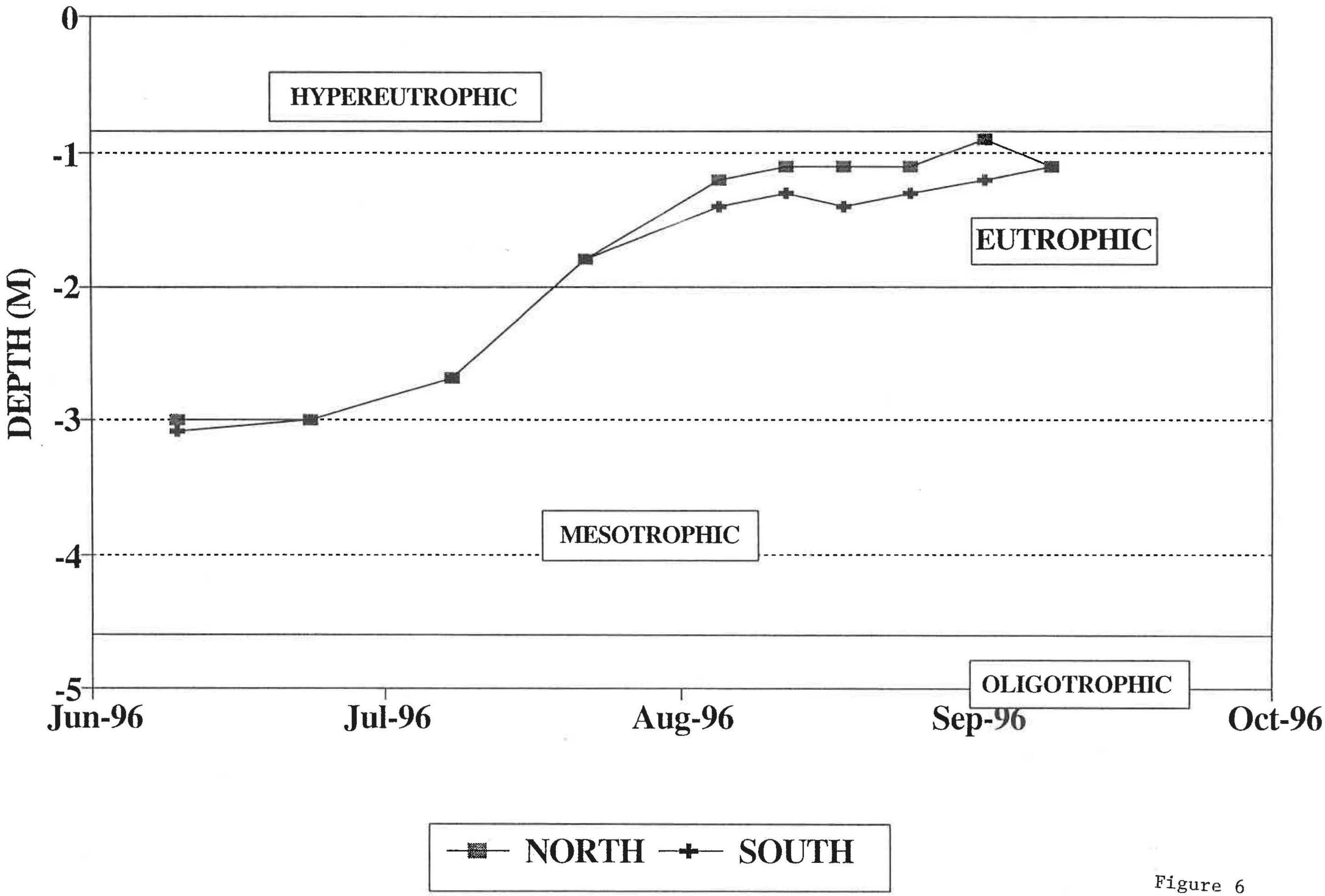


Figure 6

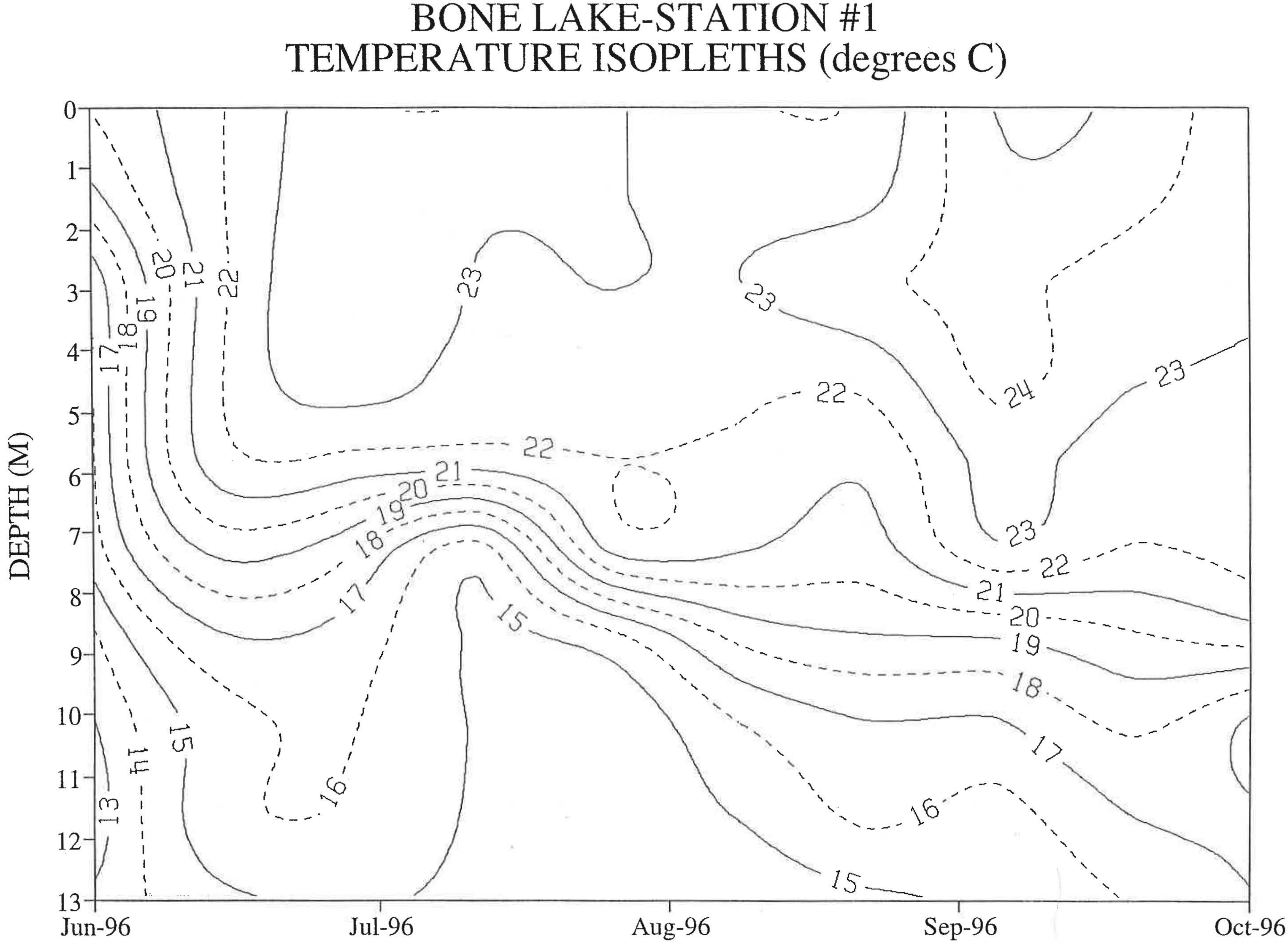

BONE LAKE-STATION #1
TEMPERATURE ISOPLETHS (degrees C)
DEPTH (M)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
13
14
15
16
17
18
19
20
21
22
23
24

Figure 7

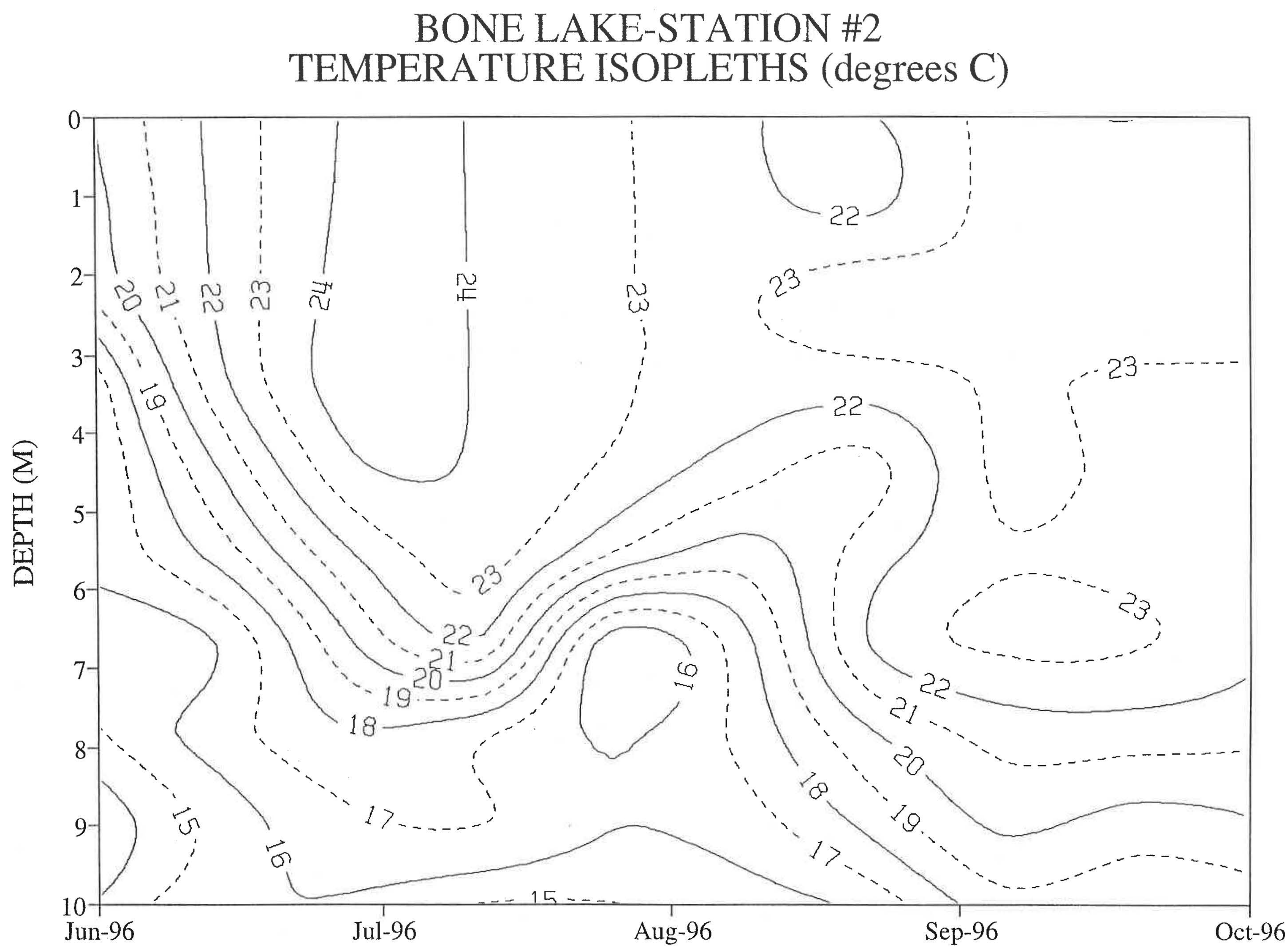

BONE LAKE-STATION #2
TEMPERATURE ISOPLETHS (degrees C)
DEPTH (M)
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96

Figure 8

BONE LAKE-STATION #1
DISSOLVED OXYGEN ISOPLETHS (mg/L)

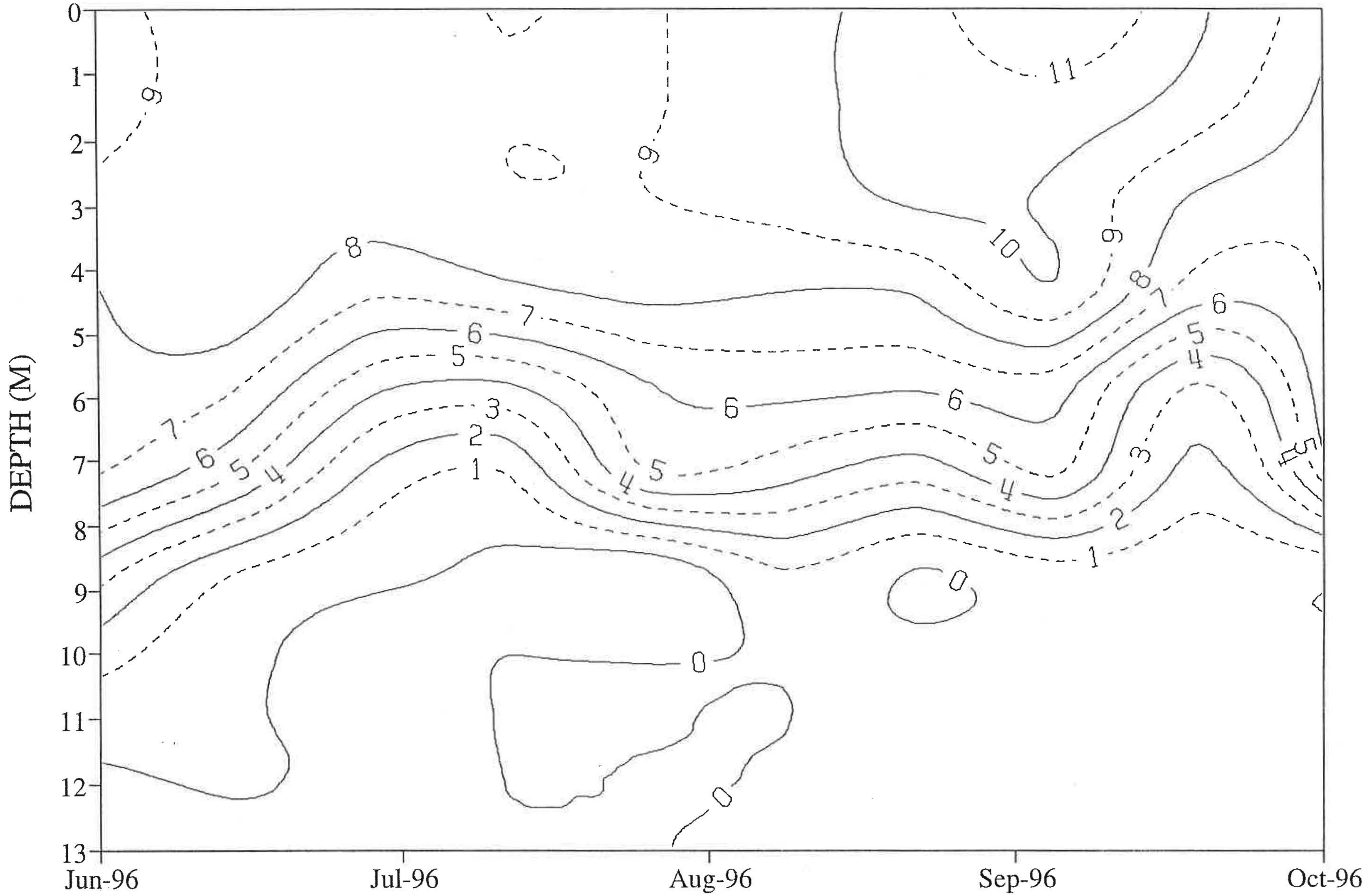


Figure 9

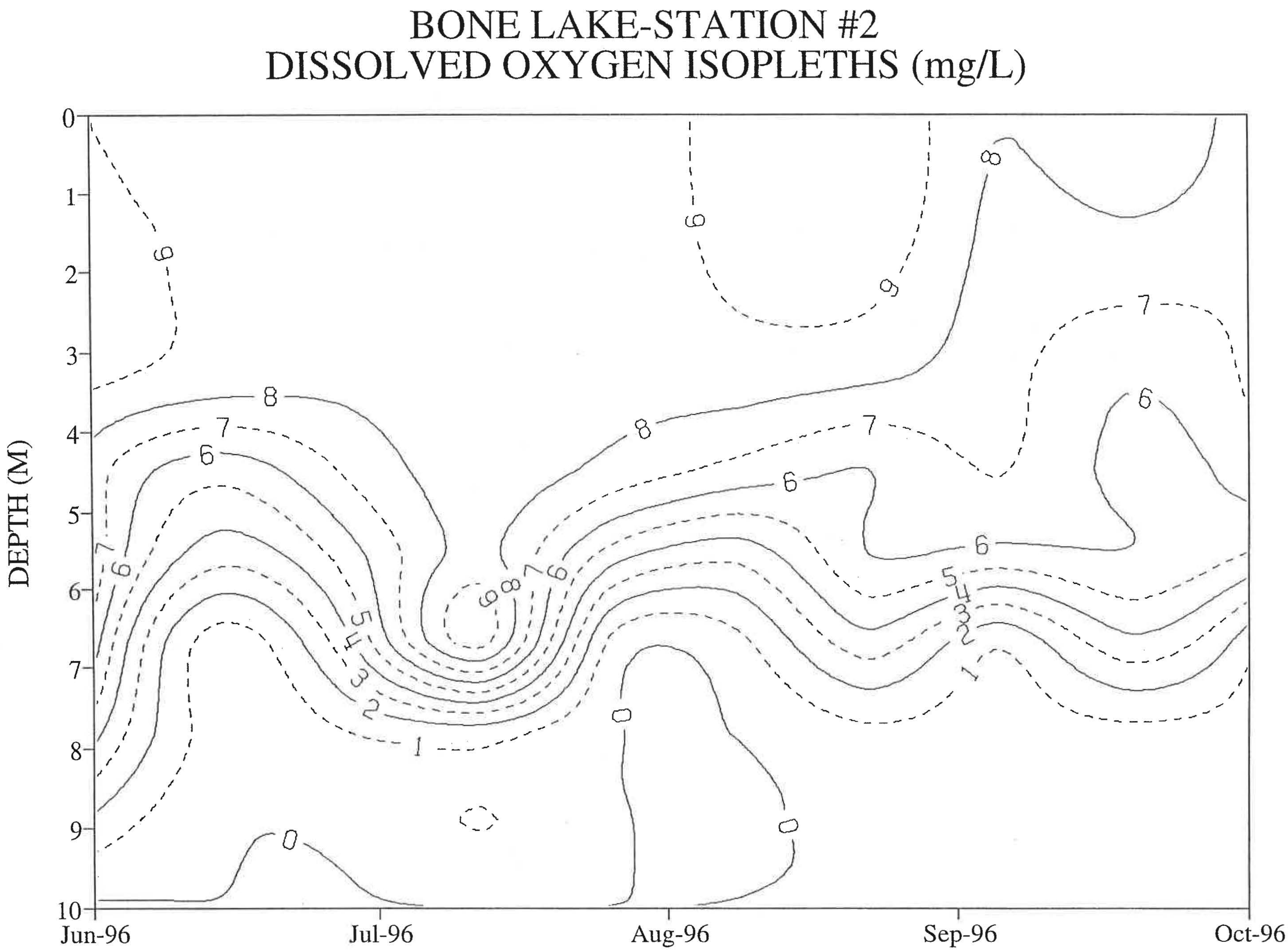

BONE LAKE-STATION #2
DISSOLVED OXYGEN ISOPLETHS (mg/L)
DEPTH (M)
0
1
2
3
4
5
6
7
8
9
10
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96

Figure 10

The period of oxygen depletion in the hypolimnion matches the period of apparent internal phosphorus loading, shown in the total phosphorus isopleth diagrams (Figures 11 and 12). The importance of the internal phosphorus load to the lake's annual load is discussed later in the section "Phosphorus Budget and Lake Water Quality Mass Balance Model." The specific conductance isopleth diagrams (Figures 13 and 14) provide confirming evidence of apparent internal phosphorus loading. Specific conductance provides a general measurement of dissolved solids, including phosphorus. Increased levels of dissolved solids in the anoxic (i.e., void of oxygen) bottom waters suggests internal phosphorus loading may be occurring.

5.2.5 Macrophytes

> *Aquatic plants (i.e., macrophytes and phytoplankton) are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. They are the primary producers in the aquatic food chain, providing food for other aquatic life. Macrophytes describe the aquatic plants growing in the shallow (littoral) area of the lake.*

The Bone Lake macrophyte community was surveyed during August to determine locations of macrophyte growth. Survey results indicate plant growth occurred throughout the littoral area of the lake. The maximum depth of macrophyte growth was, on average, 7 feet ranging from 5 feet to 9 feet (Figure 15).

BONE LAKE-STATION #1
TOTAL DISS. PHOSPHORUS ISOPLETHS (ug/L)

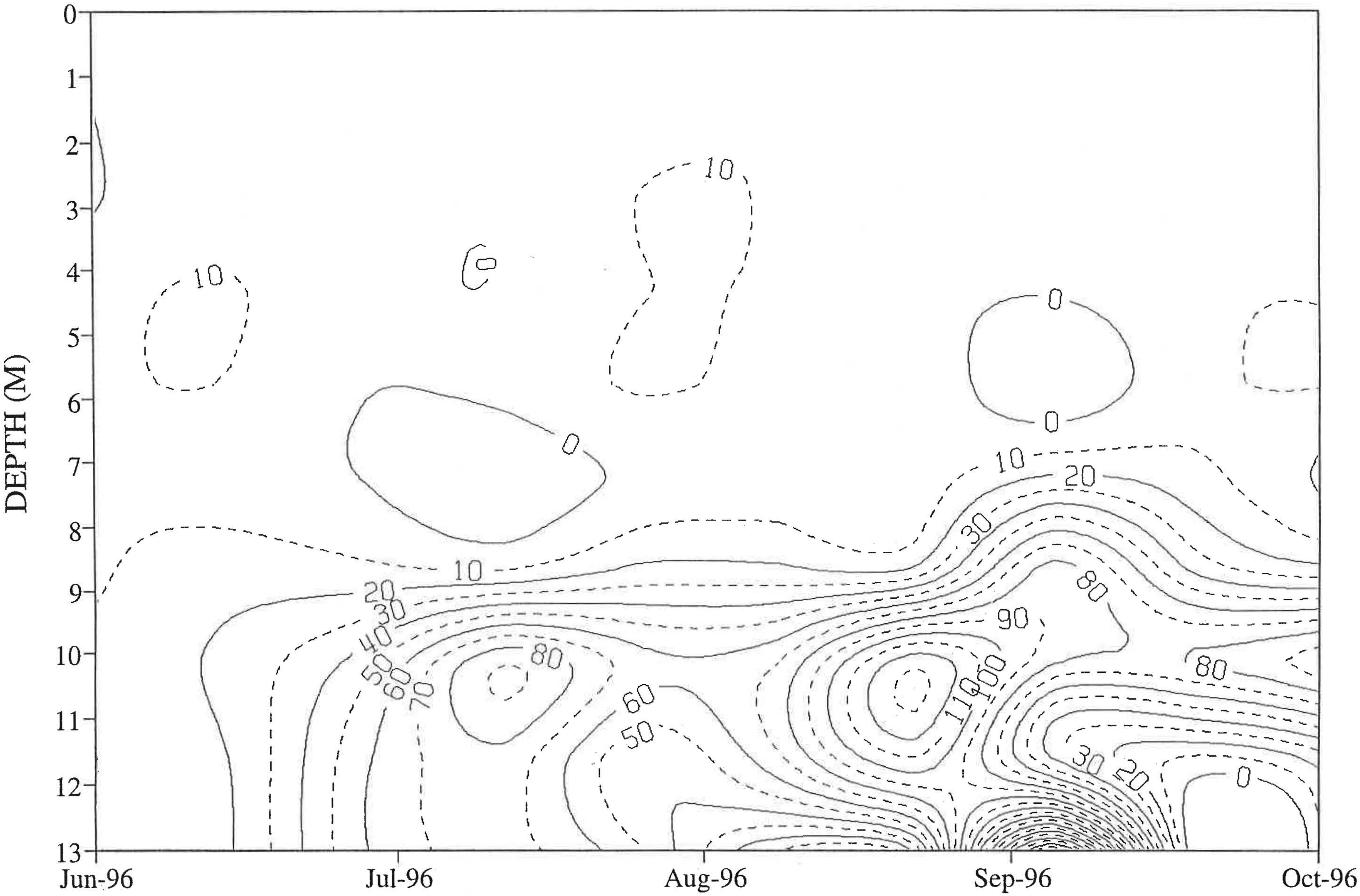


Figure 11

BONE LAKE-STATION #2
TOTAL DISS. PHOSPHORUS ISOPLETHS (ug/L)

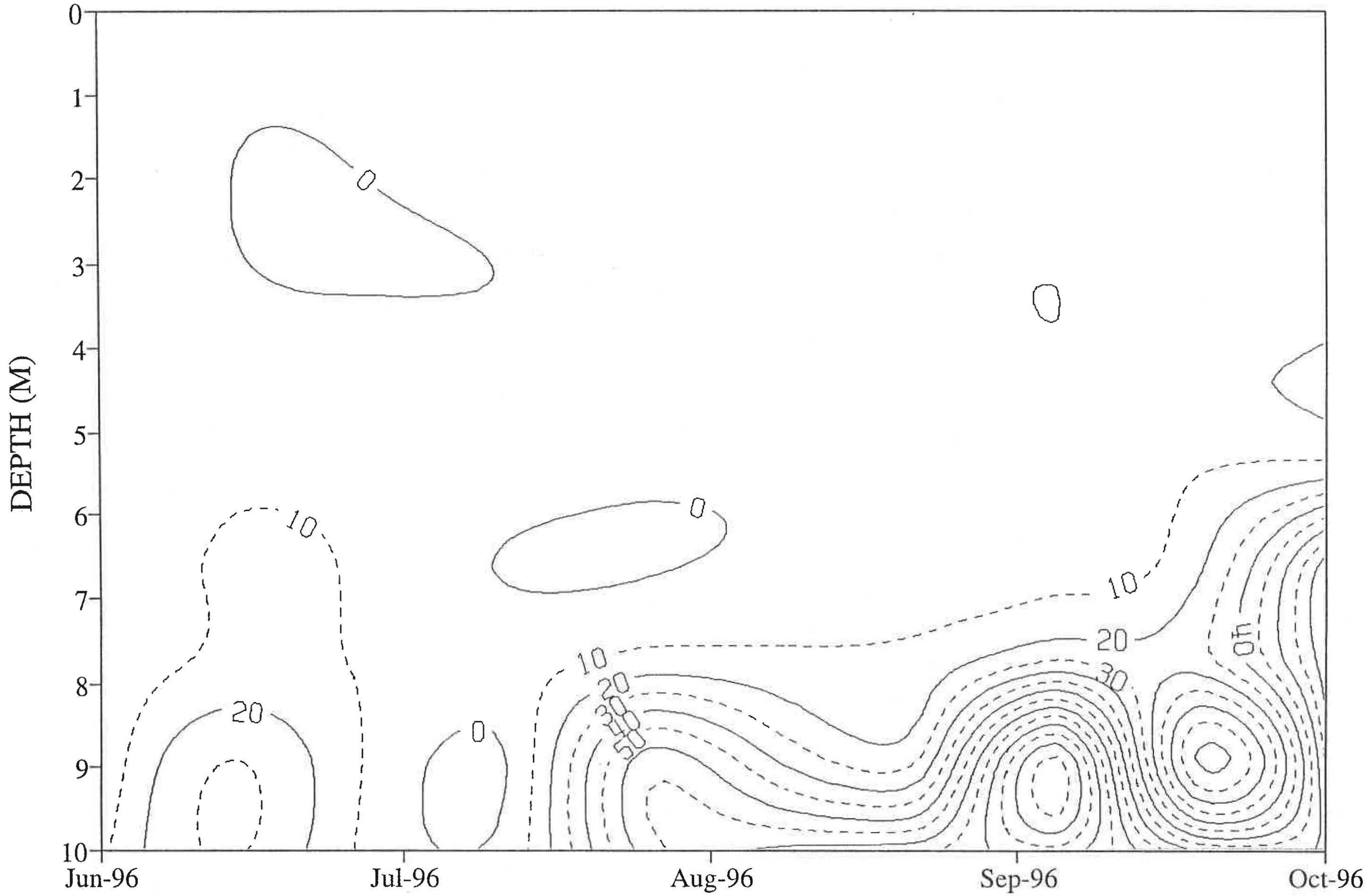


Figure 12

BONE LAKE-STATION #1
SPECIFIC CONDUCTANCE ISOPLETHS (umhos)

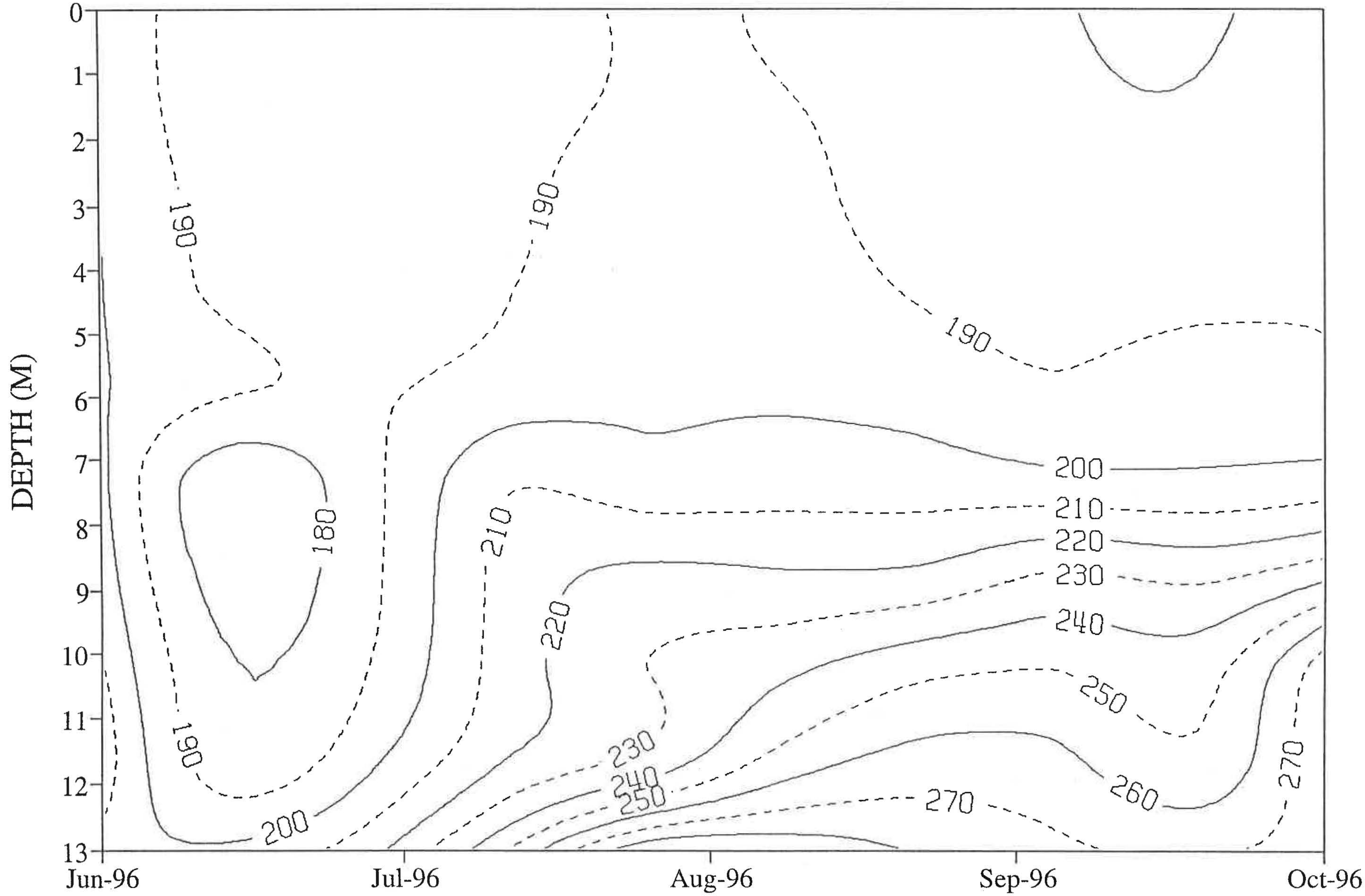


Figure 13

BONE LAKE-STATION #2
SPECIFIC CONDUCTANCE ISOPLETHS (umhos)

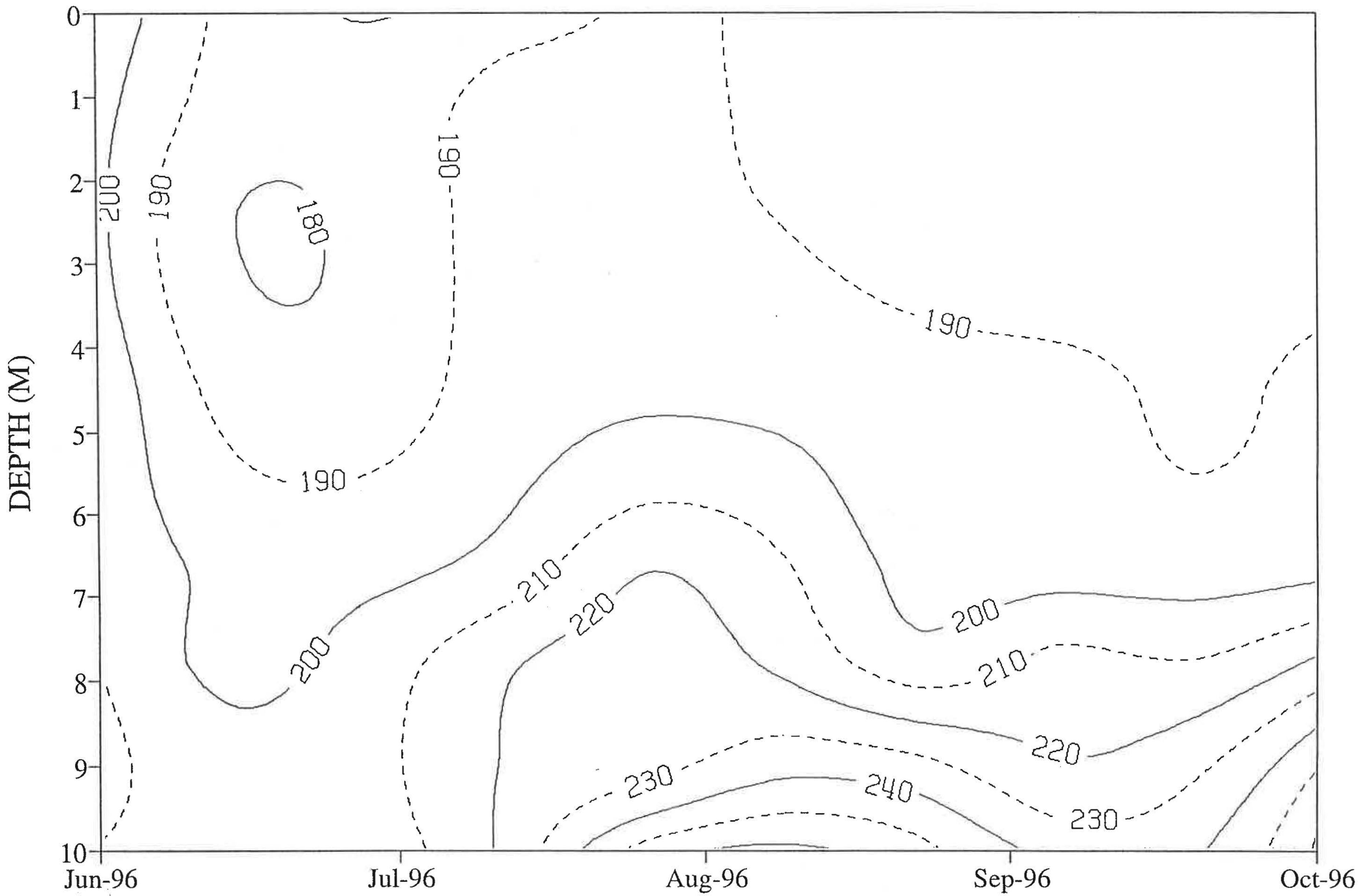


Figure 14

Reserved for:

Figure 15 Bone Lake Macrophyte Survey Results

5.3 Evaluation of Historical Secchi Disc Data

An evaluation of Secchi disc data collected during 1989 through 1996 (Figure 16) indicates a similar seasonal pattern has occurred annually:

- Good water transparency is observed during the spring and early summer months.
- Transparency has declined sharply throughout each summer resulting in a moderate to severe use impairment by late summer.

The average summer Secchi disc transparency has declined steadily over time (Figure 17) from 2.61 meters during 1990 to 1.88 meters during 1996. The decline has occurred despite annual algicide treatments to improve water transparency. The District should collect and evaluate Secchi disc data annually to determine whether the apparent trend of declining Secchi disc transparency continues.

5.4 Sediment Phosphorus Release Data

Sediment phosphorus release rates were determined through experiments using cylindrical "microcosms" (see discussion in Methods section, 4.2). Water levels in the microcosms were measured daily. By multiplying the microcosm's cross-sectional area by the height of the water, the microcosm's water volume was determined for each day of the experiment.

Total phosphorus concentrations in the water overlying the sediments were also measured and recorded each day for each microcosm. By multiplying the microcosm volume by the phosphorus concentration, and then adding in the cumulative mass of the phosphorus removed through sampling, a daily total phosphorus mass was computed for each of the four containers. Results of these measurements and computations may be found in Appendix E.

Figure 18 shows daily changes in the mass of phosphorus in the water column for the experiments. Since phosphorus release cannot occur in the presence of oxygen, the onset of anoxia was inferred by noting the time at which phosphorus concentrations in the microcosms began to rise. The experimentally determined phosphorus release rates were computed using the steepest portions of the plots of phosphorus mass versus elapsed time. This is the period during which anoxia has been established, but for which the sediments have not yet begun to be depleted of phosphorus.

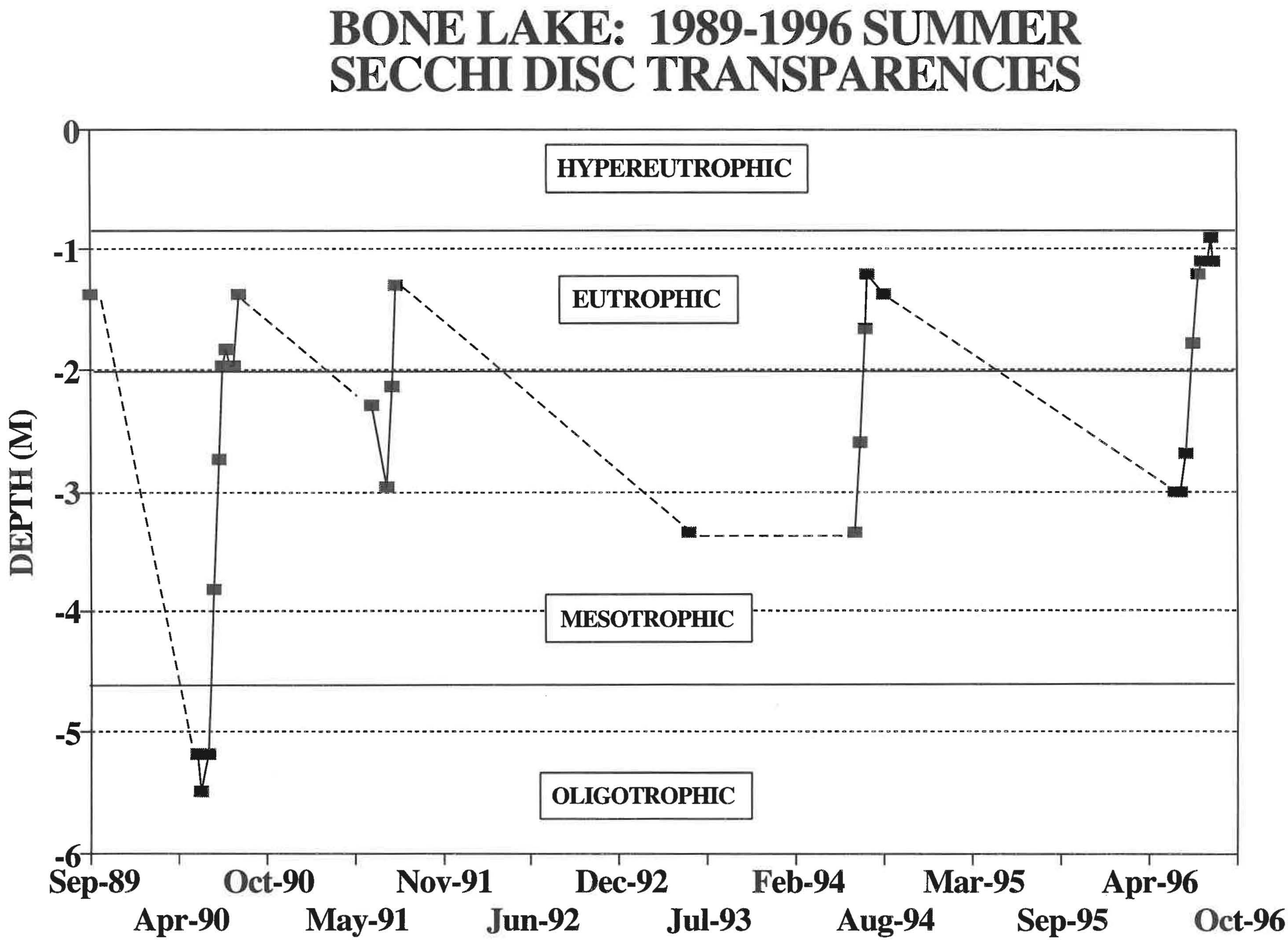
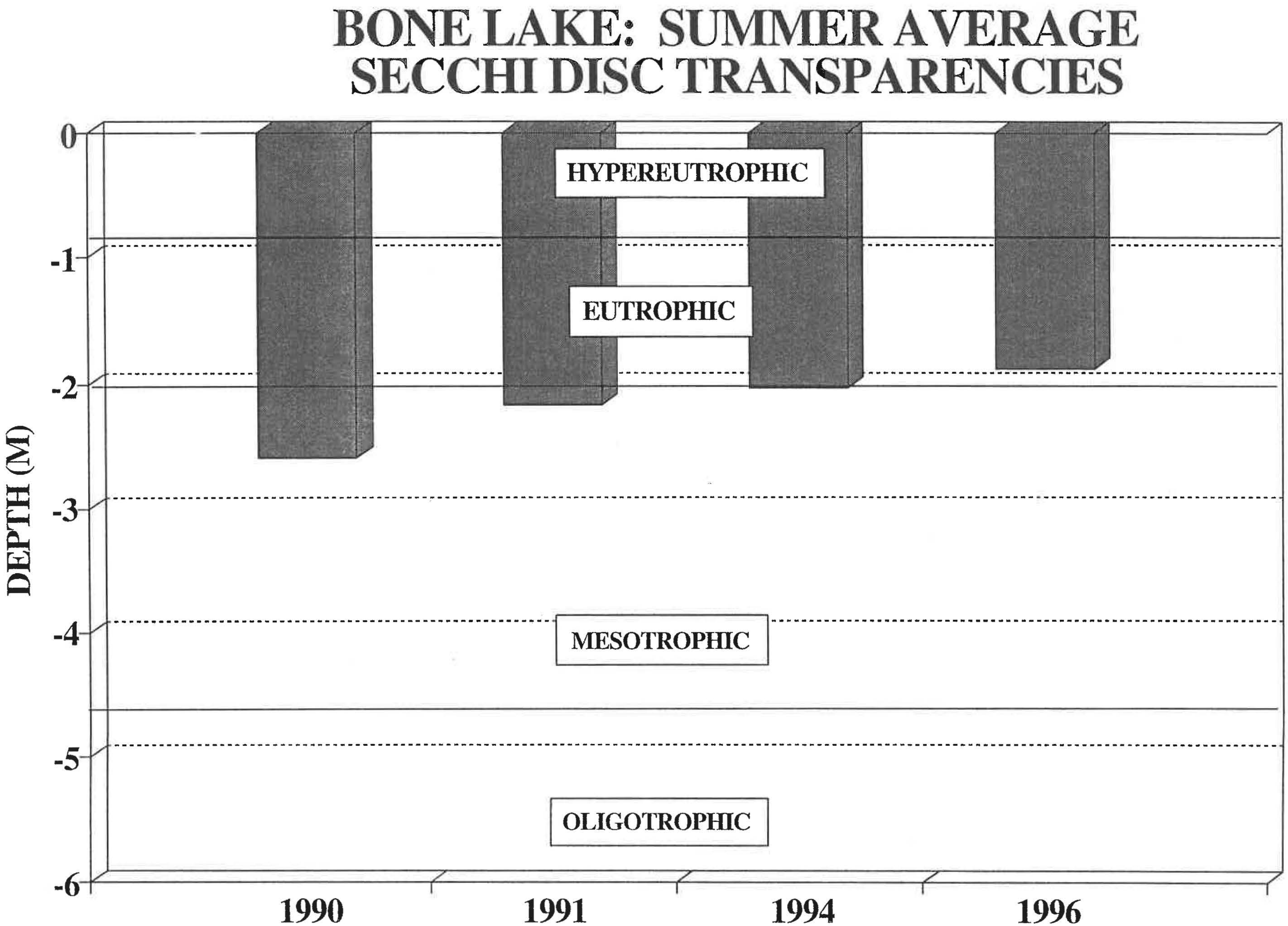

BONE LAKE: 1989-1996 SUMMER
SECCHI DISC TRANSPARENCIES
HYPEREUTROPHIC
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
DEPTH (M)
0
-1
-2
-3
-4
-5
-6
Sep-89
Apr-90
Oct-90
May-91
Nov-91
Jun-92
Dec-92
Jul-93
Feb-94
Aug-94
Mar-95
Sep-95
Apr-96
Oct-96

Figure 16



BONE LAKE: SUMMER AVERAGE
SECCHI DISC TRANSPARENCIES
DEPTH (M)
0
-1
-2
-3
-4
-5
-6
HYPEREUTROPHIC
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
1990
1991
1994
1996

Figure 17

Bone Lake Sediment P-Release Exp
9/19/96 - 10/17/96

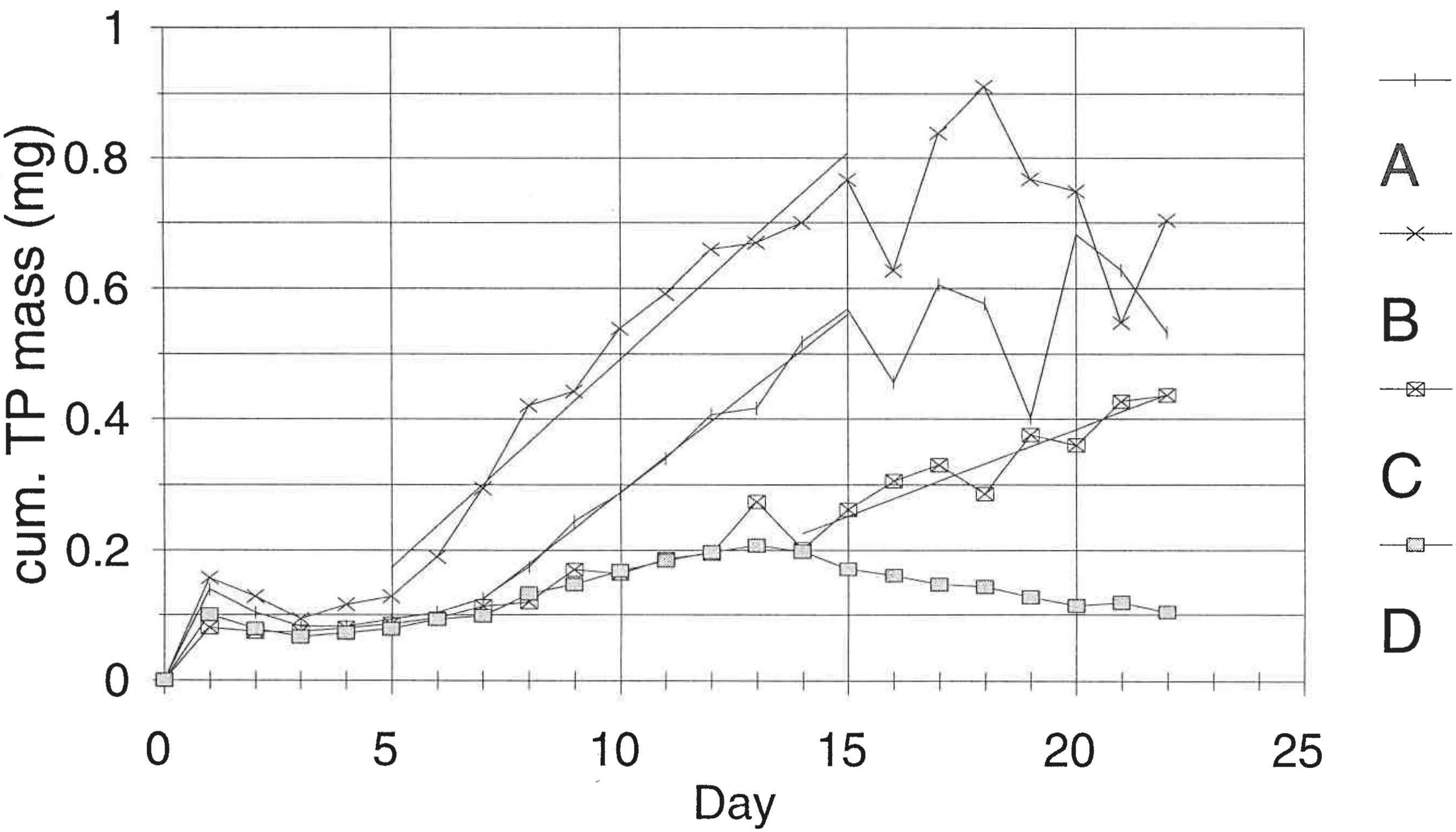


Figure 18

The water in two of the microcosms became anoxic approximately five to seven days after the start of the experiment, and significant amounts of phosphorus were released into the water column until day 15. One microcosm did not exhibit anoxia until 14 days after the start of the experiment, and significant amounts of phosphorus were released into the water column until the experiment ended on day 22. The results from the fourth microcosm are believed to be anomalous and are not included in this discussion.

Regression analysis of the phosphorus mass versus elapsed time during this period showed the phosphorus release rate to range from 3.27 mg/sq.m./day to 8.03 mg/sq.m./day in the three microcosms exhibiting significant phosphorus release. The average phosphorus release rate from the three microcosms was 6.00 mg/sq.m./day.

The sediment phosphorus release rates for Bone Lake estimated above are within the range of 0.8 to 34 mg/sq.m./day given in the literature (Nurnberg, 1984). The Bone Lake water quality data, however, suggest that a lower release rate occurred, on average, in the lake. A release rate of 1 mg/sq.m/day is suggested by the data. Although the reason for the apparent discrepancy is unknown, a couple of variables could account for at least some of the difference. Intermittent mixing between sampling dates could have added phosphorus released from the sediments to the surface waters. Furthermore, the lake's weekly algicide treatment removed part of the total phosphorus from the surface waters (i.e., phosphorus stored in algae was added to lake sediments). The combination of these variables could have caused the sediment phosphorus release rate estimated from the lake's water quality data to be somewhat lower than actually occurred.

5.5 Bone Lake Survey Results

The 1993 survey of Bone Lake riparian owners solicited opinions regarding lake usage, boat traffic and boating issues, water quality perceptions, aquatic plant growth, and actions to address lake concerns. The survey results indicated most residents purchased property to obtain peace and tranquility (42 percent), to go fishing (20 percent), or to entertain friends and relatives (12 percent). When asked which use of your lake property is the most important to you, 44 percent indicated peace and tranquility, 14 percent indicated fishing, and 8 percent indicated entertaining friends and relatives. However, when asked how do you actually use the lake, the responses indicated entertaining friends and relatives occurred more frequently than fishing, and apparently reduced the quantity of time available for appreciating peace and tranquility. The responses were: 35 percent appreciating peace and tranquility, 19 percent entertaining friends and relatives, and 16 percent fishing.

Survey results regarding the types of watercraft kept at riparian owners' property provide an indication of lake recreational usage involving watercraft. Responses indicate the largest number of residents use motorboats with a motor larger than 25 horsepower (30 percent of total), followed by canoes (15 percent of total), and motor boats with a motor smaller than 25 horsepower (14 percent of total). Other responses include rowboats (13 percent of total), sailboats (10 percent of total), pontoons (9 percent of total), paddle boats (5 percent of total), rafts (2 percent of total), and jet skis (2 percent of total).

To determine the level of boat traffic on the lake and to assess conflict occurring between boaters, survey questions were asked regarding these issues. Survey results indicated 68 percent of riparian residents consider the boat traffic moderate, while 28 percent considered the boat traffic heavy. The remaining respondents considered the lake over used (3 percent) or unusable (1 percent) relative to boat traffic. Residents considered conflict levels among boaters to be little (54 percent), moderate (44 percent), or heavy (1 percent). Approximately 1 percent indicated displacement occurs due to jet ski usage.

Residents were asked questions regarding their perception of water clarity, water quality, and changes in water quality during their time of residence on the lake. Results indicated 1 percent perceived the lake to be crystal clear, 72 percent clear, 23 percent cloudy, and 4 percent murky. Most residents perceived the lake to have good (61 percent) or fair (32 percent) water quality. When asked to evaluate lake water quality changes during the period of lake residence, most riparian owners indicated the water quality had remained the same (43 percent) or slightly degraded (32 percent). A few indicated the water quality had improved (10 percent), considerably degraded (4 percent), or were unable to tell (4 percent).

Perceptions of aquatic plant growth were also surveyed. Most riparian residents considered the lake's aquatic plant growth moderate (60 percent) or heavy (34 percent). A few considered the growth light (3 percent) or dense (3 percent).

Residents were asked what actions should be taken to deal with concerns for the lake. The majority indicated: strengthen the lake district (21 percent), develop a long-term management plan for the lake (20 percent), or survey people living on the lake to document concerns (12 percent).

5.6 Rainfall, Evaporation and Lake Outlet Data

As previously mentioned, rain gages were installed at a location within Bone Lake's watershed and read daily by volunteers during the ice-free period, to determine daily precipitation amounts. Total average precipitation during the 1995–96 water year (monitored) was 31.00 inches. During one very large storm event from May 17–19, 1996, the average measured rainfall was 3.77 inches. Data from the Village of Luck was used during the winter months to determine total precipitation amounts for the unmonitored periods. Based the Village's data, approximately 4.68 inches (water equivalent) of precipitation occurred during December through March of 1995–96.

The monthly evaporation rates estimated from the Meyer Watershed Model ranged from 0.36 inches (in January) to 4.68 inches (in July). Monthly evaporation rates were translated into daily evaporation rates to allow estimation of the hydrologic budgets on an event basis. The daily evaporation rates were assumed to be the same for each day of each month. Total estimated evaporation during 1995–96 was 28.08 inches.

Two staff gages were installed on the south end of the lake and a stage-storage curve was developed for determining the change in storage within the lake at the various lake levels. The gage was read on a daily basis during the period May 7 through November 14. The monitored lake water surface elevations had a range of approximately 1 foot. The low lake surface elevation occurred in late September and the high lake surface elevation resulted from the 3.77-inch storm event from May 17–19, 1996. The large storm event caused the lake level to rise approximately one-half foot. The normal water surface elevation is 1152.0 feet MSL.

The staff gage readings and floating orange flow measurements, taken at the lake outlet, were used to develop an outlet rating curve for the lake. The staff gage readings and outlet rating curve were used to determine daily lake volume changes and average lake outflow volumes.

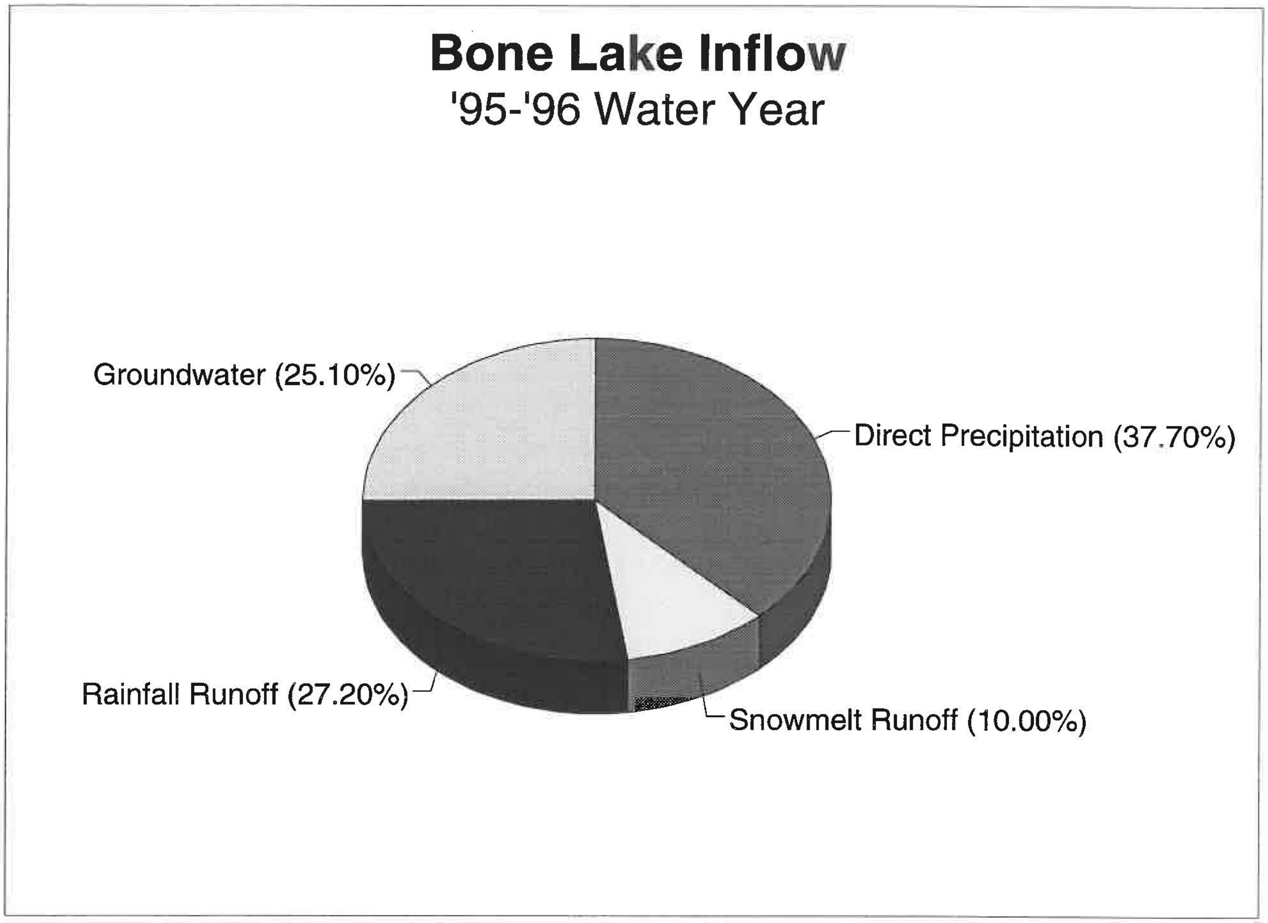
5.7 Hydrologic Budget

Table 2 shows the watershed areas for each of the lakes and sub-basins that are directly connected to Bone Lake. The 1995–96 water year (October 1, 1995 through September 30, 1996) hydrologic budget for Bone Lake is presented on Figure 19. As the budget indicates, watershed runoff, and direct precipitation play an important role in providing water to Bone Lake. Direct precipitation and watershed runoff represent approximately 38 and 37 percent, respectively, of the inflows to Bone Lake with groundwater inflow providing the remainder. The watershed runoff volume represents an annual water yield of approximately 4.3 inches from the Bone Lake watershed. The runoff yield divided by the 31 inches of total precipitation for the monitored period results in a runoff coefficient of 0.14 (or 14 percent of the total precipitation runs off the watershed).

Evaporation (28.08 inches over the water surface area) was slightly less than precipitation (31.00 inches) during 1996. Ordinarily, evaporation would be expected to be approximately the same as the observed annual precipitation amount. Estimated evaporation for this study agrees well with average evaporation for this portion of Wisconsin which is 28 inches (Linsley, Jr., 1982).

The large amount of watershed runoff which reached the lake during 1996 indicates that watershed runoff may have a significant impact on the water quality of Bone Lake. The majority of the watershed runoff which reached the lake came from rainfall runoff, however, snowmelt runoff, which occurred during the months of February and March, also represents a significant portion of the total inflow (10 percent of the total). As a result, snowmelt runoff can contribute a significant phosphorus load to the lake during the spring and early summer months.

The hydrologic budget is an important factor in determining the breakdown of nutrient loads into Bone Lake. Because phosphorus is the parameter of most concern, the discussion of nutrient budgets will be limited to phosphorus only.



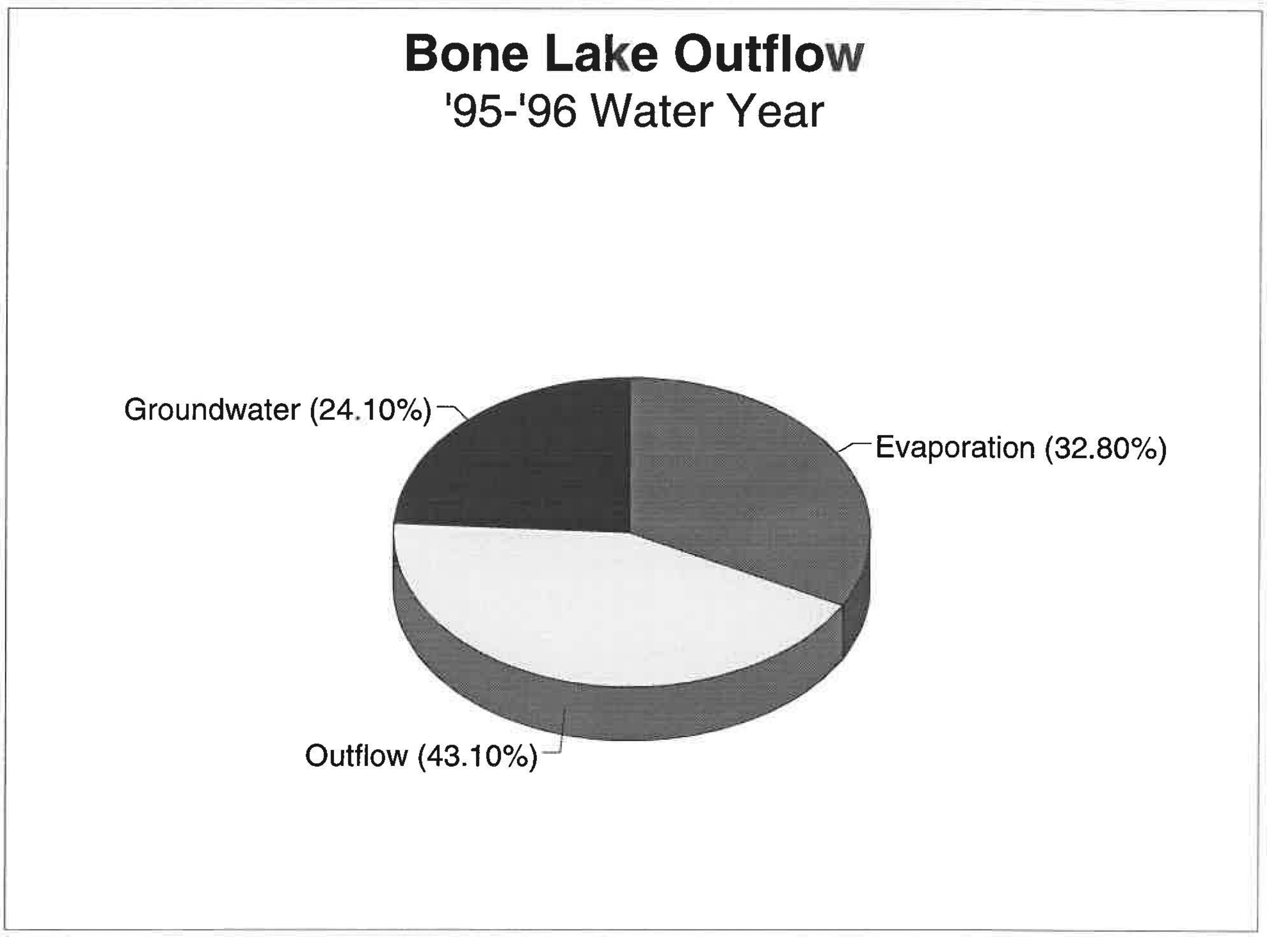


Figure 19
Bone Lake Hydrologic Budget

5.8 Phosphorus Budget and Lake Water Quality Mass Balance Model

As previously mentioned, the tributary water quality data and corresponding watershed runoff volumes combined with the export rates for each of the phosphorus input sources within the direct watersheds were used to estimate the total loads to each of the lake's basins. The computations revealed that the total annual phosphorus load into Bone Lake is approximately 2,067 pounds per year, based on 1995–96 data. The results of the phosphorus loading budgets are presented in Table 3. Phosphorus export rates, used in the WILMS model and published by the U.S. EPA for septic systems, and the septic system survey information were used to estimate an annual load of 107 pounds per year from drain fields. Depending on the soil retention capacity and export rates assumed for this computation, this value may actually range from 11 to 285 pounds or 0.5 percent to 12.9 percent of the total load. An atmospheric wet and dry deposition rate used by the WILMS model of 0.22 lbs/ac/yr was applied to the surface area of Bone Lake. The computation indicates that the atmospheric component of the load is approximately 374 pounds per year. The watershed runoff component was estimated using the measured inflow concentrations and estimated runoff from each of the tributary watersheds along with phosphorus export coefficients for each of the direct subwatersheds. The result is an estimate of 984 pounds per year from the watershed surface runoff. The estimated groundwater inflow phosphorus load was approximately 158 pounds. Internal loading represents the remaining 444 pounds of phosphorus into the lake.

Table 3 Bone Lake Phosphorus Budget

Source	Station #1 Load (lbs.)	% of Total	Station #2 Load (lbs.)	% of Total	Overall Load (lbs.)
Watershed Runoff	406	45%	578	44%	984
Internal Load	222	25%	222	17%	444
Atmospheric Deposition	146	16%	228	17%	374
Groundwater Inflow	83	9%	75	6%	158
Septic System Inputs	39	5%	68	5%	107
Upstream Lake Basin	—	—	139	11%	—
Total Load	896		1,310		2,067

Each of the phosphorus input loadings was used to calibrate the lake mass balance model to the water quality observed in each of the lake's basins during 1996. The fraction of total phosphorus in the bottom waters that would be released to the lake basin epilimnion (or surface water) following fall turnover, used to estimate internal load, was the only refinement that had to be made to the original phosphorus loading estimates to calibrate the mass balance model. The calibrated model predicts an average total phosphorus concentration that is slightly higher than the average observed concentration in the Station #1 basin (i.e., modeled total phosphorus concentration of 0.047 mg/L and observed late summer concentration of 0.039 mg/L) and the same as the observed concentration in Station #2 (i.e., modeled total phosphorus concentration of 0.030 mg/L and observed late summer concentration of 0.030 mg/L).

Station #1 and #2 subwatersheds contribute their phosphorus loads directly to the lake and, therefore, increasing their loads is very undesirable. In general, new development or changes to more intense land uses within the subwatersheds of the tributary lakes and wetlands will have a smaller effect on Bone Lake's water quality than if the same land use changes were made to Bone Lake's direct subwatersheds.

As the budgets indicate, phosphorus inputs into Bone Lake primarily result from the watershed runoff, internal and atmospheric sources. The data suggest that with increased watershed development the greatest potential for increased nutrient loads into Bone Lake will be from the lake's tributary watershed and drain fields.

The calibrated lake mass balance model will be used to model the effects of additional watershed development and potential improvement options on the water quality of the lake (with average climatic conditions) during Phase III of the overall Bone Lake Management Plan. Hydraulic loading rates to the lake will be changed during the Phase III portion of the plan to compare development scenarios under normal climatic conditions.

5.9 Comparison of Results with Previous Feasibility Study

This section compares the hydrologic and phosphorus budgets from this study (i.e., 1996 study) with the Feasibility Study Results (feasibility study), completed by the Wisconsin Department of Natural Resources (WDNR), Office of Inland Lake Renewal in 1980. The feasibility study hydrologic and phosphorus budgets were based on data obtained from 1977 through 1978 (WDNR, 1980). Climatic records for the feasibility study indicated that 34.7 inches of precipitation occurred during the study year.

Table 4 shows the comparison between this study (i.e. 1996 study) and the feasibility study (i.e., 1977–1978) for the hydrologic and phosphorus budget inputs. The table shows that the largest disparities between the two studies involve the inputs to the lake from both the watershed runoff and the internal load for both the hydrologic and phosphorus budgets. The feasibility study estimated watershed runoff inputs that were approximately two times higher than the 1996 study for both the hydrologic and phosphorus budgets. The feasibility study also estimated an internal loading input that was more than seven times higher than the 1996 study for the phosphorus budget.

Table 4 Bone Lake Hydrologic and Phosphorus Budget Comparison—This Study and Feasibility Study

	Hydrologic Budget (ac.ft.)		Phosphorus Load (lbs.)	
Input	This Study	Feasibility Study	This Study	Feasibility Study
Watershed Runoff	4,294	7,964	984	2,266
Internal Load	—	—	444	3,300
Precipitation/Deposition	4,345	5,150	374	372
Groundwater Inflow	2,896	2,896	158	156
Septic System Inputs	—	—	107	66
Total Inflow	11,535	16,010	2,067	6,160

The feasibility study does not say how the watershed runoff volumes were determined, only that the study included measurement of nutrient loading from stream and groundwater inflow. The 7,964 acre-feet of watershed runoff determined from the feasibility study represents 12.2 inches of runoff over the watershed area, which would translate to 35 percent of the study year total precipitation becoming surface runoff. The water yield estimated for the feasibility study would be considered high, even for residential areas, despite the wetter than average year monitored during the study. As previously mentioned, this study (i.e., 1996) estimated an annual water yield of approximately 4.3 inches from the Bone Lake watershed. This runoff yield translates to 14 percent of the total precipitation becoming surface runoff for the monitored period, and is more in line with the expected watershed runoff for other similar watersheds.

The disparity in the estimated internal phosphorus loads between the feasibility study and this study appears to be a result of the methods used to determine the respective loads. As previously mentioned, the estimated internal load for this study was determined using the total phosphorus mass released to the surface waters of the lake from the lake water quality data, at each sampling depth. The feasibility study estimated the spring phosphorus concentration to be 25 µg/L, based on a loading of 1,270 kg (2,794 pounds). This total loading did not include any internal or septic system loading. The feasibility report then states that, "In order to yield an average chlorophyll *a* concentration of 25 µg/L, the loading should have been 2,800 kg or 1,530 kg more than delivered through external sources." In other words, their phosphorus internal load determination was based on their intent of predicting the phosphorus concentration required to yield the observed chlorophyll *a* concentration, not the average observed phosphorus concentration in the lake. Therefore, a lake water quality mass balance model with the internal load determined in the feasibility study, would greatly over predict the actual observed total phosphorus concentrations because the chlorophyll *a* concentration in Bone Lake is generally higher than would be predicted, based on the total phosphorus concentration. As a result of the lake water quality modeling, the total phosphorus loadings estimated from this study appear to be more representative of the actual loadings to Bone Lake than the loadings estimated in the feasibility study.

6.0 Recommendations and Management Actions

An evaluation of 1996 Bone Lake water quality data, together with Secchi disc data collected during 1989 through 1996, indicates the lake's water quality has varied from mesotrophic (i.e., good) to eutrophic (i.e., undesirable) each summer. Average summer transparency values have declined since 1990 and are currently within the eutrophic (i.e., undesirable) category. Further eutrophication of Bone Lake may upset the current balance between the lake's phytoplankton, zooplankton, and fisheries communities, thus adversely affecting the lake's fishery. Water quality degradation may also result in additional algal blooms. Such a change would be detrimental to the lake's recreational usage. Diligent management of the lake and its watershed, however, will preserve the current water quality and the current balance in the lake's ecosystem. Opportunities for reduction of the lake's phosphorus load may provide water quality improvement options for the lake.

Development of a management plan for Bone Lake and its watershed affords the opportunity to evaluate potential lake water quality improvement practices and the water quality impacts of different watershed development scenarios. The Phase III portion of the Bone Lake Management Plan development will:

- Establish a long-term water quality goal for Bone Lake;
- Evaluate best management practices and water quality improvement options for Bone Lake;
- Explore development scenarios and their impacts on the water quality of Bone Lake; and
- Develop a management plan for Bone Lake and its watershed which achieves its long-term water quality goal.

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Appendix A
In-Lake Water Quality Data

BONE LAKE - STATION #1

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
06/10/96	11.5	3.0	0-2	2.36*	--	--	--	0.013	--	0.39 h	<0.01
			0	--	9.4	20.0	198	--	--	--	--
			1	--	9.5	20.0	198	--	--	--	--
			1.5	--	--	--	--	--	<0.007	--	--
			2	--	9.4	17.0	197	--	--	--	--
			3	--	8.6	16.1	200	--	<0.007	--	--
			4	--	8.0	16.0	200	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	7.8	15.8	201	--	--	--	--
			6	--	7.4	15.8	201	--	--	--	--
			6.1	--	--	--	--	--	0.008	--	--
			7	--	7.2	15.6	202	--	--	--	--
			7.6	--	--	--	--	--	0.008	--	--
			8	--	6.0	15.1	200	--	--	--	--
			9	--	1.5	13.0	210	--	--	--	--
			9.1	--	--	--	--	--	0.012	--	--
			10	--	1.4	13.0	210	--	--	--	--
			10.7	--	--	--	--	--	0.020	--	--
			11	--	0.4	12.5	216	--	--	--	--
06/24/96		3.0	0	--	8.5	22.5	180	--	--	--	--
			1	--	8.5	22.5	180	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	8.4	22.8	183	--	--	--	--
			3	--	8.3	22.8	183	--	0.007	--	--
			4	--	8.3	22.8	185	--	--	--	--
			4.5	--	--	--	--	--	0.009	--	--
			5	--	8.1	22.8	186	--	--	--	--
			6	--	6.2	22.0	189	--	--	--	--
			6.1	--	--	--	--	--	0.007	--	--
			7	--	4.3	19.8	171	--	--	--	--
			7.6	--	--	--	--	--	0.012	--	--
			8	--	1.9	18.0	171	--	--	--	--
			9	--	0.0	16.8	172	--	--	--	--
			9.1	--	--	--	--	--	0.027	--	--
			10	--	0.0	16.0	176	--	--	--	--
			10.7	--	--	--	--	--	0.029	--	--
			11	--	0.0	16.0	179	--	--	--	--
			12	--	0.0	16.0	180	--	--	--	--
			12.2	--	--	--	--	--	0.029	--	--

* Low absorbance, result approximate.
h EPA sample extraction or analysis holding time was exceeded.

BONE LAKE - STATION #1

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
07/09/96		2.7	0-2	10.7	--	--	--	0.021	--	0.6	<0.01
			0	--	9.0	24.0	184	--	--	--	--
			1	--	9.0	23.5	185	--	--	--	--
			1.5	--	--	--	--	--	<0.007	--	--
			2	--	8.8	23.0	187	--	--	--	--
			3	--	8.8	23.0	187	--	<0.007	--	--
			4	--	8.4	23.0	187	--	--	--	--
			4.5	--	--	--	--	--	<0.007	--	--
			5	--	6.0	22.0	191	--	--	--	--
			6	--	3.4	21.0	194	--	--	--	--
			6.1	--	--	--	--	--	<0.007	--	--
			7	--	1.0	16.0	208	--	--	--	--
			7.6	--	--	--	--	--	<0.007	--	--
			8	--	0.0	15.0	212	--	--	--	--
			9	--	0.0	15.0	212	--	--	--	--
			9.1	--	--	--	--	--	0.074	--	--
			10	--	0.0	15.0	212	--	--	--	--
			10.7	--	--	--	--	--	0.077	--	--
			11	--	0.0	15.0	212	--	--	--	--
			12	--	--	--	--	--	--	--	--
			12.2	--	--	--	--	--	0.074	--	--
07/23/96		1.8	0-2	22.8	--	--	--	--	0.007	--	--
			0	--	9.0	23.0	192	--	--	--	--
			1	--	9.0	23.0	192	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	9.0	23.0	192	--	--	--	--
			3	--	9.0	23.0	196	--	0.011	--	--
			4	--	8.8	23.0	196	--	--	--	--
			4.5	--	--	--	--	--	0.010	--	--
			5	--	7.4	22.0	199	--	--	--	--
			6	--	6.0	22.0	199	--	--	--	--
			6.1	--	--	--	--	--	0.009	--	--
			7	--	5.4	22.0	200	--	--	--	--
			7.6	--	--	--	--	--	0.016	--	--
			8	--	0.0	18.0	215	--	--	--	--
			9	--	0.0	15.5	227	--	--	--	--
			9.1	--	--	--	--	--	0.058	--	--
			10	--	0.0	14.5	233	--	--	--	--
			10.7	--	--	--	--	--	0.043	--	--
			11	--	0.0	14.5	233	--	--	--	--
			12	--	0.0	14.5	234	--	--	--	--
			12.2	--	--	--	--	--	0.044	--	--
			13	--	0.0	14.0	294	--	--	--	--

BONE LAKE - STATION #1

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
08/06/96		1.2	0-2	35.9	--	--	--	0.033	--	0.8	<0.01
			0	--	9.6	23.8	190	--	--	--	--
			1	--	9.6	23.6	191	--	--	--	--
			1.5	--	--	--	--	--	0.011	--	--
			2	--	9.3	23.2	191	--	--	--	--
			3	--	8.8	23.2	191	--	0.009	--	--
			4	--	7.5	22.8	193	--	--	--	--
			4.5	--	--	--	--	--	0.009	--	--
			5	--	7.3	22.7	193	--	--	--	--
			6	--	6.0	22.0	201	--	--	--	--
			6.1	--	--	--	--	--	0.013	--	--
			7	--	4.9	21.2	204	--	--	--	--
			7.6	--	--	--	--	--	0.023	--	--
			8	--	0.4	20.2	208	--	--	--	--
			9	--	0.2	17.1	232	--	--	--	--
			9.1	--	--	--	--	--	0.121	--	--
			10	--	0.2	15.6	240	--	--	--	--
			10.7	--	--	--	--	--	0.133	--	--
			11	--	0.2	14.9	254	--	--	--	--
			12	--	0.2	14.8	273	--	--	--	--
			12.2	--	--	--	--	--	0.13	--	--
08/13/96		1.1	0-2	--	--	--	--	--	0.009	--	--
			0	--	11.4	24.2	178	--	--	--	--
			1	--	11.2	24.2	183	--	--	--	--
			1.5	--	--	19.0	--	--	0.007	--	--
			2	--	11.2	24.2	183	--	--	--	--
			3	--	11.2	24.2	183	--	<0.007	--	--
			4	--	10.0	24.0	184	--	--	--	--
			4.6	--	--	19.0	--	--	<0.007	--	--
			5	--	7.0	23.3	191	--	--	--	--
			6	--	5.9	22.7	193	--	--	--	--
			6.1	--	--	19.0	--	--	<0.007	--	--
			7	--	2.6	22.1	201	--	--	--	--
			7.6	--	--	19.0	--	--	<0.007	--	--
			8	--	0.7	21.0	205	--	--	--	--
			9	--	0.5	17.8	229	--	--	--	--
			9.1	--	--	19.0	--	--	0.090	--	--
			10	--	0.4	16.0	250	--	--	--	--
			10.7	--	--	19.0	--	--	0.083	--	--
			11	--	0.4	15.6	252	--	--	--	--
			12.2	--	--	19.0	--	--	0.037	--	--

BONE LAKE - STATION #1

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
08/19/96		1.1	0-2	43.8	--	--	--	0.034	--	0.9	<0.01
			0	--	11.9	24.8	181	--	--	--	--
			1	--	11.2	24.8	181	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	10.2	24.3	183	--	--	--	--
			3	--	9.9	24.2	183	--	0.007	--	--
			4	--	9.7	24.2	183	--	--	--	--
			4.6	--	--	--	--	--	<0.007	--	--
			5	--	9.4	24.0	189	--	--	--	--
			6	--	6.4	23.2	191	--	--	--	--
			6.1	--	--	--	--	--	<0.007	--	--
			7	--	5.4	23.0	198	--	--	--	--
			7.6	--	--	--	--	--	0.067	--	--
			8	--	1.8	20.8	217	--	--	--	--
			9	--	0.6	18.2	238	--	--	--	--
			9.1	--	--	--	--	--	0.085	--	--
			10	--	0.4	17.0	249	--	--	--	--
			10.7	--	--	--	--	--	0.039	--	--
			11	--	0.3	15.8	263	--	--	--	--
			12	--	0.3	15.7	263	--	--	--	--
			12.2	--	--	--	--	--	0.239	--	--
08/26/96		1.1	0-2	42.1	--	--	--	--	0.008 h	--	--
			0	--	10.5	24.5	182	--	--	--	--
			1	--	10.2	24.2	184	--	--	--	--
			1.5	--	--	--	--	--	0.0070 h	--	--
			2	--	9.3	24.0	184	--	--	--	--
			3	--	7.5	23.3	186	--	0.0070 h	--	--
			4	--	7.3	23.2	186	--	--	--	--
			4.6	--	--	--	--	--	0.0080 h	--	--
			5	--	6.0	23.0	187	--	--	--	--
			6	--	2.4	22.3	200	--	0.0080 h	--	--
			7	--	1.4	22.0	201	--	--	--	--
			7.6	--	--	--	--	--	0.0190 h	--	--
			8	--	0.5	19.8	232	--	--	--	--
			9	--	0.5	19.1	235	--	--	--	--
			9.1	--	--	--	--	--	0.0750 h	--	--
			10	--	0.4	18.2	250	--	--	--	--
			10.7	--	--	--	--	--	0.0130 h	--	--
			11	--	0.3	17.2	255	--	--	--	--
			12	--	0.3	16.3	259	--	--	--	--
			12.2	--	--	--	--	--	0.0310 h	--	--

BONE LAKE - STATION #1

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
09/03/96		0.9	0	57.9	10.2	24.9	175	0.039	--	0.94 h	<0.01
			1	--	9.8	24.9	175	--	--	--	--
			1.5	--	--	--	--	--	0.009	--	--
			2	--	8.8	24.0	179	--	--	--	--
			3	--	8.5	23.8	179	--	0.008	--	--
			4	--	7.2	23.6	185	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	5.7	23.0	192	--	--	--	--
			6	--	4.1	22.5	194	--	--	--	--
			6.1	--	--	--	--	--	0.008	--	--
			7	--	3.3	22.5	194	--	--	--	--
			7.6	--	--	--	--	--	0.044	--	--
			8	--	0.7	21.5	203	--	--	--	--
			9	--	0.5	20.1	226	--	--	--	--
			9.1	--	--	--	--	--	0.083	--	--
			10	--	0.4	18.1	239	--	--	--	--
			10.7	--	--	--	--	--	0.020	--	--
			11	--	0.4	17.3	243	--	--	--	--
			12	--	0.4	17.0	249	--	--	--	--
			12.2	--	--	--	--	--	0.011	--	--
09/10/96		1.1	0-2	44.0	--	--	--	--	0.008	--	--
			0	--	8.3	23.0	187	--	--	--	--
			1	--	7.8	23.0	187	--	--	--	--
			1.5	--	--	--	--	--	0.007	--	--
			2	--	7.6	23.0	187	--	--	--	--
			3	--	7.3	23.0	187	--	0.007	--	--
			4	--	7.1	23.0	187	--	--	--	--
			4.6	--	--	--	--	--	0.009	--	--
			5	--	7.2	23.0	192	--	--	--	--
			6	--	7.0	23.0	192	--	--	--	--
			6.1	--	--	--	--	--	0.007	--	--
			7	--	6.1	22.8	199	--	--	--	--
			7.6	--	--	--	--	--	0.010	--	--
			8	--	0.8	22.0	212	--	--	--	--
			9	--	0.4	19.8	254	--	--	--	--
			9.1	--	--	--	--	--	0.088	--	--
			10	--	0.3	16.8	280	--	--	--	--
			10.7	--	--	--	--	--	0.032	--	--
			11	--	0.3	17.2	277	--	--	--	--
			12	--	0.3	17.0	290	--	--	--	--
			12.2	--	--	--	--	--	0.019	--	--

BONE LAKE - STATION #2

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
06/10/96	9.7	3.1	0-2	2.08*	--	--	--	0.014	--	0.43 h	<0.01
			0	--	9.0	20.0	209	--	--	--	--
			1	--	9.2	19.7	204	--	--	--	--
			1.5	--	--	--	--	--	0.007	--	--
			2	--	9.8	19.4	202	--	--	--	--
			3	--	9.4	17.0	203	--	0.007	--	--
			4	--	8.0	16.2	207	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	7.6	16.1	208	--	--	--	--
			6	--	6.9	15.9	208	--	--	--	--
			6.1	--	--	--	--	--	<0.007	--	--
			7	--	6.0	15.2	207	--	--	--	--
			7.6	--	--	--	--	--	<0.007	--	--
			8	--	4.0	14.7	210	--	--	--	--
			9	--	1.6	13.3	214	--	--	--	--
			9.1	--	--	--	--	--	0.007	--	--
06/24/96	9.7	3.0	0	--	8.6	23.0	182	--	--	--	--
			1	--	8.6	23.0	182	--	--	--	--
			1.5	--	--	--	--	--	<0.007	--	--
			2	--	8.5	23.0	177	--	--	--	--
			3	--	8.5	23.0	177	--	<0.007	--	--
			4	--	6.5	22.0	180	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	3.1	19.0	190	--	--	--	--
			6	--	1.0	18.0	194	--	--	--	--
			6.1	--	--	--	--	--	0.012	--	--
			7	--	0.5	17.0	197	--	--	--	--
			7.6	--	--	--	--	--	0.024	--	--
			8	--	0.2	17.0	197	--	--	--	--
			9	--	0.0	16.0	202	--	--	--	--
			9.1	--	--	--	--	--	0.028	--	--
			10	--	0.0	16.0	202	--	--	--	--
			11	--	--	--	--	--	--	--	--

* Low absorbance, result approximate.
h EPA sample extraction or analysis holding time was exceeded.

BONE LAKE - STATION #2

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
07/09/96		2.7	0-2	13.4	--	--	--	0.021	--	0.6	<0.01
			0	--	8.4	24.0	184	--	--	--	--
			1	--	8.5	24.0	194	--	--	--	--
			1.5	--	--	--	--	--	0.007	--	--
			2	--	8.5	24.0	194	--	--	--	--
			3	--	8.5	24.0	194	--	<0.007	--	--
			4	--	8.5	24.0	194	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	8.3	23.0	198	--	--	--	--
			6	--	8.3	23.0	198	--	--	--	--
			6.1	--	--	--	--	--	<0.007	--	--
			7	--	8.1	21.0	205	--	--	--	--
			7.6	--	--	--	--	--	<0.007	--	--
			8	--	1.0	17.0	220	--	--	--	--
			9	--	1.0	17.0	220	--	--	--	--
			9.1	--	--	--	--	--	<0.007	--	--
			10	--	0.0	15.0	218	--	--	--	--
07/23/96		1.8	0-2	23.8	--	--	--	--	0.008	--	--
			0	--	8.4	23.0	192	--	--	--	--
			1	--	8.4	23.0	192	--	--	--	--
			1.5	--	--	--	--	--	0.007	--	--
			2	--	8.4	23.0	192	--	--	--	--
			3	--	8.2	23.0	196	--	0.007	--	--
			4	--	8.2	23.0	196	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	5.0	22.0	200	--	--	--	--
			6	--	0.0	16.0	225	--	--	--	--
			6.1	--	--	--	--	--	<0.007	--	--
			7	--	0.0	15.0	224	--	--	--	--
			7.6	--	--	--	--	--	0.051	--	--
			8	--	0.0	16.0	226	--	--	--	--
			9	--	0.0	16.0	226	--	--	--	--
			9.1	--	--	--	--	--	0.072	--	--
			10	--	0.0	15.0	260	--	--	--	--

BONE LAKE - STATION #2

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
08/06/96		1.4	0-2	28.7	--	--	--	0.035	--	0.8	<0.01
			0	--	9.2	23.0	187	--	--	--	--
			1	--	9.2	23.0	187	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	9.2	22.8	188	--	--	--	--
			3	--	8.6	22.8	188	--	0.009	--	--
			4	--	6.8	21.1	194	--	--	--	--
			4.5	--	--	--	--	--	0.007	--	--
			5	--	6.5	22.0	191	--	--	--	--
			6	--	5.6	21.6	198	--	--	--	--
			6.1	--	--	--	--	--	0.008	--	--
			7	--	4.8	21.2	199	--	--	--	--
			7.6	--	--	--	--	--	0.017	--	--
			8	--	0.7	20.3	203	--	--	--	--
			9	--	0.1	18.5	226	--	--	--	--
			9.1	--	--	--	--	--	0.106	--	--
			10	--	0.1	15.8	251	--	--	--	--
08/13/96		1.3	0-2	--	--	19.0	--	--	0.008	--	--
			0	--	10.5	24.0	179	--	--	--	--
			1	--	10.5	24.0	184	--	--	--	--
			1.5	--	--	19.0	--	--	<0.007	--	--
			2	--	9.4	24.0	184	--	--	--	--
			3	--	8.3	22.8	188	--	<0.007	--	--
			4	--	6.6	23.2	191	--	--	--	--
			4.5	--	--	19.0	--	--	<0.007	--	--
			5	--	5.5	23.0	192	--	--	--	--
			6	--	2.6	22.2	195	--	--	--	--
			6.1	--	--	19.0	--	--	<0.007	--	--
			7	--	0.6	21.5	198	--	--	--	--
			7.6	--	--	19.0	--	--	0.028	--	--
			8	--	0.4	20.0	209	--	--	--	--
			9	--	0.3	17.2	243	--	--	--	--
			9.1	--	--	19.0	--	--	0.068	--	--
			10	--	0.3	16.8	257	--	--	--	--

BONE LAKE - STATION #2

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	NO2+NO3 Nitrogen (mg/L)
08/19/96		1.4	0-2	25.3	--	--	--	0.016	--	0.7	<0.01
			0	--	8.2	23.2	185	--	--	--	--
			1	--	8.0	23.2	185	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	7.8	23.2	185	--	--	--	--
			3	--	7.6	23.1	185	--	<0.007	--	--
			4	--	7.5	23.1	192	--	--	--	--
			4.6	--	--	--	--	--	<0.007	--	--
			5	--	5.9	23.0	192	--	--	--	--
			6	--	2.8	22.3	200	--	--	--	--
			6.1	--	--	--	--	--	0.007	--	--
			7	--	0.8	22.7	199	--	--	--	--
			7.6	--	--	--	--	--	0.104 h	--	--
			8	--	0.5	21.0	216	--	--	--	--
			9	--	0.4	20.0	220	--	--	--	--
			9.1	--	--	--	--	--	0.107 h	--	--
			10	--	0.4	18.4	237	--	--	--	--
08/26/96		1.3	0-2	32.0	--	--	--	--	0.0080 h	--	--
			0	--	9.4	24.0	184	--	--	--	--
			1	--	9.1	24.0	184	--	--	--	--
			1.5	--	--	--	--	--	0.0070 h	--	--
			2	--	8.8	24.0	184	--	--	--	--
			3	--	7.2	23.2	186	--	0.0060 h	--	--
			4	--	6.6	23.0	187	--	--	--	--
			4.6	--	--	--	--	--	0.0060 h	--	--
			5	--	6.1	23.0	192	--	--	--	--
			6	--	5.5	22.8	193	--	--	--	--
			6.1	--	--	--	--	--	0.0070 h	--	--
			7	--	4.0	23.5	196	--	--	--	--
			7.6	--	--	--	--	--	0.003 h	--	--
			8	--	0.6	20.8	217	--	--	--	--
			9	--	0.5	19.2	223	--	--	--	--
			9.1	--	--	--	--	--	0.0720 h	--	--
			10	--	0.5	18.0	239	--	--	--	--

h EPA sample extraction or analysis holding time was exceeded.

BONE LAKE - STATION #2

Date	Max. Depth (M)	Secchi Disc (M)	Sample Depth (M)	Chlor. a (ug/L)	D.O. (mg/L)	Temp. (deg. C)	Spec. Cond. (umhos/cm @25 C)	Total P (mg/L)	Total Diss. P (mg/L)	TKN (mg/L)	N02+N03 Nitrogen (mg/L)
09/03/96		1.2	0	28.2	7.9	23.8	184	0.030	--	0.70 h	<0.01
			1	--	7.2	22.8	188	--	--	--	--
			1.5	--	--	--	--	--	0.007	--	--
			2	--	6.0	23.0	187	--	--	--	--
			3	--	5.8	22.8	188	--	<0.007	--	--
			4	--	5.6	22.7	188	--	--	--	--
			4.5	--	--	--	--	--	0.008	--	--
			5	--	5.7	22.5	189	--	--	--	--
			6	--	4.3	22.4	194	--	--	--	--
			6.1	--	--	--	--	--	0.007	--	--
			7	--	1.5	22.0	201	--	--	--	--
			7.6	--	--	--	--	--	0.028	--	--
			8	--	0.6	21.5	209	--	--	--	--
			9	--	0.6	20.0	231	--	--	--	--
			9.1	--	--	--	--	--	0.098	--	--
			10	--	0.5	18.5	237	--	--	--	--
09/10/96		1.1	0-2	37.3	--	--	--	--	0.009	--	--
			0	--	7.4	23.0	187	--	--	--	--
			1	--	7.4	23.0	187	--	--	--	--
			1.5	--	--	--	--	--	0.008	--	--
			2	--	7.2	23.0	187	--	--	--	--
			3	--	7.3	23.0	187	--	0.008	--	--
			4	--	7.0	23.0	192	--	--	--	--
			4.6	--	--	--	--	--	0.008	--	--
			5	--	5.7	22.9	193	--	--	--	--
			6	--	2.2	22.3	199	--	--	--	--
			6.1	--	--	--	--	--	0.090	--	--
			7	--	0.7	22.0	201	--	--	--	--
			7.6	--	--	--	--	--	0.086	--	--
			8	--	0.5	21.0	227	--	--	--	--
			9	--	0.5	19.9	253	--	--	--	--
			9.1	--	--	--	--	--	0.118 h	--	--
			10	--	0.4	18.4	265	--	--	--	--

Appendix B
Inflow/Outflow Data

Bone Lake Inflow/Outflow Data Summary
Total Phosphorus (mg/L)

Location	06/12/96	06/29/96	07/09/96	07/23/96	08/06/96	08/13/96	08/19/96	08/26/96	09/03/96	09/10/96
Procker Creek (I-1)	0.024	0.022	0.027	0.021	0.015	0.020	0.021	0.026	0.023	0.028
Inflow #2	0.066	0.102	0.098	0.159	0.059	0.051	0.087	0.089	0.155	0.044
Spring	--	0.064	0.066	0.066	0.064	0.061	0.066	0.066	--	0.065
Outflow	0.014	0.024	0.027	0.040	0.030	0.032	0.040	0.033	0.039	0.044

Appendix C
Lake Level Data

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 1 (left)

MONTH: May	
Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	1.37
8	1.36
9	1.37
10	
11	
12	1.33
13	1.28
14	
15	1.28
16	1.28
17	1.31
18	1.30
19	1.80
20	1.86
21	1.86
22	1.86
23	
24	1.76
25	1.67
26	1.64
27	1.57
28	
29	1.52
30	1.47
31	1.42

MONTH: June	
Day	Lake Level (Ft.)
1	1.44
2	1.38
3	
4	1.41
5	
6	1.34
7	1.32
8	1.26
9	1.24
10	1.22
11	1.20
12	1.18
13	1.18
14	1.16
15	1.14
16	1.12
17	
18	1.20
19	1.21
20	1.20
21	1.24
22	1.22
23	1.18
24	1.18
25	1.16
26	1.34
27	1.37
28	1.35
29	1.35
30	1.36

MONTH: July	
Day	Lake Level (Ft.)
1	1.34
2	1.35
3	1.33
4	1.30
5	1.28
6	1.26
7	1.22
8	1.22
9	1.20
10	1.16
11	1.14
12	1.12
13	1.13
14	1.14
15	1.12
16	1.10
17	1.06
18	1.04
19	1.04
20	1.02
21	1.01
22	1.00
23	0.98
24	0.98
25	0.96
26	0.96
27	0.95
28	1.04
29	1.05
30	1.03
31	1.00

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 1 (left)

MONTH: August	
Day	Lake Level (Ft.)
1	0.98
2	0.96
3	0.95
4	0.95
5	1.03
6	1.01
7	1.09
8	1.04
9	1.04
10	1.03
11	1.02
12	1.00
13	0.98
14	0.97
15	0.96
16	0.95
17	0.93
18	0.90
19	0.91
20	0.91
21	0.88
22	0.95
23	0.96
24	0.95
25	0.94
26	0.91
27	0.92
28	0.89
29	0.88
30	0.87
31	0.86

MONTH: September	
Day	Lake Level (Ft.)
1	0.85
2	0.83
3	0.83
4	0.82
5	0.81
6	0.80
7	0.80
8	0.82
9	0.83
10	0.82
11	0.81
12	0.79
13	0.77
14	0.75
15	0.75
16	0.75
17	0.74
18	0.73
19	0.72
20	0.72
21	0.71
22	0.74
23	0.75
24	0.74
25	0.76
26	0.80
27	0.81
28	0.81
29	0.80
30	0.78

MONTH: October	
Day	Lake Level (Ft.)
1	0.77
2	0.76
3	0.76
4	0.75
5	0.74
6	0.74
7	0.74
8	0.74
9	0.75
10	0.75
11	0.75
12	0.76
13	0.76
14	0.76
15	0.77
16	0.87
17	0.88
18	0.86
19	0.86
20	0.86
21	0.86
22	1.00
23	0.99
24	0.98
25	0.98
26	0.98
27	0.97
28	0.98
29	1.06
30	1.07
31	1.06

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJE

GAGE # 1 (left)

MONTH: November	
Day	Lake Level (Ft.)
1	1.05
2	1.03
3	1.01
4	1.01
5	1.02
6	1.03
7	1.04
8	1.04
9	1.04
10	1.00
11	1.00
12	0.97
13	0.95
14	0.95
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 2 (right)

MONTH: May

Day	Lake Level (Ft.)
1	
2	
3	
4	
5	
6	
7	5.49
8	5.48
9	5.49
10	
11	
12	5.45
13	5.40
14	
15	5.40
16	5.40
17	5.43
18	5.42
19	5.92
20	5.98
21	5.98
22	5.98
23	
24	5.88
25	5.79
26	5.76
27	5.69
28	
29	5.64
30	5.59
31	5.54

MONTH: June

Day	Lake Level (Ft.)
1	5.56
2	5.50
3	
4	5.53
5	
6	5.46
7	5.44
8	5.38
9	5.36
10	5.34
11	5.32
12	5.30
13	5.30
14	5.28
15	5.26
16	5.24
17	
18	5.32
19	5.33
20	5.32
21	5.36
22	5.34
23	5.30
24	5.30
25	5.28
26	5.46
27	5.49
28	5.47
29	5.47
30	5.48

MONTH: July

Day	Lake Level (Ft.)
1	5.46
2	5.47
3	5.45
4	5.42
5	5.40
6	5.38
7	5.34
8	5.34
9	5.32
10	5.28
11	5.26
12	5.24
13	5.25
14	5.26
15	5.24
16	5.22
17	5.18
18	5.16
19	5.16
20	5.14
21	5.13
22	5.12
23	5.10
24	5.10
25	5.08
26	5.08
27	5.07
28	5.16
29	5.17
30	5.15
31	5.12

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE # 2 (right)

MONTH: August	
Day	Lake Level (Ft.)
1	5.10
2	5.08
3	5.07
4	5.07
5	5.15
6	5.13
7	5.21
8	5.16
9	5.16
10	5.15
11	5.14
12	5.12
13	5.10
14	5.09
15	5.08
16	5.07
17	5.05
18	5.02
19	5.03
20	5.03
21	5.00
22	5.07
23	5.08
24	5.07
25	5.06
26	5.03
27	5.04
28	5.01
29	5.00
30	4.99
31	4.98

MONTH: September	
Day	Lake Level (Ft.)
1	4.97
2	4.95
3	4.95
4	4.94
5	4.93
6	4.92
7	4.92
8	4.94
9	4.95
10	4.94
11	4.93
12	4.91
13	4.89
14	4.87
15	4.87
16	4.87
17	4.86
18	4.85
19	4.84
20	4.84
21	4.83
22	4.86
23	4.87
24	4.86
25	4.88
26	4.92
27	4.93
28	4.93
29	4.92
30	4.90

MONTH: October	
Day	Lake Level (Ft.)
1	4.89
2	4.88
3	4.88
4	4.87
5	4.86
6	4.86
7	4.86
8	4.86
9	4.87
10	4.87
11	4.87
12	4.88
13	4.88
14	4.88
15	4.89
16	4.99
17	5.00
18	4.98
19	4.98
20	4.98
21	4.98
22	5.12
23	5.11
24	5.10
25	5.10
26	5.10
27	5.09
28	5.10
29	5.18
30	5.19
31	5.18

1996 LAKE LEVEL READINGS
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJE

GAGE # 2 (right)

MONTH: November	
Day	Lake Level (Ft.)
1	5.17
2	5.15
3	5.13
4	5.13
5	5.14
6	5.15
7	5.16
8	5.16
9	5.16
10	5.12
11	5.12
12	5.09
13	5.07
14	5.07
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Appendix D
Precipitation Data

1996 PRECIPITATION DATA--
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE LOCATION: 2016 100th St., Luck

MONTH: April	
Day	Precipitation (Inches)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	0.04
23	0.14
24	0.21
25	0.20
26	
27	
28	
29	
30	

MONTH: May	
Day	Precipitation (Inches)
1	
2	0.13
3	
4	0.40
5	0.60
6	
7	0.07
8	0.14
9	0.16
10	
11	
12	
13	
14	0.57
15	
16	
17	0.27
18	0.21
19	4.2
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	

MONTH: June	
Day	Precipitation (Inches)
1	0.32
2	0.12
3	0.38
4	
5	0.02
6	
7	
8	
9	
10	
11	0.10
12	
13	
14	
15	0.37
16	0.27
17	1.35
18	0.07
19	
20	
21	0.62
22	
23	0.17
24	
25	
26	1.72
27	
28	
29	0.35
30	

1996 PRECIPITATION DATA--
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE LOCATION: 2016 100th St., Luck

MONTH: July	
Day	Precipitation (Inches)
1	0.58
2	
3	
4	
5	
6	0.04
7	
8	0.40
9	0.03
10	
11	0.05
12	0.06
13	0.50
14	0.30
15	
16	
17	0.43
18	
19	
20	
21	
22	0.02
23	0.29
24	0.12
25	
26	
27	0.89
28	0.21
29	0.01
30	0.04
31	

MONTH: August	
Day	Precipitation (Inches)
1	
2	
3	
4	
5	0.91
6	0.80
7	
8	
9	
10	
11	
12	
13	0.04
14	0.04
15	
16	
17	
18	
19	0.11
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	

MONTH: September	
Day	Precipitation (Inches)
1	
2	0.20
3	
4	
5	
6	
7	0.20
8	0.05
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	0.17
21	0.18
22	
23	0.25
24	0.02
25	
26	0.17
27	0.32
28	0.10
29	0.03
30	

1996 PRECIPITATION DATA--
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE LOCATION: 2110 W. Bone Lake Dr.

MONTH: June	
Day	Precipitation (Inches)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	0.05
13	
14	
15	0.30
16	
17	1.55
18	0.05
19	
20	
21	0.80
22	
23	
24	
25	
26	1.60
27	
28	
29	0.45
30	

MONTH: July	
Day	Precipitation (Inches)
1	
2	0.45
3	
4	
5	
6	
7	
8	0.25
9	0.15
10	
11	
12	0.10
13	0.40
14	0.20
15	
16	
17	
18	0.35
19	
20	
21	
22	
23	0.25
24	0.10
25	
26	
27	1.05
28	
29	
30	
31	

MONTH: August	
Day	Precipitation (Inches)
1	
2	
3	
4	
5	0.75
6	
7	0.65
8	
9	
10	
11	
12	
13	0.10
14	trace
15	
16	
17	
18	
19	0.10
20	
21	0.45
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	

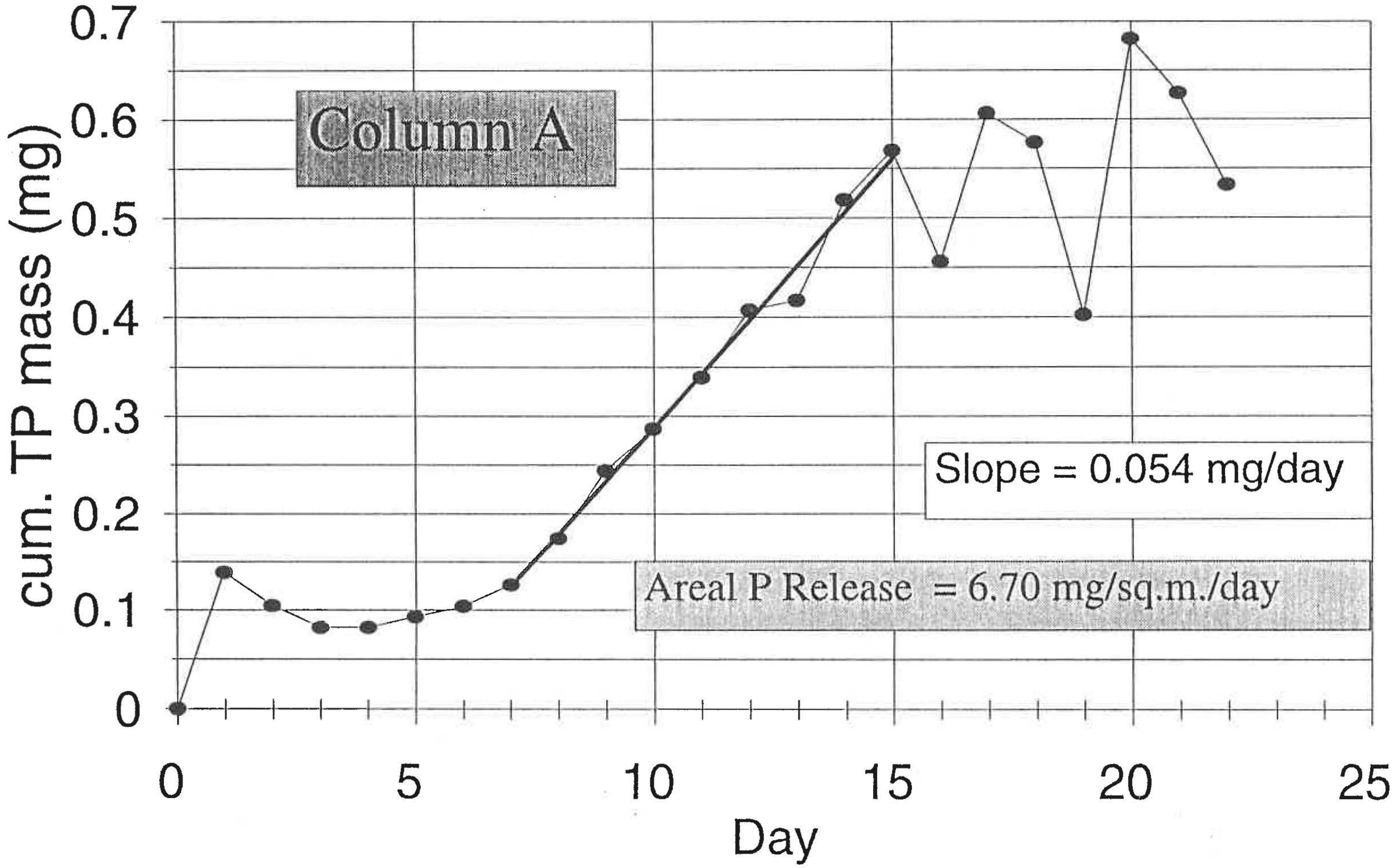
1996 PRECIPITATION DATA--
BONE LAKE WISCONSIN LAKE MANAGEMENT PROJECT

GAGE LOCATION: 2110 W. Bone Lake Dr.

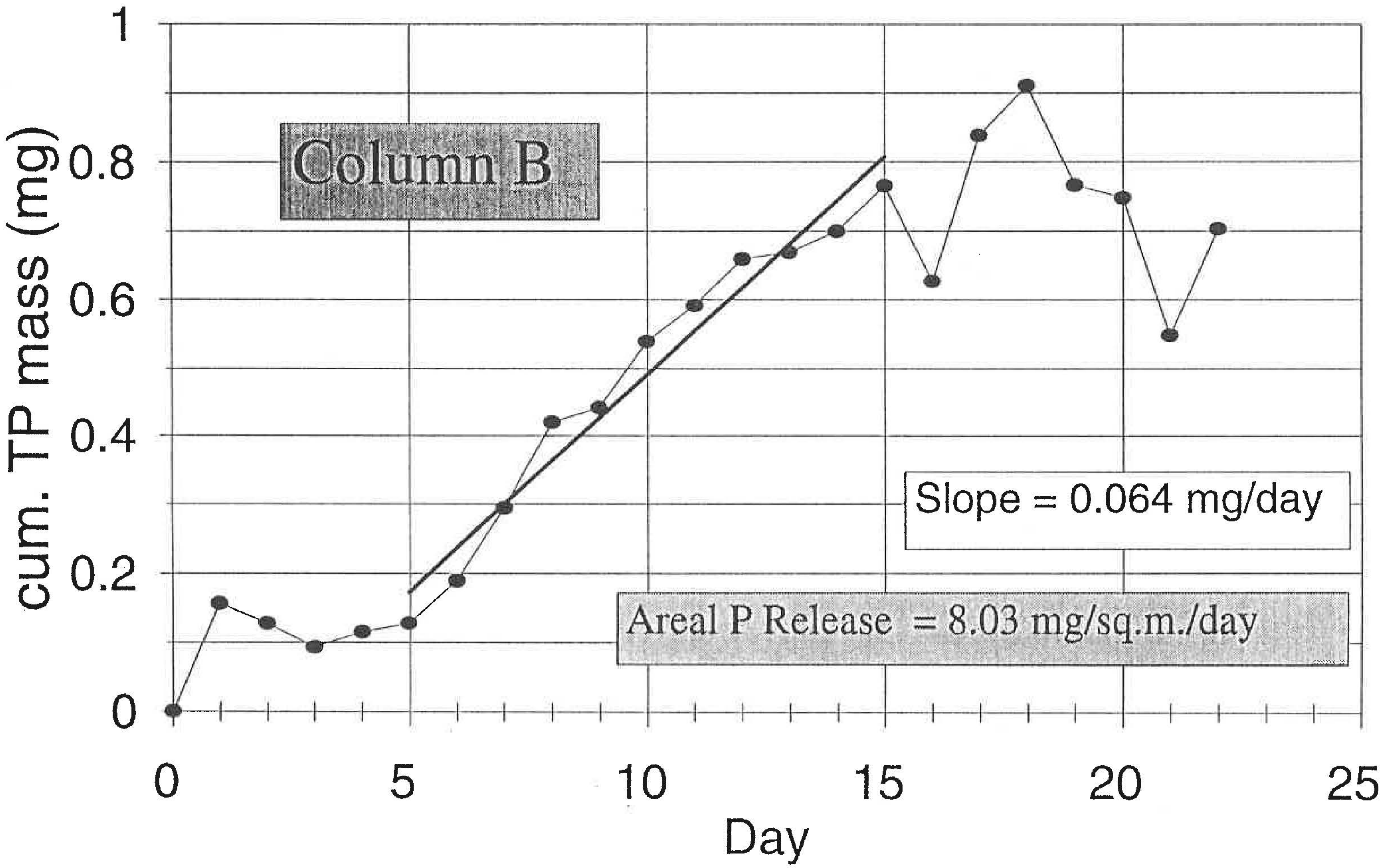
MONTH: September	
Day	Precipitation (Inches)
1	
2	0.30
3	
4	
5	
6	
7	
8	0.20
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	0.15
21	
22	0.2
23	0.2
24	
25	
26	0.55
27	0.05
28	0.15
29	
30	

Appendix E
Sediment/Phosphorus Release Data

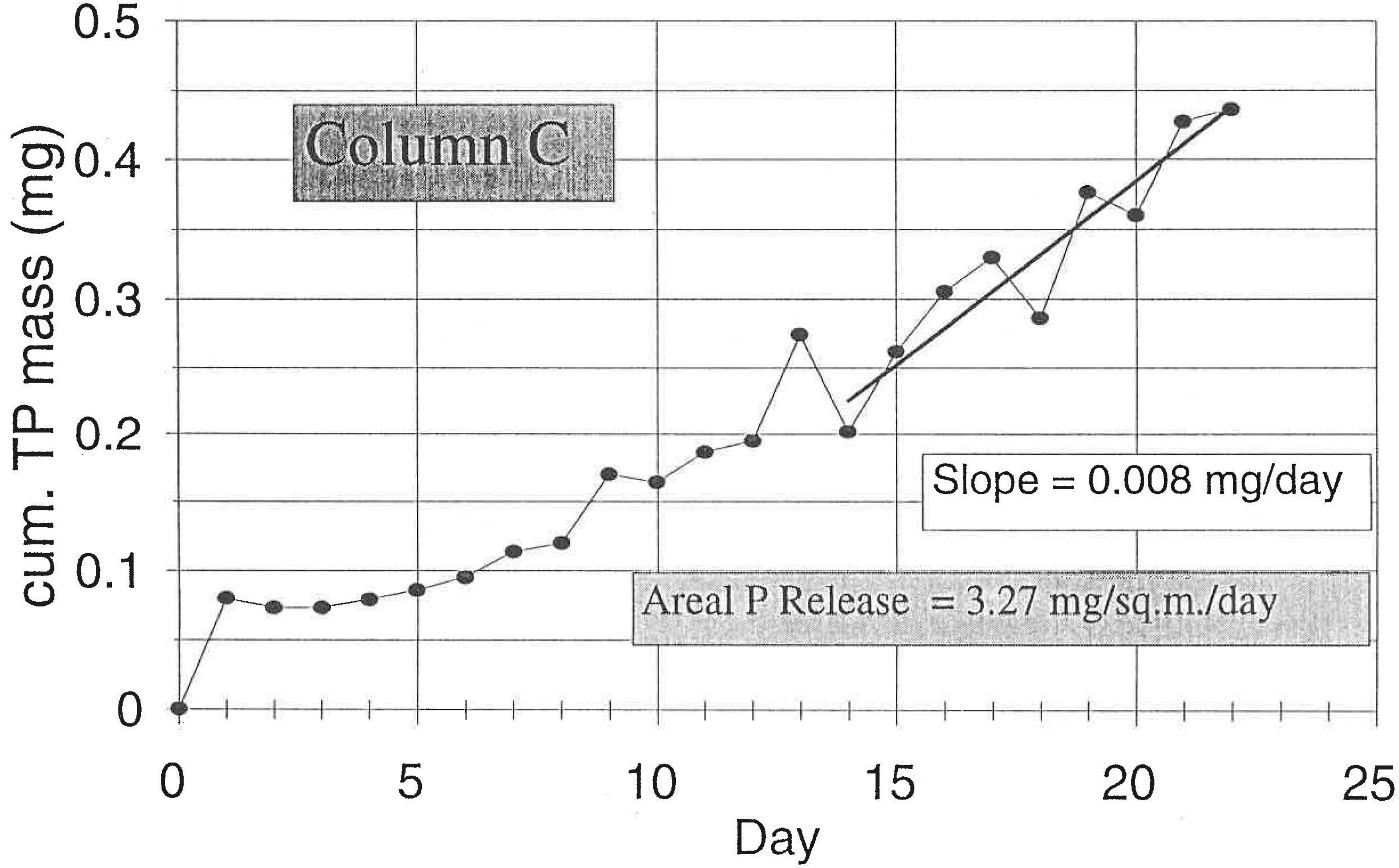
Bone Lake Sediment P-Release Exp
9/19/96 - 10/17/96



Bone Lake Sediment P-Release Exp
9/19/96 - 10/17/96



Bone Lake Sediment P-Release Exp
9/19/96 - 10/17/96



Bone Lake Sediment Phosphorus Release Experiments

09/19/96
10/17/96

Days of Incubation	Water Volume (mL)				Total Phosphorus (µg/L)				sample P mass (mg)				cum. sample mass (mg)				Cumulative Total Phosphorus Mass (mg)			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
0	5,807	5,830	3,336	3,260	27	29	29	35									0	0	0	0
1	5,762	5,783	3,302	3,192	24	27	24	31	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.139	0.157	0.080	0.101
2	5,714	5,740	3,250	3,130	18	22	22	24	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.105	0.128	0.073	0.079
3	5,673	5,696	3,195	3,061	14	16	22	20	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.005	0.082	0.094	0.073	0.066
4	5,636	5,659	3,147	3,000	14	20	24	22	0.001	0.001	0.001	0.001	0.003	0.004	0.004	0.006	0.082	0.117	0.080	0.072
5	5,539	5,576	3,106	2,948	16	22	26	24	0.002	0.002	0.001	0.001	0.005	0.005	0.005	0.008	0.093	0.128	0.086	0.078
6	5,495	5,536	3,061	2,893	18	33	29	29	0.001	0.001	0.001	0.002	0.005	0.007	0.007	0.009	0.104	0.189	0.095	0.093
7	5,447	5,489	3,000	2,838	22	52	35	31	0.001	0.002	0.002	0.002	0.006	0.009	0.009	0.011	0.126	0.295	0.114	0.099
8	5,351	5,395	2,948	2,777	31	75	37	43	0.003	0.007	0.002	0.003	0.009	0.016	0.011	0.014	0.175	0.421	0.120	0.133
9	5,306	5,348	2,880	2,729	44	79	54	48	0.002	0.004	0.004	0.002	0.011	0.020	0.014	0.016	0.245	0.442	0.170	0.147
10	5,258	5,301	2,835	2,667	52	97	52	56	0.002	0.005	0.002	0.003	0.014	0.025	0.017	0.019	0.287	0.539	0.164	0.169
11	5,155	5,208	2,787	2,605	62	107	60	62	0.006	0.010	0.003	0.004	0.020	0.035	0.020	0.023	0.340	0.592	0.187	0.185
12	5,110	5,161	2,742	2,557	75	120	63	67	0.003	0.006	0.003	0.003	0.024	0.040	0.022	0.026	0.407	0.659	0.195	0.198
13	5,062	5,114	2,687	2,509	77	122	92	71	0.004	0.006	0.005	0.003	0.027	0.046	0.028	0.030	0.417	0.670	0.275	0.208
14	4,994	5,067	2,605	2,440	97	128	65	67	0.007	0.006	0.005	0.005	0.034	0.052	0.033	0.034	0.518	0.700	0.202	0.198
15	4,874	4,963	2,557	2,385	107	141	88	56	0.013	0.015	0.004	0.003	0.047	0.067	0.037	0.037	0.568	0.766	0.262	0.171
16	4,826	4,910	2,492	2,320	84	113	105	52	0.004	0.006	0.007	0.003	0.051	0.073	0.044	0.041	0.456	0.627	0.306	0.161
17	4,774	4,870	2,444	2,258	115	156	115	46	0.006	0.006	0.006	0.003	0.057	0.079	0.049	0.044	0.606	0.839	0.330	0.148
18	4,716	4,789	2,375	2,203	109	171	97	44	0.006	0.014	0.007	0.002	0.063	0.093	0.056	0.046	0.577	0.912	0.287	0.143
19	4,668	4,729	2,306	2,155	72	141	135	37	0.003	0.008	0.009	0.002	0.067	0.101	0.065	0.048	0.403	0.768	0.377	0.128
20	4,578	4,669	2,238	2,100	132	137	128	31	0.012	0.008	0.009	0.002	0.078	0.109	0.074	0.050	0.683	0.749	0.361	0.115
21	4,510	4,585	2,176	2,039	120	94	158	33	0.008	0.008	0.010	0.002	0.087	0.117	0.084	0.052	0.628	0.548	0.428	0.119
22	4,462	4,535	2,128	1,987	99	128	162	26	0.005	0.006	0.008	0.001	0.091	0.124	0.092	0.053	0.533	0.704	0.436	0.105
23	4,414	4,485	2,094	1,932					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053
24	4,366	4,431	2,035	1,867					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053
25	4,283	4,394	2,001	1,812					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053
26	4,235	4,348	1,963	1,778					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053
27	4,187	4,307	1,895	1,733					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053
28	4,149	4,267	1,860	1,692					0.000	0.000	0.000	0.000	0.091	0.124	0.092	0.053	0.091	0.124	0.092	0.053

Appendix F
Aquatic Plant Management-Sensitive Area Assessment Summary
(WDNR, July 18, 1988 and July 26, 1989)

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Northwest District Headquarters

P.O. Box 309
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Spooner, Wisconsin 54801
TELEPHONE 715-635-2101

AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989

NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

BONE LAKE SITE RECOMMENDATION SUMMARY

Site

A.
1. No chemical treatment allowed.
2. No mechanical harvesting allowed.
   a. Minimal hand control allowed around docks.

B.
1. No chemical treatment allowed.
2. No mechanical harvesting allowed.
   a. Minimal hand control allowed around docks.

C.
1. Chemical treatment allowed for 25 foot navigational channels to developed properties.
2. Mechanical control allowed for 25 foot navigational channels to developed properties.

D.
1. No chemical treatment allowed.
2. No mechanical control allowed.

E.
1. No chemical treatment allowed.
2. No mechanical control allowed.

F. 1. No chemical treatment allowed.
   2. Mechanical control allowed for a 25 foot navigational channel to developed properties.

G. 1. No chemical treatment allowed.
   2. No mechanical control allowed.

H. 1. Chemical treatment of submergents only for the development of a 25 foot navigational channel to developed properties.
   2. Mechanical control for the development of a 25 foot navigational channel to developed properties only.

I. 1. Chemical treatment of submergents only.
   2. Mechanical control allowed.

J. 1. No chemical treatment allowed.
   2. No mechanical control allowed.

K. 1. Chemical treatment of submergents to develop a 25 foot navigational channel to developed properties only.
   2. Mechanical control to develop a 25 foot navigational channel to developed properties only.

mr
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Northwest District Headquarters

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE | COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988; JULY 26, 1989 | NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE A

This is a bay-like area located on the eastern shore at the north end of Bone Lake. The length of shoreline involved is approximately 1000 feet and extends 150 feet out from shore. The substrate in this area is predominantly sand, gravel, and rubble. The maximum depth at the outer boundary on this site is 7 to 9 feet. The riparian property is in contiguous development, lawns are present, the area is wooded and the south half of the shoreline is rip-rapped.

This area is fairly lacking in emergent vegetation with only arrowhead found in a few locations. Submergent vegetation appears to be a diverse balanced aquatic plant community. Species found here include muskgrass, bushy pondweed, flatstem pondweed, milfoil, coontail, large leaf pondweed, clasping leaf pondweed, whitestem pondweed, wild celery, narrow leaf pondweed, curly leaf pondweed and filimentous algae.

Distribution of these species vary from low density and low-growing forms of most species in the shallow, 0 to 3 feet depth, to abundant populations and larger plants in the 3 to 6 foot depth.

Fish species using the area consist of bluegill, largemouth bass, northern pike, and muskie. Vegetation in the bay provides valuable spawning, feeding, and nursery areas for the fish populations.

Protection of the existing native plants is an important method of helping diminish invasions of exotic species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE A

1. No chemical treatment allowed.
2. No mechanical harvesting allowed.
3. Minimal hand control allowed near dock areas.
4. Efforts should be undertaken to prevent erosion from developments.
5. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989

NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE B

This site is a bay located along the eastern shore on the northern half of the lake. It may best be identified as the bay along which "E-Z Living Campground" is located. The area is comprised of 1000 feet of shoreline and extends out 150 feet from shore to a depth of 6 feet. The substrate is sand and gravel with pockets of muck.

Emergenct vegetation is found along the northern half of the bay near the shore. Spikerush, bullrush, whitewater lily, and arrowhead are present. Submergent species are very diverse in the area. Wild celery is most dominant, found throughout the site. Bushy pondweed and filimentous algae were found to be abundant. Common species are largeleaf pondweed, clasping leaf pondweed, milfoil, and flatstem pondweed. Coontail and narrow leaf pondweed were also present.

Fish species using the area consist of musky, northern pike, largemouth bass, and panfish. Vegetation in the bay provides valuable spawning, feeding, and nursery areas for the fish populations.

Protection of existing native plants is an important method of helping diminish invasions of exotic species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE B

1. No chemical treatment allowed.
2. No mechanical harvesting allowed.
3. Minimal hand control in high use areas near docks.
4. Efforts should be undertaken to prevent erosion from developments.
5. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE　　　　COUNTY: POLK
DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989　　　　NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE C

This site is a small bay situated near the midpoint of the eastern shore. The total shoreline length is approximately 600 feet. The substrate is mostly muck. The riparian property is mostly undeveloped and wooded. There are two cabins at the very northern most part of this area.

The aquatic vegetation found here is very diverse. Emergent species include cattails, burreed, bull rush, yellow water lily, white water lily, and arrowhead. Wild celery and mud plantain are abundant submergent species found throughout the bay. Bushy pondweed, flatstem pondweed, narrow leafed pondweed, clasping pondweed, large leafed pondweed, and filimentous algae are common in this area. Also present is milfoil, coontail, curly leaf pondweed, and clasping leaf pondweed.

Fish species using the site consist of musky, northern pike, large mouth bass, and panfish. Vegetation in the bay provides valuable spawning, feeding, and nursery areas for the fish populations. Northern pike will use the emergent vegetation around the bay for spawning.

Shorebirds, songbirds, and water fowl use this area for feeding, nesting, and rearing young. Muskrat, raccoon, and other furbearers feed and care for young here.

This area contains many high value aquatic plant species. They provide cover and make up a very stable base in the food web of the bay. Also aquatic vegetation helps prevent shoreline erosion and the protection of the existing native plants is an important method of helping diminish invasions of purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE C

1. Chemical control will be allowed in the form of a 25 foot navigational channel to the two existing developed properties. Only water lilies are to be treated to allow navigation.

2. Mechanical control is limited to a 25 foot navigational channel into the two existing developed properties only.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988, JULY 26, 1989 — NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE D

This site is located along the smaller of two islands found on the lake. The specified area is a small bay at the northeast corner of the island. This site is approximately 400 feet of shoreline and extends outward 100 feet. The wooded island is state owned, so no development has taken place here. The substrate around the entire island consists of gravel and sand with sediment accumulations deposited over the substrate.

White water lily is found along the shore. Coontail is dominant throughout the area. Filimentous algae and bushy pondweed are abundant in the shallow water. Sago pondweed, large leg pondweed, milfoil, and flatstem pondweed are also present in the area nearest the shore.

There are no riparian owners, so there should not be permits issued for any alterations. This area provides wildlife and fisheries habitats.

MANAGEMENT RECOMMENDATIONS FOR SITE D

1. No chemical treatment allowed.

2. No mechanical treatment allowed.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE | COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988 | NUMBER OF SENSITIVE AREAS: 11
JULY 26, 1989

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE E

This site is a bay found along the northern shore of the larger of two wooded islands found on Bone Lake. The riparian property is privately owned but no shoreline development has taken place anywhere on the island. The bay is approximately 650 feet of shoreline and extends 150 to 200 feet from shore. The substrate is gravel and sand.

The site is lacking in emergent vegetation. Abundant submergents found in the bay are musk grass, large leaf pondweed, and bushy pondweed. Wild celery is commonly found here. Variable pondweed, clasping pondweed, white stem pondweed, curly leaf pondweed, and flatstem pondweed are also present.

Fish species using the area are musky, large mouth bass, and panfish. Vegetation in the bay provides valuable spawning, feeding, and nursery areas for the fish populations. Shorebirds, songbirds, and waterfowl use this area for feeding.

Aquatic vegetation helps prevent shoreline erosion. Protection of the existing native plants is an important method of helping diminish invasions of exotic species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE E

1. No chemical treatment allowed.

2. No mechanical control allowed.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

WISCONSIN DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Northwest District Headquarters

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989 — NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE F

This site is a large shallow bay along the eastern shore. The shoreline is completely developed with lawns extending to the water along its entire length. This area is approximately 1100 feet long and extends 100 feet out from shore. The maximum depth of this area is 3 feet. The substrate is made up of gravel and sand.

Emergent vegetation is concentrated near the shoreline. Species present are spike rush, arrowhead, cattails, and bull rush. Yellow and white water lily can be found in spots further from shore. Submerged plants include bushy pondweed, buttercup, and clasping leaf pondweed. All plant species are sparsely distributed throughout this area and most submergents are growing in a low profile form.

Largemouth bass and panfish use this area to feed, spawn, and rear their young. Songbirds and water fowl feed in the bay.

Existing native species of plant in the bay can help prevent shoreline erosion and help diminish invasions of exotic species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE F

1. No chemical treatment allowed.

2. Minimal hand control is allowed in dock areas.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

WISCONSIN DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Northwest District Headquarters

P.O. Box 309
STH 70 West & First Street
Spooner, Wisconsin 54801
TELEPHONE 715-635-2101

AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE
COUNTY: POLK
DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989
NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE G

This site is located at the southeast corner of the lake. Fox Creek leaves the lake at the midpoint of this area. The approximate length of this site is 2000 feet and extends to 150 feet from shore. The northern and southern halves of this areas vary greatly. The northern portion is mostly developed with lawn extending to the waters edge. This is the only location with emergent vegetation. The depth varies from 0 to 5 feet in the site boundaries. The southern half of the site is undeveloped and wooded. Most submergents will be in this location. The littoral zone in this area is very narrow with site boundaries having 10 to 20 foot depths.

Plant species would be classified as common or present. No species are found throughout the area and plant populations are considered sparse. Emergent vegetation consists of bull rush only. Submergent species include bushy pondweed, milfoil, wild celery, sago pondweed, flatstem pondweed, clasping pondweed, buttercup, white stem pondweed, large leaf pondweed, muskgrass, and filimentous algae.

Fish species consist of northern pike, musky, largemouth bass, and panfish. The vegetation in the lake provide valuable spawning, feeding, and nursery areas for the fish populations. Heavy use by muskies during the spawning season has been observed here.

Aquatic vegetation helps prevent shoreline erosion. Protection of existing native plants is an important method of helping diminish invasions of non-native species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE G

1. No chemical treatment allowed.

2. No mechanical control allowed.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989 — NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE H

This site includes a bay and adjacent shoreline along the western shore of the southern portion of Bone Lake. The total shoreline length of this site is approximately 2500 feet extending 150 to 200 feet from shore. The substrate of the site is gravel and sand. Development is found intermittently along the site making up about half of the total shoreline involved.

Emergent species are very diversified and found scattered throughout the area. Species include bullrush, white water lily, bur reed, tall spike rush, pickerel week, cattail, yellow water lily, and arrowhead. Submergent vegetation consists of muskweed, wild celery, milfoil, flatstem pondweed, largeleaf pondweed, clasping pondweed, white stem pondweed, coontail, bushy pondweed, and buttercup. Filimentous algae is found periodically here throughout the year.

Fish species using the area consist of musky, northern pike, large mouth bass, and panfish. The vegetation on this site provides valuable spawn, feeding, and nursery ares for the fish populations.

Shorebirds, songbirds, and waterfowl use this area for feeding and resting during migration. Many of these birds remain, nest, feed, and bear their young here.

Raccoon and muskrat can be found frequenting the edges of this site. Many raise young in the area.

Aquatic vegetation helps prevent shoreline erosion. The protection of the existing native plants is an important method of helping diminish invasions of purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE H

1. Chemical control with conditions:

   a. No treatment of spike rush and bull rush.
   b. Chemical control is limited to a 25 foot navigational channel to developed properties only.

2. Mechanical control with conditions:

   a. Avoid harvest of spike rush and bull rush.
   b. Mechanical harvesting providing a 25 foot navigational channel to developed properties only.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE

COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989

NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE I

This site is the largest designated in the survey. It is located midway along the length of the lake on the western shore. The total length of this site is approximately one mile and extends 150 feet from shore. The substrate is mostly gravel with areas of rubble, sand, and silt. Most of the shoreline is undeveloped with those dwellings present lacking lawns that extend to the lakeshore. The riparian property is heavily wooded.

The emergent community found here is the most dominant aquatic vegetation. Bullrush and spike rush can be found along the entire length of this site. Submergent vegetation consists of an average mix of all species common to this lake. None of these could be classified as abundant.

Fish species using this site include large mouth bass, musky, northern pike, and panfish. The aquatic vegetation provides valuable spawning, feeding, and nursery areas for the fish populations.

Shorebirds, songbirds, and waterfowl use this area for feeding and nesting during migration. Many remain in the spring and nest and rear their young. Muskrat, raccoon, and other furbearers use this area for cover and food.

The aquatic vegetation helps prevent shoreline erosion. Protection of the existing native plants is an important method of helping diminish invasions of purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE I

1. Chemical treatment with conditions:

   a. No chemical treatment of emergent vegetation.
   b. Chemical treatment of submergent vegetation is allowed.

2. Mechanical control allowed.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988
JULY 26, 1989 — NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE J

This site consists of a stand of bullrush which forms a small 150 by 150 foot island. The location is near the north end of the lake and approxiamtely 1000 feet from the western shore. The substrate is rubble and drops off to the 30 foot depth within 100 feet of this stand.

This site is used by musky and largemouth bass as a feeding area. Great Blue Herons feed on this site.

MANAGEMENT RECOMMENDATIONS FOR SITE J

1. No chemical treatment allowed.

2. No mechanical treatment allowed.

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AQUATIC PLANT MANAGEMENT

SENSITIVE AREA ASSESSMENT SUMMARY

LAKE: BONE — COUNTY: POLK

DATE OF ASSESSMENT: JULY 18, 1988; JULY 26, 1989 — NUMBER OF SENSITIVE AREAS: 11

SITE EVALUATORS: FRANK KOSHERE - WATER QUALITY BIOLOGIST
RICK CORNELIUS - FISH MANAGER
RANDY MCDONOUGH - WILDLIFE TECHNICIAN
LARRY DAMMAN - FISH MANAGER
MARK SUNDEEN - ENVIRONMENTAL SPECIALIST

RESOURCE VALUE OF SITE K

This site is located at the north end of the lake. The approximate length of this site is 3000 feet and extends out to the 5 foot depth. This site receives drainage from a large area of farm land which forms a bowl surrounding the northern portion of the lake. The substrate is mostly muck over a rubble bottom.

This area has dominant emergent vegetation. Cattails, pickerel weed, bull rush, spike rush, arrowhead, wild rice, and white and yellow water lily are found here in abundant populations. Submergent plants consist of an average mix of all species found on the lake. No submergent species would be classified as dominant.

This site provides feeding, spawning, and nursery ares for the fish populations. Northern pike, largemouth bass, musky, and panfish use this site.

Shorebirds and wading birds feed in this area. Waterfowl use the area for feeding and resting during migration. Some nest and rear their young on this site. Furbearers such as muskrat and raccoon use the area for feeding.

Protection of the existing native plants is an important method of helping diminish invasions of exotic species such as purple loosestrife and Eurasian milfoil.

MANAGEMENT RECOMMENDATIONS FOR SITE K

1. Chemical treatment with restrictions:

    a. No chemical treatment of emergents.
    b. Chemical treatment of submergents allowing a 25 foot navigational channel to developed properties only.

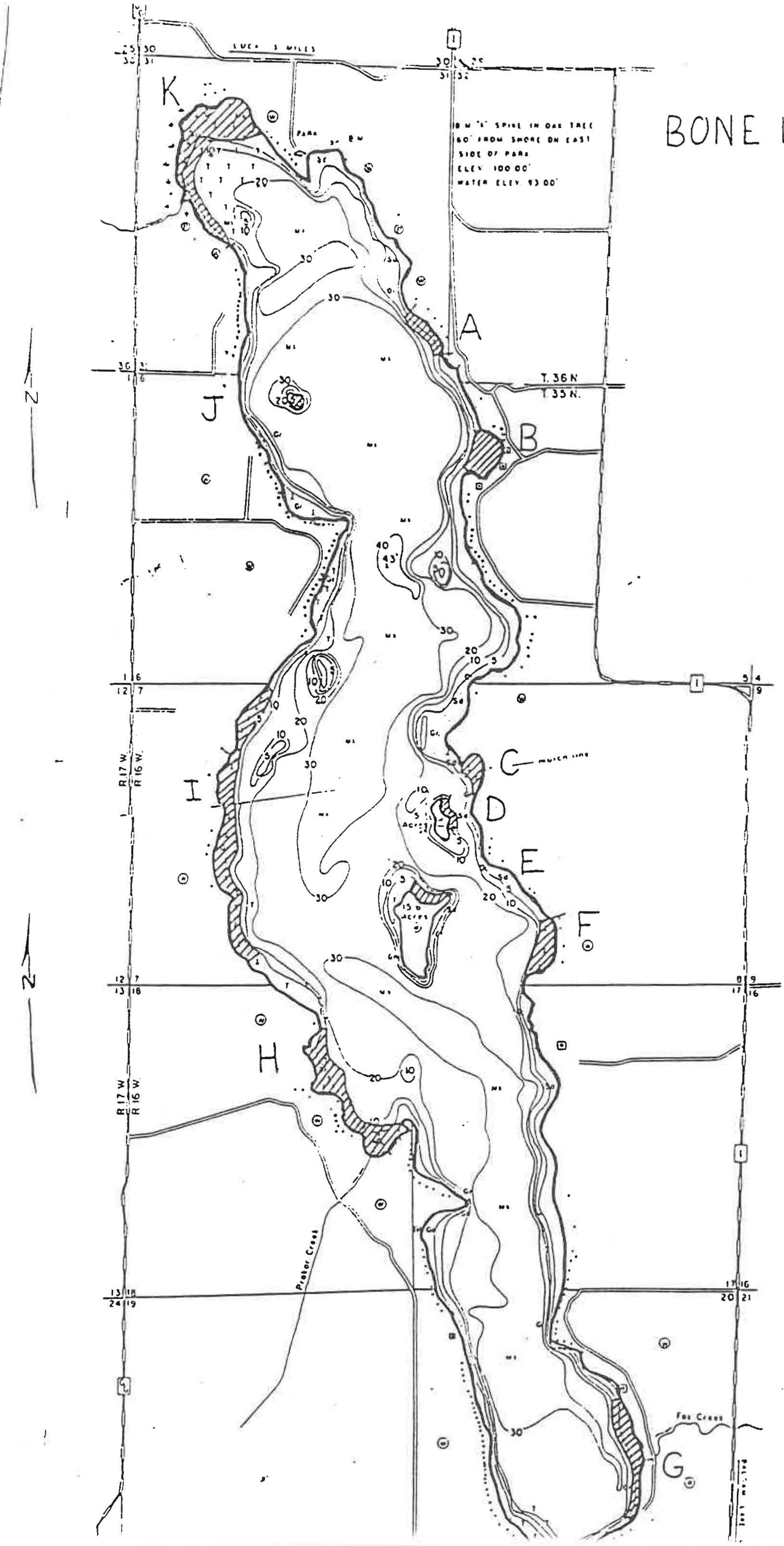
2. Mechanical control with restrictions:

    a. Mechanical harvesting to form navigational channels, 25 feet wide, to developed sites only.

3. Efforts should be undertaken to prevent erosion from developments.

4. Strictly enforce shoreland and wetland ordinances.

BONE LAKE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