Observations on changes in the status of cattails at Horicon Marsh, Wisconsin. Report 66 1971

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RESEARCH REPORT 66

OBSERVATIONS ON CHANGES IN THE STATUS OF CATTAILS AT HORICON MARSH, WISCONSIN

By
Harold A. Mathiak

Department
of
Natural
Resources

Madison, Wis.

1971

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ABSTRACT

Vegetation losses became a problem at Horicon Marsh in 1950, and summer drawdowns were held in many subsequent years to promote growth of emergent vegetation. A somewhat different type of loss was experienced in 1967 when several hundred acres of cattail (Typha spp.) failed to green-up in June and therefore appeared as conspicuous brown patches in sharp contrast to other cattail with normal growth. Several thousand additional acres of cattail failed to grow normally in spring. There were no vegetation problems in the state portion of the marsh in the spring of 1969, but at that time the federal marsh had about 5,000 acres of cattail with greatly subnormal growth.

The 1967-69 vegetation losses are attributed to the continuous flooding of new cattail growth produced during the dramatic drawdowns from 1962-64, and to the feeding and house-building activities of extremely high numbers of muskrats. Drawdowns of the state marsh during the 1968 and 1969 growing seasons resulted in the return of much of the lost emergent vegetation.

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INTRODUCTION

An apparent large-scale dieoff of cattail on the Horicon Marsh Wildlife Area caused concern among local conservation employes and some private individuals. If the emergent vegetation should continue to disappear, wildlife values might be seriously altered.

The state-owned portion of Horicon Marsh, nearly 11,000 acres, lies at the south end and is managed by the Department of Natural Resources primarily for waterfowl hunting. A high water level of 75.3 feet, Horicon datum, was established by the former Public Service Commission to prevent flooding on adjoining private lands. A dam in the City of Horicon is used to regulate water levels on the state marsh with the exception of several small impoundments. The larger federal portion of the marsh consists of about 21,000 acres managed primarily as a refuge for waterfowl. Water levels are held somewhat higher by a main dike and dam just north of the state area. Additional water level control is secured by subimpoundments in which water can be raised or lowered by means of pumps.

In June, 1967, new green growth in the state portion of Horicon Marsh failed to take place as normally occurs, and old emergent vegetation became conspicuous as brown patches. Close examination of the brown stands disclosed that new shoots were absent, or very scarce and often retarded in growth. Several emergent species including cattail (*Typha* spp.), river bulrush (*Scirpus fluviatilis*), and bur-reed (*Sparganium eurycarpum*) were affected. Cattail, however, constituted by far the largest percentage of vegetation which normally grew in the area, hence this condition became known as the cattail dieoff. No indication of this coming problem had been noticed during the previous summer and fall.

The dieoff was apparent the next year over a larger acreage in both the state and federal areas. Quite a different story unfolded in 1969 when most of the state marsh seemed to have normal-appearing emergent vegetation, while the federal marsh had the large acreage in which cattail failed to grow except for widely scattered shoots.

An exploratory investigation was started in June, 1968, to seek an explanation for the vegetation losses. Field observations were made primarily on the state portion of Horicon Marsh but information on the federal area was obtained for comparison where possible.

METHODS

Essentially no studies on either muskrats or vegetation had been conducted in the area affected by present vegetation losses in the years just preceding these losses. However, specific data were available on spring and fall muskrat harvest, water levels, dam regulation and weather. These data from both state and federal files were studied for possible correlation with vegetation losses.

Frequency of water level readings varied greatly from daily for some months, to weekly, to sporadically over the years on both the state and federal parts of the marsh. No readings are available for some months when the federal dam was inaccessible due to snow-blocked roads. Monthly average readings used in this report (rounded off to tenths of a foot) were compiled from the readings in any one month closest to the first, tenth, and twentieth days of the month (Tables 1 and 2; Fig. 3, Appendix).

Soil samples, cattail leaves and rhizomes were collected from brown patches and nearby healthy cattail stands in Horicon Marsh. The samples were tested for chemical content at the University of Wisconsin Soil Science laboratories.

Intensive monitoring for chemicals in the soil and water was not undertaken because so little is known of what chemical factors may be lethal to emergent aquatics and because there was no way of anticipating further losses or where they might occur. In addition, the losses thus far appeared to

TABLE 1

Horicon Marsh Wildlife Area Water Levels

(Monthly Average of Readings Closest to 1st, 10th, and 20th of each Month)

	1944	1945	1946	1947	1948	1949	1950	1951*	1952*	1953*	1954	1955	1956*
Jan.	73.6	74.1	75.0	74.4	74.8	74.7	75.0	75.5	75.4	75.3	75.3	75.2	75.1
Feb.	74.0	74.1	74.5	74.3	74.5	74.4	74.7	75.4	74.7	74.9	75.1	75.3	75.2
Mar.	75.6	74.6	75.5	74.3	75.1	74.5	74.3	75.2	74.6	74.9	75.0	74.8	74.4
April	76.4	74.9	75.5	75.1	75.5	75.2	75.8	76.5	76.3	74.9	75.1	74.5	75.0
May	74.4	74.6	74.4	74.9	75.0	75.2	75.2	75.8	74.7	74.8	75.0	74.6	75.2
June	74.2	74.9	74.4	74.7	74.9	75.1	75.2	74.9	74.5	74.5	75.1	74.7	75.2
July	74.3	74.4	74.4	75.0	74.8	75.2	75.4	74.2	74.7	74.6	75.2	74.6	75.0
Aug.	74.0	74.3	74.1	74.6	74.5	75.0	75.6	74.5	75.4	74.9	75.1	74.8	75.0
Sept.	74.0	74.4	73.9	74.4	74.1	74.9	75.3	74.7	74.7	75.0	75.1	74.5	75.2
Oct.	74.1	74.6	73.9	74.6	74.0	74.7	75.3	75.1	75.0	75.0	75.5	74.5	75.2
Nov.	73.7	74.6	74.2	74.9	74.2	74.8	75.3	75.4	75.2	75.0	75.3	74.9	75.2
Dec.	74.1	74.7	74.4	75.1	74.6	75.0	75.0	75.5	75.3	75.1	75.3	75.1	75.3
Avg.	74.4	74.5	74.5	74.7	74.7	74.9	75.2	75.2	75.0	74.9	75.2	74.8	75.1

	1957	1958	1959	1960	1961	1962*	1963*	1964*	1965	1966	1967	1968*	1969*
Jan.	75.2	75.2	75.1	75.8	75.5	75.4	75.1	73.8	75.2	75.3	75.6	75.7	75.1
Feb.	75.2	75.2	75.2	75.2	75.4	75.8	75.2	73.8	75.4	75.0	75.6	75.6	75.1
Mar.	74.9	74.8	73.9	74.9	74.9	75.1	74.8	74.3	75.7	75.1	74.3	75.4	74.9
April	74.9	74.8	76.6	76.0	75.0	76.2	74.9	75.0	75.6	75.0	75.2	75.4	75.0
May	75.0	74.9	75.4	75.9	75.0	75.0	74.3	75.1	75.6	75.3	75.2	75.4	74.5
June	74.9	75.0	75.2	75.0	75.1	74.3	74.1	74.7	75.6	75.2	75.4	74.9	74.6
July	74.9	74.7	75.1	75.4	75.1	74.1	73.9	74.3	75.3	75.4	75.2	74.6	75.6
Aug.	74.9	74.6	75.1	75.3	75.3	73.9	73.6	74.4	75.3	75.3	75.0	74.3	74.5
Sept.	74.9	74.5	74.7	75.1	75.3	73.9	73.6	74.3	75.6	75.3	74.9	74.5	74.3
Oct.	74.8	74.5	75.5	75.4	75.8	74.1	73.3	74.7	75.4	75.3	75.1	75.0	74.5
Nov.	75.1	74.8	75.6	75.0	75.5	74.3	73.4	74.7	75.5	75.4	75.5	75.2	74.8
Dec.	75.3	75.0	75.6	75.1	75.1	74.7	73.8	75.0	75.3	75.5	75.7	75.1	75.1
Avg.	75.0	74.9	75.3	75.3	75.3	74.7	74.2	74.5	75.5	75.3	75.2	75.1	74.8

*Drawdowns

be beneficial rather than detrimental to wildlife.

Cattail rhizomes from apparently dead plants were taken to Madison and planted in a greenhouse in November, 1967. Other rhizomes from live and some from apparently dead cattails were collected August 17, 1968 and planted in moist sand in Horicon.

Available literature was searched for reports which might have a bearing on the vegetation losses. Several consultants were brought in to look at the affected vegetation. Boat trips were made to photograph and record the current status and to speculate on future changes in the emergent vegetation. Because of a possible link between high winter water levels and cattail losses, tight control of the Horicon dam was maintained by the Department during the winter of 1968-69. The status of submerged aquatics was not studied because there was general agreement that large carp populations had been the main factor responsible for their chronic scarcity.

TABLE 2

Horicon National Wildlife Refuge Water Levels

(Monthly Average of Readings Closest to 1st, 10th and 20th of each Month)

	1962	1963	1964	1965	1966	1967	1968	1969
Jan.	76.1	75.9	73.8	74.4	75.8	76.0	75.9	----
Feb.	76.3	75.9	73.8	74.9	76.8	76.3	75.9	----
Mar.	76.3	75.6	74.2	75.0	76.8	76.4	75.9	76.3
April	77.8	75.3	74.8	76.5	77.4	77.3	76.3	76.8
May	76.2	74.4	75.0	75.9	77.5	77.3	76.9	77.2
June	76.1	74.1	74.9	75.6	76.9	77.3	77.0	75.9
July	76.1	73.8	74.5	75.4	76.1	77.0	75.9	76.9
Aug.	75.7	73.6	74.1	75.2	76.0	76.5	76.0	75.5
Sept.	75.6	73.6	74.1	75.8	76.0	76.3	76.1	75.4
Oct.	75.7	73.3	74.1	76.1	75.7	76.0	75.7	75.3
Nov.	75.8	73.4	74.1	76.0	75.7	76.6	75.8	75.5
Dec.	75.9	73.4	74.3	75.9	75.8	76.3	75.4	75.6
Avg.	76.1	74.4	74.4	75.6	76.4	76.6	76.1	76.0

MANAGEMENT HISTORY

In 1943 sufficient state land had been acquired so that water level manipulations were begun to improve waterfowl habitat and hunting opportunities in the Horicon Marsh Wildlife Area. Water levels were gradually increased until the summer of 1950, when they were first held close to the legally established management level of 75.3 feet. Several small subimpoundments were constructed to permit holding water levels independent of those resulting from the Horicon dam.

Due to excessive increases in size of open water areas, summer drawdowns were made 8 times from 1950 to 1969 (Table 1). A ninth drawdown was made in 1964 to facilitate wetland farming in one of the subimpoundments. Manipulations of the Horicon dam were influenced by water levels, and also occasionally by special considerations in connection with the carp removal program, and show that vegetation losses prior to 1967 were common . However, brown nongrowing patches were not conspicuous in early summer in those years.

In some years, spring floods cause extensive damage to emergent vegetation. Damage was most severe when the buoyancy of the ice caused large beds of vegetation to float free during spring floods. The translocated beds seldom survived more than a year or two because much of the soil became washed free from the roots while floating about. This type of vegetation loss was especially common at Horicon in 1959.

VEGETATION CHANGES

During the drawdowns in 1962-64 in the state portion of Horicon Marsh, the water levels for May through August (the main portion of the growing season) averaged 74.3 feet (Table 1). Many established cattail stands expanded by sending rhizomes into territory not normally occupied by cattail, and also increased in vigor and density. Along the Boathouse Ditch it appeared as if the new cattail growth would block the ditch. In addition many of the mudflats appearing during the drawdowns produced dense beds of vegetation from seeds, including cattail. In fact, the marsh became seriously unbalanced with far too large an acreage of dense vegetation, having relatively little value to wildlife, and too little dispersion of open water areas. Hunting was difficult in the dense emergents and retrieving of downed game even harder.

Since the local population was very low, muskrats had practically no influence on the spread of cattails, bur-reed (Sparganium eurycarpum), bulrushes (Scirpus spp.) and other aquatic species in 1964 and 1965. Muskrats were not trapped on the state marsh in these two years because they were so scarce.

During 1965 and 1966, the two years following the drawdowns, the water level was held at an average of 13 inches higher (75.4 feet). In the spring of 1967 brown areas where cattails failed to "green-up" were first noticed (Fig. 1). Often these areas consisted of long strips about 8-10 feet wide paralleling and adjacent to healthy appearing cattail. The strips were along the ditchbanks and old river channels where the extension of cattail stands was observed during the drawdown. Extension of cattail stands not adjacent to channels usually did not show the strip effect because of the irregular shape of the stands and because much of the area between the stands became dry and completely closed in with new growths. In contrast, deeper water in channels limited the extent to which new growths could expand. An estimated 300 acres failed to "green-up" (James G. Bell, pers. comm.) (Fig. 1).

What appeared to be an all time high in the muskrat population of the state marsh was reached in the fall of 1967. Concentrations of houses in many sections of the marsh indicated a population of 20 or more muskrats per acre. The literal explosion from a low in 1964 to a high in 1967 was augmented by the high water levels from 1965 to 1967.

Water remained high during early 1968. In December 1967 and January 1968, rainfall totalled 2.35 inches. With the ground frozen, much of this rainfall from the watershed drained into the marsh. Also contributing to a rise in water level of the state marsh was the partial opening of the federal dam from

Strip of dead cattail along Main Ditch, Horicon Marsh, 1968.

A concentration of muskrat houses in Horicon Marsh Wildlife Area, winter 1968-69. Heavier concentrations were widespread when muskrats were at peak numbers a year earlier.

November 8, 1967 to January 17, 1968. During this period the state dam was closed at times causing water to back up to a high point of 75.9 feet on January 4, 1968. This amounted to 7 inches over the managed level. In June, 3,000 acres of the state marsh failed to "green-up". In addition 500 acres of the Horicon National Wildlife Refuge quite close to the state marsh also failed to produce normal cattail growth (James Bell, in litt., June 11, 1968) (Fig. 1).

Many brown areas so conspicuous in June in the state marsh produced numerous green shoots and made a good recovery by the end of July. The best recovery was made in areas that lost the surface water after the dam was fully opened June 18, 1968. Where surface waters persisted, new cattail sprouts were widely scattered and less vigorous. Many of the scattered sprouts were clipped by muskrats, thus delaying or preventing the recovery.

Water levels during the winter of 1968-69 were held between 75.1 and 75.3 feet by means of 17 manipulations of the Horicon dam in December, January and February. In late April of 1969, cattails in the previous problem areas were producing numerous new sprouts. By June it was obvious that no vegetation growth problems were occurring on the state marsh. A dramatic decline in the muskrat population was taking place since the peak numbers of 1967-68. In September 1969, a long trip in the state marsh disclosed practically no fresh signs of muskrats. One of the best local trappers made 40 sets in one section on opening day and caught only 6 muskrats overnight. Usually he would have caught at least 30 muskrats in the same number of sets.

The federal portion of Horicon Marsh had over 5,000 acres of vegetation which failed to grow normally in 1969. Figure 1 shows the affected areas as mapped by Bell and Corbett on July 24, 1969. Aerial photos of the federal marsh taken by Manager Robert Personius showed a strong correlation between areas with high concentrations of muskrat houses and areas with vegetation losses.

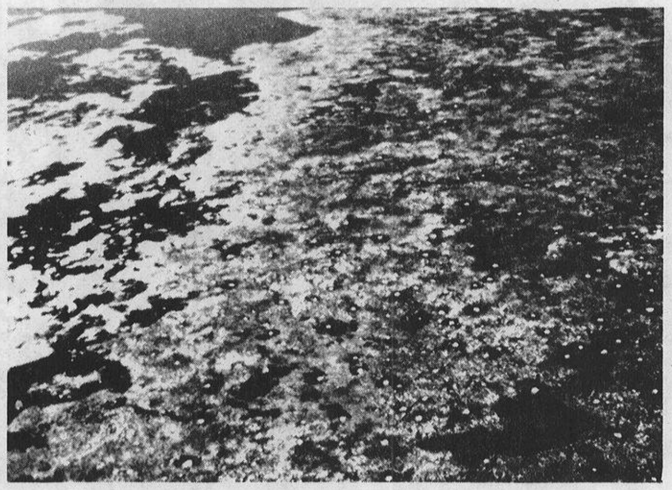
Chronology of events following the 1964 drawdown is shown in Table 3. The major vegetation loss on the state area took place in 1968, a year after the peak in muskrat numbers. This was 4 years after the drawdown. Why the muskrats peaked a year later on the federal marsh is unknown but the correlation between peak muskrat numbers and major vegetation losses seems clear.

TABLE 3

Relation of Major Vegetation Loss To Time Span of Reflooding After Drawdown and Peak Muskrat Populations

	1964	1965	1966	1967	1968	1969
STATE MARSH						
Average water level	74.5*	75.5	75.3	75.2	75.5*	74.7*
Change from 1964 (ft)		+1.0	+0.8	+0.7	+1.0**	+0.2
Year past drawdown		1	2	3	4	5
Peak muskrat numbers				1967-8		
Major vegetation loss					1968	
FEDERAL MARSH						
Average water level	74.4*	75.6	76.4	76.6	76.1	76.2
Change from 1964 (ft)		+1.2	+2.0	+2.2	+1.7	+1.8
Year past drawdown		1	2	3	4	5
Peak muskrat numbers					1968-9	
Major vegetation loss						1969

* Drawdown
** Prior to drawdown in June



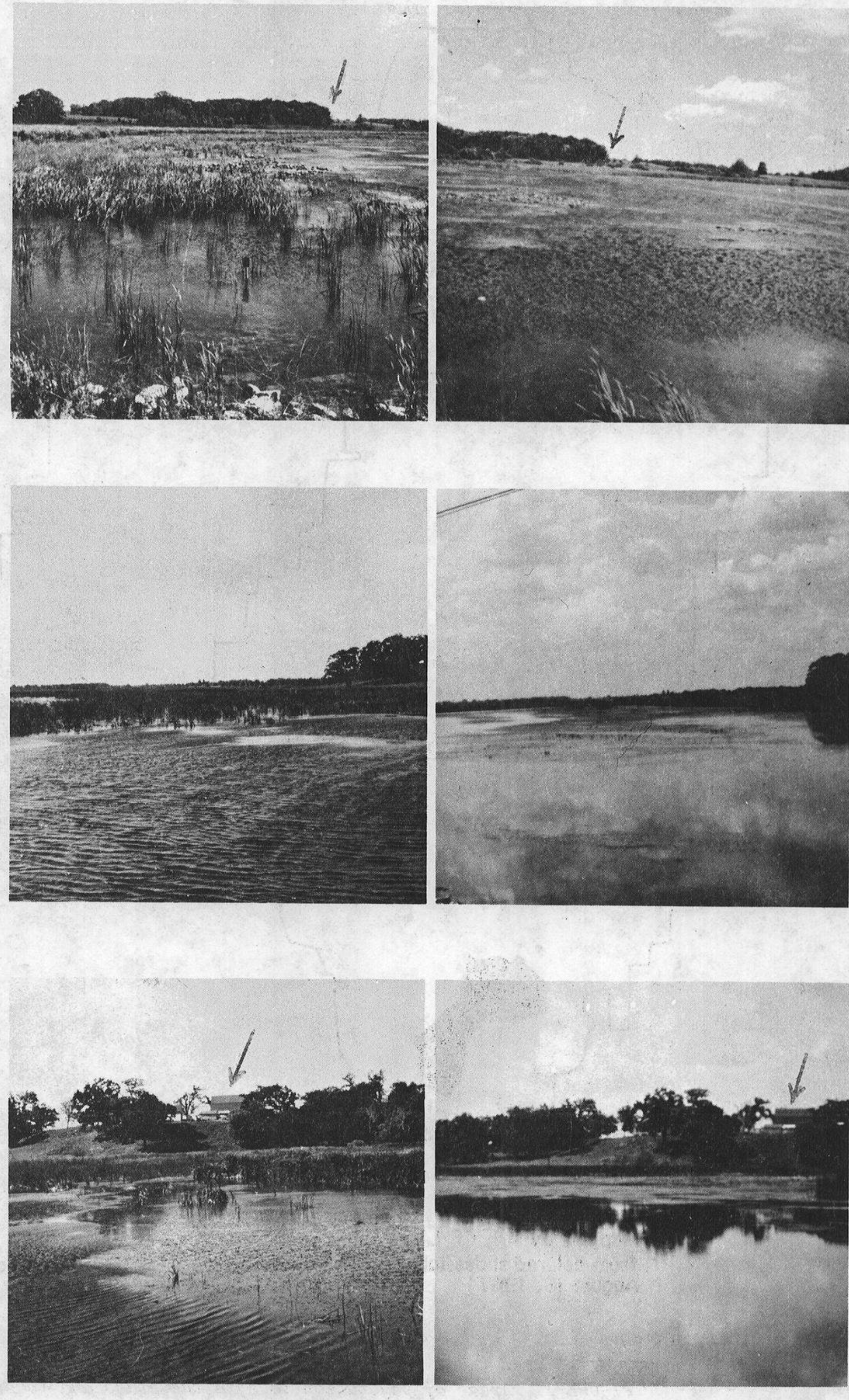
Typical view of muskrat house concentrations on Horicon National Wildlife Refuge, July 1969. (Photo courtesy Robert G. Personius)

DISCUSSION

Water Levels

Other observations made simultaneously with the Horicon Marsh investigation shed additional light on the effects of changing water levels. At Fox Lake (Dodge County) delayed action of high water on vegetation produced by a drawdown was demonstrated in 1968 and 1969. This lake had been drawn down 3 or more feet in 1966 to facilitate chemical treatment to kill fish. A large section of the inlet bay, which consisted of open waterprior to the drawdown, became covered with vegetation including cattail in 1966. Water had been restored to the lake's original level by April of 1967.

A series of pictures taken in 1968 and 1969 documents the fact that reflooding with over 3 feet of water did not kill the new growths during the first year, but resulted in widespread dieoff during the second year. By 1971 the distribution and amount of emergent vegetation will probably be essentially as it was before the drawdown.



Inlet area of Fox Lake, 1968 (left) 1969 (right)

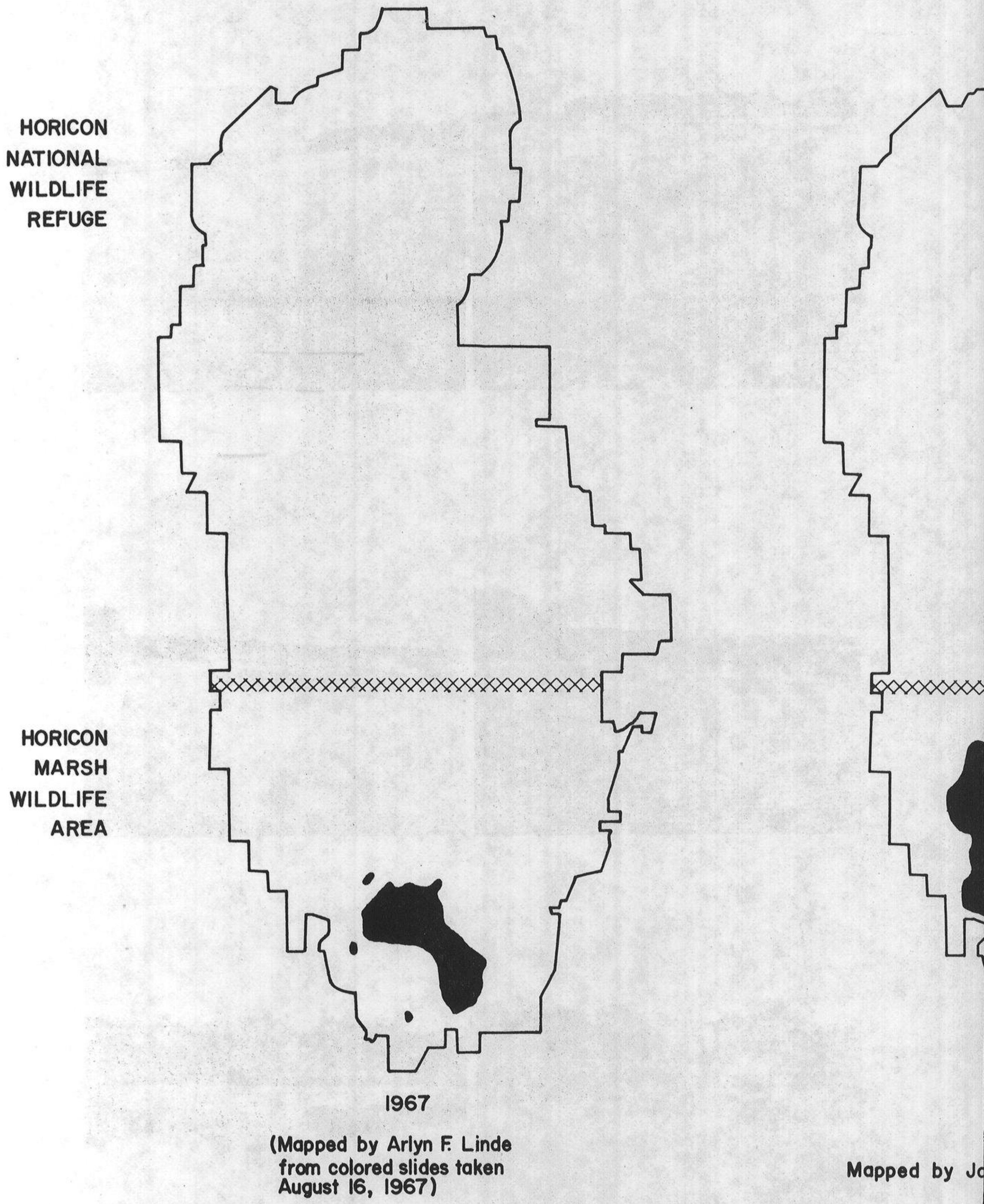
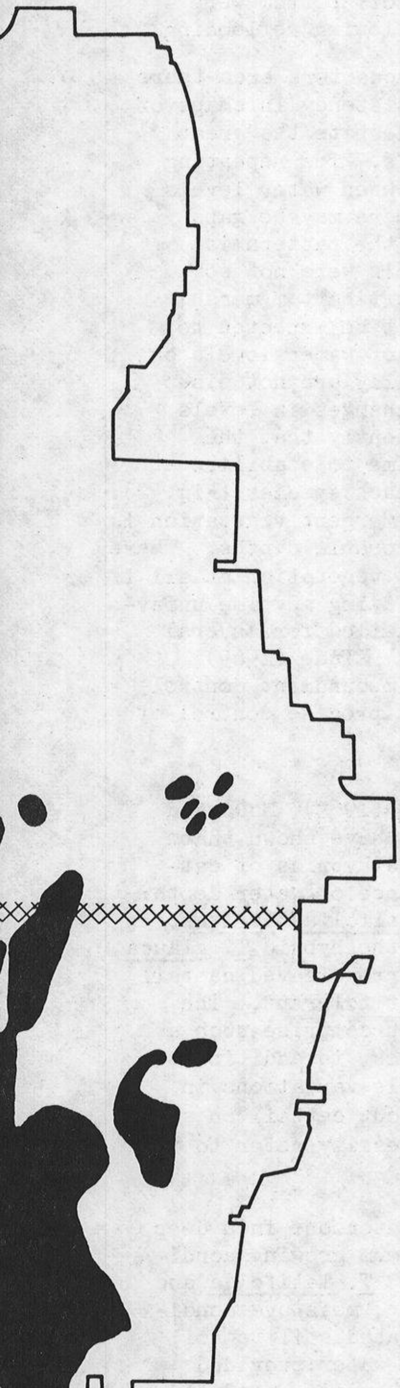
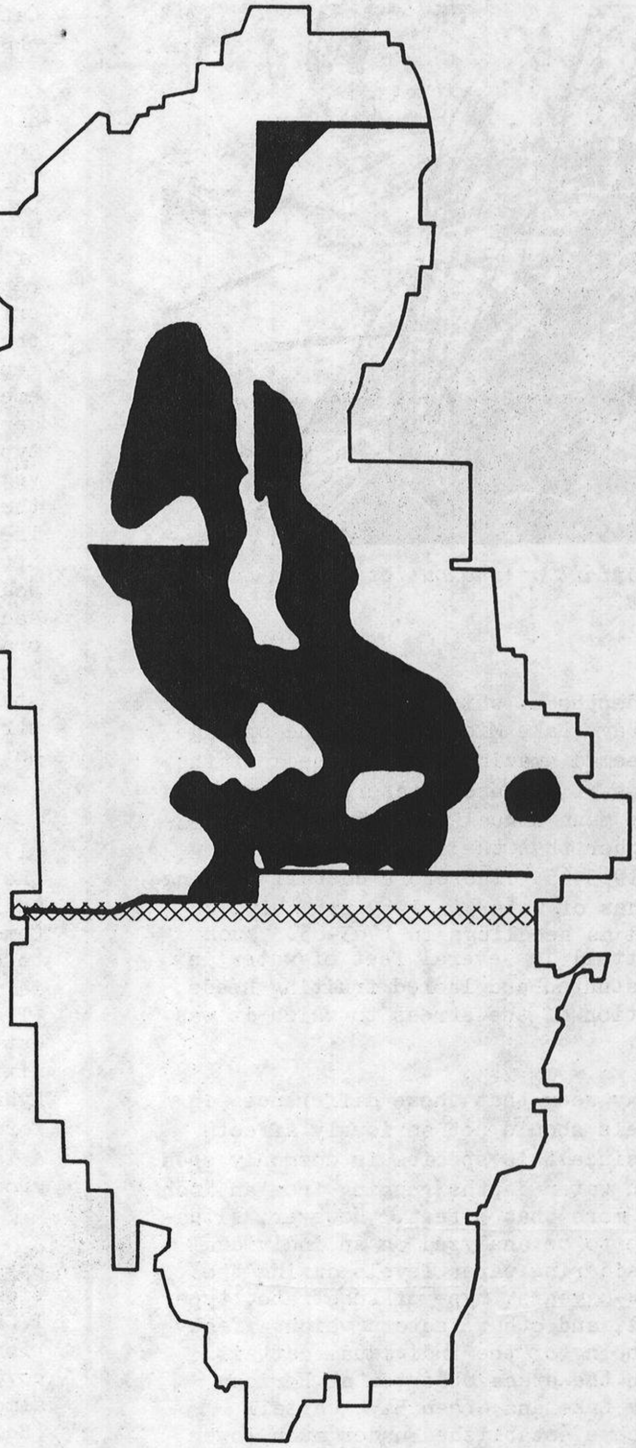


FIGURE 1. Areas of vegetation loss in the state and federal portions



1968

G. Bell June 10, 1968



1969

Mapped by James G. Bell July, 1969

oricon Marsh.

Tipped cattail at the outlet of Fox Lake, 1968.

The depths at which cattail was growing in Green Bay (Lake Michigan) in the spring of 1969 seemed amazing until a check of the U. S. Corps of Engineers water level records showed the mean annual level in 1969 was 33 inches higher than the average for the low years of 1963-65. Therefore cattail growing in 33 inches of water in 1969 probably originated as seedlings in 1963-65. Much of the cattail in several feet of water in 1969 was stunted and lacked fruiting heads, an indication of the stress to which it was subjected.

It may seem that these differences in water levels should not seriously affect cattail, since this species is commonly seen growing in water depths ranging from an inch or two to more than 3 feet. However, situations have to be analyzed on an individual basis considering water levels during the previous 4-6 years, type of substrate, type of cattail, and other factors which affect the well-being of the individual cattail stand. In the areas observed at Horicon Marsh, Fox Lake and Green Bay, cattail stands became established under much lower water conditions, and were then subjected to 2 or more years of higher water levels.

Substrate becomes important during periods of high water and heavy wave action. Horicon Marsh has mostly soft bottom except where a dense network of roots is present. Some older cattail stands persist in deeper water mainly because the stands are semi-floating so the crowns seldom get flooded. Cattails uprooted over soft bottom were observed in Fox Lake following reflooding.

In the Horicon headquarters area there has been remarkable consistency in shape of several cattail stands despite the great variation in water levels. The repeating pattern is recognizable when water levels are right even though there may be gaps of several years before the pattern is repeated. If water levels were not so critical, at least in soft bottom marsh, these patterns should not be expected to repeat. Direct effects of water levels on emergent vegetation usually are not discernible because gross changes in levels typically occur so frequently that the vegetation seldom has time to stabilize at the level preferred by each species (Fig. 2). The net result is that emergent vegetation is often subjected to unfavorable depths. There would be little emergent vegetation at all if each species reacted by dying anytime unfavorable water levels prevailed for several months to a year or two. Linde (1969) stresses the fact that impoundment control structures should permit precise control of water levels.

Harris and Marshall (1963), McDonald (1955), and Smith (1967) have shown that the different species and hybrids of cattail have varying tolerance of water depth. Common cattail (Typha latifolia) is least tolerant of deep water, the hybrid T. glauca is more tolerant, and narrow-leaved cattail (T. angustifolia) is most tolerant. The cattails of Horicon Marsh comprise such a mixture of the two species, in addition to hybrids having innumerable variations in form, that statements about cattail on such a large area must of necessity refer to the group as a whole.

Soil covered with water one inch deep appeared to provide optimum growing conditions for hybrids between T. latifolia and T. angustifolia. However, moisture conditions ranging from saturated soil to soil covered with 6 inches of water provided almost equally favorable growing conditions (Bedish, no date). Dane (1956) found an overcrowding of emergents during years of low water level, and concluded that water level during the growing season was the single most important factor in growth and spreading of emergent plants.

Many authors in various parts of the country have reported detrimental effects of high water on cattail. McDonald (1955) in particular cites several cases of cattail

The state portion of Horicon Marsh from headquarters, 1962 (left). A similar pattern is present in 1968, six years later (right). The repeating pattern in this shallow water area tends to corroborate the finding of McDonald (1955) and Kadlec (1960) that relatively small changes in water depth affect the distribution of emergent aquatics.

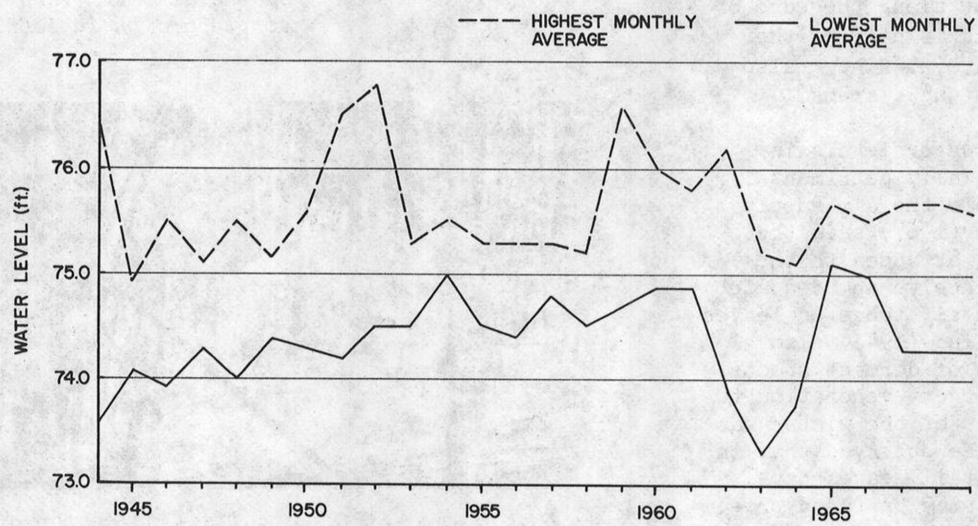


FIGURE 2. Fluctuations in water levels, Horicon Marsh Wildlife Area.

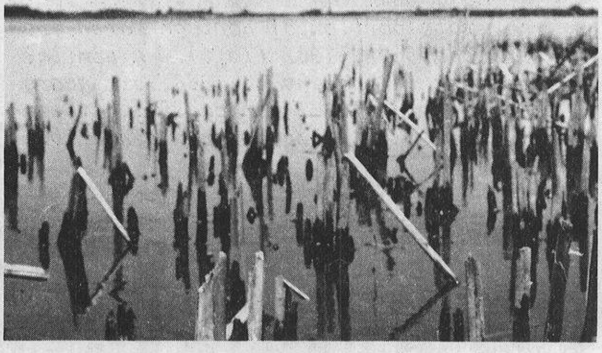
being eliminated by high water in New York. The irregular boundary of the cattail stands he studied seemed to follow minute differences in water level and all plants submerged below a certain level died. Kadlec (1960) reported a remarkable degree of association between the average water depths for individual species and the characteristic water depth of the cover types. In his study almost all characteristic species had an average water depth within 6 inches of the type depth.

Nelson and Dietz (1966), who developed cattail control methods in Utah, found cattail growth was reduced where cut stems were exposed to air. When cut at 4 inches above the water line, growth was lessened, but was much further reduced when stems were cut close to the water line, probably because of fluctuations in water level. When continuously flooded, the plants died. These investigators believed cattail roots receive their needed air supply through the stems. This air supply is apparently curtailed when cut stems are kept below the water surface. Stems cut under water failed to grow in most cases.

To test the effects of high water levels and cutting on cattail growth, we cut one-half of a small stand of cattail along the edge of a fish hatchery pond at Delafield down to the waterline on October 31, 1968, severing all rhizomes joining the cut and uncut portions. The water was then raised 10 inches over winter. When next inspected on June 3, 1969, only a few small shoots were found in the cut section. Shoots in the uncut section were larger and more numerous, but these were considerably less vigorous than those right along the edge of the pond. It appeared as if holding the water higher than normal over winter also weakened the plants with uncut stems.

Higher than normal water levels in winter may also be especially detrimental to cattails by cutting off the air supply to the rhizomes. Bedish (1967) said that rhizome shoots are still attached to the dead parent plants and receive an adequate supply of oxygen through air tubes in leaves of the parent plant. Laing (1941) also believed that the access of dormant shoots of cattail and other emergent vegetation to air through at least part of the winter was important to survival. He observed that in winter, when the old cattail leaves have died, young green shoots may be found preserved in between the old leaves and extending above the ice. In the latitude of Chicago and Detroit these shoots stay green all winter.

A muskrat eat-out area on Horicon Marsh Wildlife Area, 1968. Stubs of cattail were flooded all of the 1967-68 winter.



Cattail cut by muskrats in the fall of 1967, probably flooded most of the winter. Very little growth in 1968.

Cattail in center of photo again cut by muskrats.

Cattail partially clipped at Delafield, October, 1968. The light-colored unclipped cattail (right center) was apparently hurt by raising the water 10 inches over winter. The clipped section to the left now appears as open water. The vigorous cattail in the background was on higher ground and not affected by high water. (Photo taken June 3, 1969).

Muskrats

Large populations of muskrats can seriously damage cattail and cause eat-outs. They are especially prone to feed on new shoots developing along the edges of established cattail stands, and when large numbers are present probably act as a powerful deterrent to expansion of old stands.

In addition to cutting cattail stems above water, muskrats also feed extensively on the rhizomes, especially when the marsh is frozen. The paucity of submerged aquatics increases the pressure on cattails by muskrats. As the ice thickens, less and less food is available so that plants bordering deeper water may have all the rhizomes eaten or severed in many places. Beard (1969) suggested that severe drawdowns may have contributed to the decline of certain species of submerged aquatics, coontail (ceratophyllum demersum) in particular.

Rings of brown vegetation around muskrat house potholes were very evident from the air on July 27, 1968, especially on the federal marsh. Excessive feeding on rhizomes under thick ice conditions may have weakened the bordering plants to the point where they failed to grow in spring.

Weller and Spatcher (1965) gave a clear account of the role of muskrats and high water in relation to habitat changes, and indicated that an uncontrolled population soon reaches a stage where all vegetation is used for food and lodges (the eat-out). The cattail stalks within an enclosure along Lake Erie were taller (9 feet) and more abundant than those in the immediate surrounding area which were shorter (4 feet) and thinner Giltz and Myser (1954). These authors believed carp were exposing cattail rhizomes which were then eaten by muskrats.

Other Factors

Samples of live cattail rhizomes, green stems, dead stems, and bottom soils were collected in three vegetation die-off and two normal vegetated areas in the marsh on August 15, 1968. Water was 3 to 6 inches deep in each of the three die-off areas while both of the normal growth areas were slightly above the water level at the time of sampling. The samples were taken to the University of Wisconsin Soils Laboratory: cattail tissue samples were analyzed for N, P, K, Ca, Mg, Zn, Mn, B, Cu, Fe, AL, and HCN content. Soil samples were run for pH, organic matter, P, K, and Mn (Tables 4 and

5). All of the samples show zero cyanide content. The data showed no marked differences in parameter values found in the die-off and normal growth areas.

In another test, rhizomes and crowns from cattail plants in die-off areas were collected and transplanted in 1967 (in November in a greenhouse) and 1968 (in August in moist sand at Horicon). Examination of rhizomes in the die-off areas revealed firm white tissues, showing that they were not dead. Delayed sprouting occurred in both transplanting experiments.

Muskrat eat-out area on Horicon National Wildlife Refuge, September 1969. Heavy duck use occurred during the fall.

TABLE 5

Marsh Soils Measurements for Cattail Die-off and Normal Growth Areas in Horicon Marsh in 1968

Measurement	A	B	C	D	E
pH	7.5	6.6	7.5	7.5	7.3
Organic matter/acre (tons)	120	120	100	125	100
Available P/acre (lb)	24	55	31	37	67
Available K/acre (lb)	150	100	100	160	125
Mn/acre (lb)	-	-	14	14	19

A - Die-off area along the main ditch.
B - Normal growth area 150 feet west of area A.
C - Normal growth area adjacent to duck pond.
D - Die-off area in duck pond.
E - Die-off area below state headquarters building.

TABLE 4

Cattail Tissue Measurements for Die-off and Normal Growth Areas in Horicon Marsh in 1968

	Cattail Tissue Samples														
Measurement	Live Rhizomes					Green Stems					Dead Stems				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Percent N	.78	1.18	.61	1.22	1.49	1.18	1.99	1.11	1.31	3.55	.43	.55	.63	.01	.43
Percent P	.37	.31	.68	.42	.19	.19	.19	.19	0.19	.46	.06	.02	.02	.06	.09
Percent K	.47	1.38	.82	2.00	.47	1.52	1.09	.66	.82	1.52	.36	.36	.36	.36	.36
Percent Ca	1.76	.89	1.37	.62	.89	1.23	.97	1.53	1.27	1.09	1.70	1.41	1.70	1.49	2.34
Percent Mg	.70	.33	.66	.39	.61	.35	.27	.72	.54	.42	.27	.15	.25	.27	.35
ppm Zn	32	32	22	16	22	12	22	14	12	44	16	28	16	26	10
ppm Mn	168	111	252	100	132	188	228	280	198	147	192	172	202	132	378
ppm B	32	27	44	21	22	8.2	12	12	8.2	19	15	17	15	14	17
ppm Cu	12.2	7.2	7.8	2.0	5.6	5.1	5.2	5.6	2.0	5.1	7.8	3.6	2.0	5.1	5.1
ppm Fe	1000+	1000+	1000+	1000+	1000+	35	42	85	120	600	170	115	165	145	230
ppm Al	1000+	1000+	1000+	215	540	26	26	38	51	485	106	106	180	138	180
ppm HCN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A - Die-off area along the main ditch.
B - Normal growth area 150 feet west of area A.
C - Normal growth area adjacent to duck pond.
D - Die-off area in duck pond.
E - Die-off area below state headquarters building.

CONCLUSIONS

The 1967 emergent vegetation loss occurred at the south end of Horicon Marsh and involved about 300 acres of cattail. Vegetation losses increased to 3,000 acres of the state marsh and 500 acres of federal marsh in 1968. There was no loss on the state marsh in 1969, but 5,000 acres of cattail on the federal marsh failed to green-up.

I believe that these dramatic losses in cattails at Horicon Marsh were caused by damaging effects of high water levels (avg. of 13 inches higher) on the new vegetation which had developed following three consecutive years of drawdown. The high water weakened or killed the cattails directly, and at the same time fostered a population explosion of muskrats (estimated as high as 20 per acre) which also weakened and killed vegetation.

Although vegetation losses in the past made drawdowns necessary to promote growth of emergents, brown patches of cattail were not conspicuous in the earlier years. Never before, however, have three years of such high water followed three years of such low water. In addition the muskrats were more numerous and harvested less efficiently in 1967-68 than in previous population highs.

While other factors may have been involved, and certainly cannot be ruled out at this time, the fact that no vegetation losses were found in the state marsh in 1969 following a drastic reduction in muskrat numbers and rigid water control the previous winter and supports the conclusions of this report. Furthermore, it would appear that these observations lend support to those investigators in other states who have found that flooding is an effective means of controlling dense growths of cattail.

A scene in the Horicon National Wildlife Refuge south of Highway 49 at the Main Ditch, July 1969. What was a very dense stand of cattails a few years ago has been improved here by muskrats.

APPENDIX

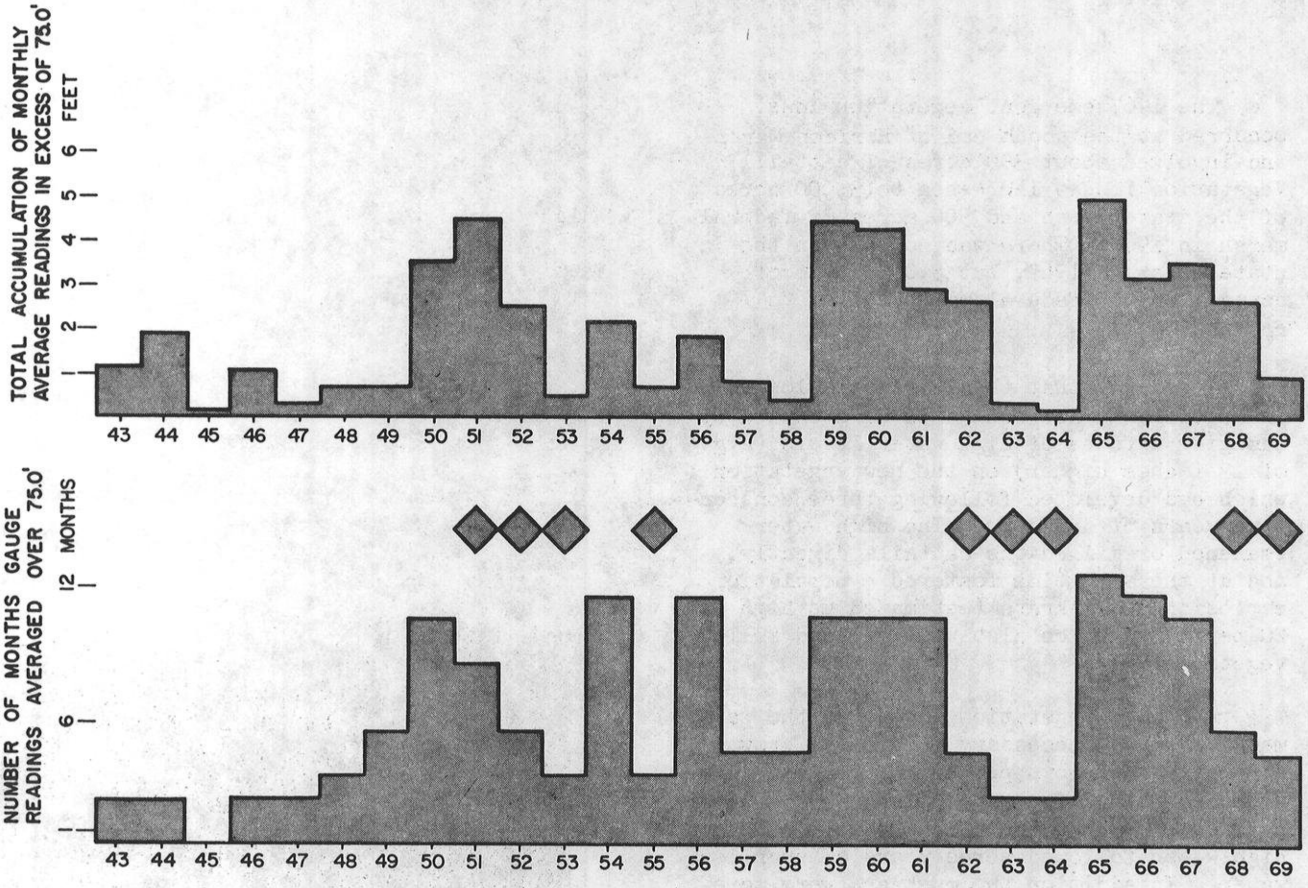


FIGURE 3. Extent and duration of water over 75.0 ft. datum. The upper section of the graph represents volume and is derived from the total of average monthly readings in excess of 75.0 feet. The lower section relates to the number of months per year the average monthly readings exceeded the arbitrary level of 75.0 feet. Viewed together, the three major periods of high volume correlate quite well with the three periods of extended flow. Each of the three periods of abundant water were followed by drawdowns for two to three summers. The 1964 drawdown was made to facilitate farming on a subimpoundment rather than to stimulate growth of emergents on the marsh proper.

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