Turtle Mountain Band of Chippewa Indians

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SUBMITTED TO: U.S. ENVIRONMENTAL PROTECTION AGENCY

T.M. LAKE WATER QUALITY ASSESSMENT

June, 1993

Prepared By: Ronald D. Davis — Turtle Mt. Natural Resources Dept. - Lake Water Quality

TURTLE MOUNTAIN LAKE WATER QUALITY ASSESSMENT

JULY, 1991 THRU JUNE, 1992

PREPARED FOR:

THE

TURTLE MOUNTAIN BAND OF CHIPPEWA INDIANS

AND

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII; DENVER, CO

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LAKE WATER QUALITY ASSESSMENT STUDY
EXECUTIVE SUMMARY

The Clean Lakes Program began in 1972 under Section 314 of the Federal Water Pollution Control Act and was amended in 1987 by adding a new section 518 entitled "Indian Tribes". This Act authorizes EPA to treat federally recognized Indian Tribes as States for financial assistance. The Turtle Mountain Band of Chippewa received treatment as a State in 1989 and subsequently a Lake Water Quality Assessment (LWQA) grant was issued in 1990 under Section 314 of the Clean Lakes Act. The purpose of the LWQA was to assess the current status of lake water quality on the Turtle Mountain Reservation (TMR) lakes. The information collected under this program was intended to provide a framework in which comparisons and trends can be made for future assessments, for protection of current conditions, and for the development of lake management strategies/practices.

The Turtle Mountain LWQA study consisted of an assessment on four lakes associated with the TM Chippewa Indian Reservation: Belcourt, Gordon, Jarvis, and Wheaton lakes. The data derived from the project was used to classify the lakes according to their trophic status of biological productivity as measured by physical, chemical, and biological parameters. The trophic state of a lake is determined by a number of factors including latitude, altitude, climate, watershed characteristics, soil types, human activities, and lake morphometry. The three broad factors seem to be the most important are climate, nutrient supply, and lake depth.

The study examined the water quality of four Tribally managed lakes. All four lakes studied are within close proximity to each other and have similar designated uses:

> Fisheries
> Immerse recreation - swimming, skiing, etc.
> Limited contact recreation
> Stock watering and wildlife habitat

The population within a 20-mile radius is estimated to be around 20,000. The four lakes surveyed on the TMR occur at elevations ranging from 2012 to 2135 feet above sea level. The latitude of the four lakes range from 48°52'30 at Belcourt Lake to 48°55'30" at Jarvis and Gordon Lakes, which is very close to the Canadian Border located on the 49th degree latitude. The Turtle Mountains have a wide variety of seasonal temperature extremes varying from 90°F to 100° F in the summer to temperatures of -30° F to -40° F in the winter. The lakes are quite shallow, having mean depths less that 15 feet. The lakes vary in size from 56 acres at Wheaton Lake to 593 acres at Belcourt Lake.

The same parameters were analyzed on each of the four lakes, with an emphasis on Belcourt Lake, due to the proximity of the lake to the majority of the population. The lake water samples that were taken on monthly basis from Belcourt Lake and analyzed by the North Dakota State Department of Health and Consolidated Laboratories in Bismarck, ND. The samples from the other three lakes - Jarvis, Gordon, and Wheaton Lakes - were taken on a quarterly basis. Samples were collected from July, 1991 throughout June, 1992. Sampling stations were located at mid-depth in the deepest portion of the lakes.

The field parameters that were analyzed monthly at surface and bottom depths on all four lakes were: total depth and sample depth, temperature, conductivity, alkalinity (surface), pH, dissolved oxygen, and secchi transparency. The parameters that were sent to the North Dakota State Laboratory for analysis each month were: total phosphorus, total dissolved phosphorus, nitrite + nitrate, ammonia (N), chlorophyll-a, and total suspended solids. In addition, the following parameters were analyzed by the State Laboratory on a one time basis from each lake (see Appendix A): calcium, iron, magnesium, manganese, potassium, sodium, bicarbonate, carbonate, chloride, sulfate, total hardness, total dissolved solids, sodium adsorption ratio, and total kjeldahl nitrogen.

Trophic status was assessed for each lake in the assessment data base using Carlson's Trophic State Index (TSI). This index was developed from the interrelationships of summer Secchi transparency and epiliminic concentrations of chlorophyll-a and total phosphorus. The resulting index value generally range from 0 to 100 with increasing values indicating more eutrophic conditions.

This data reflects the current conditions of the lakes, although temporary and spatial fluctuations do occur naturally. Table 1 summarizes the chemical information collected on the four lakes. In many respects, these lakes were found to be very similar. As is evident from the dissolved oxygen and temperature plots, under ice cover concentrations of oxygen become critical in all four lakes.

Belcourt Lake, which was emphasized in this assessment, had a TSI of 64.6. This indicates that the lake is moderately eutrophic. Because of these conditions, Belcourt Lake is a high priority for a Phase I study which would specifically document the causes of the problem and recommend remediation measures. Currently, the Bureau of Indian Affairs is proposing to eliminate the resident fish population and restock the lakes with more desirable species.

The second most eutrophic lake in the assessment is Jarvis Lake with a TSI of 62.5. Since all three index values were very similar, it is assumed that the index provides an accurate representation of the lake's condition. Jarvis Lake would also be an appropriate candidate for a Phase I study. This is impacted by cattle and associated feedlot activities in the watershed.

Gordon and Wheaton Lakes had a similar TSI values at 50.9 and 49.8 respectively. Phosphorus and chlorophyll-a TSI values indicate a mid-eutrophic condition, while transparency indicates a oligotrophic/mesotrophic status. Neither of these two lakes have shoreline development or livestock feedlots which impact the lakes. It is important that measures be taken to ensure that water quality is not impaired in the future.

Table 1. Carlson Trophic Index Values

	BELCOURT	GORDON	WHEATON	JARVIS
Secchi	56.55	38.62	39.75	62.50
Total P	68.07	58.41	56.62	62.45
Chlorophyll-a	69.20	55.73	53.16	62.66
TSI Mean	**64.61**	**50.92**	**49.84**	**62.53**

In the near future, a thorough study of the watershed characteristics and sources of pollution (point and non-point) would be in priority for the Tribe's next lake project. A Phase I Clean Lakes study may be proposed, which would include Belcourt and Jarvis Lakes.

It is of the utmost importance that all people, especially Native Americans, take the lead to preserve and protect all natural resources - particularly water. Our creator does not want us to destroy our natural resources for if we destroy these invaluable and irreplaceable assets, we will be destroying ourselves.

Turtle Mountain Band of Chippewa
Lake Water Quality Assessment Report

I. INTRODUCTION

The Clean Lakes Program began in 1972 under Section 314 of the Federal Water Pollution Control Act and was amended in 1987 by adding a new section 518 entitled "Indian Tribes." This Act authorizes the EPA to treat federally recognized Indian Tribes as States for financial assistance, as well as other certain provisions. Section 518 establishes three broad tests an Indian Tribe must meet before treatment as a State is authorized. The Turtle Mountain Band of Chippewa has recieved treatment as a State since 1989, when it recieved a Section 106 grant of the Clean Water Act.

The purpose of this assessment is to collect and generate data- on four Turtle Mountain (TM) lakes- that will provide a framework in which comparisons and trends can be made not only for future assessments, but also protection of current conditions and generate information which will be useful in lake management practices.

The report is divided into four chapters and an appendix that includes the data that is used in this report. The following is a brief summary of each chapter:

Project Description - This chapter will provide a general discussion of the Turtle Mountain Lake Water Quality Assessment Program (TMLWQA).

Data Base Development - This chapter includes the sampling, analytical, and data analysis procedures that were used in this assessment.

Considerations and Case Studies - This chapter discuss each of the four lakes in the TMLWQA in detail and also will identify a number of factors or "considerations" that should be taken into account when setting water quality standards that are suitable for protecting uses of lake resources from further deterioration or for improving or expanding use of this resource. Such factors as trophic status, lake morphometry and mixing status, fisheries, land and watershed uses, and user expectations will be considered in this chapter.

Conclusions and Recommendations - This chapter will discuss the assessment that brought together a body of information on the water quality of TM lakes. It was not intended to address all aspects of lake management, as lake management includes a number of other issues including fisheries, macrophytes, watershed and shoreline protection- to name a few, although some of these issues are discussed as they relate to water quality.

II. PROJECT DESCRIPTION

Each lake in the Clean Lakes Program requires a monitoring plan. The Turtle Mountain Lake Water Quality Assessment (TMLWQA) Program consisted of an assessment of four lakes on the TM Chippewa Indian Reservation or adjacent to it -Belcourt, Gordon, Jarvis, and Wheaton lakes. The purpose of the project was to classify the lakes according to their trophic status or biological productivity as measured by physical, chemical, and biological parameters, with the lakes with the lowest biological productivity or lowest concentrations of plant nutrients called oligotrophic, and the lakes with high concentrations of plant nutrients or biological productivity called eutrophic. Lakes with characteristics between oligotrophic and eutrophic are called mesotrophic. The trophic state of a lake is determined by a number of factors including latitude, altitude, climate, watershed characteristics, soil types, human activities, and lake morphometry. Three broad factors seem to the most important -climate, nutrient supply, and the lake depth. Generally, lakes in colder climates tend to be less productive, while warmer climates promote more eutrophic conditions. The mean depth is extemely important when determining trophic status. Most oligotrophic lakes tend to be deepest and the shallower the lake the more the eutrophic the conditions tend to be. By the same token, the effect that depth has plays a major role in reducing nutrient concentrations (USEPA, 1980) -the solution to pollution is dilution.

The four lakes in the TMLWQA occur at elevations ranging from 2012 to 2135 feet above sea level. The latitude of the four lakes range from 48°52'30" at Belcourt Lake to 48°55'30" at Jarvis and Gordon Lakes, which is very close to the Canadian border located on the 49th degree latitude. The Turtle Mountains have a wide variety of seasonal temperature extremes varying from 90°F to 100°F in the summer to temperatures of -30°F to -40°F in the winter, with wind chill factors much colder. The lakes are quite shallow, as the mean depth of each lake will affirm: Belcourt Lake= 12.5 feet, Gordon Lake= 15 feet, Jarvis Lake= 11 feet, and Wheaton Lake= 12 feet. The lakes vary in size from 56 acres at Wheaton Lake to 593 acres at Belcourt Lake.

The TMLWQA examines the water quality of four Tribally managed lakes. The same parameters were analyzed on each of the four lakes, with an emphasis on Belcourt Lake- due to the proximity of the lake to the majority of the population. The lake water samples that were taken from Belcourt Lake were analyzed by the North Dakota State Department of Health and Consolidated Laboratories in Bismarck, ND on a monthly basis. The samples were either driven directly to the lab or were shipped via Federal Express. The samples from the other three lakes- Jarvis, Gordon, and Wheaton Lakes- were delivered to the State Lab on a quarterly basis.

The parameters that were analyzed in the field each month for each of the four lakes in the assessment were as follows:

- Depth
- Temperature (top & bottom)
- Conductivity (top & bottom)
- Alkalinity (top)
- pH (top & bottom)
- Secchi disk (transparency)
- Dissolved oxygen (top & bottom)

The parameters that were sent to the State Lab for analysis every month were as follows (one meter below surface):

- Total phosphorus
- Total dissolved phosphorus
- Nitrites/nitrates
- Chlorophyll a
- Total suspended solids
- Ammonia

The following parameters were analyzed by the State Lab one time from each of the four lakes (one meter below surface) for comparison purposes (see Appendix I):

- Total phosphorus
- Ammonia
- Total Kjeldahl Nitrogen
- Nitrite
- Alkalinity
- pH
- Conductivity
- Bicarbonate
- Carbonate
- Total hardness
- Total dissolved solids
- Sodium adsorption ratio
- Anion sum
- Calcium
- Chloride
- Iron
- Magnesium
- Manganese
- Potassium
- Sodium
- Sodium %
- Sulfate
- Cation sum

Due to unfortunate and unanticipated circumstances, a infinitesimal amount of work was completed towards the watershed and drainage area characteristics and also in the areas of point and non-point sources of pollution. The contributing factors that lead to these inauspicious happenings were mainly a shortage of time, money, and also the lack of expertise in these areas. However, a general understanding of these areas may be all that is needed for all the TM Chippewa Tribe's requirements at this point. In the near future, depending on the funds that are available, a thorough study of the watershed characteristics and sources of pollution (point and non-point) would be in sequence for the Tribe's next project (Phase I), which could include Belcourt and Jarvis Lakes.

III. DATA BASE DEVELOPMENT

The data that was used for this assessment was collected from four Tribal lakes- Belcourt, Jarvis, Gordon, and Wheaton, with an emphasis on Belcourt Lake. The measurements that were used include the physical characteristics such as temperature, sample depth, secchi disk depth, and lake stratification and mixing. The chemical characteristics that were measured include conductivity, pH, alkalinity, dissolved ions (phosphorus, nitrites/nitrates, ammonia), and dissolved oxygen. Also measured were the biological characteristics, including chlorophyll-a, total suspended solids, and macrophytes (species). The data was collected by the TM Lake Water Quality staff of one.

Water quality data was collected from July, 1991 throughout June, 1992 on a monthly basis, with the samples taken from Belcourt Lake sent in to the ND State Lab every month and the samples taken from Gordon, Jarvis, and Wheaton Lake sent in to the State Lab on a quarterly basis, however, as stated earlier certain parameters were sampled for each month on each of the four lakes- such as depth, temperature, conductivity, alkalinity, pH, secchi disc, and dissolved oxygen- and were analyzed by the TM staff. Sampling stations were located at midlake at the greatest depth. The samples were collected with an alpha sampler water bottle with a maximum volume of 4.2 liters. The samples that were to be field tested were all analyzed immediately, except for alkalinity and titration of dissolved oxygen (fixed in field immediately), however the relatively short distances from the wet lab, located at the Natural Resources building in Belcourt, enabled the samples to be brought back and either analyzed (D.O. & alkalinity) or prepared for delivery to the State Lab within six hours from the time of collection.

The methods that were employed by the ND State Lab for analysis are displayed in Table 2. The method that was used for determining total phosphorus, total dissolved phosphorus, nitrates/nitrates, and ammonia was flow injection analysis with a precision of 5% and accuracy of 7-10% as shown in Table 2. The method that was used to determine total suspended solids was gravimetric means with a precision of 10% and accuracy of 10%. Chlorophyll-a samples were chilled and wrapped in aluminum foil immediately after being filtered through 4.7 cm diameter glass microfibre filters within six hours of collection. The samples were analyzed at the State Lab by spectrophotometer and corrected for pheophytin, according to Standard Methods (APHA, 1989). A Fisher Scientific Accument Model 1002 pH meter was used to measure pH. The pH meter was calibrated each sampling event with standard buffer solutions of 4.00, 7.00, and 10.00. The method that was used to determine alkalinity in the wet lab was by titration and Gran Analysis, also in accordance with Standard Methods. Due to problems that were encountered in determining color

TURTLE MOUNTAIN CLEAN LAKES PROGRAM

TABLE 2 : Data Quality Objectives for Detectability, Accuracy, and Completeness

SITE (a)	VARIABLE	METHOD (Reference) (b)	LAB REPORTING UNITS	REQUIRED DETECTION LIMITS (Expected Range)	PRECISION (%)	ACCURACY (Absolute Bias)	COMPLETENESS
2	Alkalinity	Titration and Gran Analysis	eq/L	<10 mq/L (LO-500>)	10%	10%	90%
2	Conductance	Conductivity Cell & Meter	µS/cm	10-1000	2%	5%	90%
2	Dissolved Oxygen	Winkler-Azide	mg/L				
2	pH	pH electrode & meter	pH units	(3-8)	+.1 (field)	+.1	90%
1	Secchi Disk Transparancy	Secchi Disk	meters				90%
1	Temperature	Probe	Centigrade	0-30° C			
3	Total Phosphorus	Flow Injection Analysis	mg/L	(<0.01)	5%	7%	>95%
3	Total Dissolved Phosphorus	Flow Injection Analysis	mg/L	(<0.01)	5%	7%	>95%
3	Nitrates	Flow Injection Analysis	mg/L	(<0.01)	5%	7%	>95%
3	Nitrites	Flow Injection Analysis	mg/L	(<0.005)	5%	7%	>95%
3	Chlorophyll a	Spectrophotometric	ug/L	(<10)	10%	10%	>95%
3	Total Suspended Solids	Gravimetric	mg/L	<4	10%	10%	>95%
3	Ammonia	Flow Injection Analysis	mg/L	(<0.01)	5%	10%	>95%
3	Total Kjeldahl Nitrogen	Flow Injection Analysis	mg/L	(< 0.1)	5%	10%	>95%

Site	Variable	Method	Lab R.U.	R.D.L.	Precision	Accuracy	Completeness
3	Conductivity	Conductivity Cell and Meter	umhos/cm	(<1)	2%	5%	>95%
3	Alkalinity	Auto Titrator	mg/L	(<2)	3%	5%	>95%
3	pH	pH Electrode & meter	pH units	NA(Z-12)	I0.1	I0.1	>95%
3	Bicarbonate	Auto Titrator	mg/L	(<0.5)	3%	5%	>95%
3	Carbonate	Auto Titrator	mg/L	(<0.5)	3%	5%	>95%
3	Total Hardness	Calculated	mg/L				>95%
3	Total Dissolved Solids	Calculated	mg/L				>95%
3	Sodium Absorption Ratio	Calculated	None				>95%
3	Anion Sum	Calculated	me/L				>95%
3	Calcium	Inductively Coupled Plasma	mg/L	<0.01	7%	10%	>95%
3	Chloride	Flow Injection Analysis	mg/L	(<5)	5%	7%	>95%
3	Iron	Inductively Coupled Plasma	mg/L	<0.01	7%	10%	>95%
3	Manganese	Inductively Coupled Plasma	mg/L	<0.005	7%	10%	>95%
3	Magnesium	Inductively Coupled Plasma	mg/L	<0.1	7%	10%	>95%
3	Potassium	Inductively Coupled Plasma	mg/L	<0.5	7%	10%	>95%
3	Sodium	Inductively Coupled Plasma	mg/L	<0.01	7%	10%	>95%
3	Sodium %	Calculated	%				>95%
3	Sulfate	Flow Injection Analysis Turbidimetric	mg/L	<5	5%	7%	>95%
3	Cation Sum	Calculated	me/L				>95%

a) 1= lake site; 2= field laboratory; 3= analytical laboratory

b) For the most part, the EPA approved method is listed (40 CFR 136). Standard Methods is also listed as a reference, 16th ed.

changes, the pH meter was used to determine end points, with the phenolthalien alkalinity end point at 8.3 and the total alkalinity end point at 4.5. Conductivity tests were performed in the field with a YSI Model 33 S-C-T meter and conductivity cell. The meter was calibrated on each sampling event with conductivity calibration standards of 0.01 and 0.001 megohms according to manufacturers specifications. Analysis for dissolved oxygen were accomplished by the means of a Hach dissolved oxygen test kit which correspond with the Winkler-Azide method. Under this method the samples were treated with manganous sulfate (pre-measured pillows) and alkaline iodide-azide reagent to form an orange-brown precipitate. Upon acidification of the sample, this floc reacts with iodide to produce free iodine as I_3^-, in proportion to the oxygen concentration. The iodide is then titrated with sodium thiosulfate to the starch-iodide end point.

Due to relatively short holding times, the samples that were sent to the State Lab for analysis were filtered, preserved (as required), cooled on ice, and delivered to the State Lab within 24 hours. One quart of unfiltered and unpreserved lake water was prepared each month for the State Lab to analyze for total suspended solids. The sample for total dissolved phosphorus was filtered and preserved with sulfuric acid and sent to the State lab in a 200 ml container. A 200 ml container was also sent in for total P, nitrate/nitrite, and ammonia that was preserved with sulfuric acid and unfiltered. Only one month there was a problem that was encountered because the samples were not delivered within the 24 hour holding time by Federal Express- for which a refund was recieved. In July, 1991 the samples for total dissolved phosphorus exceeded the 24 hour holding time. But, since the samples were preserved and cooled, the results should be representative of the lakes conditions (Rathke, 1991), although a second set of samples were sent in to the Lab for additional analysis of total phosphorus. Due to the relatively short holding times, it was determined that it was easier to drive the samples down to the State lab in Bismarck, rather than to use a carrier. Although this was slightly more expensive and time-consuming (400 miles round trip), this assured that the samples were there within the holding times and also required less handling of the samples.

Trophic Status was assessed for each lake in the assessment data base using Carlson's Trophic State Index (TSI)(Carlson, 1977). This index was developed from the interrelationships of summer Secchi transparency, and epilimnetic concentrations of chlorophyll-a and total phosphorus. TSI values are calculated as follows:

$$TSI(SD) = 10\left(6 - \frac{\ln SD}{\ln 2}\right)$$

$$TSI(Chl) = 10\left(6 - \frac{2.04 - 0.68 \ln Chl}{\ln 2}\right)$$

$$TSI\ (TP) = 10\left(6 - \frac{\frac{48}{\ln TP}}{\ln 3}\right)$$

with chlorophyll-a and total phosphorus in ug/l and Secchi disk in meters.

The resulting index values generally range from 0 to 100 with increasing values indicating more eutrophic conditions (with one exception of some very high TP measurements of the TSIP values will exceed 100). The trophic states for the index are defined by using each doubling of the Secchi transparency as the standard for the division between each state, i.e. each the transparency doubles from some base value a decrease in TSIS of 10 units occurs and a new trophic state will be identified. Because the relationship between Secchi and total phosphorus is a simple inverse function a doubling of total phosphorus causes TSIP to increase by 10 units. The TSI scale and corresponding trophic states are noted in Figure 1. There may be discrepancies that exist between th TSIP, TSIS, and TSIC values for a given lake, due to the nature of this data compilation. These discrepancies may require the user to further evaluate the data to determine which data refects the trophic status of a lake. If there is a substantial difference between the TSI values of a given lake (e.g. >5 units), it is necessary to determine which index value(s) more accurately reflects the trophic conditions of the lake. This data reflects the current conditions of the lakes, although temporary and spatial fluctuations do occur naturally.

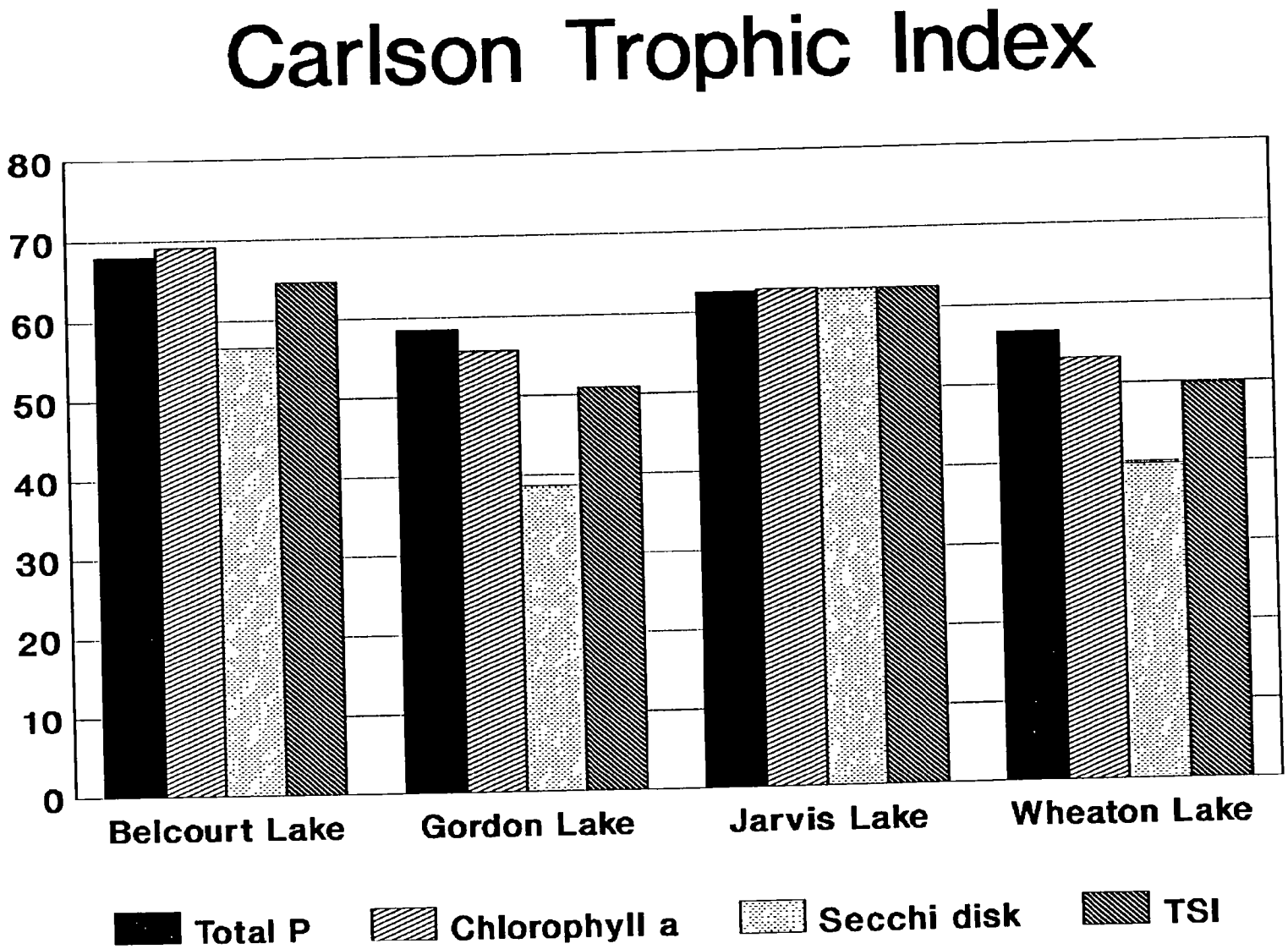

Carlson Trophic Index
80
70
60
50
40
30
20
10
0
Belcourt Lake
Gordon Lake
Jarvis Lake
Wheaton Lake
Total P
Chlorophyll a
Secchi disk
TSI

Figure 1

IV. CONSIDERATONS AND CASE STUDIES

BELCOURT LAKE

County: Rolette
Latitude: 48 deg. 52 min. 30 sec.
Longitude: 99 deg. 45 min. 30 sec.
Area: 593 acres
Volume: 7412 acre-feet
Origin of Basin: Glacial
Major Inflows/Outlets: none (stagnant)

Township: 162N
Range: 70W
Section(s): 5,6,7,8, & 9
Average Depth: 12.5 ft.
Watershed/Lake Area:
Thermal Stratification: yes

Lake Uses

1. Fisheries
2. Immerse recreation - swimming, skiing, etc
3. Limited contact recreation
4. Stock watering and wildlife habitat

Estimated Population within 20-mile radius: 20,000
Ownership status: Checkerboarded w/ Deeded government, Tribal, and Trust
Public interest: varies

Chemical parameters	Samples	Concentration
Secchi disk depth (meters)	12	1.27
Total Phosphorus (ug/L)	12	84.0
Chlorophyll a (ug/L)	12	41.83
Alkalinity (mg CaCo3/L)		
phenolthalien alkalinity (pH 8.3)	11	3.09
total alkalinity (pH 4.5)	12	235.17
pH (top)	12	8.66
(bottom)	12	8.45
Total suspended solids (mg/L)	12	7.17
Dissolved phosphate as P (mg/L)	12	0.05
Nitrate/nitrite nitrogen (mg/L)	12	0.125
Ammonia (mg/L)	12	0.169
Dissolved oxygen (mg/L)		
(top)	12	5.65
(bottom)	12	4.53
Conductivity (umhos/deg. C)		
(top)	12	400/9.08
(bottom)	12	398.25/9.23
Depth (feet)	12	18.25

TSI Values	Mean: 64.61
Secchi disk	56.55
Total phosphorus	68.07
Chlorophyll a	69.20

Aquatic Plants
Type of vegetation: cattail and bullrush

Watershed Description

Soil Association within watershed:
Bottineau loam - 3 to 9% slopes
Bottineau loam - 9 to 25% slopes
Kelvin loam - 3 to 9% slopes
Kelvin loam - 9 to 25% slopes
Metigoshe sandy loam - 3 to 9% slopes
Metigoshe sandy loam - 9 to 25% slopes
Divide loam
Eramosh peat

Algal Species and Plant Species: N/A

Fisheries

Mainly bass-panfish-walleye-northern pike & millions of bullheads. Suffered partial winterkill during winter of 1991-92, due to low oxygen levels.

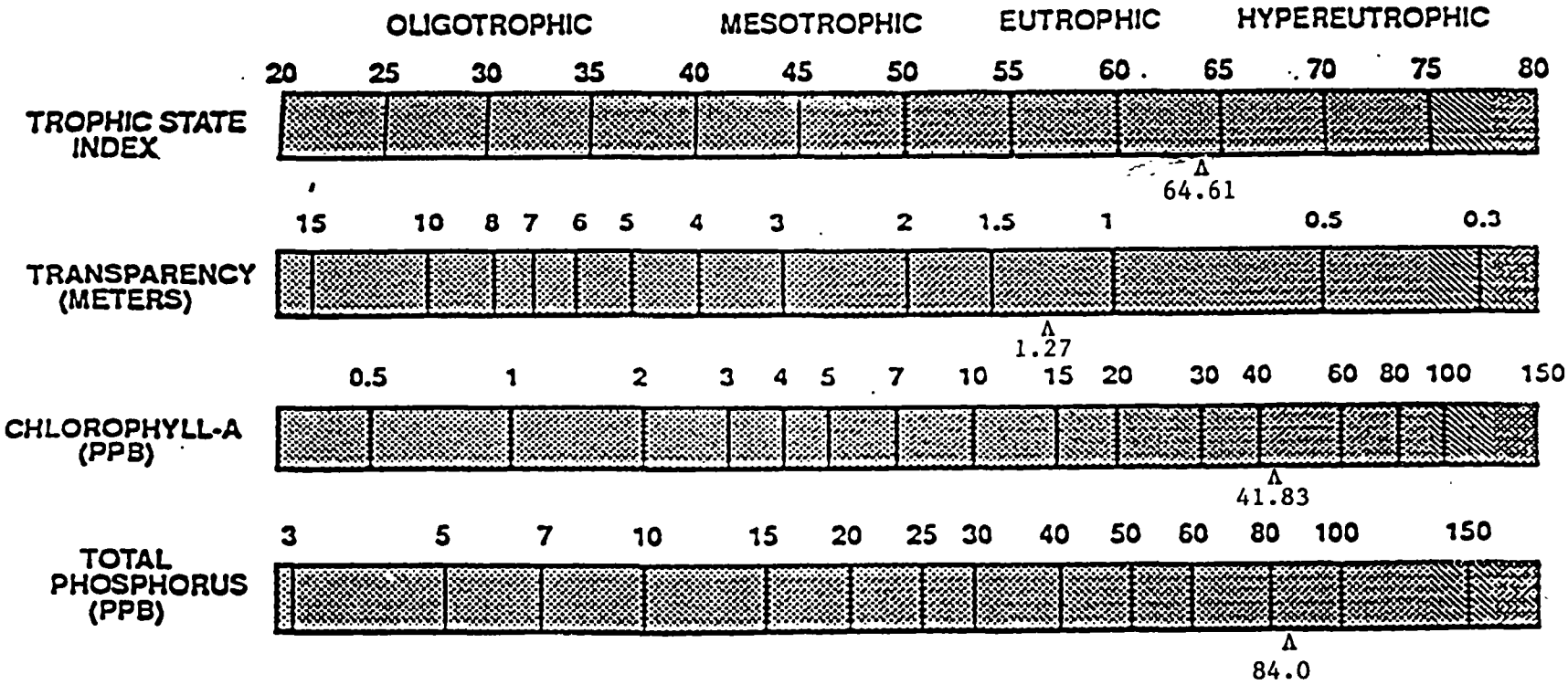
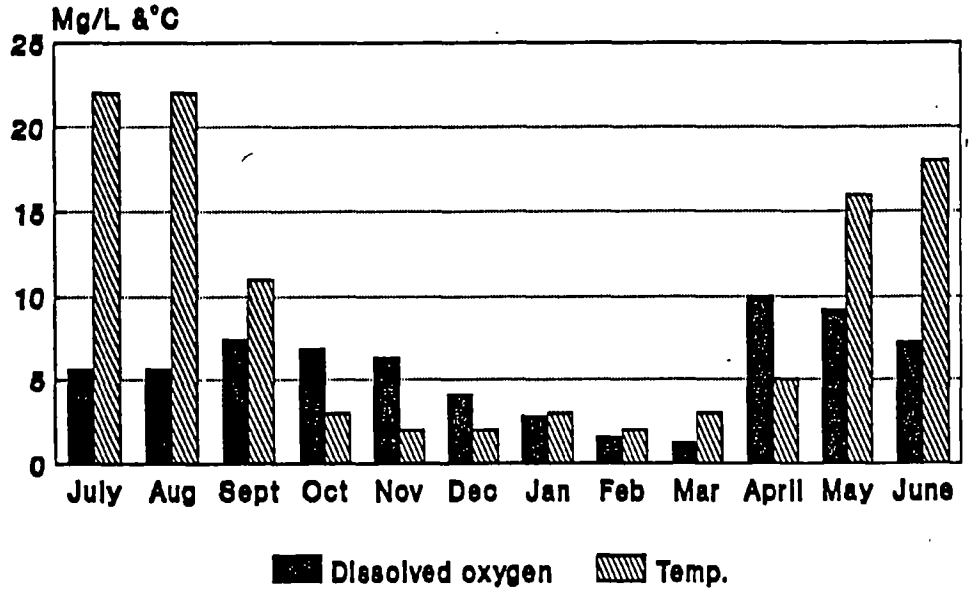


FIGURE 1. CARLSON'S TROPHIC STATE INDEX. Taken from NALMS (1988).

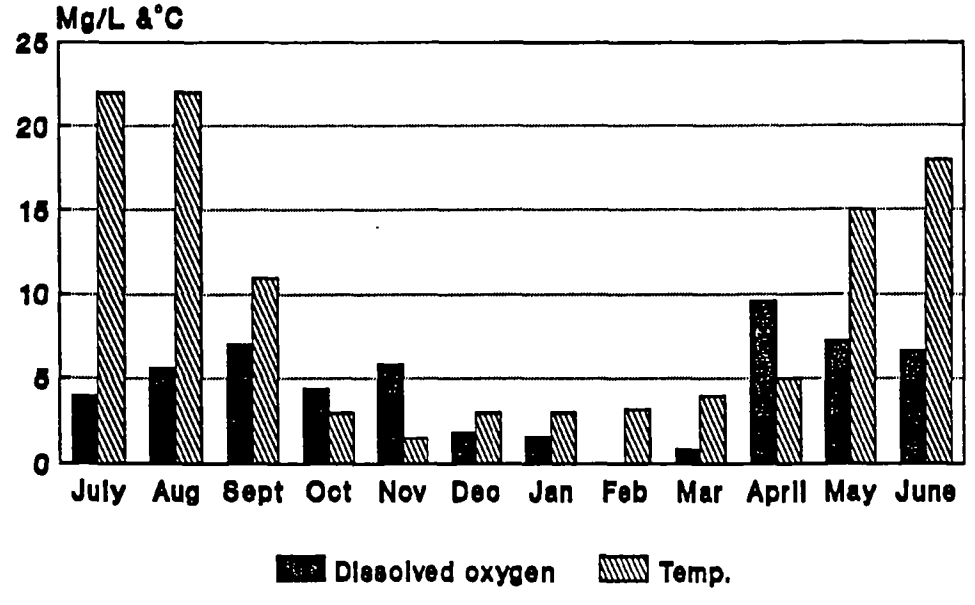
BELCOURT LAKE

Belcourt Lake
Dissolved Oxygen/Temperature



1 meter below surface

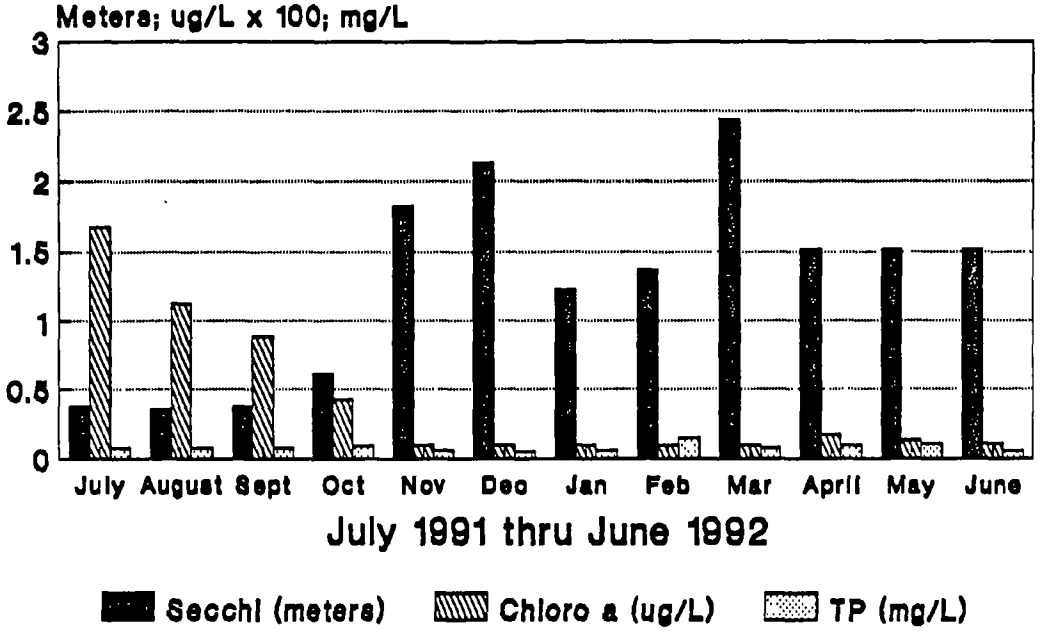
July 1991 thru June 1992
Dissolved oxygen/Temp.



1 meter above bottom

Belcourt Lake

Secchi disk/Chlorophyll a/Total P



July 1991 thru June 1992

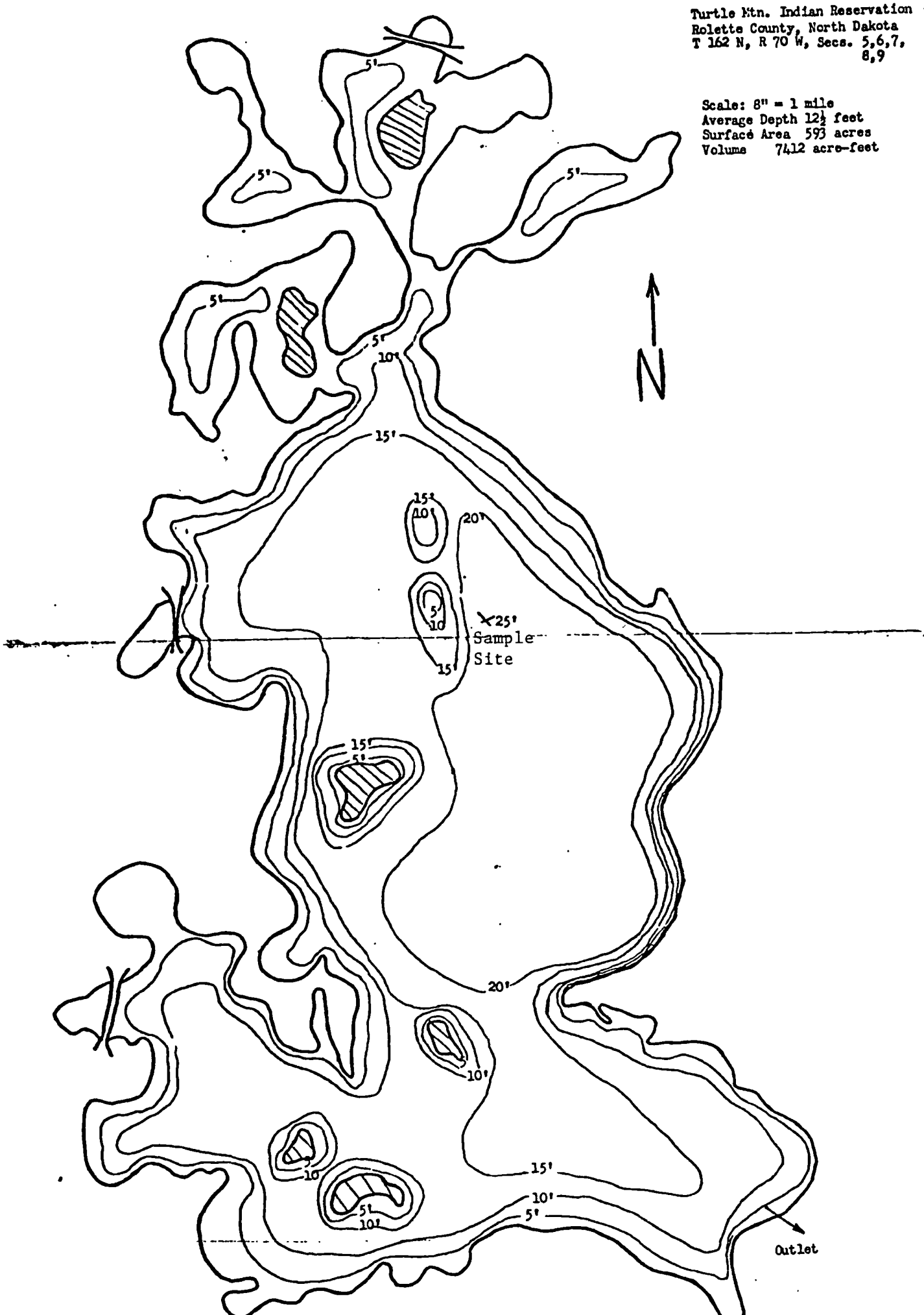
Secchi (meters) Chloro a (ug/L) TP (mg/L)

miles

B E L C O U R T L A K E

Turtle Mtn. Indian Reservation
Rolette County, North Dakota
T 162 N, R 70 W, Secs. 5,6,7, 8,9

Scale: 8" = 1 mile
Average Depth 12½ feet
Surface Area 593 acres
Volume 7412 acre-feet



JARVIS LAKE

County: Rolette
Latitude: 48 deg. 55 min. 30 sec.
Longitude: 99 deg. 46 min.
Area: 260 acres
Volume: 2,860 acre-feet
Origin of Basin: Glacial
Major Inflows/Outlets: none (stagnant)

Township: 163N
Range: 70W
Section(s): 19 & 20
Average Depth: 11 ft.
Watershed/Lake Area:
Thermal Stratification: yes

Lake Uses

1. Fisheries
2. Immerse recreation - swimming, skiing, etc
3. Limited contact recreation
4. Stock watering and wildlife habitat

Estimated Population within 20-mile radius: 20,000
Ownership status: Tribal and Deeded Government
Public interest: varies

Chemical parameters	Samples	Concentration
Secchi disk depth (meters)	12	0.84
Total Phosphorus (ug/L)	4	74.0
Chlorophyll a (ug/L)	4	13.0
Alkalinity (mg CaCo3/L)		
phenolthalien alkalinity (pH 8.3)	11	14.73
total alkalinity (pH 4.5)	12	253.25
pH (top)	12	8.82
(bottom)	12	8.33
Total suspended solids (mg/L)	4	12.75
Dissolved phosphate as P (mg/L)	4	0.029
Nitrate/nitrite nitrogen (mg/L)	4	0.01
Ammonia (mg/L)	4	0.359
Dissolved oxygen (mg/L)		
(top)	12	5.4
(bottom)	12	2.7
Conductivity (umhos/deg. C)		
(top)	12	450/9.2
(bottom)	12	455/8.7
Depth (feet)	12	19.8

TSI Values	Mean: 62.53
Secchi disk	62.5
Total phosphorus	62.45
Chlorophyll a	62.66

Aquatic Plants
Type of vegetation: cattail and bullrush

Watershed Description

Soil Association within watershed:
Kelvin loam - 3 to 9% slopes
Kelvin loam - 9 to 25% slopes
Metigoshe sandy loam - 3 to 9% slopes

Algal Species and Plant Species: N/A

Fisheries

Mainly walleye. Suffered severe winterkill during winter of 1991-92, due to low oxygen levels. Jarvis Lake was restocked in the spring of 1992 with rainbow trout, but due to low water levels and expected low oxygen levels, the lake has a good chance of another winterkill in the winter of 1992-93.

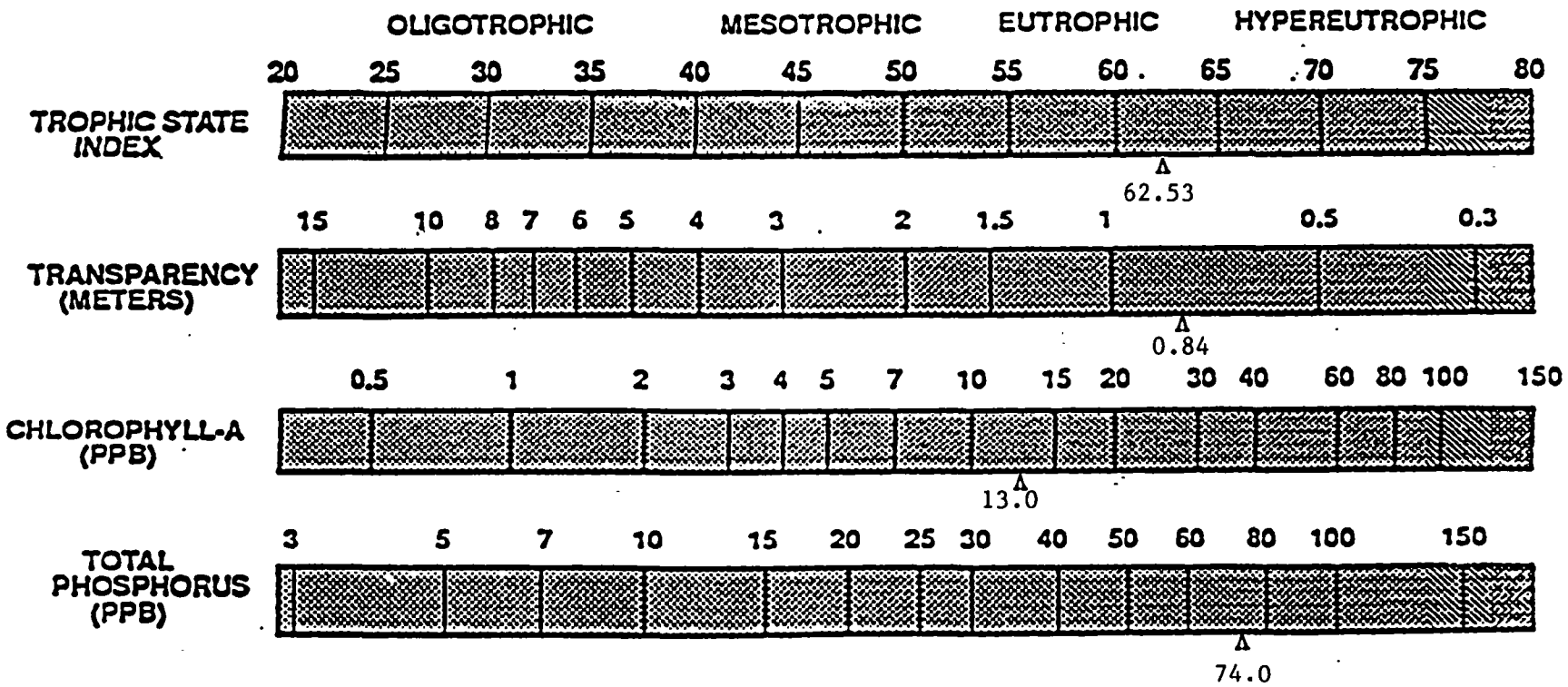
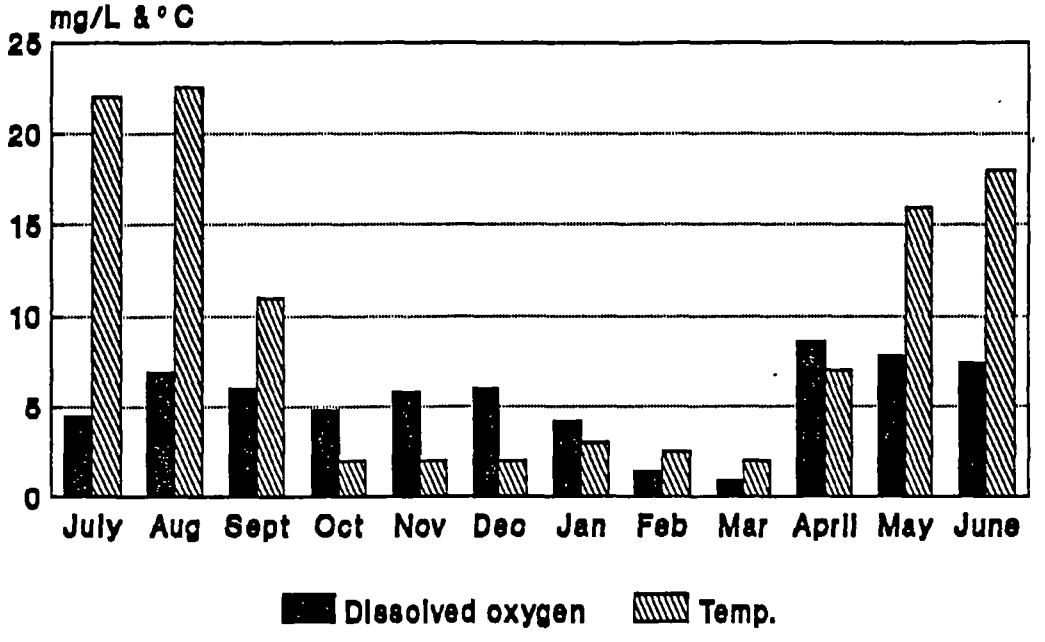


FIGURE 3. CARLSON'S TROPHIC STATE INDEX. Taken from NALMS (1988).

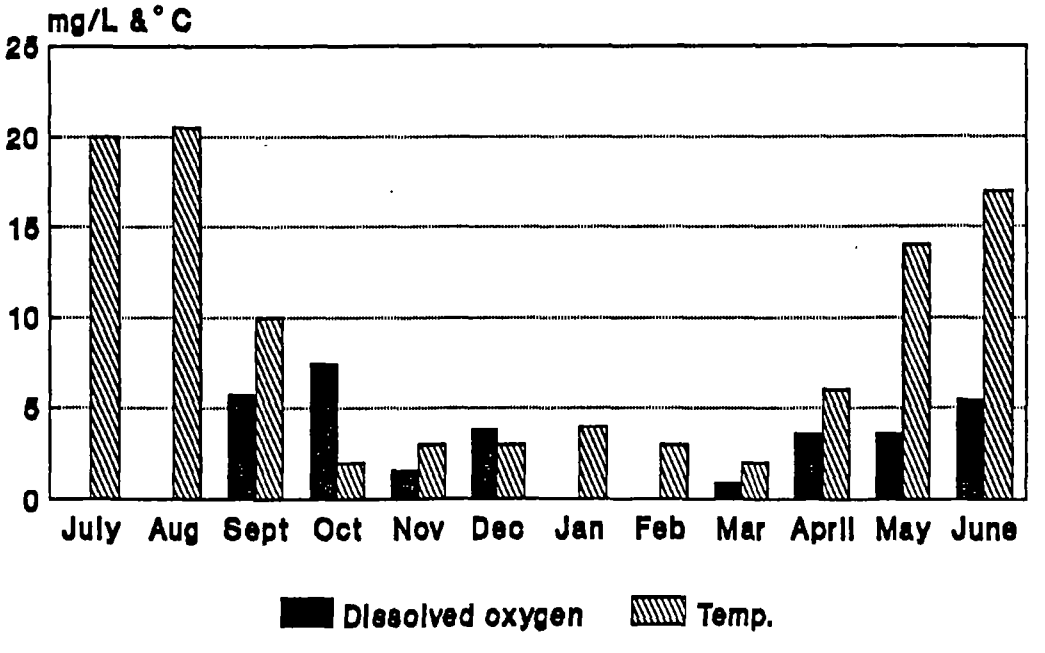
JARVIS LAKE

Jarvis Lake
Dissolved oxygen/Temperature



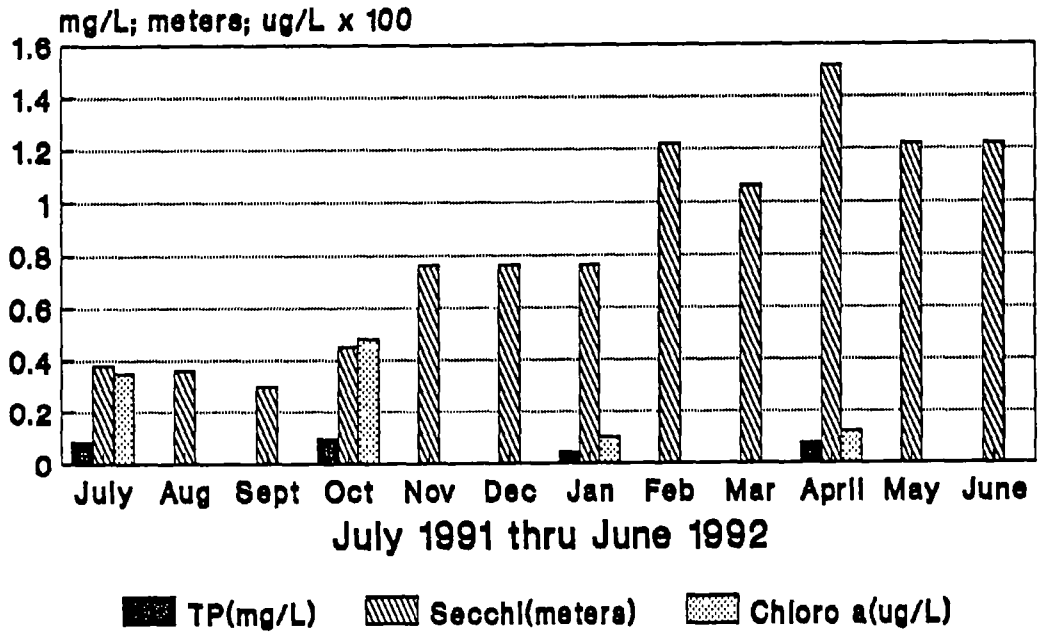
1 meter below surface

July 1991 thru June 1992
Dissolved oxygen/Temp.



1 meter above bottom

Jarvis Lake
Total P/Secchi disk/Chlorophyll a

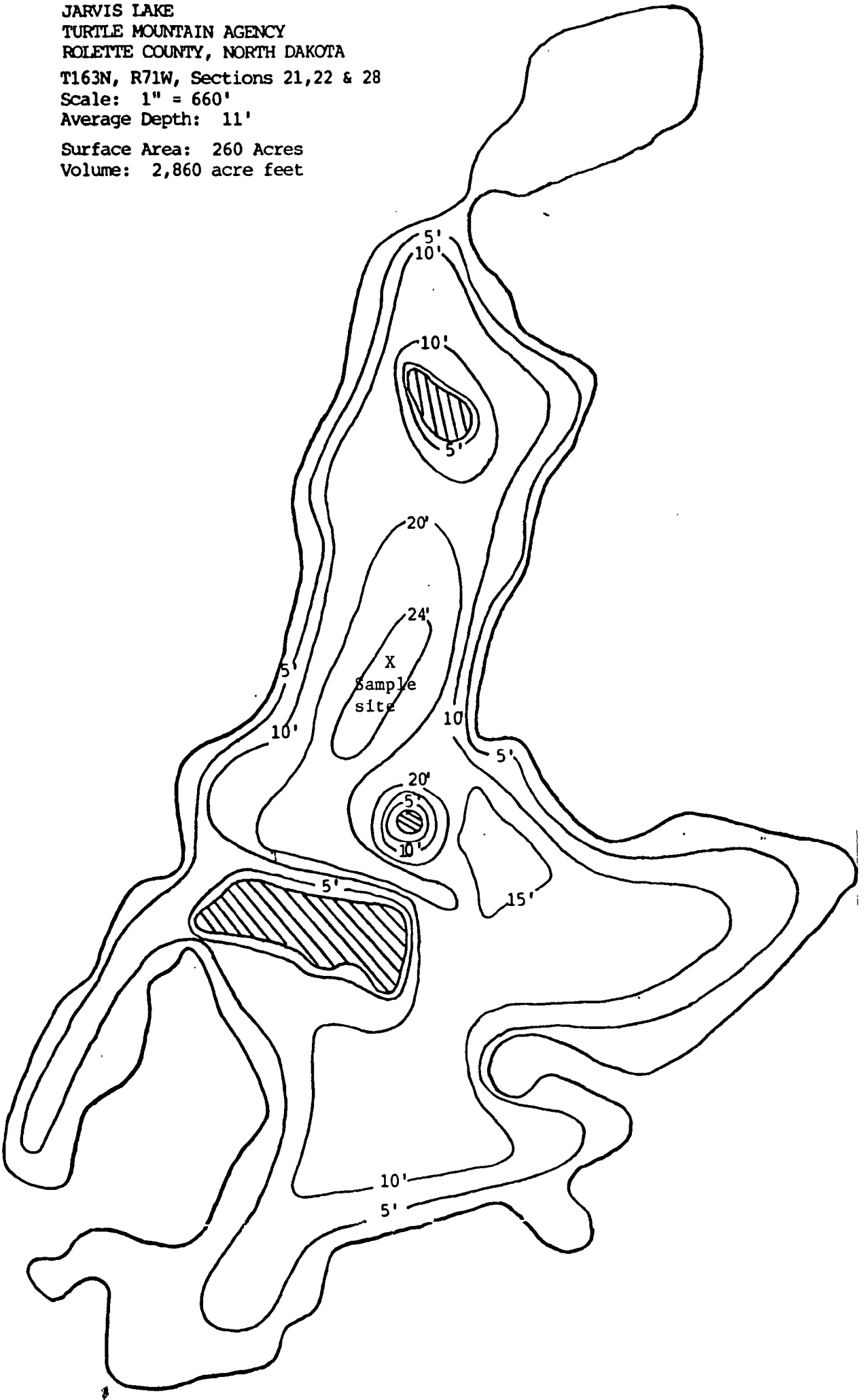


Total P & Cholorophyll quarterly basis

JARVIS LAKE
TURTLE MOUNTAIN AGENCY
ROLETTE COUNTY, NORTH DAKOTA

T163N, R71W, Sections 21,22 & 28
Scale: 1" = 660'
Average Depth: 11'

Surface Area: 260 Acres
Volume: 2,860 acre feet



WHEATON LAKE

County: Rolette
Latitude: 48 deg. 55 min.
Longitude: 99 deg. 47 min. 30 sec.
Area: 56 acres
Volume: 672 acre-feet
Origin of Basin: Glacial
Major Inflows/Outlets: none (stagnant)

Township: 163N
Range: 71W
Section(s): 25 & 30
Average Depth: 12 ft.
Watershed/Lake Area:
Thermal Stratification: yes

Lake Uses

1. Fisheries
2. Immerse recreation - swimming, skiing, etc
3. Limited contact recreation
4. Stock watering and wildlife habitat

Estimated Population within 20-mile radius: 20,000
Ownership status: Tribal
Public interest: varies

Chemical parameters	Samples	Concentration
Secchi disk depth (meters)	12	4.07
Total Phosphorus (ug/L)	4	38.0
Chlorophyll a (ug/L)	4	< 10
Alkalinity (mg CaCo3/L)		
phenolthalien alkalinity (pH 8.3)	11	11.7
total alkalinity (pH 4.5)	12	302.25
pH (top)	12	8.66
(bottom)	12	8.45
Total suspended solids (mg/L)	4	2.75
Dissolved phosphate as P (mg/L)	4	0.022
Nitrate/nitrite nitrogen (mg/L)	4	0.01
Ammonia (mg/L)	4	0.136
Dissolved oxygen (mg/L)		
(top)	12	7.4
(bottom)	12	4.46
Conductivity (umhos/deg. C)		
(top)	12	513/9.2
(bottom)	12	507/8.7
Depth (feet)	12	20

TSI Values	Mean: 49.84
Secchi disk	39.75
Total phosphorus	56.62
Chlorophyll a	53.16

Aquatic Plants
Type of vegetation: cattail and bullrush

Watershed Description

Soil Association within watershed:
Kelvin loam - 3 to 9% slopes
Kelvin loam - 9 to 25% slopes

Algal Species and Plant Species: N/A

Fisheries

Mainly walleye-panfish-northern pike. Wheaton Lake had good oxygen levels throughout the winter of 1991-92, and no problems were encountered from low oxygen levels.

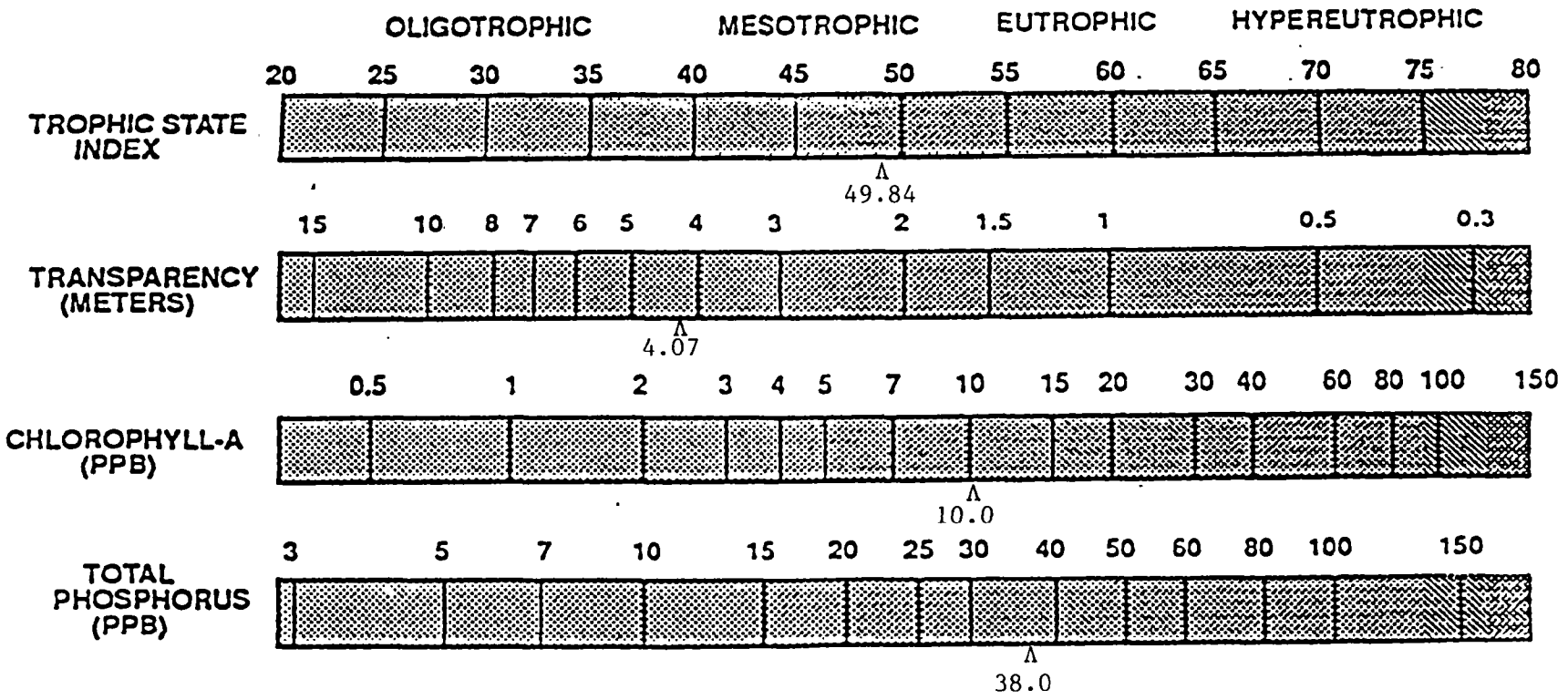
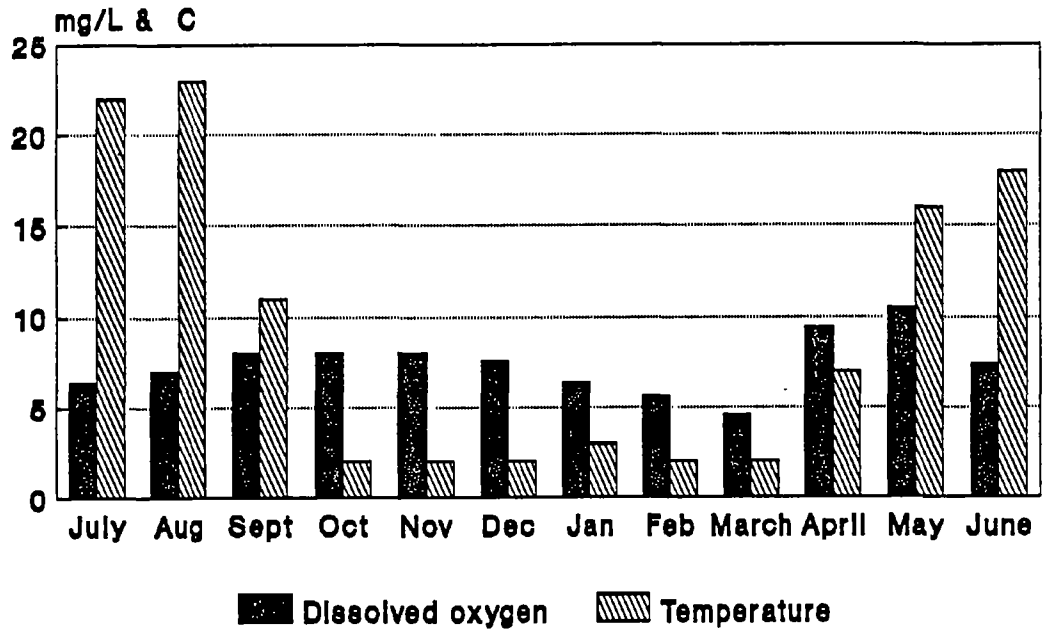


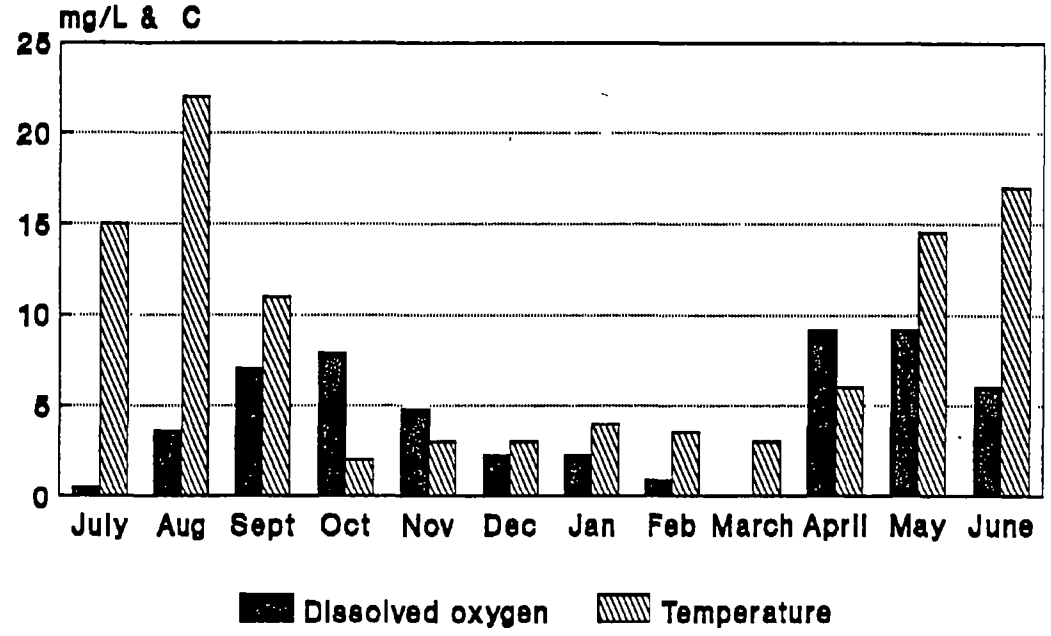
FIGURE 4. CARLSON'S TROPHIC STATE INDEX. Taken from NALMS (1988).
WHEATON LAKE

Wheaton Lake
Dissolved oxygen/Temperature



1 meter below surface

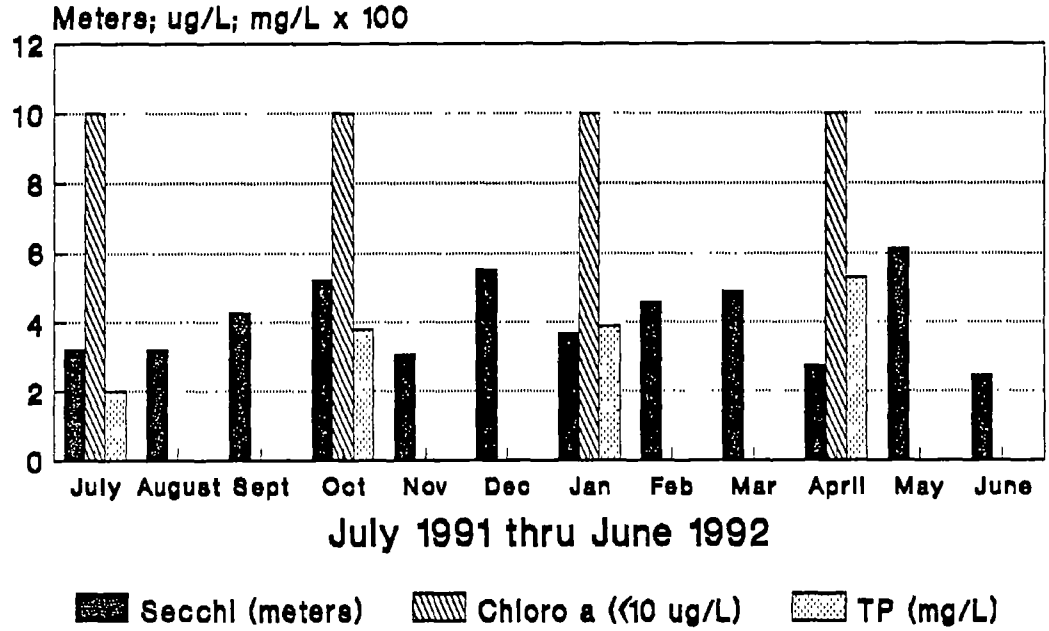
July 1991 thru June 1992
Dissolved oxygen/Temperature

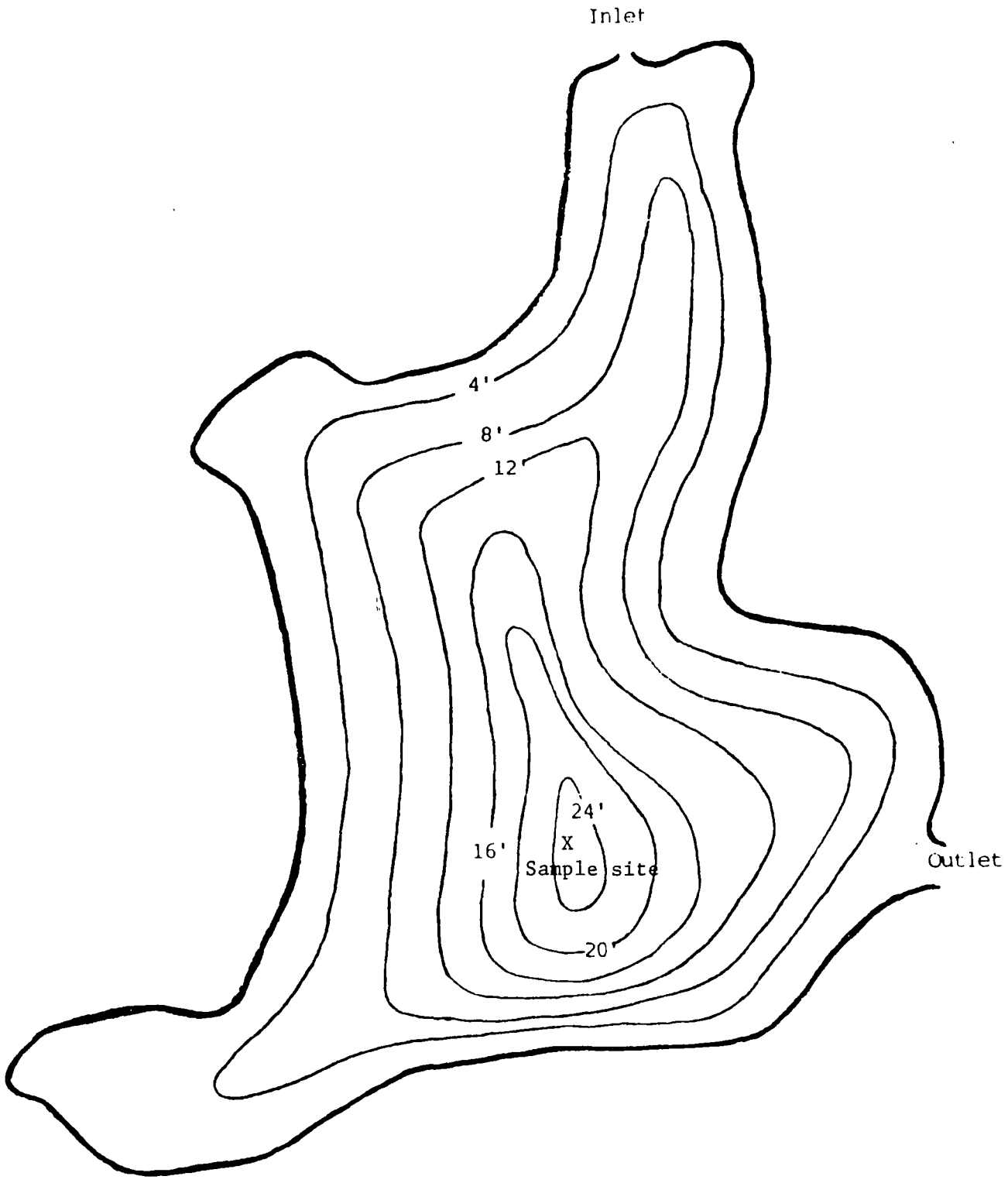


1 meter above bottom

Wheaton Lake

Secchi disk/Chlorophyll a/Total P





WHEATON LAKE
TURTLE MOUNTAIN RESERVATION
ROLETTE COUNTY, NORTH DAKOTA
T163N, R70W, Sections 25 & 30
Scale: 1" = 660'
Average Depth: 12'
Surface Area: 56 Acres
Volume: 672 acre feet

GORDON LAKE

County: Rolette
Latitude: 48 deg. 55 min. 30 sec.
Longitude: 99 deg. 46
Area: 164 acres
Volume: 2,460 acre-feet
Origin of Basin: Glacial
Major Inflows/Outlets: none (stagnant)

Township: 163N
Range: 70W
Section(s): 19 & 30
Average Depth: 15 ft.
Watershed/Lake Area:
Thermal Stratification: yes

Lake Uses

1. Fisheries
2. Immerse recreation - swimming, skiing, etc
3. Limited contact recreation
4. Stock watering and wildlife habitat

Estimated Population within 20-mile radius: 20,000
Ownership status: Tribal
Public interest: varies

Chemical parameters	Samples	Concentration
Secchi disk depth (meters)	12	4.40
Total Phosphorus (ug/L)	4	43.0
Chlorophyll a (ug/L)	4	13
Alkalinity (mg CaCo3/L)		
phenolthalien alkalinity (pH 8.3)	11	9.27
total alkalinity (pH 4.5)	12	233.83
pH (top)	12	8.69
(bottom)	12	8.46
Total suspended solids (mg/L)	4	3.25
Dissolved phosphate as P (mg/L)	4	0.036
Nitrate/nitrite nitrogen (mg/L)	4	.0025
Ammonia (mg/L)	4	0.121
Dissolved oxygen (mg/L)		
(top)	12	7.7
(bottom)	12	5.5
Conductivity (umhos/deg. C)		
(top)	12	347/9.2
(bottom)	12	507/9.2
Depth (feet)	12	24.5

TSI Values	Mean: 50.92
Secchi disk	38.62
Total phosphorus	58.41
Chlorophyll a	55.73

Aquatic Plants
Type of vegetation: cattail and bullrush

Watershed Description

Soil Association within watershed:
Kelvin loam - 3 to 9% slopes
Kelvin loam - 9 to 25% slopes
Metegoshe sandy loam - 3 to 25% slopes
Eramosh peat

Algal Species and Plant Species: N/A

Fisheries

Mainly walleye-panfish-northern pike. Gordon Lake had good oxygen levels throughout the winter of 1991-92, and no problems were encountered due to low oxygen levels.

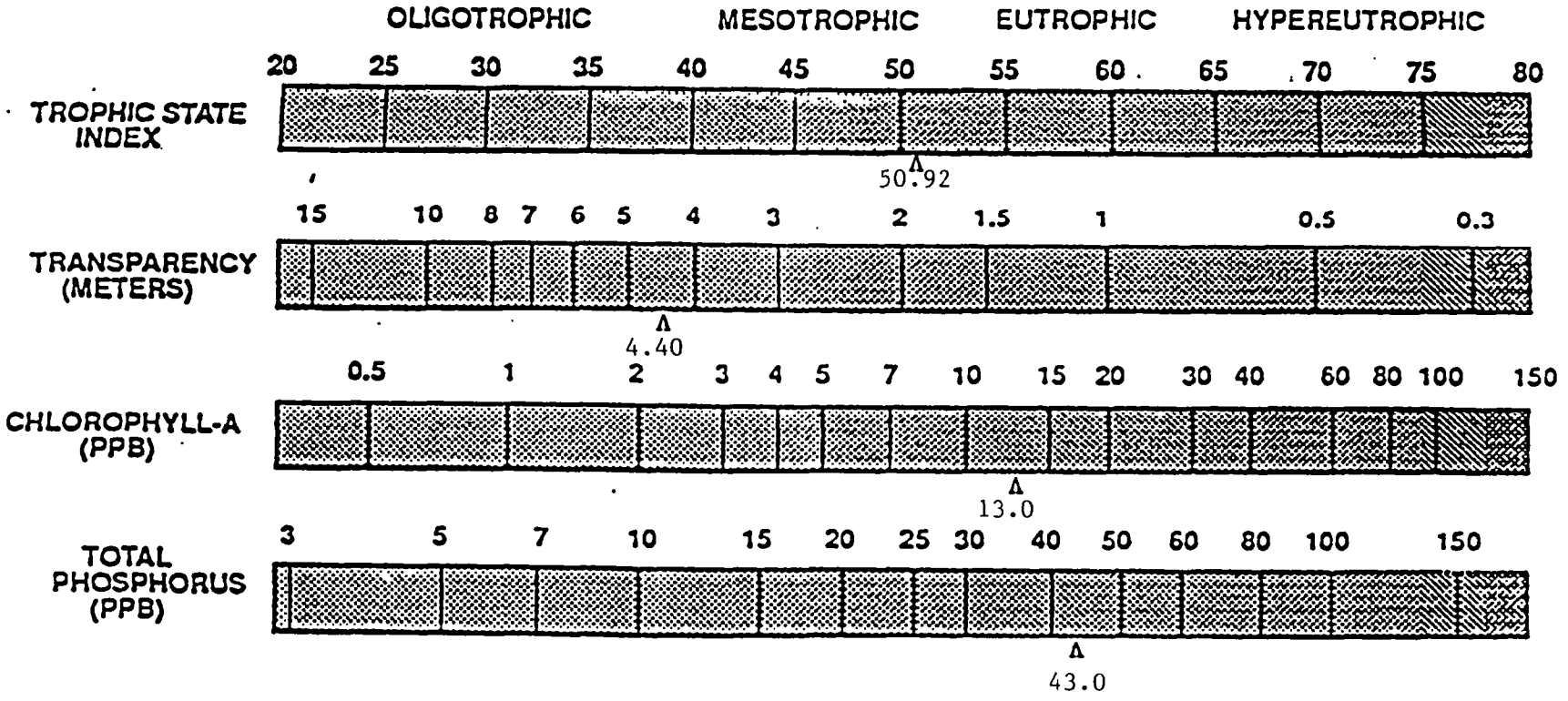
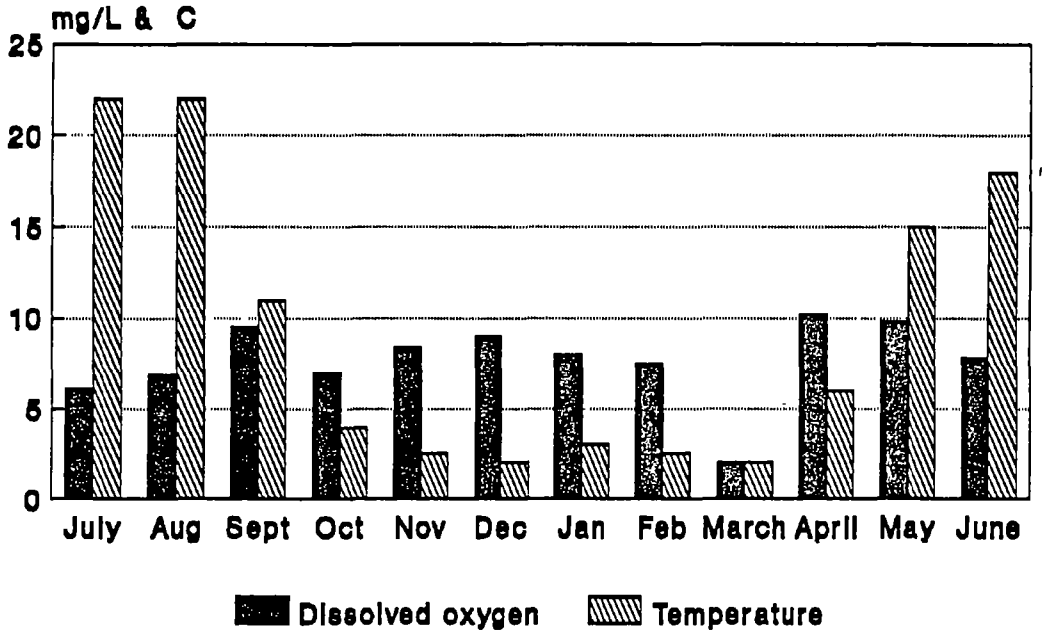


FIGURE 5. CARLSON'S TROPHIC STATE INDEX. Taken from NALMS (1988).

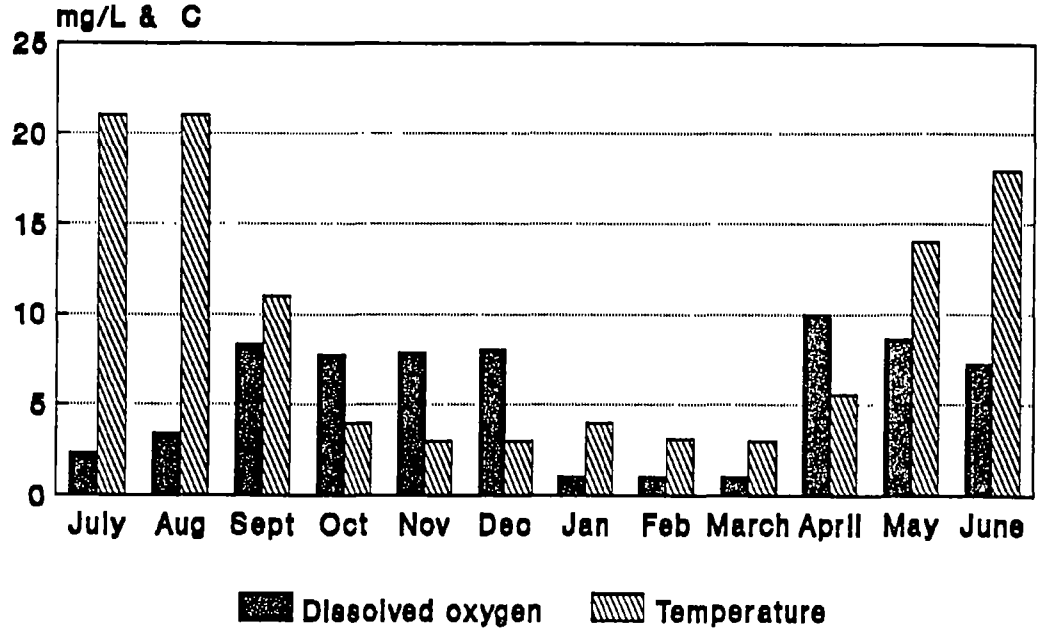
GORDON LAKE

Gordon Lake
Dissolved oxygen/Temperature



1 meter below surface

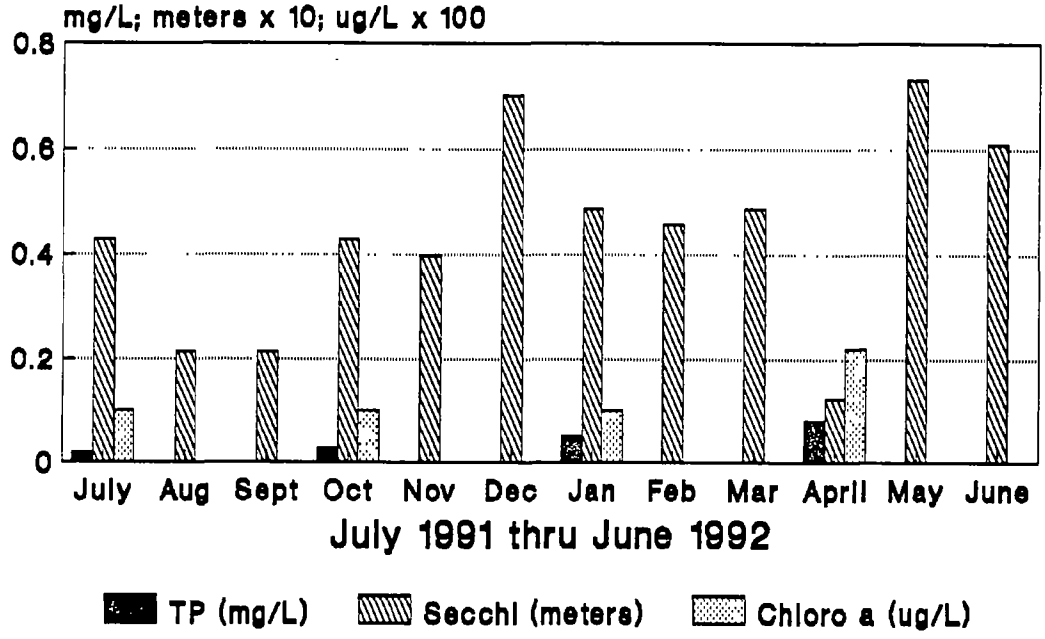
July 1991 thru June 1992
Dissolved oxygen/Temperature



1 meter above bottom

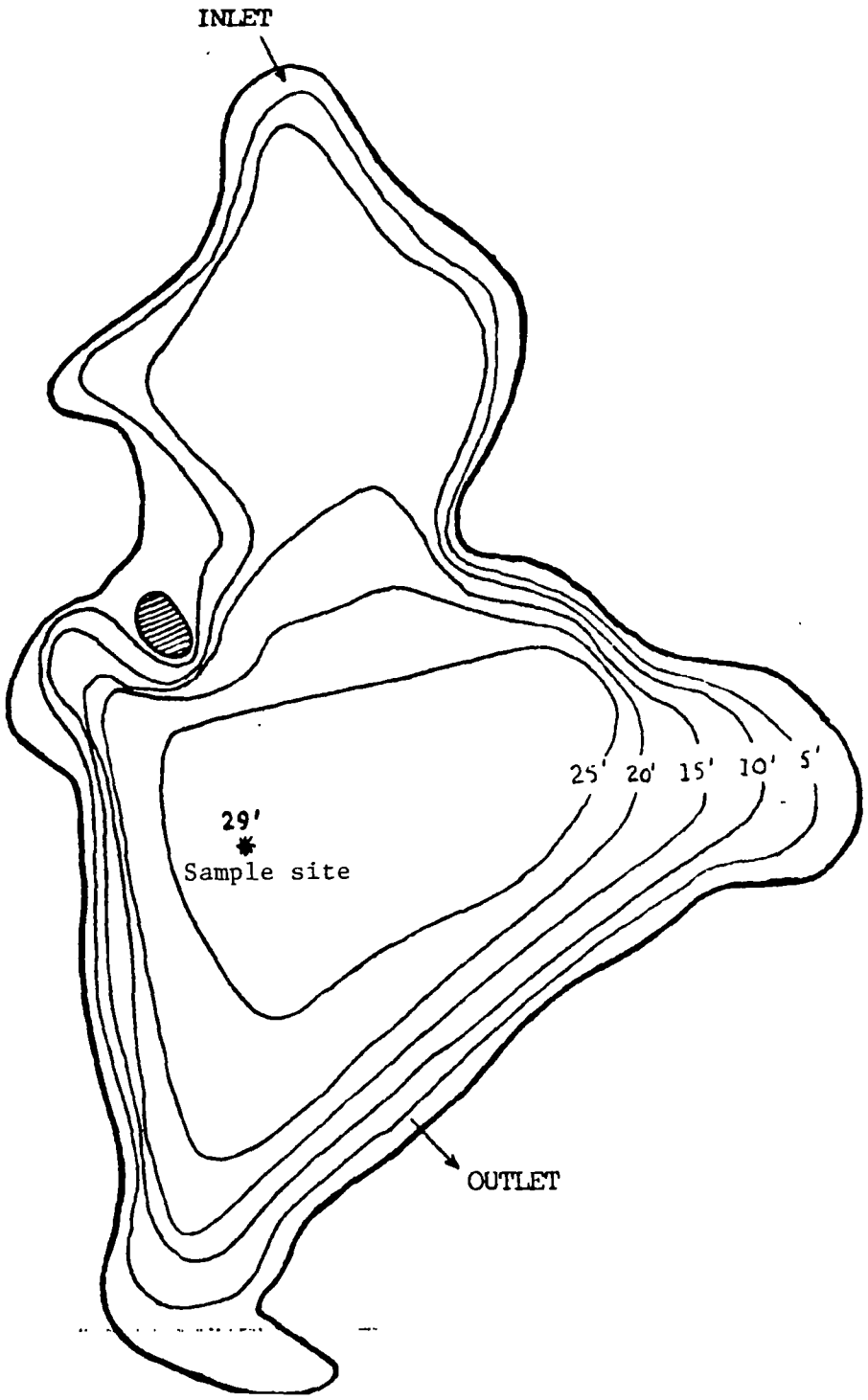
Gordon Lake

Total P/Secchi disk/Chlorophyll a



Total P & Cholorophyll quarterly basis

GORDON LAKE
TURTLE MOUNTAIN RESERVATION
ROLETTE COUNTY , NORTH DAKOTA
T 163N, R70W, Sections 19 & 30
Scale: 1" = 660'
Average Depth: 15'
Surface Area: 164 Acres
Volume: 2,460 acre feet



CONCLUSIONS AND RECOMMENDATIONS

The originator of the Carlson Trophic Index, Robert E. Carlson, makes an emphasis that the number that is generated by this process (Carlson Trophic Index) is only an index of the trophic status of a lake and does not define trophic status. Total phosporus and chorophyll are considered only as indicators of a more broadly defined concept and not as a basis of a definition of trophic status. The best trophic status indicators vary from lake to lake and also from season to season, so the indicators should be chosen with certain discretion. Carlson also suggests that chlorophyll-a values are best for estimating algal biomass, especially if the values are corrected for phoephytin and should be given priority for its TSI value.

The Carlson Trophic Index is numerical rather than nomenclatural, which allows for a large number of individual lake classes rather than three to five distinct ones. A trophic state index is not the same as a water quality index and quality is best kept seperate from the concept of trophic status. One of the major problems with existing terminology is that eutrophic is often associated with poor water quality. Water quality, whether excellent or poor, depends on the use of that water and the attitudes of the people that make use of that water (Carlson, 1977).

Belcourt Lake, which was emphasized in this assessment, with an index of 62.61 on the Carlson Trophic Index indicates that it has moderately eutrophic conditions. Because of these conditions Belcourt Lake would be a prime candidate for a Phase I study, which would pin point what are underlying causes for these conditions.

Because of overwhelming numbers of bullhead fish, the idea of killing the Belcourt Lake is currently being considered by the Bureau of Indian Affairs (who is currently responsible for the management of the lakes), but if more studies of the lake are to be conducted, killing the lake would not be recommended at this point in time (Rathke, 1991). But, if available funds for further studies on Belcourt Lake are not available, it may be the best management practice to go ahead and kill the lake to prevent the populations of bullheads from increasing and deteriorating conditions even further.

A comparison of the data that was collected from Belcourt Lake on June 6, 1985 and on June 24, 1991 indicates that of the twenty-one parameters measured, there were increases in fourteen of those parameters (see Appendix 1), this could be seen as an obvious deteriorating condition. On the other hand, seven of those parameters actually decreased. This would demonstrate the need for a further and more thorough study of this lake.

The second worst lake in the assessment on the Carlson Trophic Index is Jarvis Lake with a index of 62.53, with all three of the values in the Trophic Status Index (TSI) very similar in values, with the secchi disk value at 62.5, total phoshorus at 62.45, and the chlorophyll value at 62.66. Due to the fact that it is unusual for all three of the values to be the same, it should be a very accurate representation of the lakes true conditions. Jarvis Lake would also be a candidate for further studies in a Phase I monitoring study. One of the main problems with the lake seems to be the livestock that is currently being reared directly next to the shoreline of the lake. This lake also suffered a major winterkill in the winter of 1991-92, due to oxygen levels depleted. Jarvis Lake was restocked in the spring of 1992 with 20,000 rainbow trout and 20,000 walleye. Unless better aeration systems are put into place in Jarvis Lake (for which there may be lack of funds) and more control over the watershed to eliminate the cattle feedlots, it would seem to be useless to stick any more money or time into this lake.

The last two lakes in the assessment - Gordon and Wheaton Lake - have similar TSI values, with Gordon Lake at a value of 50.92 and Wheaton Lake at a value of 49.84. Perhaps the two lakes are so similar because they both have relatively little development on the shoreline and also have little or no livestock feedlots near the lakes. Another reason the lakes may have such similar TSI values is the fact that the two lakes are located very close to each other (a couple hundred yards seperate the two shorelines) and quite possibly may have been connected together at one point in time. Although the total phosphorus and chlorophyll values for both of the lakes indicate mild euthrophic conditions for both of these two lakes, the secchi disk value indicates that these lakes are relatively clean, with the secchi disk visible nearly all the way to the bottom of the lake in the spring, fall, and winter, making these two lakes the cleanest lakes in the assessment by far. It is very important that measures be taken to prevent any further deterioration of these lakes so that they may provide recreaton for future generations.

It is of the utmost importance that people, especially Native Americans, take the lead to preserve and protect all natural resources - particularily water. Our creator does not want us to destroy our natural resources, for if we destroy these invaluable and irreplacable assets, we will be destroying ourselves.

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3. Minnesota Pollution Control Agency. 1990. Minnesota Lake Water Quality Assessment Report. 2nd Edition. 95 pages.

4. Rathke, David. 1991. U.S. Environmental Protection Agency, Region VIII. Personal Communication.

5. U.S. Environmental Protection Agency. 1980. Clean Lakes Program Guidance Manual. 103 pages.

APPENDIX I

LAKE WATER QUALITY ASSESSMENT DATA COMPARISON
1985 (Belcourt Lake only) - 1991 (Belcourt, Jarvis, Gordon, & Wheaton Lakes)

	Sampling Date		
BELCOURT LAKE	6/6/1985	6/24/1991	
Parameter	Result		Unit
Total Alkalinity (CaCO3)	209.	243.	mg/l
Ammonia (N)	0.112	0.00	mg/l
Bicarbonate (HCO3)	241.	230.	mg/l
Carbonate (CO3)	7.	33.	mg/l
Chloride	3.5	6.4	mg/l
Total Hardness (as CaCO3)	296.	271.	mg/l
pH	8.5	9.06	
Percent Sodium	3.2	6.3	%
Total Dissolved Solids (C)	283.	303.	mg/l
Total Phosphate as (P)	0.041	0.084	mg/l
Sodium Adsorption Ratio	0.12	0.22	
Conductivity	465.	592.	umhos/cm
Total Kjeldahl Nitrogen	1.56	2.28	mg/l
Nitrate as (N)	0.019	0.010	mg/l
Calcium (Ca)	38.6	26.7	mg/l
Iron (Fe)	0.046	0.027	mg/l
Magnesium (Mg)	48.6	49.6	mg/l
Manganese (Mn)	0.028	0.106	mg/l
Potassium (K)	3.50	11.9	mg/l
Sodium (Na)	4.60	8.4	mg/l
Sulfur as Sulfate (SO4)	59.	54.	mg/l

APPENDIX I

T.M.L.W.Q.A. Data (con't.)

Sampling date: 6/24/1991

Parameter	LAKE JARVIS	GORDON	WHEATON	Unit
Conductivity	657.0	522.0	762.0	umhos/cm
Total Dissolved Solids	361.	262.	393.	mg/l
Total Hardness (as CaCO3)	340.	247.	347.	mg/l
Total Alkalinity	247.	225.	312.	mg/l
pH	9.18	9.14	9.06	
Iron (Fe)	0.016	0.006	0.007	mg/l
Manganese (Mn)	0.067	0.014	0.022	mg/l
Calcium (Ca)	25.1	24.7	28.6	mg/l
Magnesium (Mg)	67.4	44.9	66.9	mg/l
Sodium (Na)	9.9	7.6	10.5	mg/l
Potassium (K)	18.5	10.5	13.6	mg/l
Carbonate (CO3)	42.	36.	47.	mg/l
Bicarbonate (HCO3)	216.	202.	285.	mg/l
Sulfate as (SO4)	86.	35.	82.	mg/l
Chloride	6.0	3.9	3.8	mg/l
Ammonia (N)	0.082	0.009	0.019	mg/l
Hydroxide (OH)	0.	0.	0.	mg/l
Phosphate (Total) (P)	0.068	0.016	0.027	mg/l
Nitrate + Nitrite (N) Total	0.008	0.016	0.017	mg/l
Total Kjeldahl Nitrogen	3.01	1.52	2.02	mg/l
Hardness (Total)	20.	14.	20.	gr/gal
Percent Sodium	5.9	6.3	6.2	%
Sodium Adsorption Ratio	0.23	0.21	0.25	

NOTE: One sample taken for comparison purposes at a later date.