IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

LAKE MANAGEMENT PLAN
UPPER RED LAKE
SHAWANO COUNTY, WISCONSIN

1991

REPORT TO:
RED LAKES ASSOCIATION

May, 1992

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ACKNOWLEDGEMENTS

This plan was prepared with guidance provided by the Advisory Committee of the Red Lakes Association. Thanks is extended to Dan Boucher - President, Peg Hoffman and Lonnie Schreiber with special recognition to the late Chet Hanson who was strongly committed to the Red Lakes and this program from its initiation.

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GLOSSARY OF TERMS (1, 2, 3)

Anoxic — Water that has extremely low or no dissolved oxygen.

Chlorophyll a — Green pigment present in all green plant life and needed in photosynthesis. The amount present in lake water is related to the amount of algae and is therefore used as an indicator of water quality.

Edge — A biologically diverse area located at the interface of differing habitat types.

Eutrophic — From Greek for "well nourished", describes a lake of high photosynthetic activity and low transparency.

Fetch — The longest distance over which the wind can sweep unobstructed.

Immediately Adjacent Watershed — Here defined as the drainage area immediately around a lake, i.e. within 1,000 feet of shore and any inlet(s).

Impoundment — A body of water created by the damming of a river, stream or brook.

Littoral — The shallow area of a lake from the shore to the depth where light no longer penetrates to the bottom.

Macrophyte — Commonly referred to as lake "weeds", actually aquatic vascular plants that grow either floating, emergent or submergent in a body of water.

Mesotrophic — A lake of intermediate photosynthetic activity and transparency.

N/P Ratio — Total nitrogen divided by the total phosphorus found in a water sample. A value greater than 15 indicates that phosphorus is limiting for primary production.

Physicochemical — Pertaining to physical and/or chemical characteristics.

GLOSSARY OF TERMS
(Continued)

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

Upper Red Lake, Shawano County, Wisconsin, is an **impoundment**[1] created by construction of a hydroelectric dam on the Red River in 1880. Impoundments, compared to natural lakes, drain relatively large watersheds, have relatively low residence times (exhibit periodic flushing), have extensive shelf areas and are continually affected by flow conditions of the parent river. The Red River drains a primarily forested watershed, and Upper Red Lake, therefore, is subject to lower potential sediment and nutrient inflow than it would be in an agricultural watershed.

Upper Red Lake water quality is generally good with minimal sedimentation in the main river channel. Extensive shallow shelf areas (as related to original basin morphometry and long-term sediment deposition) are silt covered and support abundant macrophyte growth. Rain event samples suggest substantial sediment and nutrient inputs from the immediate area.

Management objectives should emphasize enhancement of aesthetic and recreational potential and minimization of the comparatively high "aging" potential (relative to sediment and nutrient input) of impounded ecosystems. Common-sense riparian landowner applications and control of agricultural runoff should be implemented in areas adjacent to the lake to maintain or enhance good existing water quality. Near-term macrophyte control should be localized applications of different methods with emphasis on improvement of accessibility and fishery habitat enhancement; these procedural alternatives should be closely evaluated relative to long-term implications regarding cost-effectiveness and potential negative effects including competitive advantages of nuisance or exotic plants.

Specific near-term recommendations for Upper Red Lake are:

- Riparian landowner diligence relative to septic system upkeep, yard practices and creation of buffer strips
- Identification and control of non-point sources of nutrients and sediment entering the lake, emphasis should be given to adjacent agricultural areas
- Localized application of macrophyte harvest alternatives to create access lanes and "**edge** effect"
- Follow-up evaluation of macrophyte control areas with respect to cost-effectiveness (time or cost/area), time frame efficiency (duration of effect) and potential of invasion of cut areas by nuisance or exotic species

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

INTRODUCTION

Upper Red Lake is located in the Towns of Red Springs and Herman in central Shawano County, Wisconsin, and is the seventh largest lake (188 acres) in the county. Upper Red Lake is actually an impoundment, formed in 1880 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 Upper 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

Upper Red Lake (T28N R14E S33,34; T27N R14E S3) is an impoundment of the Red River located in and near the Village of Gresham, Shawano County, Wisconsin (Figure 1). The general topography of Shawano County is related to glacial activity and the watershed is predominantly forested. Topography adjacent to Upper Red Lake is level to steeply sloped. Low-lying areas immediately adjacent to the lake are comprised primarily of Rosholt-rock outcrop with 25-45 percent rock; these are well drained soils not generally suitable for septic tanks due to rapid permeability and minimal filtration. Major soil types in other areas are well drained Menahga and Kennan loamy sands on 1-30 percent slopes (4).

Upper Red Lake has a surface area of 188 acres, an average depth of 6 feet, and a maximum depth of 15 feet. Upper Red Lake is comprised of two distinct pools; the impoundment is divided near the middle by a railroad trestle. The relatively narrow upstream pool is comprised of the original river channel and a small amount of inundated area adjacent to it; the downstream pool is much wider with extensive shallow areas. The **fetch** of the upstream portion is 0.6 miles and lies in a east-west orientation and that of the downstream portion is 0.8 miles in a northwest-southeast orientation. Lake volume is about 1,100 acre feet with a **residence time** of about 3.6 days (5).

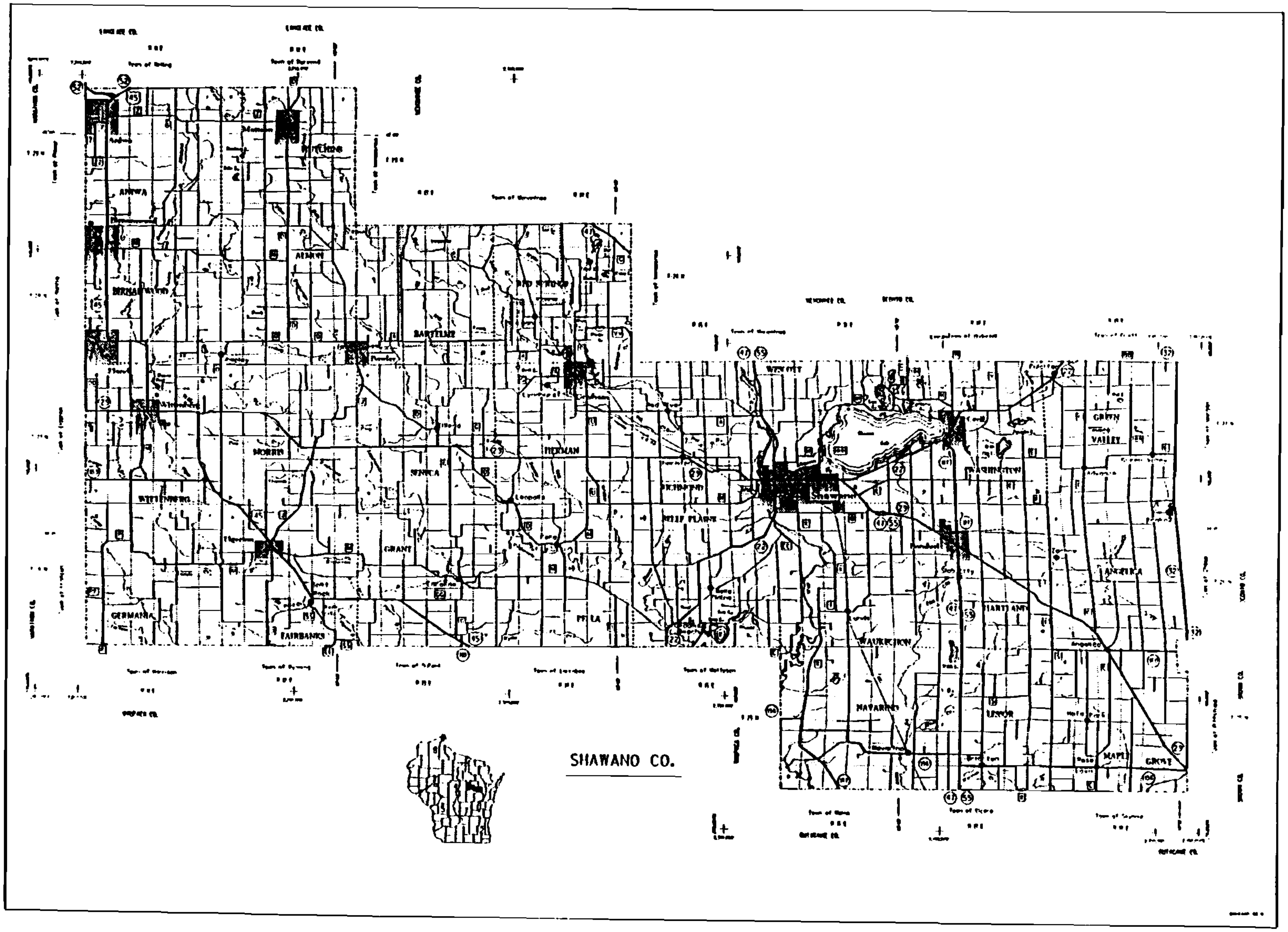

Figure 1. Location Map, Upper Red Lake, Shawano County, WI.

The Upper Red Lake dam, constructed on the Red River in 1880, was most recently altered in 1963 to raise the pool to its present level of 102 feet. The current dam is 231 feet long with a 35 foot head. A 650 foot long six foot diameter steel penstock directs the water from the bottom of the dam through a hydroelectric plant operated by the Village of Gresham before entering Lower Red Lake. The plant which currently has a capacity of 300 kilowatts at 145-160 cfs was granted a 30 year license in 1986 (6). The dam was licensed to operate in an instantaneous run-of-river mode with water surface elevation maintenance between 102 and 103 feet to protect fish and wildlife resources.

The **immediately adjacent watershed** is about 660 acres and is about half forested with areas of agriculture (36%) and residence (5%) areas. Approximately 15 acres of wetland lie adjacent to the lake near the upstream end. Woodland areas (48%) are comprised mainly of hardwood forests (maples and oaks) with areas of pine plantations (6).

The water is colored and appears dark brown to red at times. Predominant **littoral** substrates in 1986 (6) included sand (70%), gravel (12%) and silt (15%) with some areas of rubble. Recently, concern has been expressed about the excessive aquatic **macrophyte** growth.

Upper 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), black bullhead (Ictalurus melas) and brown trout (Salmo trutta). During the period from 1985-1990, 1225 7-10" muskellunge (Esox masquinongy) were stocked in the lake (Personal comm. WDNR); a size limit of 40 inches is currently in effect. Two points of public access are located on the lake, one on the north shore and one on the south shore. Parking facilities are available at both points and the landing on the south shore has a public fishing pier.

The impoundment is used by migrating waterfowl and is host to mallards, blue-winged teal and wood ducks. Mammals present include muskrat, mink, weasel, striped skunk, raccoon, red fox, gray squirrel, cottontail rabbit and white-tailed deer (6). Nesting bald eagles have also been spotted during the summer months.

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 three sites (Table 1, Figure 2). Station 0103 (Red River inlet) was sampled at mid-depth (designated "M"), and Station 0101 (near dam) and 0102 (mid-lake, deepest point) were sampled near surface (designated "S") and near bottom (designated "B").

Two event sites (01E1, 01E2) were established in the Red River upstream from the lake. One (01E1) was located where Morgan Road crosses the Red River and the other (01E2) was further downstream on the north side in a small intermittent. These sites were designated to be sampled after a major rain event (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

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

WATER QUALITY

Site	Latitude/Longitude		Depth
0101	44° 51.27′	88° 47.38′	10.0 ft.
0102	44° 51.84′	88° 47.63′	15.0 ft.
0103	44° 51.71′	88° 48.71′	9.0 ft.

MACROPHYTE TRANSECTS

Transect	Latitude/Longitude Origin	Latitude/Longitude End	Transect Length (m)	Bearing (Degrees)	Depth Range[1]
A	45° 21.77' 88° 27.04'	45° 21.66' 88° 27.19'	19	252	1/2/3
B	45° 17.67' 88° 29.65'	45° 15.78' 88° 30.90'	24	45	1/2/3
C	45° 14.26' 88° 31.42'	45° 14.10' 88° 31.35'	21	90	1/2/3
D	45° 14.23' 88° 31.36'	44° 51.73' 88° 47.56'	30	175	1/2/3
E	44° 51.16' 88° 47.58'	NR[2]	40	38	1/2/3

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

[2] NR no reading available

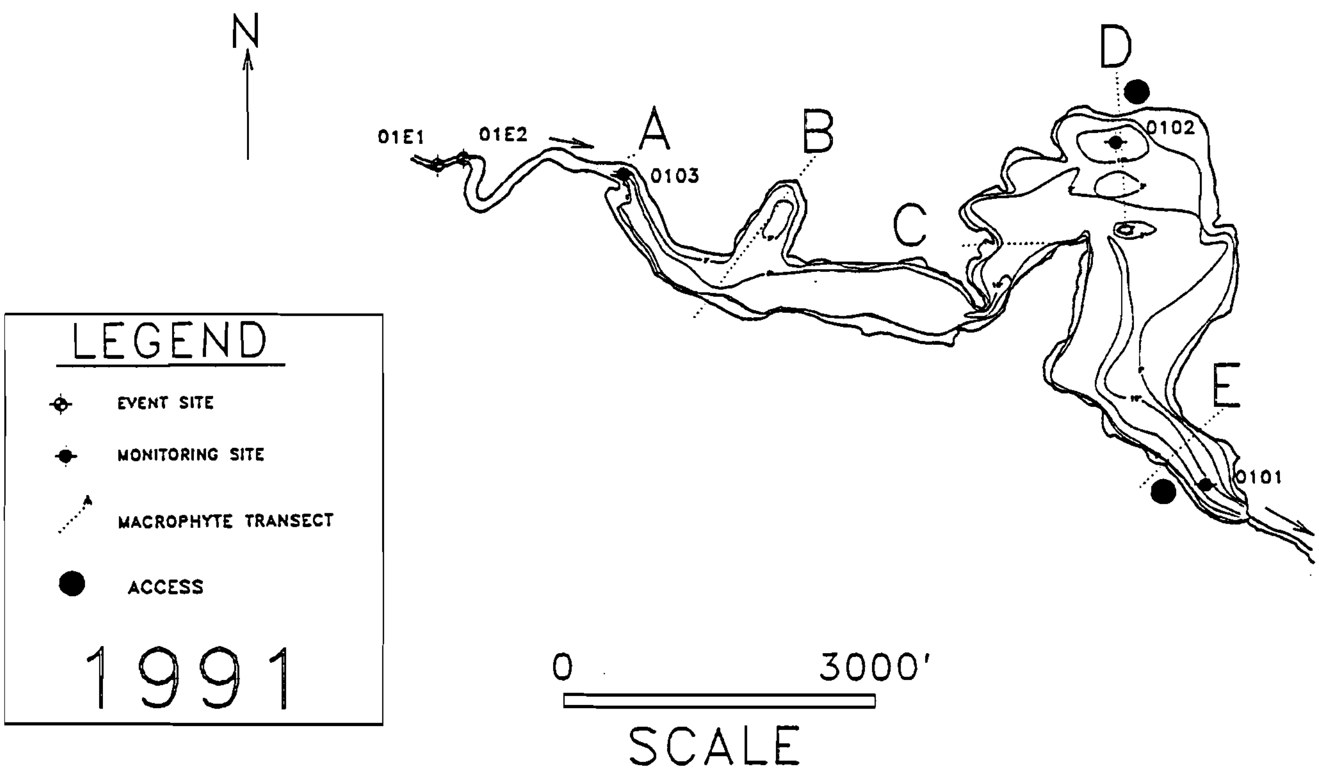

Figure 2. Sampling Sites, Upper Red Lake, Shawano County, Wisconsin, 1991.

multiparameter meter; Hydrolab units were calibrated prior to and 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 (7) methods. Winter water quality parameters determined in the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorous and dissolved phosphorous. Spring parameters included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorous and dissolved phosphorous, 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 phosphorous, dissolved phosphorous, 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 (8). 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 (9), the 1986 dam relicensing report (6) 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's zoning maps, United States Soil Conservation Service soil maps (4), aerial photography, 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 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. Upper Red Lake has a ratio over 200:1 which means that 200 times more land than lake surface area drains to Upper Red Lake. Since land use can directly affect water quality, this large number would typically indicate a high potential of non-point source impacts on the system. This potential appears to be comparatively minor in the Upper Red Lake impoundment due to the primarily forested Red River watershed. Four major land uses in the immediately adjacent Upper Red Lake watershed are, wooded (48%), agricultural (36%), cleared (11%) and residential (5%) (Figure 3).

Phosphorus is most often the limiting factor in algal and plant production in lakes. Surface total phosphorus during 1991 monitoring in Upper Red Lake (Stations 0101 and 0102) ranged from .016 to .052 mg/l (parts per million) with a mean value of .031 mg/l; that in the Red River ranged from .019 to .049 mg/l (Tables 2-4). Nitrogen to phosphorous ratios (**N/P ratio**) consistently greater than 15 also indicate Upper Red Lake to be phosphorous limited most of the time.

Spring values for surface total phosphorous were somewhat higher than respective Summer values and probably reflected input from

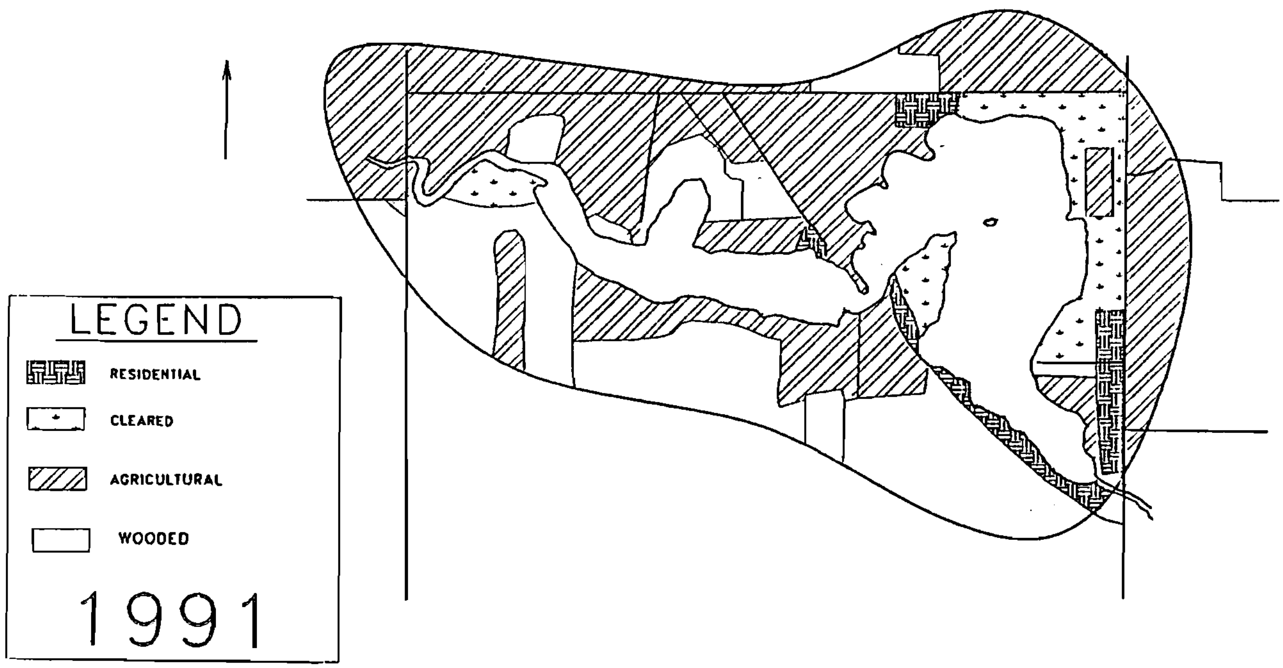

Figure 3. Land Uses in the Immediately Adjacent Watershed, Upper Red Lake, 1991.

Table 2. 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

Table 3. Water Quality Parameters, Station 0102, Upper Red Lake, 1991.

PARAMETER	SAMPLE[1]	MAR 7	JUN 6	JUL 29	AUG 26
Secchi (feet)		-	4.0	10.0	11.0
Temperature (°C)	S	-	20.34	19.92	22.90
	B	3.55	11.35	17.90	20.17
pH (S.U.)	S	-	8.06	8.39	8.54
	B	NR[2]	7.57	7.59	7.67
D.O. (mg/l)	S	-	8.09	8.54	9.20
	B	4.05	4.10	1.44	2.24
Conductivity (µmhos/cm)	S	-	283	324	322
	B	352	290	295	328
Laboratory pH (S.U.)	S	-	8.4	-	-
	B	7.8	7.7	-	-
Total Alkalintiy (mg/l)	S	-	127	-	-
	B	204	128	-	-
Total Kjeldahl N (mg/l)	S	-	0.9	0.5	0.3
	B	0.3	0.7	1.5	1.4
Ammonia Nitrogen (mg/l)	S	-	0.027	0.053	0.019
	B	0.015	0.135	0.075	0.025
NO_2+NO_3 Nitrogen(mg/l)	S	-	0.186	0.053	0.030
	B	0.850	0.271	0.051	0.019
Total Phosphorous (mg/l)	S	-	0.052	0.029	0.018
	B	0.015	0.033	0.192	0.197
Diss. Phosphorous (mg/l)	S	-	0.006	0.008	<0.002
	B	0.003	0.011	0.017	0.036
Suspended Solids (mg/l)	S	-	2	-	-
	B	-	<2	-	-
Vol. Susp. Solids (mg/l)	S	-	4	-	-
	B	-	2	-	-
Chlorophyll _a_ (µg/l)	S	-	24	14	4
Total Nitrogen (mg/l)	S	-	1.086	0.553	0.330
	B	1.150	0.971	1.551	1.419
N/P Ratio	S	-	20.9	19.1	18.3
	B	76.7	29.4	8.1	7.2

[1] S = Near Surface; B = Near Bottom
[2] NR = No Reading

Table 4. Water Quality Parameters, Station 0103, Upper Red Lake, 1991.

PARAMETER	SAMPLE[1]	JUN 6	JUL 29	AUG 26
Secchi (feet)		5.0	8.0	b[2]
Temperature (°C)	M	17.40	16.40	20.55
pH (S.U.)	M	7.99	8.14	8.14
D.O. (mg/l)	M	8.44	8.71	7.68
Conductivity (μmhos/cm)	M	344	333	340
Laboratory pH (S.U.)	M	8.2	-	-
Total Alkalintiy (mg/l)	M	157	-	-
Total Kjeldahl N (mg/l)	M	0.7	0.4	0.3
Ammonia Nitrogen (mg/l)	M	0.041	0.031	0.018
NO_2+NO_3 Nitrogen(mg/l)	M	0.516	0.464	0.333
Total Phosphorous (mg/l)	M	0.049	0.024	0.019
Diss. Phosphorous (mg/l)	M	0.022	0.013	0.007
Suspended Solids (mg/l)	M	4	-	-
Vol. Susp. Solids (mg/l)	M	4	-	-
Chlorophyll a (μg/l)	M	4	6	2
Total Nitrogen (mg/l)	M	1.216	0.864	0.633
N/P Ratio	M	24.8	36.0	33.6

[1] M = Mid-depth
[2] b = Secchi disk visible to bottom

the large watershed during times of relatively higher flow. Summer surface phosphorous levels, according to a recent compilation of Summer total phosphorus levels in upper midwestern lakes (10), were only slightly higher than typical for the primarily forested region in which the Upper Red Lake watershed is located. Much higher values were observed near bottom in July and August at Station 0102 and were attributable to phosphorous release from the sediments, which likely occurred under near-**anoxic** conditions during partial summer **stratification** at this relatively deeper point (Figure 4).

Rain event related monitoring (one event) suggested that nutrient input from the upstream Red River watershed may be minor relative to direct input from the immediately adjacent watershed, which may be substantial. Very high values of both total phosphorous and total nitrogen at event site 01E2 may be a result of fertilizer or animal waste run-off, respectively, from this predominantly agricultural area (Table 5).

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

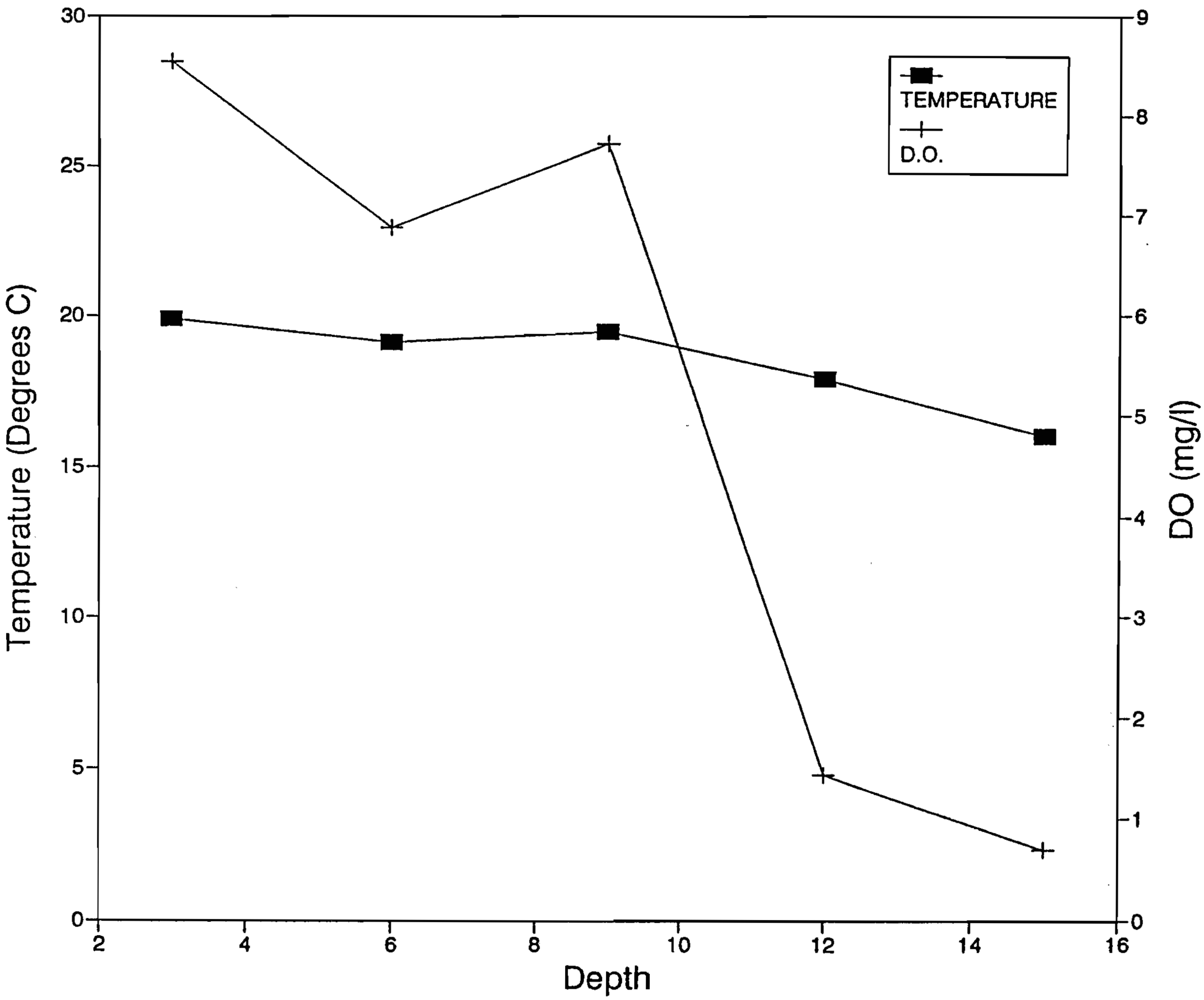

Figure 4. Temperature/DO Profile, Upper Red Lake, July 29, 1991.

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

		STATION	
PARAMETER	UNITS	01E1	01E2
Total Kjeldahl N	mg/l	.5	2.9
Ammonia Nitrogen	mg/l	.033	.526
NO_2+NO_3 Nitrogen	mg/l	.731	.699
Total Phosphorous	mg/l	.034	.490
Diss. Phosphorous	mg/l	.006	.082
Total Nitrogen	mg/l	1.264	4.125
N/P Ratio		37.2	8.4

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 (i.e. that associated with color).

TSI numbers for Upper Red Lake indicate a **mesotrophic** or early **eutrophic** classification for all parameters measured (Figures 5 and 6). 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 II), macrophytes (Table 6) were found at 28 of 30 sample sites (sample sites = number of depth ranges). Coontail (Ceratophyllum demersum) is widely distributed (at 25 of 30 sites), and the most abundant macrophyte overall (Tables 7-9). Coontail has worldwide range, is a submergent plant typically found on soft substrates, and often does well in turbid water where many plants do not. It is rated as a fair waterfowl food and provides fish with both forage and spawning habitat. The plant develops roots but does not need them as it can often be found free-floating. Coontail has been known to reach nuisance levels and does so in part because the plant can grow to over six feet long with many branches (12). Thorny seeds are produced underwater during the growing season but coontail reproduces primarily by the formation of winter buds which fall to the bottom and form new plants in the Spring (13).

Leafy pondweed (Potamogeton foliosus) is the second most prevalent macrophyte (at 20 of 30 sites). It is also typically submergent on soft substrates in turbid water but can be found in cooler water than many other plants. It reproduces by seeds and winter buds, is known to be a good waterfowl food source (seeds, roots and leaves), and provides fish forage and cover (12).

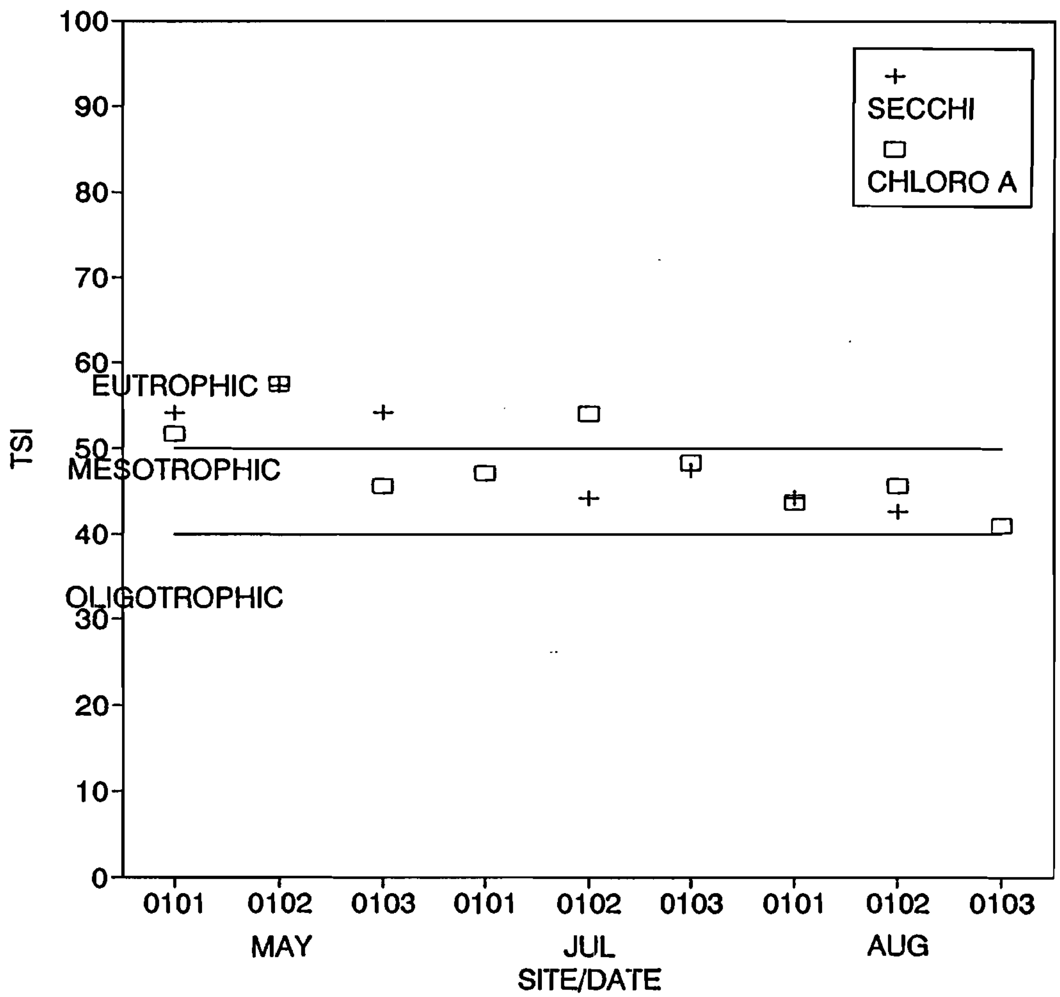

Figure 5. Trophic State Index for Secchi Transparency and Chlorophyll a, Upper Red Lake.

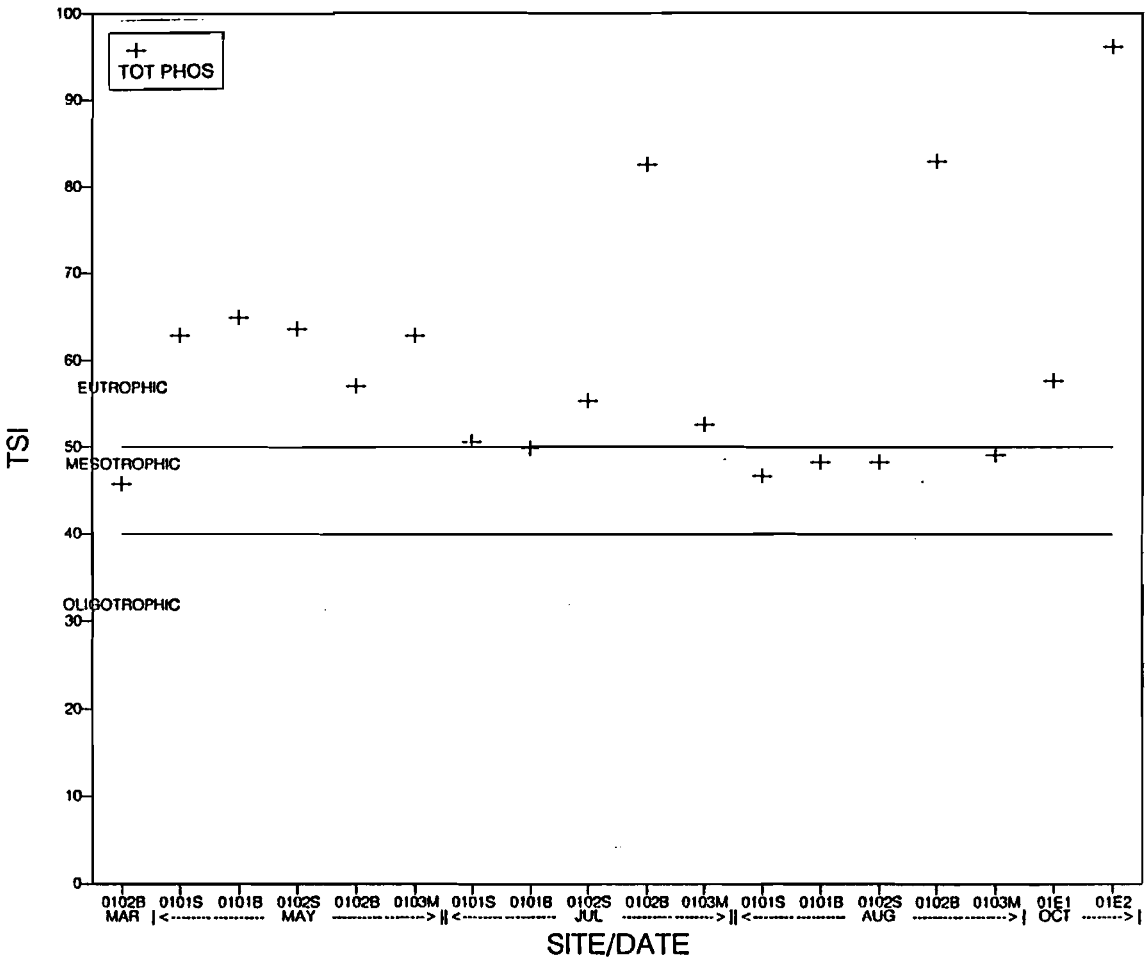

Figure 6. Trophic State Index for Total Phosphorus, Upper Red Lake.

BASELINE CONCLUSIONS

- Upper Red Lake water quality is fair to good. Summer total phosphorous, related to the primarily forested watershed, is only slightly higher than normally found in natural lakes in this region; higher levels near bottom in deeper areas appear related to sediment release under near-anoxic conditions. High nitrogen and phosphorous inputs occurred during a rain event near agricultural areas upstream from the inlet.

- Much of Upper 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. Coontail and leafy pondweed are dominant; water milfoil (<u>Myriophyllum</u> sp.) [which may include Eurasian Milfoil (<u>Myriophyllum spicatum</u>)] is present in relatively high numbers.

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

MANAGEMENT ALTERNATIVES AND RECOMMENDATIONS

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 that natural lakes. 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

Upper 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 appears relatively minimal; that from adjacent agricultural areas, however, may be substantial during surface runoff events.

Efforts should be made to identify and control localized non-point sources of nutrients entering the lake. Probable sources include agricultural areas located on the north and south shores of the upstream portion of Upper Red Lake. Cattle are known to wade into the lake area, 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. Major concerns are sediment and nutrient inputs; common sense approaches are relatively easy and can be very effective in minimizing these inputs.

Proper septic upkeep is important in Upper 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 phosphorous 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 use phosphate-free fertilizers and apply small amounts more often instead of large amounts at one or two times. Composting lawn clippings and leaves can reduce nutrient inputs to the lake. If leaves are burned, it should be done in an area where the ash cannot wash directly into the lake (14).

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 III.

Macrophytes

Management of dense macrophyte growth should be a major objective on Upper 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.

Dredging is a drastic form of habitat alteration which could entail massive whole-lake 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. The success potential for spot dredging in Upper Red Lake appears low, however, due to continual sediment input from the Red River basin and the potential for wind-driven and current-driven sediment redistribution in the shallow habitat (15). Neither form of dredging presently appears appropriate as a practical near-term alternative. Some form of dredging, given the relatively undisturbed upper watershed, may have a place in the longer term or in combination with other alternatives, e.g., drawdown, subsequent to completion of more immediate objectives.

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, e.g., invasion of nuisance exotics. Chemical treatment has been implemented without lasting effect in the past, and should not be considered 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 (15). A summer drawdown would facilitate manual removal of near-shore macrophytes and could also aid mechanical harvester efficiency in reaching macrophytes in deeper areas of the lake. The partial drawdown still permits some recreational use of the lake and may, within regulatory constraints, be implemented by a lake association. Potential problems with this method are that some species are reported to increase in density after drawdown. Specific to Upper Red Lake, the Federal Energy Regulatory Commission license states that the level must be kept at between 102 to 103 feet.

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 have to 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 (16). A potential problem is disturbance of the sediments and resuspension of nutrients or toxics.

Installation of floating platforms (black plastic attached to wooden frames) just 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 (17). 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 Upper Red Lake. Nuisance macrophyte growth on Upper 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 Upper 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 Eurasian Milfoil dispersal and the ability of coontail 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 substantially reduced. It can also be used to target only desired species (coontail or Eurasian Milfoil). This method is labor intensive, but has proved to effectively reduce nuisance plant levels for up to two years (16).

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 Upper 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 strongly encourage riparian land owner diligence with respect to nutrient input and erosion control to maintain or enhance good water quality and retard siltation and resultant loss of impoundment capacity.

- Input of nutrients (and probably sediment) from agricultural areas in the immediate watershed during surface runoff events appears to be substantial. This runoff from the immediate watershed can have significant impact on near-shore shelf areas even though large volumes of water flush through Upper Red Lake. Installation of animal waste containment facilities would substantially reduce this immediate problem but fencing and creation of buffer strips may be a more cost effective application for reaching the same end.

- Residential input is relatively less substantial on an individual basis, but, cumulatively can have a large impact. Septic system upkeep, yard waste and fertilizer management, macrophyte raking and buffer stripping can all have a positive effect, especially in near-shore areas.

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 creation of habitat, access improvement, minimization of nuisance species (coontail and water milfoil dispersal) and evaluation of alternative control methods. Follow-up surveys of these experimental "cuts" or "corridors" should be conducted and the results assessed relative to duration of effect and species reestablishment to maximize cost effectiveness of long-term management. Near-term procedure according to the following rationale is recommended:

- A harvest strategy should maximize "edge" and improve access to more lake area to benefit the fishery and recreational use potential. This scheme, implemented (where practical) 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 complete and efficient removal of cut macrophytes. Informational brochures/posters should be distributed or displayed at access points to inform users and to discourage 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 (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

- Eurasian Milfoil beds should be identified and selective SCUBA aided removal implemented.

- Substrate characterization, to determine depth of silt to sand may be undertaken to evaluate potential for localized dredging to expose 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 Upper 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 Upper Red Lake plan are summarized in Appendix IV.

Potential sources of funding are listed in Appendix V.

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