IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

LAKE MANAGEMENT PLAN
LOWER RED LAKE
SHAWANO COUNTY, WISCONSIN

1991

REPORT TO:
RED LAKES ASSOCIATION

May, 1992

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GLOSSARY OF TERMS
(Continued)

Physicochemical Pertaining to physical and/or chemical characteristics.

Residence Time Commonly called the hydraulic residence time. The amount of time required to completely replace the lake's current volume of water with an equal volume of "new" water.

Secchi Depth A measure of optical water clarity as determined by lowering a weighted Secchi disk (20 cm in diameter) into the water body to a point where it is no longer visible.

Stratification Layering of water caused by differences in water density. Thermal stratification is typical of most deep lakes during the Summer. Chemical stratification can also occur.

SUMMARY

Lower Red Lake, Shawano County, Wisconsin, is an **impoundment**[1] of the Red River created by construction of a dam in 1965. Its location, immediately downstream from Upper Red Lake (impoundment created in 1880), makes Lower Red Lake a rather unique impoundment in that parent river inflow is "sediment poor". A primarily forested watershed also contributes to relatively low sediment and nutrient input to the system as a whole.

Lower Red Lake water quality is presently good with respect to all parameters measured but appears to be affected by periodic nutrient "pulses". Upper and Lower Red Lakes, despite similar watersheds, chemical water quality and basin morphometry, support dense but taxonomically different **macrophyte** populations. Differences are probably related to impoundment age (successional implications) or location (associated substrate or physical water quality differences) and should be investigated further before intensive macrophyte management or habitat manipulation is initiated.

Long term management should emphasize water quality maintenance/enhancement and macrophyte management to improve accessibility and fishery potential.

Specific near-term recommendations include:

- Identification of non-point sources and implementation of preventative riparian land use practices to retard localized sediment or nutrient inflows
- Continued study of macrophytes with emphasis on substrate and habitat relations in areas of highest concern
- Localized application of macrophyte harvest alternatives to create access lanes and **"edge"** effect
- Follow-up evaluation of macrophyte control techniques to determine the most cost effective and temporally efficient methods available for long-term application

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

INTRODUCTION

Lower Red Lake is located in the Towns of Red Springs and Herman in central Shawano County, Wisconsin, and is the fourth largest lake (240 acres) in the county. Lower Red Lake is an impoundment, formed in 1965 by construction of a hydroelectric dam on the Red River in the Village of Gresham.

The Red Lakes Association (RLA) was formed in 1990 to provide leadership and coordination of lake preservation and educational activities pertinent to Upper and Lower Red Lakes. Overall objectives of the RLA, and their major concerns in development of a lake management plan included investigation of recent excessive weed growth, recovery of property resale values, restoration of the natural beauty of the lake, and continued production of relatively inexpensive hydroelectric power. Currently, the RLA has over 100 members with a five member elected Board of Directors.

The RLA formed an advisory committee in February, 1990 to determine the actions that would be necessary to protect the lake and, further, to pursue the development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. Since the RLA was not yet in existence for one year (as required) at the time of grant application, the Village of Gresham agreed to be the grant applicant. The RLA Board of Directors selected IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin as its consultant to develop the plan. A grant application, incorporating required or recommended program components and the following general objectives, was prepared, submitted, and approved in the Fall of 1990:

- establishment of a monitoring study designed to track long-term trends,
- acquisition of existing historic data and analysis, along with current data, to assess the current status of the resource,
- identification of aquatic macrophyte control techniques appropriate to Lower Red Lake, and
- identification of property owner activities to help maintain or enhance the quality of the lake.

A Planning Advisory Committee, comprised of representatives from RLA, IPS, Shawano County Board, WDNR, University of Wisconsin-Extension, the Towns of Herman and Red River, and the Village of Gresham, was formed and met initially in September, 1990 to provide program guidance and direction.

DESCRIPTION OF AREA

Lower Red Lake (T27N R14E S2,3; T28N R14E S35) is an impoundment of the Red River located in the Village of Gresham, Shawano County, Wisconsin (Figure 1). The general topography of Shawano County is related to glacial activity. The Lower Red Lake watershed is predominantly that of Upper Red Lake and is primarily forested. The Lower Red Lake watershed also includes the Miller Creek basin which is also primarily forested. Topography adjacent to Lower Red Lake is level to sloping. The major soil types in the area are well drained Menahga loamy sands on flats and 0-12 percent convex slopes, excessively drained Cromwell sandy loams on 1 to 6 percent slopes and well drained Tilleda fine sandy loams on 1 to 12 percent slopes (4). Soil permeability is rapid in Menahga soils and moderate in Cromwell and Tilleda soils. There is potential of septic runoff or infiltration to groundwater or surface waters because these soils may not adequately filter the septate.

Lower Red Lake has a surface area of 240 acres, an average depth of about 6 feet, and a maximum depth of 26 feet. The **fetch** is 0.9 miles and lies in a northwest-southeast orientation and the width is 0.5 miles in a southwest-northeast orientation. Lake volume is about 1,440 acre feet with a **residence time** of about 4.8 days compared to 3.6 days for Upper Red Lake (5).

Lower Red Lake was created by the construction of a dam on the Red River in 1965. The dam, currently operated by the Village of Gresham, is 105 feet long with a 25 foot head and a 64 foot spillway. The plant which currently has a capacity of 470 kilowatts at 145-160 cubic feet per second (cfs) was granted a 50 year license in 1965 (6). The license requires a minimum flow to the spillway section of at least 7 cfs to protect fish and wildlife resources.

The **immediately adjacent watershed** is about 780 acres and is mostly agricultural (69%) with forested (16%), wooded residential (9%) and commercial (6%) areas. Woodlands are comprised mainly of hardwood forests (maples and oaks) with areas of pine plantations (7).

The water is colored and appears dark brown to red at times. Predominant **littoral** substrates include sand, gravel and silt with some areas of rubble and bedrock outcrop. Recently, concern has been expressed about the excessive aquatic macrophyte growth.

Lower Red Lake supports a moderate sport fishery for largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), smallmouth bass (Micropterus dolomieui), yellow perch (Perca flavescens), bluegill (Lepomis macrochirus), black crappie (Pomoxis nigromaculatus), pumpkinseed (Lepomis gibbosus) and black bullhead (Ictalurus melas). Numerous attempts[1] have been made to stock walleye (Stizostedion vitreum) in Lower Red Lake; tag return and fish survey data indicate these attempts have been unsuccessful. Muskellunge (Esox masquinongy) have been stocked in Upper Red Lake (Personal comm. WDNR) and a size limit of 40 inches is currently in effect for Upper and Lower Red Lakes.

Two points of public access are located on the lake, one near the Miller Creek inlet off Geider Road and the other off Highway G in the village park. Parking facilities and a public fishing pier are available at the village park access.

Migrating waterfowl including mallards, blue-winged teal and wood ducks and mammals including muskrat, mink, weasel, striped skunk, raccoon, red fox, gray squirrel, cottontail rabbit and white-tailed deer are known to use the area (7). Nesting bald eagles have also been spotted during the summer months.

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[1] 1 million fry - 1968
10,000 fingerlings - 1975
100 Rush Lake adults - 1978
5,000 fingerlings - 1978
163 Fox River (De Pere) adults - 1978

METHODS

FIELD PROGRAM

Water sampling in 1991 was conducted in Winter (March 7), late Spring (June 6), mid-Summer (July 29) and late Summer (August 26) at one or two sites (Table 1, Figure 2). Station 0201 (mid-lake) and 0202 (near dam, deepest point) were sampled near surface (designated "S") and near bottom (designated "B").

Two event sites (02E1, 02E2) were established at the mouth of two streams tributary to Lower Red Lake to yield information on nutrient input to the lake. One (02E1), was located where a small intermittent stream enters the lake near the hydroelectric powerhouse and the other (02E2) was located in Miller Creek. These sites were designated to be sampled after major rain events (greater than 1" in a 24 hour period) to evaluate nutrient input at times of increased overland flow. One event sample was collected at each of these points (October 24).

Physicochemical parameters measured in the field were **Secchi depth**, water temperature, pH, dissolved oxygen (DO), and conductivity. Field measurements were taken using a standard Secchi disk and either a Hydrolab Surveyor II or 4041 multiparameter meter; Hydrolab units were calibrated prior to and

Table 1. Sampling Station Locations, Lower Red Lake, 1991.

WATER QUALITY

Site	Latitude/Longitude		Depth
0201	44° 51.08'	88° 46.39'	11.0 ft.
0202	44° 50.50'	88° 45.53'	28.0 ft.

MACROPHYTE TRANSECTS

Transect	Latitude/Longitude Origin	End	Transect Length (m)	Bearing (Degrees)	Depth Range[1]
A	44° 51.17' 88° 47.07'	NR[2]	6	165	1/2/3
B	44° 50.53' 88° 45.95'	44° 50.61' 88° 46.02'	43	352	1/2/3
C	44° 50.80' 88° 46.21'	44° 50.86' 88° 46.21'	61	26	1/2/3
D	44° 51.28' 88° 46.31'	44° 51.22' 88° 46.45'	61	98	1/2/3
E	44° 51.12' 88° 46.89'	NR	12	218	1/2/3

[1] 1 = 0.0 - 0.5m (0.0 - 1.7ft)
2 = 0.5 - 1.5m (1.7 - 5.0ft)
3 = 1.5 - 3.0m (5.0 - 10.0ft)

[2] No reading

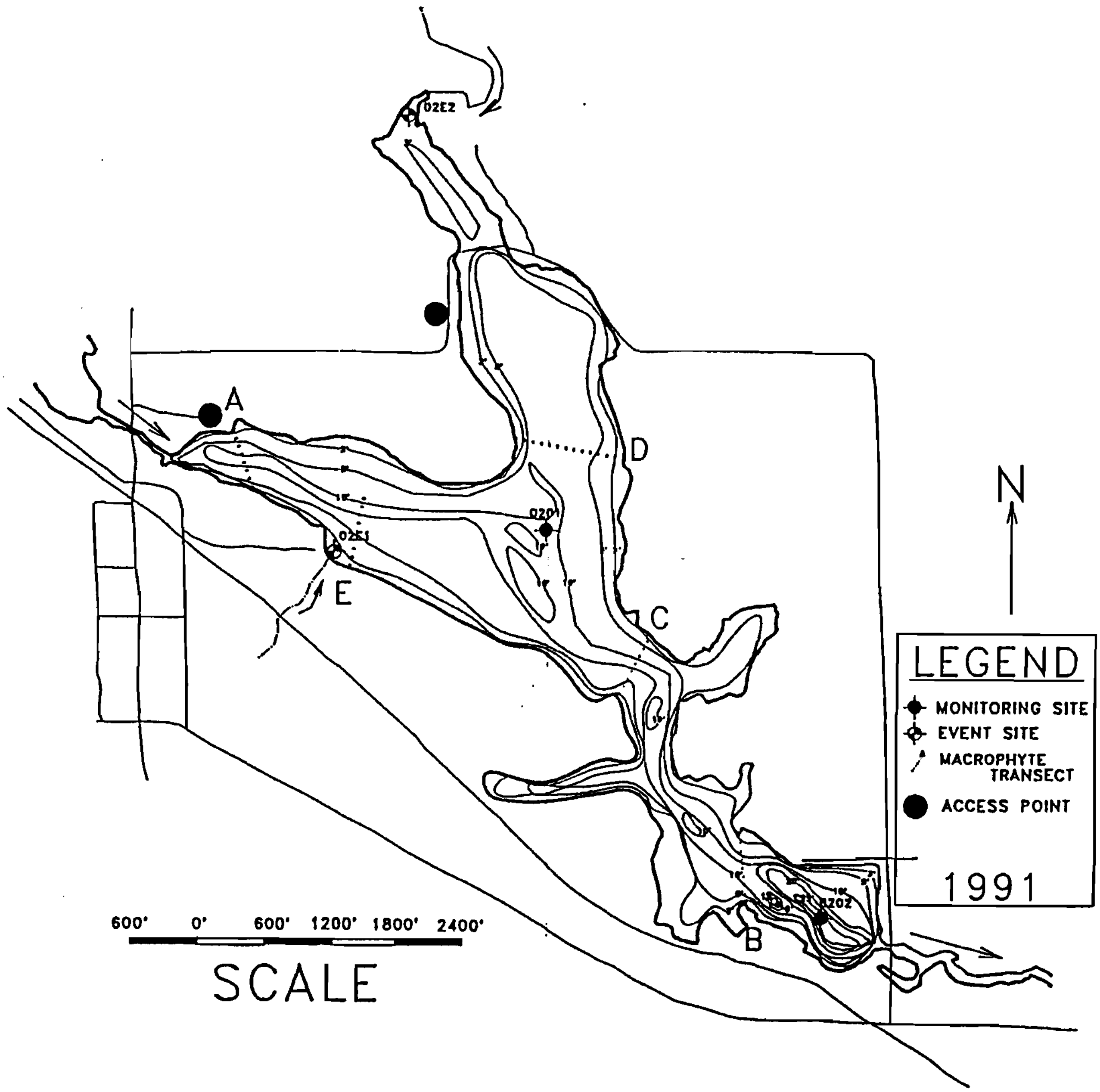

Figure 2. Sampling Sites, Lower Red Lake, Shawano County, Wisconsin, 1991.

subsequent to daily use.

Samples were taken for laboratory analyses with a Kemmerer water bottle. Samples were labelled, preserved if necessary, and packed on ice in the field; samples were delivered by overnight carrier to the laboratory. All laboratory analyses were conducted at the State Laboratory of Hygiene (Madison, WI) using WDNR or APHA (8) methods. Winter water quality parameters determined in the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus. Spring parameters included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus, suspended solids and volatile suspended solids and **chlorophyll a**. Summer and late Summer laboratory analyses included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus, dissolved phosphorus, and chlorophyll a.

Macrophyte surveys were conducted in early Summer (July 29) and again later in the season (August 28) using a method developed by Sorge et al and modified by the WDNR-Lake Michigan District (WDNR-LMD) for use in the Long Term Trend Lake Monitoring Program (9). Transect endpoints were established on and off shore for use as reference from one sampling period to the next. These points were determined using a Loran Voyager Sportnav latitude/longitude locator and recorded with bearing and distance of the transect (line of collection) for future surveys. Five transects were chosen and sampled in 1991 to provide information from various habitats and areas of interest.

Data were recorded from three depth ranges, i.e., 0 to 0.5 meters (1.7 feet), 0.5 to 1.5 meters (5.0 feet), and 1.5 to 3.0 meters (10.0 feet), as appropriate along each transect. Plants were identified (collected for verification as appropriate), density ratings assigned (see below), and substrate type recorded along a six foot wide path on the transect using a garden rake, snorkel gear or SCUBA where necessary. Macrophyte density ratings, assigned by species, were: 1 = Rare, 2 = Occasional, 3 = Common, 4 = Very Common, and 5 = Abundant. These ratings were treated as numeric data points for the purpose of simple descriptive statistics in the field data discussion section of this report.

OTHER PHYSICOCHEMICAL CHARACTERISTICS

Water Quality Information

Additional lake information was retrieved from the WDNR Surface Water Inventory (10), the 1965 and 1986 dam licensing reports (6, 7) and from the WDNR Wisconsin Lakes publication (5).

Land Use Information

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

Ordinance information was taken from Shawano County Zoning Ordinance, Shawano County Floodplain Zoning Ordinance, and Shawano County Erosion Control and Animal Waste Management Plans which were acquired from the Shawano County Land Conservation Department.

Public Involvement Program

A summary of the public involvement activities coordinated with the lake management planning process is outlined in Appendix I.

FIELD DATA DISCUSSION

Impoundments characteristically have large watershed to lake ratios. Lower Red Lake has a ratio over 200:1 which means that 200 times more land than lake surface area drains to Lower Red Lake. Land use can directly affect water quality and this large number would typically indicate a high potential of non-point source impacts on the system. The potential for nutrient input appears to be relatively minor in Lower Red Lake due to the primarily forested Red River watershed. The potential for sedimentation from the upstream basin is negligible due to depositional conditions immediately upstream (in Upper Red Lake) and the forested nature of the Upper Red River upstream watershed. Four major land uses in the immediately adjacent Lower Red Lake watershed are, agricultural (69%), wooded (16%), residential (9%) and commercial (6%) (Figure 3).

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. Surface total phosphorus during 1991 monitoring ranged from .017 to .050 mg/l (parts per million) with a mean value of .031 mg/l (Tables 2-3). Total phosphorus at Station 0201 (mid-lake) was very similar to that observed immediately upstream from the Upper Red Lake dam (Station 0101) (Table 4). During past (1975-1977) monitoring, in-lake surface total phosphorus data ranged from .01 to .110 mg/l with a mean

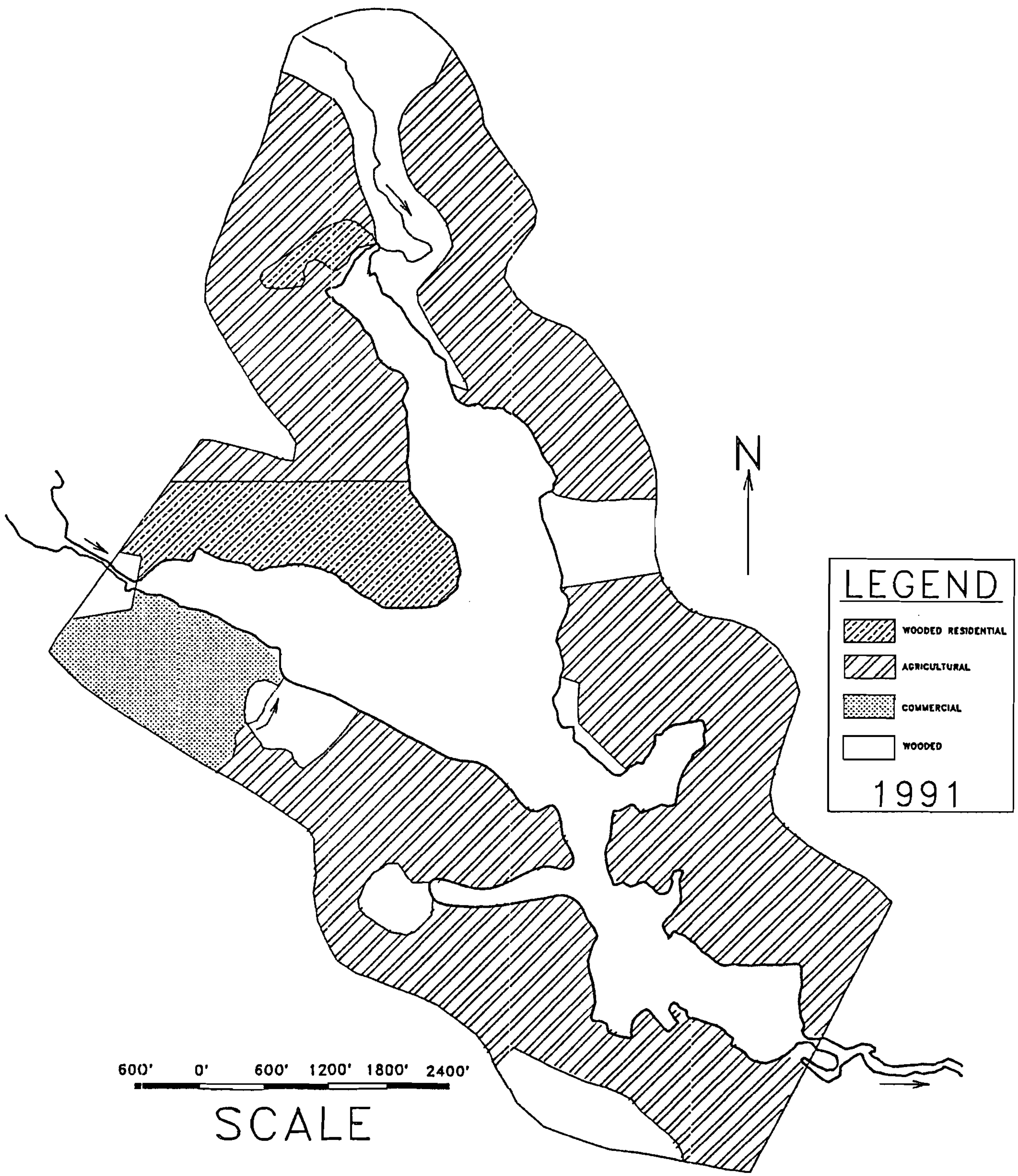

Figure 3. Land Uses in the Immediately Adjacent Watershed, Lower Red Lake, 1991.

Table 2. Water Quality Parameters, Station 0201, Lower Red Lake, 1991.

PARAMETER	SAMPLE[1]	JUN 6	JUL 29	AUG 26
Secchi (feet)		4.0	9.0	11.0
Temperature (°C)	S	20.83	20.52	22.91
	B	20.11	20.20	22.41
pH (S.U.)	S	8.07	8.37	8.48
	B	7.94	8.40	8.37
D.O. (mg/l)	S	7.44	7.02	8.37
	B	6.63	6.97	4.95
Conductivity (µmhos/cm)	S	294	309	309
	B	300	314	314
Laboratory pH (S.U.)	S	8.1	-	-
	B	8.1	-	-
Total Alkalintiy (mg/l)	S	125	-	-
	B	128	-	-
Total Kjeldahl N (mg/l)	S	0.9	0.4	0.3
	B	0.9	0.4	0.3
Ammonia Nitrogen (mg/l)	S	0.054	0.040	0.021
	B	0.071	0.046	0.022
NO_2+NO_3 Nitrogen(mg/l)	S	0.215	0.050	0.036
	B	0.256	0.083	0.051
Total Phosphorus (mg/l)	S	0.050	0.022	0.017
	B	0.054	0.022	0.018
Diss. Phosphorus (mg/l)	S	0.017	0.008	0.002
	B	0.024	0.009	0.002
Suspended Solids (mg/l)	S	<2	-	-
	B	2	-	-
Vol. Susp. Solids (mg/l)	S	2	-	-
	B	3	-	-
Chlorophyll a (µg/l)	S	8	6	3
Total Nitrogen (mg/l)	S	1.115	0.450	0.336
	B	1.156	0.483	0.351
N/P Ratio	S	22.3	20.5	19.8
	B	21.4	22.0	19.5

[1] S = Near Surface; B = Near Bottom

Table 3. Water Quality Parameters, Station 0202, Lower Red Lake, 1991.

PARAMETER	SAMPLE[1]	MAR 7	JUN 6	JUL 29	AUG 26
Secchi (feet)		-	3.0	8.0	9.0
Temperature (°C)	S	-	20.80	20.85	23.09
	B	0.45	19.98	16.46	17.22
pH (S.U.)	S	-	7.99	8.25	8.48
	B	7.03	7.51	7.69	7.64
D.O. (mg/l)	S	-	7.02	6.09	8.25
	B	9.79	3.60	0.43	0.17
Conductivity (μmhos/cm)	S	-	266	313	303
	B	339	262	266	323
Laboratory pH (S.U.)	S	-	8.3	-	-
	B	7.9	7.7	-	-
Total Alkalintiy (mg/l)	S	-	119	-	-
	B	192	113	-	-
Total Kjeldahl N (mg/l)	S	-	0.9	0.5	0.3
	B	0.3	1.0	0.5	2.3
Ammonia Nitrogen (mg/l)	S	-	0.048	0.058	0.029
	B	0.032	0.190	0.093	1.5
NO_2+NO_3 Nitrogen(mg/l)	S	-	0.156	0.047	0.023
	B	1.17	0.149	0.058	0.015
Total Phosphorus (mg/l)	S	-	0.047	0.030	0.020
	B	0.013	0.067	0.035	0.34
Diss. Phosphorus (mg/l)	S	-	0.016	0.012	<0.002
	B	0.007	0.033	0.018	0.26
Suspended Solids (mg/l)	S	-	<2	-	-
	B	-	2	-	-
Vol. Susp. Solids (mg/l)	S	-	4	-	-
	B	-	2	-	-
Chlorophyll a (μg/l)	S	-	9	7	5
Total Nitrogen (mg/l)	S	-	1.056	0.547	0.323
	B	1.47	1.149	0.558	2.315
N/P Ratio	S	-	22.5	18.2	16.2
	B	113.1	17.1	15.9	6.8

[1] S = Near Surface; B = Near Bottom

Table 4. Water Quality Parameters, Station 0101, Upper Red Lake, 1991.

PARAMETER	SAMPLE[1]	JUN 6	JUL 29	AUG 26
Secchi (feet)		5.0	b[2]	10.0
Temperature (°C)	S	20.56	19.46	22.90
	B	19.42	18.94	20.79
pH (S.U.)	S	8.29	8.50	8.48
	B	8.01	8.49	8.35
D.O. (mg/l)	S	8.56	8.56	9.28
	B	7.20	7.95	8.38
Conductivity (μmhos/cm)	S	299	318	321
	B	317	326	336
Laboratory pH (S.U.)	S	8.5	-	-
	B	8.2	-	-
Total Alkalintiy (mg/l)	S	137	-	-
	B	145	-	-
Total Kjeldahl N (mg/l)	S	0.9	0.4	0.2
	B	0.7	0.3	0.2
Ammonia Nitrogen (mg/l)	S	0.039	0.045	0.016
	B	0.083	0.048	0.025
NO_2+NO_3 Nitrogen(mg/l)	S	0.271	0.075	0.046
	B	0.368	0.103	0.156
Total Phosphorous (mg/l)	S	0.049	0.021	0.016
	B	0.057	0.020	0.018
Diss. Phosphorous (mg/l)	S	0.016	0.006	<0.002
	B	0.032	0.010	0.003
Suspended Solids (mg/l)	S	2	-	-
	B	<2	-	-
Vol. Susp. Solids (mg/l)	S	5	-	-
	B	4	-	-
Chlorophyll a (μg/l)	S	10	5	3
Total Nitrogen (mg/l)	S	1.171	0.475	0.246
	B	1.068	0.403	0.356
N/P Ratio	S	23.9	22.6	15.4
	B	18.7	20.2	19.8

[1] S = Near Surface; B = Near Bottom
[2] b = Secchi disk visible to bottom

value of .036 mg/l (Appendix II). Nitrogen to phosphorus ratios (**N/P ratio**) consistently greater than 15 also indicate Lower Red Lake to be phosphorus limited much of the time.

Spring values for total phosphorus (surface samples at Stations 0201 and 0202) were somewhat higher than respective Summer values and probably reflected input from the large watershed during times of relatively higher flow. Summer surface phosphorus levels, according to a recent compilation of Summer total phosphorus levels in upper midwestern lakes (11), were only slightly higher (.017 to .030 mg/l) than typical (.010 to .014 mg/l) for the primarily forested region in which the Lower Red Lake watershed is located. Much higher values were observed near bottom at Station 0202 and were attributable to phosphorus release from the sediments, which likely occurred under **anoxic** or near-anoxic conditions in the **hypolimnion** during summer **stratification** at this relatively deep point (Figure 4).

Upper Red Lake monitoring suggested that nutrient input from the upper Red River watershed may be minor relative to direct (rain event) input from the immediately adjacent watershed, which may be substantial. Event sampling on Lower Red Lake showed somewhat higher values of nitrate and nitrite and total nitrogen at event Station 02E1, located on the southwest shore just below the hydroelectric powerhouse (Table 5). Relatively low total

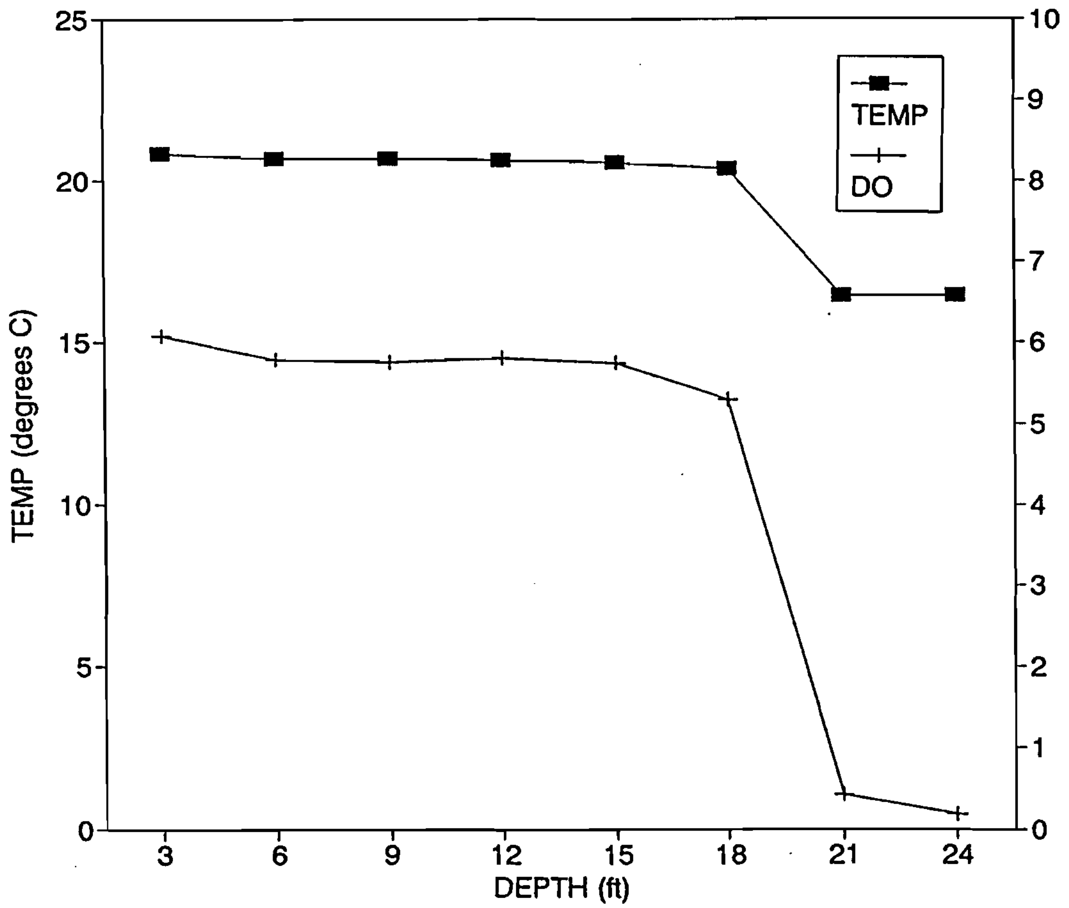

Figure 4. Temperature/DO Profile, Lower Red Lake, July 29, 1991.

Table 5. Event Water Quality Parameters, Lower Red Lake, October 24, 1991.

		STATION	
PARAMETER	UNITS	02E1	02E2
Total Kjeldahl N	mg/l	.5	.5
Ammonia Nitrogen	mg/l	.048	.023
NO_2+NO_3 Nitrogen	mg/l	1.90	.437
Total Phosphorus	mg/l	.019	.015
Diss. Phosphorus	mg/l	.005	.011
Total Nitrogen	mg/l	2.4	.937
N/P Ratio		126.3	62.5

phosphorus levels were observed at Station 02E2 (Miller Creek which drains a primarily agricultural area) and Station 02E1.

Other indicators of lake eutrophication status include light penetration and algal production. Numerous summarative indices have been developed, based on a combination of these and other parameters, to assess or monitor lake eutrophication. The Trophic State Index (TSI) developed by Carlson (12) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indices, application is generally most appropriate on a relative and trend monitoring basis. This particular index does not account for natural, regional variability in total phosphorus levels nor in Secchi transparency reduction unrelated to algal growth (e.g. that associated with color).

TSI numbers for Lower Red Lake indicate a **mesotrophic** or **eutrophic** classification for all parameters measured (Figures 5-7). Total phosphorus indicated a relatively more eutrophic classification than did the other parameters. This discrepancy probably relates to the classification scheme for this index being primarily applicable to natural lakes; higher total phosphorus in impoundments may occur with relatively higher watershed inflow.

During recent macrophyte surveys (Appendix III), macrophytes (Table 6) were found at all 30 sample sites (sample sites = number of depth ranges sampled). Water milfoil (Myriophyllum sp.) was widely distributed (at 27 of 30 sites), and overall the most abundant macrophyte (Tables 7-10). Water milfoil, with the exception of flower parts, is typically a submergent macrophyte found on soft or hard substrata; growth can vary with turbidity. Water milfoil produces seeds, but spreads mainly by fragments, winter buds and rhizome growth. The plants are most often found in deep, slow moving, relatively cool water (13). They are rated as fair to poor waterfowl food and provide fish with forage and cover but have been known to reach nuisance levels (14).

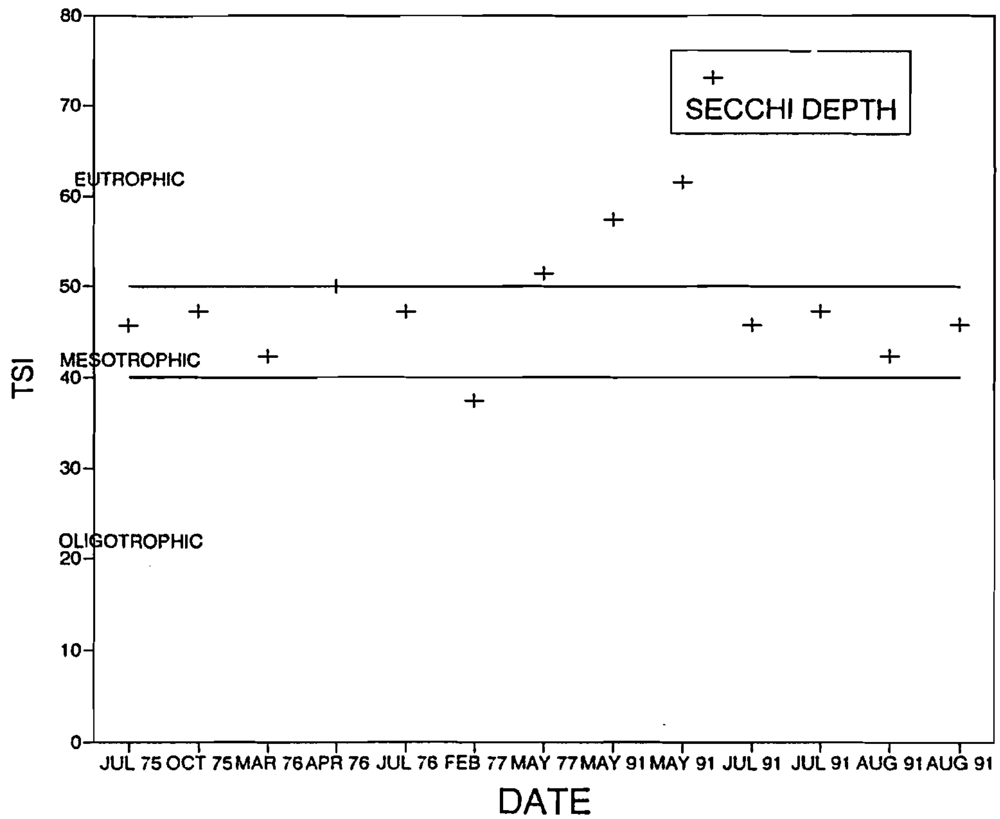

Figure 5. Trophic State Index for Secchi Depth, Lower Red Lake.

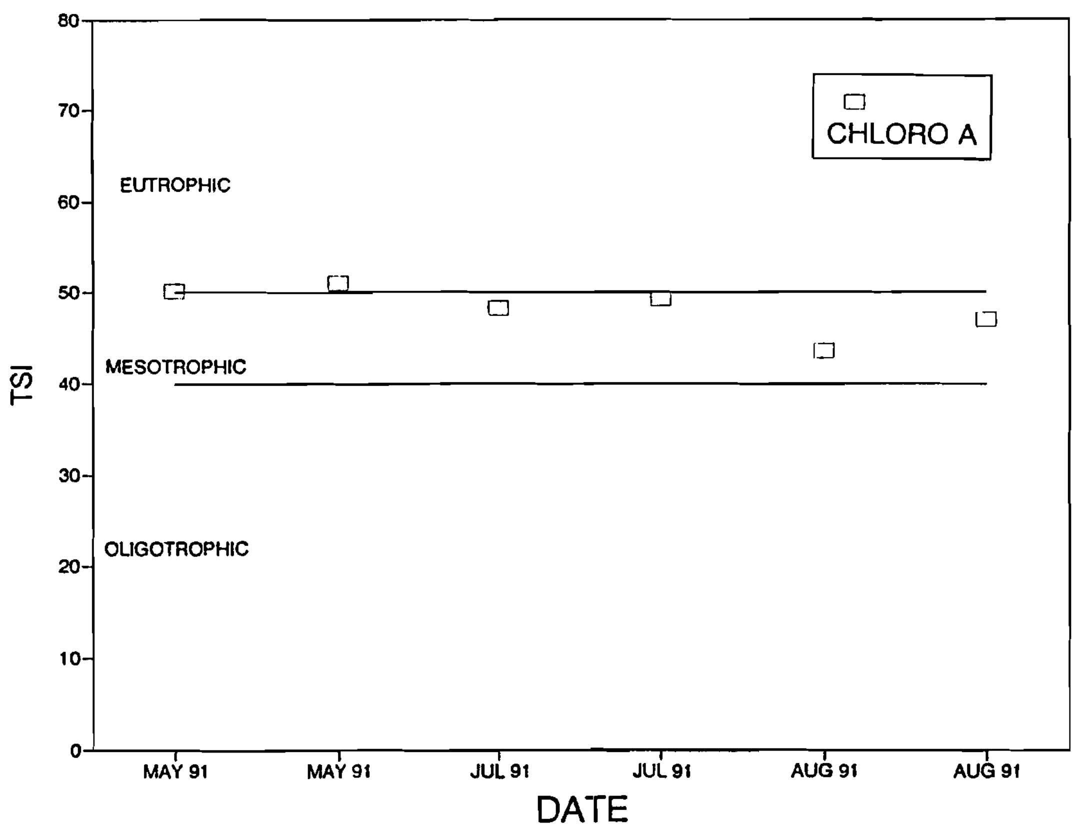

Figure 6. Trophic State Index for Chlorophyll a, Lower Red Lake.

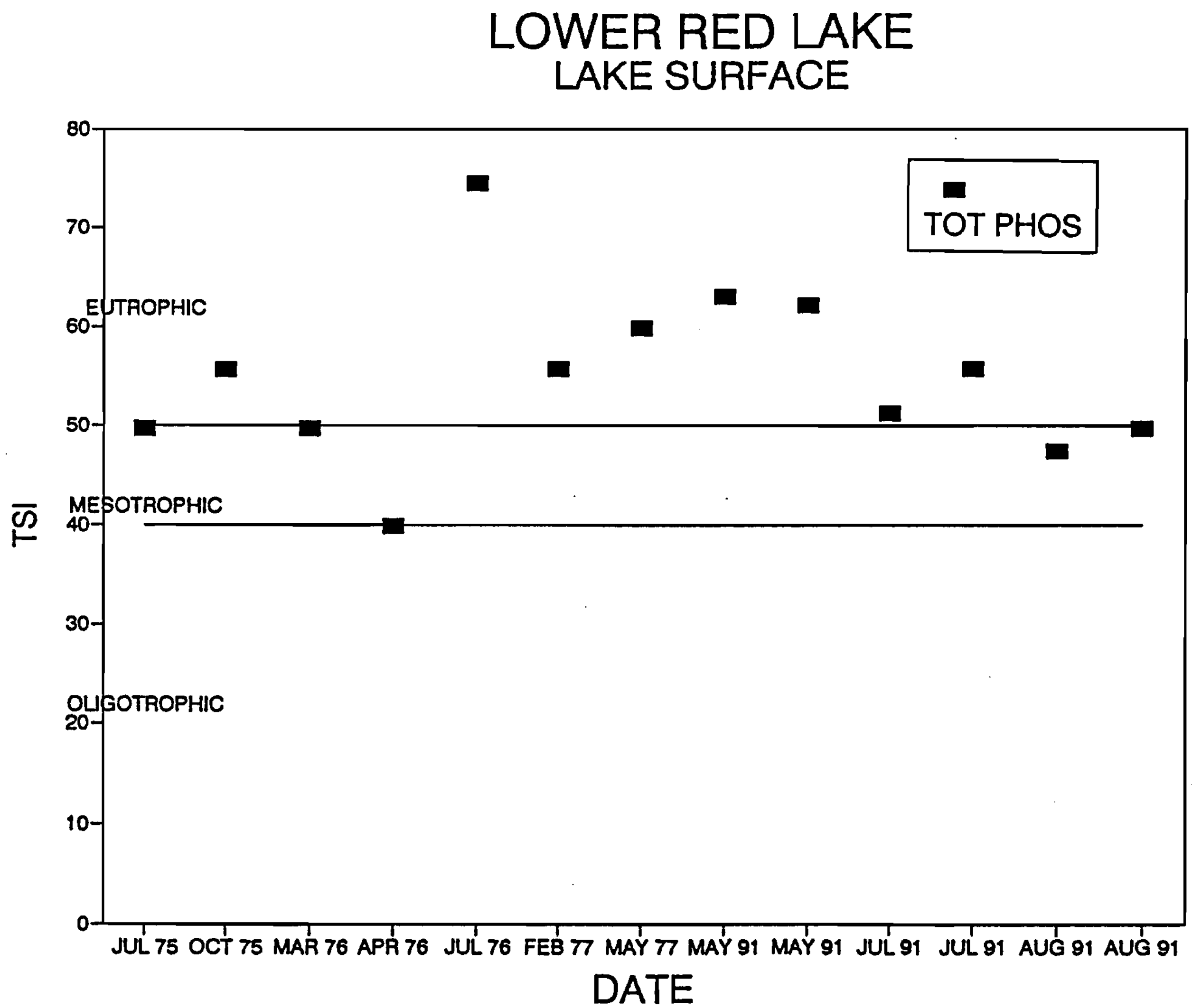

Figure 7. Trophic State Index for Total Phosphorus, Lower Red Lake.

BASELINE CONCLUSIONS

- Lower Red Lake water quality is fair to good. Summer total phosphorus, related to the primarily forested watershed, is only slightly higher than normally found in natural lakes in this region; higher levels near bottom at the stratified, deepest point appear to be a result of sediment release under anoxic conditions. High nitrogen inputs occurred during a rain event near the village but may not be critical since the lake system is phosphorus limited. Similar water chemistry parameters were observed in Upper and Lower Red Lakes.

- Much of Lower Red Lake, due to extreme shallow, soft-substrate, shelf areas adjacent to the original stream channel and good transparency, supports prolific macrophyte growth which has recently (personal comm. RLA) reached nuisance levels. Water milfoil (Myriophyllum sp.) [which may include Eurasian Milfoil (Myriophyllum spicatum)] and water celery (Vallisneria americana) are present in high numbers.

- Very different populations of macrophytes exist in Upper and Lower Red Lakes. Coontail and leafy pondweed, found in high numbers on Upper Red Lake, are present in low numbers on Lower Red Lake. Water milfoil and water celery are more abundant on Lower Red Lake; water celery was absent from Upper Red Lake samples. These differences may reflect somewhat different habitats (physical, chemical, or biological) related to successional differences between the Upper (older) and Lower (younger) Red Lake impoundments.

- Long term management efforts should concentrate on effective practical macrophyte management and detection and control of localized non-point nutrient inputs to benefit use of the resource through water quality maintenance/improvement and accessibility and habitat enhancement.

MANAGEMENT ALTERNATIVES DISCUSSION

Impoundments are artificial lakes created by interrupting and slowing the natural flow of a river. While natural lakes tend toward a state of dynamic equilibrium, the physical, chemical and biological characteristics of impoundments tend towards dynamic equilibrium as they are continuously affected by the parent river. Physicochemical parameters and biological communities in reservoirs are longitudinally and transectionally related to basin morphometry, are temporally affected by flow conditions (in the upstream reach) and water mass retention time (in the lower reach), and are influenced by flow release operations at the dam.

Impoundments, due to the natural process of sediment transport by river systems, typically "fill in" substantially faster than natural lakes. (This may be negligible for Lower Red Lake since Upper Red Lake acts as a sediment "sink", settling out sediment as the water is slowed above the dam.) Impoundments, in comparison to natural lakes, however, have a limited retention time and experience periodic "flushing" which may benefit the resource relative to other aspects of eutrophication. Biological expression of excessive nutrient loading, for example, may be only transient or less severe than in natural lakes.

Water Quality

Lower Red Lake is a small impoundment but benefits from a large, predominantly forested watershed. Water quality relative to transparency, productivity, sedimentation and nutrients is seasonally variable but appears good. Net inputs from the upstream watershed appear relatively minimal; that from adjacent areas, however, may be substantial during surface runoff events.

Efforts should be made to identify and control localized non-point sources of nutrients entering Upper and Lower Red Lakes. Probable sources include agricultural areas located on the north and south shores of the upstream portion of Upper Red Lake and areas on the southwest side of Lower Red Lake. Cattle are known to wade into Upper Red Lake, thereby contributing to erosion, sedimentation, and nutrient inputs.

Riparian land use practices can have a significant influence and land owner diligence should be strongly emphasized and encouraged to prevent (to the extent practical) nutrient and sediment inflows. A major concern is nutrient inputs; common sense approaches are relatively easy and can be very effective in minimizing these inputs.

Proper septic upkeep is important in Lower Red Lake because soils are potentially too sandy to permit effective filtration by soil particles. An improperly functioning septic system can cause excessive bacterial or nutrient input and cause algal and macrophyte growth in near-shore areas of the lake. Owners should also use phosphate or phosphorus free detergents, curb unnecessary water use, and avoid dumping chemicals down drains.

Yard practices can minimize both nutrient and sediment inputs. Lawn fertilizers should be used sparingly, if at all. If used, the land owner should select phosphate-free fertilizers and apply small amounts more often instead of large amounts at one or two times. Composting lawn clippings and leaves away from the lake can reduce nutrient inputs to the lake. If leaves are burned, it should be done where the ash cannot wash into the lake (15).

Creation of a buffer strip with diverse plants at least 20 feet wide immediately adjacent to the lake can control wave erosion, trap soil eroded from the land above, increase infiltration (to filter nutrients and soil particles), and shade areas of the lake to reduce macrophyte growth (especially on south shores) and provide fish cover. Placement of a low berm in this area can enhance effectiveness of the buffer strip by further retarding runoff during rainfalls. A buffer zone protects lake water quality, creates habitat for wildlife, and provides privacy (15).

There are a number of informational sources for land owners with questions regarding land management practices. Some sources are outlined in Appendix IV.

Macrophytes

Management of dense macrophyte growth should be a major objective on Lower Red Lake. Existing macrophytic growth not only affects resource aesthetics and recreational uses, but physical (e.g. organic sediment build-up) and biological (e.g. critical habitat reduction) aspects as well. Numerous methods of macrophyte control ranging from radical habitat alteration to more subtle habitat manipulation are available and are discussed below relative to Lower Red Lake applicability.

Dredging is a drastic form of habitat alteration. Dredging could entail massive lake-wide sediment removal (to a depth at which macrophyte growth would be retarded due to reduced sunlight) or spot dredging of limited (high priority) areas. Large scale sediment removal is very costly. Spot dredging, because of lower cost may be a reasonable alternative in some cases. Spot dredging may be a viable alternative in Lower Red Lake in the near-term since Upper Red Lake acts as a sediment catch basin and thus reduces the amount of sediment available to quickly fill in the dredged area.

Chemical treatment has been shown to eradicate some undesirable species and leave others intact. The WDNR strongly discourages the use of chemicals because of nutrient release, oxygen depletion, sediment accumulation, bioaccumulation and other unknown environmental hazards including invasion potential from nuisance exotics. Chemical treatment has been implemented in the past and does not appear to have had any lasting impact on macrophyte populations. Therefore, chemical treatment is not recommended for Lower Red Lake at this time.

Partial drawdown can be an effective macrophyte control method. Lowering the water level 12-18" would expose littoral area roots, tubers and rhizomes of macrophytes to freezing conditions in the winter and desiccating conditions in the summer and could eliminate some of the near-shore species (16). A summer drawdown could also improve mechanical harvester efficiency in reaching macrophytes in deeper areas of the lake. The partial drawdown still permits recreational use of the lake and may, within regulatory constraints, be implemented by a lake association. A potential problem with this method is that some species are known to increase in density after drawdown.

Aquatic plant screens have been shown to reduce plant densities in other lakes and may be applicable here. A fiberglass screen or plastic sheet is placed and anchored on the sediment to prevent plants from growing. This may also make some sediment nutrients unavailable for algal growth. Screens should be removed each fall and cleaned in order to last a number of years.

A newer technique of rototilling sediments to destroy plant roots appears to be effective in controlling plant growth for a relatively longer period than harvesting. The process is about the same cost per hour as a contracted macrophyte harvester (17). A potential problem is disturbance of the sediments and resuspension of nutrients or toxics.

Installation of floating platforms (opaque plastic attached to wooden frames) just before or after ice-out can shade the sediments, restrict plant growth and help to open corridors for swimming or boat navigation. Shading is usually required for three weeks to two months to significantly impact nuisance plant growth (18). A potential drawback is that the area cannot be used while the platform is in place.

Remaining control methods consist, in one form or another, of macrophyte harvest. It is a commonly used technique which can be applied on a widespread or localized basis. Its efficiency, based on method of cut/harvest, can vary substantially with depth.

Several conditions should be considered with respect to macrophyte harvest in Lower Red Lake. Nuisance macrophyte growth on Lower Red Lake is widespread and would require intensive application to achieve widespread effect across the extensive shallow shelf areas. The exotic Eurasian Milfoil may be present in Lower Red Lake and spreads easily by fragmentation; strong consideration should also be given to the potential of this species to invade areas where competing macrophytes have been removed.

Macrophyte harvesting is typically conducted with a mechanical harvester which cuts the vegetation and removes (harvests) it onto a platform for out-of-lake disposal. Given the previously mentioned precautions regarding potential Eurasian Milfoil dispersal and the ability of some native plants to survive and spread when detached from the substrate, harvest practices may even enhance the nuisance macrophyte problem through seed dispersal, fragmentation or incomplete removal. Indiscriminate power boat usage outside river channels, through formation of "prop cut" floating weed masses, may also contribute to this problem.

Selective SCUBA assisted harvest has been shown to effectively manage some macrophytes in deeper areas where a mechanical harvester cannot reach bottom and removal efficiency is relatively poor. It can also be used to target only desired species (i.e. water milfoil). This method is labor intensive, but has proved to effectively reduce nuisance plant levels for up to two years (17).

Raking weeds (using an ordinary garden rake) in the frontage area can be a very effective localized plant control method when done on a regular basis. Such concentration on the shallow water areas would reduce efforts expended on mechanical or other control methods.

Macrophyte control techniques vary considerably with respect to cost-effectiveness. To ensure selection of the most cost-effective implementational approach to Lower Red Lake macrophyte control, RLA should consider a combination of techniques with localized and/or seasonal application. These applications in the near-term may be targeted toward accessibility and habitat improvement (i.e., creation of edge) rather than intense "clear cuts" on the shelf areas. These localized efforts should be closely monitored relative to efficiency (time and space) and potential problems, e.g. invasion of exotic species, for consideration in future long-term management efforts.

MANAGEMENT RECOMMENDATIONS

RLA should encourage land owner diligence with respect to nutrient input and erosion control to maintain good water quality and retard siltation and resultant loss of impoundment capacity.

- Septic upkeep, fertilizer management, macrophyte raking and buffer stripping can all have a positive effect in near-shore areas. There is potential for nutrient infiltration to surface or groundwaters because soils in the immediate Lower Red Lake area may not filter septate adequately. Residential input, relatively small on an individual basis, can cumulatively have a large impact.

- Input of nutrients (and probably sediment) from the immediate watershed during surface runoff events appears to be significant. Runoff from the immediate watershed can have significant impact on near-shore shelf areas even though large volumes of water flush through the lake. Installation of animal waste containment facilities can greatly help to reduce this immediate problem but fencing and creation of buffer strips may be a more cost effective application for reaching similar ends.

Intensive and widespread macrophyte control measures would be necessary to achieve readily noticeable lakewide improvement. This is not recommended for the near-term because of cost versus ultimate efficiency considerations, lack of information regarding potential competitive advantages of nuisance or exotic species, and other ecological considerations. Near-term macrophyte management objectives should emphasize investigation of sediment and macrophyte population differences and relations in Upper and Lower Red Lakes through more intensive surveys. Management then, can emphasize creation of habitat, access improvement, minimization of nuisance species (water milfoil dispersal), and evaluation of alternative control methods to maximize cost effectiveness of long-term management. Near-term procedure according to the following rationale is recommended:

- Further macrophyte study should be conducted (in Upper and Lower Red Lakes) on the same transects in addition to more intensive study of specific target areas. This may yield important information relative to successional or habitat differences necessary in understanding the two water bodies and implementing a successful macrophyte management plan.

- A harvest strategy which may include spot dredging (based on more detailed substrate information) should maximize "edge" and improve access to more lake area; this would benefit the fishery and improve recreational use potential. This scheme, implemented in previous feeder creek channels (i.e. deeper portions of the shelf areas) would increase access and improve habitat for predator species. Mechanical harvesting should be confined to near shore areas where harvester efficiency is high with emphasis on <u>complete and efficient removal</u> of cut macrophytes. Informational brochures/posters should be distributed or displayed at access points to inform users of the resource and to discourage unnecessary macrophyte disruption by power boat usage outside of the river channel.

- Demonstration areas to evaluate efficiencies of various combinations of methods should be concurrently implemented in the above strategy. Experimental design considerations should include:

    * Shallow vs. deep water (depth related efficiency)
    * Mechanical vs. SCUBA assisted harvest vs. spot dredges (species/time frame efficiency)
    * Documentation of taxonomic changes (successor species)

* Evaluation of introduction/seeding (species competition/growth characteristics) and creation of edges around desirable species beds

Information gathered through this experimental design should also aid in the development of an understanding of the populational differences between Upper and Lower Red Lakes.

- Eurasian Milfoil beds (if present) should be identified and selective SCUBA aided removal implemented.

- Substrate characterization (specifically to determine depth of silt to sand) may be undertaken to evaluate potential for future localized or extensive dredging to a depth of less productive substrate; also has implication to partial drawdown alternative.

IMPLEMENTATION

The success of any lake management plan relates directly to the ability of the association/district to obtain funds and regulatory approval necessary to implement the plan. The RLA was formed in 1990 under provisions of Chapter 181, Wisconsin Statutes. The RLA is a voluntary association that does not have a lake district's specific legal or financial powers (to adopt ordinances or levy taxes or special assessments) to meet plan objectives.

The Lower Red Lake watershed is located within the political jurisdictions of the Village of Gresham, Towns of Herman and Red Springs, County of Shawano and the State of Wisconsin. These units have the power to regulate land uses and land use practices. Shawano County ordinances and plans possibly pertinent to the Lower Red Lake plan are summarized in Appendix V.

Potential sources of funding are listed in Appendix VI.

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