ASSESSMENT OF BRANT LAKE

Warren County Lake George Affairs Committee

&

The Village of Brant Lake

prepared by:

Lawrence W. Eichler, M.S.
Laboratory Supervisor

Rensselaer Fresh Water Institute
Rensselaer Polytechnic Institute
Troy, NY 12180-3590

FWI Report #90-17
December 1990

TABLES OF CONTENTS

* For appendices, see Rensselaer Fresh Water Institute Lake Management Manual: Lake Assessment Appendices for 1989. FWI Report #90-3.

EXECUTIVE SUMMARY

During July 1990, the staff of the Rensselaer Fresh Water Institute conducted the field portion of an assessment of the water quality and aquatic plant populations of Brant Lake, Warren County, NY. This evaluation was performed at the request of and with financial support from the Warren County Lake George Affairs Committee of the Warren County Board of Supervisors.

The following findings and recommendations represent the conclusions of this assessment.

Findings

1. The transparency and phosphorus concentration of Brant Lake waters indicate that the lake should be classified as oligotrophic.

2. Water quality in Brant Lake is currently adequate for the primary use of its' residents, namely recreation.

3. The low alkalinity of Brant Lake makes it susceptible to acidification by acid deposition, although it currently seems to have sufficient capacity to neutralize the acidic inputs it receives. Historical data for Brant Lake indicates that the pH and alkalinity have remained relatively stable over the last 50 years.

4. The deeper waters of the lake (hypolimnion) show low dissolved oxygen concentrations and elevated nutrient levels during summer stratification.

5. The steep slopes and coarse textured soils in the watershed of this lake make erosion of this material and deposition into the lake's basin a serious concern.

6. Changes in lake water chemistry over the last eight years have been minor.

7. A total of 38 submersed plant species were observed in Brant Lake, of which 34 were found along the six transects studied. Of these species, the dominant plants were *Najas flexilis*, *Nitella* spp., *Isoetes* spp., *P. robbinsii*, *Scirpus subterminalis*, *Vallisneria americana*, and *Utricularia purpurea*. Vascular plant species were found to a depth of 6 meters.

8. Eurasian Watermilfoil (*Myriophyllum spicatum*) was the 26th most abundant species. A single dense stand was

found at the northeastern end of the lake at a depth of 1.5 to 3.0 meters (4 to 10 feet) with scattered individuals surrounding this bed at a depth of 0.5 to 3.0 meters (2 to 10 feet). Eurasian Watermilfoil also occurred as scattered plants at 5 other locations.

9. Several areas that are as yet without or only slightly infested with Eurasian Watermilfoil have the potential to support larger, dense beds of this plant. These include the outlet area, the shallow southwestern bay, and the large shallow wetland area known as Pickerel Pond.

Recommendations

1. Although Brant Lake is currently near neutral pH, the buffering capacity of the lake is quite low. Without information on the pH of the lake in the spring, when the largest volumes of acid generally enter a lake, the full extent of the impacts of acid precipitation on Brant Lake are uncertain. Collection of pH and alkalinity data in the spring of the year should be encouraged by the lake association.

2. The lake association should contact the Warren County Soil and Water Conservation Service to review appropriate erosion control techniques as a first step in controlling sediment and nutrient addition to the lake. Many techniques can be applied on an individual homeowner basis such as planting erosion resistant species along shorelines and steep slopes, maintenance of a green strip along the lakeshore, and altering the flow of runoff water to prevent direct entry into the lake.

3. Continued membership in the Citizens Statewide Lake Assessment Program (CSLAP) should be encouraged and monitoring of Eurasian Watermilfoil populations should be included. Information generated by this program will provide a substantial database for objective decision-making and can be crucial for rapid response and remediation activities should any prove necessary.

4. Encouragement of an active lake association with ties to regional and state lake federations is an important step. A water quality committee could organize education, prevention, control and evaluation activities. A thorough review of townzoning and planning laws with respect to mitigations of stormwater and wastewater controls should also be considered. A number of factors that threaten the lake are more

regional or national problems, such as acid precipitation, runoff of sediments, nutrient additions, salt and corrosion products from area roads. Solutions for these problems will require the participation of a broad based organization.

5. An active aquatic plant management committee should be formed to develop and implement a long-term aquatic plant management plan, as part of an overall lake management plan. In addition to selecting and implementing control techniques, the committee should develop education, prevention, evaluation and monitoring activities to be responsive to changing conditions.

6. Although an in-depth study of aquatic plant control alternatives should be performed, two initial suggestions for control are to develop a hand-harvesting effort on the scattered plant areas before they grow into dense beds, and apply benthic barrier (mats) to the small dense bed.

SECTION 1

BACKGROUND

Brant Lake is located in the northeastern portion of Warren County in the Town of Horicon. The lake's watershed is located in the Adirondack Mountains and is part of the Upper Hudson drainage system. The principle tributaries to the lake include Spuytenduivel, Swede Pond and Red Fin Brooks which drain into the northeastern end via Pickerel Pond and Lily Pond Brook. Brant Lake drains into the Hudson River via the Schroon River. Elevations within the watershed range from 797 feet at the surface of the lake to approximately 2200 feet above sea level (Table 1-1 and Figure 1-1).

The lake has a surface area of 1376 acres and a steeply sloping watershed of 25,547 acres (Mikol and Polsinelli, 1985). The lake has a maximum depth of 19.8 meters (65 ft.) and a mean depth of 9.1 meters (30 feet). Typical of lakes in the temperate region, it is dimictic, exhibiting both summer and winter thermal stratification. Located on the southwestern margin of the lake is the only outlet. Lake level is maintained by two dams on the outlet of the lake.

Table 1-1. Physical Features of Brant Lake. (Mikol and Polsinelli, 1985)

BRANT LAKE - Horicon, Warren County, New York.

Latitude	43 degrees 41 minutes
Longitude	73 degrees 44 minutes
Topographic Quad. Map	Brant Lake
Watershed	Upper Hudson
NYSDEC Pond Number	347
Mean Depth	9.1 meters (30 feet)
Maximum Depth	19.8 meters (65 feet)
Volume	50,939,520 cubic meters (41280 acre-feet)
Hydraulic Retention Time	1.0 years
Surface Area	557 hectares (1376 acres)
Watershed Area	10347 hectares (25547 acres)
Shoreline Length	26.4 kilometers (16.4 miles)
Elevation Above Sea Level	243 meters (797 feet)
Water Quality Classification	AA (special)

The lake is best classified as oligotrophic which indicates that nutrients necessary for the growth of algae and subsequently the myriad of organisms that feed on these plants, are low.

The surficial geology is primarily glacial till (a sand and gravel soil without exposed bedrock). The soil associations are Bice-Woodstock and Hinckley-Plainfield deposits with some glacial outwash deposits. Soil depths range from 10 to 60 inches over bedrock with some exposed bedrock outcrops. Slopes are variable, but generally steep (5-60%) and drainage in these deposits is rapid. Their ability to furnish lime, nitrogen and phosphorus to terrestrial plants via root uptake is poor. Excessive slope is the principle limitation to development within the basin. The rapid movement of water through these coarse textured soils reduces septic system performance and increases the hazard of groundwater contamination since sewage treatment is on an individual septic system basis.

Brant Lake is a residential/recreational lake with boating, fishing and swimming the primary uses. The lake has a AA (special) classification indicating the best uses include recreation and allowing its use as a drinking water source. Public access is available via a NYSDEC maintained boat-launch ramp at the westernmost end of the lake and a town maintained beach downstream of the first outlet dam. The watershed is moderately populated, but areas of undeveloped shoreline with potential for residential use remain. Commercial land use on the shore of the lake is minimal.

A watershed map depicting the tributaries of Brant Lake is included as Figure 1-1. A bathymetric map of Brant Lake was generated by the NYSDEC (Mikol and Polsinelli, 1985) and is included as Figure 1-2.

The fisheries resources of Brant Lake are characteristic of a two-story fishery with both warm-water and cold-water species present (Table 1-2). The species present indicate overall good water quality.

Brant Lake has a relatively extensive historical data set with information available from as early as 1933. Levels of indicator bacterial abundance have been gathered by Warren County (Table 1-3). Samples for microbiological analyses were collected by Warren County during July and August, 1990. Water chemistry (Table 1-4) and aquatic plant information (Table 1-5) has been included courtesy of NYS DEC (Table 1-4), the Citizens Statewide Lake Assessment Program (CSLAP) and the Rensselaer Fresh Water Institute Aquatic Plant Identification Program. Volunteer monitors at Brant Lake have participated in the NYS DEC administered

Table 1-2. Fish Indigenous to Brant Lake (Mikol and Polsinelli, 1985).

Common Name	Classification
Smallmouth Bass	Micropterus dolomieu
Largemouth Bass	Micropterus salmoides
Yellow Perch	Perca flavescens
Chain Pickerel	Esox niger
Northern Pike	Esox lucius
Brown Bullhead	Ictalurus nebulosus
Pumpkinseed Sunfish	Lepomis gibbosus
Brown Trout	Salmo trutta

Table 1-3. Results for Bacteria Analyses of Brant Lake Conducted by Warren County (D. Olson, personal communication).

Sampling Location	Date	TC Bacteria /100ml	FC Bacteria /100ml	Plate Count/ml
Town Beach, Brant Lake	11-JUL-90	20	2	23
Town Beach, Brant Lake	01-AUG-90	80	12	70
Town Beach, Brant Lake	20-AUG-90	30	4	400
Beach, Mead's Cottages	18-JUL-90	lt 1	10	13
Stream, Mead's Cottages	18-JUL-90	1420	190	693(est.)
Culvert below Rte. 8	18-JUL-90	530	92	28

TC - Total Coliform
FC - Fecal Coliform

lt = less than

Table 1-4. Historical Water Chemistry for Brant Lake (Kishbaugh and Saltman, 1989; Kishbaugh, personal communication).

Zsound = Maximum Depth in Meters
Zsd = Secchi Depth in Meters
Zsamp = Sampling Depth in Meters
TP = Total Phosphorus in ug P/l

TColor = True Color
Chl.a = Chlorophyll a in ug/l
NO3 = Nitrate in mg N/l

PName	Date	Zsound	Zsd	Zsamp	TP	NO3	TColor	pH	Cond25	Chl.a
Brant L	6/19/87	13.0	5.500	1.5	0.003	-0.02	13	7.38	76	3.30
Brant L	6/28/87	16.0	4.500	1.5	0.010	0.02	10	7.38	72	5.70
Brant L	7/5/87	16.5	4.750	1.5	0.008	-0.02	16	7.42	73	4.40
Brant L	7/12/87	17.0	5.650	1.5	0.005	-0.02	11	7.21	73	2.80
Brant L	7/19/87	16.5	5.750	1.5	0.001	-0.02	11	7.55	73	5.20
Brant L	7/26/87	17.2	5.100	1.5	0.007	-0.02	10	7.65	74	51.10
Brant L	8/2/87	16.0	4.900	1.5	0.005	-0.02	12	7.32	74	3.00
Brant L	8/10/87	17.0	5.375	1.5	0.008	-0.02	10	#N/A	#N/A	5.70
Brant L	8/10/87	17.0	5.375	1.5	0.006	-0.02	11	7.25	77	4.40
Brant L	8/16/87	16.5	5.850	1.5	0.003	-0.02	7	7.29	76	2.80
Brant L	8/23/87	17.4	6.000	1.5	0.007	-0.02	7	7.45	76	3.30
Brant L	8/30/87	16.5	5.450	1.5	0.003	-0.02	6	7.41	75	3.50
Brant L	9/7/87	17.0	5.000	1.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Brant L	9/14/87	17.3	5.600	1.5	0.004	#N/A	6	7.07	75	5.20
Brant L	9/20/87	17.3	4.300	1.5	0.009	-0.02	9	7.46	74	7.10
Brant L	6/15/88	9.7	3.700	1.5	0.008	-0.02	11	7.79	74	3.85
Brant L	7/4/88	16.2	5.725	1.5	0.004	-0.02	9	7.70	85	2.44
Brant L	7/17/88	15.7	5.850	1.5	0.008	-0.02	5	7.85	78	0.85
Brant L	7/31/88	17.3	6.100	1.5	0.004	-0.02	6	7.89	78	1.53
Brant L	8/5/88	16.5	5.550	12.0	0.008	-0.02	15	7.69	80	2.96
Brant L	8/22/88	16.5	5.400	1.5	0.004	-0.02	5	7.81	79	1.78
Brant L	9/5/88	16.0	5.500	1.5	0.006	-0.02	8	7.88	77	3.03
Brant L	9/19/88	15.3	4.600	1.5	0.005	-0.02	#N/A	7.80	78	1.70
Brant L	7/4/89	15.3	5.000	1.5	0.005	-0.02	10	7.66	77	2.21
Brant L	7/16/89	14.5	5.400	1.5	0.006	#N/A	8	7.40	78	2.78
Brant L	7/31/89	17.0	5.800	1.5	0.008	-0.02	10	7.63	77	1.58
Brant L	8/14/89	16.5	5.400	1.5	0.004	#N/A	5	7.56	80	2.07
Brant L	8/29/89	17.1	5.950	1.5	0.003	-0.02	10	7.88	78	2.55
Brant L	9/10/89	17.0	6.350	1.5	0.003	#N/A	14	7.51	79	1.40
Brant L	7/8/90	16.5	4.400	1.5	0.010	-0.02	8	7.58	70	2.36
Brant L	7/19/90	15.0	4.750	1.5	0.004	#N/A	8	7.91	72	2.21
Brant L	7/19/90	15.0	4.650	1.5	0.005	-0.02	8	7.94	71	1.67
Brant L	8/8/90	17.0	5.900	1.5	0.010	-0.02	12	6.97	71	2.38
Brant L	8/20/90	17.9	5.050	1.5	0.005	#N/A	13	7.63	71	2.16
Brant L	8/30/90	17.1	6.200	1.5	0.018	-0.02	10	6.81	72	1.37
Brant L	9/9/90	16.5	4.900	1.5	0.005	#N/A	7	7.56	69	2.70
Brant L	9/29/90	15.5	4.750	1.5	0.008	-0.02	11	7.70	461	2.43
Brant L	10/7/90	16.0	4.350	1.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Table 1-4 (cont.). Historical Water Chemistry for Brant Lake*.

Date	ZSAMP m	ZBOT m	pH	Secchi m	CHLA ug/l	TP ug/l	TFP ug/l	ALK. mg/l	COLOR
08/13/33	9.1	18.3	6.7					17	
08/13/33	13.7	18.3	6.6					17	
08/13/33	18.3	18.3	6.3					20	
08/13/33	2.7	OUTLET	7.0					18	
07/14/48	0.0	16.8	7.2						
07/14/48	9.1	16.8	6.7						
07/14/48	16.8	16.8	6.6						
07/15/48	0.0	15.2	7.1						
07/15/48	3.0	15.2	7.2						
07/15/48	6.1	15.2	6.7						
06/28/66	0.0	15.2	7.0						
06/28/66	15.2	15.2	7.0						
08/10/80								20	
05/01/82	1.0	2.0	6.6	>2		11		17	
08/13/82	1.0	18.0	7.4	6.5	3	15	5	21	
08/13/82	17.0	18.0	6.6		2.1	15	10	20	
05/05/87	3.0	15.0	7.1	4.4	9.2	13	6		10
07/08/87	3.0	17.0	7.5	5.0	6.8	8	5		16
09/15/87	2.0	17.0	7.3		3.5	7	2		34
09/15/87	11.0	17.0	6.8	6.0		11	4		4

Date	ZSAMP m	ZBOT m	TKN mg/l	SKN mg/l	NO3 mg/l	NH4 mg/l	COND umhos	TOC mg/l	TURB mg/l
05/01/82	1.0	2.0					59		
08/13/82	1.0	18.0	0.38	0.2	0.06	62	76	2.8	
08/13/82	17.0	18.0	0.22	0.16	<0.05	7	78	2.6	
05/05/87	3.0	15.0	0.13	0.11	0.03	36	62	3.1	
07/08/87	3.0	17.0	0.13	0.13	<0.02	15	57	3.5	0.3
09/15/87	2.0	17.0	0.16	0.15	<0.02	110	57	5.3	3
09/15/87	11.0	17.0	0.27	0.24	<0.02	26	55	3.5	0.4

CHLA = Chlorophyll
TP = Total Phosphorus
TOC = Total Organic Carbon
NO3 = nitrate
TURB = Turbidity

TKN = Total Kjeldahl Nitrogen
SKN = Soluble Kjedahl Nitrogen
ALK. = Alkalinity
NH4 = ammonium
COND = Conductivity

Table 1-5. Aquatic Plant Species Reported for Brant Lake.

Species	Date Reported	Project Reference
Bidens beckii	02-AUG-90	RFWI-APIP
Brasenia schreberii	06-AUG-90	CSLAP
Ceratophyllum demersum	06-AUG-90	CSLAP
Elodea canadensis	06-AUG-90	CSLAP
Fontinalis spp.	07-OCT-90	CSLAP
Myriophyllum spicatum	30-OCT-89	RFWI-APIP
	06-AUG-90	CSLAP
Najas spp.	06-AUG-90	CSLAP
N. flexilis	07-OCT-90	CSLAP
Nymphaea odorata	06-AUG-90	CSLAP
Potamogeton perfoliatus	06-AUG-90	CSLAP
P. robbinsii	06-AUG-90	CSLAP
P. zosteriformis	07-OCT-90	CSLAP
Proserpinaca palustris	06-AUG-90	CSLAP
Ranunculus spp.	07-OCT-90	CSLAP
Typha spp.	06-AUG-90	CSLAP
Utricularia spp.	07-OCT-90	CSLAP

CSLAP - Citizens Statewide Lake Assessment Program (S. Kishbaugh, personal communication)

RFWI-APIP - Rensselaer Fresh Water Institute Aquatic Plant Identification Program

Figure 1-1. Map Showing Brant Lake and its Tributaries.

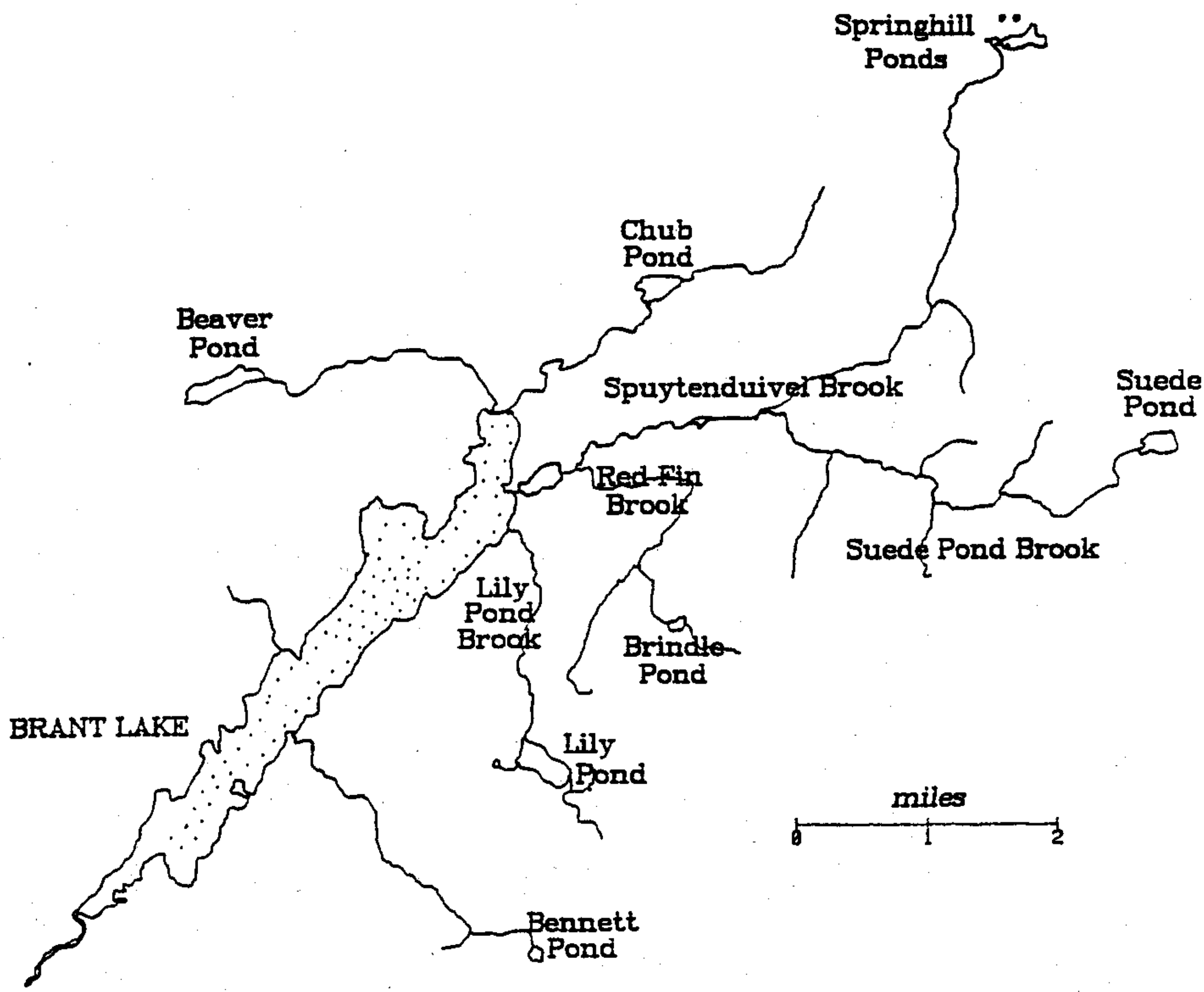


Figure 1-2. Bathymetric Map of Brant Lake.

LOCATION

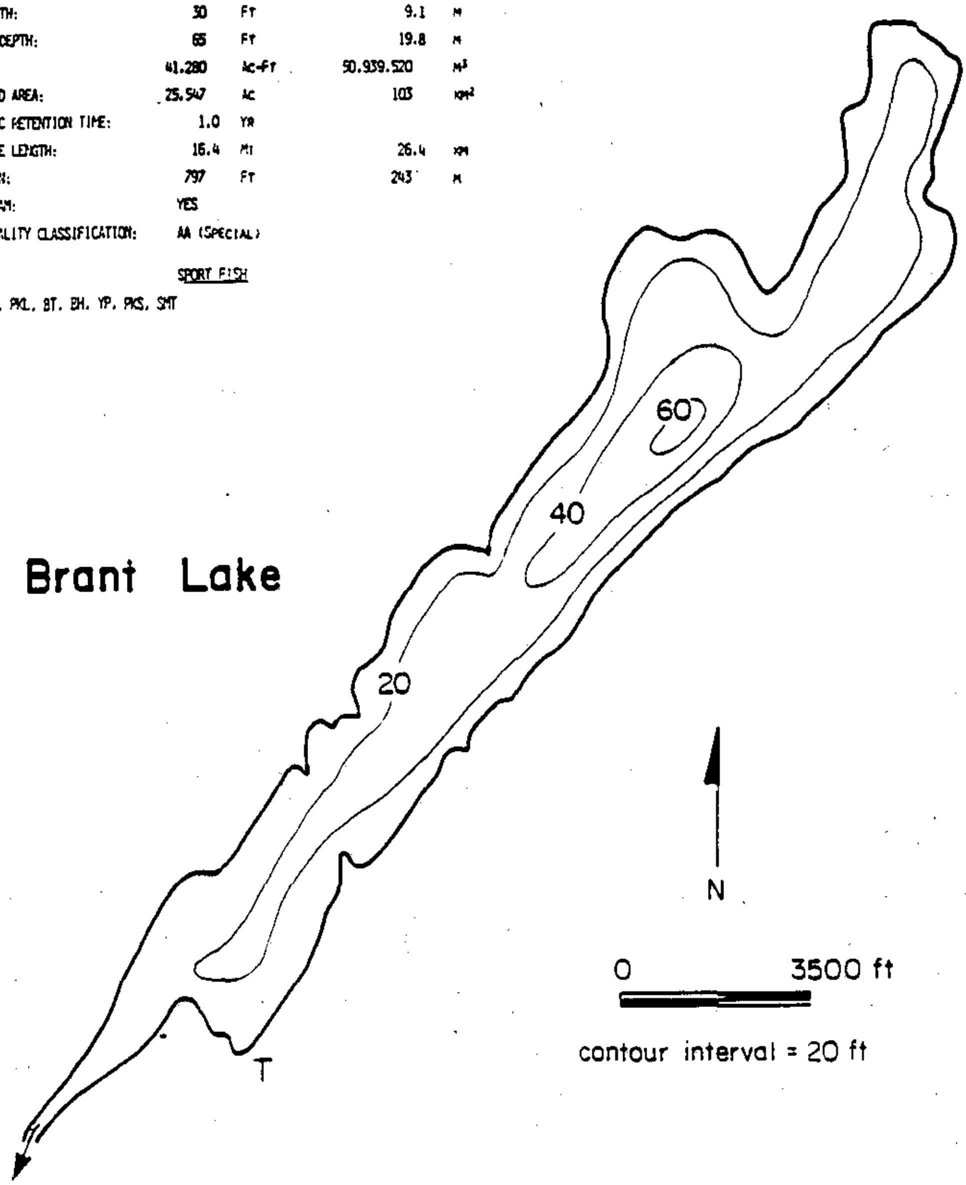
POND NUMBER:	347	LATITUDE:	43 41 12
WATERSHED:	UPPER HUDSON	LONGITUDE:	73 44 28
COUNTY:	WARREN		
TOPOGRAPHIC QUADRANGLE:	BOLTON LANDING		

MORPHOMETRY

SURFACE AREA:	1,376	AC	5.6	KM^2
MEAN DEPTH:	30	FT	9.1	M
MAXIMUM DEPTH:	65	FT	19.8	M
VOLUME:	41,280	AC-FT	50,939,520	M^3
WATERSHED AREA:	25,547	AC	103	KM^2
HYDRAULIC RETENTION TIME:	1.0	YR		
SHORELINE LENGTH:	16.4	MI	26.4	KM
ELEVATION:	797	FT	243	M
OUTLET DAM:	YES			
WATER QUALITY CLASSIFICATION:	AA (SPECIAL)			

SPORT FISH

LBM, SMB, PKL, BT, BH, YP, PKS, SMT



SECTION 2

METHODS

Water Quality

In order to characterize the chemistry of Brant Lake water, four sampling sites were selected (Figure 2-1 and Table 2-1). Sites were selected to provide samples representative of the lake as a whole. Selection criteria include: water depth, degree of shoreline development,

Table 2-1. Chemical Water Quality Sampling Sites.

Site	Name	Location
1	Outlet	Samples were collected in the outlet channel adjacent to the dam at Market Street. A surface grab sample was taken. The maximum water depth at this site was 0.75 meters.
2	S. Midlake	Samples were collected in the south-central portion of the lake approximately midway between the small islands to the NW and the SE shore of the lake. A sample of the epilimnion was taken at 0.5 meters below the lake surface and a deep water sample was taken at 7.5 meters below the lake surface. Maximum water depth at this site was 8.0 meters.
3	N. Midlake	Samples were collected in the north-central portion of the lake approximately 200 meters southwest of the midlake island. A sample of the epilimnion was taken at 0.5 meters below the lake surface and a sample of the hypolimnion was taken at 17.0 meters below the lake surface. The maximum water depth at this site was 18.0 meters.
4	Inlet	Samples were collected from the inlet adjacent to the Palisades Road bridge separating Pickerel Pond from the main lake. A surface grab sample was taken. Maximum water depth at this site was 2.0 meters.

density of aquatic weed growth, and proximity to inlets or outlets.

At each lake site, measurements were made of maximum water depth and water transparency by Secchi depth, conditions permitting (i.e., not greater than maximum depth). Temperature and dissolved oxygen (D.O.) were measured using a YSI Model 54 D.O./Temperature Meter. Determinations were made at 1 meter intervals for the entire water column. Also at each site, a surface water (epilimnion) sample at a predetermined depth (0.5 meter) was taken. At the midlake sites, a deep point sample from near the bottom of the lake and below the thermocline was collected to be representative of the hypolimnion of the lake.

Surface grab samples were collected by submerging an appropriate container below the surface of the water and then inverting it to fill in such a manner that the mouth of the bottle was as far as possible from the samplers arm and hand. Care was taken to avoid collecting portions of the surface film in these samples. Surface grab samples were collected at all sites. At the midlake sites, deep-water samples were also taken using a Van Dorn collection bottle which was lowered to the desired depth and remotely triggered to shut, thus collecting a sample of water at that depth.

All water samples were stored on ice until return to the laboratory. Immediately upon returning to the laboratory a portion of each sample was analysed for pH, specific conductance, orthophosphorus, total suspended solids and alkalinity. A separate portion, to be used for total phosphorus determination, was frozen until analysed. The remainder of each sample was filtered (0.4 um Nuclepore filter) and stored at 4 °C until analysed for nitrate, ammonia chloride and sulfate concentrations. The analytical methods used for all determinations are listed in Appendix K.

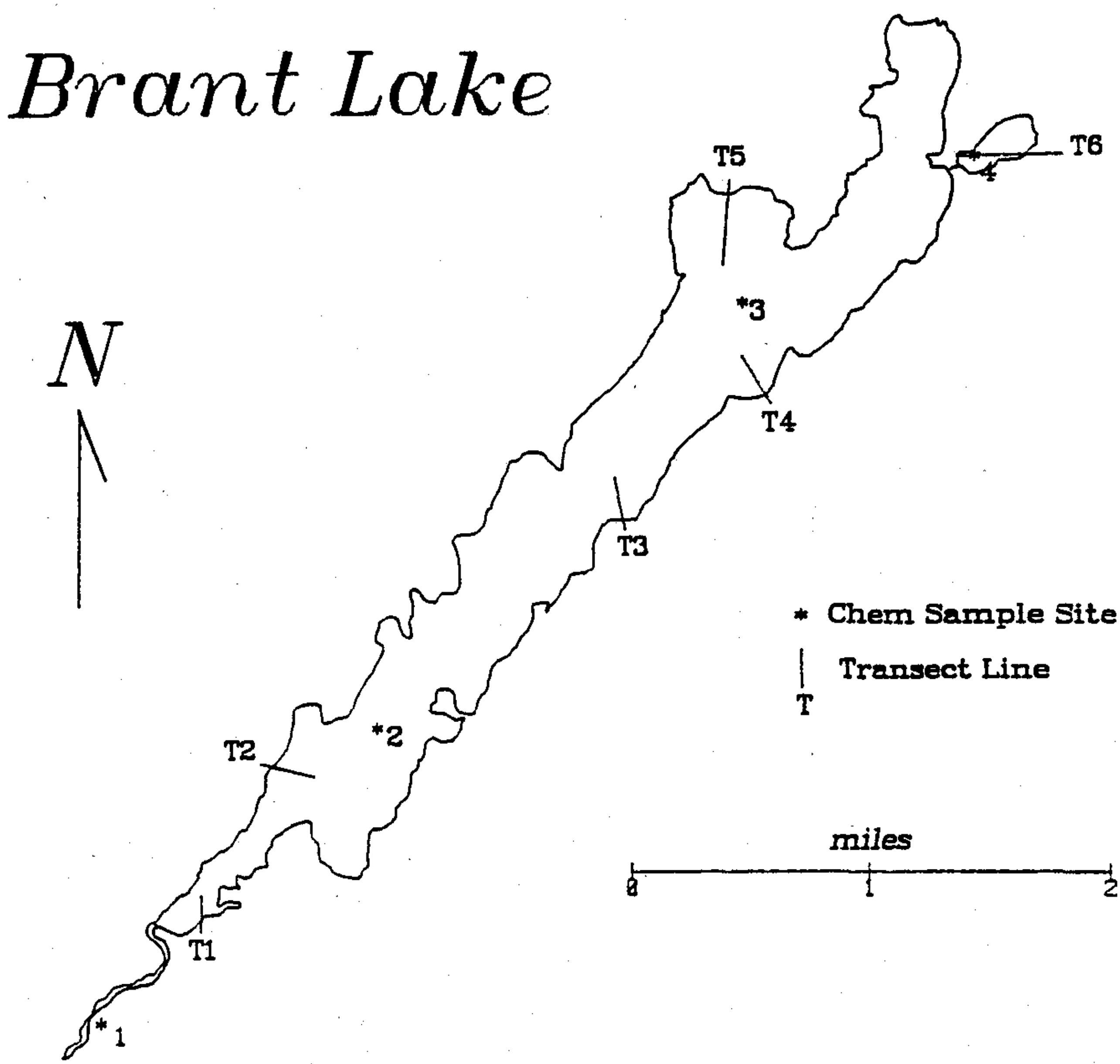
VEGETATION METHODS

The location of scattered and dense Eurasian Watermilfoil (Myriophyllum spicatum L.) populations for the entire lake were noted on a map. To further quantify the aquatic plant populations around the lake, six sites were located evenly around the lake for diver swim-over transects (Figure 2-1). Along each transect, the diver estimated the abundance of all aquatic plant species in each depth interval using the following abundance classes:

Class	Code	% Cover Range	Centroid
Abundant	A	greater than 50% cover	75%
Common	C	25% to 50% cover	37.5%
Present	P	15% to 25% cover	20%
Occassional	O	5% to 15% cover	10%
Rare	R	less than 5% cover	2.5%

In addition to using these abundance class data to evaluate plants at each transect, the abundance class data was summed for all transects using the centroid of the abundance class percent cover range. This data provides both average depth distributions of plants, and an estimate of the relative abundance of all species in the lake.

Figure 2-1. Map of sampling locations indicating vegetation transects and chemical sampling sites on Brant Lake.



SECTION 3

WATER QUALITY IN BRANT LAKE

Samples were collected from Brant Lake on July 24, 1990. At the time of sampling, the temperature of the upper waters of the lake (epilimnion) at the mid-lake sampling sites was between 22.0 and 25.0 °C (70 - 77 °F) and the lake was thermally stratified (Figure 3-1). It is apparent that the thermocline, a zone of rapid temperature change, occurred between 5 and 8 meters (16 and 26 feet). The most rapid temperature change was observed between 5 and 6 meters depth at the north mid-lake site (5.2 °C). A drop in temperature from 23.0 °C at 5 meters to 17.8 °C at 6 meters meters was observed. The bottom temperature at this site was 11.2 °C at 18 meters (59 feet). The south mid-lake site showed similar thermal stratification (Figure 3-1; see Appendix A for a discussion of stratification).

Oxygen levels in the surface waters of the lake were near saturation for both the north and south mid-lake sites. Saturation in the surface waters is generally a result of oxygen equilibria with the atmosphere, particularly in low productivity lakes such as Brant Lake. Reduced levels of oxygen in the hypolimnion (waters deeper than 8 meters) of Brant Lake during the summer (see Figure 3-1) could control the type of organisms capable of utilizing this portion of the lake. The low concentrations of oxygen in waters just above the bottom sediments is due to decomposition processes occurring in the deep waters and sediments. Bacterial activity in the sediments of the lake bottom consumes oxygen and once the lake is stratified, the deep waters are effectively cut off from the primary source of oxygen to a lake, the atmosphere.

The chemical constituents of primary concern for the overall condition of Brant Lake would be those which promote the growth of algae and aquatic plants. These materials, notably phosphorus and nitrogenous compounds, are fertilizers in that they are present in the shortest supply relative to the amounts needed to sustain algal growth. Addition of one or both of these nutrients generally results in a reduction of water quality since the concentrations of these nutrients control the amount of plant and thus animal material capable of growing in the lake. Sources of nitrogen and phosphorus to the lake include: the atmosphere through rain, snow, etc., surface runoff of soils, septic system leachate, resuspension from the sediments of the lake, runoff of fertilizers from farm fields or lawns and gardens, and fecal material from domestic animals.

Phosphorus is generally considered to be the primary limiting nutrient to aquatic plant growth. The most readily available form of phosphorus for aquatic plants and algae is orthophosphorus. This nutrient was available in the surface waters of Brant Lake in a concentration of 1 to 2 parts per billion (ppb). Total phosphorus concentrations listed in Table 3-1 indicate that the amount of phosphorus in the surface waters of Brant Lake is low (4 ppb) and comparable to other area lakes. Total phosphorus concentrations reported for the surface waters of the lake in 1982 ranged from 11 to 15 ppb while surface water concentrations in 1987 ranged from 7 to 13 ppb. Results for Total Phosphorus concentrations in the surface waters of Brant Lake from the CSLAP were between less than 2 ppb and 10 ppb in 1987; 4 and 8 ppb in 1988, 3 and 8 ppb in 1989; and 4 and 18 ppb in 1990. At any one time, most of the phosphorus is probably tied up in the cellular material of the organisms in the lake. Concentrations of phosphorus entering the lake from the inlet were slightly higher than those of the surface waters of the lake. Surface runoff of precipitation, the eroded soils that it carries and the other terrestrial materials that it collects (lawn fertilizers, septic materials, and pollutants) are frequently a major source of phosphorus to a lake. The wetland system (Pickerel Pond) that the inlet drains may provide an effective buffer. The luxuriant plant growth in these wetlands captures nutrients and removes suspended sediments before they can enter the lake.

Phosphorus concentrations in the deeper waters of the lake (midlake sites) were higher (7 to 8 ppb) than those of the surface waters. As the lake turns over in the fall, rapid algal growth may result from the phosphorus present in the deep waters being brought to the surface. Total phosphorus concentration reported for the deeper waters of Brant Lake in 1982 was 15 ppb, and in 1988 was 8.0 ppb; which falls within the range of those currently reported.

The methods used to determine the amount of nitrogenous compounds in the lake water only measure materials not contained in living tissue or particulate material. Trace amounts of nitrate were found in the surface waters while no ammonia was detectable. Most of the nitrogenous material is probably bound up in living tissue (i.e. algae, plants, fish, etc.). The deeper waters of the lake at the north midlake site had measureable amounts of nitrate and ammonia (0.053 and 0.06 mg N/l, respectively). These materials are byproducts of the decompositional processes going on in the sediments of the lake bottom. Results for 1990 are quite similar to nitrate and ammonia concentrations reported for 1982 and 1987 through 1990 by NYS DEC.

Alkalinity and pH recorded for Brant Lake are listed in Table 3-1. The pH at the midlake surface sites was alkaline (above pH 7.00), while the deep-water sites were closer to neutral (pH near 7.00). The ability of a lake to neutralize additions of acid via acid rain or surface runoff is measured by alkalinity or the buffering capacity present in the lake water. The alkalinity of Brant Lake ranged from 18.0 to 27.0 mg/L as $CaCO_3$ in the surface waters (epilimnion). This alkalinity value is low but as evidenced by the alkaline pH of the lake water, it presently has an adequate capacity to buffer any acids coming into the lake. The greatest amount of acid enters the lake during the spring when rapid melting of snow occurs. This is generally the time when the most acidic pH values (less than 7) are observed in lakes and streams. Since spring water samples were not included in this study, the effects of spring snowmelt on the pH of Brant Lake remain to be determined. Alkalinity and pH values were recorded in a 1933 study and by NYS DEC in 1982. Alkalinity results from both these years are comparable to those recorded in 1990. Results for pH determinations have remained circumneutral in both the early studies of 1933 and 1948 (see Table 1-4) as well as those of CSLAP from 1987 through 1990.

Water transparency is controlled by the density of plankton, dissolved organic materials and the amount of fine grained silts and clays present in the water. Nutrient rich lakes, for example Saratoga Lake listed in Table 3-2 for comparison, generally have large numbers of plankton in the water which result in low transparency. Shallow lakes in areas where the soils are mainly fine clays and silts also have generally low Secchi depth readings due to constant resuspension of the fine sediments via wave activity. Water transparency in Brant Lake as measured with a Secchi disk was 5.5 and 5.0 meters for the north and south mid-lake sites respectively. Secchi transparency in 1982 and 1987 from data collected by NYS DEC, was 6.5 and 5.5 meters, respectively, during the latter part of the summer. Secchi transparency data from CSLAP had means of 5.3, 5.3, and 5.7 meters for 1987 through 1989. Transparency values in this range are indicative of good water quality and low algal productivity.

Specific conductance is a measure of the total dissolved ions present in the water. Conductivity values for the surface waters of Brant Lake were 62.0 umhos. Samples taken from the hypolimnion, waters deeper than seven meters, exhibited similar conductivities to surface water samples with values of 63.0 and 60.0 umhos at the north and south mid-lake sites, respectively. Conductivities in this range are generally considered indicative of moderate amounts of dissolved ions present in the water. Conductivity values for the inlet (90 umhos) and outlet (79 umhos) were somewhat higher than surface water values. Conductivity values from NYS DEC data and CSLAP data range around those reported for this study with year to year and seasonal variability.

Sedimentation via runoff of soils and terrestrially derived materials can have a major impact on lake water quality. The general "filling in" of a lake by these materials has the consequence of providing additional areas for the growth of aquatic plants, providing a variety of nutrients to encourage their growth, and leading to a general warming of the lake. Substantial amounts of nutrients are also contributed to the lake by these runoff materials, thus increasing the overall productivity.

One way of quantifying the amount of solid materials present in water is Total Suspended Solids (TSS). The levels of suspended solids in the waters of Brant Lake was quite low with a range from 0.73 to 2.10 milligrams per liter (Table 3-1). Suspended solids generally include soil particles, plant and animal plankton and a variety of terrestrially derived materials. Elevated levels of these materials generally indicate either a very productive lake or substantial additions of materials eroding from the watershed of the lake.

Water Quality Management Options

Water quality management is generally keyed to maintenance or improvement of an accustomed use rather than what is best for a lake from a purely environmental standpoint. In the case of Brant Lake, maintenance of the lake for recreational uses such as swimming, sailing and fishing is the desired goal. The principal threat to these uses at present is excessive growth of non-native aquatic plants in the lake. The ability of the lake waters to neutralize inputs of acid from precipitation is currently adequate, however this is one aspect of lake water quality which may require closer monitoring.

Brant Lake is a moderately productive lake in terms of rooted aquatic plants, a condition which may impact the desired use of the lake. The level of productivity of suspended algae in the lake is low to moderate as evidenced by the high transparency. Productivity of both suspended algae and rooted aquatic plants is tied to the availability of nutrients or fertilizers in the lake water and sediments. An extensive discussion of nutrients and their relationship to plant production is included in Appendices A and B.

Reduction in the density of aquatic plants and algae, from a water quality standpoint, revolves around reduction of the amount of nutrients present in or added to the lake. A management plan to reduce nutrient concentrations in Brant

Lake should include the following basic components.

EDUCATION
PREVENTION
IMPLEMENTATION OF CONTROLS
MONITORING AND EVALUATION

Education. In order to develop support for lake management, area residents need to understand the need for and the justification of activities relative to water quality management. They need to understand how their actions may effect the use of the lake and how they can get assistance to remedy any real or perceived problems. Education can provide understanding and enlist support for programs to improve water quality. In order to assist your lake association in developing an educational program for your members, we have included basic information as Appendices to this report.

Prevention. Reduction of nutrients within Brant Lake should start with prevention of excess nutrients from entering the lake. Nutrients enter the lake in three ways; directly with precipitation, through runoff of waters from the lake's watershed and via resuspension from the sediments of the lake. Little can be done to reduce the amount of nutrients falling directly on the lake as precipitation, at least on the local level. Substantial reductions in the nutrients carried by runoff waters can be accomplished by local residents at the grass roots level. Reduction of nutrients coming into the water column of the lake via resuspension from the sediments will generally require in-lake control.

Reductions of the amount of impermeable surfaces adjacent to the lake (paved roads and driveways, sidewalks, etc.) will slow the flow of rainwater to the lake by forcing it to percolate through soils prior to entering the lake. Soils act as a natural filter removing much of the nitrogen and phosphorus compounds before the water reaches the lake. Eliminating stormwater drains emptying directly into the lake is also helpful. The drains may be redirected to small gravelled areas for slow dispersal of the water.

Sewage from failing or improperly located septic systems can be a major source of nutrients to a lake. In a properly maintained and located septic system, solid material is allowed to settle in the septic tank where microorganisms can decompose it into water soluble material. The water soluble components (leachate) are allowed to pass into lateral drainage fields where the liquid slowly percolates into adjacent soils. In the soil, chemical reactions and bacteria remove the nitrogen and phosphorus compounds from the water and convert it to insoluble material, cellular material and gaseous material. Thus, in a properly operating system nitrogen and phosphorus are removed or reduced before the water finally percolates back to the lake. In a system which is not operating properly, insufficient time is available for complete removal of nitrogen and phosphorus compounds before the leachate reaches the lake. Septic system failure is likely to occur when the systems are:

1) built in fill over an old wetland or natural drainage area whose water table is near the surface of the soil.

2) not of sufficient size to handle normal and peak loading rates.

3) located where the depth of soil present over bedrock is less than six feet.

4) located less than 50 feet from the shore of a lake or a stream.

5) located in soils with extremely high permeability or steeply sloping ground resulting in too rapid a movement of liquid through the system.

6) receiving excessive amounts of undigestable or slowly digested materials (i.e. plastics, bone or eggshells) without frequent pumpout.

7) older than 30 years and have never been upgraded.

Extreme septic system failures may be observed as clogged toilets and drains or puddling of water on the surface of the ground near the location of the septic leaching device of the system. Puddling is most likely to occur when the soils are quite wet primarily during the spring of the year and after periods of heavy rain in the summer. Surface pooling of water is also most common at high water usage times of day, generally in the morning. Septic inputs directly into the lake generally result in excessive growth of dense filamentous mats of algae near the point where the sewage enters the lake.

Eroding soils carry considerable amounts of nutrients into the lake. Soils generally contain much greater amounts of nitrogen and phosphorus compounds than lake water. If soils are stabilized by good vegetation cover, only small amounts of nutrients are washed into the lake. If large areas of timber are logged or if roads and developments are improperly designed, large scale erosion of soils frequently results. Soil erosion may be controlled in several ways by: 1) maintaining or planting effective ground cover vegetation (e.g. Crown Vetch) in erosion prone areas, 2) restricting both the amount of acreage that may be logged at any one time and the time of year when logging operations occur, 3) providing guidelines on road construction within the basin and methods that contractors use to develop property, and 4) maintenance of a vegetated area along the shoreline. Considerable amounts of soils are deposited in the lake by streams. Some of the soils may be kept out of the lake by minimum adjustments to the stream bed to reduce the water velocity in the stream prior to entry into the lake. Reduced water velocity in the stream will cause the bulk of the suspended soils to be deposited in the low velocity area and with occasional cleanout this area can be maintained fairly easily. Your local Soil Conservation Service representative (Appendix H) can provide valuable assistance in determining the extent of erosion problems and suggesting methods for soil conservation.

The runoff of fertilizers applied to lawns and gardens can frequently add nitrogen and phosphorus to a lake. There are a number of "common sense" methods for reducing the inputs from these sources. Follow label instructions for the fertilizer used and don't overfertilize. Don't fertilize early in the spring or at other times when soils are saturated from a recent rainstorm. Try to apply small amounts of fertilizer more frequently (i.e. twice per year add one-half the amount usually applied once per year). Don't locate vegetable gardens or other gardens that you plan to fertilize heavily close to the lake. Don't fertilize immediately before a rainstorm is forecast.

Implementation of Controls. A number of control techniques are available, however each has advantages and disadvantages (Appendix C). Control of nutrient inputs from the terrestrial part of the lake basin has been discussed in the previous section. In-lake controls (Appendix J), are frequently costly, large scale projects requiring permits from state and local agencies. Considering the good water quality, in-lake controls for nutrient reduction as probably not warranted at present.

Monitoring and Evaluation. Continued monitoring of Brant Lake water quality by your association is desirable. A chemical assay program as extensive as that presented in this report is not necessary on an annual basis. Lake Association members in conjunction with the CSLAP program are currently making certain measurements that will prove extremely useful in observing any long-term trends in water quality. Continued active involvement in this program by the Brant Lake Association is strongly encouraged.

Findings

1. The transparency and phosphorus concentration of Brant Lake waters indicate that the lake should be classified as oligotrophic.

2. Water quality in Brant Lake is currently adequate for the primary use of its' residents, namely recreation.

3. The low alkalinity of Brant Lake makes it susceptible to acidification by acid deposition, although it currently seems to have sufficient capacity to neutralize the acidic inputs it receives. Historical data for Brant Lake indicates that the pH and alkalinity have remained relatively stable over the last 50 years.

4. The deeper waters of the lake (hypolimnion) show low dissolved oxygen concentrations and elevated nutrient levels during summer stratification.

5. The steep slopes and coarse textured soils in the watershed of this lake make erosion of this material and deposition into the lake's basin a serious concern.

6. Changes in lake water chemistry over the last eight years have been minor.

Recommendations

1. Although Brant Lake is currently near neutral pH, the buffering capacity of the lake is quite low. Without information on the pH of the lake in the spring, when the largest volumes of acid generally enter a lake, the full extent of the impacts of acid precipitation on Brant Lake are uncertain. Collection of pH and alkalinity data in the spring of the year should be encouraged by the lake association.

2. The lake association should contact the Warren County Soil and Water Conservation Service to review appropriate erosion control techniques as a first step in controlling sediment and nutrient addition to the lake. Many techniques can be applied on an individual homeowner basis such as planting erosion resistant species along shorelines and steep slopes, maintenance of a green strip along the lakeshore, and altering the flow of runoff water to prevent direct entry into the lake.

3. Continued membership in the Citizens Statewide Lake Assessment Program (CSLAP) should be encouraged and monitoring of Eurasian Watermilfoil populations should be included. Information generated by this program will provide a substantial database for objective decision-making and can be crucial for rapid response and remediation activities should any prove necessary.

4. Encouragement of an active lake association with ties to regional and state lake federations is an important step. A water quality committee could organize education, prevention, control and evaluation activities. A thorough review of your town's zoning and planning laws with respect to mitigations of stormwater and wastewater controls should also be considered. A number of factors that threaten the lake are more regional or national problems, such as acid precipitation, runoff of sediments, nutrient additions, salt and corrosion products from area roads. Solutions for these problems will require the participation of a broad based organization.

Table 3-1. Chemical Water Quality Characteristics of Brant Lake.

Site	Depth (m)	pH	Conductivity umhos	OP mg P/l	TP mg P/l	NO3 mg N/l	NH4 mg N/l	Alkalinity mg CaCO3/l	TSS mg/l	Secchi Depth meters	Cl mg/l	SO4 mg S/l
Inlet	0.5	6.90	90	0.002	0.011	<0.010	<0.010	25.0	0.89		9.21	1.18
Midlake North	0.5	7.62	62	0.001	0.004	0.014	<0.010	18.0	0.73	5.5	4.67	2.16
	17.0	6.72	63	0.002	0.008	0.053	0.060	17.5	1.00		4.41	2
Midlake South	0.5	7.59	62	0.002	0.004	0.015	<0.010	21.0	0.73	5.0	4.52	2.12
	7.5	7.05	60	0.002	0.007	<0.010	<0.010	17.5	2.10		4.36	2.1
Outlet	0.5	7.35	79	0.007	0.018	<0.010	0.010	27.0	3.53		6.12	1.94

Table 3-2. Surface Water Chemistry for Selected Lakes.

Lake	Secchi Transparency (meters)	Alkalinity (ppm as $CaCO_3$)	Total Phosphorus (ppb)
Lake George New York	8.0	26.0	5
Brant Lake New York	5.3	20.0	4
Eagle Lake New York	8.0	30.0	7
Lake Luzerne New York	4.7	17.5	8
Galway Lake New York	2.7	64.0	23
Saratoga Lake New York	2.2	77.0	100

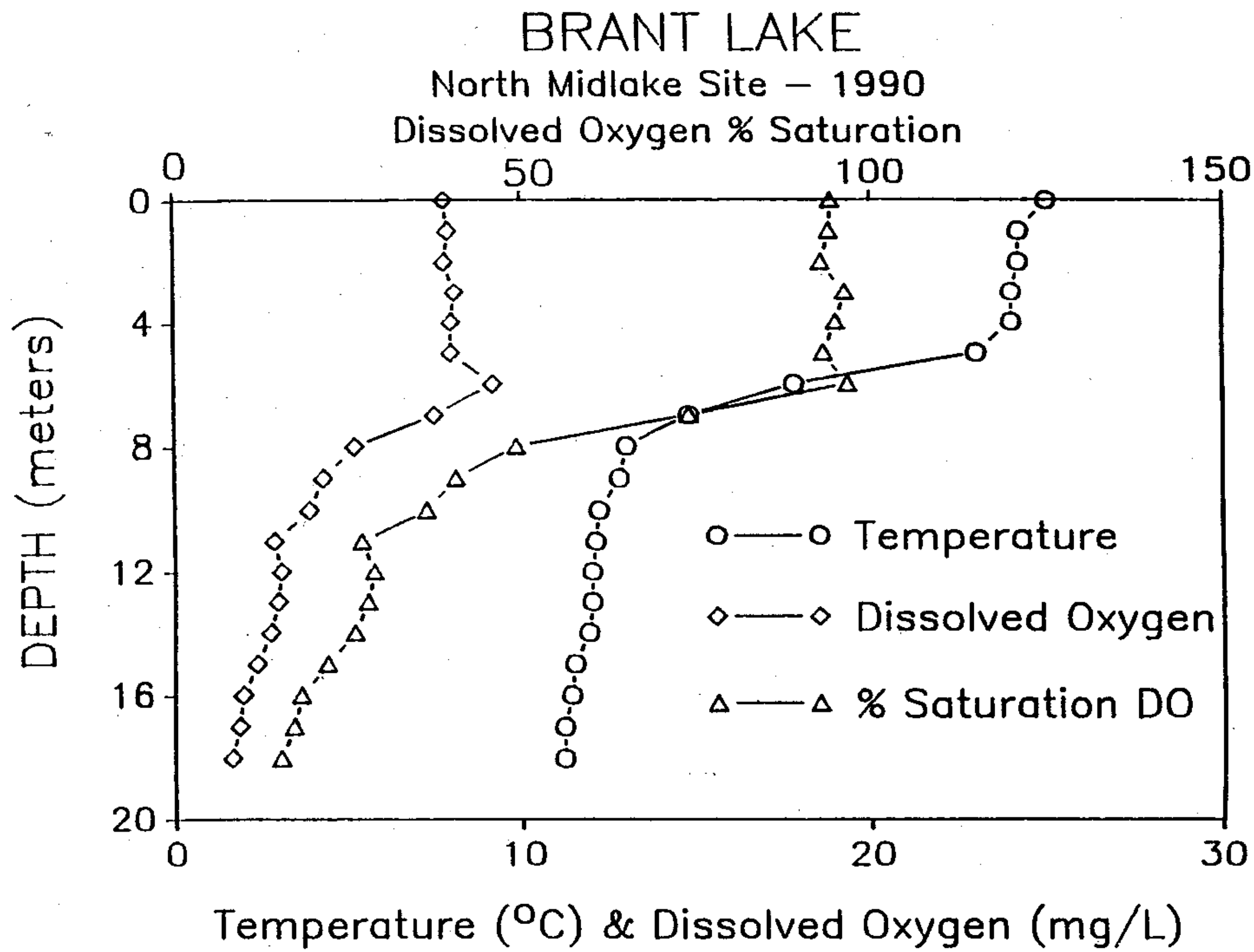


Figure 3-1. Dissolved Oxygen and temperature profiles for Brant Lake.

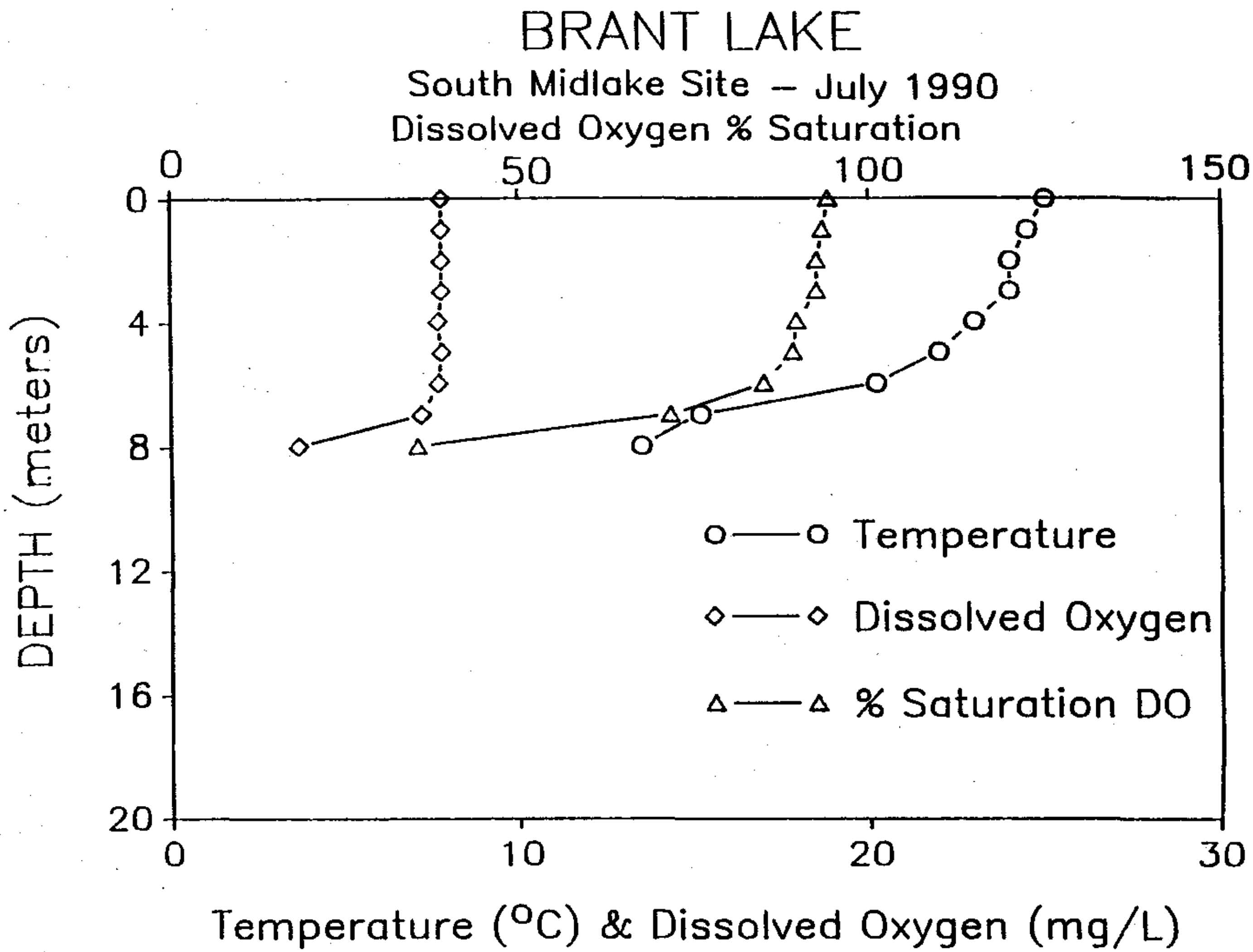


Figure 3-1 (cont.). Dissolved Oxygen, Percent Saturation and temperature profiles for Brant Lake.

SECTION 4

VEGETATION IN BRANT LAKE

The topics addressed in this section are the status of the submersed vegetation of the lake in the summer of 1990, including that of Eurasian Watermilfoil, and potential plant management strategies. First, the plant species observed will be discussed. Second, the results of the semi-quantitative vegetation transects will be examined, followed by a summarization of this data in terms of plant relative abundance and depth distribution. Third, the distribution patterns of Eurasian Watermilfoil will be discussed, noting how this distribution may be related to its introduction, and indicating some future areas of concern. Finally, management alternatives will be discussed with regard to development of a vegetation management plan, as a component of an overall lake management plan.

Submersed Plant Species in Brant Lake

A list of all submersed and floating-leaved aquatic plant species observed in Brant Lake is given in Table 4-1, totaling 38 species. Of these species, one is a macroscopic alga, or charophyte (Nitella), three are floating-leaved species (Brasenia, Nuphar and Nymphaea), three have emergent leaves (Pontederia, Scirpus and Typha) and the remaining 31 are submersed. This list does not include marsh species, such as found on the lower basin, but only those within the lake. The large number of species observed indicates excellent diversity, typical of low-elevation Adirondack lakes (Madsen et al. 1989). For instance, Lake George has 47 submersed species (RFWI et al., 1988) and 19 were observed in Lake Luzerne (Eichler and Madsen, 1990a). In each of these lakes, this high diversity is threatened by further growth and expansion of Eurasian Watermilfoil, which will have negative implications for the health of the lake as a whole (Madsen et al., 1989, 1990).

One important factor to account for during the permitting process of an aquatic plant management program is the occurrence and abundance of rare plant species that might be affected by a given management technique. Myriophyllum alterniflorum was the only plant observed that is on the New York State Rare Plant list (Mitchell, 1986; Clemants, 1989). However, the placement of this species on the rare plant list may be due to the lack of appropriate observations, or searches, for this species, rather than its actual rarity. We have observed this species in many regional lakes including Lake George (Madsen et al., 1989), Schroon Lake (Taggett and Boylen, 1989) and Lake Luzerne (Eichler and Madsen, 1990a).

The composition of the species list for Brant Lake was very similar to that of other nearby lakes. For instance, all of the species observed in Brant Lake have been noted for Lake George (RFWI et al., 1988).

Vegetation Transects

The locations of the six transects examined are indicated in Figure 2-1. We selected sites that had both shallow and moderately steep slopes, with and without dense Eurasian Watermilfoil stands.

Observations for Transect 1 are indicated in Table 4-2. This location was a shallow zone adjacent to a small wetland at the outlet of the lake, near the public boatlaunch. In the shallow wetland zone (0-1 m), Scirpus subterminalis was abundant, while both Utricularia purpurea and Pontederia cordata were common. From 1 to 2 meters, Utricularia purpurea and P. epihydrus shared dominance. Despite being near a boatlaunch and at the outlet of the lake, individuals of M. spicatum were not observed. However, given the shallow and productive habitat this site offered, it is very susceptible to dense growth of M. spicatum. Also, due to its shallowness and proximity to a major access point of the lake, the nuisance created by such a dense growth would be considerable.

Observations for Transect 2 are shown in Table 4-3. This rocky shoreline sloped rapidly to the edge of the lake. The lake bottom had a relatively steep slope with sediments dominated by sand and gravel. The macrophyte population in this area was scattered. In shallower zones (0-1 meter), Eriocaulon septangulare formed a sparse, low-growing mat with Eleocharis spp. also present. In depths of 1 to 3 meters, Elodea canadensis, Najas flexilis and Isoetes spp. were the principle species present. Vallisneria americana, Najas flexilis and Isoetes spp. were the major species at 3 to 4 meters depth with Isoetes spp. present to the maximum depth of aquatic plants observed at this site of 5 meters.

A gradual sloped site with Eurasian Watermilfoil was examined at Transect 3 (Table 4-4). The diversity at this site was considerably higher than at Transects 1 or 2. Dominant species from 0 to 2 meters included P. robbinsii, P. pusillus and Vallisneria americana. A very diverse macrophyte community with no clear dominants was found from 2 to 3 meters, but some important species were Najas flexilis, P. robbinsii, and U. purpurea. Beyond 3 meters, Najas flexilis was the major macrophyte species. The charophytes (Nitella spp.) were abundant through the depth range at this site. Two plants and a number of fragments of M. spicatum were found at this site in depths of 1 to 2 meters.

Observations along Transect 4 are recorded in Table 4-5. At this location, the bottom sloped gradually and was primarily sand with a soft clay layer below the sand. The dominant species from 0 to 1 meters was Eriocaulon septangulare which formed clumps raised above the surrounding bottom. A diverse macrophyte community was found from 1 to 3 meters, dominated by Najas flexilis and P. robbinsii. Between 3 and 4 meters, Najas flexilis and V. americana were the major macrophyte species. Beyond 4 meters depth only V. americana, P. robbinsii, and E. canadensis were present.

In the shallow zone at Transect 5 (0-2 m), the dominant species was N. flexilis (Table 4-6). No plants were observed in the 0-1 m depth range since the bottom sediment was reported as hard sand. From 2 to 5 meters, a sparse community was observed, including several Potamogeton species, E. canadensis and V. americana. From 5 to 6 meters, V. americana was the only species present. Approximately 20 specimens of M. spicatum were observed around the end of a dock in this bay.

Observations for Transect 6 are indicated in Table 4-7. This location was a wetland area (Pickerel Pond) located at an inlet to the lake on the northeast margin. In the shallow wetland zone (0-2 m), Scirpus subterminalis, Pontederia cordata, and the pond lilies Nuphar and Nymphaea were abundant. M. sibaricum and P. natans were also common within this range. No M. spicatum was observed in this area though given the shallow and productive habitat this site offered, it is very susceptible to dense growth of M. spicatum.

The depth distribution and total relative abundance of all aquatic plants in Brant Lake is shown in Table 4-8. These species are ranked in order of abundance in Table 4-9. The abundance of species observed in Brant Lake was very similar to that for Lake George (RFWI et al., 1988; Madsen et al., 1989). The majority of species occur between 1 and 3 meters.

Eurasian Watermilfoil in Brant Lake

Scattered Eurasian Watermilfoil was found at six locations within the lake (Figure 4-1). These scattered locations were probably due to the dispersal of fragments from the one dense stand in the lake. The one dense bed was located at the northeastern end of the lake. A larger area of moderately dense growth and scattered plants surrounded the single bed observed. This area has the potential to expand into substantially larger, nuisance growths.

Of the areas currently without milfoil populations, the southern end is particularly susceptible to dense growths of Eurasian Watermilfoil. The boat launch and adjacent outlet channel should be monitored carefully. Another area with depth and sediment characteristics suitable for dense growth of Eurasian watermilfoil would be the area known as Pickerel Pond. This area currently supports a lush growth of native vegetation including northern watermilfoil, _M. sibaricum_. The areas along the western shore of the lake with scattered plants will probably not grow into large infestations, only because the slope of this shore is considerable. The scattered plants observed along the eastern shore were found in areas with predominantly sand bottoms. This type of substrate is generally not conducive to excessive plant growth. Therefore, these areas do not present an immediate concern. However, Eurasian Watermilfoil control throughout the lake will ensure that locations will not remain to recolonize areas of the lake that are susceptible to extensive growth.

Since the densest area of growth was at the northern end of the lake, and no Eurasian Watermilfoil was found near the public boatlaunch, it is likely that the point of introduction was somewhere other than the boatlaunch ramp.

Management of Eurasian Watermilfoil in Brant Lake

Although lake residents all want immediate action, the first step in addressing Eurasian Watermilfoil problems in Brant Lake is to develop a long-term aquatic plant management plan as a component of an overall lake management plan. A long-term plan is needed, since it is unlikely (if not impossible) that Eurasian Watermilfoil can be eradicated from the lake. Even if eradication were to be accomplished, continued vigilance would be necessary to prevent any future reintroductions. Although Appendices B and C (Eichler _et al_. 1990) have more information on a plant management plan, some specific components to address are:

Education
Prevention
Implementation of Controls
Evaluation and Monitoring

Education. To develop support for management efforts, and to gather volunteers to assist with the program, education of lake-users and homeowners is imperative. Homeowners and lake users must know about Eurasian Watermilfoil and how to prevent further introductions and spread (Appendix C). One fact is becoming plain - in these times of tight money, the only way to protect your lake is to band together and do it as a lake association.

Prevention. Once control has been successful, efforts must be made to prevent reintroduction, and slow the spread of Eurasian Watermilfoil. Also, preventive efforts will help to curtail the spread of this plant to other lakes; both as an altruistic measure to keep other lakes from experiencing these problems, and to minimize sources of plants for potential reintroduction of exotic species. Prevention efforts might include education, nonpoint pollution control, erosion management and encouraging the reintroduction and growth of native plants.

Implementation of Controls. A wide variety of control techniques are available, none of which provides a perfect solution. All techniques have advantages and drawbacks (Appendix C). Each location with Eurasian Watermilfoil must be assessed individually, and a control technique selected that will work under those conditions.

The vegetation management committee must study the control options and decide on a suitable group of control techniques. Do not rely solely on consultants to decide for you. One important consideration generally neglected is that these techniques will have to be approved through a permitting process, so select techniques that will be acceptable to the permit administrator (See Appendix H). The permits for aquatic plant control within the Adirondack Park are administered by the Adirondack Park Agency, so more restrictions apply than are generally true elsewhere in the state.

Some recommendations for specific control techniques that might be suitable would be to treat the scattered plant areas by hand picking of Eurasian Watermilfoil, either through the use of divers and snorkelers, or by wading in depths up to 1 meter. Permits for this activity would probably be more readily obtained than others. For more dense locations, other techniques should be considered. For instance, dense beds in Lake George were managed using benthic mats. These mats are quite effective, and give control for long periods of time. Since the dense bed in the lake is not currently very large, benthic matting should not be either prohibitively expensive nor cause appreciable impacts to the deepwater vegetation or spawning fish populations.

Other possibilities for managing dense beds might include diver-operated suction harvesting or rotovating. Currently, the dense location of Eurasian Watermilfoil is localized, so more drastic measures such as drawdown or chemical control are probably not yet warranted. Chemical control is not completely beyond the realm of possibility, however Brant Lake is a class AA lake, and could be used for a drinking water supply. Chemical treatment is not recommended for waters used as a diffuse drinking water supply.

<u>Monitoring and Evaluation</u>. These two activities are similar in execution, but somewhat distinct in purpose. The vegetation committee should coordinate a lay monitoring program of lake-users to observe lake areas for the presence and spread of Eurasian Watermilfoil in the lake. In addition, these individuals might help in posting the boat launches and even inspecting boats and interviewing owners about the Eurasian Watermilfoil problem.

Monitoring the lake would include consistent visual inspections of areas of the lake, using snorkeling or scuba, for the presence and spread of Eurasian Watermilfoil. One technique for quantifying areas with dense Eurasian Watermilfoil is to use an echolocation unit ("fish/depth locator") to map the height and area of dense beds during the summer. The Fresh Water Institute will cooperate with lake associations by identifying plant samples (Appendix G). Currently the CSLAP program also collects information on the aquatic plants in the lake. Coordination with the efforts of this program should be encouraged. These monitoring activities should be part of an overall lake monitoring program.

Evaluation activities are designed to examine specific control programs and techniques, as well as assessing the rate of Eurasian Watermilfoil regrowth or recolonization and the need for repeated control at a given location. This may also be done by lay monitors, or contracted with consultants.

An ongoing effort in prevention, education, evaluation and monitoring will greatly facilitate gathering information and making decisions on future management directions.

Findings

1. A total of 38 submersed plant species were observed in Brant Lake, of which 34 were found along the six transects studied. Of these species, the dominant plants were *Najas flexilis*, *Nitella* spp., *Isoetes* spp., *P. robbinsii*, *Scirpus subterminalis*, *Vallisneria americana*, and *Utricularia purpurea*. Vascular plant species were found to a depth of 6 meters.

2. Eurasian Watermilfoil (*Myriophyllum spicatum*) was the 26^{th} most abundant species. A single dense stand was found at the northeastern end of the lake at a depth of 1.5 to 3.0 meters (4 to 10 feet) with scattered individuals surrounding this bed at a depth of 0.5 to 3.0 meters (2 to 10 feet). Eurasian Watermilfoil also occurred as scattered plants at 5 other locations.

3. Several areas that are as yet without or only slightly infested with Eurasian Watermilfoil have the potential to support larger, dense beds of this plant. These include the outlet area, the shallow southwestern bay, and the large shallow wetland area known as Pickerel Pond.

Recommendations

1. An active aquatic plant management committee should be formed to develop and implement a long-term aquatic plant management plan, as part of an overall lake management plan. In addition to selecting and implementing control techniques, the committee should develop education, prevention, evaluation and monitoring activities to be responsive to changing conditions.

2. The activities of the Citizens Statewide Lake Assessment Program (CSLAP) should be maintained and include monitoring of Eurasian Watermilfoil.

3. Although an in-depth study of aquatic plant control alternatives should be performed, two initial suggestions for control are to develop a hand-harvesting effort on the scattered plant areas before they grow into dense beds, and apply benthic barrier (mats) to the small dense bed.

Table 4-1. Macrophyte species present in Brant Lake.

SCIENTIFIC NAME	COMMON NAME
Bidens beckii	Water Marigold
Brasenia spp.	Water Shield
Ceratophyllum demersum	Coontail
Eleocharis spp.	Spike Rush
Elodea canadensis	Waterweed
Eriocaulon septangulare	Pipewort
Heteranthera dubia	Water Star Grass
Isoetes spp.	Quillwort
Juncus pelocarpus	Bog Rush
Lobelia spp.	Water Lobelia
Myriophyllum alterniflorum	Little Watermilfoil
M. sibaricum	Northern Watermilfoil
M. spicatum	Eurasian Watermilfoil
Najas flexilis	Naiad
Nitella spp.	Nitella
Nuphar spp.	Yellow Water Lily
Nymphaea spp.	White Water Lily
Pontederia cordata	Pickerelweed
Potamogeton amplifolius	Large-leaved Pondweed
P. crispus	Curly-leaved Pondweed
P. epihydrus	Leafy Pondweed
P. gramineus	Variable Pondweed
P. natans	Floating Pondweed
P. perfoliatus	Redhead Pondweed
P. praelongus	Whitestem Pondweed
P. pusillus	Slender Pondweed
P. robbinsii	Robbins Pondweed
P. spirillus	Spiral Pondweed
P. vaseyi	Vasey Pondweed
Ranunculus reptans	Creeping Buttercup
Sagittaria graminea	Arrowhead
Scirpus subterminalis	Water Bulrush
Sparganium spp.	Bur-reed
Typha spp.	Cattail
Utricularia purpurea	Purple Bladderwort
U. resupinata	Lavender Bladderwort
U. vulgaris	Common Bladderwort
Vallisneria americana	Duck Celery

Table 4-2.

BRANT LAKE VEGETATION DATA: TRANSECT 1

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
S. subterminalis	A					
U. purpurea	C	C				
P. perfoliatus	O	O				
S. graminea	O	O				
P. cordata	C					
Nuphar spp.	O					
Nymphaea spp.	O					
E. septangulare	O					
Sparganium spp.	O					
Brasenia spp.	O					
P. robbinsii		O				
P. praelongus		R				
P. epihydrus		C				

ABUNDANCE CODES:	LETTER	LABEL	PERCENTAGE RANGE
	A	ABUNDANT	>50%
	C	COMMON	25-50%
	P	PRESENT	15-25%
	O	OCCASIONAL	5-15%
	R	RARE	<5%

Table 4-3.

BRANT LAKE VEGETATION DATA: TRANSECT 2

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
E. canadensis	O	P	P			
Nitella spp.	P	P	P			
P. ampifolius	R					
P. gramineus	O					
P. robbinsii		P				
V. americana			O	P		
E. septangulare	p					
Isoetes spp.	O	P	P	C	P	
N. flexilis	R	P	P	P		
P. pusillus	O		O			
Eleocharis spp.	P					
U. purpurea	O	P			P	
P. epihydrus	O					
C. demersum		R				

ABUNDANCE CODES:	LETTER	LABEL	PERCENTAGE RANGE
	A	ABUNDANT	>50%
	C	COMMON	25-50%
	P	PRESENT	15-25%
	O	OCCASIONAL	5-15%
	R	RARE	<5%

Table 4-4.

BRANT LAKE VEGETATION DATA: TRANSECT 3

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
E. canadensis	R		P			
Nitella spp.	P	C	A	A	A	
P. robbinsii	P	C	C			
Isoetes spp.	P					
N. flexilis	C		C	C	P	
Eleocharis spp.	P					
U. purpurea			C			
P. epihydrus		P				
Sparganium spp.	P					
S. graminea	P					
V. americana	C	P	P	R	R	
P. pusillus	C	P	P	P		
M. spicatum		R				
P. praelongus		P				
P. crispus		P				
P. perfoliatus		P				
B. beckii		R	P			

ABUNDANCE CODES:

LETTER	LABEL	PERCENTAGE RANGE
A	ABUNDANT	>50%
C	COMMON	25-50%
P	PRESENT	15-25%
O	OCCASIONAL	5-15%
R	RARE	<5%

Table 4-5.
BRANT LAKE VEGETATION DATA: TRANSECT 4

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
E. canadensis		P	R	O	O	R
P. robbinsii		A	A	O	O	
Isoetes spp.			P	O		
N. flexilis	P	A	A	C		
U. purpurea			C			
P. epihydrus		P	O			
Sparganium spp.		P				
V. americana	P	P		P	O	R
P. amplifolius		P	P			
J. pelocarpus	P					
P. perfoliatus			P			
B. beckii			C	R		
Eriocaulon spp.	A					
P. gramineus	O					
Lobelia spp.	R					
P. spirillus	R	P				
U. vulgaris		O	C			
P. praelongus			R			
S. subterminalis			C			

ABUNDANCE CODES:	LETTER	LABEL	PERCENTAGE RANGE
	A	ABUNDANT	>50%
	C	COMMON	25-50%
	P	PRESENT	15-25%
	O	OCCASIONAL	5-15%
	R	RARE	<5%

Table 4-6.

BRANT LAKE VEGETATION DATA: TRANSECT 5

SITE #:	T-5
SITE NAME:	BRANT LAKE
DATE SURVEYED:	24-Jul-90
SURVEYOR:	LT

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
E. canadensis		P	R			
P. robbinsii			O	P		
Isoetes spp.				P	R	
N. flexilis		A				
U. resupinata		C				
P. epihydrus		P				
C. demersum					R	
V. americana		C	P	O	O	R
P. amplifolius		P				
H. dubia		P				
P. perfoliatus		P	P		R	
P. pusillus		R		O		
P. spirillus		P				

ABUNDANCE CODES:

LETTER	LABEL	PERCENTAGE RANGE
A	ABUNDANT	>50
C	COMMON	25-50%
P	PRESENT	15-25%
O	OCCASIONAL	5-15%
R	RARE	<5%

Table 4-7.

BRANT LAKE VEGETATION DATA: TRANSECT 6

SPECIES	DEPTH INTERVAL (M) 0-1	1-2	2-3	3-4	4-5	5-6
S. subterminalis	A	A				
M. sibaricum		C				
U. vulgaris	O	O				
Nuphar spp.	A					
N. odorata	A					
P. epihydrus	O	O				
P. cordata	A					
Brasenia	O					
P. amplifolius		O				
P. perfoliatus		O				
P.natans	O	C				

ABUNDANCE CODES:	LETTER	LABEL	PERCENTAGE RANGE
	A	ABUNDANT	>50%
	C	COMMON	25-50%
	P	PRESENT	15-25%
	O	OCCASIONAL	5-15%
	R	RARE	<5%

Table 4-8.

Relative abundance of species observed in Brant Lake

SPECIES	0-1	1-2	2-3	3-4	4-5	5-6	TOTAL
Bidens beckii	0	1	10	1	0	0	2
Brasenia spp.	3	0	0	0	0	0	1
Ceratophyllum demersum	0	1	0	0	1	0	1
Eleocharis spp.	7	0	0	0	0	0	1
Elodea canadensis	2	10	7	2	1	0	4
Eriocaulon septangulare	18	0	0	0	0	0	3
Heteranthera dubia	0	3	0	0	0	0	1
Isoetes spp.	5	3	5	11	4	0	9
Juncus pelocarpus	3	0	0	0	0	0	1
Lobelia spp.	1	0	0	0	0	0	1
M. sibaricum	0	6	0	0	0	0	2
M. spicatum	0	1	0	0	0	0	1
Najas flexilis	10	28	22	16	3	0	13
Nitella spp.	7	10	16	13	13	0	10
Nuphar spp.	14	0	0	0	0	0	2
Nymphaea spp.	14	0	0	0	0	0	2
Pontederia cordata	19	0	0	0	0	0	3
Potamogeton amplifolius	1	8	3	0	0	0	2
P. crispus	0	3	0	0	0	0	1
P. epihydrus	3	18	2	0	0	0	4
P. gramineus	3	0	0	0	0	0	1
P. natans	2	6	0	0	0	0	1
P. perfoliatus	2	10	7	1	1	0	4
P. praelongus	0	4	1	0	0	0	1
P. pusillus	8	4	5	5	0	0	4
P. robbinsii	3	24	20	5	2	0	9
P. spirillus	1	6	0	0	0	0	1
Sagittaria graminea	5	2	0	0	0	0	1
Scirpus subterminalis	25	13	6	0	0	0	7
Sparganium spp.	5	3	0	0	0	0	1
Utricularia purpurea	8	10	13	0	3	0	6
U. resupinata	0	6	0	0	0	0	1
U. vulgaris	2	3	6	0	0	0	2
Vallisneria americana	10	13	8	7	4	1	7

Table 4-9.

Relative abundance of species observed in Brant Lake

SPECIES	0-1	1-2	2-3	3-4	4-5	5-6	TOTAL
Najas flexilis	10	28	22	16	3	0	13
Nitella spp.	7	10	16	13	13	0	10
Isoetes spp.	5	3	5	11	4	0	9
P. robbinsii	3	24	20	5	2	0	9
Scirpus subterminalis	25	13	6	0	0	0	7
Vallisneria americana	10	13	8	7	4	1	7
Utricularia purpurea	8	10	13	0	3	0	6
P. epihydrus	3	18	2	0	0	0	4
P. pusillus	8	4	5	5	0	0	4
Elodea canadensis	2	10	7	2	1	0	4
P. perfoliatus	2	10	7	1	1	0	4
Pontederia cordata	19	0	0	0	0	0	3
Eriocaulon septangulare	18	0	0	0	0	0	3
Nuphar spp.	14	0	0	0	0	0	2
Nymphaea spp.	14	0	0	0	0	0	2
Potamogeton amplifolius	1	8	3	0	0	0	2
M. sibaricum	0	6	0	0	0	0	2
Bidens beckii	0	1	10	1	0	0	2
U. vulgaris	2	3	6	0	0	0	2
Sparganium spp.	5	3	0	0	0	0	1
P. natans	2	6	0	0	0	0	1
P. spirillus	1	6	0	0	0	0	1
Sagittaria graminea	5	2	0	0	0	0	1
Eleocharis spp.	7	0	0	0	0	0	1
Ceratophyllum demersum	0	1	0	0	1	0	1
M. spicatum	0	1	0	0	0	0	1
U. resupinata	0	6	0	0	0	0	1
Lobelia spp.	1	0	0	0	0	0	1
Juncus pelocarpus	3	0	0	0	0	0	1
Heteranthera dubia	0	3	0	0	0	0	1
P. crispus	0	3	0	0	0	0	1
P. praelongus	0	4	1	0	0	0	1
P. gramineus	3	0	0	0	0	0	1
Brasenia spp.	3	0	0	0	0	0	1

Figure 4-1. Depth distribution of the ten most common aquatic plant species in Brant Lake. NF, *Najas flexilis*; PR, *Potamogeton robbinsii*; N, *Nitella* spp.; I, *Isoetes* spp.; SS, *Scirpus subterminalis*; VA, *Vallisneria americana*; UP, *Utricularia purpurea*; PE, *P. epihydrus*; EC, *Elodea canadensis*; PP, *P. pusillus*.

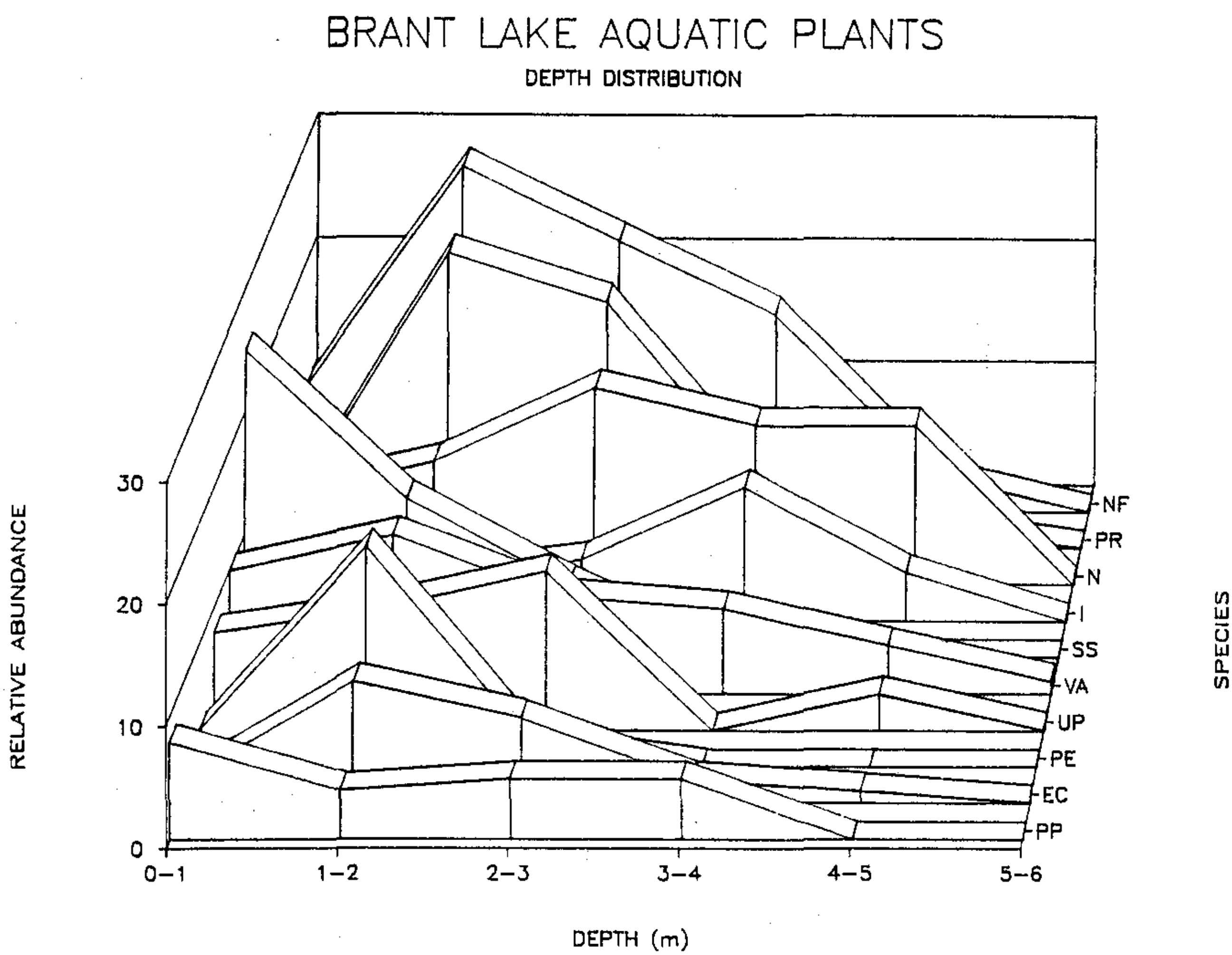
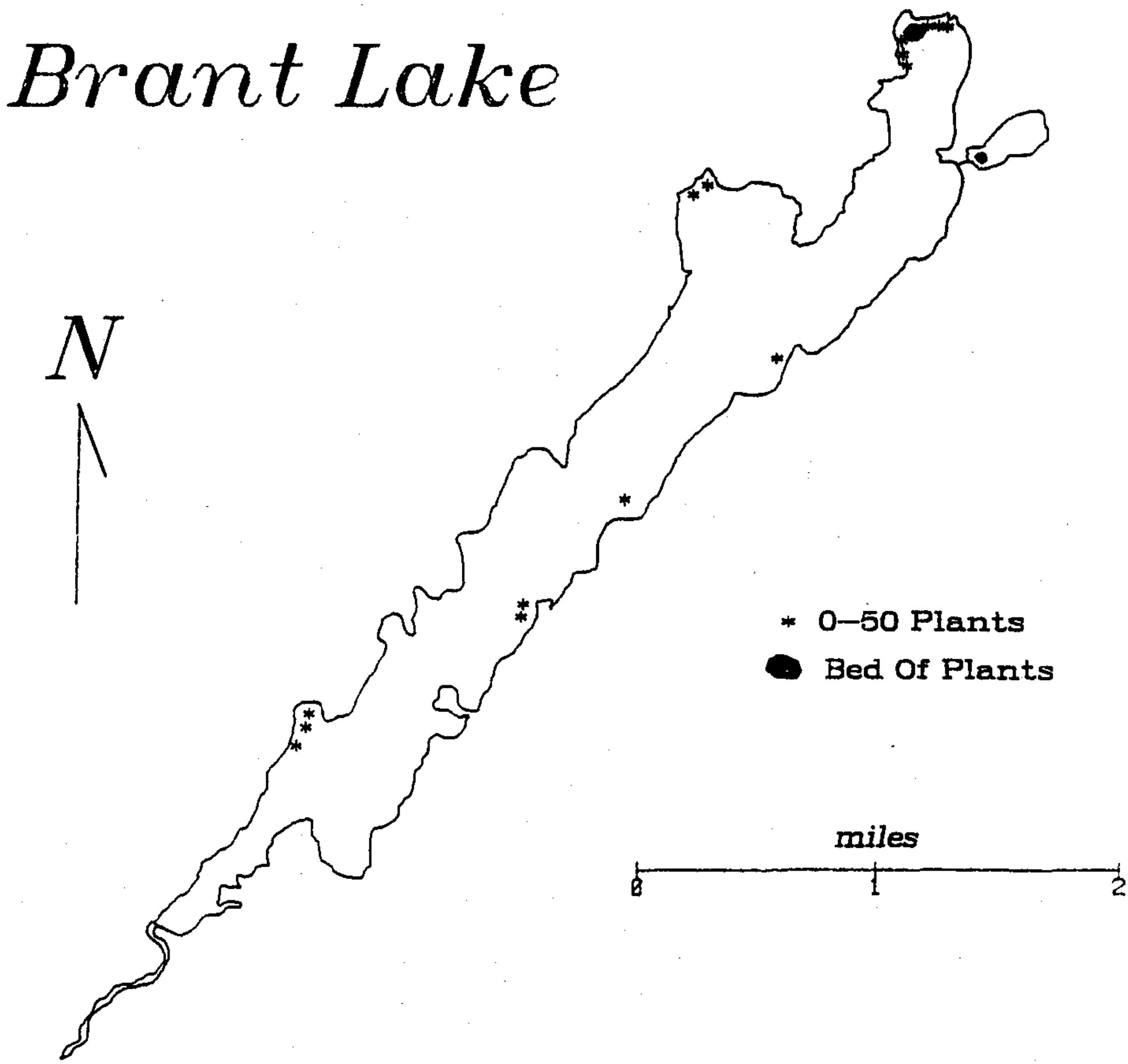


Figure 4-2. Location of dense and scattered Eurasian Watermilfoil populations in Brant Lake.



SECTION 5

ACKNOWLEDGMENTS

The authors would like to thank the Warren County Lake George Affairs Committee of the Warren County Board of Supervisors for supporting this assessment. We would also like to thank David Niles for the use of his boat, Robert Bombard, Tim Clear and Leslie Taggett for field assistance, and Tim Clear for work in the laboratory. Tim Clear, Robert Bombard and Reginald Soracco also provided critical review of the report and assistance in its preparation.

SECTION 6

REFERENCES

Clemants, S.E. 1989. New York Rare Plant Status List, New York Natural Heritage Program, Delmar, NY. February 1989. 26pp.

Eichler, L.W. and J.D. Madsen. 1990a. Assessment of Lake Luzerne. Rensselaer Fresh Water Institute Report #90-2, Rensselaer Polytechnic Institute, Troy, NY.

Eichler, L.W., J.D. Madsen and R.J. Soracco. 1990. Rensselaer Fresh Water Institute Lake Management Manual: Appendices for 1990 Lake Assessment Reports. Rensselaer Fresh Water Institute Report #90-3, Rensselaer Polytechnic Institute, Troy, NY.

Kishbaugh, S.A. 1990. Personal Communication Regarding Results of the 1990 Citizens Statewide Lake Assessment Program. Lake Services Section, Division of Water, NYS Department of Environmental Conservation, Albany, NY.

Kimbel, J.C. 1982. Factors influencing potential intralake colonization by Myriophyllum spicatum. Aquatic Botany 14:295-307

Madsen, J.D., J.W. Sutherland, J.A. Bloomfield, K.M. Roy, L.W. Eichler, and C.W. Boylen. 1989. Lake George aquatic plant survey final report. NYS DEC, Albany, NY. May, 1989.

Madsen, J.D., L.J. Taggett, R.T. Bombard and C.W. Boylen. 1990. Lake George Eurasian Watermilfoil Survey. Rensselaer Fresh Water Institute Report #90-11, Rensselaer Polytechnic Institute, Troy, NY. In preparation.

Mikol, G.F. and D.M. Polsinelli. 1985. New York State Lakes, A Morphometric Atlas of Selected Lakes, Volume 1, Region 5. NYS DEC, Albany, NY. 81 pp.

Mitchell, R.S. 1986. A checklist of New York State plants. New York State Museum Bulletin Number 458, NYS Education Department, Albany, NY. 272pp.

Olson, D. . 1990. Personal Communication of Results of Samples Collected for Coliform Bacterial Analysis From Brant Lake, New York. Warren County Sanitary Inspector, Warren County Board of Supervisors, Lake George, NY.

Rensselaer Fresh Water Institute, New York State Department of Environmental Conservation and Adirondack Park Agency. 1988. Lake George aquatic plant survey interim report. NYS DEC, Albany, NY. March, 1988.

Taggett, L.J. and C.W. Boylen. 1989. Aquatic plant inventory of the Lake George region. Rensselaer Fresh Water Institute Report #89-2, Rensselaer Polytechnic Institute, Troy, NY.