IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE I
LAKE MANAGEMENT PLAN
ENGLISH LAKE
MANITOWOC COUNTY, WISCONSIN

REPORT TO:
English Lake Management District

November, 1992

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SUMMARY

English Lake is a small, relatively deep, fertile lake located six miles southwest of the City of Manitowoc in Manitowoc County, Wisconsin. The lake receives overland runoff and drainage tile inputs from a predominantly agricultural watershed, with fertile loamy soils, and exhibits yearly and seasonal **algal**[1] blooms.

Water quality, when rated according to Trophic State Index, was **mesotrophic** to **eutrophic** for total phosphorus and **chlorophyll a**, and **oligotrophic** to eutrophic for **Secchi depth**. English Lake, however, has a very narrow **littoral** zone which limits the amount of rooted aquatic plants (**macrophytes**) and allows nutrients to be available for algal growth. Filamentous algae and water celery were most abundant; a relatively low number of species was noted on the mainly sandy substrates.

Summer surface total phosphorus in English Lake was lower than expected in 1991-1992. Lowest surface total phosphorous readings were observed during summer months and may be the result of lower runoff, algal binding of nutrients and/or **stratification**.

Management objectives should target continued monitoring, better definition and reduction of surface runoff (where possible and practical), riparian education/awareness of land use practice effects on water quality and potential use conflicts:

- Water quality monitoring, including regular, event, Secchi and rainfall data, should be continued to track trends.

- Many riparian lots on English Lake are located on a steep slope and provide the only buffer strip between the lake and the agricultural watershed. Some runoff is directed to the lake via underground tile systems, but buffer stripping, contour sloping, fertilizer management and other common sense practices should be implemented to slow overland runoff and eliminate its potentially harmful effects.

- Agricultural land owners in the English Lake watershed should implement **Best Management Practices (BMP's)** where practical and take advantage of cost-share funding where available. Consideration may specifically be given to eliminating winter manure spreading, planting sod waterways, controlling barnyard runoff and crop rotation conservation. The feasibility of redirecting drain tiles should be examined.

- Distribution of a recreational use survey may help to solicit opinions and attitudes to guide management.

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

INTRODUCTION

English Lake is located in the Town of Newton in south-central Manitowoc County, Wisconsin. The lake is a natural **seepage lake** and has no permanent inlet or outlet. Groundwater inflow and precipitation are the primary sources of water for the lake.

The English Lake Management District (ELMD) was formed in 1982 to provide leadership and coordination of lake preservation and educational activities pertinent to English Lake. Major concerns of the ELMD in development of a lake management plan included high nutrient runoff, perennial algal blooms and general water quality upkeep. Currently, the ELMD has three elected officers and about 60 voting members; the Town Chairman and a County Board member also serve on the ELMD board.

The ELMD, in October, 1990, decided to pursue development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. The ELMD officers 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 objectives, was prepared, submitted, and approved in April 1991:

- determine lake water quality and track trends,
- identify causes of water quality problems,
- increase awareness of lake property owners and establish a base of support for lake management efforts,
- locate, identify and quantify aquatic macrophyte concentrations.

A Planning Advisory Committee, comprised of representatives from ELMD, IPS, WDNR and the Manitowoc County Soil and Water Conservation Department (MCSWCD) was formed and met initially in May, 1991 to provide program guidance and direction.

DESCRIPTION OF AREA

English Lake (T18N R23E S7) is a seepage lake located southwest of Manitowoc in Manitowoc County, Wisconsin (Figure 1). The general topography of Manitowoc County is related to glacial activity. The English Lake watershed is predominantly agricultural with residential areas bordering the lake. Topography of lands adjacent to the lake basin is generally level; topography immediately adjacent to the basin varies from level to moderately steep. Major soil types in the English Lake area are well drained Kewaunee loams on 2-20 percent slopes (North and East) and poorly drained Manawa and Mundelein silt loams on 0-3 percent slopes. Soil permeability is slow to moderately slow and soils often require artificial drainage for agricultural uses; soils are also unsuited to septic systems because low permeability (4).

English Lake is within the Seven Mile-Silver Creek watershed which was designated a priority watershed in the Fall of 1985. The Priority Watershed Program provides cost-share grants to land owners to implement soil and water conservation practices to benefit water resources. The application period for Priority Watershed funding continued until July, 1990 and implementation of recommended plans will continue until July, 1995 (Pers. comm. MCSWCD).

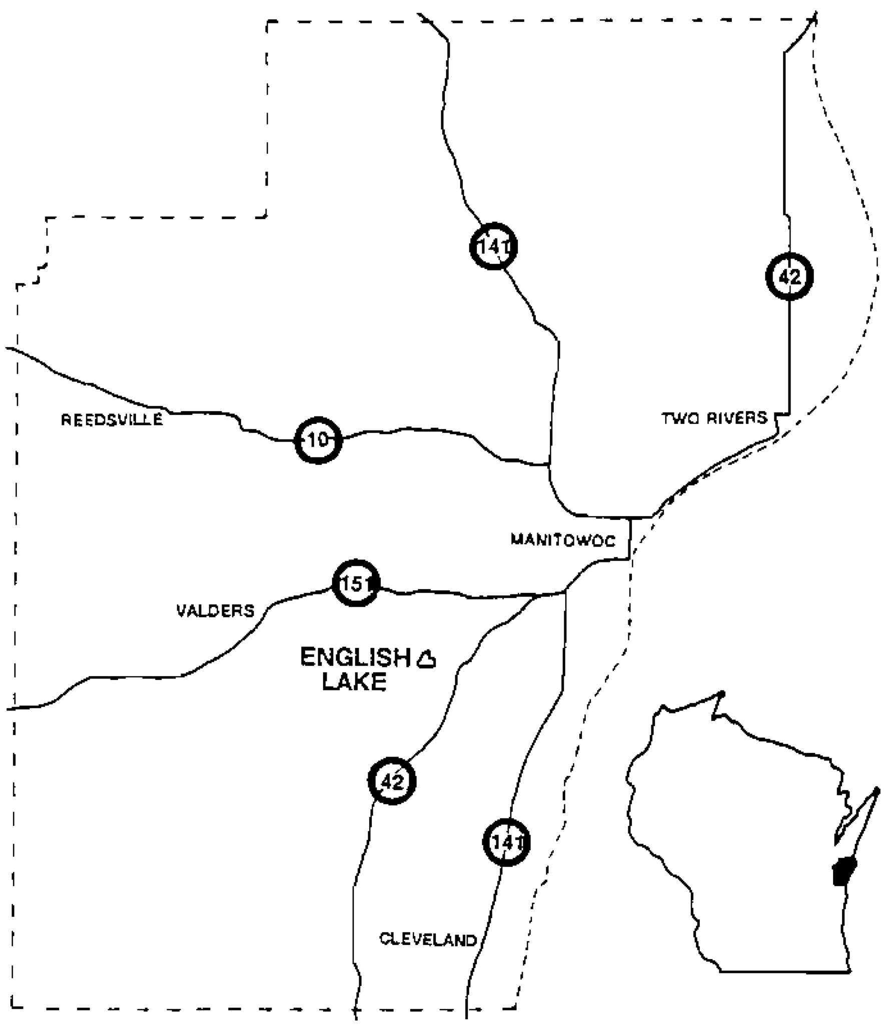

Figure 1. Location Map, English Lake, Manitowoc County, WI.

English Lake has a surface area of 51 acres, an average depth of about 34 feet, a maximum depth of 90 feet and a volume of 1,734 acre-feet (5). Only 21% of the lake surface area is less than five feet in depth and almost 60% is deeper than 20 feet. The **fetch** is 0.4 miles and lies in a southwest-northeast orientation and the width is 0.25 miles in a north-south orientation. English Lake has 1.1 miles of shoreline and a **shoreline development factor** of 1.13 (6).

The English Lake watershed is about 190 acres and is predominantly agricultural and residential; about 60 homes border the lake. The watershed to lake ratio is about 3.7 to 1 which means that 3.7 times more land than lake surface area drains to the lake. **Residence time** was not available for English Lake but when back-calculated (using linear regression equations) against the watershed to lake ratio, two estimates indicated the residence time to be 2.14 (7) to 7.01 years (8). Predominant littoral substrates include **marl** (90%) and sand/gravel (10%) with small areas of clay (6).

English Lake fish species include: largemouth bass (*Micropterus salmoides*), rock bass (*Ambloplites rupestris*), walleye (*Stizostedion vitreum*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), sunfish (*Lepomis* spp.), northern pike (*Esox lucius*), bullhead (*Ictalurus* spp.), bluntnose minnow (*Pimephales notatus*) and golden shiner (*Notemigonus crysoleucas*) (6).

A black crappie/black bullhead removal project was implemented in 1977 to thin abundant, slow growing populations of these fish. After removal of 6,973 black crappie per acre and 684 black bullhead per acre, population estimates showed large crappies (>200 mm long) to have increased by 430% and large black bullhead (>260 mm) by 1100% (9). Latest fish surveys (1980-1981) have shown black crappie to be most abundant and of good size, with healthy populations of largemouth bass and walleye. Walleye continue to be stocked on a biannual basis.

ELMD, in the past (various years, 1968 - 1985), has attempted to control algal blooms through the use of copper sulfate in a 13 acre area completely encircling the lake (Pers. comm. WDNR). Treatments have ceased, although algal blooms still occur (Pers. comm. ELMD).

Manitowoc County maintains a paved boat ramp (with parking) at a county park (with restroom and picnic area) at the southwest corner of the lake. The lake receives intensive recreational use during the open water season; an unenforced town ordinance currently specifies water skiing in a counter-clockwise direction between the hours of 11:00 a.m. and 6:00 p.m. (Pers. comm. ELMD).

METHODS

FIELD PROGRAM

Water sampling was conducted in Spring (May 28), mid-Summer (August 5), late-Summer (August 27), 1991 and Winter (February 4), Spring (May 7) and mid-Summer (July 9), 1992 at Stations 1601, the deepest point, and 1602, the intermittent outlet (Table 1, Figure 2). Station 1601 was sampled near surface (designated "S") and near bottom (designated "B"); the outlet site was sampled at mid-depth (designated "M") when outflow was adequate (not sampled July 9, 1992 because of no flow).

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

Water 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

Table 1. Sampling Station Locations, English Lake, 1991 - 1992.

WATER QUALITY

Regular Monitoring Sites

Site	Latitude/Longitude		Depth
1601	44° 02' 44"	87° 47' 12"	85.0 ft.
1602	44° 02' 39"	87° 47' 26"	1.0 ft.

Event Monitoring Sites

Site	Description
16E1	Drain tile to south shore (NS[1])
16E2	2 major drain tiles entering the southwest shore
16E3	Culvert draining land East of Union Road
16E4	Culvert draining land East of Union Road
16E5	Culvert draining land North of N. Lake Road (NS)
16E6	Ditch draining land on the northwest shore
16E7	Major drain tile from land North of the lake

MACROPHYTE TRANSECTS

	Latitude/Longitude		Transect	Bearing	Depth
Transect	Origin	End	Length(m)	(Degrees)	Range[2]
A	44° 02' 39" 87° 47' 25"	44° 02' 40" 87° 47' 24"	37	45	1/2/3
B	44° 02' 51' 87° 47.31'	44° 02' 50" 87° 47' 24"	26	17	1/2/3
C	44° 02' 50" 87° 47' 12"	44° 02' 49" 87° 47' 12"	20	185	1/2/3
D	44° 02' 49" 87° 47' 02"	44° 02' 49" 87° 47' 03"	22	286	1/2/3
E	44° 02' 39" 87° 47' 07"	44° 02' 40" 87° 47' 07"	19	355	1/2/3
F	44° 02' 38" 87° 47' 22"	44° 02' 39" 44° 47' 23"	40	320	1/2/3

[1] NS = No Sample Collected

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

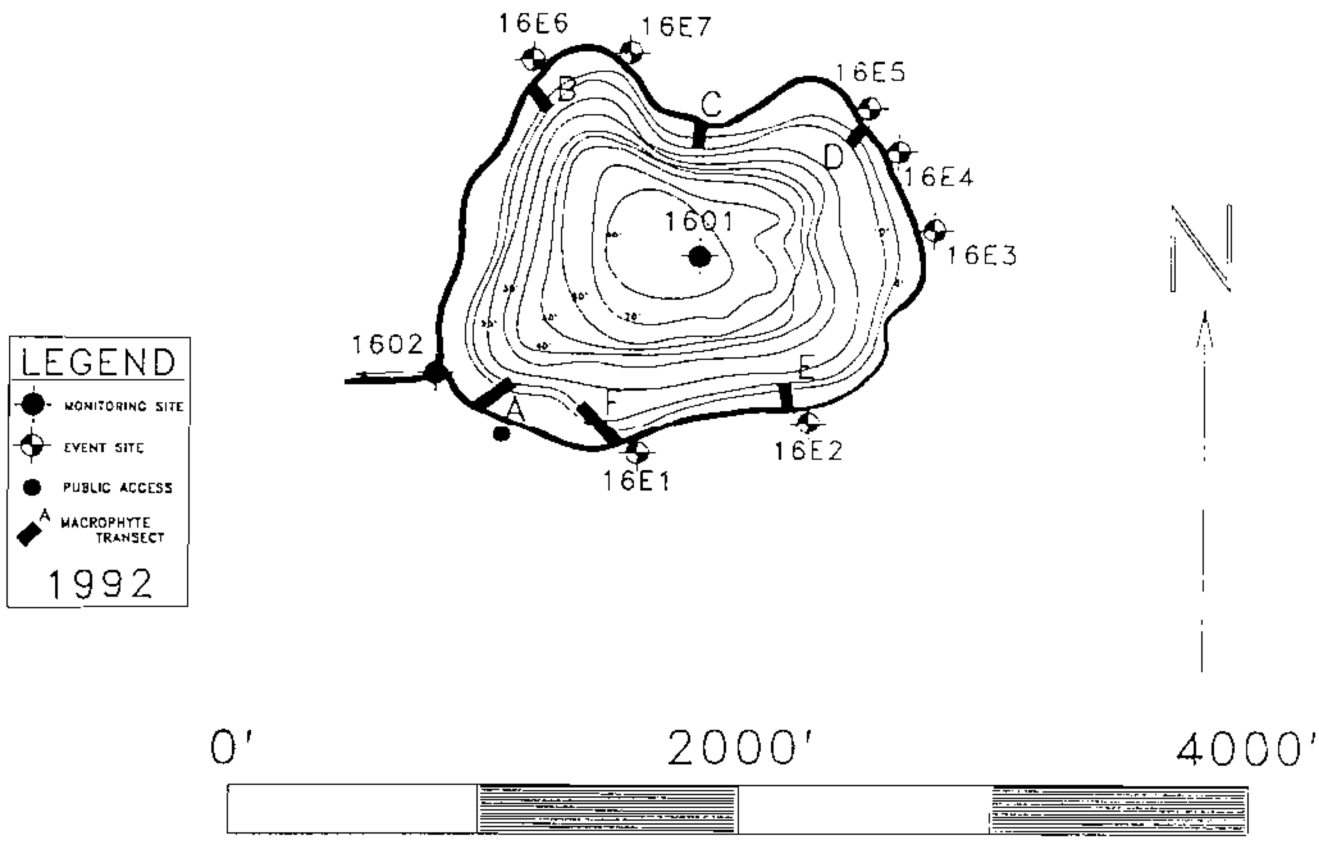

Figure 2. Sampling Sites, English Lake, Manitowoc County, WI, 1991 - 1992.

WDNR or APHA (10) methods. Spring parameters determined by the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus, total solids and chlorophyll a. Summer and late Summer laboratory analyses included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus, dissolved phosphorus, and chlorophyll a. Winter water quality parameters included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

Event (i.e., during or immediately after a major runoff or rain event) sampling was performed by ELMD on July 22, 1991 (Sites 16E2, 16E3, 16E4) and March 4, 1992 (16E2, 16E4, 16E6, 16E7). Samples were analyzed for total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

Aquatic plant surveys were conducted in early Summer (August 5) and again later in the season (September 10) during 1991 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 (11). Transect endpoints were established on and off shore for use as reference from one sampling period to the next. 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. Six transects sampled in 1991 were chosen 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. Aquatic plant 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

Water Quality Information

Additional lake information was retrieved from the WDNR Surface Water Inventory (6), ELMD water quality data, Wisconsin Self Help Monitoring Program (12) and from the WDNR Wisconsin Lakes publication (5). Additional information was retrieved through the WDNR WI LAKES Bulletin Board System.

Land Use Information

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

Ordinance information was taken from the Manitowoc County Zoning Ordinance and the Manitowoc County Soil Erosion Control Plan which were acquired from MCSWCD.

Public Involvement Program

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

FIELD DATA DISCUSSION

English Lake is a natural lake, as opposed to an artificial lake, i.e., dammed riverine system. Physicochemical characteristics of natural lakes tend toward a state of dynamic equilibrium (e.g., seasonally variable but relatively consistent within that framework over the long-term) as defined by basin morphometry and watershed characteristics.

English Lake is, by definition, a seepage lake because it has a no permanent inlet or outlet stream; the primary source of water inflow for English Lake is precipitation, groundwater inflow and surface runoff from immediately adjacent areas. Lake level elevation is controlled to a limited extent by the outlet which flows only at higher lake levels.

Land use in the immediately adjacent English Lake watershed is primarily agricultural (includes open areas, 85%) and residential (15%) (Figure 3). Agricultural areas to the North and South are tiled (artificially drained) to the lake (Pers. comm. MCSWCD).

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. In-lake surface total phosphorus (Station 1601) during 1991-1992 monitoring ranged from 0.022 to 0.151 mg/l (parts per million) with a mean value of 0.066 mg/l

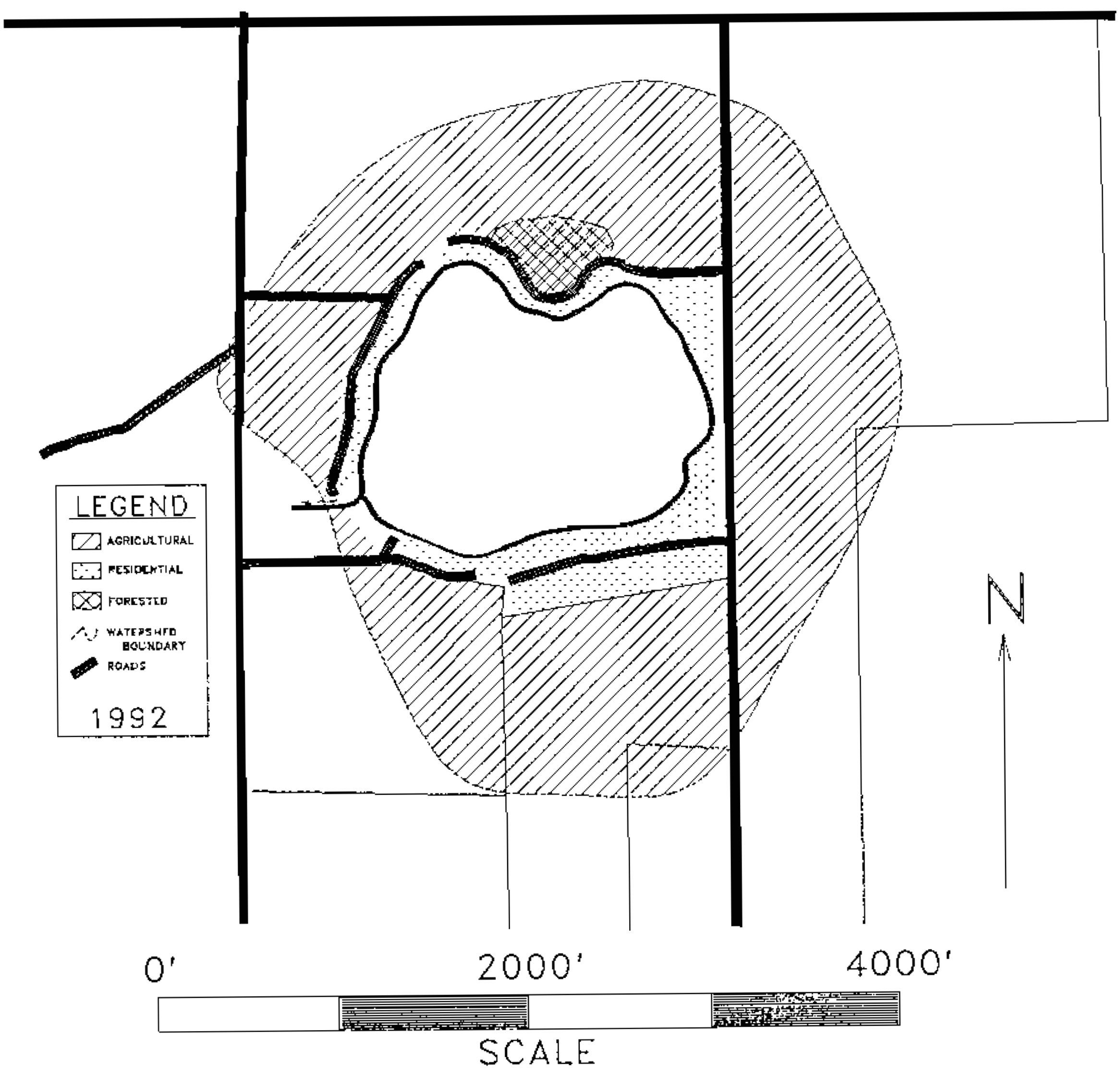

Figure 3. Land Uses in the English Lake Watershed, 1992.

(Table 2). Total phosphorus in the outlet at Station 1602 ranged from 0.023 to 0.130 mg/l (mean = 0.069 mg/l) and exhibited trends similar to Station 1601 (Table 3). During past monitoring (1976-1987), in-lake surface total phosphorus ranged from 0.02 to 0.22 mg/l with an average of 0.120 mg/l (Appendix II). Surface nitrogen to phosphorus ratios (**N/P ratio**) greater than 15 indicated English Lake to be phosphorus limited during 1991 and Summer 1992; N/P ratios less than 15 during Winter and Spring 1992 suggested nitrogen to be limiting.

In-lake Summer surface phosphorus levels during 1991-1992 (0.025, 0.022 and 0.040 mg/l) were, according to a recent compilation of Summer total phosphorus levels in upper midwestern lakes (13), lower than typical (>0.050 mg/l) for the naturally fertile, agricultural region in which English Lake is located. Substantially higher values for total phosphorous and other nutrient parameters were observed near bottom and suggested release from the sediments under **anoxic** or near-anoxic conditions in the **hypolimnion** during summer stratification at this relatively deep point (Figure 4).

Total nitrogen is highly variable among lakes and should only be related on a relative scale within the same lake. In-lake total surface nitrogen for the 1991-1992 monitoring dates ranged from <1.107 mg/L to 1.611 mg/l. Bottom samples exhibited

Table 2. Water Quality Parameters, Station 1601, English Lake, 1991 - 1992.

PARAMETER	SAMPLE[1]	05/28/91	08/05/91	08/27/91	02/04/92	05/07/92	07/09/92
Secchi (feet)		8.5	8.0	5.0	NR	5.6	4.6
Cloud Cover (%)		5	10	0	100	0	70
Temperature (°C)	S	23.32	23.11	25.06	4.67	11.09	21.57
	B	10.50	6.37	7.00	3.43	5.00	5.40
pH (S.U.)	S	9.01	9.00	9.16	7.63	8.33	8.81
	B	8.00	6.62	6.65	6.73	6.70	6.46
D.O. (mg/l)	S	10.7	9.75	9.80	10.32	14.27	9.98
	B	2.05	0.09	0.14	0.11	1.34	0.31
Conductivity (µmhos/cm)	S	387	369	354	401	375	353
	B	435	439	428	441	391	416
Laboratory pH (S.U.)	S	9.0	NR	NR	NR	8.68	NR
	B	7.6	NR	NR	NR	7.94	NR
Total Alkalinity (mg/l)	S	170	NR	NR	NR	174	NR
	B	182	NR	NR	NR	178	NR
Total Solids (mg/l)	S	288	NR	NR	NR	286	NR
	B	328	NR	NR	NR	290	NR
Total Kjeldahl N (mg/l)	S	1.2	1.1	1.1	1.4	1.3	1.3
	B	2.3	3.3	3.0	3.0	1.6	4.0
Ammonia Nitrogen (mg/l)	S	0.019	0.022	0.017	0.462	0.020	0.017
	B	0.814	2.07	1.76	1.69	0.527	1.50
NO_2 + NO_3 Nitrogen(mg/l)	S	0.053	ND[2]	ND	0.211	0.126	ND
	B	0.405	ND	ND	ND	0.392	ND
Total Nitrogen (mg/l)	S	1.253	<1.107	<1.107	1.611	1.426	<1.307
	B	2.705	<3.307	<3.007	<3.007	1.992	<4.007
Total Phosphorus (mg/l)	S	0.045	0.025	0.022	0.151	0.112	0.040
	B	0.36	0.62	0.58	0.52	0.22	0.63
Diss. Phosphorus (mg/l)	S	0.007	0.002	ND	0.131	0.030	0.005
	B	0.27	0.54	0.49	0.36	0.203	0.36
N/P Ratio	S	27.8	<44.3	<50.3	10.7	12.7	<32.7
	B	7.5	<5.3	<5.2	<5.8	9.05	<6.36
Chlorophyll *a* (µg/l)	S	15	12	16	NR	32	21

[1] S = Near Surface, B = Near Bottom
[2] ND = Not Detectable

Table 3. Water Quality Parameters, Station 1602, English Lake, 1991 - 1992.

PARAMETER	SAMPLE[1]	05/28/91	08/05/91	08/27/91	02/04/92	05/07/92
Secchi (feet)		b[2]	b	b	NR	b
Cloud Cover (%)		5	10	0	100	0
Temperature (°C)	M	24.15	22.74	24.90	4.70	11.37
pH (S.U.)	M	9.06	9.06	9.12	7.70	6.40
D.O. (mg/l)	M	10.09	10.25	9.8	10.40	10.90
Conductivity (µmhos/cm)	M	371	373	354	409	360
Laboratory pH (S.U.)	M	9.2	NR	NR	NR	8.73
Total Alkalinity (mg/l)	M	166	NR	NR	NR	174
Total Solids (mg/l)	M	280	NR	NR	NR	294
Total Kjeldahl N (mg/l)	M	1.2	0.9	1.0	1.3	1.6
Ammonia Nitrogen (mg/l)	M	0.014	0.019	0.011	0.488	0.031
NO_2 + NO_3 Nitrogen(mg/l)	M	0.029	ND[3]	ND	0.311	0.038
Total Nitrogen (mg/l)	M	1.229	<0.907	<1.007	1.611	1.638
Total Phosphorus (mg/l)	M	0.040	0.026	0.023	0.127	0.130
Diss. Phosphorus (mg/l)	M	0.005	0.004	<0.002	0.110	0.013
N/P Ratio	M	30.7	<34.9	<43.8	12.7	12.6
Chlorophyll a (ug/l)	M	15	11	20	NR	72

[1] M = Mid-depth
[2] b = Secchi disk visible to bottom
[3] ND = Not Detectable

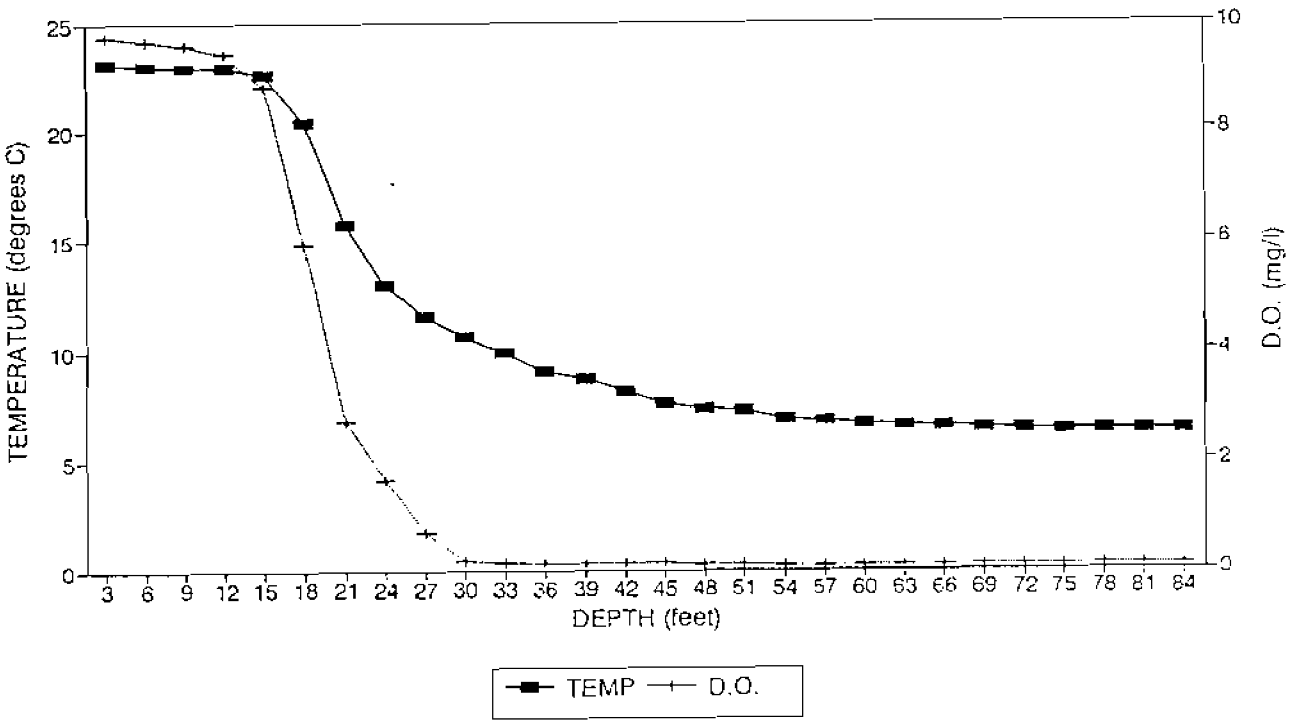

Figure 4. Temperature/DO Profile, English Lake, August 5, 1991.

significantly higher levels, particularly for ammonia nitrogen during Summer, in this dissolved oxygen limited strata.

Event monitoring (Table 4) indicated significantly higher levels of total phosphorus with values ranging from 0.153 to 5.10 mg/l (ave. = 0.977, median = .210, σ = 1.70 mg/l). Highest total phosphorus levels were observed at Station 16E3; high levels of NO_2-NO_3 nitrogen were observed at Stations 16E2 and 16E3.

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

Table 4. Event Water Quality Parameters, English Lake, 1991 - 1992.

		STATION						
PARAMETER	UNITS	16E2	16E3	16E4	16E2	16E4	16E6	16E7
Date		07/22/91	07/22/91	07/22/91	03/04/92	03/04/92	03/04/92	03/04/92
Total Kjeldahl N	mg/l	2.4	17.	1.5	NR[1]	NR	NR	NR
Ammonia Nitrogen	mg/l	0.202	1.52	0.020	NR	NR	NR	NR
NO_3+NO_2 Nitrogen	mg/l	33.4	11.4	ND[2]	NR	NR	NR	NR
Total Nitrogen	mg/l	35.8	28.4	<1.507	NR	NR	NR	NR
Total Phosphorus	mg/l	0.169	5.10	0.210	0.153	0.79	0.159	0.26
Diss. Phosphorus	mg/l	NR[3]	NB	NB	0.076	0.46	0.070	0.095
N/P Ratio		211.8	5.6	<7.2	--	--	--	--

NR = No Reading given
ND = Not Detectable
NB = No Bottle received

parameters, to assess or monitor lake eutrophication or aging. The Trophic State Index (TSI) developed by Carlson (14) 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 English Lake, in general, indicated a mesotrophic to early eutrophic classification. TSI values for Secchi depth were most variable and ranged from those indicative of oligotrophic to eutrophic classifications; TSI for chlorophyll a and total phosphorus were indicative of a eutrophic status (Figures 5-7). No discernable trends were evident in recent data.

During recent aquatic plant surveys, aquatic plants (Table 4) were found at all 36 sample sites (sample sites = number of depth ranges sampled). Filamentous algae which are not actual macrophytes, and water celery were the most abundant plants in English Lake (Tables 5-9, Appendix III). The combination of a very narrow littoral zone and relatively high nutrient levels allow much of the nutrients to be available to algal blooms during periods of high nutrient availability (Spring and Fall

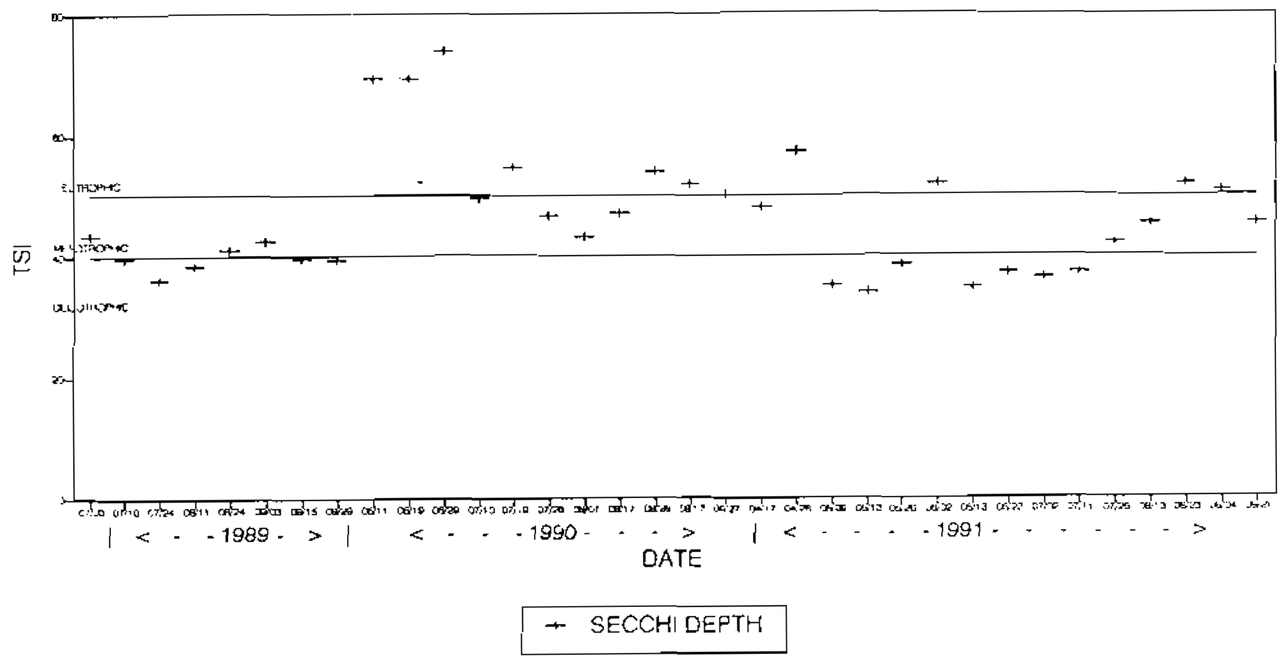

Figure 5. Trophic State Index for Secchi Data, English Lake.

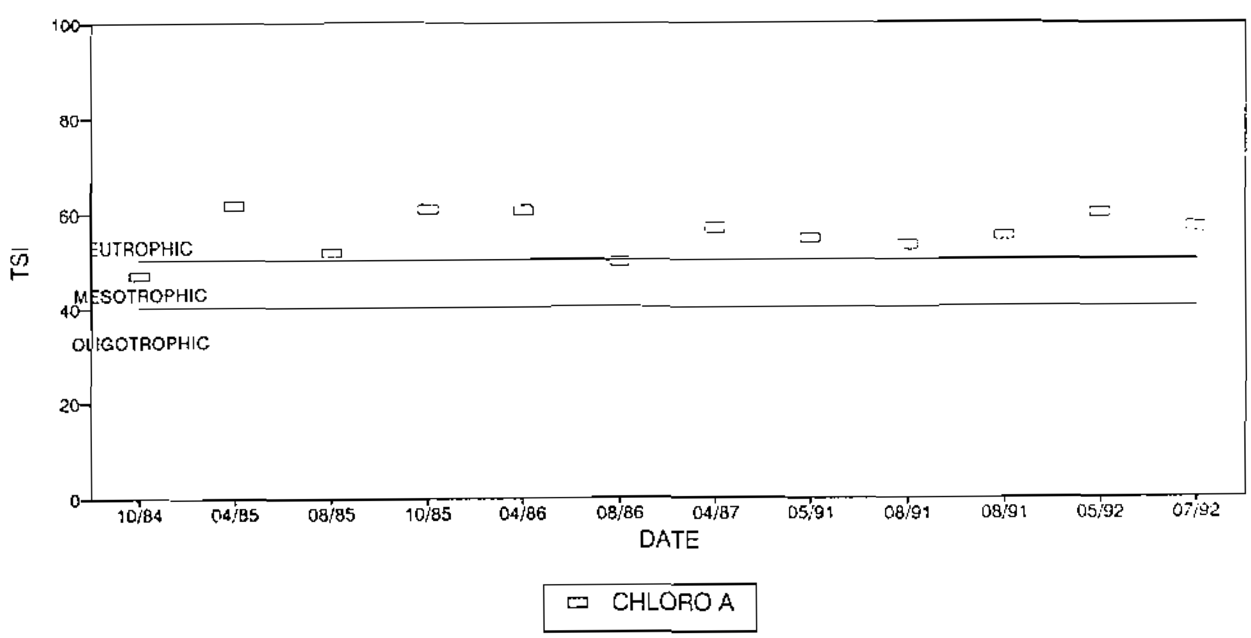

Figure 6. Trophic State Index for Chlorophyll a, English Lake.

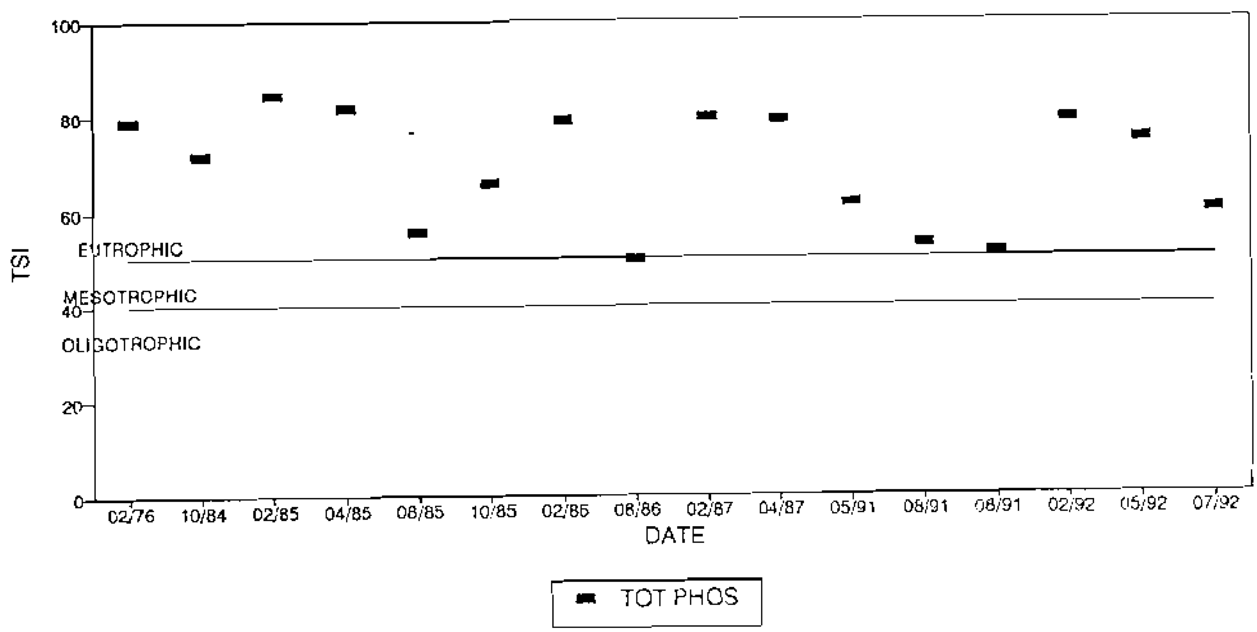

Figure 7. Trophic State Index for Total Phosphorus, English Lake.

overturn) and nutrient "pulses", (periods of high surface runoff to the lake).

Filamentous algae was most abundant and identified in previous years as <u>Oscillatoria</u> sp. (WDNR) and currently as <u>Cladophora</u> sp. (IPS) with various other filamentous and unicellular forms. Filamentous algae was present at 31 of 36 sample sites and can grow large masses which float to the surface and congregate in shoreline areas, often in nuisance proportions.

Water celery (<u>Vallisneria americana</u>), a common Wisconsin species, was found less frequently (at 23 of 36 sites). Water celery (also known as eel grass), has long tape-like leaves, grows

Table 5. Aquatic Plant Species Observed, English Lake, 1991 (15).

Taxa	Code
Watersheild (*Brasenia schreberi*)	BRASC
Coontail (*Ceratophyllum demersum*)	CERDE
Muskgrass (*Chara* sp.)	CHASP
Common waterweed (*Elodea canadensis*)	ELOCA
Filamentous algae	FILAL
Duckweed (*Lemna minor*)	LEMMI
Bushy pondweed (*Najas* sp.)	NAJSP
White pond lily (*Nymphaea* sp.)	NYMSP
Leafy pondweed (*Potamogeton foliosus*)	POTFO
Sago pondweed (*Potamogeton pectinatus*)	POTPE
Cattail (*Typha latifolia*)	TYPLA
Eel grass (water celery) (*Vallisneria americana*)	VALAM

completely submerged and is typically found on hard substrates; abundance can increase with turbidity. It is rated as excellent waterfowl food and provides fish with forage, cover and spawning habitat but has been known to reach nuisance levels (15). Water celery produces seeds, but spreads mainly from rhizome growth and reproduces mainly by tubers from one year to the next (16).

A complete conservation program was developed and implemented under the priority watershed program for a landowner North and

Table 6. Occurrence and Abundance of Aquatic Plants by Depth, English Lake, August, 1991.

CODE	1 (N=6) % of Sites	1 (N=6) Σ Abundance (range)	2 (N=6) % of Sites	2 (N=6) Σ Abundance (range)	3 (N=6) % of Sites	3 (N=6) Σ Abundance (range)
BRASC	0	0	17	1(1)	0	0
CERDE	17	1(1)	0	0	0	0
CHASP	0	0	17	3(3)	0	0
ELOCA	0	0	0	0	17	1(1)
FILAL	100	19(1-5)	100	17(2-4)	100	14(1-4)
LEMMI	17	2(2)	0	0	0	0
NAJSP	0	0	0	0	0	0
NYMSP	0	0	17	1(1)	0	0
POTFO	0	0	0	0	0	0
POTPE	0	0	17	2(2)	0	0
TYPLA	50	8(2-4)	0	0	0	0
VALAM	33	3(1-2)	67	10(1-4)	50	6(2)

Table 7. Occurrence and Abundance of Aquatic Plants by Depth, English Lake, September, 1991.

CODE	1 (N=6) % of Sites	1 (N=6) Σ Abundance (range)	2 (N=6) % of Sites	2 (N=6) Σ Abundance (range)	3 (N=6) % of Sites	3 (N=6) Σ Abundance (range)
BRASC	0	0	0	0	0	0
CERDE	17	3(3)	0	0	0	0
CHASP	33	5(2-3)	33	4(1-3)	67	9(2-4)
ELOCA	33	2(1)	33	2(1)	33	5(2-3)
FILAL	67	10(1-4)	83	12(1-3)	67	11(2-4)
LEMMI	17	2(2)	0	0	0	0
NAJSP	17	1(1)	17	1(1)	0	0
NYMSP	33	5(1-4)	33	7(3-4)	0	0
POTFO	50	4(1-2)	33	2(1)	17	1(1)
POTPE	67	8(2)	33	2(1)	0	0
TYPLA	50	11(3-4)	0	0	0	0
VALAM	83	11(1-3)	100	20(1-5)	67	13(2-4)

Table 8. Comparison of Occurrence as Percent of Total Abundance for Selected Aquatic Plants by Depth, English Lake, 1991.

Species Code	Depth Range					
	1		2		3	
	AUG	SEPT	AUG	SEPT	AUG	SEPT
FILAL	58	16	50	24	67	28
VALAM	9	18	29	40	29	33
CHASP	0	8	9	8	0	23
TYPLA	24	18	0	0	0	0
NYMSP	0	8	3	14	0	0

Table 9. Abundance Distribution and Substrate Relations for Selected Aquatic Plants, English Lake, 1991.

Transect	Substrate	Species Code									
		FILAL		VALAM		CHASP		TYPLA		NYMSP	
		A[1]	S	A	S	A	S	A	S	A	S
A1	MUCK/SILT	5	3	0	0	0	3	2	4	0	4
A2	MUCK/SILT	2	3	0	3	3	3	0	0	0	4
A3	SILT/MUCK	2	0	0	0	0	0	0	0	0	0
B1	SAND/GRAVEL	1	1	2	3	0	0	0	0	0	0
B2	SAND	3	1	4	5	0	0	0	0	0	0
B3	MUCK	3	2	2	4	0	3	0	0	0	0
C1	SA/GR/ROCK	2	0	0	2	0	0	0	0	0	0
C2	SA/GR/ROCK	3	0	2	4	0	0	0	0	0	0
C3	SA/GR/ROCK	2	3	2	3	0	0	0	0	0	0
D1	SA/GR/ROCK	5	4	0	1	0	0	4	4	0	0
D2	SA/GR/ROCK	3	2	3	1	0	0	0	0	0	0
D3	SILT/MUCK	2	2	2	4	0	2	0	0	0	0
E1	SA/GR/ROCK	4	2	1	2	0	2	0	0	0	0
E2	SAND/GRAVEL	4	3	0	4	0	1	0	0	0	0
E3	MUCK	4	4	0	2	0	0	0	0	0	0
F1	SAND/GRAVEL	2	0	0	3	0	0	2	3	0	1
F2	MUCK	2	3	1	3	0	0	0	0	1	3
F3	MUCK	1	0	0	0	0	4	0	0	0	0

[1] A = August survey; S = September survey

East of English Lake (includes 26% of the English Lake watershed). Barnyard runoff control, sod waterways, conservation rotations and a manure management system (which eliminates winter manure spreading) were included in the program. Tiled land to the South (9% of the English Lake watershed) is under conservation rotation which is designed to reduce soil erosion to the "tolerance" level; Winter manure application may still be continuing. Sediment runoff control measures have also been implemented for the parking lot of a resort located on the northeast shore of the lake. Agricultural areas to the North and West (41% of the English Lake watershed) are currently in noncompliance (having excess soil erosion and lacking an erosion control plan) (Pers. comm. MCSWCD).

There is no established sewer district for the English Lake area at this time; homes in the English Lake watershed have individual sanitary systems. Dye tests were performed on about 50 home systems (85%) in 1985. Tests, performed over a two week period, indicated no failures of those systems tested (Pers. comm. ELMD).

BASELINE CONCLUSIONS

- English Lake is a natural seepage lake subject to naturally fertile runoff from a relatively small, agricultural watershed. Significant overland and drainage tile nutrient (and probably sediment) inputs, a narrow littoral zone, and a low flushing rate combine to create ideal conditions for algal blooms.

- English Lake water quality is seasonally variable and ranges from good to poor with respect to parameters measured. Summer total phosphorus was variable but averaged lower than that typically found in lakes in its region. Higher phosphorus levels near bottom, at the stratified deepest point, appear related to sediment release under near-anoxic conditions. Event monitoring showed substantial nutrient inflow to the system. Marl may contribute to the relatively lower than expected total phosphorus levels.

- Filamentous algae and water celery were the most abundant aquatic plants. Plant growth is limited to a relatively narrow littoral zone around the perimeter of the lake. True macrophytes appear to positively affect the resource through forage (and subsequently fish)

MANAGEMENT ALTERNATIVES DISCUSSION

WATER QUALITY

English Lake is a natural lake which benefits from a small watershed and a narrow littoral zone. Water quality relative to transparency, productivity and nutrients overall, is seasonally variable from good to poor. Event samples taken by the ELMD showed significant nutrient (and probably sediment) input from the naturally fertile and largely agricultural watershed.

Control of overland runoff to the lake is probably practical and feasible and should be the major objective toward resource maintenance or enhancement. The residential strip around the lake can play a major role in this area; land use practices here can have a significant influence on water quality. Land owner diligence should be strongly emphasized and encouraged; common sense approaches are relatively easy and can be very effective in minimizing these inputs.

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 away from the lake 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), or indirectly to the lake via roadside ditches.

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), 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 (17).

There are a number of informational sources for land owners with questions regarding land management practices. Some sources are outlined in Appendix IV. A review of Best Management Practices applicable to the more extended agricultural watershed is given in Appendix V.

MACROPHYTES

Management of macrophyte populations should be, at best, only a minor objective on English Lake where littoral areas are relatively narrow. Macrophytic growth appears to positively affect the resource through forage fish production/protection, shoreline stabilization and nutrient uptake. Filamentous algal growth, however, is often extensive and at nuisance levels. It is important to note, however, that algal production is a food source for aquatic invertebrates and small fish, which drives the entire fishery. Recent fish surveys showed good populations of crappie and largemouth bass in English Lake.

While overall macrophyte populations were limited to small areas, there may be instances of nuisance localized populations in need of control by particular landowners. Numerous methods of macrophyte control and management are available ranging from radical habitat alteration to more subtle habitat manipulation and are discussed below relative to English Lake applicability.

Dredging is a drastic form of habitat alteration. Dredging could entail massive lake-wide sediment removal (to a depth at which macrophyte growth would be retarded due to reduced sunlight) or spot dredging of limited (high priority) areas. Large scale sediment removal is very costly; spot dredging, because of lower cost may be a reasonable alternative in some cases. The potential for wind-driven or power boat related sediment redistribution/resuspension from adjacent areas should be carefully assessed. Dredging does not appear to be a viable alternative to localized aquatic plant control in English Lake.

Chemical treatment has been shown to eradicate some undesirable species and leave others intact. The WDNR strongly discourages the use of chemicals because of nutrient release, oxygen depletion, sediment accumulation, bioaccumulation and other unknown environmental hazards including invasion potential from nuisance exotics. Chemical effects are nondiscriminate and may harm desireable or beneficial plant populations. Chemical treatment has been implemented for many years in the past and has not shown a lasting effect on algal and/or plant control and, therefore, should not be considered for English Lake at this time.

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 nutrients on soft substrates (silt, muck), unavailable for algal growth. Screens should be removed each fall and cleaned in order to last a number of years. With inputs to the system from the watershed, control of algae would be minimal. It may, however, be considered for localized control of nuisance macrophyte populations.

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 (18). 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 impact nuisance plant growth (19). A 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.

Several conditions should be considered with respect to macrophyte harvest. Some macrophyte growth on English Lake is beneficial to the resource and manipulation methods should be species selective and localized (where considered nuisance) in application. Some species may actually spread after manipulation through fragmentation or seed dispersal; consideration should be given to potential increase in nuisance potential plants.

Macrophyte harvesting is typically conducted with a mechanical harvester which cuts the vegetation and removes (harvests) it onto a platform for out-lake disposal. Because of limited areas of potential harvest, mechanical harvesting probably would not be an effective management tool for English Lake.

Selective SCUBA assisted harvest has been shown to selectively manage macrophytes. It can be used in deeper areas and to target only desired species or nuisance growth areas. This method is labor intensive, but has proved to effectively reduce nuisance plant levels for up to two years (18). With the limited areas of potential macrophyte management in English Lake, SCUBA assisted harvest may be a viable option.

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 efforts could effectively reduce problem macrophyte and possibly algal populations in a homeowner's frontage area.

MANAGEMENT RECOMMENDATIONS

Management of English Lake should concentrate on better definition and reduction of nutrient inputs, via runoff to the lake. Nutrient input may be controlled to an extent by immediately adjacent land owners, but measured levels entering the lake from the extended watershed are excessive (on an event basis).

More extensive event monitoring should better define the magnitude and timing of nutrient inputs to the lake. Agricultural/open land owners could then implement a number of Best Management Practices (BMP's) through development of a soil and nutrient conservation plan. BMP's are sometimes costly but are often common sense approaches based on awareness of land usage. Adoption of BMP's is especially important on open, sloping, tiled, tilled and fertilized lands. Some pertinent BMP's are outlined in Appendix V.

Residential landowners can also use BMP's to control nutrients and sediment entering English Lake. Buffer stripping, composting yard wastes, fertilizer management and slope contouring are just a few practices that can be adopted to slow and absorb overland runoff.

Management of English Lake should also include a use survey. The relatively small (51 acre) lake receives extensive use during the open water season and a use survey may help to identify areas of concern relative to current and future ordinances on watercraft, speed, uses and times of use. A use survey would also help to identify specific concerns about lake management and raise landowner and public awareness.

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 ELMD is a lake district (as specified under Chapter 33, Wisconsin Statutes) and has specific legal and financial powers (to adopt ordinances or levy taxes or special assessments) to meet plan objectives.

The English Lake watershed is located within the political jurisdictions of the Town of Newton, County of Manitowoc and the State of Wisconsin. These units have the power to regulate land uses and land use practices. Manitowoc County ordinances and plans possibly pertinent to the English Lake plan are summarized in Appendix VI.

Potential sources of funding are listed in Appendix VII.

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