LPL-90
(LPL-6012-01)

Bear Lake

Planning Grant Project

December 1994

Aron & Associates
26111 W. Loomis Rd.
Wind Lake, WI 53185

BEAR LAKE PLANNING GRANT
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BEAR LAKE PLANNING GRANT

Background

In August of 1991, the Bear Lake Association of Barron County applied for a Lake Management Planning Grant from the Wisconsin Department of Natural Resources. The Planning Grant program was established in 1989 to help local communities manage and improve their lakes. In October of 1991, Bear Lake received a commitment for a $10,000 planning grant.

The Bear Lake planning grant addresses three primary concerns:

- water quality--how clean is the water and is it changing
- plants in the lake--changes were being seen by residents as a sign of possible problems
- the opinions of the residents and landowners--what they see, and what they would like to see

Water Quality Monitoring

The U.S. Geological Survey (USGS) was contracted by the Town of Bear Lake to conduct water quality monitoring on behalf of the Bear Lake Association. Monitoring was conducted from October 1991 through September 1993. The annual reports from USGS are included in the Appendix. The results were presented by Steve Field, USGS, to the local residents at the annual meeting June 25, 1994.

The USGS monitoring was complemented by volunteer efforts. A local resident sampled clarity on Bear Lake weekly. Another volunteer recorded the lake elevation weekly during ice-free periods.

Aquatic Plant Survey

Bear Lake is a large, quiet lake with tea-stained waters. Approximately 75 homes surround the lake. Expansive areas of wetlands, bogs and conservancy areas protect the quiet nature and water quality of Bear Lake. Bald Eagles are frequently seen soaring overhead. Wild Rice is common in two areas on Bear Lake. The aquatic plant community is very diverse, with 42 species present during the planning grant project period. A wide variety of Pondweeds can be found throughout the lake's littoral zone. A healthy fishery attracts anglers looking for Largemouth Bass, Panfish and Northern Pike.

The information obtained by conducting aquatic plant surveys maybe used by future investigators to further document changes in the aquatic plant community and evaluate the impact of plant management, lake management, and watershed activities upon the plant communities. This information can be used to guide future lake management decisions on Bear Lake.

In late July of 1992 Aron & Associates (A&A) conducted a detailed aquatic plant survey on Bear Lake. The diversity, the density and frequency of the plants in Bear Lake were determined. Plant specimens were collected, analyzed, pressed, and mounted. The Bear

Lake Association has been given a collection of the plants found in the lake, for their permanent record.

In 1992 Bear Lake had excellent plant diversity--a total of 42 different species were found, including wild rice and a wide variety of pondweeds. Filamentous algae was found frequently throughout much of Bear Lake. The algae was most concentrated near the inlet from Kegema Lake. There was no evidence that there was any Eurasian Water Milfoil, a nuisance exotic plant, in Bear Lake. The public boat launch areas should be watched closely for any signs of the plant.

Bear Lake is located in Washburn and Barron County, Wisconsin. Hydrographic and morphological information are presented in Table 1 and Map 1.

Table 1. Hydrographic and Morphologic Data of Bear Lake.

Surface Area	1358 acres
Total Drainage Area	47.6 sq. miles
Volume	27253.8 acre feet
Length	3.9 miles
Width	1.0 mile
Shoreline Length	14.9 miles
Maximum Depth	87 feet
Mean Depth	20 feet

Source: USGS, DNR

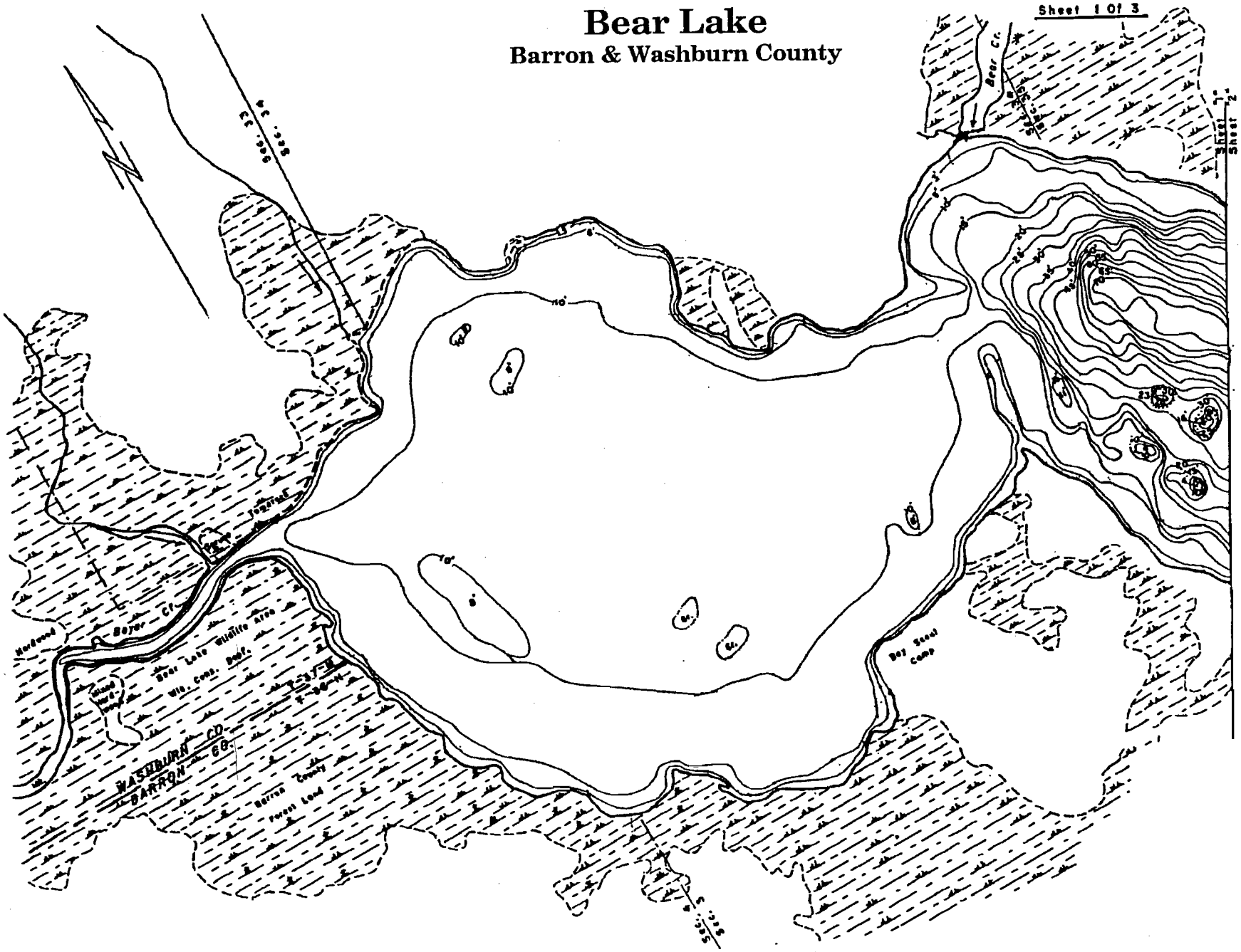
METHODOLOGY

General Survey

A preliminary survey of the lake was made by boat. An attempt was made to locate all plant communities in the lake by region. All plant species found were collected and identified. Specimens were pressed, dried, and mounted for a permanent record. Nomenclature follows Fassett (1956) and Helquist and Crow (1980). Additional species located during the transect survey were also pressed, dried, and mounted. The 1992 maximum rooting depth in Bear Lake was determined to be eleven feet.

Bear Lake

Barron & Washburn County



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Bear Lake

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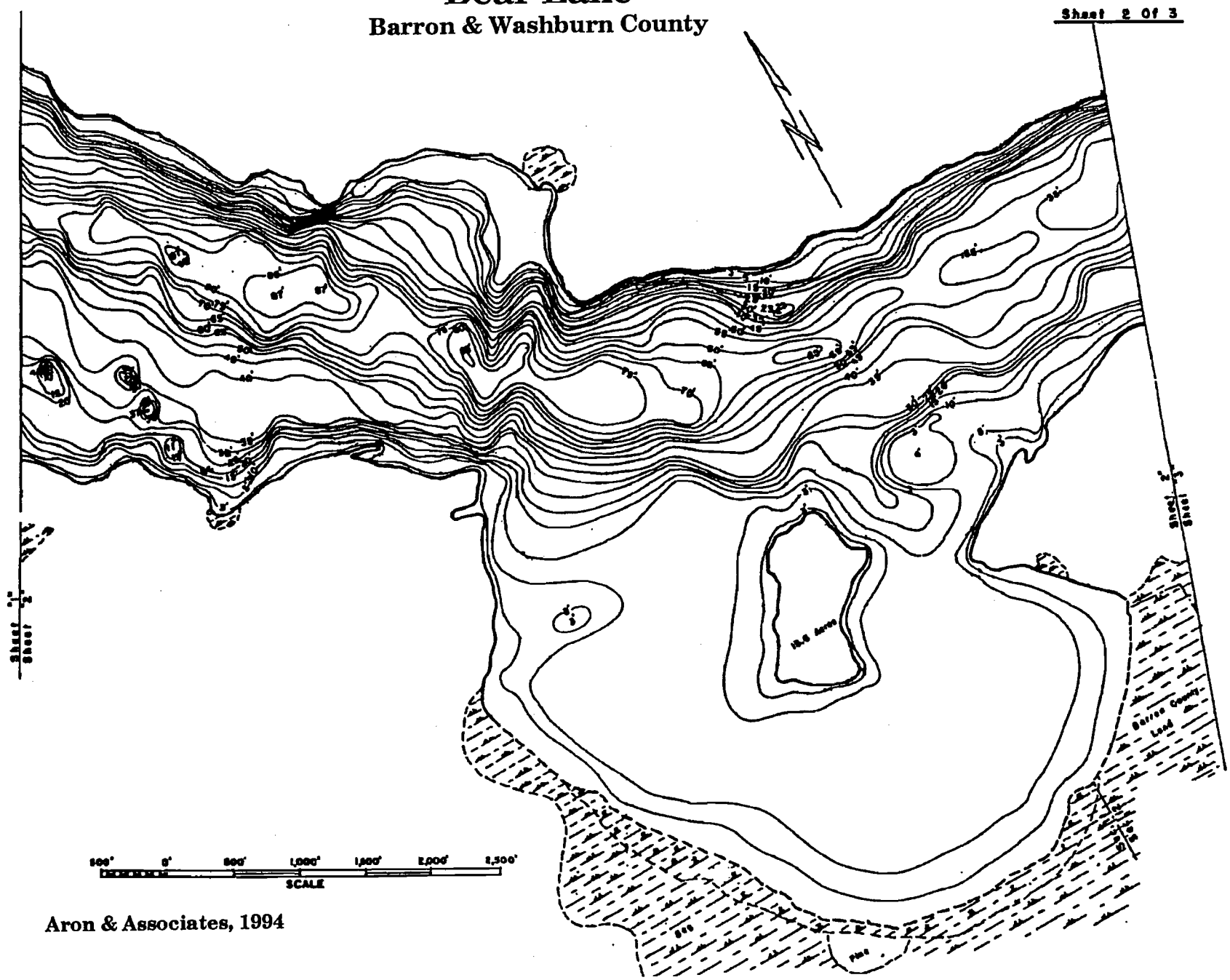

Bear Lake

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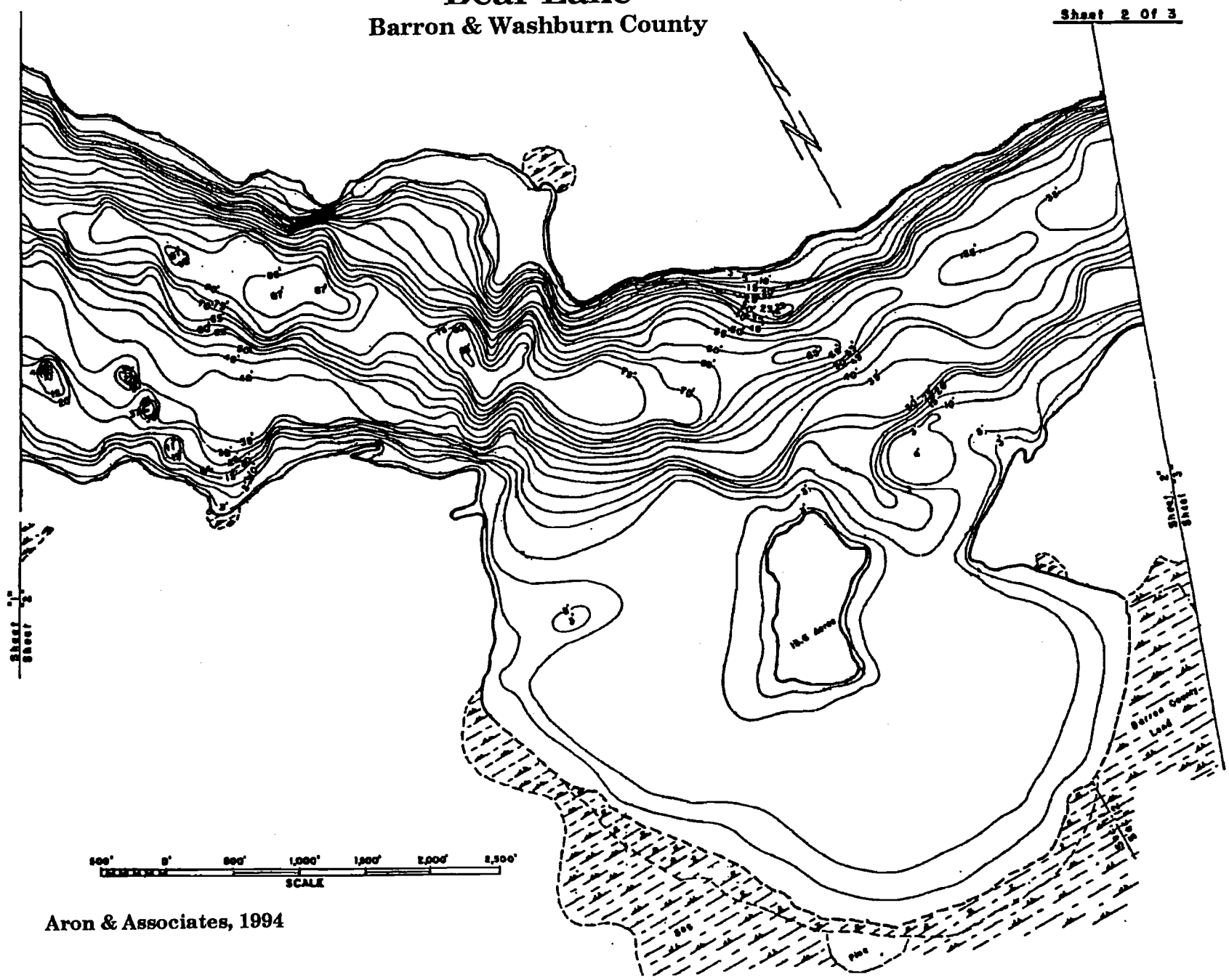

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Bear Lake

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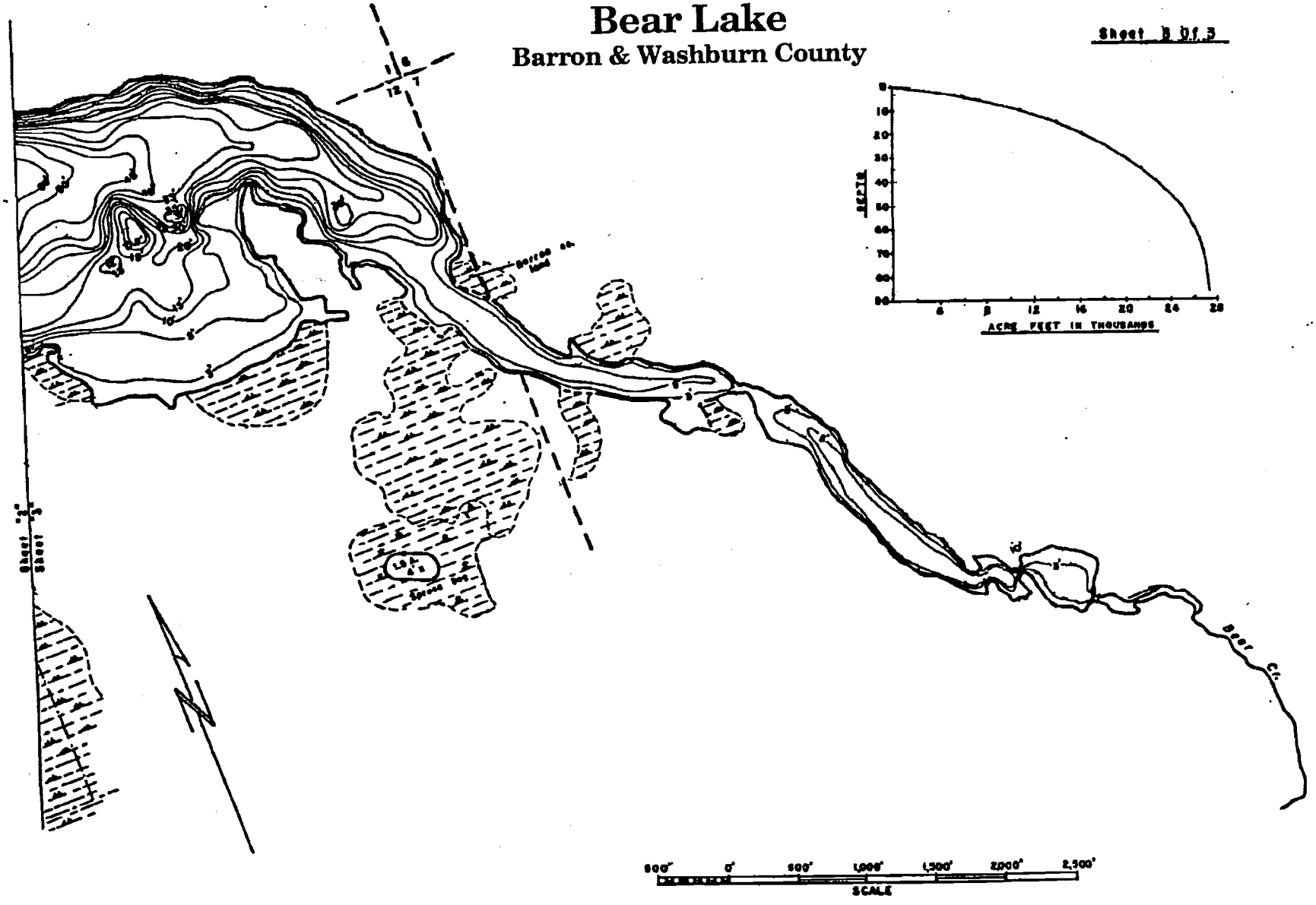

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Transect Survey

The methodology for the transect survey follows the methods used by the Wisconsin Department of Natural Resources (WDNR) in their Long Term Trend Monitoring Program. Twenty-five transects were established along the lake perimeter (Map 2). Each transect was identified by a landmark, compass bearing, and way point. Transects extended from shore to the maximum rooting depth (eleven feet) or to a point approximately half way to the opposite shore (way point). Photographs were taken of each transect shore location to facilitate duplication in future surveys.

Four sampling locations along each transect were established at water depths of 1.5, 4.0, 6.0, and 9 feet. At each sampling point an imaginary six foot diameter circle was divided into four quadrants. Sampling of aquatic vegetation took place once within each quadrant producing a total of four samples for each sample point. A rake with a telescoping handle was used to collect plant samples. Samples were collected by casting the rake into each of the four quadrants and pulling the rake to the center of each sampling point. Each plant species retrieved was recorded and given a density rating in accordance with the following criteria:

Rake Recovery of Aquatic Plant	Density Rating	Descriptive Term
Rake teeth full, all 4 casts	5	Heavy
Teeth partly full, all 4 casts	4	Dense
Plants taken on 3 casts	3	Moderate
Plants taken on 2 casts	2	Scattered
Plants taken on 1 cast	1	sparse

The data collected were then used to calculate frequency of occurrence, and density ratings for each species along each transect at each sample depth.

The abundance of each species was determined using four estimates:

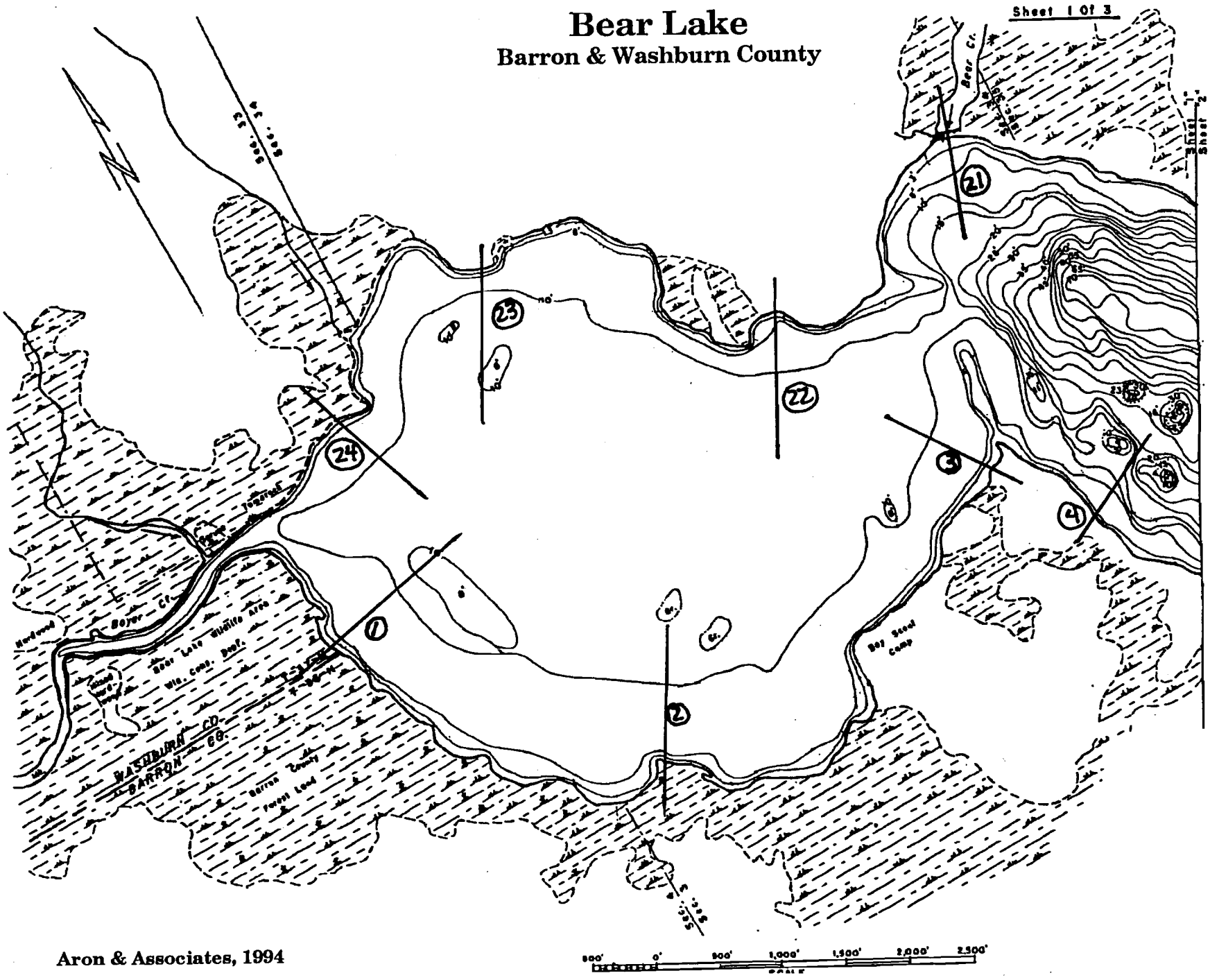
1) The **frequency** is an estimate of how often a species occurs in the sample points.
2) The **average density** rating, or the average density of a species in the sample point where it occurred.
3) The **relative density** rating, or the average density of a species averaged over all sample points whether or not any species were present.
4) The **relative density** rating averaged over all sample points in which any species occurred.

A Sitek strip chart recorder was used to obtain a permanent record of the depth profile and plant distribution along each transect.

Map 2 - Transect Locations for 1992 Aquatic Plant Survey
Source: Aron & Associates

Bear Lake

Barron & Washburn County



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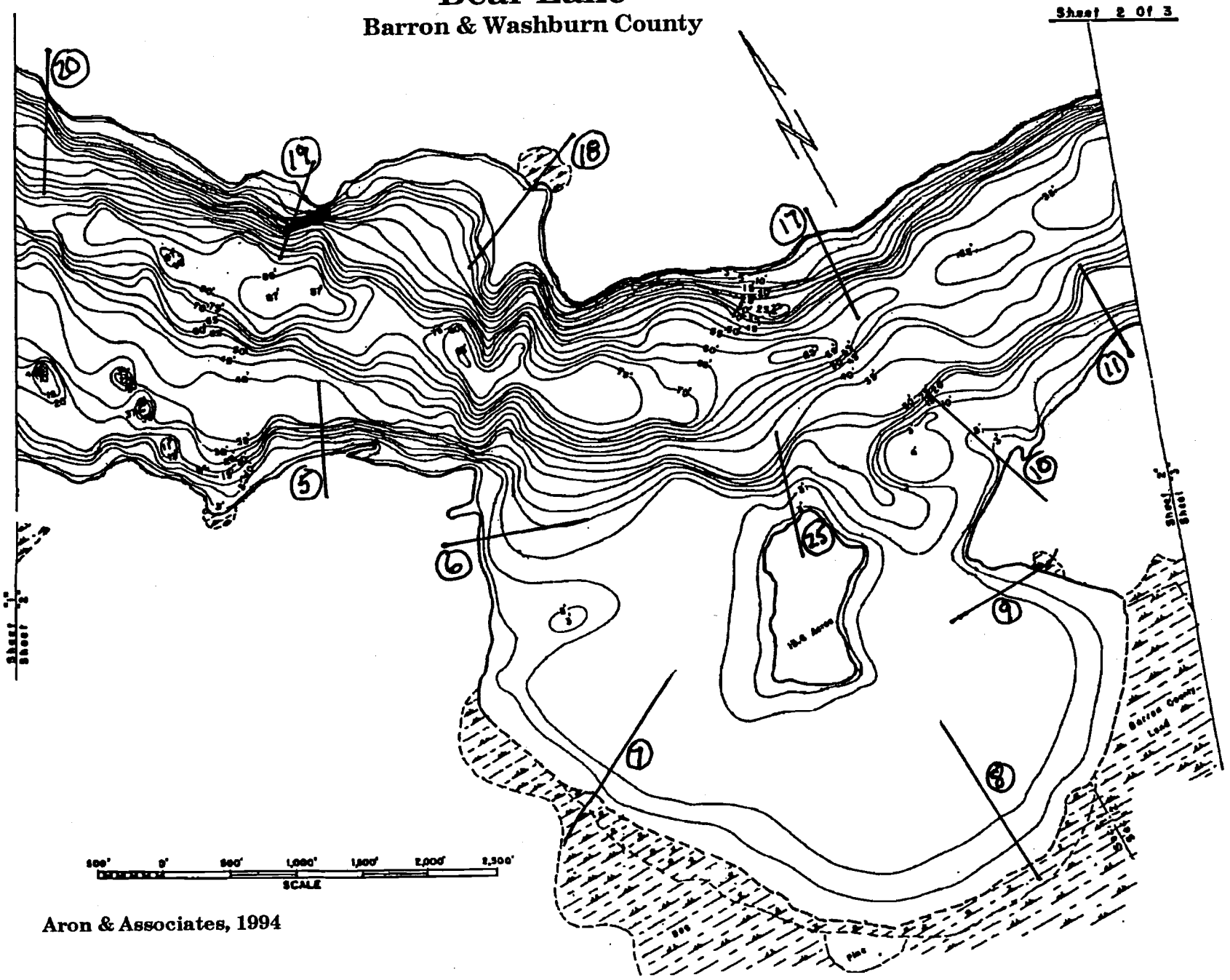

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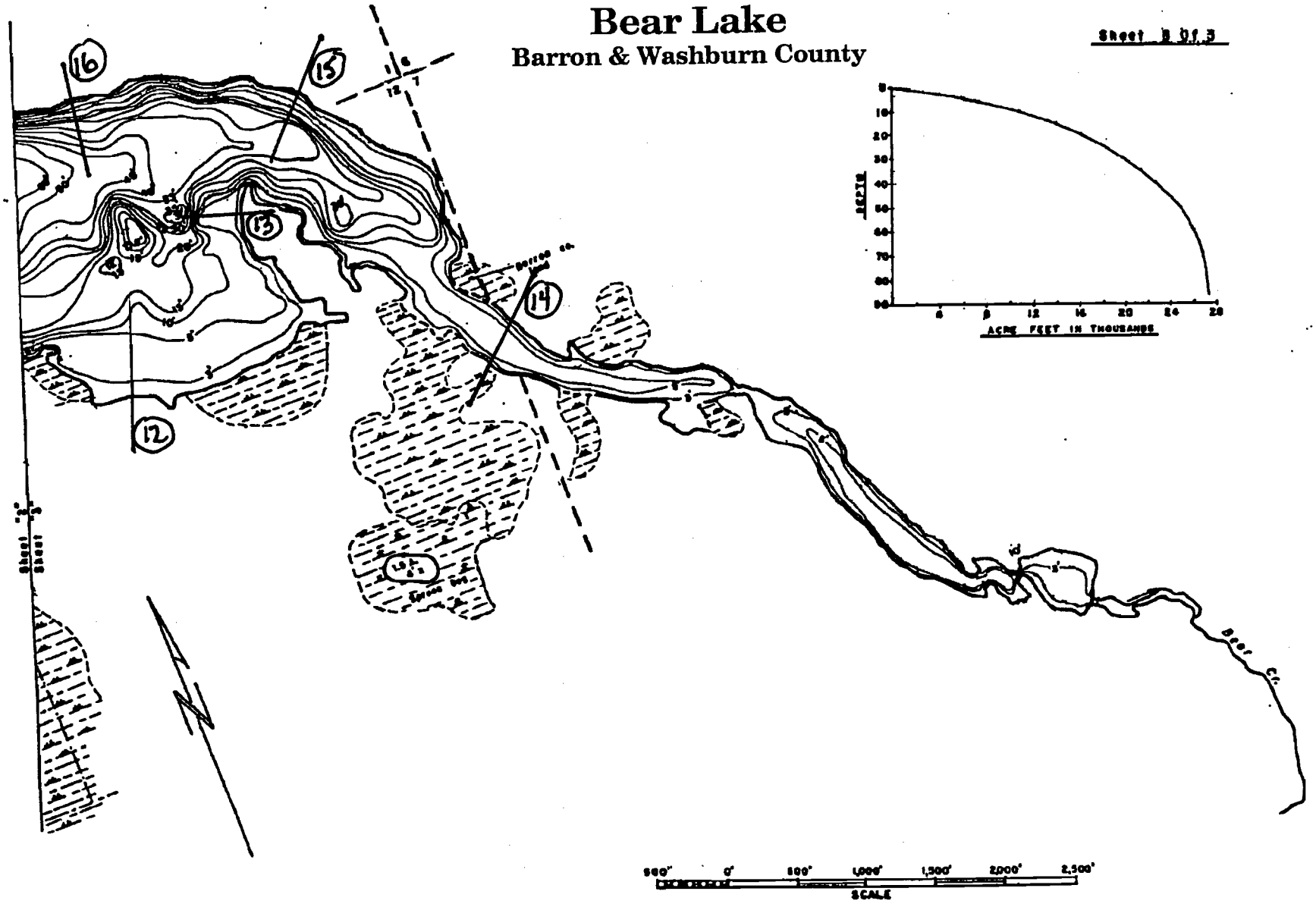

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RESULTS

During the survey, a total of forty-two (42) aquatic plant species were observed. Thirteen (13) species were observed only during the general survey, and twenty-nine (29) species were observed in the transect survey (Table 2). Of the species observed only in the general survey, six (6) were emergent plant species and include Swamp Loosestrife (Decodon verticillatus), Water horsetail (Equisetum fluviatile), Reed grass (Phragmites maximus), Pickerel weed (Pontederia cordata), Common arrowhead (Sagittaria latifolia), and Common Bur-reed (Sparganium eurycarpum). These species were associated with wetland complexes located around the lake. Wild rice (Zizania aquatica) was found near the Boyer Creek inlet on the west end of the lake, and in a large bay south of the 15 acre island.

The distribution of plants by water depth is summarized in Table 3. Of those species found during the transect survey, fourteen (14) were found at all sample depths and include Coontail (Ceratophyllum demersum), Waterweed (Elodea canadensis), Whorled Water Milfoil (Myriophyllum verticillatum), Slender Naiad (Najas flexilis), Nitella (Nitella sp.), Large leaf Pondweed (Potamogeton amplifolius), Leafy Pondweed (P. foliosus), Variable-leaf Pondweed (P. gramineus), Illinois Pondweed (P. Illinoensis), Clasping-leaf Pondweed (P. Richardsonii), Fern Pondweed (P. Robbinsii), Flat-stem Pondweed (P. zosterformis), Great Bladderwort (Utricularia vulgaris), Water Celery (Vallisneria americana), and Forked Duckweed (Lemna trisulca).

Two species were found at the 4, 6 and 9 foot depths: Fries Pondweed (P. friesii) and Small Pondweed (P. pusillus). Elodea (Elodea canadensis) and Yellow Water Lily (Nuphar variegatum) were found at the 1.5, 4 and 9 foot depths. Small Duckweed (Lemna minor) and Hard-stem Bulrush (Scirpus acutus) was found at the 1.5 and 4 foot depths. Grassy Arrowhead (Sagittaria graminea) and White Water Lily (Nymphaea tuberosa) was found at the 1.5, 4 and 6 foot depths. Wild Rice (Zizania aquatica) and Water Crowfoot (Ranunculus longirostris) was found at the 4 foot depth. Water Marigold (Megalodonta Beckii) was found only at the 4 and 6 foot depths. Three plants, Water Stargrass (Heteranthera dubia), Floating-leaf Pondweed (P. natans) and Sago Pondweed (P. pectinatus) were found at the 1.5 foot depth. Curly-leaf Pondweed (P. crispus), an exotic plant that may grow to nuisance conditions, was found only on transect 14S at the 6 foot depth. Map 3 shows the area of Bear Lake that is available for aquatic plant growth.

Using the total mean density ratings for each species (Table 4 and Appendix), the most dominant species were Slender Naiad, Coontail, Whorled Milfoil and Wild Celery, respectively. Slender Naiad reached its maximum density at the one and a half foot depth. Coontail and Wild Celery reached their maximum densities at the four foot depth. Whorled Milfoil was dominant at the six foot depth. Filamentous algae was found in almost all transect locations. Aquatic plants were frequently covered with the algae especially in the Bear Creek inlet area.

Aquatic plants were found throughout the littoral zone of Bear Lake. Aquatic vegetation was sparse along the steeply sloped northern shoreline. Slender Naiad and a variety of pondweeds were found in this area. The large flat muddy bay south

of the island had a very diverse plant community, including Wild Rice, a variety of Pondweeds, Bladderwort, Lilies, Coontail, Whorled Milfoil, Wild Celery and Naiad. The inlet from Bear Creek was also diverse, with Wild Celery, Coontail, Duckweed and Pondweeds.

Table 2 -**Aquatic Macrophytes - 1992**
Bear Lake - Barron-Washburn County, Wisconsin

EMERGENTS

Scientific Names	**Common Names**
Decodon verticillatus[2]	swamp loosestrife
Equisetum fluviatile[2]	water horsetail
Phragmites maximus [1]	reed grass
Pontederia cordata[2]	pickerel-weed
Sagittaria graminea	grassy arrowhead
S. latifolia[1]	common arrowhead
Scirpus acutus[3]	hard-stem bulrush
Sparganium eurycarpum[2]	common bur-reed
Zizania aquatica [3]	wild rice

SUBMERGENTS

Ceratophyllum demersum	coontail
Elodea canadensis	common waterweed
Heteranthera dubia	water star grass
H. limosa[2]	
Megalodonta Beckii	water marigold
Myriophyllum verticillatum	whorled water milfoil
Najas flexilis	slender naiad
Nitella sp.	nitella
Potamogeton amplifolius	large-leaf pondweed
P. crispus	curly-leaf pondweed
P. epihydrus[2]	ribbon-leaf pondweed
P. foliosus[3]	leafy pondweed
P. friesii	Fries pondweed
P. gramineus	variable-leaf pondweed
P. illinoensis[3]	Illinois pondweed
P. natans	floating-leaf pondweed
P. pectinatus	sago pondweed
P. praelongus [2]	white-stem pondweed
P. pusillus	small pondweed
P. Richardsonii	clasping-leaf pondweed
P. Robbinsii	fern pondweed
P. Spirillus [1]	spiral-fruited pondweed
P. strictifolius[1]	stiff pondweed
P. zosterformis	flat-stem pondweed
Ranunculus longirostris[3]	water crowfoot

Table 2 Continued:

Spirodella polyrhiza[2]	big duckweed
Utricularia vulgaris	great bladderwort
Vallisneria americana	water celery

FLOATING

Brasenia Schreberi[1]	watershield
Lemna minor	small duckweed
L. trisulca	forked duckweed
Nymphaea tuberosa [3]	white water lily
Nuphar variegatum [3]	yellow water lily

1 No specimen collected - found during general survey
2 Found only during general survey
3 No specimen collected

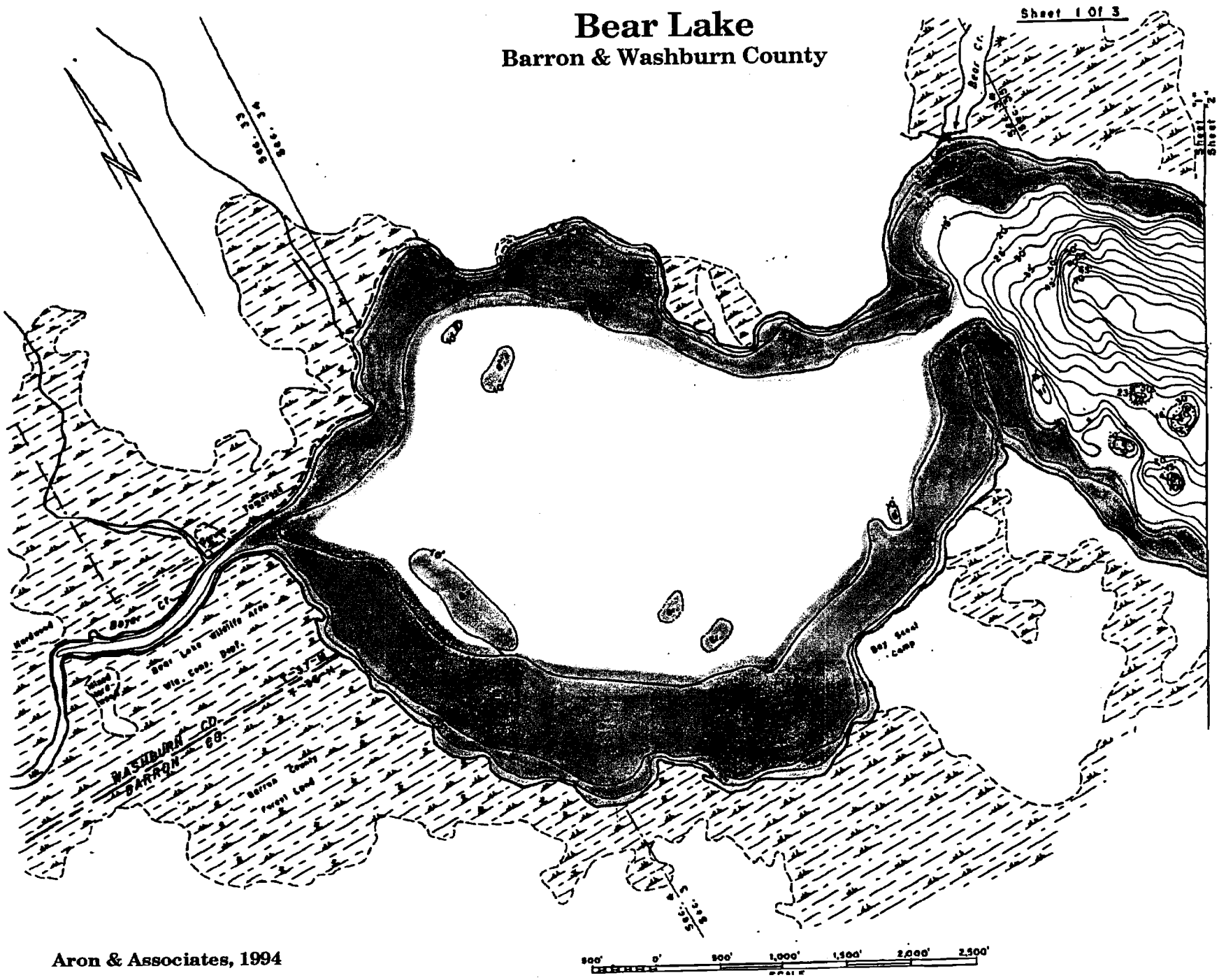
42 aquatic plant species identified. 28 species submerged macrophytes

Surface water flow through lake. Maximum depth 85 feet, 1300 acres. Sand and gravel substrate on slopes, deep muck on flat bottom. Specific conductance 125 uS at 25 c, pH 8.3 at surface. Maximum rooting depth 11 feet (3.1 m) Average secchi disk depth 1.7 m. Plant identification confirmed SGS 11/92.

Map 3 - Area Available for Aquatic Plant Growth-Bear Lake
Source: Aron & Associates

Bear Lake

Barron & Washburn County



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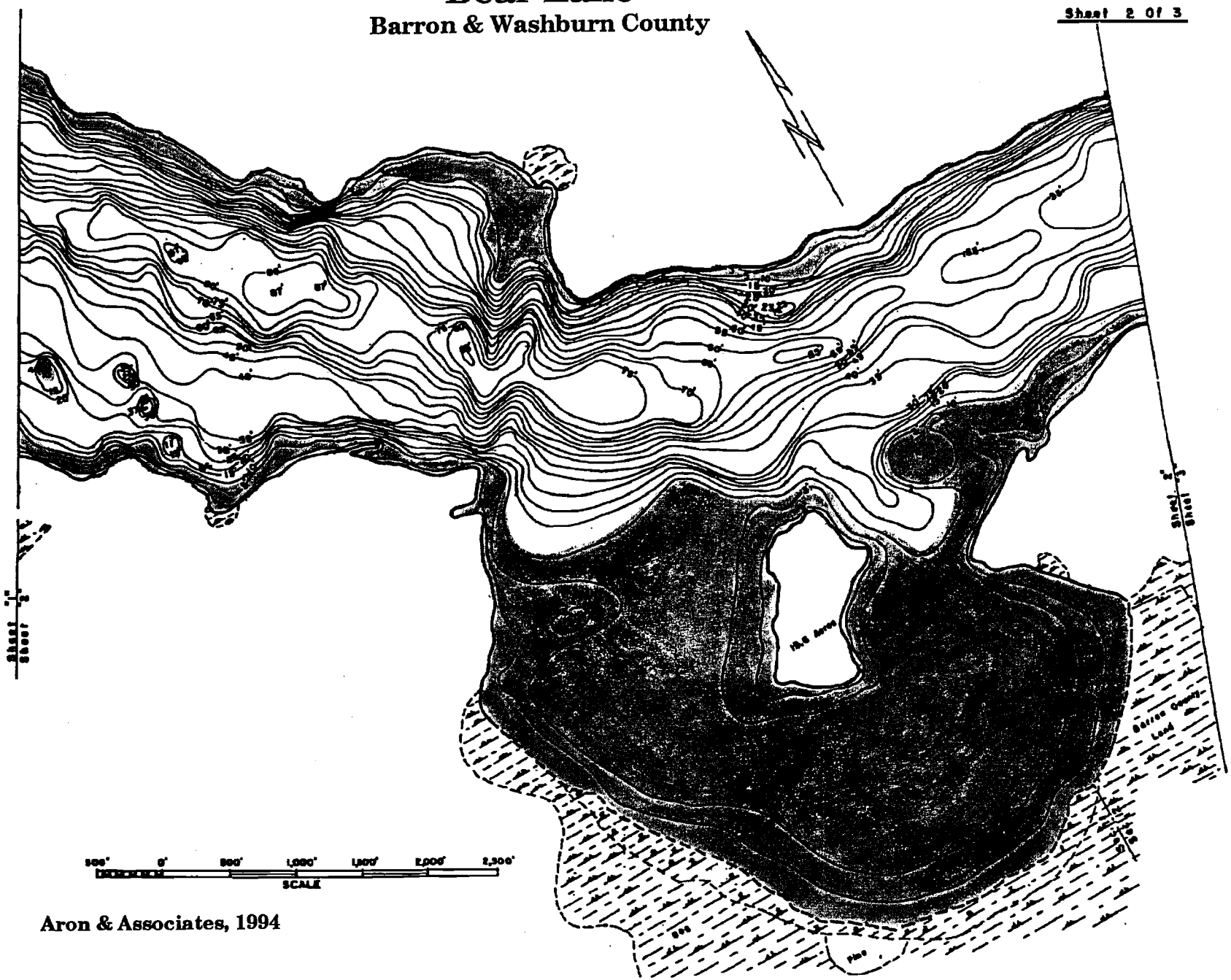

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Barron & Washburn County

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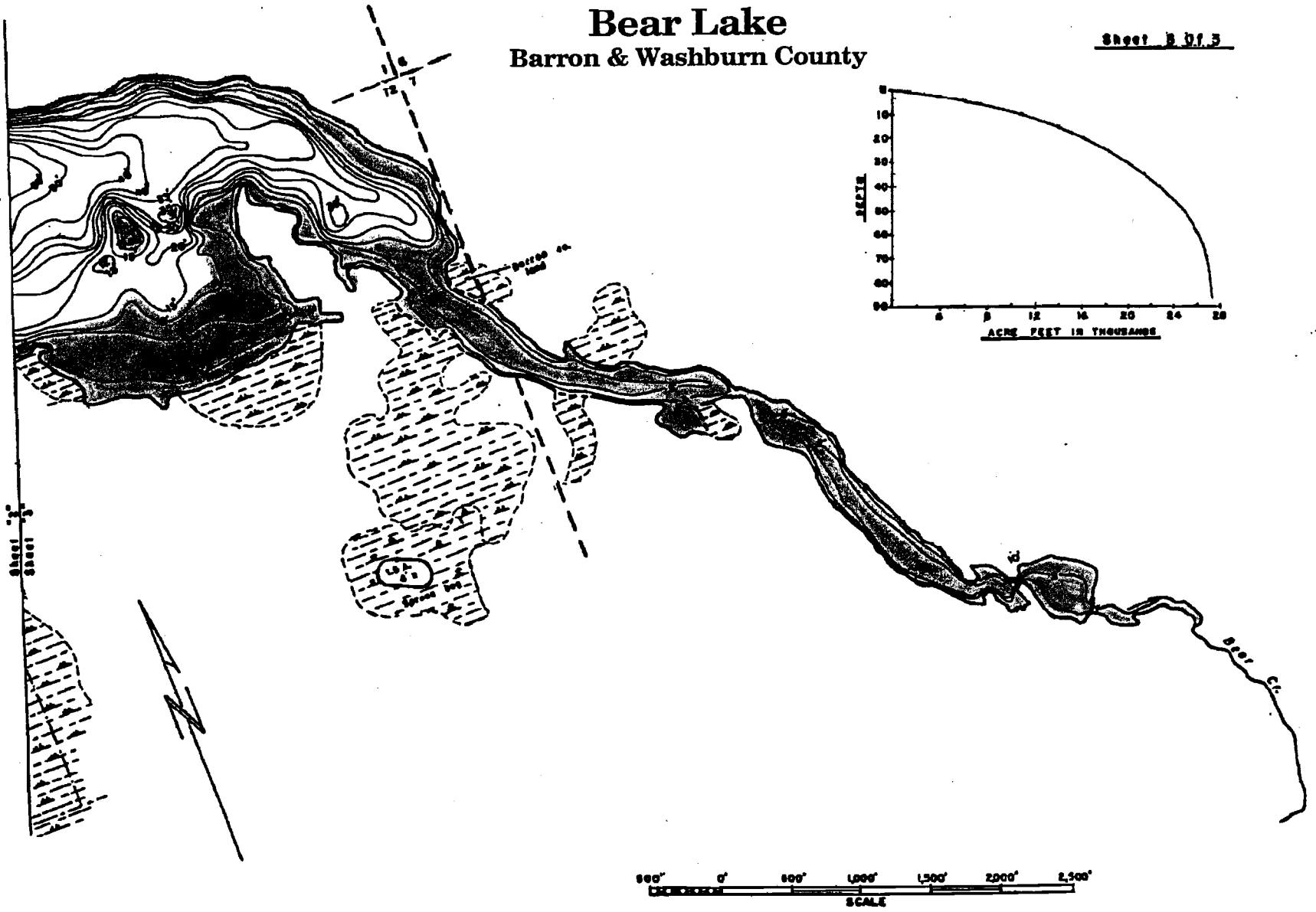

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Table 3 -Distribution of Aquatic Plants by Depth
Bear Lake - Barron-Washburn County, Wisconsin

Scientific Names	Common Names	Depths in feet 1.5	4	6	9
Decodon verticillatus[2]	swamp loosestrife				
Equisetum fluviatile[2]	water horsetail				
Phragmites maximus [1]	reed grass				
Pontederia cordata[2]	pickerel-weed				
Sagittaria graminea	grassy arrowhead	X	X	X	
S. latifolia[1]	common arrowhead				
Scirpus acutus[3]	hard-stem bulrush	X	X		
Sparganium eurycarpum[2]	common bur-reed				
Zizania aquatica [3]	wild rice		X		
Ceratophyllum demersum	coontail	X	X	X	X
Elodea canadensis	common waterweed	X	X		X
Heteranthera dubia	water star grass	X			
H. limosa[2]					
Megalodonta Beckii	water marigold		X	X	
Myriophyllum verticillatum	whorled water milfoil	X	X	X	X
Najas flexilis	slender naiad	X	X	X	X
Nitella sp.	nitella	X	X	X	X
Potamogeton amplifolius	large-leaf pondweed	X	X	X	X
P. crispus	curly-leaf pondweed			X	
P. epihydrus[2]	ribbon-leaf pondweed				
P. foliosus[3]	leafy pondweed	X	X	X	X
P. friesii	Fries pondweed		X	X	X
P. gramineus	variable-leaf pondweed	X	X	X	X
P. illinoensis[3]	Illinois pondweed	X	X	X	X
P. natans	floating-leaf pondweed	X			
P. pectinatus	sago pondweed	X			
P. praelongus [2]	white-stem pondweed				
P. pusillus	small pondweed		X	X	X
P. Richardsonii	clasping-leaf pondweed	X	X	X	X
P. Robbinsii	fern pondweed	X	X	X	X
P. Spirillus [1]	spiral-fruited pondweed				
P. strictifolius[1]	stiff pondweed				
P. zosterformis	flat-stem pondweed	X	X	X	X
Ranunculus longirostris[3]	water crowfoot		X		
Spirodella polyrhiza[2]	big duckweed				
Utricularia vulgaris	great bladderwort	X	X	X	X
Vallisneria americana	water celery	X	X	X	X

TABLE 3 Continued:

Scientific Names	Common Names	Depths in feet 1.5	4	6	9
Brasenia Schreberi[1]	watershield				
Lemna minor	small duckweed	X	X	X	X
L. trisulca	forked duckweed	X	X	X	
Nymphaea tuberosa [3]	white water lily	X	X	X	
Nuphar variegatum [3]	yellow water lily	X	X		X

1 No specimen collected - found during general survey
2 Found only during general survey
3 No specimen collected

1993 General Survey

In July of 1993, a general survey of the lake was conducted. Few changes from the 1992 survey were noted during the summer of 1993. The sizes of the plant beds appeared relatively unchanged. The diversity also appeared to be unchanged. The primary difference had to do with the filamentous algae. In 1992 filamentous algae covered many plants, especially in the Bear Creek Inlet area and it was found in varying degrees throughout the littoral zone of Bear Lake. In 1993, however, a small amount of filamentous algae was found near the Bear Creek Inlet area but was rarely found anywhere else in Bear Lake.

According to communication from the residents, 1993 was a much drier summer than 1992. This produced less runoff entering the lake. During summer field inspections Lake Kegema upstream of Bear Lake was found to have very green water with an abundance of algae. During high flow conditions, these nutrient-rich waters make their way to Bear Lake and appear to provide nutrients that encourage the growth of algae. Thus, during the lower flows in 1993, less filamentous algae was found in Bear Lake.

Bear Lake

Barron & Washburn County

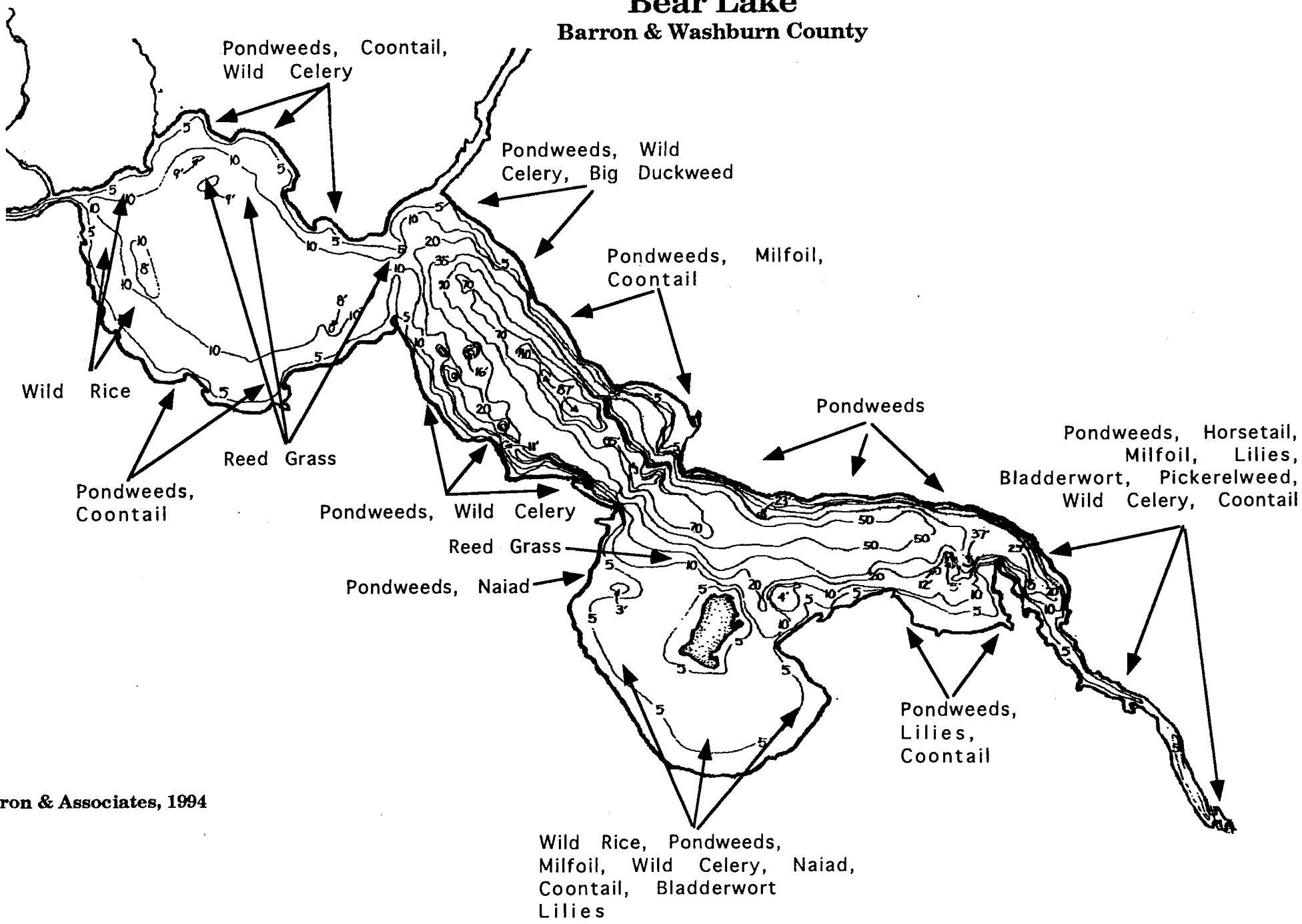

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Table 4 - Mean Density of Aquatic Plants, 1992				
SPECIES	SPECIE	% OF	SPECIE MEAN	
	CODE	OCCURRENCE	DENSITY	sum density
Sago pondweed	POTPE	1	4.00	4
Water stargrass	HETDU	1	3.00	3
Slender naiad	NAJFL	53	2.47	131
Coontail	CERDE	51	2.47	126
Whorled milfoil	MYRVE	27	2.26	61
Water marigold	MEGBE	4	2.25	9
Wild celery	VALAM	46	2.17	100
Forked duckweed	LEMTRI	43	2.16	93
Flat-stem pondweed	POTZO	55	2.15	118
Nitella	NITSP	21	2.10	44
Floating-leaf pondweed	POTNA	1	2.00	2
Wild rice	ZIZAQ	1	2.00	2
Small pondweed	POTPU	31	1.94	60
Common waterweed	ELOCA	11	1.91	21
Leafy pondweed	POTFO	26	1.77	46
Fern pondweed	POTRO	25	1.76	44
Great bladderwort	UTRVU	8	1.75	14
White waterlily	NYMPH	4	1.75	7
Variable pondweed	POTGR	19	1.63	31
Large-leaf pondweed	POTAM	23	1.57	36
Yellow waterlily	NUPHA	4	1.50	6
Clasping-leaf pondweed	POTRI	11	1.27	14
Illinois pondweed	POTIL	9	1.22	11
Fries pondweed	POTFR	5	1.20	6
Arrowhead	SAGGR	6	1.17	7
Small duckweed	LEMMI	3	1.00	3
Hard-stem bulrush	SCIAC	4	1.00	4
Curly-leaf pondweed	POTPC	1	1.00	1
Water horsetail	EQUFL	1	1.00	1
Water crowfoot	RANLO	1	1.00	1

Table 5-Transect Density					
		DEPTHS			SUM
TRANSECT	1.5 FT	4 FT	6 FT	9FT	DENSITY
1	0	14	17	5	36
2	0	11	7	1	19
3	9	20	13	1	43
4	0	15	14	3	32
5	2	13	16	14	45
6	7	11	12	2	32
7	4	13	9	0	26
8	0	17	12	0	29
9	15	10	12	15	52
10	3	6	8	14	31
11	10	10	12	6	38
12	12	15	13	11	51
13	2	4	14	11	31
14S	14	13	21	0	48
14N	14	14	19	0	47
15	7	9	12	17	45
16	0	14	11	17	42
17	0	13	21	7	41
18	14	13	23	10	60
19	8	13	21	16	58
20	10	16	18	10	54
21	9	19	15	5	48
22	10	22	12	3	47
23	11	11	5	0	27
24	4	11	9	2	26
25	0	3	5	4	12

Watershed

A watershed consists of all the land that contributes water to a lake. To outline a watershed boundary, connect the points of highest elevation around a lake on a topographic map. Water falling within this bowl flows by gravity in streams and ground water to the lake.

A watershed can extend for miles. So, lake protection must extend to the entire watershed. Because watersheds almost always extend beyond municipal boundaries, solutions may be difficult to implement.

Picture a drop of rainwater landing in your yard 3 miles from Bear Lake. It washes onto the driveway and down to the roadside ditch where it flows into a culvert under the road, which then empties into a stream that feeds Bear Lake.

That drop of water might contain lawn fertilizer, motor oil from the road, cow manure from the farm downstream, or dirt from the new development across the road. It all ends up in Bear Lake. And it is probably loaded with phosphorus. Water entering Bear Lake may have actually come from much farther away. So you can see, the potential for problems can be great.

A lake is a reflection of its watershed. It's not just a large tub of water. Take a clear jar and scoop up some lake water. At first glance it doesn't look like much. But if you look real close you'll see a jar teeming with life. Tiny whitish specks are swimming throughout the water. Those are zooplankton. They consume the tiny green algae cells in the water. The zooplankton become food for small fish, who are food for big fish, etc. That huge food chain begins with those tiny critters in the jar. Disrupting one element in that chain has a domino effect on the rest of the system.

The Bear Lake watershed is 47.6 square miles (USGS, 1993). The ratio of watershed area to lake size is 22:1. Lakes with ratios greater than 10:1 tend to develop water quality problems (Uttermark, 1978). The greater the land area the more opportunities there are for land changes that may lead to soil erosion, nutrient, fertilizers and pesticide use that may wash into lakes.

Map 5 illustrates the boundary of the Bear Lake watershed as identified by the USGS. Map 6 shows the land uses found during field inspections by Aron & Associates staff. The dominant land use in the watershed is wetlands and woodlands, accounting for 70% of the drainage area.

Table 4- Land Use within the Bear Lake Drainage Area

Land Use	Area-Percent	Area-Sq. Miles
Open space and Agriculture	20%	9.5
Residential	4%	1.9
Surface water	6%	2.9
Wetlands/woodlands	70%	33.3
Total	100 %	47.6

Source: Aron & Associates

These wetlands and woodlands are extremely important to the protection of Bear Lake. Protection of these areas from uses that degrade and destroy the values of the area and the preservation of these areas in an open and natural state is crucial to maintaining the high level of environmental quality of the watershed.

It is recommended that these valuable lands be preserved, preferably through public land use controls. Preservation should be promoted by establishing and enforcing regulations to protect natural resources. Should urban, agricultural or logging pressures threaten to destroy the natural resources of these areas, public agencies should consider acquisition of such lands. The agencies should also consider linking areas as part of environmental corridors, providing migration routes and enhancing opportunities for outdoor recreational activities.

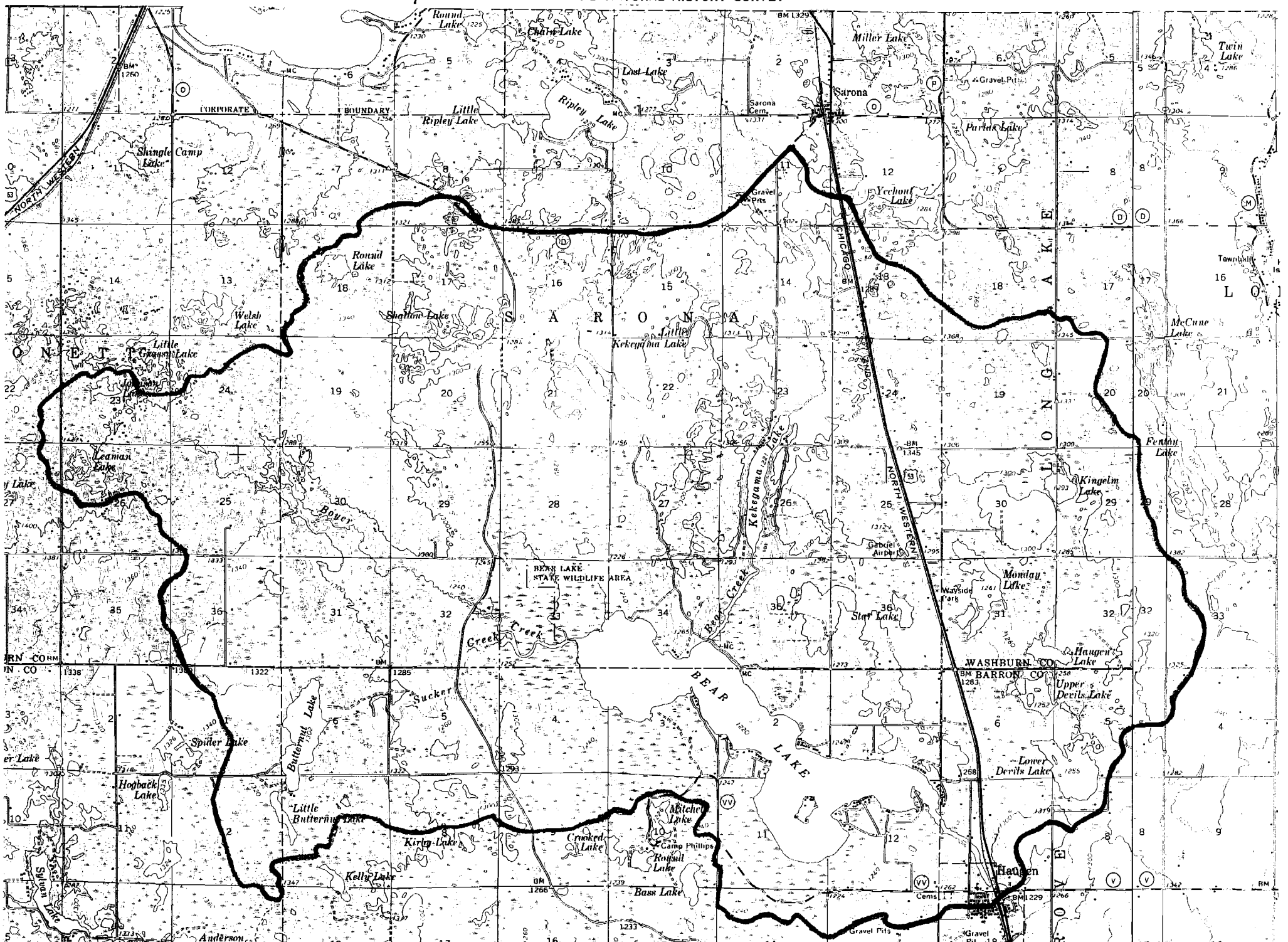
Acquisition of lands to protect the degradation of a natural resource can be funded with the support of a number of grant programs. The Wisconsin Stewardship Grant Program and the Wisconsin Lake Protection Grant Program are two that may assist with funds for acquisition. Purchase of land or easements are options under the funding programs. The Department of Natural Resource Community Assistance staff will assist with applications for such projects.

Because of the steeply-sloped shorelines of Bear Lake, construction site erosion during urban development can pose a significant problem for the lake should development pressures in the area increase. State requirements for prevention of construction erosion should be followed carefully, and enforced, during any shoreline construction. Landowners should be encouraged to minimize disruption of the steep slopes.

Although wetlands have a great capacity to retain nutrients, excessive loading from sources such as barnyards, can overload a fragile wetland community. The Association should work with public agencies to ensure that steps are taken to protect the watershed should logging be proposed. These problems can be minimized with a high level interaction between municipalities and agencies.

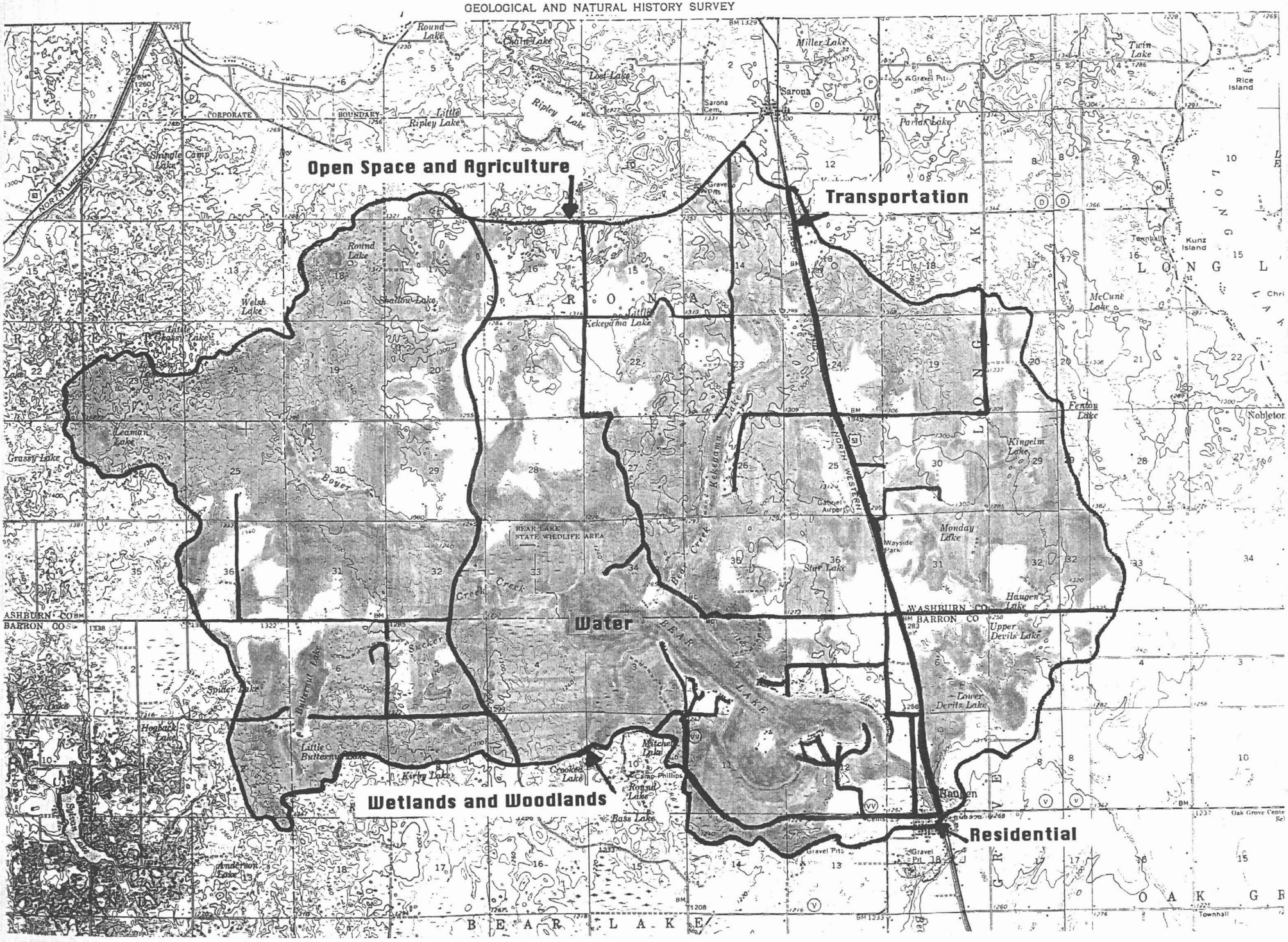
Map 5 - Bear Lake Watershed
Source: United States Geological Survey

ST___OF ___ONS
STATE HIGHWAY COMMISSION
GEOLOGICAL AND NATURAL HISTORY SURVEY



Map 6 - Land Use in the Bear Lake Drainage Area
Source: Aron & Associates

STATE OF WISCONSIN
STATE HIGHWAY COMMISSION
GEOLOGICAL AND NATURAL HISTORY SURVEY



Community Survey

Efforts to manage lakes and lake related problems can often run into roadblocks if the proposed measures are inconsistent with the opinions, needs and desires of local residents and property owners. Surveys are often used to assess the local climate, to inform constituents and provide a basis for sound planning. A survey must be balanced and unbiased. It should lead respondents to put forth their opinions and thoughts without suspicions or contrivances.

The Bear Lake Community Survey was developed using the protocol established by the DNR for the conduct of surveys under the Planning Grant Program. The Bear Lake Association, the DNR and the University of Wisconsin Extension worked with the consultant to develop the survey to meet the needs of the Bear Lake community.

The twelve page survey was mailed first class to all landowners and residents of Bear Lake in October 1992 (Appendix). To encourage response, a postage paid return envelope was provided with the survey packet.

Follow-up correspondence was sent in early January (Appendix) to encourage participation from everyone and to provide preliminary results of the planning project. The survey results were presented at the annual meeting of the Bear Lake Association in July 1993. After the meeting, the results were mailed to all residents and landowners who were unable to attend the meeting. A total of 90 surveys were mailed; 65 were returned and tabulated for a response rate of 72%. This high degree of response indicates a great appreciation for the lake resource on the part of the respondents and their desire to preserve, protect and enhance their community.

The following image of the average survey respondent is a generalization drawn from the responses:

Seasonal resident, with no children
Owned Bear Lake property for 2 to 10 years
College educated professional earning more than $50,000
Male between 30 and 55 years old
Completed the survey with their spouse's input

Nearly all the respondents (94%) were aware of the Bear Lake Association and its activities, while 85% indicated they were members. Most respondents indicated they purchased their property because of the peace and tranquillity of the area. Eighty-five percent of the respondents believe the lake is not crowded on weekdays. That dropped to 52% who believe the lake is not crowded on weekends. The most popular activities on Bear Lake are scenic viewing, fishing, hiking/walking and swimming. Fishing is important to the area: 85% indicated they fish on Bear Lake. Residents and landowners believe there is adequate public access to Bear Lake. Twenty-three percent believe the existing sites need improvements such as parking and paving.

Most respondents recognize the changes that can occur from year to year. Far more indicated that plant and algae problems existed in 1992 than did in 1991. Most believe that the water quality of Bear Lake is good. Forty-two percent are concerned that the water quality is deteriorating while only 2% believe the quality is improving. Water clarity was the most important criterion for judging the quality of the water. Respondents believe that farmland runoff is the number one cause of problems on Bear Lake. That is followed by aquatic plants and algae, and then runoff from lawns.

The natural beauty of the area, recreation and the fishery were listed as the three most valuable resources in the Bear Lake area. Past problems controlling the lake level were apparent in the responses. Thirty-one percent believe the lake level is just right while 28% believe the level varies too much. Concerns regarding land and zoning regulations were split: 37% feel that the regulations are adequate while 23% believe they are inadequate. Enforcement was believed to be inadequate by 31% of the respondents, while an equal number believe enforcement is fine. Numerical data and calculations are included in the Appendix.

Management Recommendations

The Bear Lake Association and the area residents are to be commended for their efforts during this planning project and for the terrific amount of time and energy spent working to improve their public resource. Based on this planning effort, a number of items are presented for further consideration.

Aquatic Plants

The aquatic plant community appears to be very healthy at this time. There is a good diversity of beneficial native plants. One troublesome exotic, Curly-leaf pondweed, was rarely found in Bear Lake. Another plant of concern, Eurasian Water Milfoil, was not found in Bear Lake during 1992 and 1993 surveys. A watch program should be established to keep a look out for new invasions of Eurasian Water Milfoil. Volunteers should check the area surrounding each public access site on Bear Lake for the plant. Another option is to hire a consultant to routinely check the access sites. Early infestations of Eurasian Water Milfoil can be manually removed to prevent long term disruption of the aquatic plant community.

Another way to minimize problems with nuisance plants is to protect the native plant communities. Eurasian Water Milfoil will rarely move into an already inhabited area. Minimize boating in the shoreline areas and large shallow bays. Confine high speed boating activities to the deep water zones of the lake. Educate lake users to keep jet-skiers in the deep water zones as well.

Maintaining a consistent water level is also important to protect the wild rice plant community. Raising the water level too high will kill wild rice. Boaters should avoid the wild rice beds and the reed grass.

Changes in aquatic plant communities can signal problems with water quality. An aquatic plant survey should be conducted every three to five years and should repeat the transects established through this planning effort.

Water Quality

Water quality data is extremely important to lake management. Without actual, long term data, it is very difficult and often impossible to make good management decisions. Lake organizations have at times spent lots of time, energy and money and failed to produce their desired results, usually because not enough information was acquired on which to base their decisions.

It is recommended that the Bear Lake Association, in cooperation with the Town of Bear Lake consider water quality sampling every two to three years. This would minimize the costs to the Association while at the same time developing the very important database.

Other Recommendations

The local lake community appears to be very invested in their water resource. Many hours are spent on projects such as measuring water clarity and installing fish cribs. Bringing new members into the Association activities can go a long way towards minimizing volunteer burnout. A well-educated, informed public will be more inclined to contribute time and effort towards protecting something important to them. The Association should consider developing a newsletter for the residents and the community. Even when done once or twice a year, a newsletter can give people a valuable link to their lake, especially important in areas with high numbers of seasonal homes. Local University Extension agents, DNR staff or private consultants can assist with articles for a newsletter and can help provide ideas for layout and design.

The Association should consider the results of the Community Survey when planning projects or developing informational programs. Careful consideration of the information provided may point to specific needs the community may wish to focus on.

Residents should begin to get involved in land use planning decisions for lands within the watershed of Bear Lake. Attending Town and County meetings will alert residents to potential problems that may be forthcoming. Maintain regular contact with Town officials and County representatives (through the new newsletter) to improve their understanding of how to protect the valuable natural resource. The public officials can also provide information about who is the best person to contact to solve particular concerns.

Watch for invasions of purple loosestrife. Once sold in nurseries as a landscape plant, purple loosestrife is now destroying our wetlands. The plant invades marshes and lake shores, replacing cattails and other more beneficial wetland plants. The plant can form dense stands which are unsuitable as cover, food or nesting sites for animals and waterfowl. The plant is a prolific seed producer: one

plant can disperse 2 million seeds annually. The plant can also resprout from roots and broken stems that fall to the ground or into the water. The best way to control loosestrife is to catch it in the early stages, before it takes over an area. Handpulling young plants, taking care to contain the flower stalks and seeds, and burning the plants will help prevent its spreading.

Zebra mussels are another invader the Association should watch for. Zebra mussels began clogging up pipes in waste water treatment plants along the Great Lakes in 1988. The mussels have been found in the Milwaukee River, and the Wisconsin shoreline of Lake Michigan. Inland lakes are now keeping close watch out for the mussels. Female mussels can produce 30,000 to 300,000 eggs per year. An adult mussel can attach to virtually any solid underwater surface. In its larvae form (called veligers) they can be spread by scuba divers, waterfowl and boat motors. Because mussels filter one or more liters of water per day, there is a significant potential for a negative impact on aquatic food chains. They may also impact fish spawning areas by colonizing rocky bottom areas used for spawning. Zebra mussels can be very costly for recreational boaters. Extensive engine damage can occur from veligers and mussels. If you find evidence of zebra mussels, do not throw it back into the water. Store it in rubbing alcohol if possible, and immediately contact the DNR and the Lake District and the University of Wisconsin Sea Grant Institute.

There are things people can do to minimize the threat of exotics. Thoroughly rinse any equipment used in the Great Lakes or other infested waters. Water of 110° F will kill the veligers (young mussels), 140° F will kill the adult mussels and water fleas. Thoroughly drain and rinse all boat compartments, cooling systems, livewells, bilge water and transom wells. Empty your bait bucket on land, never into the water. Never dip your bait or minnow bucket into one lake, if it has water in it from another. And let everything dry for three days before transporting your boat to another body of water. For more information contact the Wisconsin Sea Grant Institute.

Another valuable activity revolves around wetlands. Protection of wetlands is critical to the long term health of Bear Lake. The Association can help residents and property owners understand their importance:

- Wetlands are important water storage areas. They release water slowly and help prevent flooding downstream.
- Wetlands trap sediment that may be eroding from upland areas. Too much polluted runoff can be damaging. Without wetlands, our lakes fill in more rapidly.
- They also trap the nutrients and chemicals that are carried with the silt. Too many nutrients in our lakes produce aquatic plant and algae problems.
- Wetlands serve as natural sponges, holding excess water, and recharging ground water systems that provide water for people's wells.
- Wetlands provide cover, food and water for hundreds of species of wildlife year-round. The decline in waterfowl, that many depend on for hunting, has been directly attributed to the lack of wetlands for waterfowl migration patterns.

- Wetlands provide breeding and nursery areas for fish. Game fish spawn in wetland areas. Larger fish depend on food produced in and near wetlands.
- Many people depend on wetlands for their recreation: hunters, anglers, photographers, bird-watchers, and others.
- In-lake wetland areas protect shorelines against wave action and erosion.

Final Report

Public meetings have been held to present the results of this planning project. The Association held annual meetings in 1992, 1993, and 1994. At the 1992 and 1993 annual meetings the results of the plant surveys were presented. Mounted plant specimens were available for the residents to review. The results of the community survey were mailed by direct mail to all residents and property owners. Discussion of the results also took place at the annual meetings. The USGS presented the results of their water quality sampling at the 1994 annual meeting. A summary of the planning project including review of the watershed also was conducted during the 1994 meeting. The Bear Lake Association notified landowners and residents of the meetings.

Table 6 - Public Involvement in Bear Lake Planning Grant Project

July 1991	Annual Meeting - discuss the Planning Grant process, needs and wants.
July 1992	Annual Meeting - discuss the Grant award and to present the projects that will be done, methods used and community input needed.
October 1992	Send out community survey
January 1993	Send out summary of water quality sampling for 1992 and encourage everyone to return the survey.
July 1993	Annual Meeting - present the results of the aquatic plant survey conducted in 1992, and the results of the community survey.
July 1994	Annual Meeting - USGS presents the water quality monitoring results; present summary of planning project.

Glossary

Aquatic Plants: Plants that grow and live in water; they may be floating, submerged or emergent.
Algae: Minute floating plants distributed throughout a lake as deep as light penetrates. Are generally microscopic in size, and lacking roots, stems and leaves.
Algal blooms: Overgrowth of algae in a water body caused by excessive nutrient inputs; turns water a greenish color and reduces clarity; can cause fish kills.
Ecosystem: An interactive community of animals, plants and microorganisms and the physical and chemical environments in which they live.
Erosion: The wearing away of the land surface by running water, wind, or ice.
Eutrophication: The aging process by which lakes are fertilized with nutrients. Natural eutrophication will very gradually change the character of a lake. Humans greatly accelerate the eutrophication process.
Food Chain: An arrangement of the organisms in an ecological community according to the order of predation in which each uses the next, usually lower, member as a food source.
Groundcover: Plants grown to keep soil from eroding.
Habitat: The place where an animal or plant lives; its living and non-living surroundings.
Herbicides: Chemicals designed to kill a variety of undesired plant species.
Impervious Surface: Ground cover that does not allow for infiltration of water, such as roads and parking lots; increases the volume and speed of runoff after a rainfall or snow melt.
Nutrients: A chemical element or compound that sustains life and promotes the growth of organisms. Nitrogen and phosphorus are important nutrients in lakes.
Nonpoint Source Pollution: Contaminated runoff from many diffuse sources.
Pollution: The presence of matter or energy whose nature, location or quantity produces undesired environmental effects.
Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the land surface or through pipes and eventually runs into lakes and streams.
Watershed: The land area that drains into a given body of water.
Wetlands: Low-lying lands in which the soil is saturated with water at some time during the year.
Zooplankton: The passively floating or weakly swimming microscopic animals in aquatic systems.

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Water Quality

The condition of Bear Lake's water quality is being tested by the U.S. Geological Survey (USGS), a division of the U.S. Department of the Interior. The lake was sampled in 1992 and will be again in 1993. Samples are taken five times during the year: in February through the ice, in spring soon after ice-off, and in June, July and August. Although many different things are tested for, three areas are commonly used to evaluate a lake: the *secchi disk reading*--how clear the water is; the *chlorophyll a levels*--the amount of algae in the water; and the *phosphorus concentrations*--the amount of nutrients in the water. The table below shows how the Bear Lake data ranks. (based on USGS draft data) It is important to remember that this data represents only one year, a very short time in the life of a lake.

	Range in milligrams per liter	Condition
	<0.010	Best Condition
1991 mean Total Phosphorus →	.010 - .020	↓
	.020 - .030	
	.030 - .050	
	.050 -.100	
	.100 - .150	
	>.150	Worst Condition

	Range in micrograms per liter	Condition
	0 - 5	Best Condition
1991 mean Chlorophyll a →	5 - 10	↓
	10 - 15	
	15 - 30	
	30	Worst Condition

	Range in feet	Condition
	>19.7	Best Condition
	9.8 - 19.7	↓
	6.6 - 9.8	
1991 mean Secchi →	3.3 - 6.6	
	<3.3	Worst Condition

All of the data collected under this project will be used to make recommendations for the Bear Lake Association for future projects and studies. The project is expected to be completed by mid 1994.

For further information, contact the Association or Aron & Associates at 26111 W. Loomis Rd • Wind Lake, WI 53185 • 414-895-6457.

453754091490900 BEAR LAKE, AT DEEP HOLE, NEAR HAUGEN, WI--CONTINUED

WATER-QUALITY RECORDS

PERIOD OF RECORD.--March 1992 to current year (discontinued).

REMARKS.--Lake sampled near center of lake at a depth of about 80 ft. Lake ice-covered during March sampling. Water-quality analyses by Wisconsin State Laboratory of Hygiene.

WATER-QUALITY DATA, MARCH 04 TO AUGUST 12, 1993
(Milligrams per liter unless otherwise indicated)

	Mar. 04		May 06		June 24		July 16		Aug. 12	
Depth of sample (ft)	1.5	81	1.5	78	1.5	73	1.5	70	1.5	74
Lake stage (ft)	5.84		6.62		6.97		6.47		6.47	
Specific conductance (µS/cm)	148	170	133	138	134	146	132	147	127	144
pH (units)	8.2	7.7	7.8	7.7	8.5	7.7	8.6	7.8	8.5	7.8
Water temperature (°C)	1.0	3.0	14.5	6.0	21.0	8.0	22.5	8.5	26.0	8.5
Color (Pt-Co. scale)	---	---	25	20	---	---	---	---	---	---
Turbidity (NTU)	---	---	0.80	1.4	---	---	---	---	---	---
Secchi-depth (meters)	---		1.8		2.4		1.5		1.5	
Dissolved oxygen	10.8	0.2	11.1	7.8	8.5	1.0	9.6	0.1	9.0	0.1
Hardness, as CaCO3	---	---	70	73	---	---	---	---	---	---
Calcium, dissolved (Ca)	---	---	18	19	---	---	---	---	---	---
Magnesium, dissolved (Mg)	---	---	6.0	6.3	---	---	---	---	---	---
Sodium, dissolved (Na)	---	---	2.1	2.2	---	---	---	---	---	---
Potassium, dissolved (K)	---	---	1	1	---	---	---	---	---	---
Alkalinity, as CaCO3	---	---	69	72	---	---	---	---	---	---
Sulfate, dissolved (SO4)	---	---	<5.0	<5.0	---	---	---	---	---	---
Chloride, dissolved (Cl)	---	---	1.0	<1.0	---	---	---	---	---	---
Fluoride, dissolved (F)	---	---	<0.0	<0.0	---	---	---	---	---	---
Silica, dissolved (SiO2)	---	---	6.6	8.0	---	---	---	---	---	---
Solids, dissolved, at 180°C	---	---	86	90	---	---	---	---	---	---
Nitrogen, nitrate, total (as N)	---	---	0.05	0.14	---	---	---	---	---	---
Nitrogen, NO2 + NO3, diss. (as N)	---	---	0.05	0.14	---	---	---	---	---	---
Nitrogen, ammonia, dissolved (as N)	---	---	0.01	0.09	---	---	---	---	---	---
Nitrogen, organic, total (as N)	---	---	0.39	0.41	---	---	---	---	---	---
Nitrogen, amm. + org., total (as N)	---	---	0.40	0.50	---	---	---	---	---	---
Nitrogen, total (as N)	---	---	0.45	0.64	---	---	---	---	---	---
Phosphorus, total (as P)	---	---	0.004	0.010	0.015	0.035	0.019	<0.020	0.018	0.050
Phosphorus, ortho, dissolved (as P)	---	---	<0.002	<0.002	---	---	---	---	---	---
Iron, dissolved (Fe) µg/L	---	---	<50	<50	---	---	---	---	---	---
Manganese, dissolved (Mn) µg/L	---	---	<40	130	---	---	---	---	---	---
Chlorophyll a, phytoplankton (µg/L)	---	---	4.5	---	8.0	---	16	---	18	---

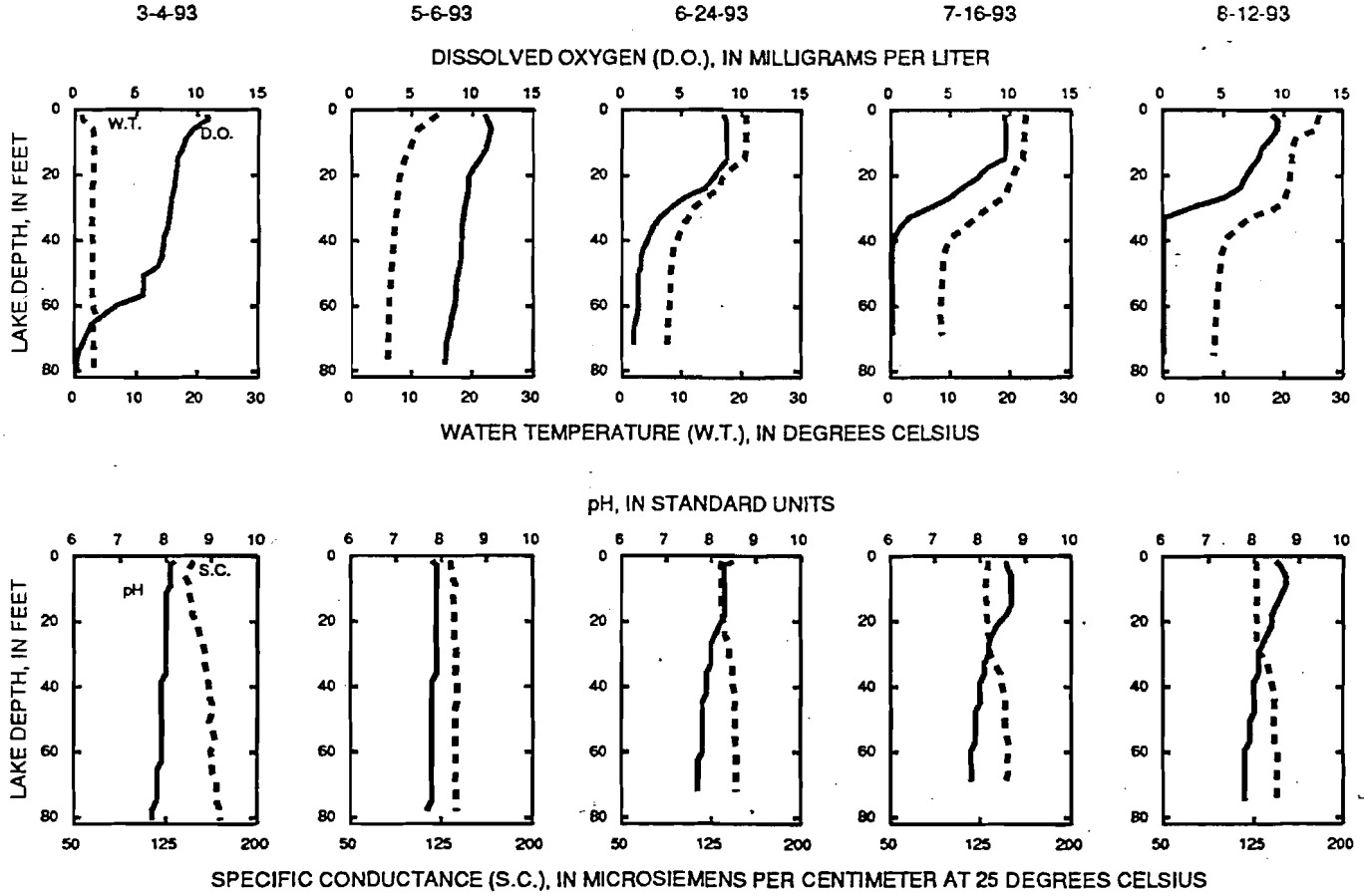

Figure 2. Lake water-quality data for Bear Lake near Haugen, Wisconsin, 1993 water year

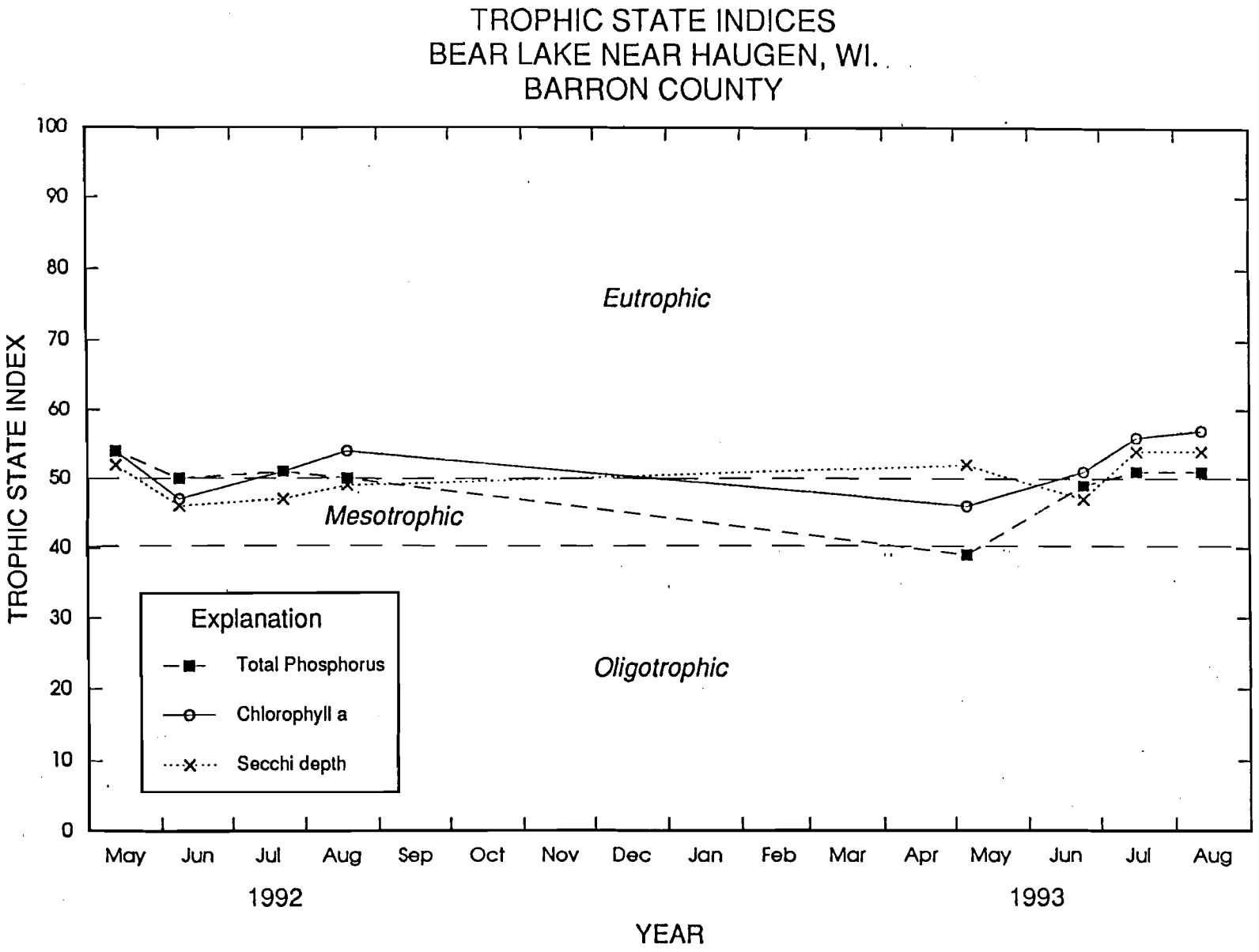

Figure 3. Trophic State Indices for Bear Lake near Haugen, Wisconsin