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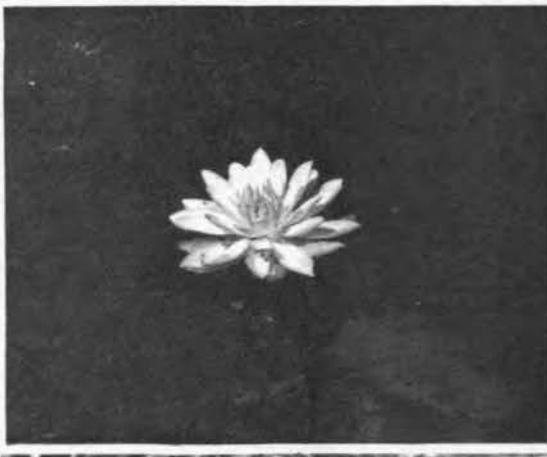

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AQUATIC PLANT SURVEY

of Major Lakes in the Milwaukee River Watershed

AQUATIC PLANT SURVEY

OF MILWAUKEE RIVER WATERSHED LAKES

By

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Research Report No. 52

DEPARTMENT OF NATURAL RESOURCES
Madison, Wisconsin 53701

1970

1000-30

ACKNOWLEDGMENTS

I would like to gratefully acknowledge Jim Weckmueller, Pat Klingelhoets, and Vern Trulson for the valuable assistance they gave to me while conducting this survey. I would also like to acknowledge Mrs. Rosanne Knight for typing and assisting in the preparation of the original manuscript. I am greatly indebted to Stanton Kleinert who was my supervisor during this survey, and for the advice and criticism he offered during the writing of this report. Grateful acknowledgment goes to all others associated with the Department of Natural Resources who aided me in any way during this survey, and to the Department of Transportation for their cooperation in taking aerial photographs of the lakes studied.

The present survey was part of an intensive survey of the water resources of the Milwaukee River Watershed coordinated by the Southeastern Wisconsin Regional Planning Commission. Finances for this project of the study were made available by Chapter 36, 1965 Supplement to the Wisconsin Statutes (36.245), known as "The Accelerated Water Resources Research and Data Collection Program".

The preparation of this (publication) (map) was financed in part through a joint planning grant from the Wisconsin Department of Natural Resources, Division of Resource Development; the U.S. Department of Housing and Urban Development; and the U.S. Department of the Interior, Federal Water Pollution Control Administration, under the provisions of Section 701 of the Federal Housing Act of 1954, as amended, and under the provisions of the Federal Water Pollution Control Act of 1965, as amended.

(Submitted for publication in December, 1969)

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Edited by Ruth L. Hine.

ABSTRACT

Twenty-three lakes of the Milwaukee River Watershed were surveyed from June to September, 1968, to record the abundance and species composition of aquatic vegetation. There was a variety of aquatic plant communities, and 39 genera and 61 species were identified. The greatest variety recorded from any single lake was 24 genera and 34 species. Stonewort (Chara), cattail (Typha), softstem bulrush (Scirpus validus), sago pondweed (Potamogeton pectinatus), and white water lily (Nymphaea tuberosa) occured most widely and in greatest abundance.

Some changes in abundance and dominance were noticed over the summer. The marl lakes of the northeast basin and the tea-colored lakes of the northwest basin had a very small biomass and scattered distribution of plants, while the other lakes had a very large biomass and continuous distribution of plants. Evidence of nutrient enrichment of certain waters, indicated by nuisance growths of aquatic vegetation, was noted and is described.

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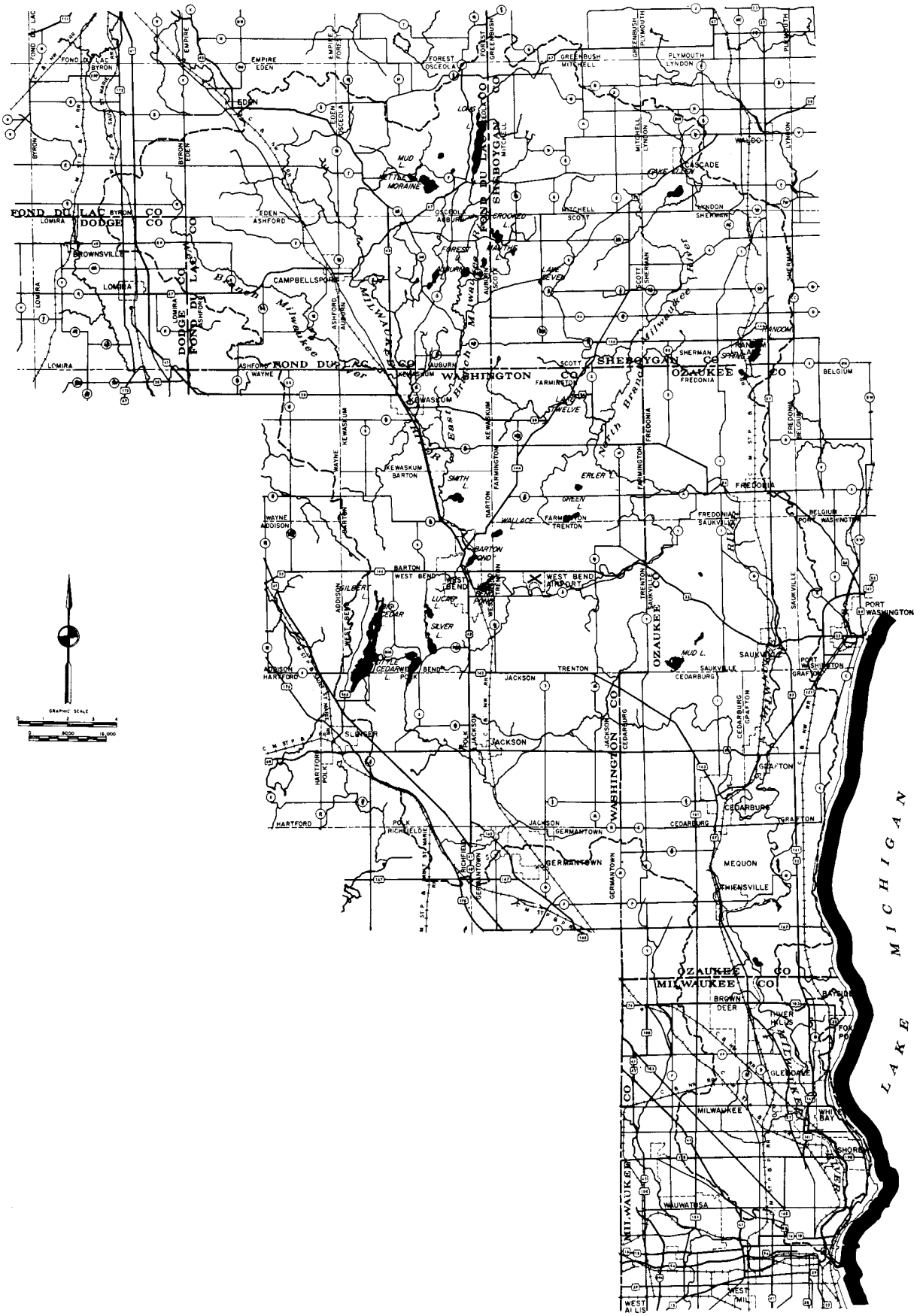


Map of the Milwaukee River Watershed showing major lakes having 50 acres or more of surface water.

INTRODUCTION

A survey of the aquatic vegetation of the Milwaukee River Watershed was conducted during the summer of 1968. It encompassed 24 major lakes exceeding 25 acres in area within the watershed. This survey is the first of its kind on this watershed. A similar survey was conducted by Belonger (1969) on lakes of the Fox River watershed in southeastern Wisconsin. The primary objective of both of the surveys was to determine species composition, relative abundance, and distribution of the vegetation within the major lakes of these two large watersheds.

Belonger's survey looked into the impact vegetation has on man's activities and the importance of vegetation to fish and wildlife. In this report an attempt is made to point out some of the possible factors affecting the distribution and abundance.

PROCEDURES

Transportation

Most of the field sampling was done with a 16-foot aluminum pram powered by a 5-horsepower outboard motor. The shallow draft of this pram, less than 3 inches, permitted sampling in vegetation-choked, shallow marsh areas as well as deeper waters. It was very stable even in choppy waters, permitting the field survey crew to work freely without fear of capsizing. The size and weight of the pram did, however, necessitate a launching site where the boat could be launched directly from the trailer. Such sites were found on 21 of the lakes surveyed.

An aluminum canoe was used on Barton Pond in West Bend and on Mud Lake in Ozaukee County. Launching here required dragging the canoe through marsh, swamp or tamarack bog to reach open water.

Vegetation Sampling Methods

In order to obtain a representative sample of the vegetation within a lake, 50 or more sampling stations were chosen around the perimeter. A sampling station consisted of a circular area with a radius of about 30 feet. The boat was used as the center. All vegetation within the area (emergent, floating, and submergent) was identified to genus and if possible to species. Where field identification could not be positively made samples were taken and identified in the laboratory. The approximate area in which each species was found was recorded on a hydrographic map of the lake using a number to denote the genus and a letter to denote species. Sampling was done visually where possible, and with the use of a rake where the vegetation could not be seen.

The field survey crew sampled with a "vegetation rake" in deeper water where plants could not be seen from the boat.

The average linear distance along the shore between sampling stations was about 40 yards. Depending on the specific situation, however, sampling areas were as close together as 5 feet or as distant as 100 yards. During the resurvey, most stations were about 100 yards apart.

In areas where vegetation covered the bottom from shore to shore, transects were made across the area. A situation such as this was encountered in the southern end of Little Cedar Lake, and parallel transects were run across the area with about 50 yards between each transect. The length of the transect determined the number of stations on it. During normal situations, sampling was done from shore to the point where the vegetation reached its maximum depth. The number of sampling stations again depended on the distance the vegetation extended from shore.

The relative abundance of individual species was determined by estimating the density of the species occurring within a sampling area. The density was then recorded by writing the species number and letter in a specific color. Black represented a very heavy concentration, where plants formed a mat with very little space between individuals; red denoted moderate abundance, where plants occurred in clumps but where the space between individuals might be as great as one yard; blue denoted a scattered occurrence, where plants could be abundant but where individuals were highly scattered, and green denoted occasional occurrence. Each color was given a numerical value to represent the relative abundance of a species in a lake: Green - 1, Blue - 2, Red - 3, Black - 4. This method is crude, but was expedient for this type of

survey. One disadvantage is that the sampling must always be done by the same person because the estimations are arbitrary. The use of a great number of stations minimizes the error.

The colors were also assigned a specific number of points which were used to determine what percentage the individual species constituted in the total population. The point values for each color were: black-10, red-6, blue-4, and green-1. Although this method is also crude, the percentage figures obtained suggest the dominance and frequency of occurrence of each species.

Where the water was too turbid or too deep, sampling was accomplished by the use of a standard lawn rake. The rake head was 15 inches wide and contained 14 two-inch teeth. A piece of wire screen with 1/8-inch-square openings was interwoven between the teeth to retain fragile plants. The screen also aided in obtaining the very small plants which were common in the deeper water. Without the screen these would have been lost. The rake handle was the standard 6-foot length. The handle and the attached rope were marked at one-foot intervals in order to determine depth.

Determining abundance with the use of the rake was difficult. A set number of rake throws were used to be consistent. If the rake was completely filled with one species on the retrieval of each throw, the abundance was considered heavy (black color code). If only one or two plants were found, the abundance was sparse (green color code), and so on. Again the system is arbitrary so the advantage of having the same person sampling reduces the error. At depths greater than 10 feet usually only one species occurred. Three species were the greatest number encountered. Diversity apparently is not great beyond the range of visibility.

Samples of plants, either for the collection or for identification, were stored in plastic bags and brought to the laboratory. These bags were kept in the refrigerator until the plants could be identified. Identification was done by using Fassett's (1960) key. Many of the specimens were pressed, mounted and added to the Wisconsin Department of Natural Resources' collection.

General Observations and Water Quality

Other observations were made during the survey, including looking for factors which would influence or hinder distribution or abundance of vegetation, and observing bottom sediments in some areas for overt composition and hardness. A standard secchi disc was used to measure water clarity. Readings were always taken in the deepest part of the lake.

Aerial Photography

Colored aerial photographs of the study lakes taken by the Department of Transportation were a tremendous aid in locating heavily vegetated areas in the lakes before field survey. Nine-by-nine inch photographs were made on Kodak Aero-Ecktachrome MS type 2448 film using a Zeiss RMK 15/23 Camera with a 6-inch lens.

The aerial photographs were taken at 3,000 feet with each inch of photograph equal to 500 feet of ground distance. In most cases the vegetation was visible to its maximum depth. Careful examination of the photographs revealed areas where vegetation was heavily concentrated and in certain cases revealed specific dominant species prior to the field survey.

Such species as cattails (Typha) and bulrushes (Scirpus) could be identified in the aerial photographs by their color. Large stands of cattails reflected a black-green color while bulrush stands appeared yellow-green. The round leaves of the water lilies (Nymphaea) and the ovoid leaves of the spatterdock (Nuphar) were also apparent in the aerial photographs. Areas covered by duckweed (Lemna) could be distinguished from algal mats because the duckweed's waxy leaves reflect large amounts of light. This gives the duckweeds a chartreuse green color from the air. Algal mats were a dull green, brown or yellow which usually blended with the bottom. Submergent species could not be positively identified from the aerial photographs.

GEOGRAPHY, GEOLOGY AND LIMNOLOGY OF THE MILWAUKEE RIVER WATERSHED

Encompassed within the watershed are five counties: Fond du Lac and Sheboygan on the north, Washington and Ozaukee in the middle, and Milwaukee on the south. The area was formed by two lobes of the Wisconsin glacier. The Green Bay lobe moved from northwest to southeast and the Lake Michigan lobe moved from northeast to southwest. The two combined to form a terminal moraine that divides the area into two drainage basins.

The northwestern basin is subdivided by a series of morainic ridges and valleys which are oriented northwest to southeast, and has a general flow of water to the southeast. This area contains three major tributaries which unite in the area of Kewaskum to form the Milwaukee River. Within the basin are eight major lakes. The Long Lake-Mauthe Lake complex forms the East Branch of the Milwaukee River.

Just south of Kewaskum the Milwaukee River crosses the terminal moraine and in the city of West Bend, it turns and winds its way east toward Lake Michigan. After the union of the North Branch and the main stream about 5 miles south of the Ozaukee-Sheboygan county line, the river turns south and parallels Lake Michigan for about 25 miles before it enters the lake at Milwaukee. At various points along this 25-mile stretch, the river comes within one mile of the lake. However, it does not enter the lake due to the scarcity of east-west valleys through the morainic ridge paralleling the lake. (Poff et al., 1964).

Most of the drainage area south of West Bend is farm land. There is a gradual increase in population and industrialization along the southern flow. Reflecting this increase in urbanization the river becomes more and more fertile. By the time it enters Lake Michigan the river is considered highly polluted.

All of the lakes surveyed contain a considerable amount of dissolved minerals and nutrients, reflecting the glaciated silt loams upon which they are formed. Certain lakes, however, display distinct characteristics. The northwest basin of the watershed is forested and contains many landlocked kettle areas which contain a considerable amount of peat. The peat and forest drainage in this basin tend to give the lake water a tea-colored tint. Marl lakes, characterized by extensive areas of marl bottom sediments, occur in the northeast basin. Other special types of lakes include Barton Pond and West Bend Pond which are coffee-colored impoundment lakes of the Milwaukee River. Mud Lake in Ozaukee County is the only tea-colored bog lake surveyed in the northeast basin. The physical characteristics of the lakes surveyed in the Milwaukee River Watershed are shown in Table 1.

FINDINGS

Abundance and Diversity of Aquatic Plants

Most of the lakes displayed moderate to abundant vegetation in areas from the shore zone to depths as great as 20 feet. In general, situations of extensive shallows, clear water, and muck bottoms supported the highest densities of aquatic vegetation. Situations of limited shallow areas, either turbid or tea-colored water and marl, sand, gravel, or suspended ooze bottoms supported lower densities of aquatic vegetation. Lakes varied in abundance of aquatic vegetation from Ellen Lake with a relatively low abundance to Crooked Lake which displayed a superabundance of aquatic vegetation.

Plants representing 26 families were encountered, and within these, 39 genera and 45 species were identified (Table 2). The presence and relative abundance of plants are presented for all species in all lakes surveyed in Tables 3 and 4. Diversity of aquatic plant communities at

TABLE 1

Physical Characteristics of Milwaukee River Watershed Lakes Surveyed

Lake	Surface Acres	Miles of Shoreline	Maximum Depth (ft.)	Secchi Disc Reading* (ft.)	Maximum Depth of Plant Occurrence (ft.)
Auburn	107	2.4	29	6.5	10
Barton Pond	51	1.2	7	1.5	2
Big Cedar	1,004	10.0	105	10.0	12
Crooked	84	2.1	30	8.0	10
Ellen	109	1.9	45	5.5 (7)	9
Erler	35	0.9	38	5.0	8
Forest	50	1.3	32	10.0	12
Gilbert	40	-	30	3.0	3
Green	82	2.1	35	10 (7)	11
Kettle Moraine	240	2.4	30	10.0	15
Little Cedar	259	4.0	55	4.0	3
Long	409	5.0	47	9 (11)	8
Lucas	73	2.8	15	10.5	12
Mauthe	63	2.5	22	5.5 (9)	6
Mud (Fond du Lac)	56	-	16	3.0	4
Mud (Ozaukee)	245	3.1	4	4.0	3
Random	213	3.5	19	6.0 (6)	8
Seven	25	0.9	25	12.0 (5)	12
Silver	119	2.6	45	12.0	20
Smith	77	1.7	5	5.0	5
Spring	66	1.7	20	9.0	14
Twelve	56	1.1	20	8.0	6
Wallace	50	1.2	35	13.0	12
West Bend Pond	73	2.5	9	4.0	5

*In the secchi disc reading column, the number in parenthesis is the secchi disc reading during the resurvey in late summer.

each lake varied from 12 genera present (Spring Lake, July 29, 1968) to 23 genera present (Long Lake, July 1, 1968). The average number of genera found per lake was 16.

Long Lake contained the greatest diversity of plants encountered, with 34 species observed. Big Cedar Lake, the largest lake surveyed, contained 30 species. In both of these lakes, the submergent aquatics were in greatest abundance. The lowest number of species (16) was observed in Lake Twelve. Gilbert Lake, part of the Big Cedar complex, had the largest population of floating aquatics, most of which were white water lilies (Nymphaea tuberosa).

TABLE 2

List of Common and Scientific Names of the Aquatic Plants and Their Frequency of Occurrence in the 1968 Survey of 24 Lakes in the Milwaukee River Watershed.

Aquatic Plant	Lakes Where Found	
	Number	Percent
Acorus Calamus - Sweet Flag	1	4
Anacharis canadensis - Waterweed	16	66
Asclepias incarnata - Swamp Milkweed	10	42
Brasenia Schreberi - Water Shield	2	8
Caltha palustris - Marsh Marigold	1	4
Carex comosa - Sedge	13	55
Ceratophyllum demersum - Coontail	16	66
Chara - Stonewort or Muskgrass	22	92
Cyperus spp. - Sedge	14	58
Decodon verticillatus - Swamp Loosestrife	7	27
Eleocharis spp. - Spike Rush	17	70
Equisetum spp. - Horsetail	2	8
Eupatorium purpureum - Joe-Pye-Weed	3	12
Heteranthera dubia - Water Star Grass	11	46
Iris spp. - Iris	3	12
Juncus spp. - Rush	1	4
Lemna - Duckweed	16	66
L. minor - Lesser Duckweed	(11)	(46)
L. trisulca - Star Duckweed	(2)	(8)
Lythrum alatum - Spiked Loosestrife	1	4
Myriophyllum - Water Milfoil	21	88
M. exalbescens - Water Milfoil	(15)	(62)
Najas - Bushy Pondweed	16	66
N. flexilis - Bushy Pondweed	(14)	(58)
N. marina - Bushy Pondweed	(3)	(12)
Nasturtium officinale - Water Cress, Nasturtium	1	4
Nuphar sp. - Yellow Water Lily, Spatterdock	22	92
Nymphaea - White Water Lily	24	100
N. tuberosa - White Water Lily	(23)	(96)
Phragmites spp. - Reed Grass	1	4
Polygonum natans - Water Smartweed or Amphibious Smartweed	3	12
Pontederia cordata - Pickerelweed	6	25
Potamogeton - Pondweeds	24	100
P. amplifolius - Largeleaf Pondweed, Musky Weed or Bass Weed	(19)	(79)
P. crispus - Curlyleaf Pondweed	(3)	(12)
P. Friesii - Frie's Pondweed	(15)	(62)
P. gramineus - Variable Pondweed	(13)	(55)
P. natans - Floating-leaf Pondweed	(21)	(88)

TABLE 2 (Contd.)

List of Common and Scientific Names of the Aquatic Plants and Their Frequency of Occurrence in the 1968 Survey of 24 Lakes in the Milwaukee River Watershed.

Aquatic Plant	Lakes Where Found	
	Number	Percent
P. nodosus - American Pondweed	(16)	(66)
P. pectinatus - Sago Pondweed	(23)	(96)
P. Richardsonii - Richardson Pondweed, Clasping Leaf Pondweed	(4)	(17)
P. Robbinsii - Robbin's Pondweed	(2)	(8)
P. strictifolius	(3)	(12)
P. zosteriformis - Flat-stemmed Pondweed	(19)	(79)
Ranunculus longirostris - Buttercup, Crowfoot	8	33
Ruppia maritima - Wigeon Grass	1	4
Sagittaria latifolia - Arrowhead, Wapato	18	75
Scirpus - Bulrush	24	100
S. americanus - Three-square Bulrush	(4)	(17)
S. atrovirens	(6)	(25)
S. subterminalis - Water Bulrush	(5)	(21)
S. validus - Softstem Bulrush, Great Bulrush	(21)	(88)
Sparganium - Bur Reed	13	55
S. eurycarpum - Bur Reed	(10)	(42)
Sium sauve - Water Parsnip	2	8
Typha spp. - Cattail	23	96
Utricularia - Bladderwort	11	46
U. geminiscapa - Bladderwort	(1)	(4)
U. vulgaris - Common Bladderwort	(2)	(8)
Vallisneria americana - Wild Celery or Eel Grass	10	42
Veronica spp. - Speedwell	1	4
Wolffia columbiana - Watermeal	2	8
Zizania aquatica - Wild Rice	3	12

Scientific nomenclature from A Manual of Aquatic Plants, by Norman C. Fassett, 1960.

The pondweed family (Najadaceae), made up of Potamogeton and Najas was the most frequently encountered plant family. Species of the genus Potamogeton were found in all of the lakes surveyed. P. pectinatus and P. amplifolius were most common (Table 4). Both of these species were most obvious in the marl lakes. Stonewort (Chara) was the single most abundant genus found. Chara was found in all lakes except Barton Pond and West Bend Pond on the Milwaukee River. Representatives of the sedge family (Cyperaceae) were found in all lakes. Softstem bulrush (Scirpus validus) was the most abundant species of this family. Members of the

cattail family (Typhaceae) were the most abundant emergents and were found in 96 percent of the lakes. The white water lily (Nymphaea tuberosa) of the family Nymphaceae was found in all lakes and was the most abundant floating aquatic plant.

In some areas there was an abrupt departure from nonaquatic plants to submergents. However, the more common pattern, emergent to floating to submergent, occurred along most moist shorelines. Typha, Scirpus, Sparganium, Carex, Cyperus, Eleocharis, were usually found confined to the shore and the shallow water fringing the shore. Occasionally Scirpus occurred in areas where the depth of the water was 3-4 feet. Pontederia was always found off shore where water depths were 1-2 feet. Nymphaea and Nuphar, the floating leaf species, extended from shore to depths of 8 feet. Nymphaea was usually nearest the shore. Since Lemna was not attached to the bottom, it was not dependent on depth but on wind for its distribution. Species of Potamogeton, the most diverse group of submergents, occurred from shore to depths of 13 feet. Ceratophyllum, Anacharis, Utricularia, Chara, mostly occurred at depths of 1-4 feet, but were found at depths to 6 feet in very clear water lanes. Najas and Myriophyllum were commonly found at depths greater than 4 feet. Occasionally Najas occurred in shallower depths.

Seasonal Changes of Aquatic Plants

Changes in abundance and dominance were brought to light by resurveying six of the earliest surveyed lakes. An average of 58 days passed between the initial survey and the resurvey. This span of time was long enough to show the change in dominance of narrow leaf pondweed (Potamogeton spp.) to bushy pondweed (Najas). This change was very obvious in Lake Seven, Mauthe Lake, and Long Lake. Eel grass (Vallisneria americana) was found to be very abundant in Green Lake and Mauthe Lake, whereas it was hardly noticed during the first survey. Changes in the emergent population were very difficult to determine. However, as the season progressed various unnoticed species became apparent because of their production of flowers. Lesser duckweed (Lemna minor) was found to increase tremendously in late summer. Watermeal (Wolffia), which was very abundant in early summer, was almost absent and the area it once covered was taken over by lesser duckweed. Apparently water lilies (Nymphaea tuberosa) must die off earlier than spatterdock (Nuphar), because spatterdock became dominant where water lilies had been dominant. In all the lakes resurveyed, beds of water lilies were observed in various stages of die-off.

The most drastic change in abundance was noticed in Lake Seven, the first lake surveyed. Here, vegetation increased from an abundant condition to a superabundant condition in 69 days.

DISCUSSION: FACTORS AFFECTING AQUATIC PLANT DISTRIBUTION

General Review

Curtis (1959) showed that lakes in southern Wisconsin contained 300 to 2,500 times as much plant material per unit area as lakes in northern Wisconsin. He found that this greater plant production corresponded to the geographic region of very hard, alkaline waters with high conductivity characteristic of lakes in southern Wisconsin. Moyle (1945) classified the flora of Minnesota lakes according to water quality into three general groups: (1) the flora of the soft-water lakes that are most frequent in northeastern Minnesota, (2) the flora of the hard-water morainic lakes of the central, northern, and southern part of the state, and (3) the flora of the alkali or high sulphate lakes of the extreme western and southwestern prairies. Swindale and Curtis (1957) found that aquatic plant distribution within a lake is dependent on variation of hydrography, topography, land use, exposure to wind, and proximity to inlets and outlets.

Within the Milwaukee River Watershed, the distribution and abundance of aquatic plants tended to vary depending upon the character of the lake. All of the lakes studied could probably be described as Moyle's type 2 classification in that they are all hard-water lakes with total alkalinities between 90 and 150 ppm or greater, sulphate ion less than 50 ppm, and summer pH of surface waters often between 8.0 to 8.8. Certain definite relationships were apparent, however, between the occurrence of aquatic vegetation and water transparency, bottom sediments, water fertility, and man's weed control activities.

Water Transparency

There was a definite correlation between maximum depth at which the vegetation occurred and the depth the secchi disc vanished. In many cases cutting operations and plankton blooms altered conditions. The average secchi disc reading was 7 feet indicating that most lakes in the watershed were fairly clear in summer. However, the range was from 3 feet, observed in Mud Lake (Fond du Lac County) to 13 feet in Wallace Lake (Table 1). Silver Lake was found to contain the deepest occurring plant -- bushy pondweed (*Najas flexilis*), growing at 20 feet.

Excluding the marl lakes, the greatest concentration and diversity of plant life occurred in the lakes with the greatest transparency. Lakes like Long Lake, Wallace Lake, Forest Lake, and Kettle Moraine Lake supported moderate to heavy growths of vegetation. Usually the narrow leaf pondweeds (*Potamogeton* spp.) were common. However, stonewort (*Chara*), waterweed (*Anacharis canadensis*) and bushy pondweeds (*Najas flexilis*) were also abundant.

Submergents in the tea-colored lakes (Mauthe Lake, Auburn Lake, and the two Mud Lakes) were sparse to scattered. Various species common in tea-colored lakes were pondweeds (Potamogeton), waterweeds (Anacharis), bushy pondweeds (Najas) and coontail (Ceratophyllum). Coontail was very characteristic of these lakes. These all tended to be concentrated in shallow water. The limiting factor in tea-colored lakes appeared to be the rapid extinction of solar radiation (Juday and Birge, 1933). The tea-color is due to the humic acids produced by the decomposition of large concentrations of plant materials. The color tends to rapidly reduce the quality of solar radiation causing the restriction of plant life to the shallower waters (Shapiro, 1957).

Bottom Sediments

Lakes or portions of lakes that contain sediments formed from suspended ooze normally have very few submergents. Such areas occurred in Long Lake, Mud Lake in Ozaukee County, Crooked Lake, and Auburn Lake, and they all contained water bulrush (Scirpus subterminalis). According to Moyle (1945), water bulrush occurs in soft-water or bog lakes. All the lakes described are hard-water lakes but have characteristics of a bog with tea-colored water, and suspended peat bottom. Tamaracks, dogwoods, cattails, and spike rushes (Eleocharis) were common along the shores of tea-colored lakes and other lakes where the soil or sediment tended to be highly organic.

Because of the chemical condition of marl lakes, the nutrients are not readily available to the plants (Reid, 1967). Typically marl lakes have little submerged vegetation, and the deeper basins are characterized by an abrupt slope or dropoff (Hooper, 1956). In the marl lakes of the Milwaukee River Watershed like Ellen Lake, Smith Lake, Spring Lake and Lake Twelve, the submergents were sparse to scattered. The broad leaf pondweeds (Potamogeton) and bushy pondweeds (Najas) were common in marl lakes, with beds of stonewort (Chara) often present. Generally softstem bulrush (Scirpus validus), cattails (Typha), sedges (Cyperus and Carex) and grasses occurred as prominent growths of emergent vegetation in marl lakes.

Water Fertility

Some of the lakes surveyed displayed unusually rank aquatic plant growth or extensive algae blooms. These situations may indicate pollution by unnatural enrichment. Near the end of summer Crooked Lake, Kettle Moraine Lake, Long Lake, and Big Cedar Lake exhibited a super-abundance of plants. Also about this time algae caused problems in Lucas Lake, Lake Seven and West Bend Pond, although higher aquatic plants were also abundant in most areas. West Bend Pond presented a particularly unattractive appearance, indicative of fertile conditions. Here the water contained much foreign material, floating, suspended, and dissolved -- probably the products of effluents entering the river from drain pipes from the city.

At the mouths of streams that drained pasture lands coontail (Ceratophyllum demersum) occurred in moderate to heavy abundance. This was evident in Auburn Lake, Mauthe Lake, Long Lake and several others. Portions of lakes that received drainage from fertile areas such as farm yards, cow pastures, or residential areas also contained large concentrations of coontail. An example of this was seen on the eastern shore of Kettle Moraine Lake, which was choked with coontail. Apparently this species is responsive to situations of excessive fertility. Barton Pond had moderate amounts of coontail, while the back waters of West Bend Pond, downstream, were choked with coontail. The Milwaukee River, which flows through these ponds, receives enriched effluents from upstream sources.

Man's Weed Control Activities

Man exerts considerable influence on the aquatic vegetation. He can enhance plant growth or inhibit or remove the vegetation. Predictably when homes are built along a lakeshore the vegetation is altered. Seepage from inadequate sewage facilities enhances vegetation growth, docks and retaining walls can cause a change in species composition by shading or deepening the immediate area. The greatest recreation interest of lakeshore property owners is swimming. Many lakeshore property owners strive to either remove or control vegetation in front of their properties to establish swimming beaches. Those owners not interested in swimming still attempt to remove vegetation from the immediate area. This can be done in a variety of ways: by raking the vegetation from the bottom, by using herbicides, or by mechanical weed harvesters. These practices were observed in Big Cedar Lake, Little Cedar Lake, Random Lake, and Forest Lake. All these factors will temporarily or for perhaps a longer time change the species composition and abundance of the aquatic vegetation.

Sand or gravel fills were installed by property owners to create swimming beaches. These fills, often applied over areas where native vegetation grew, can inhibit regrowth of aquatic vegetation. The landowner needs a permit from the state to physically alter a shoreline or build a beach, but these alterations were common in all lakes especially in Big Cedar Lake, Little Cedar Lake, Random Lake, and Silver Lake.

MANAGEMENT IMPLICATIONS

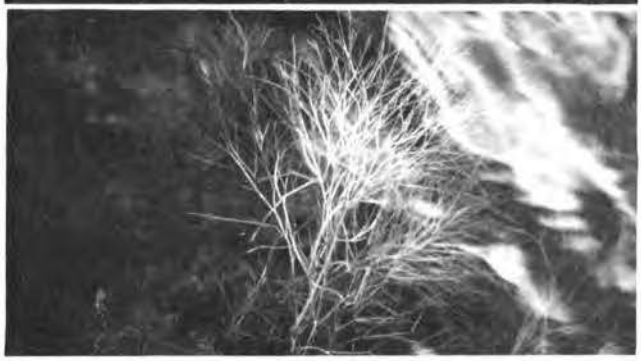
Only a small amount of wildlife was observed during the survey, but lakes containing areas of undeveloped shoreline contained more wildlife than lakes that did not. Shorelines that had growths of cattails, bulrushes, and sedges usually supported a community of marsh animals. Vegetation is important to animals for cover, production of food, and nesting. Submergent vegetation is important in providing habitat for fish. When lakes are being developed for human habitation, some areas should be kept in their natural state.

While vegetation is important to a lake, any species has the capability of becoming overabundant and interferring with lake use. Such situations often reflect enrichment, pollution, or other unnatural conditions. Some shorelines could be improved by encouraging the growth of specific emergent and floating aquatics. Arrowheads, milkweeds, water lilies, and pickerelweeds flower throughout most of the summer and add color to a lakeshore. Such improvement would be especially important on lakes in or near metropolitan areas. Because of their location, these lakes can be very important recreational areas. Proper shoreline development and beautification, cleanup of litter, and strict control of pollutants draining into the lakes can transform such unsightly areas as Barton's Pond and West Bend Pond into recreational areas.

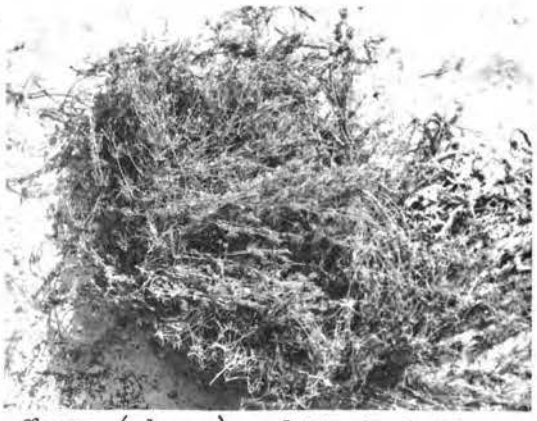
A unique attempt to create and preserve the aquatic vegetation in a lake was being undertaken in Little Cedar Lake. This lake contained little vegetation because of its morphometery and extensive shore development by landowners. Marked areas have been set aside as weed preservation areas. These will eventually provide habitat for fish and birds as well as improve the aesthetics of the lake.

These are the most common aquatic plants found in the Milwaukee watershed lakes sampled . . .

Occurring in 75% or more of the lakes:



Potamogeton natans (above left), P. pectinatus (left), P. amplifolius (above)



Chara (above) and Myriophyllum (below)

Nymphaea tuberosa

Nuphar

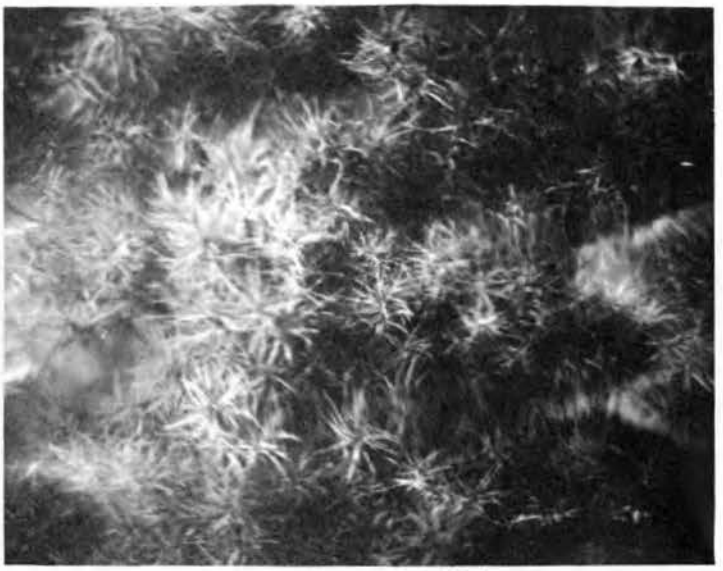
Sagittaria latifolia

Scirpus validus

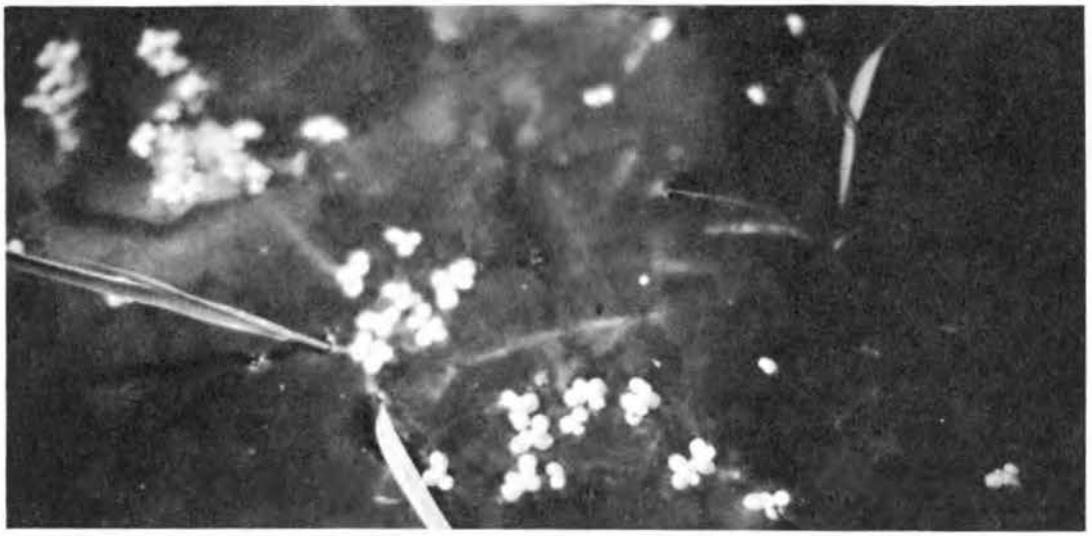
(Also Potamogeton zosteriformis and Typha spp., not pictured)

. . . Occurring in 50% or more of the lakes:

Anacharis



Najas flexilis



Lemna minor

Eleocharis

Carex comosa

(Also Ceratophyllum, Cyperus and Sparganium, not pictured)

INDIVIDUAL LAKE REPORTS

Since each lake is an entity with its own unique conditions, information on the species composition, relative abundance, and percentage of the total population is included for the aquatic vegetation in each lake (Table 3 and 4).

Physical data on the lakes such as acreage, maximum depth, and secchi disc readings are presented in Table 1.

Individual lake reports include descriptions of the distribution of the dominant species and some rarely occurring species within the lake. Also included are factors which may influence or inhibit vegetation and any unusual circumstances that were observed. The lake reports are arranged alphabetically.

Auburn Lake (Fond du Lac County) August 2, 1968

This tea-colored-water lake is connected directly to the Milwaukee River. Originally there were two lakes, Auburn Lake and Lake Fifteen. A wide canal now connects both kettle lakes. Much of the bottom is organic muck. The presence of marl beneath the muck suggests that

TABLE 3

Presence and Relative Abundance of Aquatic Plants in Milwaukee River Watershed Lakes

Lake & Survey Date	Acorus Calamus	Anacharis canadensis	Asclepias incarnata	Brasenia Schreberi	Caltha palustris	Carex comosa	Ceratophyllum demersum	Chara	Cyperaceae	Cyperus spp.	Decodon verticillatus	Eleocharis spp.	Equisetum spp.	Eupatorium purpureum	Heteranthera dubia	Iris spp.	Juncus spp.	Lemna minor	Lemna trisculca	Lemna spp.	Lythrum alatum	Myriophyllum exalbescens	Myriophyllum spp.	Najas flexilis	Najas marina	Nasturtium officinale	Nyphar spp.	Nymphaea tuberosa	Nymphaea spp.	Phragmites spp.	Polygonum natans
Auburn 8/2	-	-	-	-	-	-	1	1	3	1	1	1	-	-	1	1	-	-	-	-	-	-	1	3	-	-	3	1	-	-	-
Barton Pond 8/15	-	2	1	-	-	-	3	-	-	-	-	-	-	-	2	-	-	4	3	-	-	-	-	-	-	-	-	1	-	-	-
Big Cedar 8/12	-	-	-	-	-	1	1	4	-	-	1	1	-	1	1	-	-	-	-	1	-	2	-	1	-	-	2	2	-	-	-
Crooked 7/5	-	3	-	-	-	2	4	2	2	-	1	-	-	-	-	-	-	1	-	-	-	4	-	1	-	-	3	3	-	-	-
Ellen 7/11	-	2	-	-	1	-	2	2	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	1	1	-	-	-
Ellen 8/27	-	1	-	-	0	-	2	2	-	-	0	-	-	-	-	-	-	-	-	0	-	1	-	2	-	-	1	1	-	-	-
Erler 6/17	-	4	-	-	1	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	2	-	-	-
Forest 7/3	-	1	-	-	1	-	3	-	1	-	1	-	-	-	1	-	-	-	-	-	-	3	-	-	-	-	1	1	-	-	1
Gilbert 8/12	-	-	-	-	1	1	2	-	-	2	1	1	-	1	-	-	1	-	-	-	-	1	-	1	-	-	3	4	-	-	-
Green 7/16	-	-	1	-	-	0	3	-	-	0	1	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	2	2	-	-	-
Green 9/4	-	-	0	-	-	1	3	-	-	2	2	-	-	-	-	-	1	-	-	-	-	-	1	3	-	-	1	2	-	-	-
Kettle Moraine 8/1	-	4	-	2	-	4	4	2	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1	1	-	-	1	3	-	-	-
Little Cedar 8/9	-	1	1	-	-	-	2	-	-	-	1	-	-	1	-	-	1	-	-	-	-	2	-	-	-	-	2	1	-	-	-
Long 7/1	-	1	-	-	1	1	4	2	2	1	1	1	-	0	-	-	2	-	-	-	-	3	-	-	0	-	2	2	-	-	-
Long 8/23	-	1	-	-	1	1	4	2	0	1	0	0	-	1	-	-	1	-	-	-	-	3	-	-	1	-	2	2	-	-	-
Lucas 8/6	-	1	1	-	-	1	1	3	-	1	-	1	-	1	-	1	-	-	-	-	-	2	-	4	-	-	2	2	-	-	-
Mauthe 6/20	-	0	-	-	-	1	3	3	4	-	-	3	-	-	0	-	-	-	-	2	-	1	-	2	-	-	2	1	-	-	-
Mauthe 8/20	-	1	-	-	-	1	3	1	0	-	-	1	-	-	1	-	-	-	-	3	-	1	-	2	-	-	2	1	-	-	-
Mud (Fond du Lac) 7/22	-	-	1	-	-	-	3	2	1	2	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	3	3	-	-	-
Mud (Ozaukee) 8/16	-	-	-	2	-	-	-	1	-	2	1	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	1	3	-	-	-
Random 7/9	1	1	-	-	-	1	1	3	2	1	-	2	-	-	-	-	-	1	-	-	-	2	-	-	1	-	2	-	2	-	1
Random 8/27	1	0	-	-	-	0	1	3	0	0	-	0	-	-	-	-	-	0	-	-	-	2	-	-	2	-	1	-	1	-	0
Seven 6/13	-	1	-	-	-	1	4	3	-	-	-	2	-	-	-	-	-	2	-	-	-	2	-	-	-	-	2	1	-	-	-
Seven 8/20	-	0	-	-	-	0	3	4	-	-	-	2	-	-	-	-	-	1	-	-	-	2	-	-	-	-	1	2	-	-	-
Silver 8/8	-	1	1	-	1	1	2	4	-	2	-	1	-	1	1	-	1	1	-	-	-	1	-	1	-	1	1	2	-	-	-
Smith 7/25	-	-	1	-	-	1	-	3	2	4	-	2	-	-	-	-	-	1	-	-	-	-	1	3	-	-	1	4	-	-	-
Spring 7/29	-	1	1	-	-	-	-	2	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	2	1	-	-	-
Twelve 7/19	-	-	1	-	-	-	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-
Wallace 6/28	-	1	-	-	-	1	-	4	-	2	-	2	-	-	-	-	-	-	-	1	-	3	-	-	-	-	2	2	-	1	1
West Bend Pond 7/30	-	4	1	-	-	-	4	-	-	1	-	-	-	-	2	-	-	4	-	-	1	-	-	-	-	-	1	-	-	-	-

TABLE 3 (Contd.)

Presence and Relative Abundance of Aquatic Plants in Milwaukee River Watershed Lakes

Lake & Survey Date	Pontederia cordata	Potamogeton amplifolius	Potamogeton crispus	Potamogeton Friesii	Potamogeton gramineus	Potamogeton natans	Potamogeton nodosus	Potamogeton pectinatus	Potamogeton Richardsonii	Potamogeton Robbinsii	Potamogeton strictifolius	Potamogeton zosteriformis	Ranunculas longirostris	Ruppia maritima	Sagittaria latifolia	Scirpus americanus	Scirpus atrovirens	Scirpus subterminalis	Scirpus validus	Scirpus spp.	Sparganium eurycarpum	Sparganium spp.	Sium suave	Typha spp.	Utricularia geminiscapa	Utricularia vulgaris	Utricularia spp.	Vallisneria americana	Veronica spp.	Wolffia columbiana	Zizania aquatica
Auburn 8/2	-	1	-	-	-	1	2	1	-	-	-	1	-	-	1	-	1	1	2	-	-	-	-	2	-	-	-	-	-	-	-
Barton Pond 8/15	-	-	-	1	-	1	1	2	-	-	-	1	1	-	1	-	1	-	1	-	4	-	-	3	-	-	-	1	-	-	-
Big Cedar 8/12	-	1	1	1	1	1	-	4	2	-	2	1	1	-	1	-	-	-	1	1	1	-	-	1	-	1	-	-	-	-	-
Crooked 7/5	-	1	-	3	1	1	-	1	-	-	-	3	-	-	1	-	-	2	2	-	-	-	-	1	-	-	1	-	-	-	-
Ellen 7/11	-	-	-	-	-	-	1	1	2	-	-	-	-	-	1	-	-	-	3	-	1	-	-	2	-	-	1	-	-	-	-
Ellen 8/27	-	-	-	-	-	-	1	2	1	-	-	-	-	-	1	-	-	-	3	-	1	-	-	2	-	-	0	-	-	-	-
Erler 6/17	-	1	-	1	-	1	1	3	-	-	-	1	3	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-
Forest 7/3	-	2	-	2	1	1	1	2	-	-	-	1	-	-	-	1	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
Gilbert 8/12	-	2	-	-	-	1	-	2	1	-	-	1	-	-	1	-	-	-	4	4	-	-	-	4	-	1	-	1	-	-	-
Green 7/16	0	1	-	1	1	1	1	2	-	-	-	1	-	-	1	-	-	-	2	-	1	-	-	1	-	-	-	1	-	-	0
Green 9/4	2	1	-	0	2	2	1	1	-	-	-	1	-	-	0	-	-	-	2	-	1	-	-	1	-	-	-	3	-	-	1
Kettle Moraine 8/1	2	2	-	1	1	2	2	2	1	-	3	2	-	-	-	-	-	-	2	-	1	-	-	2	-	-	-	2	-	-	-
Little Cedar 8/9	-	3	-	1	-	1	-	3	-	-	-	1	-	-	1	-	-	-	1	-	-	1	-	2	-	-	-	1	-	-	-
Long 7/1	1	2	-	2	-	1	1	1	1	1	-	2	2	-	1	-	-	1	1	-	1	-	-	2	-	-	2	1	-	2	-
Long 8/23	0	2	-	0	-	1	1	1	2	0	-	0	1	-	1	-	-	0	2	-	1	-	-	2	-	-	1	1	-	1	-
Lucas 8/6	-	-	-	-	-	-	1	-	2	-	-	2	2	2	-	1	-	1	-	2	-	-	-	1	-	-	1	-	-	-	-
Mauthe 6/20	-	2	-	0	-	-	-	2	-	-	-	-	1	-	1	1	-	-	1	-	-	1	1	1	1	-	-	1	-	-	-
Mauthe 8/20	-	2	-	1	-	-	-	1	-	-	-	-	1	-	1	0	-	-	0	-	-	1	1	1	0	-	-	1	-	-	-
Mud (Fond du Lac) 7/22	-	2	-	3	1	1	1	2	-	-	-	2	-	-	1	-	-	-	1	-	-	-	-	4	-	-	2	-	-	-	-
Mud (Ozaukee) 8/16	3	1	-	-	1	2	-	-	-	1	-	-	-	-	1	-	-	3	3	-	-	1	-	4	-	-	1	1	1	-	2
Random 7/9	-	1	-	1	1	1	1	3	-	-	-	1	-	-	1	1	-	-	3	-	-	-	-	2	-	-	1	-	1	-	-
Random 8/27	-	1	-	0	0	1	0	1	-	-	-	1	-	-	1	0	-	-	3	-	-	-	-	2	-	-	0	-	0	-	-
Seven 6/13	1	1	-	4	-	-	-	1	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	4	-	-	-	-	-	0	-
Seven 8/20	2	1	-	0	-	-	-	1	-	-	-	1	0	-	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	3	-
Silver 8/8	-	2	-	-	1	2	1	2	-	-	-	1	-	-	1	1	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
Smith 7/25	-	1	-	1	1	2	2	1	-	-	-	1	-	-	1	-	-	-	3	2	1	-	-	2	-	-	1	-	-	-	-
Spring 7/29	-	1	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	3	-	-	-	-	-	-	-
Twelve 7/19	-	-	-	-	-	1	1	1	1	-	-	-	-	-	1	-	-	-	4	-	1	-	-	3	-	-	1	-	-	-	-
Wallace 6/28	1	2	2	1	1	1	1	2	-	-	-	1	3	-	1	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-
West Bend Pond 7/30	-	-	1	-	-	-	1	1	-	-	-	-	1	-	1	-	-	-	1	-	2	-	-	1	-	-	-	-	-	-	-

TABLE 4

Percent of Total Population of Various Aquatic Plants in Milwaukee River Watershed Lakes

Lake & Survey Date	Acorus Calamus	Anacharis canadensis	Asclepias incarnata	Brasenia Schreberi	Caltha palustris	Carex comosa	Ceratophyllum demersum	Chara	Cyperaceae	Cyperus spp.	Decodon verticillatus	Eleocharis spp.	Equisetum spp.	Eupatorium purpureum	Heteranthera dubia	Iris spp.	Juncus spp.	Lemna minor	Lemna trisculca	Lemna spp.	Lythrum alatum	Myriophyllum exalbescens	Myriophyllum spp.	Najas flexilis	Najas marina	Nasturtium officinale	Nyphar spp.	Nymphaea tuberosa	Nymphaea spp.	Phragmites spp.	Polygonum natans
Auburn 8/2	-	-	-	-	-	-	1	1	14	1	1	3	-	1	1	T	-	-	-	-	-	-	1	8	-	-	28	1	-	-	-
Barton Pond 8/15	-	5	1	-	-	-	11	-	-	-	-	-	-	-	3	-	-	31	9	-	-	-	-	-	-	-	-	1	-	-	-
Big Cedar 8/12	-	-	-	-	-	T	T	24	-	-	2	1	-	T	T	-	-	-	-	1	-	8	-	T	-	-	4	5	-	-	-
Crooked 7/5	-	6	-	-	-	-	3	15	6	1	-	1	-	-	-	-	-	T	-	-	-	13	-	T	-	-	9	2	-	-	-
Ellen 7/11	-	8	-	-	-	-	-	20	6	-	-	3	-	-	-	-	-	-	-	1	-	4	-	3	-	-	9	2	-	-	-
Ellen 8/27	-	T	-	-	-	T	-	13	9	-	-	-	-	-	-	-	-	-	-	-	-	1	-	12	-	-	8	4	-	-	-
Erler 6/17	-	23	-	-	-	T	2	6	4	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	6	7	-	-	-
Forest 7/3	-	T	-	-	-	T	-	12	-	T	-	3	T	-	-	T	-	-	-	-	-	22	-	-	-	-	T	7	-	-	3
Gilbert 8/12	-	-	-	-	-	1	3	2	-	-	5	2	-	-	4	-	-	2	-	-	-	3	-	2	-	-	15	20	-	-	-
Green 7/16	-	-	1	-	-	-	-	29	-	-	-	3	-	-	-	-	-	2	-	-	-	-	7	7	-	-	4	5	-	-	-
Green 9/4	-	-	-	-	-	-	2	18	-	-	4	5	-	-	-	-	-	2	-	-	-	-	8	13	-	-	3	7	-	-	-
Kettle Moraine 8/1	-	11	-	4	-	-	8	21	1	-	4	-	-	-	1	-	-	-	-	-	-	-	2	2	-	-	2	5	-	-	-
Little Cedar 8/9	-	T	2	-	-	-	-	11	-	-	-	1	-	-	2	-	-	1	-	-	-	6	-	-	-	-	15	7	-	-	-
Long 7/1	-	2	-	-	-	T	3	36	4	1	T	T	T	-	-	-	-	1	-	-	-	11	-	-	-	-	3	3	-	-	-
Long 8/23	-	1	-	-	-	T	5	23	8	-	3	-	-	-	2	-	-	1	-	-	-	14	-	-	T	-	5	6	-	-	-
Lucas 8/6	-	3	2	-	-	2	1	-	16	-	1	1	-	T	-	2	-	-	-	-	-	5	-	18	-	-	4	8	-	-	-
Mauthe 6/20	-	-	-	-	-	1	11	4	14	-	-	9	-	-	5	-	-	-	-	8	-	3	-	2	-	-	10	5	-	-	-
Mauthe 8/20	-	3	-	-	-	1	13	4	-	-	-	2	-	-	-	-	-	-	-	10	-	6	-	13	-	-	11	2	-	-	-
Mud (Fond du Lac) 7/22	-	-	2	-	-	-	7	9	T	2	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-	-	13	10	-	-	-
Mud (Ozaukee) 8/16	3	-	-	-	-	-	-	1	-	2	T	-	-	-	1	-	-	-	-	-	-	-	1	2	-	-	1	12	-	-	-
Random 7/9	2	1	-	-	-	T	T	34	2	T	-	1	-	-	-	-	-	-	-	1	-	6	-	-	1	-	6	-	6	-	1
Random 8/27	1	T	-	-	-	-	17	24	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	9	-	7	-	12	-	0
Seven 6/13	-	3	-	-	-	1	17	13	-	-	-	6	-	-	-	-	-	4	-	-	-	8	-	-	-	-	7	5	-	-	3
Seven 8/20	-	-	-	-	-	-	22	20	-	-	-	8	-	-	-	-	-	2	-	-	-	9	-	-	-	-	4	12	-	-	3
Silver 8/8	-	2	T	-	T	T	4	37	-	6	-	1	-	3	1	-	T	3	-	-	-	3	-	2	-	2	T	6	-	-	-
Smith 7/25	-	-	1	-	-	T	-	14	1	12	-	1	-	-	-	-	-	T	-	-	-	-	3	12	-	-	5	10	-	-	-
Spring 7/29	-	1	1	-	-	-	-	31	5	T	-	4	-	-	-	-	-	-	-	-	-	-	-	1	T	-	8	2	-	-	-
Twelve 7/19	-	-	T	-	-	-	-	10	-	19	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	8	4	-	-	-
Wallace 6/28	-	-	T	-	-	T	-	25	-	1	-	3	-	-	-	-	-	-	-	4	-	5	-	-	-	-	4	6	-	T	T
West Bend Pond 7/30	-	-	31	-	-	-	27	-	-	1	-	-	-	-	6	1	-	24	-	1	1	-	-	-	-	-	-	1	-	-	-

TABLE 4 (Contd.)

Percent of Total Population of Various Aquatic Plants in Milwaukee River Watershed Lakes

Lake & Survey Date	Pontederia cordata	Potamogeton amplifolius	Potamogeton crispus	Potamogeton Friesii	Potamogeton gramineus	Potamogeton natans	Potamogeton nodosus	Potamogeton pectinatus	Potamogeton Richardsonii	Potamogeton Robbinsii	Potamogeton strictifolius	Potamogeton zosteriformis	Ranunculas longirostris	Ruppia maritima	Sagittaria latifolia	Scirpus americanus	Scirpus atrovirens	Scirpus subterminalis	Scirpus validus	Scirpus spp.	Sparganium eurycarpum	Sparganium spp.	Sium suave	Typha spp.	Utricularia geminiscapa	Utricularia vulgaris	Utricularia spp.	Vallisneria americana	Veronica spp.	Wolffia columbiana	Zizania aquatica
Auburn 8/2	-	3	-	-	-	6	6	4	-	-	-	2	-	-	1	-	T	4	10	-	-	-	-	3	-	-	-	-	-	-	-
Barton Pond 8/15	-	-	-	T	-	1	3	5	-	-	-	1	T	-	1	-	T	-	1	-	14	-	-	8	-	-	-	1	-	3	T
Big Cedar 8/12	1	2	1	1	T	1	-	26	7	-	4	2	1	-	T	-	-	-	2	2	1	-	-	2	-	T	-	T	-	-	-
Crooked 7/5	-	6	-	5	2	3	-	3	-	-	-	7	-	-	T	-	-	2	6	-	-	-	-	T	-	-	2	-	-	-	-
Ellen 7/11	-	-	-	-	-	1	6	5	-	-	-	-	-	2	-	-	21	-	-	-	6	-	-	5	-	-	1	-	-	-	-
Ellen 8/27	-	-	-	-	-	T	11	6	-	-	-	-	-	1	-	-	22	-	-	-	1	-	-	9	-	-	-	-	-	-	-
Erler 6/17	-	10	-	6	-	1	1	11	-	-	-	5	12	-	-	-	-	-	T	-	-	-	-	1	-	-	-	-	-	-	-
Forest 7/3	-	14	-	15	2	2	4	12	-	-	-	3	-	-	-	2	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
Gilbert 8/12	-	5	-	-	-	5	-	4	1	-	-	1	-	-	1	-	-	-	11	9	-	-	-	9	-	2	-	1	-	-	-
Green 7/16	-	5	-	1	1	5	1	8	-	-	-	3	-	-	4	-	-	-	5	-	2	-	-	3	-	-	-	4	-	-	-
Green 9/4	3	T	-	-	6	6	1	3	-	-	-	T	-	-	-	-	-	-	5	-	T	-	-	2	-	-	-	10	-	-	1
Kettle Moraine 8/1	2	9	-	1	T	3	2	4	1	-	5	3	-	-	-	T	-	-	2	-	2	-	-	2	-	-	-	4	-	-	-
Little Cedar 8/9	-	17	-	-	T	5	-	12	-	T	-	9	-	-	T	-	-	-	3	-	-	T	-	10	-	-	-	T	-	-	-
Long 7/1	T	7	-	3	-	2	T	2	2	T	-	3	4	-	T	-	T	T	3	-	1	-	-	2	-	-	1	1	-	2	-
Long 8/23	-	9	-	-	-	1	1	1	5	-	-	3	2	-	1	-	0	-	3	-	2	-	-	3	-	-	1	T	-	1	-
Lucas 8/6	-	-	-	-	-	5	-	11	-	-	4	7	4	-	2	-	1	1	-	-	3	-	-	1	-	-	T	-	-	-	-
Mauthe 6/20	-	8	-	-	-	-	-	16	-	-	-	4	-	-	1	T	-	-	1	-	-	1	1	1	T	-	-	1	-	-	-
Mauthe 8/20	-	11	-	3	-	-	-	2	-	-	-	4	-	-	5	-	-	-	-	-	-	1	2	1	-	-	-	1	-	-	-
Mud (Fond du Lac) 7/22	-	8	-	13	-	1	2	3	-	-	-	8	-	-	T	-	-	-	2	-	-	-	-	11	-	-	6	-	-	-	-
Mud (Ozaukee) 8/16	8	1	-	-	1	2	2	-	-	T	-	-	-	-	3	-	-	15	15	-	-	3	-	19	-	-	4	1	T	-	4
Random 7/9	-	2	-	1	T	2	T	20	-	-	-	T	-	-	1	T	T	-	10	-	-	-	-	4	-	-	1	1	-	-	-
Random 8/27	-	T	-	-	-	3	-	10	-	-	-	4	-	-	1	-	-	-	13	-	-	-	-	7	-	-	-	-	-	-	-
Seven 6/13	-	1	-	15	-	-	-	3	-	-	-	3	T	-	-	-	-	-	T	-	-	-	-	11	-	-	-	-	-	-	-
Seven 8/20	-	T	-	-	-	-	-	2	-	-	-	T	-	-	-	-	-	-	T	-	-	-	-	9	-	-	-	-	-	-	-
Silver 8/8	-	7	-	-	1	5	1	3	-	-	-	2	-	-	2	2	-	-	6	-	-	-	-	1	-	-	-	-	-	-	-
Smith 7/25	-	1	-	1	1	8	5	4	-	-	-	1	-	-	1	-	-	-	14	1	T	-	-	2	-	-	1	-	-	-	-
Spring 7/29	-	1	-	-	1	T	2	T	-	-	-	-	-	-	-	-	-	-	32	2	-	-	-	9	-	-	-	-	-	-	-
Twelve 7/19	-	-	-	-	2	1	5	5	-	-	-	-	-	-	T	-	-	-	28	-	1	-	-	14	-	-	1	-	-	-	-
Wallace 6/28	T	8	4	3	3	-	4	16	-	-	-	T	2	-	1	-	-	-	5	-	-	-	T	-	-	-	-	-	-	-	-
West Bend Pond 7/30	-	-	T	-	-	-	1	T	-	-	-	-	2	-	2	-	-	-	T	-	4	-	-	T	-	-	-	-	-	-	-

these lakes may have once been marl lakes. Potamogeton nodosus and Scirpus validus make up a large portion of the total aquatic plant population here. These aquatics are normally found in large concentrations and abundance in marl lakes. Much of the drainage area for this lake is forested, but there is also an abundance of marsh land and pasture land.

Submergent vegetation in the lake is sparse. Scattered plants of Najas flexilis, Potamogeton natans, P. pectinatus, and P. amplifolius make up most of the population. These are scattered around the perimeter of the lake and to a depth of 10 feet. Scirpus subterminalis, the submergent that is usually found in bog lakes, occurs scattered throughout the south portion of the lake in moderate abundance. However, the largest concentration of submergents occurs at the mouth of an inlet stream on the northeast shore of the lake. Here Ceratophyllum demersum is in moderate to heavy abundance. Heteranthera dubia is also present in scattered clumps. Water lilies of the genus Nuphar are also present in this area, and are the most abundant of the floating aquatics. Several continuous large beds fringe the lake at distances of 10 to 20 feet from shore where the depth is 3 to 5 feet. Several small Nymphaea tuberosa beds occur on the west side of the lake but these are very sparse and are located almost on shore.

On the north and south ends of the lake are large concentrations of emergents. Scirpus validus is the dominant and can be found in very broad thick stands. Typha are present in one heavy concentration on the southwest shore. Species of the family Cyperaceae are also in moderate to heavy abundance.

There are many cottages on this lake so there is considerable use made of it. Water-skiing and fishing are the most popular activities.

Barton Pond (Washington County) August 15, 1968

This is a shallow impoundment of the Milwaukee River on the northwest side of the city of West Bend. At this point the river first enters the city. The backwaters form a shallow lake north of the main channel of the river. The shore is wooded on the northeast and forms marsh areas along the north. Typha lines the shore in thick heavy stands. In contrast to West Bend Pond, the shoreline is free of litter.

Submergent vegetation is scarce due to the tremendous area covered by Lemna. Ceratophyllum demersum is the most common, occurring in moderately scattered clumps. Heteranthera dubia and Potamogeton pectinatus occur in scattered growths in all areas of the lake. Heteranthera appears to be very common in bodies of brown water and extremely abundant in the Milwaukee River system.

Sparganium eurycarpum is very common. It forms a barrier along the north side of the main river channel. It also forms many small island clumps in the shallow flooded area.

The most dominant and obvious aquatic is Lemna minor. It covers almost 75 percent of the pond, and is the factor limiting an abundant growth of submergent aquatics. Nymphaea tuberosa occurs only in a few isolated beds.

Although the pond is relatively clean the surrounding area is not developed for recreational use. Development could produce an attractive area.

In contrast to West Bend Pond, the wildlife in Barton Pond is very abundant. Many ducks, herons, red-winged blackbirds were observed. The area also supports a considerable insect population.

Big Cedar Lake (Washington County) August 12-13, 1968

Big Cedar is both the largest and deepest lake surveyed. It forms the headwaters of Cedar Creek, Milwaukee River's major tributary. The portion of the lake north of Lindem Point is shallow. The average depth is 12 feet with most of the area under 6 feet. The greatest concentrations of submerged aquatics occur in this area of the lake. also, in this area are concentrated the greatest amount of floating and emergent aquatics. South of Lindem Point, the eastern shoreline slopes very rapidly to the lake's maximum depth while the western shoreline and southernmost tip have a more gradual slope. Most of the bottom in the littoral zone is gravel and marl while the northern one-third is muck.

Gilbert Lake, a small hard-water lake which was once a part of Big Cedar, is located off the northwest corner of the lake. There is a small connecting channel between the two lakes but they are considered separate. Since the two were once connected and they occupy the same basin, the entire complex will be treated as one. Some comments will be made about the distribution of the major aquatics in Gilbert Lake near the end of this discussion.

As expected, most of the vegetation is concentrated in the northern half of Big Cedar Lake. To sample this area effectively several transects were run across the lake at approximately 100-yard intervals. The submergent aquatics occur at all depths except toward the center of the area where greater water depths limit light penetration. Potamogeton pectinatus is everywhere. It occurs in great continuous stands of extremely heavy abundance. Nearer shore, Chara is in moderate to heavy abundance. It also can be found at a depth of 12 feet. Potamogeton pectinatus and Chara make up almost 50 percent of the total population in the lake. Another 15 percent is made up of Potamogeton Richardsonii

and Myriophyllum exalbescens which are scattered between the P. pectinatus and Chara. Both dominants are also in moderate abundance along the western shore of the southern half of the lake. The eastern shore is almost devoid of aquatics. Sparse growths of Chara can be found in very stunted conditions between the rocks. A protected bay north of Echo Point is the only area along the east shore south of Lindem Point to have a moderate to heavy concentration of submergents. Here again P. pectinatus and Chara are the dominants.

Floating and emergent aquatics are sparse on Big Cedar Lake. Ninety-nine percent are concentrated on the northernmost tip and around, in, and through Gilbert Lake. Species of the genus Scirpus and Typha are the most common. Sparganum eurycarpum occurs on the southern end of Big Cedar Lake just west of Lake View Point. An occasional arrowhead plant, Sagittaria latifolia, can be found along the shoreline. Nymphaea tuberosa and Nuphar are almost absent in Big Cedar Lake. Those that are present are in the northernmost area where the bottom is an organic muck. About 90 percent of all the water lilies are in Gilbert Lake.

Big Cedar Lake has a tremendous weed problem. Between 1950-1961 applications of sodium arsenite were applied to control rooted aquatics and copper sulfate to control algae. This past season cutting operations were in progress. This is as effective as mowing one's lawn. The disadvantages to this method are: it is too slow to be effective on a large lake unless many cutters are in operation simultaneously, and it is very effective in the dispersion of plant seeds and plant parts. Plant parts of many submergents have the capacity to undergo vegetative reproduction. Myriophyllum is one example.

Both seasonal cottages and year-around homes line both shores. This lake is probably the most heavily used in Washington County. Motorboating, water-skiing, fishing, and swimming are very common.

The submergent aquatic distribution in Gilbert Lake is along the shore and intermixed between the water lilies. The abundance is scattered. A large concentration of Ceratophyllum demersum occurs at the mouth of a small stream on the north end. Potamogeton amplifolius and P. pectinatus, the dominants, are scattered along the shores of the northern part of the lake. There tends to be a large concentration on the west shore just before the large bed of water lilies begins. The east shore is composed of tamarack and dogwood trees. However, in the water are large heavy stands of Scirpus validus, another species of Scirpus and Typha. The emergents along the west shore in the northern area are more scattered, and become more abundant as one moves south. The northern one-third of the lake contains the only areas of open water. The rest of the lake is completely choked with Nymphaea tuberosa and some scattered bed of Nuphar.

Crooked Lake (Sheboygan County) July 5, 1968

Of all the lakes surveyed, this lake has by far the greatest concentration of aquatics. Diversity of the aquatics is not great but those plants that are present range from moderate to heavy abundance. The gradual slope of the lake basin creating extensive shallow water areas, the clarity of the water (secchi disc visible to 8 feet), and the apparent high fertility of the water and sediments causes this luxuriant plant growth. Chara and Myriophyllum exalbescens dominate the vegetation. Chara forms a mat that completely fringes the lake. This mat is broken occasionally by thick, scattered stands of Nuphar and Nymphaea tuberosa. Myriophyllum is mostly free floating. The greatest concentration is in the bay on the southwest side of the lake.

In the northwest part of the lake the depth is very shallow, less than 5 feet deep. This area forms an enclosed bay with a bottom composed of suspended organic muck. Anacharis canadensis and Scirpus subterminalis are the dominants. Heavy thick growths of Nuphar and Nymphaea almost obliterate the shoreline which is made up of a narrow band of sedges mixed with dogwood and tamarack. The entrance to this are is impassable by motorboat because it is completely choked with floating Myriophyllum exalbescens, Chara, and various clumps of Potamogeton. Much of the area is cemented together by a lush growth of filamentous algae.

Emergents are not very common in this lake. The greatest concentration occurs along the east shore where there is a thick growth of Scirpus validus extending from shore to about 100 feet into the lake. The water lilies, Nymphaea and Nuphar, are found in scattered beds all around the lake with the greatest concentration occurring at the mouth of the outlet stream on the southeast side of the lake. Here Nymphaea tuberosa completely closes the entrance to the stream.

Recreational pressures are extremely heavy on this lake. On the day of the survey there were 5 high-powered motor boats being operated. Only about half of the lake contains water open enough for motorboating, yet the amount of motorboating far exceeds suggested limits for this lake.

Ellen Lake (Sheboygan County) July 11, 1968

This marl bottom lake supports a very sparse plant population. Chara, the most abundant, occurs in moderate to heavy concentrations along the north shore and in scattered clumps along the west shore. Only a sparse population can be observed inbetween the rocks on the south shore. Potamogeton pectinatus and P. nodosus can be found in water 3 to 4 feet deep where they occur in sparse to scattered concentrations. In an area of a slow seeping spring on the north side some widgeon grass, Ruppia maritima, occurs. The water is not as cold as would be expected and no water cress was found. For the most part the lake bottom is devoid of submergents.

Scirpus validus, the most obvious aquatic, can be found all along the shores of the lake. Its greatest concentration is along the south and west shores. Here it occurs in heavy stands with individual plants growing 200 to 300 feet out into the water. Typha occurs in scattered clumps behind the S. validus where the sediments become more organic. In the northeast corner a large stand of Sparganium eurycarpum occurs.

Nuphar is most common along the north shore where it occurs in moderate beds a short distance off shore. A small bed of Nymphaea tuberosa is located at the mouth of an outlet stream on the west side of the lake. This water lily is not very abundant in this lake.

The lake is spring fed and the water is clear except for some turbidity believed to be created by the large carp population. Recreational use of the lake is heavy on weekends. There are three resorts and several cottages along the east and south side, and one resort on the north side.

Resurvey August 27, 1969

The greatest change is the tremendous increase of Najas flexilis -- from 3 percent of the population measured on July 11, to 12 percent of the population measured on August 27, 1968. The greatest concentration is in the west end of the lake where this plant is found in heavy scattered clumps. Chara communities are beginning to die off. Most of the growths are straw-colored and very brittle. Chara has changed from 19 percent to 12 percent of the total population. Potamogeton nodosus has also increased. The Nymphaea and Nuphar beds are beginning to die off as are several of the Potamogeton spp. The distribution pattern remained the same as on July 11.

Erler Lake (Washington County) June 17, 1968

This is a small natural kettle lake formed by glacial action. It has an almost circular shoreline. The lake is spring fed. Overflow from the lake supplies a small stream on the north side which connects the lake to Wallace Creek.

On the north and west shores of the lake there are three cottages and two farms. The south shore is wooded and slopes steeply into the water. Small areas on both the east shore and the southwest shore could be considered marshy. Here the dominant emergent is found, a species of the sedge Family Cyperaceae. The balance of the shoreline is dry and contains a terrestrial flora.

Seventeen plant types were identified; of these 78 percent are submerged. Between the depths of 1 to 4 feet a mixture of plants make up a mat covering the bottom. The most abundant is Anacharis canadensis. Ranunculus longirostris and Potamogeton pectinatus also occur here. The lily pads, Nymphaea tuberosa and Nuphar occur only in scattered clumps. Their stems reach a depth of 8 feet. At the depths between 4 and 8 feet, Potamogeton amplifolius is dominant. This plant also occurs in the shallower water in scattered clumps.

The emergent plants are limited to scattered growth of sedges on the east and southwest shores and a few sparse clumps of Typha, Carex, and Scirpus.

Forest Lake (Fond du Lac County) July 3, 1968

Forest Lake is a small spring-fed kettle lake that is completely rimmed by high glacial moraine. This lake has no visible inlet or outlet. Water from the lake enters the Milwaukee River system via seepage into a low-lying area to the east.

Due to recent dredging operations, the plant communities occur in haphazard distribution patterns. The greatest concentration of aquatic plants is in the southern third of the lake. Here the water is less than 10 feet deep. Potamogeton dominates this area with P. Friesii, P. pectinatus, and P. zosteriformis ranging from scattered to heavy abundance. Interspersed among these dominants are Chara, Myriophyllum exalbescens and Polygonum natans. Emergents are also very abundant along the southern shore, Typha and Scirpus validus being the most common.

Most of the dredging operation took place in the northern part of the lake. However, Potamogeton amplifolius, Myriophyllum and Chara can be found in this area in moderate abundance. Potamogeton amplifolius is most common in water 6 to 8 feet deep, while Myriophyllum occurs in large clumps as deep as 10 feet. Chara is common in thick growths along the shore. The clarity of the water suggests good light conditions for higher aquatic growth in deep water. The limit of the aquatics is at the 12-foot depth. The secchi disc was visible to 10 feet.

Emergents are scarce throughout most of the lake. The most common emergent is the sofstem bulrush, Scirpus validus. An occasional iris plant was observed, adding to the beauty of this lake.

Because the lake shoreline is about 90 percent developed, it receives heavy recreational pressure. Both motorboating and water-skiing are allowed. The lake lies wholly within the Kettle Moraine State Forest. The area around the lake is totally or partially wooded lending to the aesthetic quality of the lake.

Green Lake (Washington County) July 16, 1968

Green Lake is a small lake believed to be a remnant of a large glacial lake. It could be considered landlocked except that it does have an intermittent outlet stream draining from the southwest corner. The lake is springfed and has extensive areas of marl and gravel. The bottoms of the northeast and southwest areas are muck.

The vegetation tends to be cocentrated in these mucky areas. Here Chara is in moderate abundance carpeting the bottom to the depth of 11 feet. Najas flexilis can also be found at this depth but in sparse abundance. The pondweeds occur here in scattered abundance. Potamogeton pectinatus, P. amplifolius, and P. natans are the dominants. Submergent aquatics throughout the rest of the lake are sparse. Chara is common, growing in and around rocks. Najas flexilis occurs sparsely in the deeper waters.

Scirpus validus is the dominant emergent. It also is concentrated in heavy stands in the more fertile areas of the lake, along the west shore and the east shore. Typha and some sedges can be found behind the bulrushes. Emergents do occur in various areas in scattered clumps. Usually these clumps are several yards off shore. Several widely scattered, dense beds of Pontederia cordata occur along the north shore.

Near and within the mouth of the stream in the southwest corner grows one large bed of Nymphaea tuberosa. These plants completely choke this area. The same situation occurs along the east shore. Beds of Nuphar are small and scattered around the perimeter of the lake.

The shoreline is not highly developed, although the lake is heavily used for fishing, motorboating, and water-skiing. Campers are accommodated by two campgrounds found on the lake.

Resurvey September 4, 1968

The major change is in the increase of Najas flexilis. It can now be found occurring in scattered stands along most shorelines in water 1 to 3 feet deep, and in sparse abundance at the depth of 9 feet. There has been a decrease in the Potamogeton community. Potamogeton pectinatus occurs only as an occasional scattered plant. P. amplifolius was not observed. However, the variable pondweed, P. gramineus, has increased. It occurs interspersed between the Chara mats. There has been a reduction in the size of the Nymphaea tuberosa beds on the east and west shores. The overall abundance of aquatics has not changed except for a slight decrease in submergents.

Kettle Moraine Lake (Fond du Lac County) August 1, 1968

Over half of this lake is less than 4 feet deep. There is no inlet or outlet, and it receives most of its water through seepage. The water is clear, the secchi disc reading was 10 feet. The bottom is mostly gravel.

Submergent vegetation is abundant and diverse. Three submergent species are in heavy abundance. However, each is in a different area. Anacharis canadensis is mostly concentrated in the northern one-third of the lake. Here it completely covers the bottom with very thick heavy beds. Chara is located in the southwest corner of the lake with thick clumps extending well along the southeast shore. The eastern shore is a heavy carpet of Ceratophyllum demersum. None of these aquatics has any apparent algae growing on or near them.

The pondweeds are well represented in this lake. Nine species were observed. The dominant broad leaf species, P. amplifolius, and the narrow leaf species, P. strictifolius, are in scattered to moderate abundance. P. strictifolius is mostly concentrated along the western shore where it occurs in heavy beds, while P. amplifolius is scattered all over the lake with one heavy concentration located off the northeast shore.

The floating aquatics are also a large part of the total population. Water shield, Brasenia Schreberi, covers vast areas in the northern half of the lake. However, its greatest concentration is in a bay along the the southeast shore. Nymphaea tuberosa is in moderate abundance along the edge of the east and north shores. Nuphar is found only in a few isolated areas.

Much of the shoreline is either developed or lined with shrub swamps. Dogwood is the common shrub. Aquatic emergents are not common. However, along the east shore Pontederia cordata can be found in several scattered thick beds. Decodon verticillatus lines parts of the east and north shore. Typha and Scirpus are scattered in isolated moderate-sized clumps all around the lake.

The lake receives much recreational activity. Motorboating is common, but with the shallowness of the lake and the extremely heavy vegetation, it is not practical. The only deep water is a small area in the south central part of the lake.

Little Cedar Lake (Washington County) August 9, 1968

This lake occupies a trough between two ridges of the terminal moraine. There are two basins to this lake, a circular one on the north and an elongated one on the south. Both are deep and slope very rapidly

to great depths. This and turbidity are the factors limiting submergent vegetation in the lake. Stirred up sediments and an abundance of phytoplankton cause a rapid extinction of light. The secchi disc was visible to only 4 feet.

Water comes into the lake from Big Cedar Lake through a dogwood-sedge marsh. It enters the west side of the north basin and eventually flows into Cedar Creek, Milwaukee River's major tributary, which originates at the south end of the lake.

Submergent vegetation is sparse and scattered. In the north basin a few stands of Potamogeton amplifolius, P. pectinatus, and Myriophyllum occur on the east shore. The north shore is developed and contains only an occasional plant. The west shore is marsh. However, there are only a few scattered species of Potamogeton mixed within several beds of Nuphar. The entrance into the north basin contains some scattered plants of Chara and Potamogeton amplifolius. Chara is very sparse throughout most of the lake. It occurs scattered between the rocks along the east and west shores. The west shore is almost devoid of plants due to the rapidly sloping shoreline. The greatest concentration of submerged aquatics occurs in the southern one-third of the main basin. This is a very shallow area, less than 4 feet deep, that contains mostly Potamogeton in moderate abundance. Myriophyllum, Heteranthera dubia, and Chara are sparsely scattered throughout this area. Typha, the dominant emergents, have their greatest concentration in this southern area. They occur in heavy abundance along each shore. Nuphar is the dominant floating aquatic. It occurs in moderate to heavy abundance in the southern end of the lake and also along the west shore of the north basin. Nymphaea beds are scarce.

Unique features in the lake are the two areas set aside for weed preservation areas. These areas, the southern end of the main basin and the west side of the north basin, have the greatest concentration of aquatics. Motorboating and other activities injurious to the vegetation is either limited or prohibited here. Eventually, this may increase the amount of vegetation in the lake.

Recreational use of the lake appears great. Most of the shoreline is developed and holds many private cottages.

Long Lake (Fond du Lac County) July 1-2, 1968

Long Lake is a long narrow lake that forms the headwaters of the east branch of the Milwaukee River. Water is supplied to the lake by springs, local drainage, seepage, and two inlet streams on the north. The Milwaukee River is the outlet stream on the south. Because of its length this lake tends to have many variations. Most of the lake water is clear; however, it begins to darken as one moves northward. Tea-colored water can be found in a small enclosed bay at the northernmost point of the lake.

There is a tremendous diversity of plants; over 30 species were observed. Only two species stand out, Chara and Myriophyllum exalbescens. Chara, the most abundant, forms a continuous carpet around the shoreline. In width, it extends from shore to about 200 yards out. At this point the water is 7 feet deep. The width varies depending on the side of the lake observed. Myriophyllum occurs in large thick heavy clumps in water 7 to 8 feet deep. These scattered clumps look like massive bushes. Myriophyllum also grows in shallower water, but here it forms small beds or occurs as occasional plants. In a few protected areas, Potamogeton amplifolius can be found. Ceratophyllum demersum occurs in a large stand at the mouth of both inlets. The water is very brown in both areas and the sediments are very organic. In protected areas Ranunculus longirostris occurs in heavy floating mats. Utricularia, Scirpus subterminalis, and Myriophyllum are very abundant in the isolated, brown water bay.

The common floating species of Nymphaea and Nuphar, as well as Wolffia columbiana and several species of Lemna cover the water. Wolffia columbiana is extremely abundant on the west shore of the northern isolated bay. The greatest concentration of Nymphaea and Nuphar is along the southeast shore. The water is shallow and the sediments appear highly organic. Most of the lakeshore is composed of glacial till and sand. The greatest concentrations of emergents occur at the ends of the lake. On the south there is a large sedge marsh containing common plants such as Scirpus validus, Typha and a grass-like sedge of the genus Cyperus. On the north end Typha and S. validus are common, interspersed with Sagittaria latifolia. A northern hillside sloping toward the water is covered with Equisetum.

Long Lake State Park covers most of the east shore and a Boy Scout camp is on the north. There is always much activity on the lake.

Resurvey August 23, 1968

The only aquatic showing signs of dying off is Nymphaea. Its leaves are becoming broken and the beds are not as thick. Wolffia and Ranunculus have disappeared. Chara and Myriophyllum exalbescens are still the dominants. There has been relatively little change in the aquatics since the first survey. This is probably due to the size of the lake, since the lake is large and deep changes occur more slowly.

Lucas Lake (Washington County) August 6, 1968

The emergent aquatics along this elongated shallow lake are sparse. Most are concentrated around a bay on the west side of the lake. The mouth of the stream from Silver Lake, which enters this area, is choked with a heavy bed of Nymphaea tuberosa. Nymphaea along with Nuphar

almost completely surround this bay, leaving only a small area of open water in the center. Thick heavy concentrations of Myriophyllum exalbescens, Anacharis canadensis and several Potamogeton spp. fill the center of the bay. Since the lake is relatively shallow, submergent aquatics are found at all depths. Najas flexilis is the most abundant and the dominant plant. In shallower waters, 1 to 2 feet deep, and mostly along the east shore are large beds of Chara. Potamogeton pectinatus, which is very abundant in the lake, is found scattered in various areas. Very long-stemmed forms occur in the deep area at the north end of the lake and a short-stemmed form occurs in the southern shallower portion of the lake.

The southern part of the lake contains the greatest concentration of submergents. At one time this area must have supported a cedar swamp, as evidenced by many stumps and fallen trees.

This is a beautiful glacial lake which lies in a valley between two ridges. The land surrounding it is undeveloped and for the most part forested. Located here is a campground from which the lake receives its only recreational use.

Mauthe Lake (Fond du Lac County) June 20, 1968

This is an almost circular kettle lake formed on the main channel of the east branch of the Milwaukee River. State-owned land completely surrounds the lake. The Mauthe Lake area supports a tremendous amount of summer activity, being one of the most popular camping, picnicking, and swimming areas in southeastern Wisconsin. Since motors are not allowed on the lake, boating use is relatively light.

The water of the lake is a dark tea color. This probably is due to the large amount of tannic materials being brought in by the Milwaukee River. The river system in this area drains much land covered by thick stands of coniferous trees. Rivers flowing through such areas are typically tea-colored. On the day of the survey there was a bloom of blue-green algae (Anabaena) which suggests fertile conditions.

Twenty-one plant types were observed. Distribution of the plants tends to be highly scattered, with heavy concentrations in the areas of the outflow and inflow of the Milwaukee River. The largest concentration of plants occurs at the inflow on the northwest side of the lake. Here large mats of Ceratophyllum demersum are dominant. At the outflow, scattered clumps of Potamogeton occur. In the lake proper the plants are highly scattered. Nuphar are dominant all around the lake. The submerged plants, at about the depth of 4 to 6 feet are Potamogeton pectinatus, P. amplifolius, and P. zosteriformis, in order of abundance.

In the shallower waters, 1 to 2 feet deep, Chara, Najas flexilis, and Myriophyllum exalbescens were observed in scattered abundance. For the most part, the bottom appeared barren. No plants occur below 6 feet. The secchi disc reading was 5.5 feet. Except for the east shore, the shoreline plants are sedges, grasses, dogwood and cedars. Sedges are the most abundant plants on the west shore.

The inflowing Milwaukee River was surveyed for about a quarter mile upstream. This portion of the river supports growths of Vallisneria americanus, Potamogeton pectinatus, and Nymphaea tuberosa . V. americanus was found only in the river. The shoreline of the river is covered by a dense growth of trees and shrubs.

Resurvey August 20, 1968

There was a drastic increase in the submergent varieties both in abundance and in diversity. Most noticeable were Najas flexilis, Potamogeton amplifolius, and Lemna. Potamogeton pectinatus decreased and several other species were not observed. However, the greatest concentration of aquatics is still at the mouth of the Milwaukee River, and the balance of the lake does not contain a large abundance. The secchi disc reading was 9 feet, however, the water's tea color may be a limiting factor in this lake. The plants found in this lake are for the most part broad leaf species. Najas flexilis is normally found in deep water, but in Mauthe Lake it is concentrated between the 2- to 3-foot depth. Most of the aquatics are concentrated in this area.

On this survey Vallisneria americanus did occur on the east side of the lake. It was in flower during this observation. Heteranthera dubia which has been occurring in many of the tea-colored-water lakes also was observed here in several large clumps.

Mud Lake (Fond du Lac County) July 22, 1968

This is a turbid, brown-water lake which occupies a remnant basin in a large glacial lake. Mud Lake forms the headwaters of the Milwaukee River.

The turbidity of the lake is the limiting factor in the distribution of the submerged aquatics. All are concentrated around the shore to a depth of 4 feet. In heavy abundance, sometimes forming mats, are Potamogeton Friesii, P. zosteriformis, and Ceratophyllum demersum. Mixed into this mat are Potamogeton amplifolius and P. pectinatus in scattered abundance. In areas where the sediments appear solid, Chara occurs in moderate abundance.

Nuphar is the most abundant of the water lilies. They fringe the lake in moderate to heavy abundance about 50 to 70 feet off shore. Nymphaea tuberosa occurs in moderate abundance next to and intermixed with the Typha stand.

Typha is the most obvious aquatic in the lake, fringing the lake in a thick heavy stand on the east, south, and west shores. Interspersed among the Typha are an occasional swamp milkweed plant, Asclepias incarnata, and the American bulrush, (Scirpus validus). The broad-leafed form of arrowhead, Sagittaria latifolia, occurs in areas where the shore protruded through the Typha.

Fishing is the only recreational activity on this lake: there are no resorts. The lake contains a diversity of wildlife and is probably a haven for migratory waterfowl.

Mud Lake (Ozaukee County) August 16, 1968

This is a shallow wilderness bog lake. It is completely surrounded by a sphagnum moss mat on which grow tamarack, dogwood, and the other flora associated with a bog community. On the north, south and east shores a thick stand of Typha extends well into the lake. The lake is characterized by many floating islands, some occasionally have terrestrial plants, but most having an aquatic flora growing on them. Most of these islands are concentrated in the eastern half of the lake.

The most obvious aquatics in the lake are the emergents, Typha being the dominant. They grow as high as 10 feet. Scirpus validus is common on the east shore and on the floating islands, but is most common on the west shore. Growing in shallow open water along the south shore are large broad beds of Pontederia cordata. Along the north shore are a few scattered beds of Zizania aquatica.

Nymphaea tuberosa is the dominant floating aquatic. It forms thick beds mostly along the southern shore. Several scattered beds of Brasenia Schreberi can be found along the south shore and near the island in the northwest corner of the lake. Nuphar is very sparse here.

The submergent aquatics can be found almost anywhere in the lake. In the greatest concentration is Scirpus subterminalis which occurs in moderate abundance throughout the lake. In scattered to sparse occurrence are such plants as Potamogeton nodosus, P. gramineus, and P. Robbinsii. Along the west shore Chara, Myriophyllum and Najas can be found. The sediments are fairly solid along this shore while the sediments of the rest of the lake are suspended and soft.

There is no recreational use made of this lake. In the summer, the inpenetrable vegetation isolates the lake. Thus giving it its wilderness quality. Some research on the bog and terrestrial flora is being conducted in this area by the University of Wisconsin-Milwaukee, which owns some of the land in the vicinity of the north side of the lake.

Random Lake (Sheboygan County) July 9, 1968

This lake is an irregular glacial lake which has two basins. Because of this irregular morphometery the lake does not have the typical oval or elongated form. Instead it has a modified oxbow shape. The northwestern basin is the shallower and consequently contains the greatest concentration of vegetation. Most of the lake contains submergents at all depths. The maximum depth at which rooted aquatics are located is 8 feet. There are only two small areas where a greater depth occurs, the center of the northwest area and the southern end of the lake.

Chara is the dominant submergent. It occurs in heavy but scattered mats mostly concentrated in the northern portion of the lake. The eastern shore contains very little Chara. Also in the northern portion, Potamogeton pectinatus is in very large moderate stands. Of all the aquatics present in the lake, Chara and P. pectinatus make up over 50 percent of the total population. Several other species of Potamogeton and Najas are present in very sparse concentration.

Large concentrations of Scirpus validus are located in the northern area. The stands along shore are in moderate to heavy abundance, while in the water the abundance of S. validus ranges from scattered to moderate. Bulrushes occur all over the northern area. Behind them are thick heavy stands of Typha which fringe the northern part of the lake and the peninsula jutting from the west shore. This is the only area where Typha occurs. Along the western shore sweetflag, Acorus Calamus, is common. This sedge closely resembles Sparganium, but can be separated by the distinctive flower.

Nymphaea and Nuphar are only in scattered abundance. Nymphaea tuberosa beds are common in the northern area and along the western shore. Nuphar can be found in the same area but nearer shore.

Since this lake lies mostly within the city limits of Random Lake with 80 percent of its shoreline developed, and a large public access, it is very heavily used for recreation. Swimming and water-skiing are the most popular recreational activities.

Resurvey August 27, 1968

Chara is still the dominant, but has decreased in size and abundance and appears to be dying off. There has been a great decrease in Potamogeton pectinatus: only an occasional clump or individual plant occurs. Najas flexilis, and marina, which were not observed on the first survey are in scattered to moderate abundance. There has been some increase in Nymphaea over the summer but during the survey it appeared as if it were beginning to break down. There appear to be no change in the Nuphar communities and relatively no change in the emergent population, although emergent stands appear heavier. However, this is from the increase in foliage and size rather than in plant numbers.

Lake Seven (Sheboygan County) June 13, 1968

Lake Seven is the smallest of the lakes surveyed. Its basin is of glacial origin and it derives its water from springs and local drainage. On the west shore is a small outlet stream which connects the lake to the Milwaukee River. The water is a light tea color. The secchi disc reading was 12 feet. The presence of abundant amounts of both green and blue-green algae tends to indicate extreme fertility.

The higher aquatic vegetation of the lake is diverse. Along most of the undeveloped shores Typha occurs in moderate stands, interspersed with grasses and sedges. Willows, tamarack, oaks, and dogwood are found along the shore as well as behind the sedge stands. The north shore is developed, so emergent vegetation is sparse.

A mixture of Nuphar and Nymphaea make up the floating aquatics. These are in scattered, thick clumps that fringe the lake about 10 to 20 feet off shore.

The submerged vegetation is abundant and diverse. Most of the submergents are concentrated in a band around the lake extending from shore to about 50 feet out to a depth of 7 to 8 feet. Three distinct areas of vegetation form this band. Chara is in very heavy abundance from a depth of about 4 to 8 feet. Interspersed among these three dominants are Myriophyllum and some other species of Potamogeton. A submerged peninsula extends about 200 feet into the lake from the east side. It contains a mixture of submerged aquatics in moderate abundance, Chara being the dominant.

Motorboating is not permitted on this lake. Recreational pressures are light and concentrated on the north shore where there is a resort and several private cottages.

Resurvey August 20, 1968

The major change is the disappearance of one of the previous dominants, Potamogeton Friesii. Ceratophyllum and Chara have taken over the area where P. Friesii was dominant. Several other minor species have disappeared.

The abundance of most species has remained relatively the same except for Chara and Ceratophyllum which have increased. Wolffia which was not observed on the first survey is also very abundant. This species occupies much the same environmental niche as Lemna and as the water warms, one or the other will increase.

The appearance of the lake has changed, becoming more like a stagnant pond. Great amounts of filamentous algae can be seen floating near shore. On the day of the survey a phytoplankton bloom was in progress, decreasing the clarity of the water. The secchi disc reading is 5 feet.

Silver Lake (Washington County) August 8, 1968

Silver Lake is a long spring-fed lake which lies in a valley between two drumlins. It occupies a basin created by the melting of large blocks of ice left behind by the retreating Lake Michigan glacier. This lake contains very clear, hard water. The bottom is composed mostly of marl and gravel and the secchi disc reading is 12 feet.

The majority of aquatics are located on the north end of the lake. This area is connected by a narrow canal to the main body of the lake. In this area Chara is the dominant with Potamogeton and Myriophyllum exalbescens being well represented. A bed of Ceratophyllum can be found on the southernmost tip of the west bay. Emergent aquatics are also plentiful here. Scirpus validus is in moderate abundance interspersed with Typha on the northernmost point of the lake. Here the lake drains into Silver Creek which feeds Lucas Lake. The area surrounding the entrance to Silver Creek is a shrub marsh containing mostly dogwood shrubs behind a growth of sedges which fringe this area.

Vegetation in the main part of the lake is very sparse, mostly limited to scattered beds of Chara and an occasional stand of Potamogeton amplifolius and/or P. nodosus. Most of the vegetation is concentrated near the southern end of the lake where the water is shallow (less than 10 feet deep). A shallow area (2 feet deep) occurs near the center of the southern half of the lake. This area is almost barren except for sparsely occuring Chara plants. Submergent vegetation is very scarce within the lake.

Floating vegetation is also scarce. It is limited to an occasional clump of Nymphaea and/or Nuphar. Again, these are found mostly along the soutern shore.

Sparse stands of Scirpus validus make up the emergent population. These plants are also concentrated near the southern end of the lake. The western shore contains a tamarack-dogwood swamp. This area has several exposed springs which contain flora typical of springs. Large beds of water cress (Nasturtium officinale) fill and border the springs. Marsh marigold (Caltha palustris) is also common near the springs.

The shoreline is about 80 percent developed and there is heavy recreational use of the lake.

Smith Lake (Washington County) July 25, 1968

This shallow depression lake is almost surrounded by marsh land. The maximum depth is 5 feet. The lake receives its water from Drickens Lake to the north. The water is clear and hard, however, the bottom of Smith Lake is marl which is easily disturbed by the large carp population thus creating some turbidity in the lake.

The most impressive feature of this lake is the extensive marsh lands surrounding the lake. They are mostly composed of Scirpus validus, species of the family Cyperaceae, and the extremely abundant water lily, Nymphaea tuberosa. In some areas the tamarack swamps, behind the marshes, add to the aesthetic quality of the lake.

Scirpus validus is the dominant emergent and can be found all over the lake. Interspersed among the S. validus stands are occasional plants of several Potamogeton spp. Najas flexilis is the dominant submergent. It forms many thick beds at all depths in the lake. Chara, which is almost as abundant as N. flexilis, can only be found in shallow water. In the bay on the southwest side of the lake there are large concentrations of Potamogeton natans intermixed with Nymphaea tuberosa and Nuphar making this area almost impassable by boat. A small stream originating from this bay connects the lake to the Milwaukee River.

The north shore is almost devoid of plants. Located here are the beginnings of a subdivision, so most of this shoreline is developed. There is no apparent recreational use of this lake except possibly for hunting in the fall. The concentrations of emergents should attract migratory waterfowl.

Spring Lake (Ozaukee County) July 29, 1968

This aesthetically beautiful kettle lake lies in a valley formed by the terminal moraine of the Lake Michigan glacier. It contains hard clear spring water and has a basin composed of gravel and marl. Most of the lake is shallow, less than 10 feet deep; however, submerged vegetation is sparse. Chara is the most common submergent aquatic, yet it is relatively scattered in abundance. In shallower depths the plant is low and sparse, but in water greater than 8 feet the Chara becomes very thick. Potamogeton nodosus can be found in some of the protected areas of the lake. Interspersed among the bulrushes, Scirpus validus, are Potamogeton gramineus and Najas flexilis.

Scirpus validus is the dominant emergent. It occurs in heavy stands along the north and northeast shores. Typha is present in moderate abundance behind the S. validus stands. Floating aquatics are scarce, and limited to several beds on the north shore.

The terrain surrounding the lake is high and irregular. A low valley on the southeast contains a tamarack swamp. The north shore is mostly marsh.

Recreational activity is limited to an occasional fisherman.

Lake Twelve (Washington County) July 19, 1968

This is a marl bottom depression lake. It is spring fed and almost devoid of submergent aquatics. Chara is present at about the 6-foot level in areas where the basin slopes rapidly to its maximum depth. Here it occurs in scattered heavy clumps. Chara also occurs in the bulrush beds along with Potamogeton nodosus and P. gramineus. As one goes deeper into the bulrush marsh the sediments become more organic and can support species such as Sagittaria latifolia, Typha and Utricularia. However, the majority of the lake bottom is sterile.

Scirpus validus and species of the Cyperaceae family are the most apparent aquatics. Scirpus validus forms heavy thick growths along the north, south, and west shores. It obliterates the north shore and extends about 100 yards into the open lake covering a vast portion of the lake with scattered clumps and individual plants. Behind the bulrushes is a sedge marsh containing Cyperus, Asclepias incarnata and Typha.

The floating aquatics are limited to two large beds of Nuphar in the open water and a bed of Nymphaea tuberosa at the mouth of a small stream. Both of these stands occur at the west end of the lake.

The south shore is high and contains a cedar forest and several cottages. Extending from the south shore to and including the west shore is a private campground. Most of the south shore is sedge marsh and a stand of hardwood trees.

There is no apparent use of the lake except for the activities centered around the campground.

Wallace Lake (Washington County) June 28, 1968

This is a kettle lake which is primarily spring fed. Intermittent Wallace Creek connects the lake with the north branch of the Milwaukee River.

The water in this lake is very clear; secchi disc is visible to 13 feet. Plant growth occurs at all depths to 15 feet. Common at depths of 10 to 15 feet are Potamogeton amplifolius, P. pectinatus, and Myriophyllum exalbescens. All these plants have stems that are 8 to 10 feet long. However, the abundance of these plants is scattered. The greatest concentration of submerged aquatics occurs at the east and west ends of the lake. Here the water is mostly shallow, less than 10 feet deep. Chara almost completely covers the bottom. Occasionally there is a heavy concentration of Potamogeton pectinatus in isolated areas various minor occurring submerged aquatics can be found. In a small bay on the north shore a large bed of Ranunculus longirostris was observed. Potamogeton gramineus and P. Friesii occur in shallower water. This is the only lake surveyed where Potamogeton crispus is in greater concentration than its usual sparse occurence. It makes up 4 percent of the total population and is found scattered in moderate clumps all around the lake. The north and south shores do not contain many aquatics. This was due to the steep slope of the shore. In some areas the water is greater than 15 feet deep 10 to 20 feet off shore.

There is a great variety of emergent species scattered around the lake. However, the abundance is not great. Typha amd Scirpus validus are the most common. Most occur on and off the east shore. Mixed within these cattail-bulrush beds are very heavy concentrations of water lilies, Nymphaea tuberosa being the most abundant. Another water lily bed is located on the west shore, but the concentration is not as great.

Nearly 100 percent of the shoreline is privately developed, creating a great recreational demand on the lake. Water-skiing and fishing appear to be the most popular sports.

West Bend Pond (Washington County) July 30, 1968

This is an impoundment of the Milwaukee River located in the southeast corner of the city of West Bend. The main stream of the river flows along the north shore. Here the shoreline is steep and the water reaches its maximum depth of 10 feet. A large bay is formed in the backwater area, with a maximum depth of 4 feet. This entire body of water is very unattractive. The shore is littered with a vast collection of debris. The water appears to be very fertile and contains much foreign material -- floating, suspended, and dissolved. A project should be undertaken to beautify the shore and control the effluent entering the river from drains and pipes as the river passes through the city.

Vegetation within the lake is mostly limited to two tolerant species, Anacharis canadensis and Ceratophyllum demersum, usually found together in large massive clumps. A filamentous algae, floating on the surface, cements these clumps together making passage impossible; thus debris is caught in this floating carpet. All three aquatics are in very heavy abundance. Several minor occurring submergents are found along the main channel of the river where the water tends to be cleaner. Here an occasional emergent is present, but the emergents geneally are very scarce in this body of water. Floating aquatics are limited to a large bed of Lemna minor and several scattered Nymphaea tuberosa plants. Lemna minor is in heavy concentrations along the southern shore where it completely covers the water.

No recreational use is made of this lake. If this area were developed, it could support many water-oriented activities.

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