Impact of an overwinter drawdown on the aquatic vegetation in Murphy Flowage, Wisconsin. Report 43 1969

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RESEARCH REPORT 43

IMPACT OF AN OVERWINTER DRAWDOWN ON THE AQUATIC VEGETATION IN MURPHY FLOWAGE, WISCONSIN

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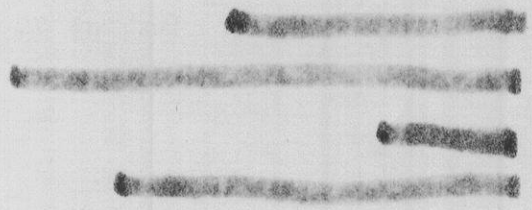

ABSTRACT

A lowering of the water level on Murphy Flowage during the winter of 1967-68 resulted in a significant reduction in the distribution, relative abundance and acreage of aquatic vegetation.

The five species in greatest dominance before the drawdown were most affected, and collectively showed a reduction of 181.7 acres in the season after the drawdown.

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INTRODUCTION

Dense growths of aquatic plants are a problem in many shallow flowages and natural lakes in northern Wisconsin. In some waters the growth of vegetation hinders fishing, swimming, boating and other forms of public recreation.

A number of control methods for aquatic plants are now being practiced throughout the country, the most common being the use of aquatic herbicides. The use of herbicides is an expensive and temporary cure for control of aquatic plants and must be repeated periodically for complete control. Biological control has been proposed by a number of authors: Allsopp (1960) discussed the use of the manatee for weed control; Mathis (1966) made observations on the control of vegetation using Israeli carp; Yeo (1967) used silver dollar fish for biological control of submerged aquatic weeds and Childers and Bennett (1967) studied the effects of largemouth bass-tilapia combination on vegetation control. Most of the biological control methods mentioned above are with species that could not survive in the colder climate of northern Wisconsin. In general, most biological controls for aquatic vegetation have been largely unsuccessful.

A few studies have been made on the effects of fluctuating water levels on aquatic vegetation. McDonald (1955) found that increased water levels in marshes along Lake Erie caused a die-off of the following emergent plants: Typha angustifolia, T. glauca, Scirpus fluviatilis, S. acutus, S. validus var. creber, Carex stricta and Phragmites communis var. Berlandieri. Robel's (1962) study in Utah showed that submerged aquatic vegetation increased by 32 percent in the shallow areas but decreased by 35 percent in the deeper areas when water levels were increased. Mathis (1966) found a complete absence of Elodea spp., Ceratophyllum demersum and Polygonum spp. after a fall and winter drawdown in Lake Catherine, Arkansas. Lantz et al. (1967) reported that a summer drawdown on Anacoco Lake, Louisiana definitely restricted the growth of Potamogeton spp. and Nuphar spp., with a total reduction of 90 percent in vegetation over a three-year period. Of the studies acted, only Robel's (1962) provided any quantitative data to support the findings and his study was concerned with the effects of increased water depths on submerged vegetation. Thus, the objectives of the present study were (1) to determine if an over-winter drawdown would prove to be an effective means of controlling aquatic plants, and (2) to provide a quantitative description of the impact of the drawdown on aquatic vegetation.

The study was conducted at 180-acre Murphy Flowage in Rusk County, Wisconsin. Maximum depth was 14 feet, but 70 percent of the flowage was less than 10 feet deep. The mean annual alkalinity was 38 parts per million. According to Moyle (1945) the natural separation between hard and soft waters seems to be at a total alkalinity of about 40 ppm, with 30 ppm being the lower limit of the hard water species and 50 ppm being the upper tolerance of most soft water species. The vegetation in Murphy Flowage included both hard and soft water plants.

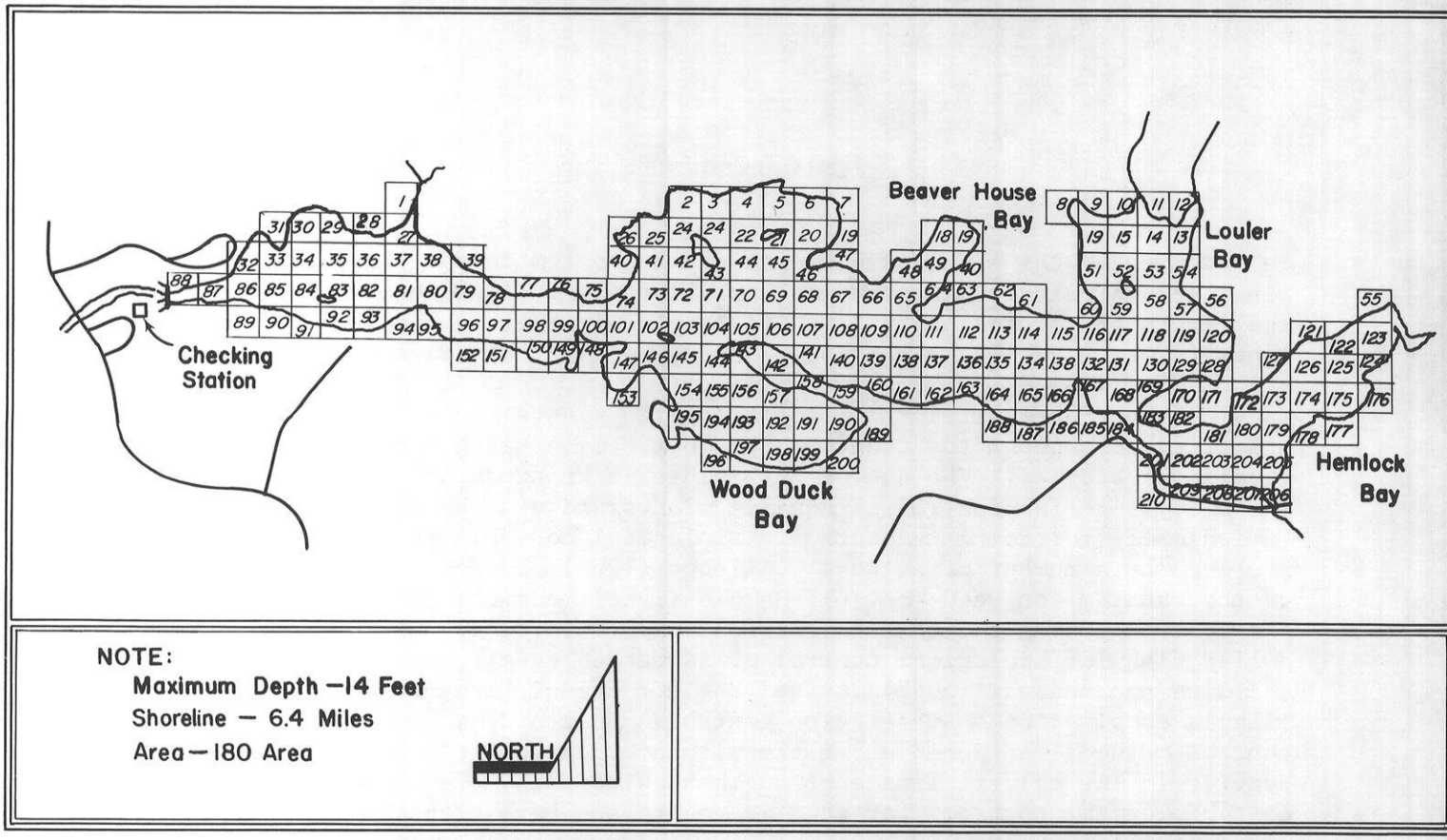


FIGURE 1. The distribution of the 210 quadrats at Murphy Flowage, Wisconsin.

Murphy Flowage was formed at its present level in 1937 and an intensive study of the fish population has been conducted on the flowage by the Wisconsin Department of Natural Resources since 1955. Observations by Department personnel indicated a gradual increase in the total acreage covered by the aquatic vegetation since 1955. The first quantitative and qualitative study made on the aquatic plants was the present study begun in 1967.

METHODS

Murphy Flowage was divided into 210 quadrats (Fig. 1). These quadrats were used originally for determining random net sets for making fish population estimates. Each quadrat was 225 feet square with a total area of 1.16 acres. Since each quadrat did not lie completely within the flowage, the approximate area which was under water was calculated so that the total acreage covered by each species could be determined.

The aquatic plants were identified in each quadrat and a visual ranking as to abundant, common, present and rare was made. If a species covered 75 percent of a quadrat it was ranked abundant; 50 percent, common; 25 percent, present; and below 25 percent, rare.

In deeper areas where visual observations were limited, a garden rake was used to determine the presence of aquatic plants. In no case was any vegetation found below visual observation range. Jessen and Loud (1962) used rake recoveries at selected sample sites to determine density of aquatic vegetation as well as visual observation of density at the same sample sites. They found that no significant differences existed between visual observation and rake determinations.

Between October 24 and November 16, 1967 the level of Murphy Flowage was lowered 5 feet. The low level was maintained until March 11, 1968, after which the water was gradually raised to the former level by April 1. During the entire winter the area of the flowage was reduced by 45 percent and the total volume by 70 percent. Observations on the abundance of vegetation were made in the last two weeks of August, 1967 and during the same period, after the drawdown, in 1968. Aerial photographs of the flowage were taken in the first week of September, 1967 and 1968.

RESULTS

Before the drawdown, in 1967, there were 24 species of aquatic plants present in the flowage. After the drawdown, in 1968, there were 20 species found, including 18 of the pre-drawdown species and two new species. The two new ones were: Vallisneria americana and Scirpus americanus (Table 1). In 1967, 202 quadrats had aquatic vegetation while in 1968 only 163 quadrats had plants.

Before Drawdown

Potamogeton Robbinsii was the most abundant species in the flowage before the drawdown (Table 2). It was found in 84 percent of the quadrats in the flowage and it covered 75 percent or more of the area in 131 quadrats. Nuphar was the next most abundant plant, being found in 69 percent of the quadrats. It was abundant or common in 22 percent. Myriophyllum occurred in 53 percent of the quadrats. Although this species was only abundant and common in 6 percent of the quadrats, it was recorded present and rare in 47 percent. Ceratophyllum demersum and Potamogeton amplifolius were recorded in 40 and 32 percent of the quadrats respectively. C. demersum was abundant in 4 and common in 11 percent, while P. amplifolius was never recorded abundant or common but only as present in 8 and rare in 24 percent of the quadrats.

After Drawdown

There was a drastic change in the abundance of aquatic vegetation noted in August, 1968, after the drawdown. Ceratophyllum demersum and Potamogeton amplifolius showed the greatest change, being absent in the flowage in 1968 (Table 3). Potamogeton Robbinsii was recorded in 42 percent of the quadrats and was not abundant or common in any of these. Nuphar was found in 53 percent of the quadrats but was only abundant or common in less than 2 percent. Myriophyllum, the third most abundant species in 1967, was found in only 5 percent of

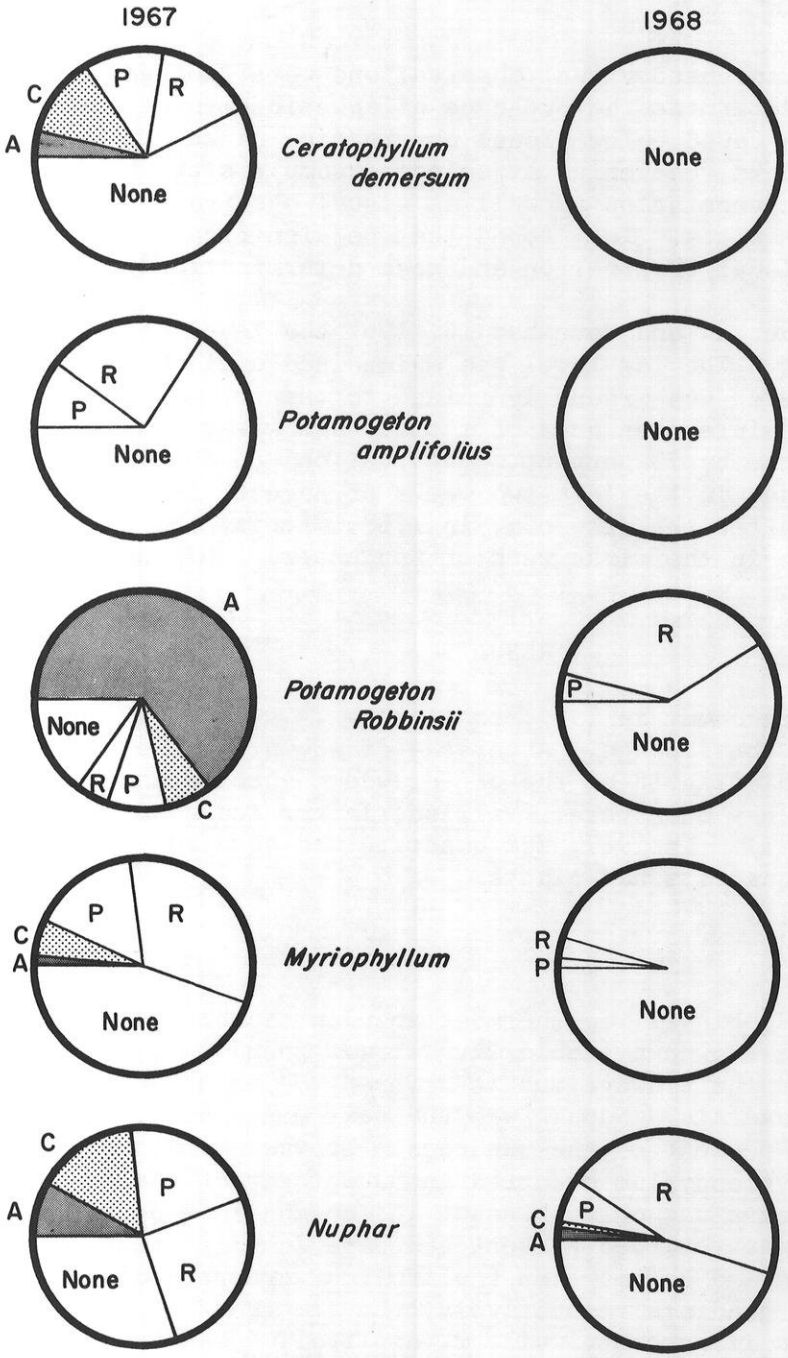


FIGURE 2. Abundance of aquatic plants before and after an overwinter drawdown at Murphy Flowage, Wisconsin. A=abundant; C= common; P=present; R=rare. Ranking was based on the percentage within the 210 quadrats, covering the entire flowage.

the quadrats after the drawdown. The five most abundant species before and after the drawdown are shown in Figure 2. The ranking was based on the percent abundant, common, present and rare within the 210 quadrats covering the entire flowage.

A number of species occurred only rarely in the flowage. Najas flexilis and Ranunculus trichophyllus were found in 2 percent and 3 percent of the quadrats in 1967. After the drawdown there was very

little change in the abundance of these two species, being present in 2 percent and 0.5 percent, respectively. Other species recorded only rarely before and after the drawdown were Sparganium chlorocarpum, Sagittaria latifolia and Potamogeton Richardsonii.

To provide a more quantitative description of the change in vegetation due to the drawdown, the approximate acres covered by each major species was calculated. The aquatic vegetation was divided into three categories, those species showing greatest decrease, slight decrease, and increase.

Species Showing Greatest Decrease

The five most abundant species in 1967 were also the species showing the most drastic decrease in 1968 (Table 4). Potamogeton Robbinsii covered 104.4 acres in 1967; in 1968, it covered only 8.0 acres for a total reduction of 96.4 acres. Myriophyllum covered 19.8 acres before the drawdown; after the drawdown it covered only 0.9 acres which was a decrease of 18.9 acres. Nuphar was reduced 30.1 acres, from a total acreage of 43.1 to 13.0.

The five major species showed a total reduction from 203.6 acres to 21.9 acres after the drawdown which was a decrease in acreage of 181.7 acres. The average acreage covered in each quadrat in which the species was present was reduced from 0.3 to 0.1 acres. The reason for the acreage covered by the major species being more than the total acreage of the flowage was that more than one species could be ranked abundant in the same quadrat.

Species Showing Slight Decrease

The largest number of species showed a slight decrease, but only one plant of major importance was in this category (Table 4). This species was Potamogeton natans which covered 21.5 acres in 1967 and 18.8 acres in 1968, for a total decrease of 2.7 acres. It was interesting to note that although P. natans decreased in total acreage it increased in the number of quadrats where it was found. The species in this category decreased from 67.3 to 37.5 acres for a total reduction of 29.8 acres. The average acreage covered in each quadrat in which the species was present was reduced by only 0.1 acres.

Species Showing Increase

Three species showed a slight increase after the drawdown (Table 4). Utricularia vulgaris increased from 10.0 to 13.6 acres for a total increase of 3.6 acres. Potamogeton Richardsonii and Sparganium chlorocarpum showed an increase of 0.5 acres and 0.1 acres, respectively. The total increase for the three species was 4.2 acres.

Distribution Changes

The distribution of the major species of aquatic plants before the drawdown is shown in Figure 3. The distribution includes only

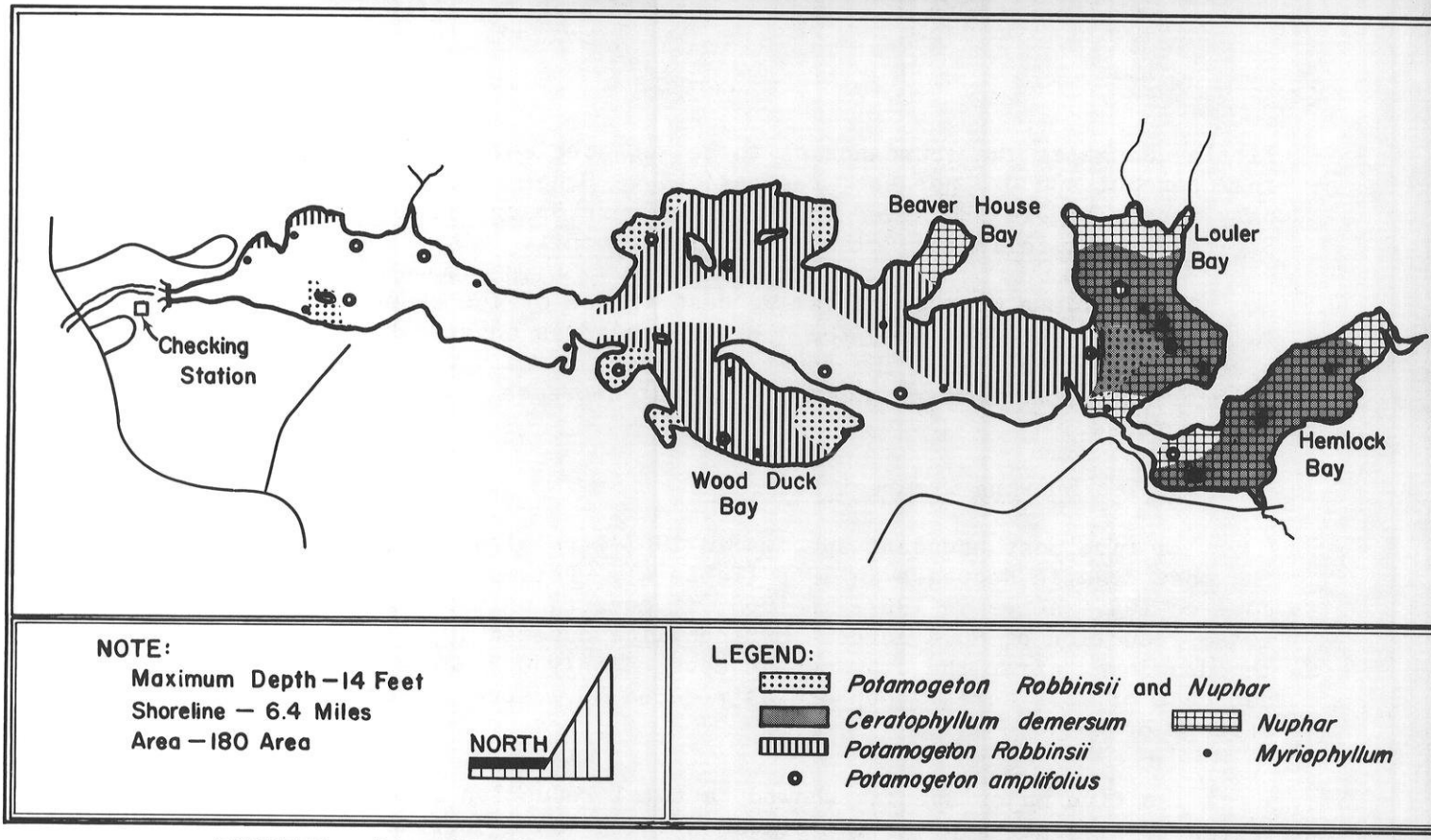
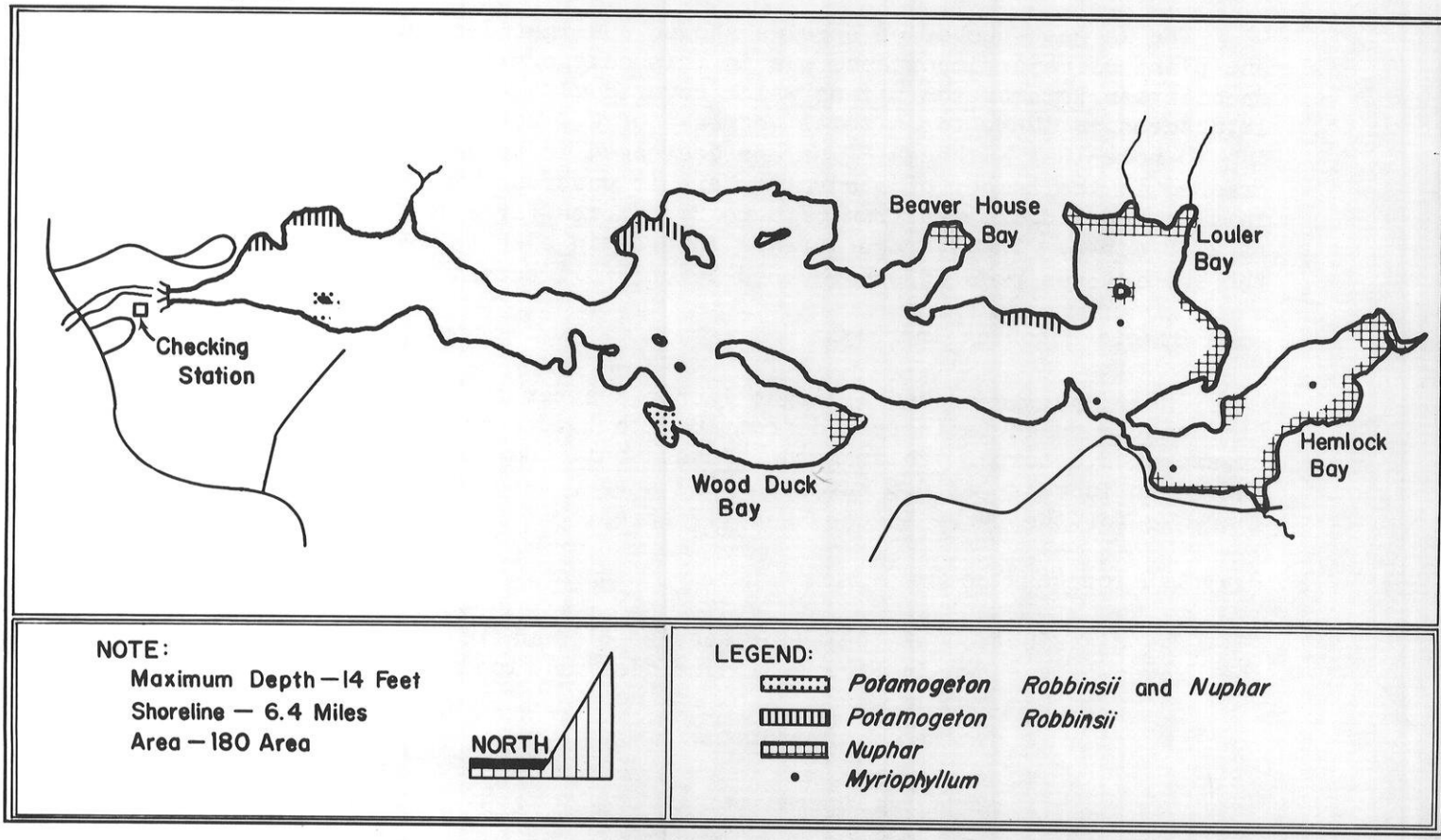


FIGURE 3. Distribution of the Major Species of Aquatic Plants in Murphy Flowage, Wisconsin before an Overwinter Drawdown in August, 1967. The distribution includes only the areas in which the species were abundant, common and present.

FIGURE 4. Distribution of the Major Species of Aquatic Plants in Murphy Flowage, Wisconsin after an Overwinter Drawdown in August, 1968.



the areas in which the species were abundant, common and present. In 1967 approximately 75 acres were covered by plants to the extent that fishing was almost impossible in this area.

Potamogeton Robbinsii was found mostly in depths of 10 feet or less. The major concentration of Nuphar was in Louler and Hemlock Bays and some of the other shallow areas of the flowage. Ceratophyllum demersum was found exclusively in Louler and Hemlock Bays where the average water depth was less than 3 feet. Myriophyllum and Potamogeton amplifolius were not concentrated at a certain depth or area but were evenly distributed throughout the flowage.

The distribution of the major species after the drawdown is shown in Figure 4. The distribution of Potamogeton Robbinsii was reduced to a few areas around the shore and Nuphar was found in only a few shallow bays. Myriophyllum was eliminated except for a few areas in Louler and Hemlock Bays. The drawdown released approximately 60 additional acres for fishing.

DISCUSSION

Lantz et al. (1967) and Mathis (1966) found that by lowering the water level there was a drastic reduction of Ceratophyllum demersum, such as was recorded in Murphy Flowage. The stress due to the low water level probably destroyed the vegetative reproductive structures. The reduction of Myriophyllum was probably due to the same factor.

Muenscher (1936) found that most potamogeton species reproduce vegetatively by either tubers, winter buds or creeping rootstocks and if any fruiting does occur it is usually in the fall. Potamogeton Robbinsii apparently matures fruit only very rarely but reproduces vegetatively from winter buds. The overwinter drawdown probably destroyed most of the winter buds and the few plants that did survive, survived from seeds produced in the fall or from winter buds in unexposed areas. The elimination of Potamogeton amplifolius could also be due to the reduction of the plant's capacity to reproduce vegetatively.

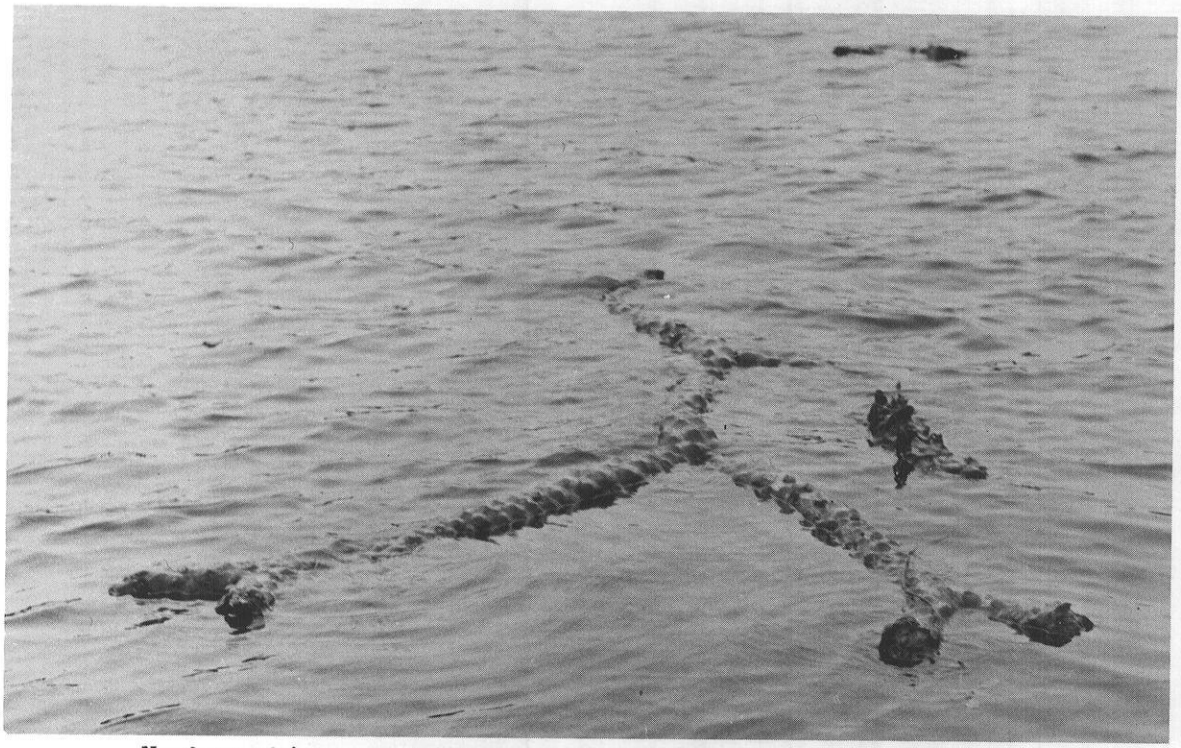
The main mode of reproduction of Nuphar was by vegetative means from underwater rhizomes. In the shallow area where Nuphar was abundant the rhizomes were exposed over the winter, and in the spring and throughout the summer large numbers of these rhizomes were found floating on the flowage. Also, much of the Nuphar sprouting from the remaining rhizomes in the spring would turn yellow and die after a short period of development. This was probably due to the lack of food reserve in the rhizomes because of the stress during the low water level period.

Shallow area in Hemlock Bay choked with Nuphar before the drawdown, August 1967.

The same area after the drawdown in August, 1968.

Aerial photograph of Wood Duck Bay looking north across the flowage in September, 1967 before the drawdown. The white area at the tip of Arrows 1 and 2 shows the relative abundance of submergent vegetation. Arrow 3 shows the scattered stands of Nuphar.

September, 1968. Notice the complete absence of submergent vegetation and the reduction of Nuphar (Arrow).



Nuphar rhizomes which were found floating on the flowage during the spring and summer of 1968.

Potamogeton natans showed very little change after the drawdown. One reason for this may be that it is one of the few potamogetons that develops mature fruiting bodies consistently (Muenscher, 1936). P. natans could have dispersed its seeds before the drawdown, with most of the reproduction coming from that source. Potamogeton coccineum did not show a drastic change after the drawdown. Most of these plants produced mature fruiting bodies before the drawdown, and most of the reproduction of this species in 1968 was by seeds produced in the fall of 1967 before the drawdown.

Utricularia vulgaris and Potamogeton Richardsonii showed a slight increase after the overwinter drawdown. Lantz (1967) found that Utricularia also increased after a summer drawdown in Louisiana. P. Richardsonii may be resistant to low water levels as evidenced by its prevalence in the Bayfield and Spooner rearing ponds that are drawn down each fall, year after year (Leon Johnson, pers. comm.).

An erroneous conclusion might be that the reduction of most of the vegetation was caused primarily by the severe winter conditions in northern Wisconsin, but Lantz (1967) obtained a reduction of Ceratophyllum demersum and Potamogeton spp. with a summer drawdown in Louisiana. Mathis (1966) observed a reduction of C. demersum with a winter drawdown in Arkansas, where the winters are not as severe as in northern Wisconsin. Winter freezing conditions were probably one of the factors responsible for the reduction in the vegetation, but it may not have been the primary factor causing the reduction.

The main mode of reproduction for the major plant species in the flowage is by vegetative means. When these species were subjected to low water levels the plants may not have had time to develop mature fruit and most of the vegetative parts were destroyed, causing the reduction observed in 1968. Also, lower water levels may modify various other factors such as temperature, light intensity, rate of photosynthesis and growth, any of which could cause a change in the vegetation.

The overwinter drawdown on Murphy Flowage did result in a marked reduction of aquatic vegetation. It is possible that the overall decline may be temporary until some other species takes over. Further studies will point toward determining if this type of succession does occur. Also, it is possible that in a number of flowages more adaptive species are the dominant plants and a drawdown would not cause a reduction in the aquatic plants.

SUMMARY

1. There was a drastic change in abundance of aquatic vegetation after the drawdown of Murphy Flowage. The five major species before the drawdown were the ones most affected. Ceratophyllum demersum and Potamogeton amplifolius were absent after the drawdown; Potamogeton Robbinsii was reduced from 84 to 42 percent of the quadrats and decreased 96 acres in extent; Nuphar was reduced from 69 to 53 percent and decreased 30 acres; and Myriophyllum, reduced from 53 to 5 percent, and decreased 19 acres.

   These five species showed an approximate acreage reduction after the drawdown of 181.7 acres.

2. The drawdown released approximately 60 additional acres for fishing in 1968.

3. The severe winter freezing conditions in northern Wisconsin were probably one of the factors involved in the reduction of the aquatic vegetation, but interference with reproduction due to the low water levels may also have been responsible.

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TABLE 1

Species of Aquatic Plants Identified in Murphy Flowage, Wisconsin in August, 1967 and 1968*

Species Name	Common Name	Present in 1967	Present in 1968
Potamogeton Robbinsii	Robbins' pondweed	x	x
P. natans	Floating-leaf pondweed	x	x
P. Richardsonii	Clasping-leaf pondweed	x	x
P. epihydrus	Leafy pondweed	x	x
P. zosteriformis	Flat-stemmed pondweed	x	-
P. amplifolius	Large-leaf pondweed	x	-
P. foliosus	Leafy pondweed	x	-
Spirodela polyrhiza	Big duckweed	x	x
Lemna spp.	Duckweed	x	x
Myriophyllum spp.	Water milfoil	x	x
Ceratophyllum demersum	Coontail	x	-
Utricularia vulgaris	Bladderwort	x	x
Megalodonta Beckii	Water marigold	x	x
Najas flexilis	Bushy pondweed	x	x
Ranunculus trichophyllus	Water crowfoot	x	x
Anacharis canadensis	Waterweed	x	-
Vallisneria americana	Wild celery	-	x
Polygonum coccineum	Smartweed	x	x
Nuphar spp.	Yellow water lily	x	x
Sparganium chlorocarpum	Burreed	x	x
Sagittaria latifolia	Arrowhead	x	x
Typha latifolia	Common cattail	x	x
Brasenia Schreberi	Water shield	x	x
Eleocharis acicularis	Needle rush	x	-
Acorus Calamus	Sweet flag	x	x
Scirpus americanus	Three-square bulrush	-	x

* Scientific nomenclature from Fassett (1966).

TABLE 2

Percentage Occurrence and Relative Abundance of Each Species in 210 Quadrats Before Overwinter Drawdown at Murphy Flowage, August 1967

Species	Occurrence		Relative Abundance (Percent)			
	No.	Percent	Abundant	Common	Present	Rare
Potamogeton Robbinsii	176	84	62	6	9	6
Nuphar spp.	145	69	7	15	20	27
Myriophyllum spp.	112	53	0.9	5	14	33
Ceratophyllum demersum	85	40	4	11	11	14
Potamogeton amplifolius	67	32			8	24
Potamogeton natans	54	26	5	11	6	3
Megalodonta Beckii	49	23		0.5	4	18
Spirodela polyrhiza	49	23			13	10
Lemna spp.	49	23			13	10
Utricularia vulgaris	32	15	0.9	4	4	7
Polygonum coccineum	29	14			3	10
Potamogeton epihydrus	21	10	0	1	2	7
Potamogeton foliosus	18	8				8
Typha latifolia	16	8		0.5	2	5
Brasenia Schreberi	18	8	0.9			8
Acorus Calamus	17	8	0.5		1	6
Potamogeton zosteriformis	12	6				6
Potamogeton Richardsonii	10	5	0	0.5	1	3
Ranunculus trichophyllus	7	3			0.5	3
Anacharis canadensis	7	3				3
Sagittaria latifolia	6	3			1	1
Najas flexilis	4	2			0.5	12
Sparganium chlorocarpum	3	1				1
Eleocharis acicularis	3	1				1

TABLE 3

Percentage Occurrence and Relative Abundance of Each Species in 210 Quadrats After Overwinter Drawdown at Murphy Flowage, August, 1968

Species	Occurrence		Relative Abundance (Percent)			
	No.	Percent	Abundant	Common	Present	Rare
Nuphar spp.	111	53	0.9	0.5	8	43
Potamogeton Robbinsii	89	42			3	40
Potamogeton natans	64	30	2	12	5	11
Utricularia vulgaris	40	19	3	2	10	4
Polygonum coccineum	27	13			0.9	12
Megalodonta Beckii	25	12	0.5	2	3	6
Potamogeton epihydrus	15	7			2	5
Spirodela polyrhiza	16	7			0.5	7
Lemna spp.	16	7			0.5	7
Potamogeton Richardsonii	12	6	0.5	0.5	0.5	4
Typha latifolia	14	6			1	5
Myriophyllum spp.	11	5			0.5	5
Sagittaria latifolia	8	4				4
Najas flexilis	5	2			0.5	2
Sparganium chlorocarpum	5	2				2
Acorus Calamus	5	2				2
Vallisneria americana	2	0.9				0.9
Ranunculus trichophyllus	1	0.5				0.5
Brasenia Schreberi	1	0.5			0.5	
Scirpus americanus	1	0.5				0.5
Potamogeton zosteriformis	0	0				
Potamogeton amplifolius	0	0				
Potamogeton foliosus	0	0				
Ceratophyllum demersum	0	0				
Anacharis canadensis	0	0				
Eleocharis acicularis	0	0				

TABLE 4

Approximate acreage covered by Vegetation Before and After Over-winter Drawdown on Murphy Flowage

Species		1967 No. Quadrats	1967 Total Acres	1967 Avg.Acres/ Quadrat	1968 No. Quadrats	1968 Total Acres	1968 Avg. Acres/ Quadrat
GREATEST DECREASE							
Ceratophyllum demersum		85	26.1	0.3	0	-	-
Potamogeton amplifolius		67	10.2	0.2	0	-	-
Potamogeton Robbinsii		176	104.4	0.6	89	8.0	0.1
Myriophyllum spp.		112	19.8	0.2	11	0.9	0.1
Nuphar spp.		145	43.1	0.3	111	13.0	0.1
	TOTALS	585	203.6	1.6	211	21.9	0.3
	AVG.	117	40.7	0.3	42	4.4	0.1
SLIGHT DECREASE							
Potamogeton natans		54	21.5	0.4	64	18.8	0.3
Megalodonta Beckii		49	7.4	0.2	25	6.2	0.3
Spirodela polyrhiza		49	7.5	0.2	16	1.5	0.1
Lemna spp.		49	7.5	0.2	16	1.5	0.1
Polygonum coccineum		29	6.0	0.2	27	3.8	0.1
Potamogeton epihydrus		21	3.4	0.2	15	1.8	0.1
Brasenia Schreberi		18	2.4	0.1	1	0.1	0.1
Potamogeton foliosus		18	1.7	0.1	0	-	-
Acorus Calamus		17	2.7	0.2	5	0.5	0.1
Typha latifolia		16	2.2	0.1	14	1.9	0.1
Potamogeton zosteriformis		12	1.1	0.1	0	-	-
Ranunculus trichophyllus		7	1.0	0.1	1	0.1	0.1
Anacharis canadensis		7	.9	0.1	0	-	-
Sagittaria latifolia		6	1.2	0.2	8	0.7	0.1
Najas flexilis		4	0.6	0.2	5	0.6	0.1
Eleocharis acicular		3	0.2	0.1	0	-	-
	TOTALS	359	67.3	2.7	197	37.5	1.6
	AVG.	22	4.2	0.2	12	2.3	0.1
INCREASE							
Utricularia vulgaris		32	10.0	0.3	40	13.6	0.3
Potamogeton Richardsonii		10	1.6	0.2	12	2.1	0.2
Sparganium chlorocarpum		3	0.4	0.1	5	0.5	0.1
	TOTALS	45	12.0	0.6	57	16.2	0.6
	AVG.	15	4.0	0.2	19	5.4	0.2