IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

LAKE MANAGEMENT PLAN
WHITE LAKE
WAUPACA COUNTY, WISCONSIN

1991

REPORT TO:
WHITE LAKE PRESERVATION ASSOCIATION

December, 1991

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This document was prepared with guidance provided by the Advisory and Grant Committees of the White Lake Preservation Association. The Advisory Committee includes:

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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.
Eutrophication	From Greek for "well nourished", describes the acceleration of a lake's aging by natural or manmade processes.
Fetch	The longest distance across a lake surface over which the wind can sweep unobstructed.
Groundwater Drainage Lake	A lake having large amounts of groundwater as a water source and a surface outlet.
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).
Littoral Zone	The zone bounded by the shore of a lake and by the maximum depth at which light can penetrate to the bottom of a lake.
Macrophyte	Commonly referred to as lake "weeds". Actually aquatic vascular plants found floating, emergent or submergent in a body of water.
Mesotrophic	A lake of intermediate photosynthetic activity and transparency.
N/P Ratio	The total nitrogen divided by the total phosphorous in a given water sample. A value greater than 15 indicates that phosphorous is the limiting nutrient for primary production.
Oligotrophic	"Poorly nourished" from the Greek. Describes a lake of low plant productivity and high transparency.
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.

GLOSSARY OF TERMS
(Continued)

Riparian	A landowner whose land lies on the shore of a particular body of 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.
Year Class	A fisheries management term relating to any of the individuals of a species hatched during a particular year.

SUMMARY

White Lake, Waupaca County, Wisconsin, is a shallow relatively large **groundwater drainage lake**[1] which, despite its location in a primarily agricultural watershed, retains good water quality with respect to all parameters measured including transparency and water column nutrient content. These same qualities, however, provide excellent habitat for aquatic macrophyte growth. Macrophyte growth in White Lake currently occurs at nuisance levels during the open water season and causes, even with aeration, dissolved oxygen depletion over much of the lake during decomposition under ice in winter.

White Lake, even if subjected to costly and drastic habitat alteration (e.g., extensive dredging), will likely continue to be a very productive habitat for aquatic macrophytes. Riparian landowner diligence with respect to land use/care and septic tank maintenance should be emphasized to maintain water quality. This and physical or mechanical control of macrophytes, to best provide a recreationally usable and aesthetic resource, are recommended as realistic and achievable management objectives.

Water quality maintenance recommendations are common sense approaches aimed at control of nutrient and sediment inputs. Macrophyte control methods will eventually have to be intense and widespread, but must be designed to 1) minimize dispersal of current (bushy pondweed) and potential (Eurasian Milfoil) nuisance species and 2) maximize retrieval efficiency of cut organic debris.

A seasonal and localized harvest strategy is recommended for the near term. "Demonstration plots", with implications for a combination of control techniques, are recommended to evaluate and ultimately select cost-effective long term management that would minimize potential complications related to dispersal, succession, and higher competitiveness of nuisance species.

[1] Text terms in bold print defined in glossary (p. vi)

INTRODUCTION

White Lake is located two miles North of the City of Weyauwega in south-central Waupaca County, Wisconsin, and is the second largest (1,026 acres) lake in the county. The White Lake Preservation Association (WLPA) was formed in 1983 to provide leadership and coordination of lake preservation and educational activities pertinent to the resource. Its primary objectives have been to control excessive "weed" growth and, in general, to make the lake more desirable for all users. Currently, the WLPA has 154 members with a three member elected Board of Directors and four officers.

The WLPA formed a Grant Committee in 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. This committee 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:

1. establishment of a monitoring study designed to track

long-term trends,

2. acquisition of existing historic data and analysis, along with current data, to assess the current status of the resource,

3. identification of aquatic macrophyte control techniques appropriate to White Lake, and

4. identification of property owner activities to help maintain the quality of the lake.

A Planning Advisory Committee, comprised of representatives from WLPA, IPS, Waupaca County Land Conservation Department, Waupaca County Board of Supervisors, WDNR, the White Lake Aeration-Conservation Club and the Town of Royalton, was formed and met initially in February, 1991 to provide program guidance and direction.

DESCRIPTION OF AREA

White Lake (T22N R13E S15, 16, 20, 21, 22) is a groundwater drainage lake located in the Town of Royalton, Waupaca County, Wisconsin (Figure 1). The general topography of Waupaca County is related to glacial activity; that adjacent to the White Lake basin is level (presumably outwash plain) to the west, north, and east, with higher moderately sloped topography to the south. Low-lying areas immediately adjacent to the lake on the southwest and northeast shores are comprised primarily of Seelyeville and Cathro/Markey mucks; these are very poorly drained soils not generally suitable for septic tank drainage fields or dwellings. Predominant soils on the north and south shores are loamy sands; those on the north shore are rather poorly drained Meehan and Roscommon soils whereas those on the south shore are moderately to well-drained Plainfield soils (4).

White Lake has a surface area of 1,026 acres, an average depth of 6.0 feet, and a maximum depth of 11 feet. The fetch is 2.0 miles and lies in a east-west orientation; maximum width is 1.2 miles and lies in an northeast-southwest orientation. An inlet exists on the west shore and an intermittent outlet, tributary to the

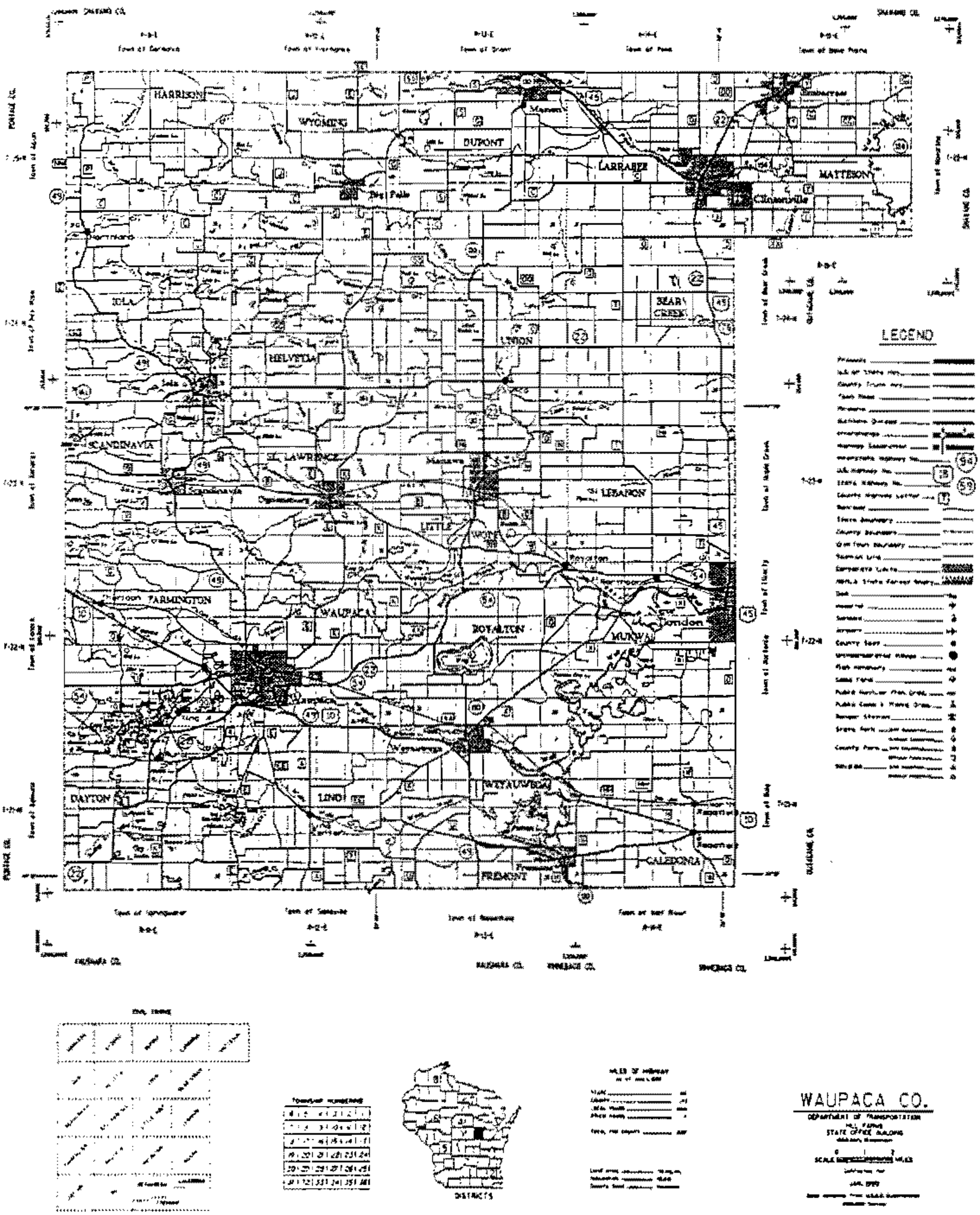

Figure 1. Location Map, White Lake, Waupaca County, WI.

South Branch of the Little Wolf River, exists on the east shore. Lake volume is about 6,200 acre feet with a residence time of about 7.4 years (5).

White Lake is a natural lake/wetland ecosystem which was, about 1870, partially drained (outlet) to create a cranberry marsh. A concrete dam with a four foot head was built in 1921 to restore and stabilize lake water level at about 96.25 feet (Railroad Commission Datum). The lake has experienced, currently and in the past, nuisance levels of macrophytes (aquatic plants) which, when the plants die and decompose under ice cover, contribute to severe dissolved oxygen (DO) depletion and fish kills in the winter. The White Lake Aeration-Conservation Club (WLACC) began winter aeration in 1973 in an attempt to alleviate this problem; partial kills, however, still occur (6). WLPA has operated a weed harvester through the open water season since 1983.

The watershed immediately adjacent to the lake, i.e. within 1,000 feet of shore, is about 1,011 acres. Land use within this immediate watershed is predominantly agricultural with areas of residential, forest and marsh. Primary watershed inflow is via the inlet which drains the lowland area on the southwest side of the lake. Groundwater flow is also in a southwest to northeast direction (7). Residential development is primarily along the north and south shores; all residences are on septic systems or holding tanks.

White Lake supports a moderate sport fishery for largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*) and catfish (*Ictalurus sp.*) (5). Other species present in a WDNR fish survey conducted in 1984 included yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigro-maculatus*), bluegill (*Lepomis macrochirus*), black bullhead (*Ictalurus melas*) and common sunfish (*Lepomis* sp. prob. *gibbosus*). Northern pike, walleye, largemouth bass, perch or bluegill were stocked in 1974-1976, 1978-1979, 1982-1984 by either WDNR or WLACC (6).

Three points of public access are located on the south shore. Parking facilities are available at the landing near the southwest corner of the lake.

METHODS

FIELD PROGRAM

Water sampling in 1991 was conducted in Winter (March 7), late Spring (May 23), mid-Summer (August 1) and late Summer (August 26) at one or two sites (Table 1, Figure 2). Station 0402 (near inlet) was sampled at mid-depth (designated "S"), and Station 0401 (mid-lake deepest point) was sampled near surface (designated "S") and near bottom (designated "B").

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 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 (8) methods.

Table 1. Sampling Station Locations, White Lake, 1991.

WATER QUALITY

Site	Latitude/Longitude		Depth
0401	44° 22.06'	88° 55.53'	10.0 ft.
0402	44° 21.78'	88° 57.29'	3.0 ft.

MACROPHYTE TRANSECTS

Transect	Latitude/Longitude Origin	End	Transect Length (m)	Bearing (Degrees)	Depth Range[1]	Interval End (m)
A*	44° 21.95' 88° 55.89'	44° 21.98' 88° 55.68'	280	84	1/2/3	15/222/280
B*	44° 21.49' 88° 56.35'	44° 22.15' 88° 56.02'	168	330	1/2/3	6/ 76/168
C*	44° 22.01' 88° 55.95'	44° 21.89' 88° 56.05'	280	204	1/2/3	12/122/280
D*	44° 21.53' 88° 56.30'	44° 21.68' 88° 56.35'	320	358	1/2	6/320
E*	44° 21.56' 88° 56.94'	44° 21.66' 88° 57.03'	220	22	1/2a/2b	6/ 12/220
F	44° 21.84' 88° 57.82'	44° 22.03' 88° 56.83'	370	180	1/2/3	5/ 24/370
G	44° 22.16' 88° 56.42'	44° 22.07' 88° 56.16'	320	155	1/2/3	5/ 30/320
H	44° 21.60' 88° 55.26'	44° 21.77' 88° 55.57'	500	320	1/2a/2b	5/ 61/500
I	44° 21.60' 88° 55.78'	44° 21.48' 88° 55.63'	220	342	1/2	6/220

* Indicates transect also sampled by WDNR-LMD in 1989

[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.)

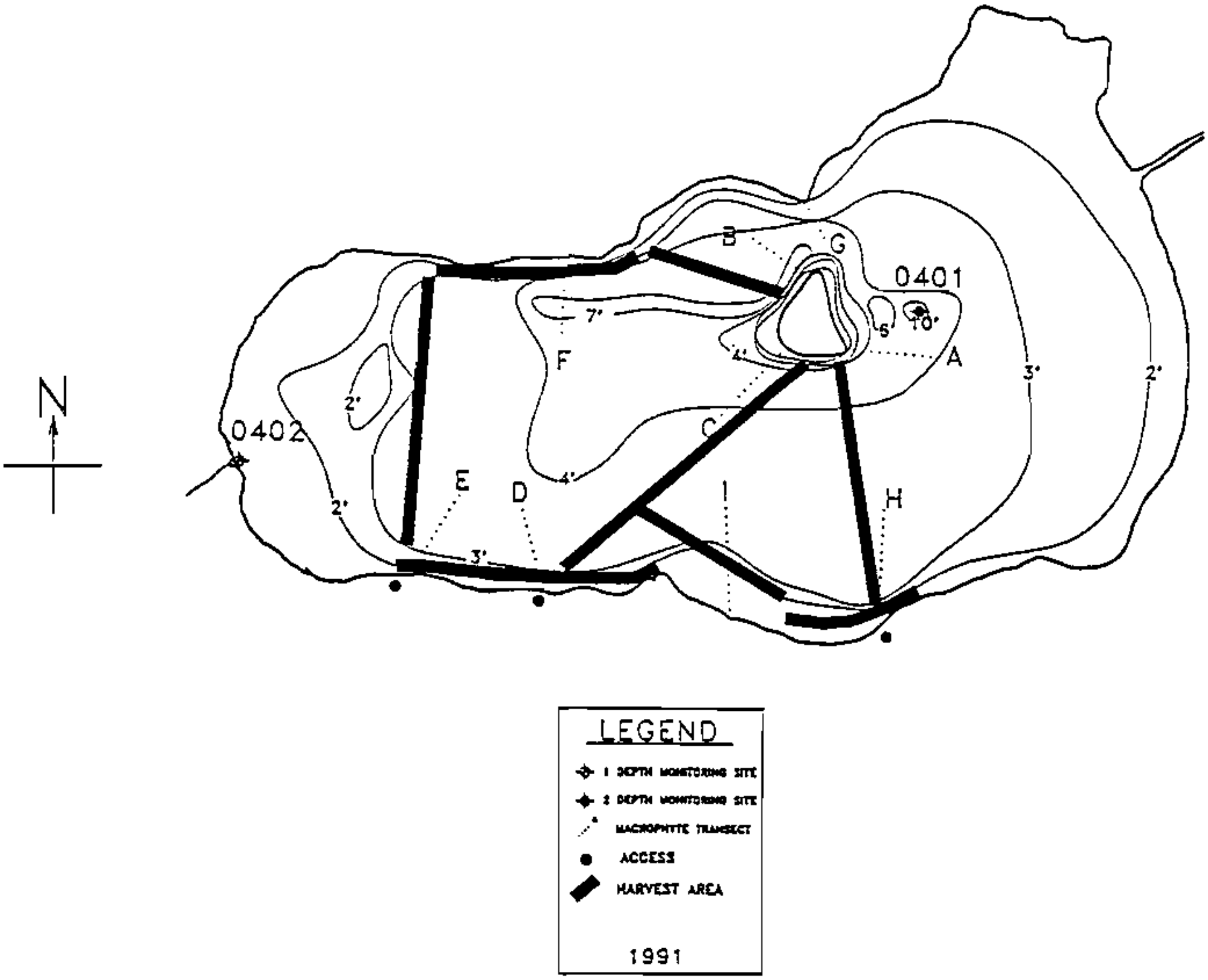

Figure 2. Sampling Sites, White Lake, Waupaca County, Wisconsin.

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, dissolved phosphorous, 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 and again later in the season 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). The method utilizes established transect endpoints 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 of the nine transects (A - E) sampled in 1991 were sampled by WDNR-LMD in July, 1989, and thus provided some historical trend information. The remaining four transects sampled in 1991 were chosen to provide information from areas of local importance (i.e. boat landings, harvesting zones, residential areas, etc.).

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 available 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, snorkeling 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 results and discussion section of this report.

OTHER PHYSICOCHEMICAL CHARACTERISTICS

Water Quality Information

Historic Secchi and water chemistry information was obtained from Hank Tank, WLPA water quality coordinator. Secchi readings dated back to August, 1985 and were measured about every two weeks through 1990 (when the lake was accessible). Additional Secchi data were taken from the 1990 WDNR Self Help Monitoring Program report (10). Spring and Fall water chemistry data (analyses performed by the University of Wisconsin-Stevens Point Environmental Task Force) were also obtained from the WLPA and dated back to November, 1985. Additional lake information was retrieved from the WDNR Surface Water Inventory (11) and from the WDNR Wisconsin Lakes publication (5).

Land Use Information

Details of zoning and specific land uses were obtained from the Waupaca County Zoning Administrator's Office zoning maps, United States Soil Conservation Service soil maps (4) 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 Waupaca County Zoning Ordinance, Waupaca County Floodplain Zoning Ordinance, and Waupaca County Erosion Control and Animal Waste Management Plans which were acquired from the Waupaca 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

The three major land uses in the immediately adjacent watershed are agriculture (45%), open-natural (36%) and residential (19%) (Figure 3). Past and current water quality monitoring data showed no significant nutrient inputs even though the overall watershed (i.e. all land draining to the lake) is predominately agricultural. White Lake has historically had low DO problems in the winter. This was observed again in the 1991 monitoring data (Tables 2 and 3). This problem apparently reflects the massive macrophyte growth rather than the occurrence and subsequent die-off/decomposition of algal blooms. When the macrophytes die, their decompositional oxygen demand depletes most of the available dissolved oxygen.

Phosphorus is most often the limiting factor in algal and plant production in lakes. Nitrogen to phosphorous ratios (N/P ratio) consistently greater than 15 also indicate White Lake to be phosphorous limited. Total phosphorus during past monitoring in White Lake (lake center surface) ranged from .002 to .032 mg/l (parts per million) with a mean value of .011 mg/l (Appendix II). Monitoring in 1991 showed total phosphorous in the range of .013 to .021 mg/l (mean = .016) at the in-lake site (0401). These in-

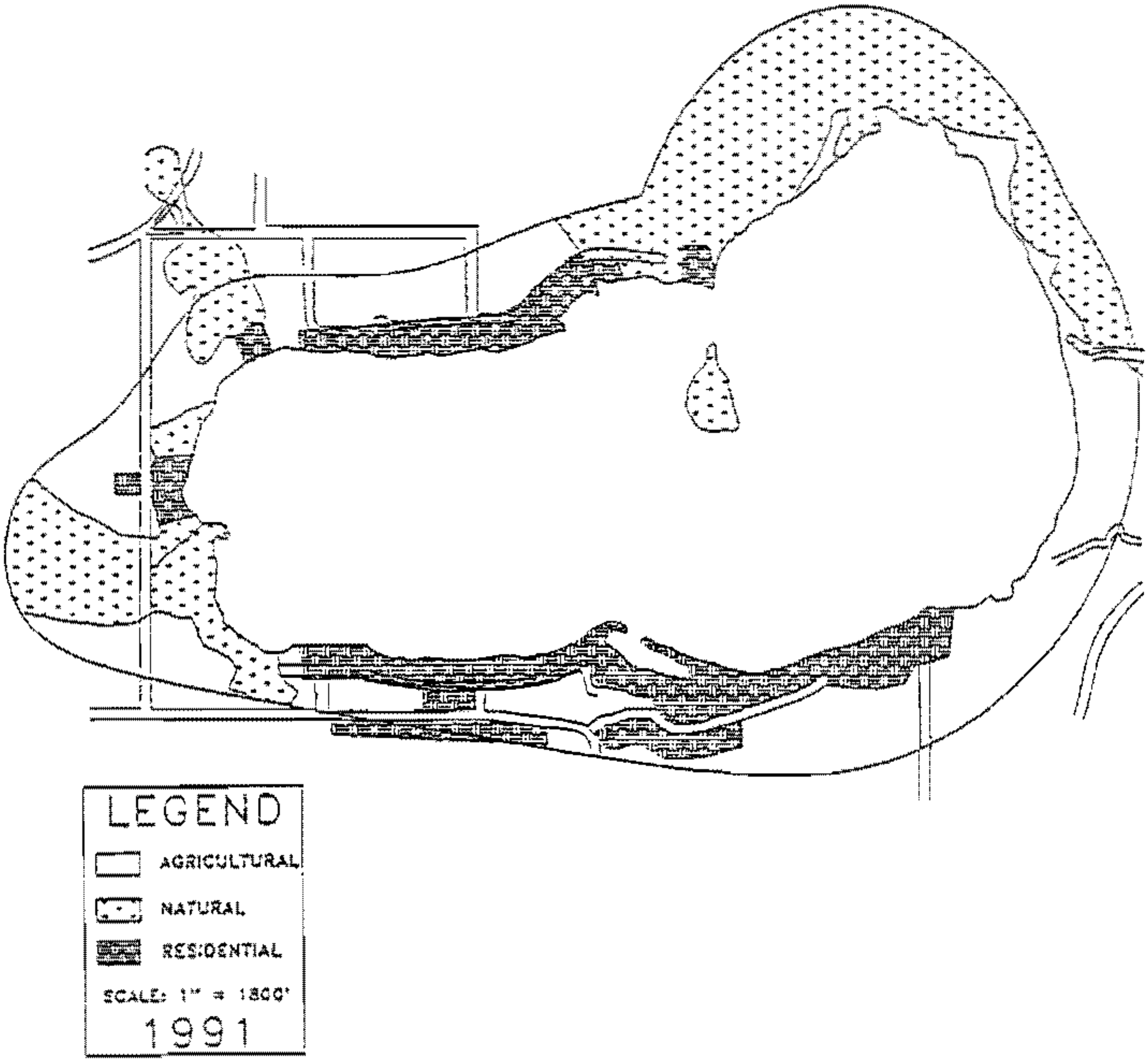

Figure 3. Land uses in the Immediately Adjacent Watershed, White Lake, 1991.

Table 2. Water Quality Parameters, Station 0401, White Lake, 1991.

PARAMETER	SAMPLE[1]	MAR 7	MAY 23	AUG 1	AUG 26
Secchi (feet)	S	-	7.5	9.0	9.0
Temperature (°C)	S	-	22.00	24.08	25.58
	B	4.13	15.80	22.63	24.91
pH (S.U.)	S	-	8.30	8.91	8.98
	B	6.64	9.30	8.59	8.92
D.O. (mg/l)	S	-	4.00	9.16	9.19
	B	.32	7.10	7.71	9.21
Conductivity (μmhos/cm)	S	-	202	192	186
	B	304	215	195	186
Laboratory pH (S.U.)	S	-	8.3	-	-
	B	7.6	8.2	-	-
Total Alkalintiy (mg/l)	S	-	95	-	-
	B	163	98	-	-
Total Kjeldahl N (mg/l)	S	-	1.2	1.0	1.0
	B	1.7	1.2	1.2	1.1
Ammonia Nitrogen (mg/l)	S	-	.045	.068	.017
	B	.231	.198	.079	.035
NO_2+NO_3 Nitrogen(mg/l)	S	-	.012	<.007	<.007
	B	<.015	.008	<.007	<.007
Total Phosphorous (mg/l)	S	-	.021	.013	.019
	B	.016	.017	.014	.014
Diss. Phosphorous (mg/l)	S	-	.004	.005	<.002
	B	.005	.005	.006	.002
Suspended Solids (mg/l)	S	-	2	-	-
	B	-	2	-	-
Chlorophyll *a* (μg/l)	S	-	11	2	2
Total Nitrogen (mg/l)	S	-	1.212	1.0	1.0
	B	1.7	1.208	1.2	1.1
N/P Ratio	S	-	57.7	76.9	52.6
	B	106.3	71.1	85.7	78.6

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

Table 3. Water Quality Parameters, Station 0402, White Lake, 1991.

PARAMETER	SAMPLE	MAY 23	AUG 1	AUG 26
Secchi (feet)	S[1]	b[2]	b	b
Temperature (°C)	S	22.70	23.15	25.03
pH (S.U.)	S	8.50	7.28	7.23
D.O. (mg/l)	S	5.60	5.29	2.63
Conductivity (μmhos/cm)	S	275	281	270
Laboratory pH (S.U.)	S	7.4	-	-
Total Alkalintiy (mg/l)	S	134	-	-
Total Kjeldahl N (mg/l)	S	2.0	2.3	2.2
Ammonia Nitrogen (mg/l)	S	.052	.030	.249
NO_2+NO_3 Nitrogen(mg/l)	S	.012	.013	.008
Total Phosphorous (mg/l)	S	.121	.111	.128
Diss. Phosphorous (mg/l)	S	.048	.040	.021
Suspended Solids (mg/l)	S	8	-	-
Chlorophyll a (μg/l)	S	6	13	22
Total Nitrogen (mg/l)	S	2.012	2.313	2.208
N/P Ratio	S	16.6	20.8	17.3

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

according to a recent compilation of summer total phosphorus levels in upper midwestern lakes (12), were lower than typical for the region in which White Lake is located.

Significantly higher concentrations of total phosphorous were observed near the inlet at Station 0402 (range of .111 to .128 mg/l; mean = .120). This inlet area receives little wind driven mixing and has very low flow which allows the water to become anoxic. Phosphorous release from the sediments, similar to that observed in deeper stratified lakes, occurs under anoxic conditions. Wetland areas adjacent to the inlet should filter out most of the runoff nutrients from adjacent agricultural lands before they reach the lake. Elevated phosphorous levels in this area, apparently related to agricultural runoff/sedimentation or long term organic buildup, are localized in this relatively stagnant area and do not appear to have significant impact on in-lake levels, which remain relatively low.

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 (13) 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 White Lake (lake center surface) chlorophyll a and total phosphorus levels range from those indicative of an oligotrophic to eutrophic condition, but overall suggest an early mesotrophic classification (Figures 4-5). TSI numbers for transparency indicate a mesotrophic to early eutrophic classification (Figure 6). Oligotrophic and early mesotrophic lakes are often relatively deep, cool, clear, and stratify in the summer. White Lake TSI values, therefore, indicate good water column quality; the lake, however, is very shallow and warm.

As would be expected given relatively clear, warm and shallow water over soft substrate, White Lake provides a habitat very conducive to macrophyte growth. During past (14) and recent macrophyte surveys (Appendix III), macrophytes (Table 4) were found at 77 of 78 sample sites (sample sites = number of depth ranges).

Bushy pondweed (*Najas* sp.) is widely distributed and, overall, the most abundant macrophyte (Tables 5-7). This plant is found completely submerged and mostly on mucky substrates in the second and third depth ranges (greater than .5 meters) (Table 8). *Najas* is an annual (which reproduces solely by seeds), is most commonly

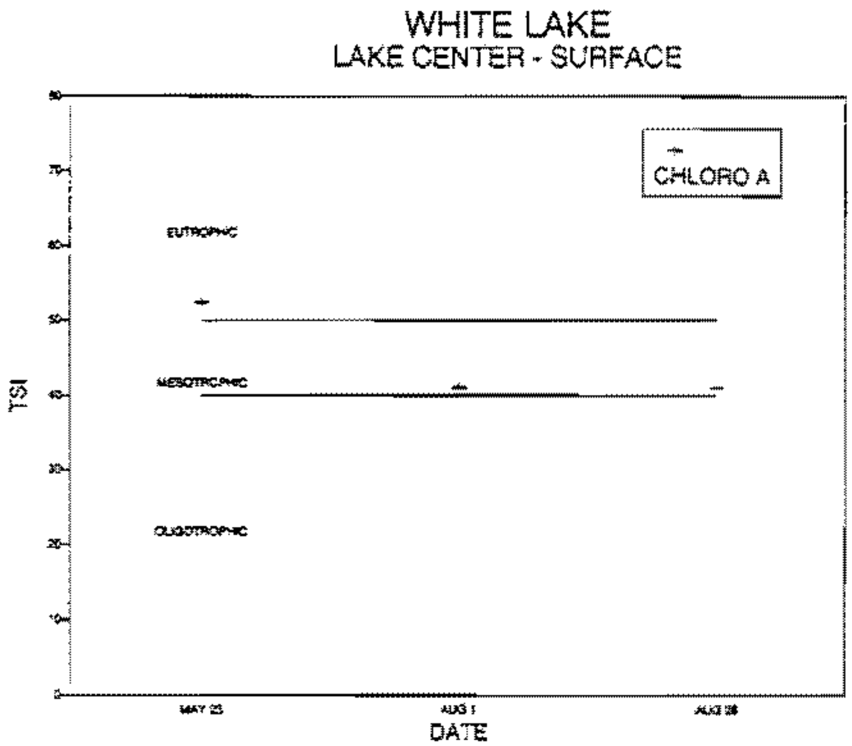

Figure 4. Trophic State Index for Chlorophyll a, White Lake, 1991.

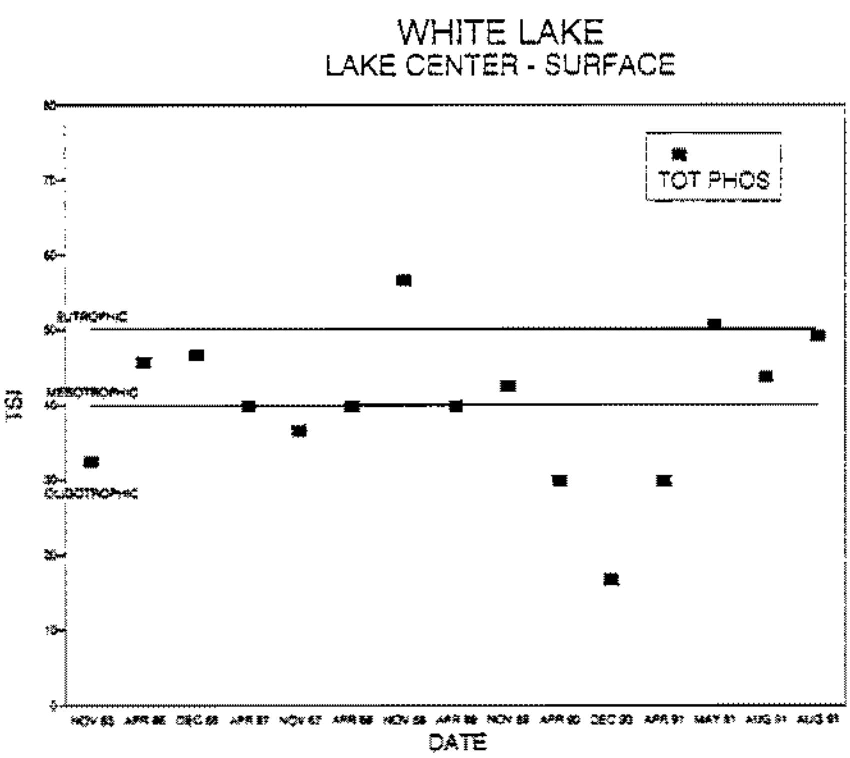

Figure 5. Trophic State Index for Total Phosphorous, White Lake, 1991.

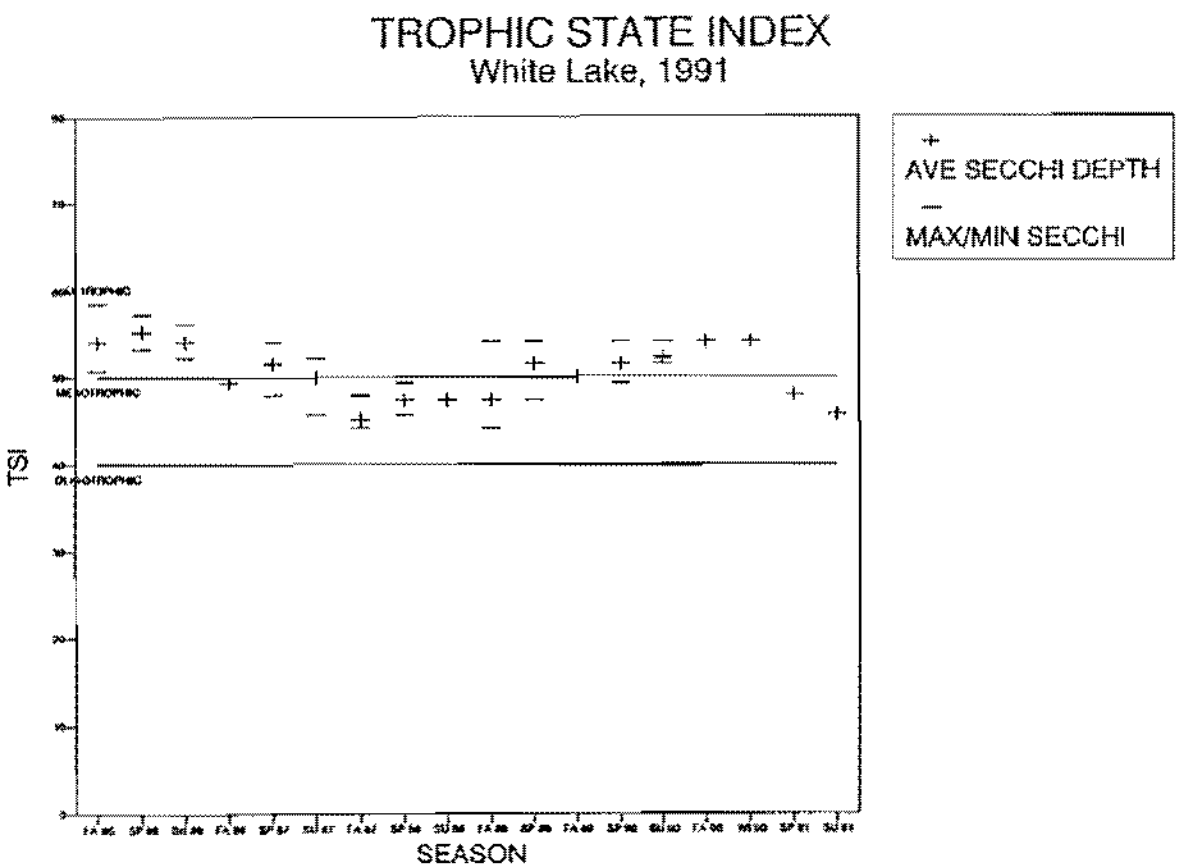

Figure 6. Trophic State Index for Secchi Depth, White Lake, 1991.

Table 4. Macrophyte Species Observed, White Lake, 1991 (15).

Taxa	Code
Coontail (*Ceratophyllum demersum*)	CERDE
Muskgrass (*Chara* sp.)	CHASP
Common waterweed (*Elodea canadensis*)	ELOCA
Filamentous algae	FILAL
Small duckweed (*Lemna minor*)	LEMMI
Water milfoil (*Myriophyllum* sp.)	MYRSPE
Eurasian Milfoil* (*Myriophyllum spicatum*)	MYRSPI
Bushy pondweed (*Najas* sp.)	NAJSP
Nitella (*Nitella* sp.)	NITSP or NITFL
Yellow pond lily (*Nuphar* sp.)	NUPSP
White pond lily (*Nymphaea* sp.)	NYMSP
No plants found	NOPLT
Pickerel-weed (*Pontedaria cordata*)	PONCO
Large-leaf pondweed (*Potamogeton amplifolious*)	POTAM
Illinios pondweed (*Potamogeton illinoensis*)	POTIL
Sago pondweed (*Potamogeton pectinatus*)	POTPE
Small pondweed (*Potamogeton pusillus*)	POTPU
White-stem pondweed (*Potamogeton praelongus*)	POTPR
Flat-stem pondweed (*Potamogeton zosteriformis*)	POTZO
Water Crowfoot (*Ranunculus* sp.)	RANSP
Rush (*Scirpus* sp.)	SCISP
Narrow-leaf cattail (*Typha angustifolia*)	TYPAN
Broad-leaf cattail (*Typha latifolia*)	TYPLA
Water celery (*Vallisneria americana*)	VALAM
Horned pondweed (*Zannichellia palustris*)	ZANPA

* Observed by WDNR in 1989

Table 5. Occurrence and Abundance of Macrophytes by Depth, White Lake, July 1991.

Depth Ranges

CODE	1 (N=9)		2 (N=11)		3 (N=5)	
	% of Sites	Σ Abundance (range)	% of Sites	Σ Abundance (range)	% of Sites	Σ Abundance (range)
CERDE	0	0	0	0	20	1(1)
CHASP	11	1(1)	9	1(1)	0	0
ELOCA	0	0	9	1(1)	0	0
FILAL	33	4(1-2)	0	0	0	0
LEMMI	11	2(2)	0	0	0	0
MYRSPE	33	6(1-3)	18	4(2)	20	1(1)
NAJSP	44	10(2-3)	90	38(1-5)	80	20(4-5)
NITSP	33	6(1-3)	9	2(2)	0	0
NUPSP	11	1(1)	0	0	0	0
NYMSP	56	8(1-2)	18	3(1-2)	0	0
NOPLT	11	0	0	0	0	0
PONCO	56	11(1-3)	27	5(1-2)	20	1(1)
POTAM	0	0	0	0	0	0
POTIL	11	1(1)	36	9(2-3)	40	3(1-2)
POTPE	22	2(1)	9	1(1)	0	0
POTPU	11	1(1)	0	0	0	0
POTPR	22	2(2)	90	26(2-5)	100	12(2-4)
POTZO	11	1(1)	18	6(3)	0	0
RANSP	0	0	0	0	0	0
SCISP	44	7(1-2)	56	8(1-2)	0	0
TYPAN	0	0	9	1(1)	0	0
TYPLA	11	5(5)	9	1(1)	0	0
VALAM	55	9(1-3)	18	5(2-3)	0	0
ZANPA	0	0	9	1(1)	0	0

Table 6. Occurrence and Abundance of Macrophytes by Depth, White Lake, August 1991.

Depth Ranges

CODE	1 (N=9)		2 (N=9)		3 (N=5)	
	% of Sites	Σ Abundance (range)	% of Sites	Σ Abundance (range)	% of Sites	Σ Abundance (range)
CERDE	0	0	11	1(1)	0	0
CHASP	0	0	0	0	0	0
ELOCA	11	2(2)	11	1(1)	0	0
FILAL	0	0	0	0	0	0
LEMMI	0	0	0	0	0	0
MYRSPE	0	0	11	1(1)	20	1(1)
NAJSP	78	15(1-4)	89	26(1-5)	60	11(3-5)
NITSP	22	3(1-2)	22	5(2-3)	0	0
NUPSP	0	0	0	0	0	0
NYMSP	11	1(1)	22	3(1-2)	0	0
NOPLT	0	0	0	0	0	0
PONCO	44	9(2-3)	56	10(1-3)	0	0
POTAM	33	6(1-3)	44	7(1-2)	0	0
POTIL	11	2(2)	89	13(1-3)	40	6(3)
POTPE	44	4(1)	11	1(1)	0	0
POTPU	0	0	0	0	0	0
POTPR	11	1	56	9(1-3)	40	5(2-3)
POTZO	22	3(1-2)	67	9(1-2)	40	2(1)
RANSP	0	0	11	1(1)	0	0
SCISP	22	3(1-2)	33	5(1-3)	0	0
TYPAN	0	0	0	0	0	0
TYPLA	11	5(5)	11	3(3)	0	0
VALAM	78	17(1-3)	89	14(1-3)	40	4(2)
ZANPA	0	0	0	0	0	0

Table 7. Comparison of Occurrence as Percent of Total Abundance for Selected Macrophytes by Depth, White Lake, 1991.

Species Code	Depth Range					
	1		2		3	
	JULY	AUG	JULY	AUG	JULY	AUG
NAJSP	13	21	31	25	48	38
POTPR	3	1	21	7	29	17
VALAM	12	24	4	14	0	14
PONCO	14	13	4	10	2	0
MYRSPE	8	0	3	1	2	3
POTIL	1	3	7	13	7	21
SCISP	9	4	7	5	0	0
TYPLA	6	7	1	3	0	0
NITSP	6	4	2	5	0	0
NYMSP	10	1	2	3	0	0

found in non-turbid water with hard substrates (15), and is rated as an excellent source of waterfowl food, but can reach nuisance levels. Bushy pondweed densities appear to have reached nuisance levels in White Lake and also to a point where they are detrimental to a more diverse plant community which typically provides a stable supply of forage organisms for fish and other aquatic organisms.

White-stem pondweed (Potamogeton praelongus) is the second most prevalent plant in White Lake (Tables 5-8). This plant typically does not reach nuisance levels and is a fair waterfowl food source which also provides fish with food and cover (15).

Table 8. Abundance Distribution and Substrate Relations for Selected Macrophytes, White Lake, July and August, 1991.

Transect	Substrate	NAJSP		POTPR		VALAM		PONCO		MYRSPE		POTIL		SCISP		TYPLA		NITSP		NYMSP	
		I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A
A1	SAND	0	2	0	0	1	3	0	0	1	0	0	0	0	0	0	0	3	2	1	0
A2	MUCK	5	0	3	0	0	3	0	0	0	0	0	1	1	1	0	0	0	0	0	0
A3	MUCK	5	3	2	3	0	2	0	0	0	1	0	3	0	0	0	0	0	0	0	0
B1	SAND	0	1	0	0	2	1	3	2	0	0	0	0	0	0	0	0	2	1	0	0
B2	MUCK	5	3	3	0	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0
B3	MUCK	5	5	4	2	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0
C1	SAND	0	0	0	0	0	0	2	2	0	0	0	0	2	0	5	5	0	0	1	0
C2	MUCK/SAND	5	4	2	1	0	1	0	1	0	0	0	2	0	3	0	3	0	2	0	1
C3	MUCK/SAND	2	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
D1	SAND	3	2	0	1	2	3	0	0	3	0	0	0	1	0	0	0	0	0	0	0
D2	MUCK	3	2	4	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
E1	SAND/MUCK	0	4	2	0	0	2	1	0	2	0	0	0	0	2	0	0	0	0	2	0
E2a	SAND/MUCK	0	5	2	3	0	1	1	0	2	0	0	2	0	0	0	0	0	0	2	0
E2b	MUCK	3	0	2	0	0	0	1	0	0	0	2	0	1	0	1	0	0	0	1	0
F1	SAND	2	1	0	0	0	3	3	3	0	0	1	2	2	1	0	0	0	0	2	0
F2	SILT/SAND	5	3	4	3	0	2	0	2	2	0	3	2	0	0	0	0	0	0	0	0
F3	SILT/MUCK	4	3	3	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0
G1	SAND	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G2	SAND	1	4	0	0	2	3	0	0	0	0	0	3	0	0	0	0	2	0	0	0
G3	MUCK	4	0	2	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
H1	SAND	3	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2a	SA/MU/SI	3	2	3	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
H2b	MUCK/SILT	3	0	1	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
I1	SAND/MUCK	2	3	0	0	3	0	2	2	0	0	0	0	2	0	0	0	0	0	2	0
I2	MUCK/SILT	5	3	2	1	0	1	2	3	0	0	2	1	2	1	0	0	0	3	0	2

White Lake also has established areas of cattail (*Typha latifolia* and *Typha angustifolia*), purple loosestrife (*Lythrum salicaria*) and water milfoil (*Myriophyllum* sp.). These species can reach nuisance levels under certain conditions (15).

A dense stand of cattails is found on the south side of the island as well as along the shore. These stands, according to WLPA, appear to have been increasing for the last 20 years and concern has been expressed about this occurrence. Otherwise, overall macrophyte species dominance in White Lake does not appear to have changed substantially since 1989 (Table 9).

Table 9. Comparison of Sum Abundance of Selected Macrophytes for Duplicated Transects, White Lake, 1989-1991.

Species Code	Sum Abundance Year 1989	Sum Abundance Year 1991
NAJSP	32	36
POTPR	23	26
VALAM	9	5
PONCO	5	8
MYRSPE	1	8
POTIL	0	4
SCISP	5	7
TYPLA	5	6
NITSP	11	5
NYMSP	0	7

Species determination for water milfoil (Myriophyllum sp.) was not possible because of lack of distinguishing flower parts during the time of survey. The WDNR-LMD 1989 macrophyte survey, however, showed only Eurasian Milfoil (Myriophyllum spicatum) present in White Lake. This species is an exotic (not native to Wisconsin) and has shown the capability to outcompete native vegetation and reach nuisance levels quickly; this has not yet been observed in White Lake. Purple loosestrife which occurs on shore, adjacent to White Lake, is also an invader which tends to displace native vegetation in marsh areas along shores.

BASELINE CONCLUSIONS

1. White Lake proper water quality during the open-water season is good with respect to all parameters. Transparency is good, i.e., to bottom over most of this shallow lake, and total phosphorous is lower (.013 to .021 mg/l) than that normally found (.030 to .050) in lakes in this region. Higher phosphorous levels and lower DO occur in and near the usually rather stagnant inlet, but effects of this inflow on lake proper water quality do not appear significant.

2. White Lake, due to physical habitat conditions including shallow depth, high transparency, and predominantly soft substrate materials, supports prolific macrophyte growth which repeatedly reaches, despite rather intensive harvesting efforts (16), nuisance levels. Bushy pondweed (*Najas* sp.) and white-stem pondweed (*Potamogeton praelongus*) are dominant and the exotic Eurasian Milfoil (*Myriophyllum spicatum*) is present.

3. Dissolved oxygen depletion during winter has been and continues to be a major problem in White Lake. Partial fish kills still occur (last documented in 1986) and severe kills are anticipated during years with thick snow

cover. The aeration system is reported to only affect areas within 500 feet of the aeration units. The major cause of this problem appears to be related to decomposition of macrophytes rather than algae (6).

4. Long term management efforts should concentrate on water quality maintenance and effective practical macrophyte control.

MANAGEMENT ALTERNATIVES DISCUSSION

Water Quality

White Lake is a rather large shallow lake with a small watershed. Direct agricultural influence is minimal and water quality is good during the open-water season. Riparian land use practices can have a major influence on this small lake and land owner diligence should be strongly emphasized and encouraged to maintain this condition. 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 especially important in White Lake because predominant soils are either too mucky to permit required flow-through or 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 the 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.

Land 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 (17).

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 out nutrients and soil particles), shade areas of the lake to reduce macrophyte growth (especially on south shores), and provide fish cover. Placement of a low berm in this area can enhance effectiveness of the buffer strip by further retarding runoff during rainfalls. A buffer zone not only protects lake water quality but creates habitat for wildlife and provides privacy.

Placement of rock rip-rap can also retard erosion and soil loss related to wave erosion, ice expansion and wind-thrown ice. A rip-rapped area two feet wide over filter cloth with rocks about 4-7" in diameter can be a very effective barrier. A WDNR permit is required for rip-rapping.

There are numerous informational sources available to land owners with questions regarding land management practices. Some sources are outlined in Appendix IV.

Dissolved oxygen depletion under ice is, and will probably continue (as long as prolific macrophyte growth continues), to be a major problem in White Lake. Aeration, through maintenance of open water and direct introduction of oxygen to the water column, can be very effective in better maintaining numerous year classes of fish. Continued operation of the existing aerator, at least, is strongly recommended, though steps should be taken to assess its effectiveness. SCUBA observation of fish concentrations and activity in aerated areas of the lake may give insight as to possible system upgrades.

Macrophytes

Control of dense macrophyte growth should be the major management objective on White Lake. Existing macrophytic growth affects the resource not only aesthetically, but physically (e.g. organic sediment build-up) and biologically (e.g. winter fish stress, critical habitat reduction) 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 White Lake applicability.

Dredging is a drastic form of habitat alteration. Dredging could range from massive whole-lake sediment removal to a depth (about

14 feet) at which macrophyte growth would be retarded due to reduced sunlight (16) to spot dredging of limited (high priority) areas with subsequent in-lake deposition of sediment to create islands. Large scale sediment removal is very costly; a previous estimate in 1986 for this on White Lake was about $60 million. Spot dredging, because of lower cost is a reasonable alternative in some cases. The success potential for spot dredging in White Lake is very low, however, due to the shallow water habitat and high potential for wind-driven sediment redistribution (18). Neither form of dredging presently appears appropriate for White Lake in the near term.

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, unknown environmental hazards and the provision of a potential avenue for invasion of exotic species. Chemical treatment should not be considered for White Lake at this time.

Partial drawdown can be an effective macrophyte control method and is implementable to some degree in White Lake. Lowering the water level 12-18" would expose littoral area roots, tubers and rhizomes of macrophytes to freezing conditions in the winter and could eliminate some of the near-shore species. A summer draw-down could aid the mechanical harvester 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 the lake association (19). Potential problems with this method are that some species are reported to increase in density after drawdown (including bushy pondweed) and that restoration of lake level may be difficult and take several years during dry years or seasons.

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 consists of rototilling sediments to destroy plant roots and 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 mechanical macrophyte harvester. 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 (20). Potential drawbacks include limited spatial applicability and elimination of use of the area 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 White Lake. Nuisance macrophyte growth on White Lake is widespread and would require intensive application to achieve lake-wide effect. Secondly, the most abundant macrophyte in the lake is bushy pondweed which spreads solely by seed dispersal. Thirdly, the exotic Eurasian Milfoil is present in White 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-lake disposal. This type of harvester is currently operated throughout the open-water season on White

Lake. Over 100 "loads" (i.e. more than in any past year of effort) were removed in 1991. Despite this effort, only marginal success in maintenance of "boat lanes" was achieved and no long term improvement overall was observed. Given the previously mentioned precautions regarding bushy pondweed and Eurasian Milfoil dispersal, present harvest practices may even enhance the nuisance macrophyte problem through seed dispersal, fragmentation or incomplete removal. Indiscriminate power boat usage outside maintained boat lanes, 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 the harvester cannot reach bottom. It can also be used to target only desired species (bushy pondweed and Eurasian Milfoil). This method is labor intensive, but has proved to effectively reduce nuisance plant levels for up to two years (18).

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 SCUBA assisted methods.

Macrophyte control techniques vary considerably with respect to cost-effectiveness. To ensure selection of the most cost-effective implementational approach to White Lake macrophyte control, WLPA should consider a combination of techniques with localized and/or seasonal application "demonstration plots." These plots, to be most effective, need to be well documented and closely watched with respect to the many field variables present in White Lake.

MANAGEMENT RECOMMENDATIONS

WLPA should strongly encourage riparian land owner diligence with respect to septic tank operation/condition, creation of shoreline buffer strips and proper fertilization practices to maintain good existing water quality.

Winter aeration should be continued, at least, at its present level to provide some relief to the fishery during winter low dissolved oxygen stress. Additional monitoring to determine present spatial effect should be conducted and the potential need for expanded aeration assessed.

Macrophyte control, which eventually would have to be intense and widespread to achieve noticeable improvement, should heavily emphasize minimization of species at nuisance levels (bushy pondweed and Eurasian Milfoil dispersal) and the build-up of in-lake organic sediments. Near-term procedure according to the following rationale is recommended:

- Control of nuisance macrophytes should be implemented by riparian landowners in their immediate shoreline area extending out to a depth of about three feet. Macrophyte control at these depths, where harvester efficiency is greatly reduced, can be accomplished relatively easily by the landowner through raking.

- Existing mechanical harvesting may be intense and widespread, if desired, but only early in the season to minimize seed dispersal. Boat lanes should be well marked (buoyed) during this time frame. Later season mechanical harvesting should be confined to areas where harvester efficiency is high and to well marked "lanes", with emphasis on <u>complete and efficient removal</u> of cut macrophytes. Informational brochures/posters should be distributed or displayed at accesses to discourage unnecessary macrophyte disruption by power boats outside of lanes.

- Demonstration plots to evaluate efficiencies of various combinations of methods should be concurrently implemented. Experimental designs should include:

    * Shallow vs. deep water (depth related efficiency with draw-down implications)
    * Mechanical vs. SCUBA assisted harvest (relative species/time frame efficiency)
    * Documentation of taxonomic changes (successor species)

* Evaluation of transplanting/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 (specifically to determine depth of silt to sand) may be undertaken to evaluate potential for future 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 WLPA was formed in 1983 under provisions of Chapter 181, Wisconsin Statutes. The WLPA 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 White Lake watershed is located within the political jurisdictions of the Town of Royalton, County of Waupaca and the State of Wisconsin. These units have the power to regulate land uses and land use practices. Waupaca County ordinances and Plans possibly pertinent to the White Lake plan are summarized in Appendix V.

Potential sources of funding for implementation projects are listed in Appendix VI.

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APPENDIX I
PUBLIC INVOLVEMENT ACTIVITIES SUMMARY
White Lake Management Plan

The White Lake Preservation Association (WLPA) initiated steps to develop a comprehensive lake management plan inder the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program in the fall of 1990. The grant was received on December 20, 1990. A public involvement program was immediately initiated as part of the planning process. The following is a summary of major public involvement efforts.

Planning Advisory Committee

A Planning Advisory Committee comprised of representatives from WDNR, IPS, the White Lake Aeration-Conservation Club, the Town of Royalton, the Waupaca County Conservation Department and Committee, Waupaca County UW-Extension and the Waupaca County Zoning was established at the start of the program. The committee provided direction during the planning program and served as main reviewer of the draft plan document,

Brochures

A brochure entitled, "White Lake Management Planning Program", was developed initially to acquaint WLPA members and others about the objectives and elements of the program. The brochure also included a brief history of the lake and described how members of the WLPA could get involved. Approximately 600 copies of the brochure were produced and distributed.

A plan brochure will also be produced. It will be made available for WLPA use and distribution when the plan has been approved by the WDNR. The brochure will describe the main features of plan development, plan recommendations and pertinent information specific to implementation.

Newsletter

The WLPA newsletter, "White Lake Clipper", with a monthly distribution of about 200 copies, provided updates on the planning effort throughout the program.

Meetings

The WLPA conducted monthly meetings for its members and other interested parties. Meeting agenda included progress reports and guest speakers on various aspects of lake management (UW-Extension Waupaca County Resource Agent, UW-Stevens Point Extension Lake Specialist and IPS among others). All meetings

APPENDIX I
(Continued)

were open to the public. Information on the planning program was also available at WLPA's fisheree and annual cook-out.

Print Media

The "Weyauwega Chronicle", a local weekly newspaper, published articles on the planning effort throughout the course of the program.

Other

The WLPA played a key role in the development of the Waupaca County Lake Association. The overall objective of the association is to provide a forum to facilitate timely exchange of lake management planning information with emphasis on Waupaca County. The Waupaca County Lake Association conducted a half-day workshop on lake management planning, water sampling and lakeshore landscaping.

APPENDIX II

HISTORIC WATER QUALITY DATA
WHITE LAKE, WAUPACA COUNTY, WI
11/85 - 04/91

		Center Lake Surface												Outlet	
		Date													
Parameter	Unit	11/85	04/86	12/86	04/87	11/87	04/88	11/88	04/89	11/89	04/90	12/90	04/91	10/84	11/85
pH	SU	7.96	8.05	7.81	7.91	8.24	7.78	8.20	7.87	8.04	8.12	7.33	7.9[illegible]	8.30	7.96
Conductivity	umhos/cm	221	164	220	206	223	216	226	220	217	220	221	216	186	221
Alkalinity	mg/l $CaCO_3$	110	86	102	92	96	92	96	108	92	116	96	108	84	110
T. Hardness	mg/l $CaCO_3$	103.5	86.9	106.3	96	108	104	116	116	112	120	104	112	86	103.5
T. React. Phos.	mg/l	< .002	0.10	.010	< .002	< .002	.002	.010	.002	< .002	< .002	.008	< .002	.010	NA
T. Phos.	mg/l	.006	.016	.015	.010	.008	.010	.032	.010	.012	.005	.002	.00[illegible]	.015	.06
Ammonium	mg/l	.17	.24	.30	.07	.11	.01	.06	< .02	.10	.05	.40	.10	.12	.17
NO_2/NO_3	mg/l	.08	.12	.05	.01	.01	< .01	.02	.20	.01	.05	.10	.05	.08	.08
Tot Kelj N	mg/l	1.70	1.17	1.45	1.12	1.22	.60	1.60	1.25	1.38	.35	1.42	.7[illegible]	1.20	1.70
N/P Ratio		29.7	80.6	100.0	112.0	153.8	60.0	50.6	145.0	115.8	80.0	69.1	166.0	85.3	29.7

APPENDIX III
MACROPHYTE SURVEY DATA
WHITE LAKE, JULY AND AUGUST, 1991

Transect	Substrate	Species Code																			
		NAJSP		POTPR		VALAM		PONCO		MYRSPE		POTIL		SCISP		TYPLA		NITSP		NYMSP	
		J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A
A1	SAND	0	2	0	0	1	3	0	0	1	0	0	0	0	0	0	0	3	2	1	0
A2	MUCK	5	0	3	0	0	3	0	0	0	0	0	1	1	1	0	0	0	0	0	0
A3	MUCK	5	3	2	3	0	2	0	0	0	1	0	3	0	0	0	0	0	0	0	0
B1	SAND	0	1	0	0	2	1	3	2	0	0	0	0	0	0	0	0	2	1	0	0
B2	MUCK	5	3	3	0	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0
B3	MUCK	5	5	4	2	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0
C1	SAND	0	0	0	0	0	0	2	2	0	0	0	0	2	0	5	5	0	0	1	0
C2	MUCK/SAND	5	4	2	1	0	1	0	1	0	0	0	2	0	3	0	3	0	2	0	1
C3	MUCK/SAND	2	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
D1	SAND	3	2	0	1	2	3	0	0	3	0	0	0	1	0	0	0	0	0	0	0
D2	MUCK	3	2	4	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
E1	SAND/MUCK	0	4	2	0	0	2	1	0	2	0	0	0	0	2	0	0	0	0	2	0
E2a	SAND/MUCK	0	5	2	3	0	1	1	0	2	0	0	2	0	0	0	0	0	0	2	0
E2b	MUCK	3	0	2	0	0	0	1	0	0	0	2	0	1	0	1	0	0	0	1	0
F1	SAND	2	1	0	0	0	3	3	3	0	0	1	2	2	1	0	0	0	0	2	0
F2	SILT/SAND	5	3	4	3	0	2	0	2	2	0	3	2	0	0	0	0	0	0	0	0
F3	SILT/MUCK	4	3	2	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0
G1	SAND	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G2	SAND	1	4	0	0	2	3	0	0	0	0	0	3	0	0	0	0	2	0	0	0
G3	MUCK	4	0	2	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
H1	SAND	3	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2a	SA/MU/SI	3	2	3	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
H2b	MUCK/SILT	3	0	1	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
I1	SAND/MUCK	2	3	0	0	3	0	2	2	0	0	0	0	2	0	0	0	0	0	2	0
I2	MUCK/SILT	5	3	2	1	0	1	2	3	0	0	2	1	2	1	0	0	0	3	0	2

APPENDIX III
MACROPHYTE SURVEY DATA
WHITE LAKE, JULY AND AUGUST, 1991

Transect	Substrate	Species Code																			
		CERDE		CHASP		ELOCA		FILAL		LEMMI		NUPSP		POTAM		POTPE		POTPU		POTZO	
		I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A
A1	SAND	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0
A2	MUCK	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
A3	MUCK	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
B1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
B2	MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1
B3	MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
C1	SAND	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
C2	MUCK/SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
C3	MUCK/SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D1	SAND	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	1	0	0	0	0
D2	MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1
E1	SAND/MUCK	0	0	1	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
E2a	SAND/MUCK	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2
E2b	MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
F2	SILT/SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
F3	SILT/MUCK	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G2	SAND	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G3	MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	2
H2a	SA/MU/SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
H2b	MUCK/SILT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I1	SAND/MUCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
I2	MUCK/SILT	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	1	0	0	0	0

APPENDIX III
MACROPHYTE SURVEY DATA
WHITE LAKE, JULY AND AUGUST, 1991

Transect	Substrate	Species Code							
		RANSP		TYPAN		ZANPA		NOPLT	
		I	A	I	A	I	A	I	A
A1	SAND	0	0	0	0	0	0	-	-
A2	MUCK	0	0	0	0	1	1	-	-
A3	MUCK	0	0	0	0	0	0	-	-
B1	SAND	0	0	0	0	0	0	-	-
B2	MUCK	0	0	0	0	0	0	-	-
B3	MUCK	0	0	0	0	0	0	-	-
C1	SAND	0	0	0	0	0	0	-	-
C2	MUCK/SAND	1	1	0	2	0	0	-	-
C3	MUCK/SAND	0	0	0	0	0	0	-	-
D1	SAND	0	0	0	0	0	0	-	-
D2	MUCK	0	0	0	0	0	0	-	-
E1	SAND/MUCK	0	0	0	0	0	0	-	-
E2a	SAND/MUCK	0	0	0	0	0	0	-	-
E2b	MUCK	0	0	0	0	0	0	-	-
F1	SAND	0	0	0	0	0	0	-	-
F2	SILT/SAND	0	0	0	0	0	0	-	-
F3	SILT/MUCK	0	0	0	0	0	0	-	-
G1	SAND	0	0	0	0	0	0	0	-
G2	SAND	0	0	0	0	0	0	-	-
G3	MUCK	0	0	0	0	0	0	-	-
H1	SAND	0	0	0	0	0	0	-	-
H2a	SA/MU/SI	0	0	0	0	0	0	-	-
H2b	MUCK/SILT	0	0	0	0	0	0	-	-
I1	SAND/MUCK	0	0	0	0	0	0	-	-
I2	MUCK/SILT	0	0	0	0	0	0	-	-

APPENDIX IV
SOURCES OF INFORMATION AND ASSISTANCE (21)
White Lake, Waupaca County

Department of Natural Resources:

Waupaca Area Office
N2490 Hartman Creek Road
Waupaca, WI 54981
715-258-2372 or

Lake Michigan District Office
Tim Rasman
Lakes-LMD
1125 N. Military Road, Box 10448
Green Bay, WI 54307-0448
414-497-6034

Can answer questions on lake management, groundwater, water quality, fisheries, regulations, zoning and wildlife or direct you to someone that can be of help.

East Central Wisconsin Planning Commission:

Ken Theine
RP, ECWRPC
132 N. Main Street
Menasha, WI 54952
414-729-4770

Has information regarding zoning and building planning information as well as information on land use.

Environmental Task Force:

Environmental Task Force
College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481

Will test soils, lake water or well water.