7D-7.3

THE MAISOU ISLAND PROJECT

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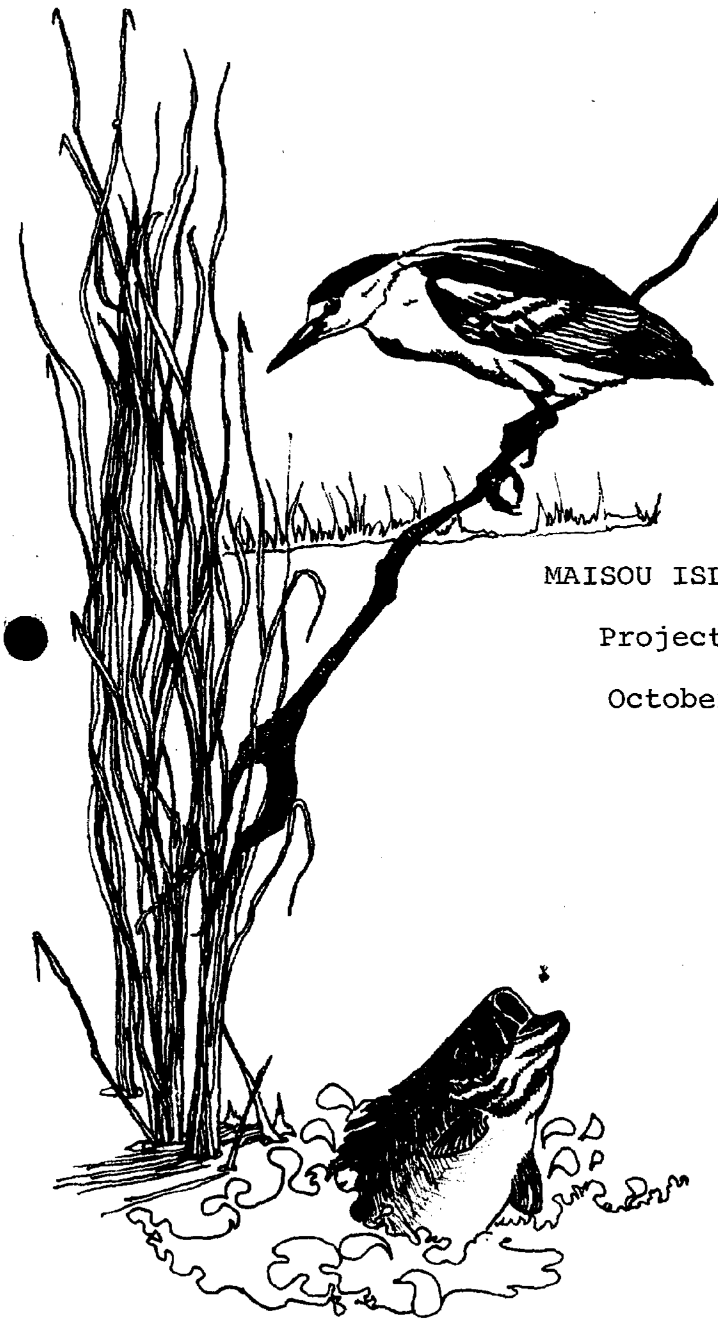

MAISOU ISLAND COMPLEX

Project Report

October, 1985

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Maisou Island Project Account! 2325 S. Cedar, Lansing, Michigan 48910; Ph (517) 484-9600.

Project 7D-7.3

EVALUATION OF MARSH LOSSES

Maisou Island Complex

Saginaw Bay, Michigan

Prepared For:

Wildlife Division

Michigan Department of Natural Resources

In Fulfillment Of:

Coastal Zone Management Project #7D-7.3

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MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, Michigan

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MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, Michigan

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INTRODUCTION

History

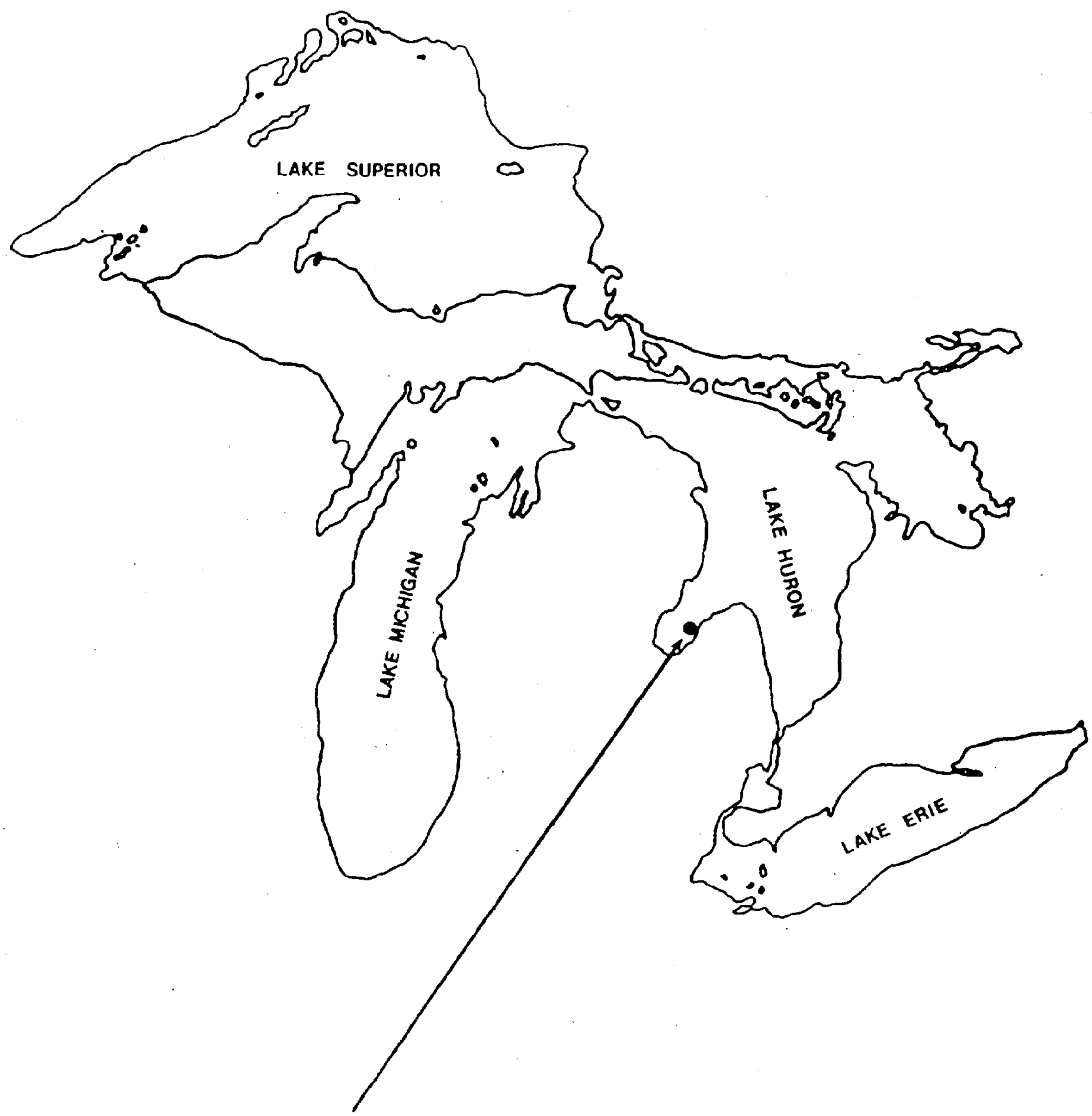
Coastal wetlands of the Great Lakes region are among the most productive natural communities in temperate North America. Michigan's coastal wetlands presently total approximately 106,000 acres and are distributed along all the Great Lakes and connecting waters. Jaworski and Raphael (1978) point out:

- Ecological and recreational values, fish, waterfowl and non-game wildlife production yield an average annual return per acre in excess of $3,000.00 (1978 dollars).
- Michigan has lost approximately 70 percent of its original coastal wetlands since the mid-1800's.

Saginaw Bay of Lake Huron holds one of the largest concentrations of Michigan's coastal wetlands. Major marsh areas are found from Point AuGres to Nayanquing Point, Tobico Beach, the Saginaw River mouth to Fish Point, and the Maisou Island Complex of Sebewaing and Wildfowl Bays (refer to Figures 1 and 2). But Saginaw Bay wetlands have undergone massive changes since pre-settlement surveys.

During the period from 1859 to 1973, wetland losses throughout the bay totalled 19,620 acres. In the region from Fish Point to Sand Point, 4,798 acres of onshore wetlands were drained for conversion to cropland. At the same time, offshore marshes showed a net increase of 1,498 acres while shifting from bulrushes and wild rice to cattails as the dominant plants. The increase in cattail marshes is probably due to two major

FIGURE 1: Map of the upper Great Lakes region showing the location of the Maisou Island complex in Saginaw Bay.



Maisou Island Complex

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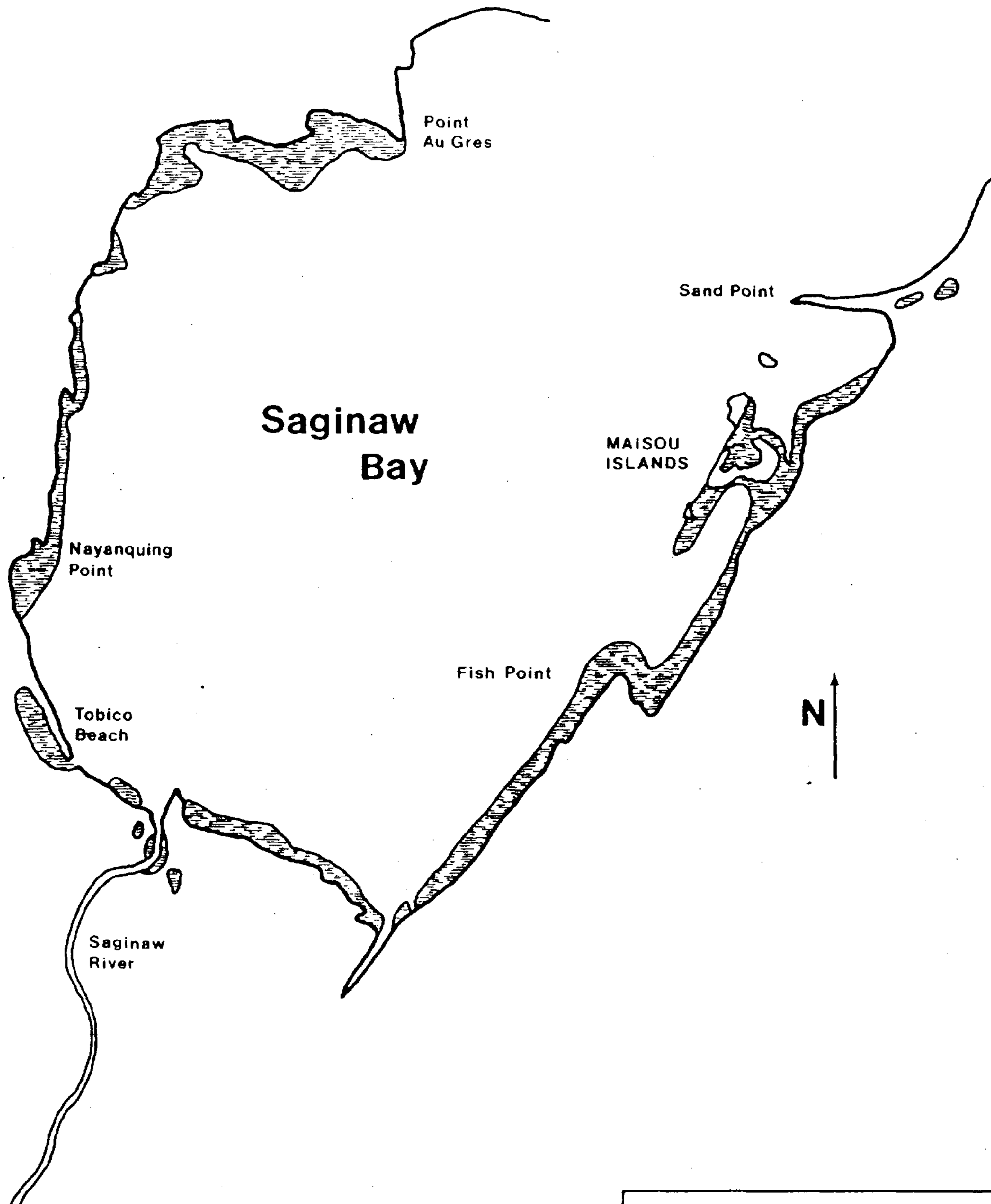
Figure 2. Major Saginaw Bay Wetland Areas



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factors:

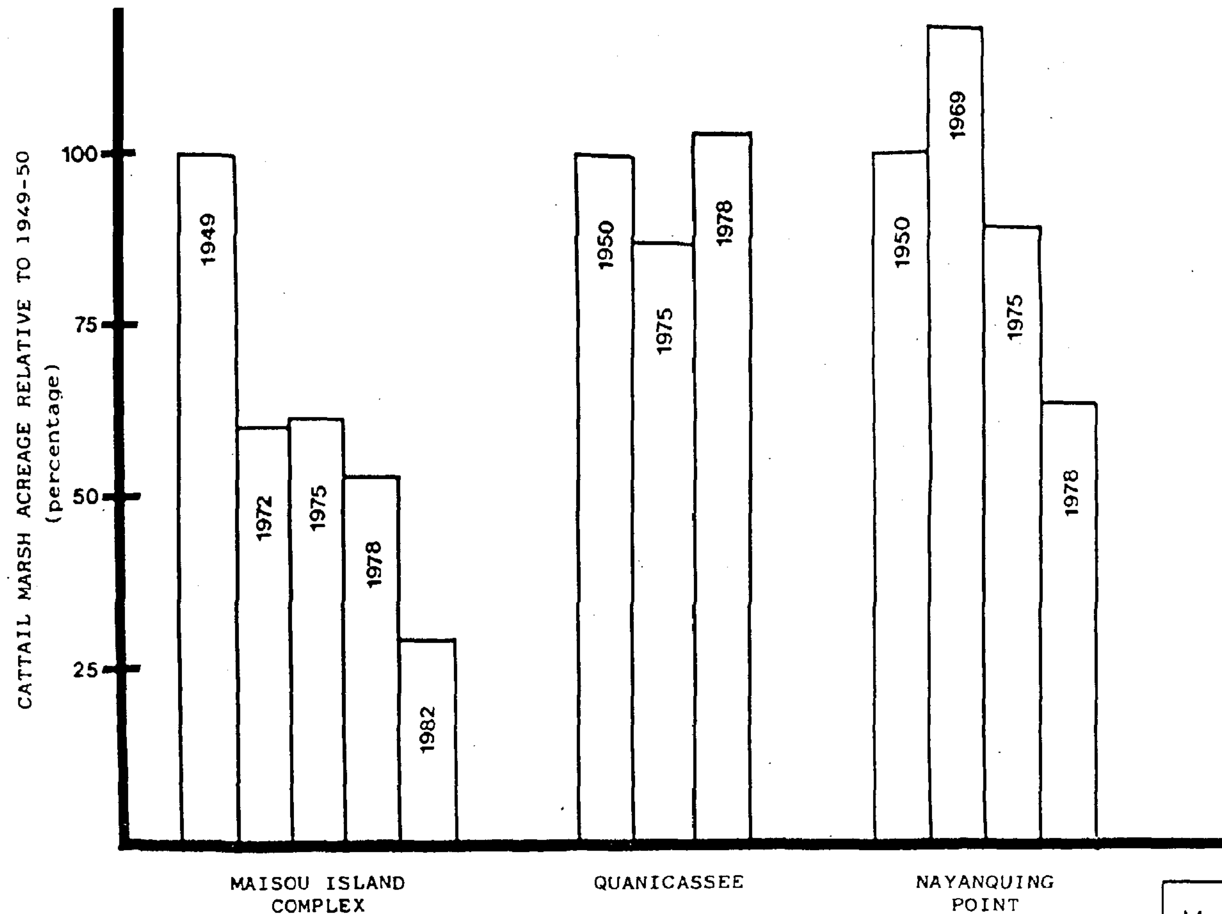
1. Erosion losses from the watershed increased sharply due to clearing of woodlands and drainage of wetlands. This sediment loading increased mud flat acreage in the Maisou Island area, a habitat in which cattails can displace bulrushes and wild rice.

2. Water-borne plant nutrient levels increased due to human settlement. Again, cattails compete well in high-nutrient settings and can be expected to displace bulrushes and wild rice.

Studies by Enslin and McIntosh (1982) quantified more recent trends in wetland acreage for specific study zones. The Maisou Island complex suffered losses of 2,364 acres from 1949 to 1978. This was 40 percent of the 1949 acreage, and more than twice the percentage loss at Quanicassee and Nayanquing Point (refer to Figure 3).

Since 1978, riparians and visitors to the Maisou Islands have observed accelerated, massive die-outs of cattail marshes. Enslin and McIntosh suggested high water levels may have influenced marsh survival from 1949 to 1978. However, loss rates in the Maisou complex were substantially higher than general losses in Saginaw Bay. Since 1978, on-going losses have been observed in protected embayment marshes, in water depths typically colonized by cattails. These observations led to the suggestion that high water, alone, may not explain the loss of marsh acreage in the Maisou complex. Saginaw Valley Waterfowlers Association retained MIDWEST WATER RESOURCE MANAGEMENT (MWRM) in June, 1983, to conduct an investigation of marsh losses in the Maisou complex.

Figure 3. Changes in acreages of major Saginaw Bay marshes relative to 1949-50 levels. Acreage values were taken from Enslin and McIntosh (1983); 1949-50 levels serve as the 100% marker. Subsequent acreages are given as the percentage remaining relative to the 1949-50 levels.



Preliminary Field Studies

MWRM staff conducted site visits to offshore wetlands from near the mouth of the Sebewaing River, north to Heisterman Island in Wildfowl Bay. These visits spanned June through October, 1983, and the ice-free season of 1984. During early site visits, MWRM staff were assisted by long-time residents of Sebewaing and Wildfowl Bays in familarization with the region's extensive marsh areas and their recent history.

Marsh areas from near the Sebewaing River mouth, north to DeFoe Island have been reduced to a small remnant of their 1972 acreages. These cattail stands were growing in 2 to 3 feet of water, with full exposure to wave and ice action. Recent high water levels seem to provide an acceptable explanation for the decline of these deepwater stands.

From DeFoe Island north to the Bayport Cut, between Maisou and Heisterman Islands, a substantially different pattern has developed. The gravel and rock reef which extends from DeFoe Island to the southern point of Maisou Island is colonized by cattail stands in 3 to 4 feet of water. These areas appeared healthy, and long-time observers report only slight decline in these stands since 1978. However, embayment marshes of Maisou and Middle Ground Islands have suffered rapid, massive losses since 1978. Active die-out areas were found in cattail stands at ½ to 1-½ foot depths. High water, alone, does not provide an adequate explanation for marsh losses in the embayment areas, particularly in view of the success of DeFoe Reef marshes which are fully exposed to wave and ice action.

Studies which followed the intial site visits focused on differences between habitat conditions in DeFoe Reef and Maisou/Middle Ground Island embayments. The objective of this approach was to detect critical habitat factors responsible for cattail losses in the embayments - factors presumably absent or reduced on DeFoe Reef.

Air photo analysis of the marsh losses confirmed the observation that embayment marshes had suffered the greatest declines between 1972 and 1982. More than 630 acres, roughly half, of the cattail stands had died. DeFoe Reef populations had been relatively stable, with two stands adjacent to DeFoe Island the only ones to disappear.

Ground level studies to support air photo analysis revealed large areas of dead cattail root mats in areas where live stands had been seen in 1972 photos. Water depths in the embayments ranged from one to three feet, as measured from the water surface to the top of the cattail root mat. In areas where the root mats broke from the bottom, water depths had become greater, up to four feet in some areas.

During July, 1983, detailed examinations were made on dying stands of the main embayment of Middle Ground Island. Cattail plants had grown, apparently normally, early in the growing season. Typically, 10 to 15 leaves grew to 6 feet in height from each branching point, or node, on the underground stem. These early leaves were green and healthy in appearance.

Then, sometime in June, young leaves died after reaching ½ to 2/3 of their normal height. By July, insects had attacked the leaves underwater, flooding the underground stems. Plants were rotting and leaves had fallen or were weak enough to be easily pulled out by hand.

By late August, remaining plants in the die-out areas showed no further damage, although the stands had reduced considerably in density. Flower production in the die-out areas was generally absent, in contrast to healthy areas of the embayments and DeFoe Reef populations. These areas had no growth at all during 1984 and the die-out was complete. New areas of die-out progressed during 1984 in the same zones as 1983.

FY 1985 Studies

Studies initiated during 1983 and 1984 showed that the Maisou Island complex had suffered alarming losses of emergent plant stands. High water could not be isolated as the sole habitat variable forcing the observed losses. Yet, potential management efforts to stabilize and possibly restore these marshes require full evaluation of habitat variables and their influence on the Maisou wetlands.

FY 1985 studies were developed to determine historical patterns of marsh expansion and contraction, and to assess the importance of several variables in Maisou marsh dynamics. Among these variables were water levels, sediment quality, siltation rates and muskrat and rough fish activities.

A series of study objectives, in two phases, was developed and incorporated into a memorandum of agreement between MWRM and MDNR Wildlife Division. Chief among these were:

1. Literature review - Survey available literature on cattails and marsh ecology, with particular reference to variables known to influence distribution of marsh plant species.

2. Air photo analysis - Quantitative historical study of marsh development through available aerial photography.

3. Correlation of water level changes with marsh expansion and contraction.

4. Field observations on the Maisou Island complex, including sediment quality, suspended sediment loadings and other variables which may become important in marsh management.

5. Examination of cattail species and hybrids.

LITERATURE REVIEW

Taxonomy and Distribution of Cattails

Cattails (*Typha* species) are widely distributed throughout North America. In the northeast third of the country, including Michigan, two species of *Typha* are commonly recognized. They are the common cattail, *T. latifolia*, and the narrow-leaved cattail, *T. angustifolia*. *T. latifolia* is characterized by its robust stature, producing broad leaves that project upright from a stout base and large fruiting heads or spikes that are positioned at a height nearly equal to that of the leaves. *T. angustifolia* can be distinguished from the common cattail by its narrower and generally longer leaves, slender base, and shorter, narrower spikes that are greatly overtopped by the leaves. Other characteristics that can be used for identification of cattails in the field are given in Table 1.

Stands of *T. latifolia* are generally found in relatively undisturbed habitats such as wet meadows, bogs, and along the margins of lakes, growing in regions with peaty soils that range from acidic to basic. The distribution of *T. angustifolia* is usually associated with basic, calcareous or somewhat saline soils. In general, it is restricted to habitats with unstable environments, such as artificial marshes, lakes with fluctuating water levels, and roadside ditches. In areas where environmental conditions strictly favor the growth of one species over the other, dense monospecific stands can be found. However, in habitats that provide an overlapping range of environments,

Table 1 . Descriptive Field Characteristics of Typha Species (after Hotchkiss and Dozier, 1949).

CHARACTER	T. LATIFOLIA	T. ANGUSTIFOLIA	T. GLAUCA
Vegetative Structures			
A. Height	variable, 1-2 m or more	variable, 1-2 m or more	variable, often 2 m or more
B. Stem	stout	slender	slender
C. Leaf			
1. Width	usually 8-15 mm	usually about 5 mm	usually 6-12 mm
2. Shape	nearly flat	strongly convex on back	moderately convex on back
3. Color	light green	dark green	medium to dark bluish green
Reproduction Structures			
A. Mature Pistillate Spikes			
1. Color	dark greenish brown to reddish brown, becoming whitish	dark brown or reddish brown, becoming matted mottled dark brown and buff	reddish brown, becoming reddish brown and buff
2. Height of Spikes in Relation to Leaves	spikes moderately over-topped by leaves	spikes much overtopped by leaves, often by half their length	spikes moderately to much overtopped by leaves
3. Size	10-18 cm long; 1.8-3 cm in diameter	8-20 cm long; 1.3-2 cm in diameter	10-25 cm long; 1.8-2.5 cm in diameter
4. Distance between Pistillate and Staminate Spikes	usually none	variable, 0.5-12 cm; usually twice diameter of pistillate space	variable, 0-4 cm; usually less than diameter of pistillate spike

both species may co-exist. In such areas, genetic crosses between the two species may occur and result in the production of a hybrid population. Hybrids are recognized by some taxonomists as a separate species, T. glauca, that shows many characteristics which are intermediate between the parental species (Table 1).

In addition to habitat preferences, cattails, like other emergent wetland species, are also restricted by the maximum water level in which they can exist. In general, T. latifolia cannot grow in water greater than one foot deep, the hybrid, T. glauca, cannot grow in water greater than two feet, and T. angustifolia in water greater than three feet deep.

Growth of Cattails and the Influence of High Water Levels

Cattails are often the dominant emergent aquatic plant in wetland habitats and usually grow in dense stands covering vast areas of marshland. The ability of cattails to maintain their dominance and to spread aggressively throughout marshes is largely due to their tremendous capacity for vegetative reproduction. This is achieved through the growth and development of large underground rootstocks, also known as rhizomes. New shoots are produced from latent buds that develop and overwinter at the tip of the rhizome. With increasing temperatures in the spring, development of the bud into an upright shoot begins. This growth is dependent upon carbohydrate reserves that are stored over winter in the rhizome. As new shoots continue to grow and emerge from the water, the photosynthetic capabilities of the plant dramatically increase. By midsummer, the shoots are photosynthetically very active and produce carbohydrates in quantities that exceed the maintenance requirements of the plant. The excess carbohydrates are translocated to the rhizome and are used throughout the winter and the following spring as the sole source of energy. Plants overwinter with some of the aerial shoots remaining attached to the rhizome. These shoots serve an important purpose. They provide a pathway for the transport of oxygen from the atmosphere to the rhizome, which is buried in sediments of low oxygen content. Oxygen transport is necessary to meet the respiratory requirements of the rhizome, not only during the winter but throughout the growing season as well. In the following spring, growth of latent buds is initiated and the growth cycle is again repeated.

Vegetative growth in cattails is extremely effective; growth increases of up to 17 feet per year have been reported. Although it is highly competitive in wetland habitats, continuous growth of cattails from year to year requires the successful completion of the entire growth cycle.

High water levels appear to disturb the growth of cattails in two major ways. First, with increasing water depths, the leaves of cattails grow taller. Since more of the plant's biomass is allocated to shoot production, less of the available energy is stored within the rhizome. The capacity for vegetative reproduction is reduced, and results in a decline of the cattail population. High water levels, especially during the winter, may also result in damage to the shoots. Once the leaves become submersed, the connection with the atmosphere is lost and oxygen is no longer supplied to the rhizome. The rhizome usually cannot survive under these conditions for extended periods of time. An abrupt decline in the cattail population is observed the following spring.

Recovery of Cattail Marshes

Cattail marshes are frequently subjected to natural disturbances such as fluctuating water levels, ice or wind damage, and the destructive activities of muskrats. The recovery of the marsh is greatly influenced by the water level regime following such disturbances. Under low water conditions, vegetative reproduction of the surviving rhizomes is favored. In addition, germination of cattail seeds may also occur on exposed mudflats. Recovery of the marsh back to the original community can occur within a single growing season. However, if high water levels follow the disturbance, flooded conditions prevent the germination of cattail seeds, and vegetative growth of surviving rhizomes is curtailed. In many areas, large mats of decaying rhizomes are freed from the sediments. This results in the lowering of the marsh floor and the development of small ponds. Under high water conditions, recovery of the marsh is delayed until low water conditions prevail.

METHODS OF ANALYSIS

Air Photo Interpretation

Aerial photography of the Wildfowl Bay area during the period of 1937-1982 was obtained from the governmental agencies listed in Table 2. Photographs from a total of nine growing seasons were examined and include the following years: 1937, 1941, 1949, 1955, 1964, 1968, 1972, 1978 and 1982. Throughout this period, water levels fluctuated considerably, as shown in Figure 4.

An initial examination of photographs was conducted in order to establish an appropriate system of wetland classification. Each set of photographs differed in scale, date of photography, quality and image resolution (Table 2). Through an analysis of photographic images in combination with results from field studies, it was determined that four different vegetation categories could be identified for each set of photographs. These categories are upland vegetation, cattail marsh, grasses and sedges, and bulrushes and mixed emergents. Criteria of interpretation were established for each category and were based on tone, texture, pattern and density of the image. These characteristics are given in Table 3.

Eight vegetation maps were prepared. The quality of photographs for 1937 were too poor for confident interpretation. For each year, a base map was constructed from scale-expanded photocopies of photographs. Whenever

Table 2. Aerial Photography of Maisou Island Complex Used in Study.

YEAR	AGENCY	YEAR ISSUED	DATE PHOTOGRAPHED	SCALE	QUALITY	MAP PREPARED
1937	ASCS	1938	10/03/37	1:20,000	POOR	NO
1941	ASCS	1941	07/22/41-09/17/41	1:20,000	POOR	YES
1949	ASCS	1949	09/03/49	1:20,000	FAIR	YES
1955	ASCS	1957	10/28/55	1:20,000	GOOD	YES
1964	ASCS	1964	07/30/64	1:20,000	FAIR	YES
1968	USGS	1969	04/11/68	1:13,000	GOOD	YES
1972	ASCS	1972	06/17/72	1:40,000	GOOD	YES
1978	MDNR	1978	09/24/78	1:24,000	GOOD	YES
1982	ASCS	1982	08/12/82	1:40,000	FAIR	YES

Figure 4.

LAKE HURON WATER LEVELS, 1860 - 1983

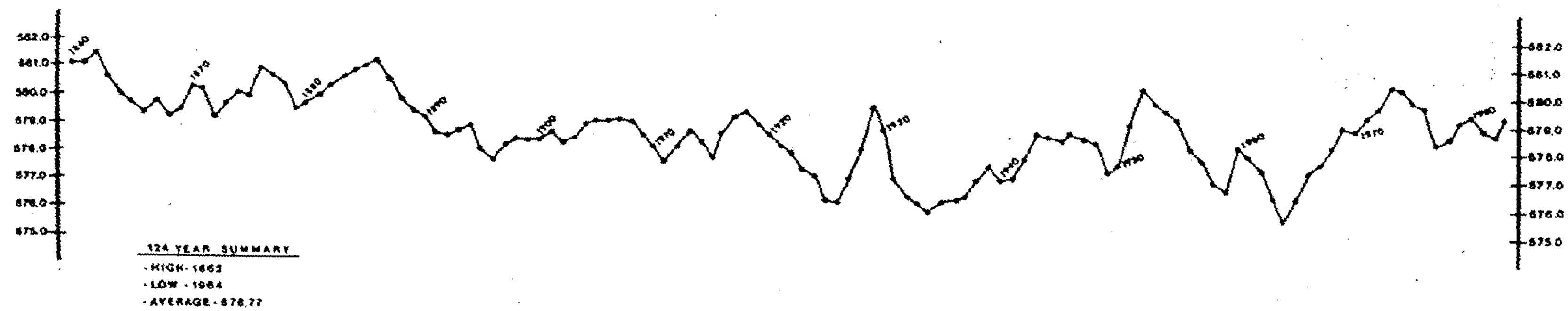


Table 3. Characteristics of photographic images used in classification of wetland vegetation.

VEGETATION CATEGORY	TONE	TEXTURE	REMARKS
UPLAND	Variable, depending on vegetation type, ranges from light to dark.	Variable, height uneven in wooded areas and smooth in grassy areas.	Vegetation dense. Boundary between upland and grasses and sedges difficult to delineate; sometimes occurring at ridges, other times drawn at point of gradation. Changes occurring within upland regions were not recorded.
CATTAIL MARSH	Variable, ranges from white to medium gray, depending on photographic exposure and contrast.	Height uneven, edges of undivided stands usually evident, at times undistinct.	Vegetation classified as cattail marsh whenever image present and may include other types of vegetation. Boundaries of cattail marsh drawn at edge of individual stands or may include several small scattered stands. Circular open areas often found within cattails, commonly containing muskrat lodges.
GRASSES AND SEDGES	Variable, usually light to medium gray.	Smooth in appearance, image somewhat granular, height not evident.	Vegetation dense, commonly found bordering edges of upland vegetation.
BULRUSHES	Charcoal gray to black.	Image diffuse, height not evident.	Vegetation sparse, commonly occurring near open water. Difficult to separate from submersed aquatics or silty areas.

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possible, overlapping frames were examined through a stereo viewer to identify vegetation categories and boundaries. These were then delineated and recorded on the base map. After completion, all base maps were sized to the same scale. It should be noted, however, that the scale accuracy of each map may vary somewhat due to irregularities in flight elevation and photographic angle.

Area statistics cited in this report were determined by overlapping a grid transparency onto the vegetation map, counting the number of squares occupied by each category and converting into acreage. The marsh complex was divided into five regions (Figure 5) and the area occupied by each of the three wetland categories within these regions was estimated. This was done in order to examine changes within the marsh in specific areas.

Sediment Analysis

Sediment samples were collected during July, 1985, for heavy metal and particle size analysis. Two 18-inch cores were collected from each of six locations shown in Figure 6 . For metals analysis, 250-ml aliquots were taken from the upper six inches of sediments using a bucket auger, and from the 12 to 18-inch depths by removing cuttings from a hammer-driven Shelby tube sampler. These samples were iced and delivered to Fishbeck, Thompson, Carr & Huber/Fairbrother Analytical Services (Grand Rapids) for extraction and analysis by inductively-coupled plasma emission spectroscopy. A

Figure 5. Map of Maisou Island complex showing the five regions examined in the study of changes in marsh coverage, 1941-1982.

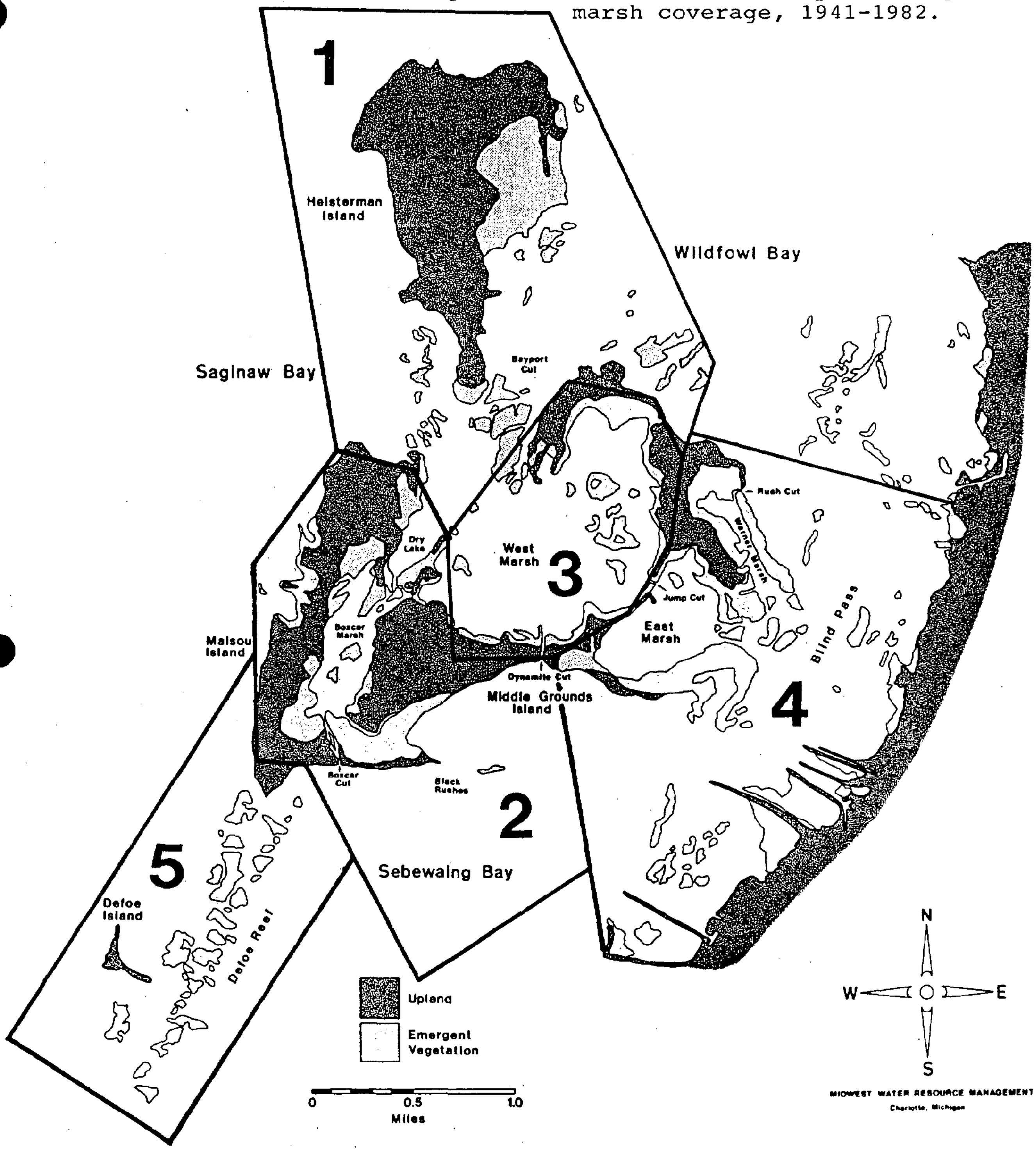
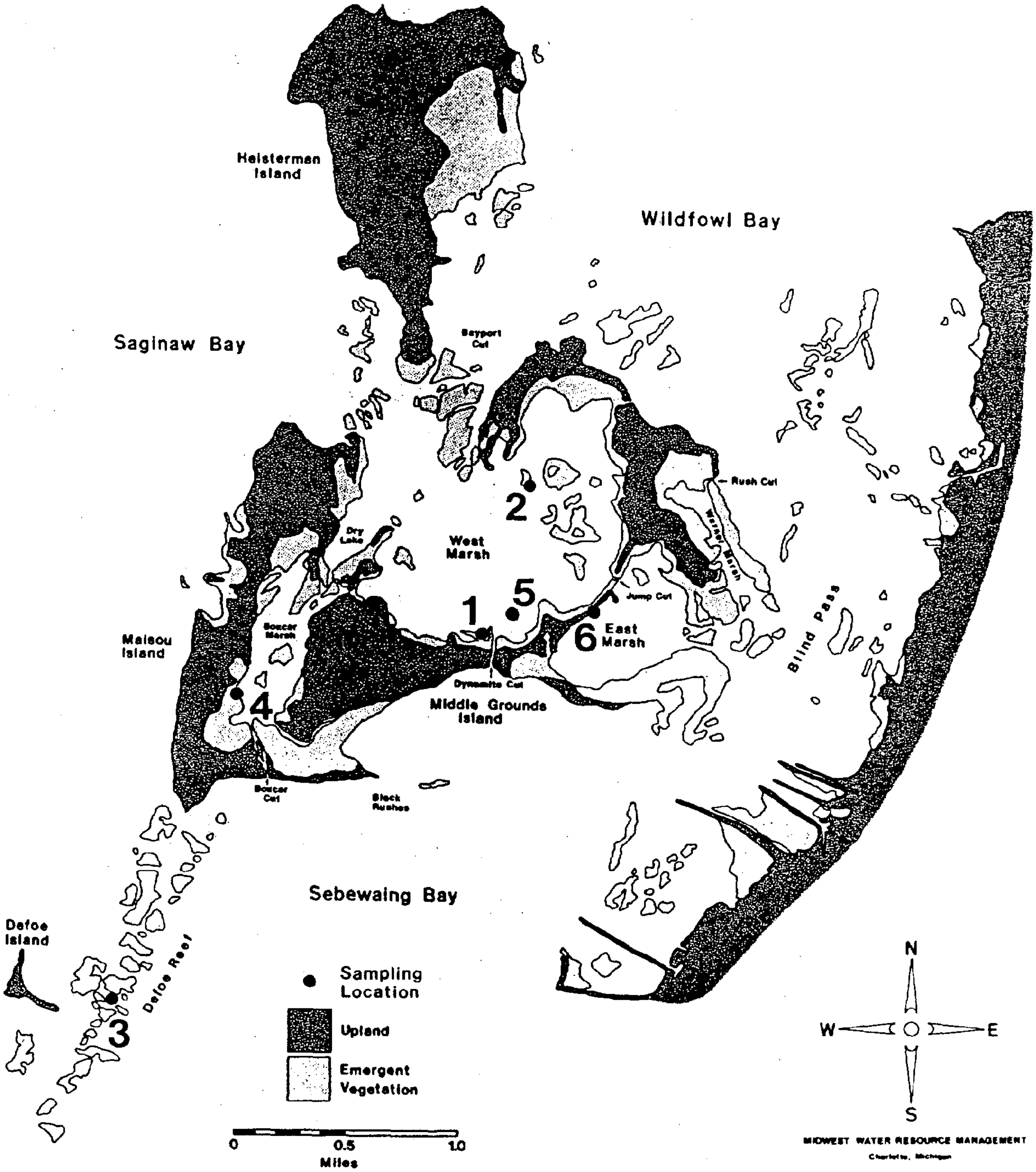


Figure 6. Locations for plant and sediment sample collection August 22, 1985.



second Shelby tube sample from each site was capped and returned to MWRM's laboratory for soil particle size analysis.

Soil Particle Size Analysis

Particle size distributions were determined by sieve analysis. Detailed procedures for this analysis are given in Appendix II.

Suspended Solids Deposition

Deposition rates for suspended solids were estimated for the main embayment region comprised of the Dry Lake and West and Boxcar Marshes. Two narrow channels connect this region with Bay Port Cut, to the north. Water samples were collected from each channel for filtration of particles larger than 0.45 microns. These glass fiber filters were dried to constant weight; suspended solids are reported as milligrams per liter. Discharge rates were determined in Boxcar and Dynamite Cuts with a Price-Gurley pygmy water flow velocity meter. We assumed that an equal flow passes through the broad channel at the north end (currect velocities in this area cannot be quantified easily). The net sediment deposition rate was calculated as the difference between incoming sediments (volume X concentration) and the outgoing sediments. Suspended solids samples were also collected in the Blind Pass, as an indicator of sediment concentrations by-passing the embayment areas.

Taxonomy of Cattail Marshes

Representative samples of cattails were collected from the exposed marsh of DeFoe Reef, from the Box Car region in an area of recent cattail expansion, and within the diminishing stands of the West Marsh near Dynamite Cut. These areas are designated as sites 1, 3, and 4 on Figure 6.

Samples were collected in August, 1985. By this time, the staminate (male) spikes had disappeared. Both floral and vegetative features were examined. Taxonomic identification followed characteristics given in Hotchkiss and Dozier (1949) (Table 1) and Fassett and Calhoun (1952).

RESULTS AND DISCUSSION

Aquatic Vegetation of the Maisou Island Complex (1941-1982)

1941:

In 1941, the wetland vegetation of the Maisou Island Complex was dominated by cattail marsh (Figure 7). Cattails accounted for more than half of the total vegetation and covered an area over three square miles (2024 acres) of the bay (Table 4). Large stands of cattails were located in offshore, wave-protected areas found to the east of Heisterman Island, throughout the West Marsh and from the East Marsh/Blind Pass region shoreward. Cattail stands were also present in the wave-exposed areas of DeFoe Reef, on the west side of Maisou Island and in the Bay Port Cut. The second most extensive class of vegetation in 1941 was the bulrushes and mixed emergents, occupying 1146 acres. Large stands were located in the offshore regions southeast of Middle Ground Island, an area locally known as the Black Rushes, and from Blind Pass shoreward. Scattered stands of bulrushes and mixed emergents were also identified near the shore of Maisou, Middle Ground and Heisterman Islands, and in areas bordering the cattail stands in the West Marsh. Grass and sedge communities, totalling approximately 655 acres (Table 4) were located in areas well-protected from wave action, commonly occupying the drier habitats bordering upland regions.

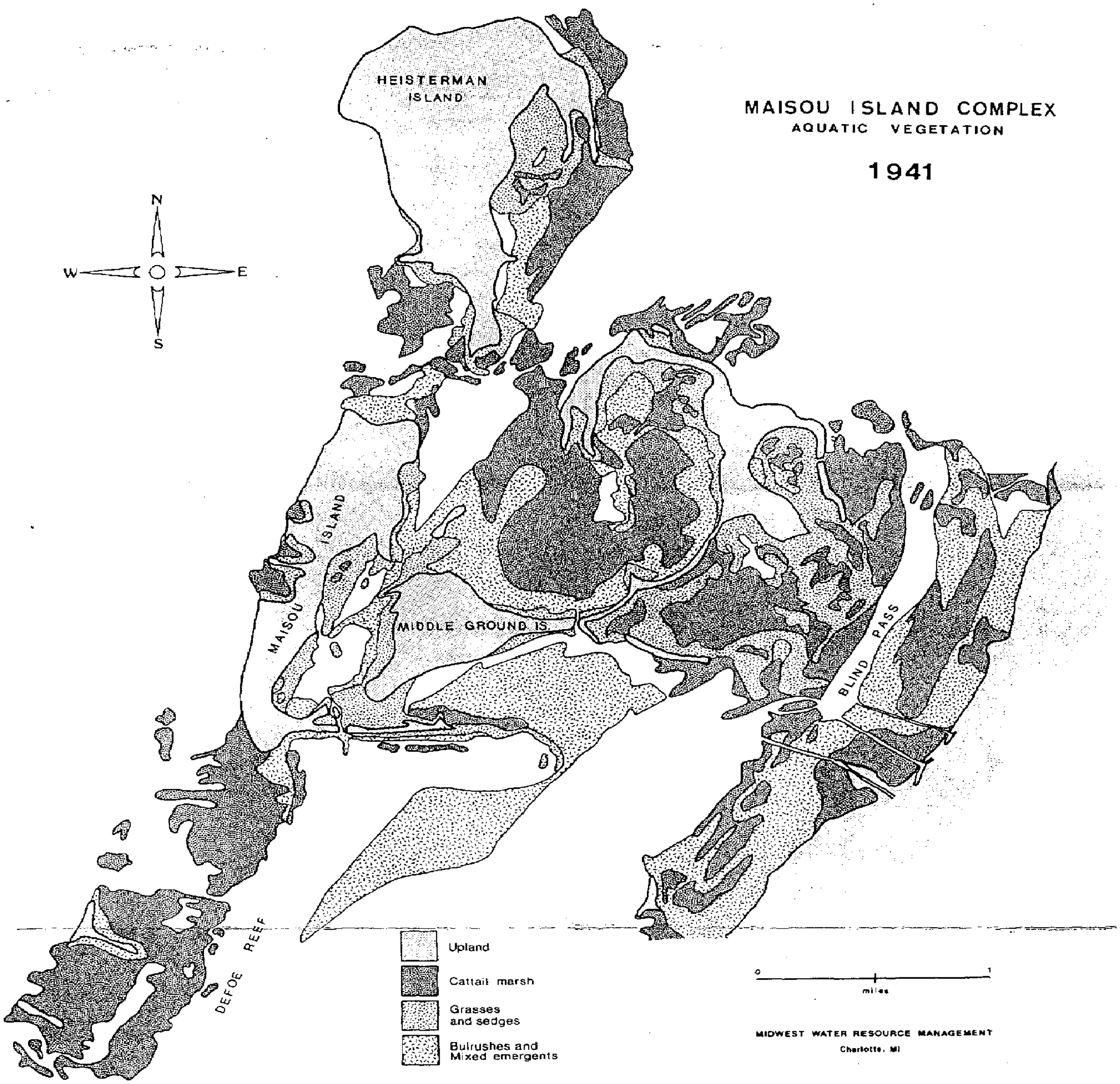

MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1941
HEISTERMAN ISLAND
MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEFOE REEF
N
S
E
W
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
0
1
miles
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

Figure 7.

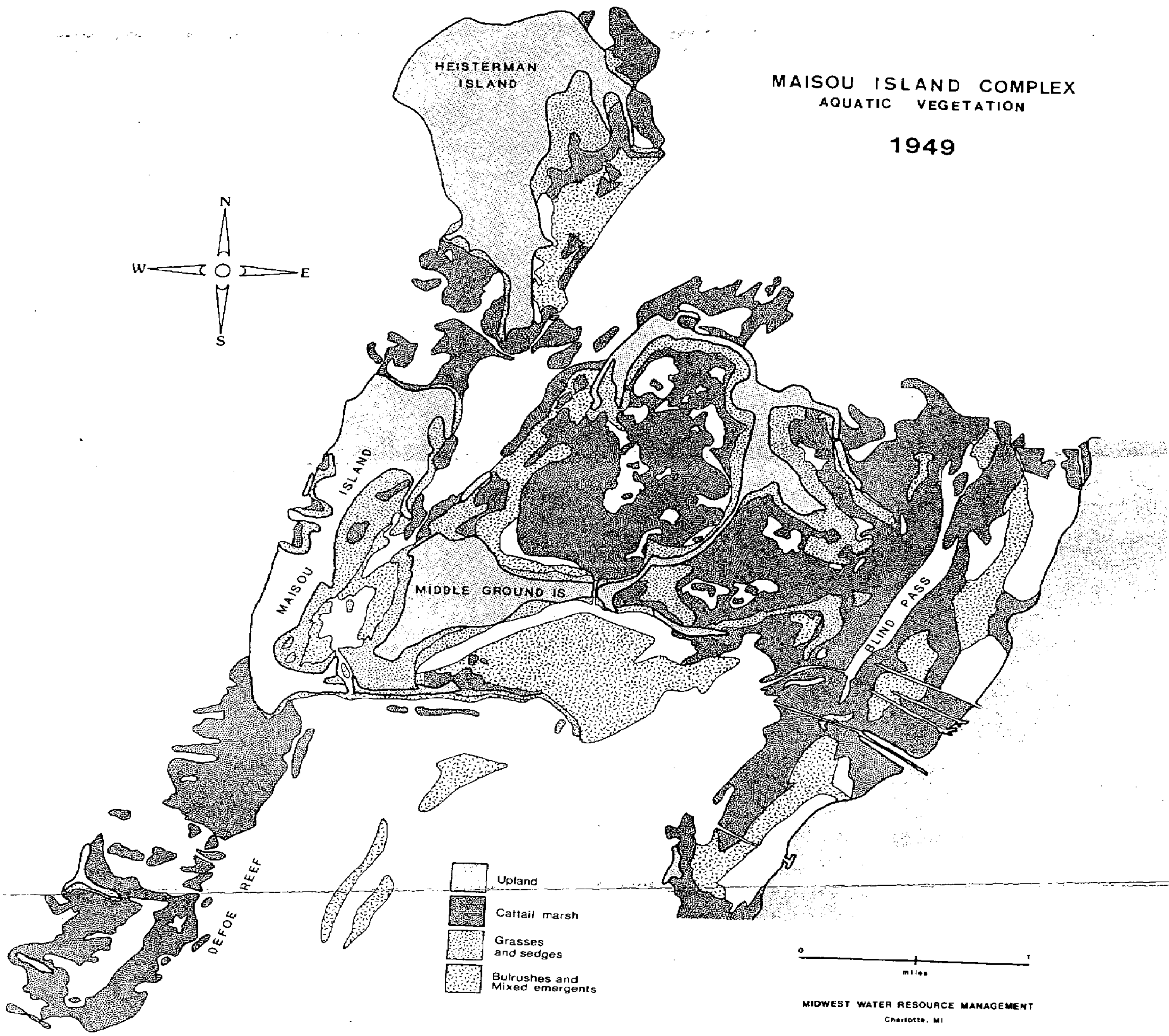
Table 4. Marsh vegetation of the Maisou Island Complex during the period of 1941-1982 (expressed in acres). Positive number indicates marsh expansion; negative number indicates marsh loss.

YEAR	CATTAIL MARSH	GRASSES AND SEDGES	BULRUSHES AND MIXED EMERGENTS	TOTAL WETLAND VEGETATION	CHANGE FROM PREVIOUS YEAR
1941	2024	655	1146	3825	
1949	2233	517	725	3475	-350
1955	1714	261	1064	3039	-436
1964	2467	570	555	3592	+553
1968	1975	451	356	2782	-810
1972	1302	262	228	1792	-990
1978	930	233	193	1356	-436
1982	817	264	165	1246	-110
NET CHANGE (1941-1982)	-1207	-391	-981	-2579	

1949:

Following 1941, water levels in Lake Huron rose about 1-1.5 feet, fluctuated around this level until 1948, and dropped one foot by 1949. The overall net change in water level during 1941-1949 was less than 0.5 foot. During this period, approximately 350 acres of the total wetland vegetation were lost from the marsh. This overall decrease was the net result of losses in both grass/sedge (138 acres) and bulrush/mixed emergent (421 acres) categories and an increase in cattail marsh (209 acres) (Table 4).

In 1949, cattails again dominated the wetland vegetation (Figure 8). Cattails were more abundant in 1949 than 1941, accounting for more than 60% of the total vegetation and covering an area of approximately 2233 acres. This increase is primarily the result of cattail expansion in the West Marsh and East Marsh/Warner Marsh/Blind Pass regions (14% and 25% increase, respectively) (Appendix I). In these regions, cattails occupied areas where grasses and sedges were present in 1941. A loss of cattail coverage was noted in the deep-water zone of the offshore region east of Heisterman Island. Cattail stands in the open water of DeFoe Reef, however, remained relatively unchanged during this period. Fewer bulrush and mixed emergent stands were identified in 1949; losses occurred in regions of the West Marsh, Black Rushes and from Blind Pass shoreward. The area occupied by grasses and sedges also diminished during this


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1949
HEISTERMAN ISLAND
N
W
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S
MAISOU ISLAND
MIDDLE GROUND IS
BLIND PASS
DEFOE REEF
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
0
1
miles
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

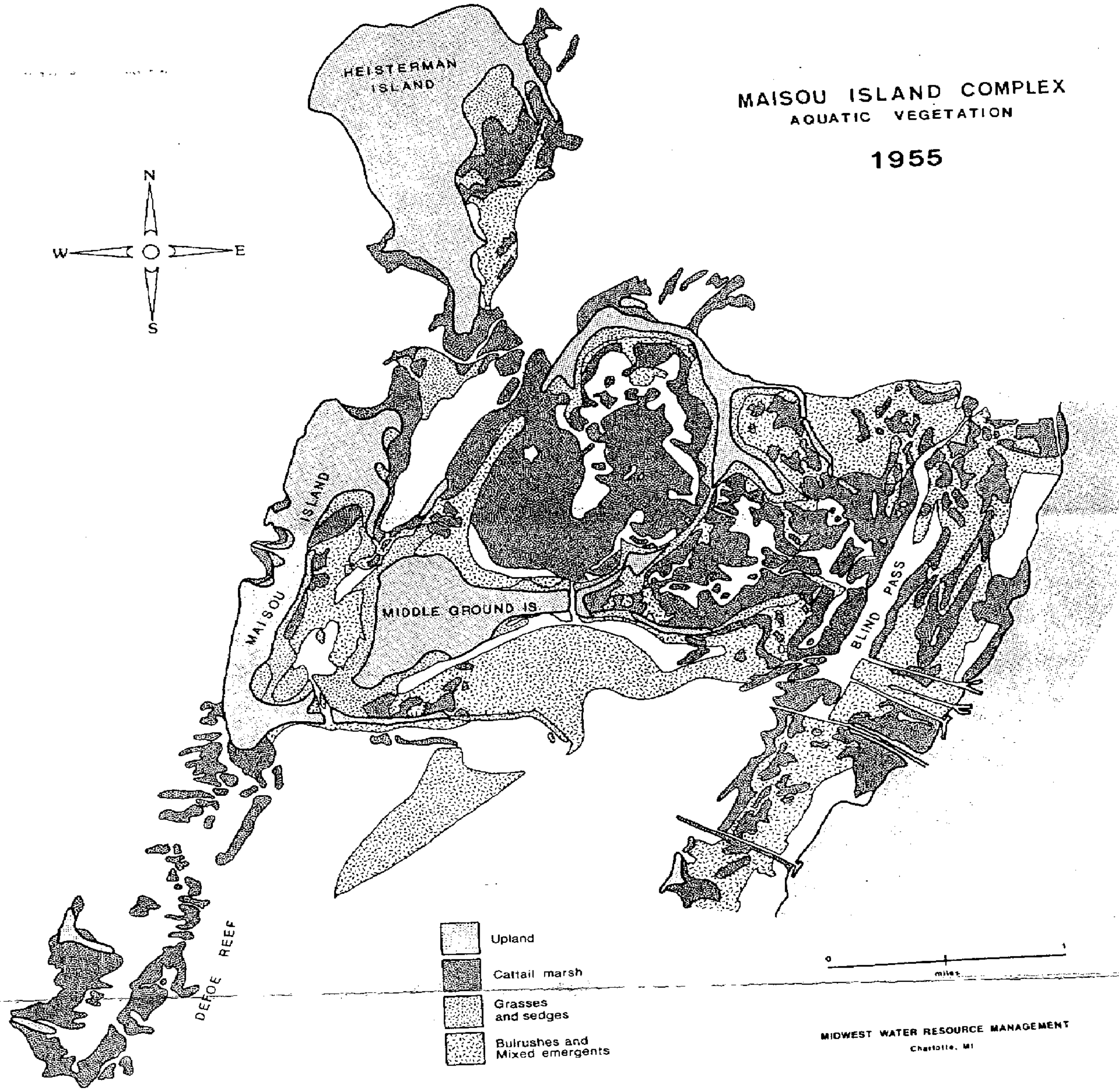
Figure 8.

period, however, largely due to invasion of cattails as described above.

<u>1955</u>:

Following 1949, water levels rose almost three feet by 1952 and subsequently dropped 1.2 feet by 1955. This resulted in an overall increase in the water level of 1.7 feet from 1949 to 1955. During this period, approximately 436 acres of the total wetland vegetation were lost (Table 4). This loss is the result of a net change in areas covered by each of the three categories. An overall loss of 519 acres within cattail marshes and 261 acres from grass/sedge communities occurred. Bulrushes and mixed emergents expanded their range by 1964, and accumulated a net increase of 339 acres.

Although a loss of more than 500 acres of cattail marsh occurred during this period, cattails maintained their dominance, accounting for more than half of the total vegetation. Areas of significant cattail loss include the offshore marshes of DeFoe Reef (222 acres) and in the East Marsh/Warner Marsh/ Blind Pass region (289 acres) (Appendix I). These losses resulted in the formation of large open-water areas, as shown in Figure 9 . The outer edge of grass/sedge communities retracted landward by 1955, restricting the range of its distribution. This recession resulted in a loss of 256 acres; less than half of the total area occupied by grasses and sedges in 1949 were present in 1955. Scattered stands of


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1955
N
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HEISTERMAN ISLAND
MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEROE REEF
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
0
1
miles
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

Figure 9.

bulrushes and mixed emergents replaced cattails and grass/sedge communities in these areas of decline.

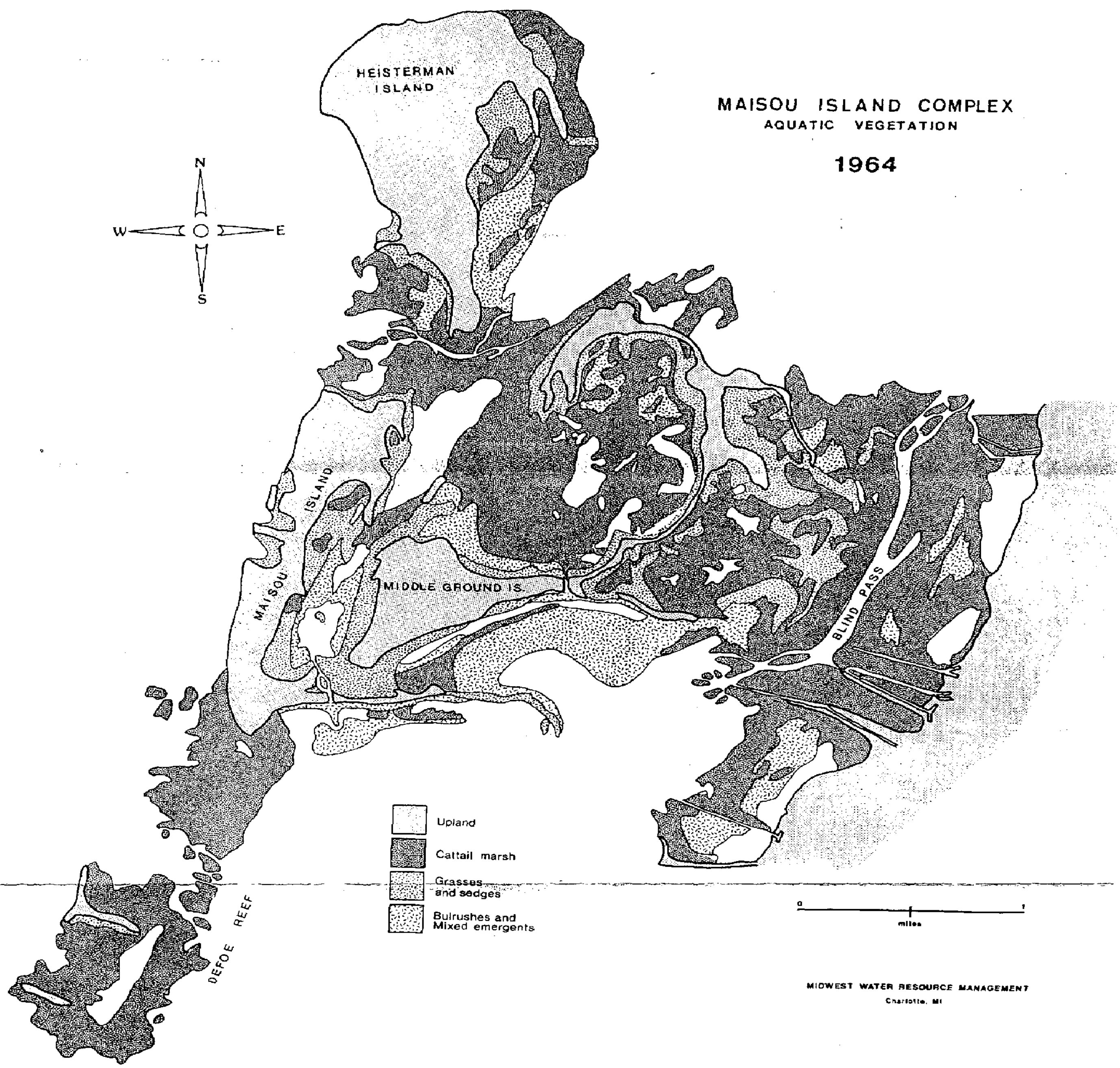
1964:

From 1955 to 1959, water levels in Lake Huron dropped by 2.3 feet, underwent an abrupt increase of 1.5 feet in 1960, then continued to decline. By 1964, water levels reached their historic low. These fluctuations resulted in a net decrease of 3.4 feet during the period of 1955-1964.

During this time interval, a net gain of 553 acres of total wetland vegetation was observed (Table 4). Both cattail and grass/sedge communities expanded significantly, representing an increase of 753 and 309 acres, respectively. By 1964, cattails re-entered the open water areas in DeFoe Reef and replaced bulrushes in areas within the East Marsh/Warner Marsh/Blind Pass complex (Figure 10). Grasses and sedges migrated into offshore regions and recolonized areas they occupied in 1949. Although these contributions are significant (1062 acres total), the net increase in marsh coverage is offset by dramatic losses within the bulrush/mixed emergent stands. These losses, totalling 509 acres, occurred in the regions of cattail and grass/sedge advancement discussed above, in addition to a reduction in the area of the Black Rushes.

1968:

After the 1964 low, water levels in Lake Huron rose rapidly, and resulted in a net increase of 2.5 feet by 1968.



MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1964
HEISTERMAN ISLAND
N
W
E
S
MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEFOE REEF
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
0
1
miles
MIDWEST WATER RESOURCE MANAGEMENT
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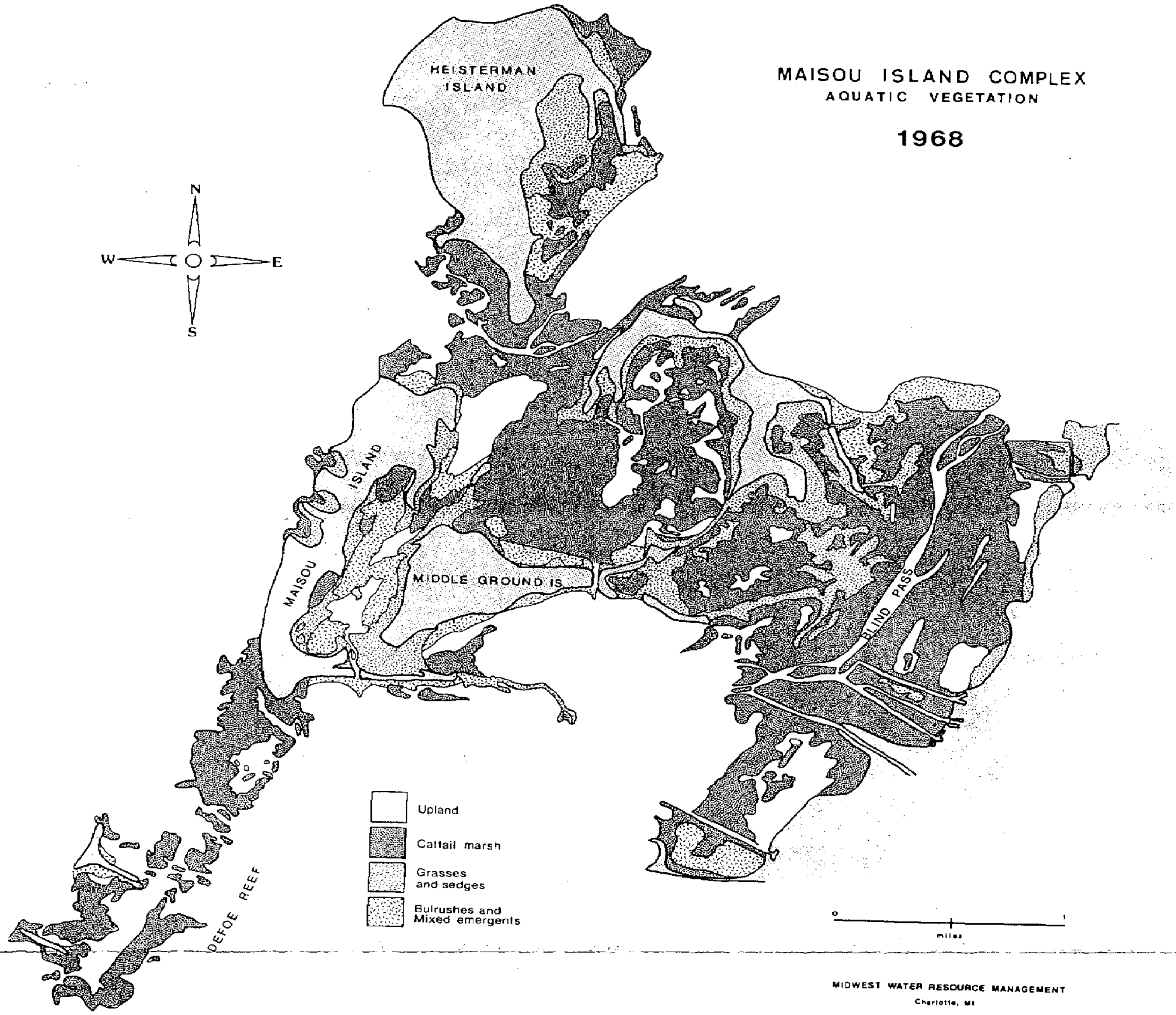
Figure 10.

During this four-year period, a total of 810 acres of marsh vegetation was eliminated (Table 4). In each of the vegetation categories, major zones of reduction were observed. Significant losses of cattail marsh occurred along the exposed edges of stands in DeFoe Reef (211 acres), and in the deep-water areas along the east side of Heisterman Island (117 acres) (Figure 11) (Appendix I). In the Box Car region, the outer edge of grass/sedge communities eroded shoreward, resulting in a loss of approximately half of the 1964 coverage (103 acres). Losses in the bulrush/mixed emergent category (158 acres) were primarily due to elimination of the Black Rush region, southeast of Middle Ground Island. In spite of these changes, cattails still dominated the marsh in 1968, occupying over 70% of the total wetland vegetation.

<u>1972</u>:

During the next four years, water levels continued to rise in Lake Huron and increased by nearly 1.5 feet in 1972. During this period (1968-1972), a total of 990 acres of wetland vegetation was eliminated from the marsh (Table 4). This represents a loss of 34% of the marsh as it existed in 1968, an area equivalent to roughly 1.5 square miles of vegetation.

As in 1968, losses occurred within each of the three wetland categories. The area covered by cattail marsh decreased 673 acres during this four period (Table 4). Losses were particularly evident in the well-protected embayment marshes,


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1968
HEISTERMAN ISLAND
MAISOU ISLAND
MIDDLE GROUND IS
BLIND PASS
DEFOE REEF
N
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W
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Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
miles
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

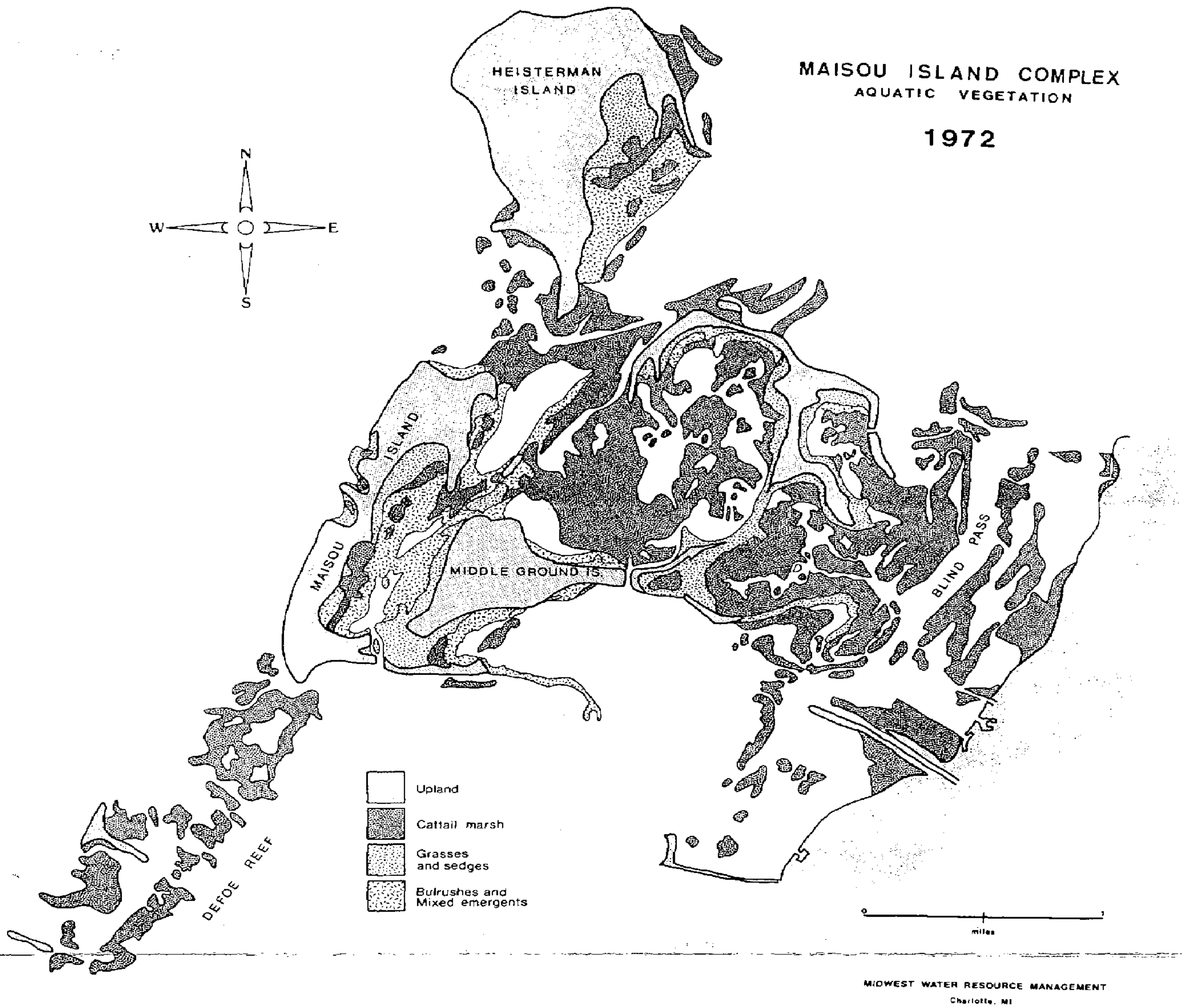
Figure 11.

occurring throughout the East Marsh/Warner Marsh/Blind Pass region, and along the outer edges of the massive cattail stand occupying the West Marsh (Figure 12). These losses together account for more than 500 acres of cattail marsh (Appendix I). Additional cattail losses occurred in the deep-water zone off the east shore of Heisterman Island, within the western exposed side of Bay Port Cut and in DeFoe Reef. Significant losses also occurred within the grass/sedge communities, covering an area of 189 acres throughout the marsh (Table 4). Losses in this category resulted from continued recession of the vegetation shoreward, and, as in the East Marsh, elimination of vegetation in the formation of open water areas (Figure 12).

1978:

Water levels in Lake Huron continued to rise, and by 1974 increased 1.6 feet. From 1974 to 1978, water levels declined approximately 2.8 feet. Overall, the water level during 1972-1978 fell by 1.2 feet. Throughout this six year period, an additional 436 acres of wetland vegetation were eliminated from the marsh (Table 4).

As in 1972, cattails suffered significant losses, totalling 372 acres. This represents approximately 85% of the total vegetation lost. Losses followed a similar pattern as those described for 1972 (Figure 13). Elimination of cattails throughout the West Marsh and East Marsh/Warner Marsh/Blind Pass regions continued, accounting for a total of 246 acres.


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1972
HEISTERMAN ISLAND
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MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEFOE REEF
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
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MIDWEST WATER RESOURCE MANAGEMENT
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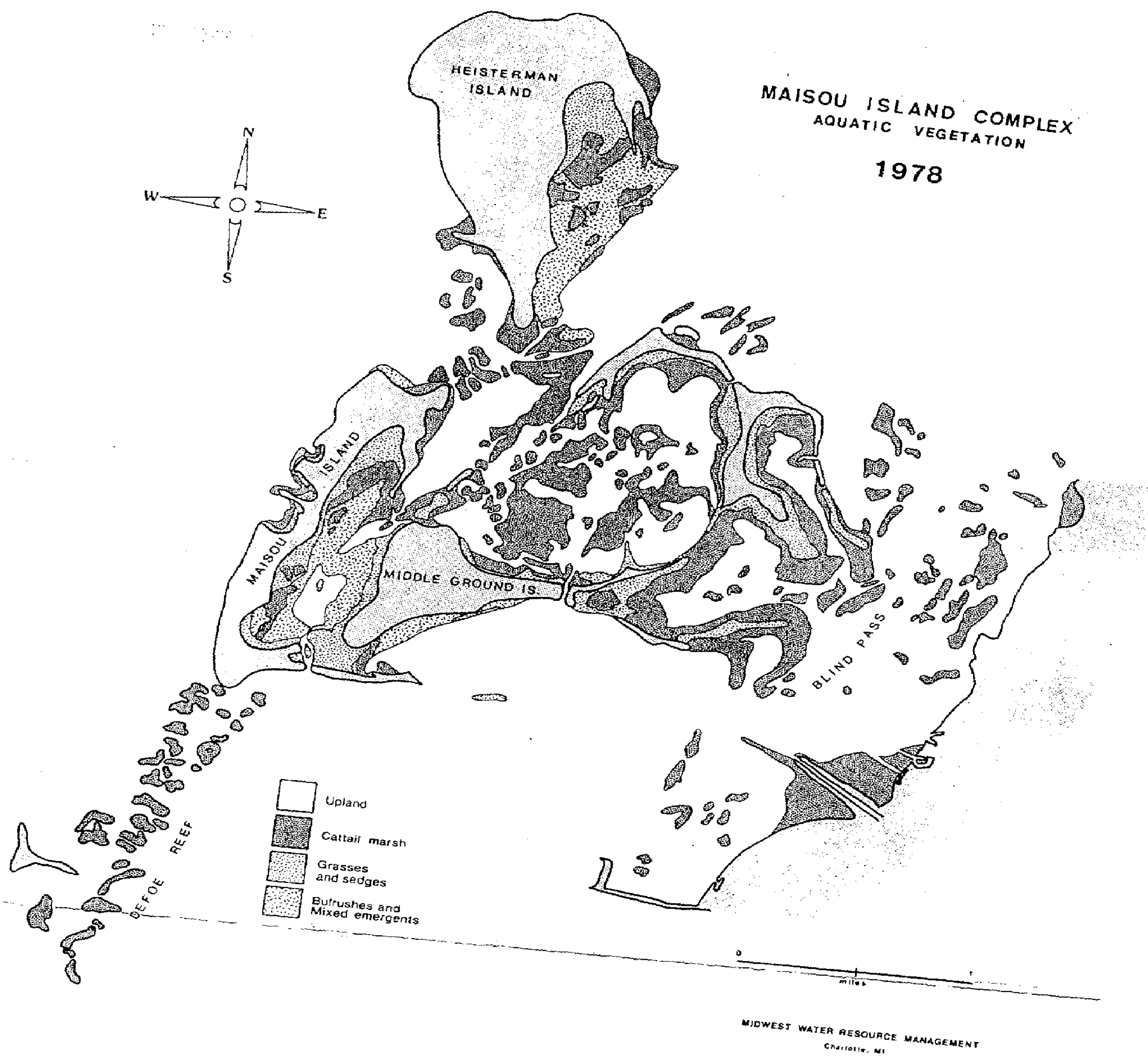
Figure 12.


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1978
HEISTERMAN ISLAND
MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEFOE REEF
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Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
miles
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

Figure 13.

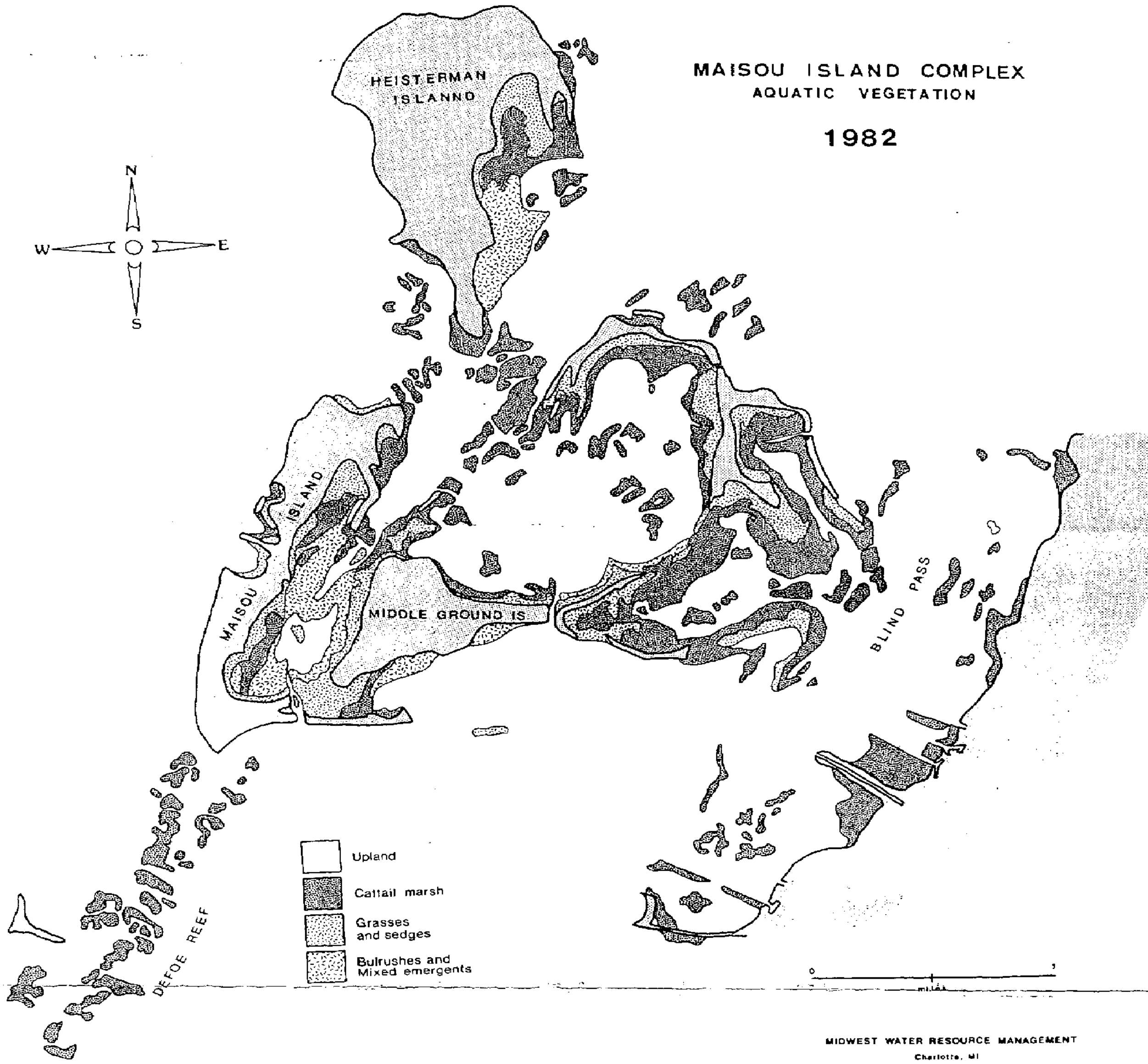
In DeFoe Reef, cattail stands diminished to less than 50% of levels present in 1972, suffering a loss of approximately 99 acres (Appendix I).

1982:

Following 1978, water levels increased by 0.7 feet in 1980 and decreased 0.7 feet by 1982. Overall, the net water level in Lake Huron remained unchanged during 1978-1982. Throughout this four year period, a total of 110 acres of wetland vegetation was lost from the marsh (Table 4). Cattail decline continued in the West Marsh (Figure 14). A total of 92 acres of cattails was lost in this region, representing over 83% of the total vegetation eliminated during this period (Appendix I). Areas of cattail die-off were located within the offshore stands, occupying the interior of the West Marsh. Cattail stands located in the remaining regions of the Maisou Island complex exhibited no significant losses or gains. The other vegetation categories investigated also showed no dramatic changes during this period.

Summary, 1941-1982:

Aerial photographs of the Maisou Island complex covering eight growing seasons during the period of 1941-1982 were examined extensively. Although these photographs represent only fragments of time during this 41-year interval, our observations on wetland vegetation types, their distribution, and changes in their abundance throughout this period show several significant and recurring trends. Specifically, our


MAISOU ISLAND COMPLEX
AQUATIC VEGETATION
1982
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MAISOU ISLAND
MIDDLE GROUND IS.
BLIND PASS
DEFOE REEF
Upland
Cattail marsh
Grasses and sedges
Bulrushes and Mixed emergents
0
MIDWEST WATER RESOURCE MANAGEMENT
Charlotte, MI

Figure 14.

analysis of the Maisou Island complex during the period of 1941-1982 shows:

1. The marsh is cattail dominated. Despite the massive cattail losses observed, cattails continued to be the most major category identified, and occupied 53-73% of the total wetland area throughout this period.

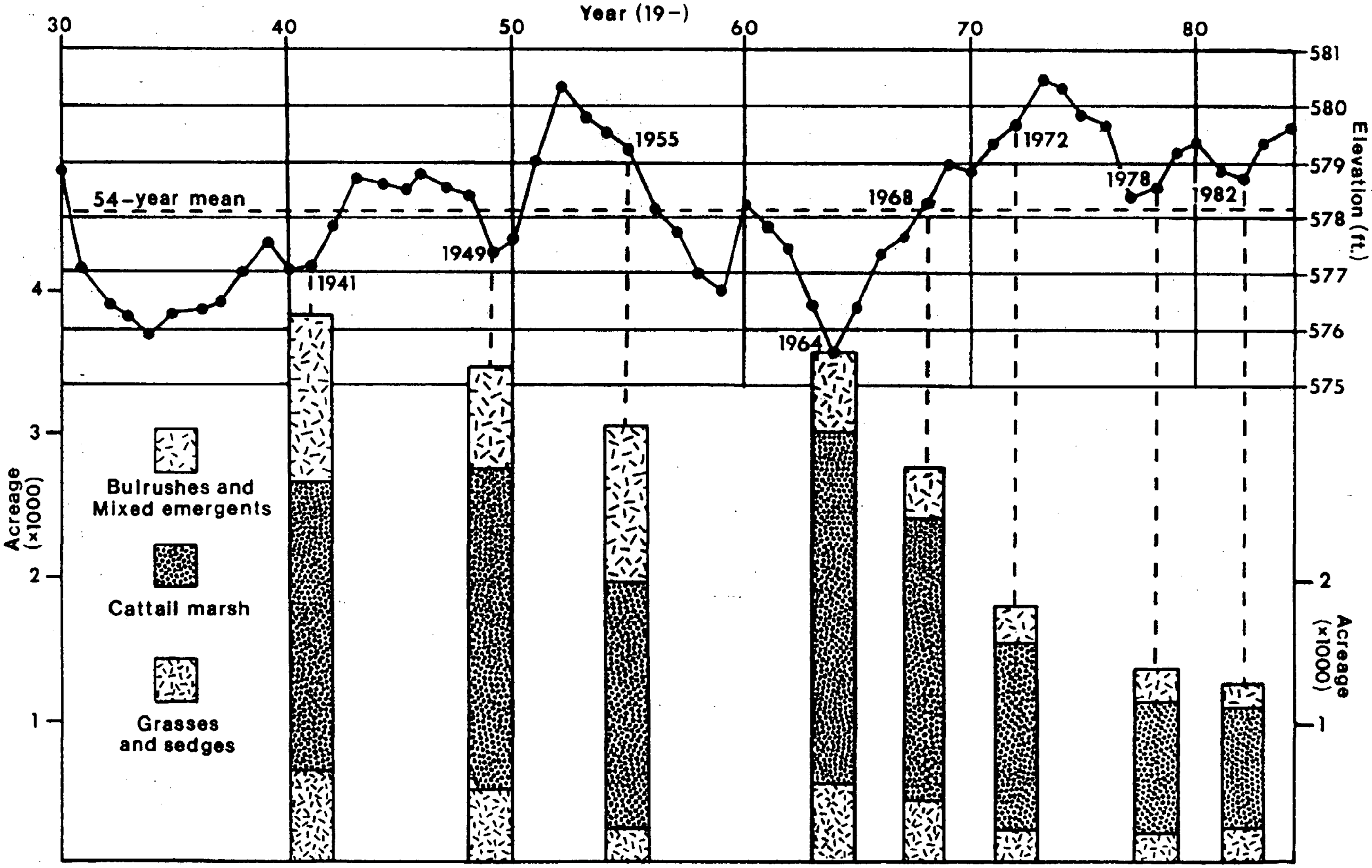
2. No major changes in the distribution of emergent vegetation types occurred. Although plant beds expanded and contracted throughout the years examined, no dramatic replacements of one vegetation type for another were noticed. In many areas of the marsh, distinct outlines and zonation patterns of plant beds and other marsh features remained unchanged from 1941 to 1982. This suggests that the distribution and zonation patterns of the marsh were well-established prior to 1941. Moreover, these patterns were highly stable under the variable water regimes.

3. The marsh has suffered significant losses. Our analysis estimates that approximately 6 square miles of wetland vegetation were present in 1941. By 1982, only 2 aquare miles remained. This represents a net loss of 4 square miles of wetland vegetation, an overall decrease to one-third of the marsh as it existed in 1941. Cattails suffered significantly, losing approximately 1.9 square miles throughout this period. In addition, 1.5 square miles of bulrushes and mixed emergents and 0.6 square miles of grasses and sedges present in 1941 had disappeared by 1982.

<u>Water Level-Marsh Relations</u>:

Water levels in Saginaw Bay fluctuated broadly throughout the period of 1941 to 1984. Two near-historic highs (1952 and 1973) and the historic low (1964) were achieved within the span of aerial photography coverage. Figure 15 plots marsh acreage and water levels to demonstrate their relationship.

Throughout the years examined, five periods of increasing water levels can be identified. These include 1941-1949, Figure **15**. Histogram of marsh coverage of the three wetland categories during the period of 1941-1982. Upper graph, a plot of mean annual water levels of Lake Huron (1930-1983).



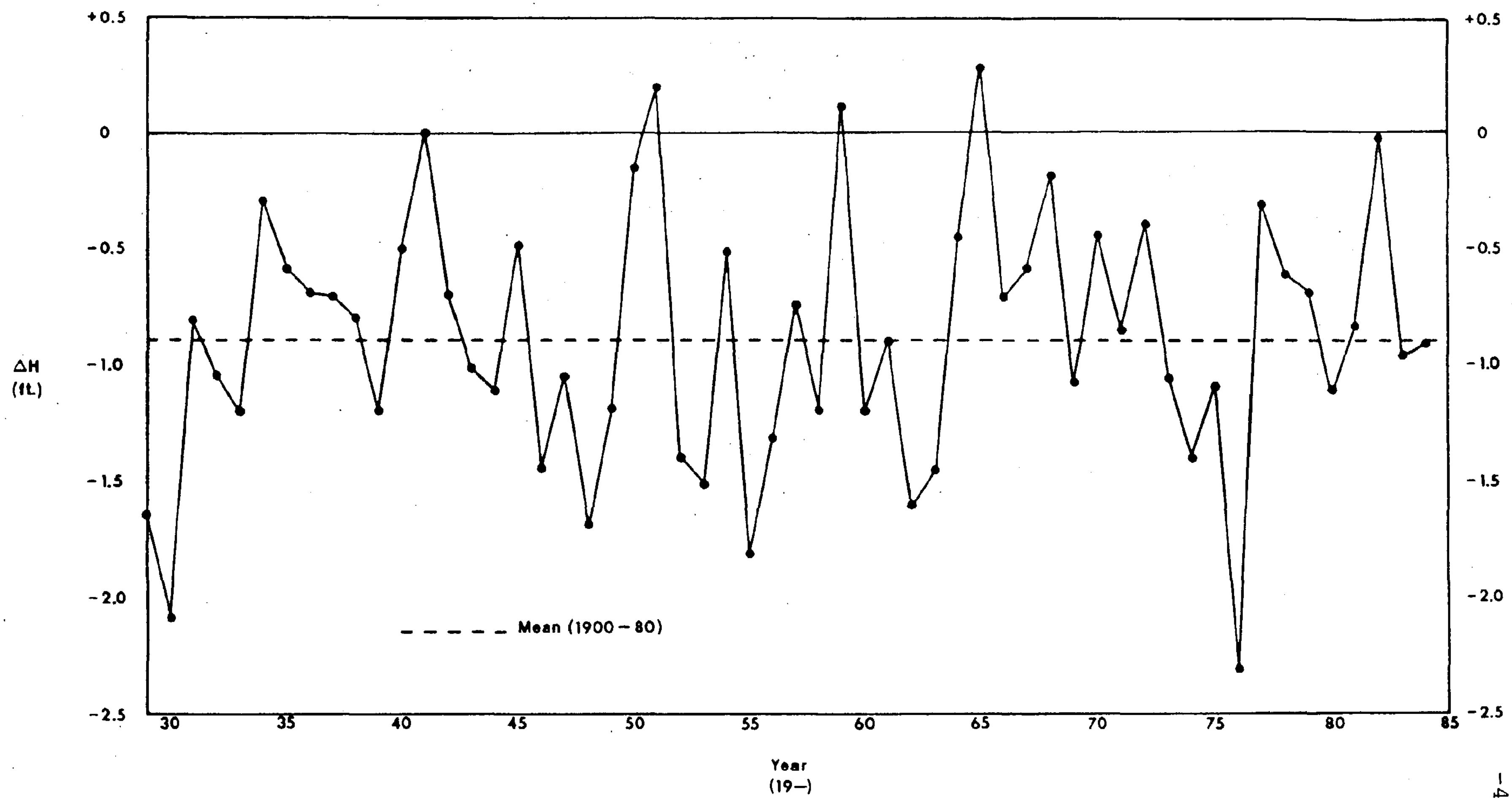
1949-1955, 1964-1968, and 1978-1982. During each of these periods, a decrease in the total area of wetland vegetation in the Maisou Island occurred. Water levels decreased during two periods examined, 1955-1964 and 1972-1978. The marsh expanded significantly between the years 1955 and 1964. However, from 1972 to 1978, losses in marsh acreage were observed. With the important exception of the period of 1972-1978, the relationship of increasing water with a decrease in marsh acreage and decreasing water levels with an increase in marsh acreage appears to follow a consistent pattern.

The magnitude of the change in marsh coverage in response to a given change in water level was not consistent over the study period. Moreover, it must also be concluded that the acreage which could be expected for any specific water level cannot be drawn from these data.

In an attempt to spot water-related forcing variables, a graph was developed to express the change in water level from growing season to the following winter (Figure 16). This variable, ΔH, is the difference between growing season mean water level (June, July, August) and the following winter mean (January, February, March). Typically, water levels decline from growing season to winter. An increase from growing season to winter can be expected to damage plant communities by flooding rhizomes through broken stems and leaves.

Figure 16 shows that 1941, 1951, 1959, 1965, and 1982

Figure 16. Difference between growing season water level (mean value of June 1-August 31) and the following winter season water level (mean value of January 1-March 31). Positive values indicate winter water levels higher than previous growing season. Dashed line indicates the 80-year mean of this variable.



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winter water levels likely stress emergent plant communities. Unfortunately, air photos were not available for growing seasons immediately following winter increases. Also, the period from 1972 to 1978, which is inconsistent with the trends shown in Figure 15, showed moderate to below-average winter levels, which should not stress overwintering of emergent plants. The noted decrease in marsh acreage from 1972 to 1978 remains unexplained.

1985 CONDITIONS

Muskrat Density

Muskrat activities, including feeding, feeding platform construction and lodge-building all consume emergent wetland vegetation. 1985 field surveys gave indications that muskrat activities may be exerting an excessive demand on vegetation production in the Maisou complex. Among the indications that muskrat populations currently exceed the optimal levels were:

1. Cleared areas surrounding individual lodges in the East Marsh have coalesced with those of neighboring lodges. Several cattail stands in the East Marsh have been eliminated entirely (see Figure 17).

2. Cattail rhizomes did not over-winter in many areas where lodges were present. This was indicated by standing dead leaves of 1984 stands, without new growth as of July, 1985.

3. Lodge and feeding platform construction from materials other than cattail exist. Available literature indicates that muskrats prefer cattails.

Low-level aerial photography was flown during October, 1985, to observe muskrat lodge densities throughout the Maisou complex. Three areas, the western fringe of the East Marsh, and the western halves of Boxcar Marsh and the Dry Lake, had lodge densities greater than 7 per acre. USGS air photos from 1968 were also examined: Several areas of the West Marsh, Bay Port Cut and Blind Pass had high lodge densities (5 to 7 per acre). Areas of high lodge density appear to correlate well with cattail loss zones in subsequent years, but the 4-year interval between photographs prohibits

Figure 17. Map showing current status of Maisou Island complex, 1985.

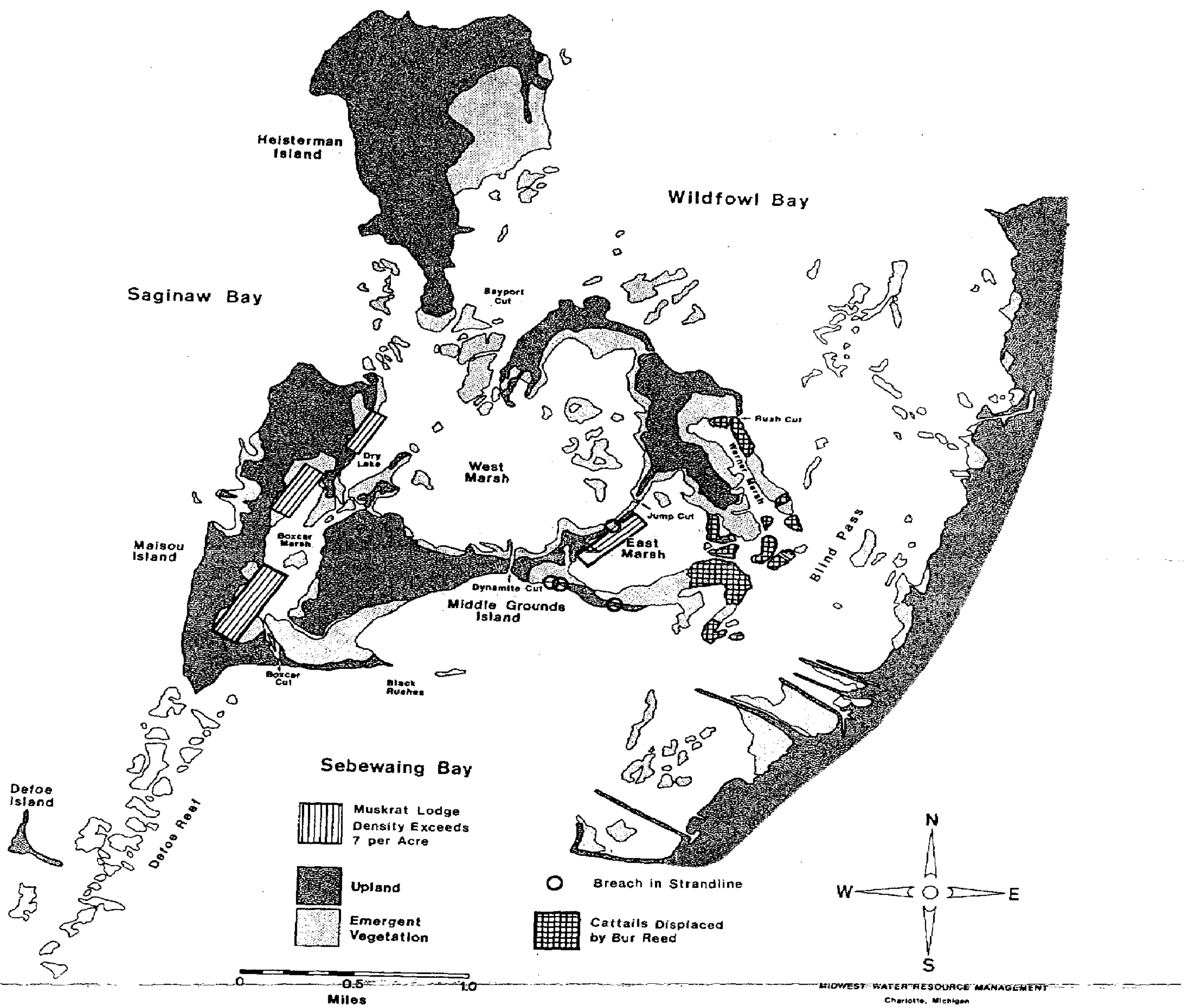

Figure 17.

detailed analysis. There is no question that muskrats are presently eliminating cattail stands which had been among the very stable features of the marsh over the past 44 years.

It is important to note that air photos show DeFoe Reef stands have not had muskrat populations since before 1972. Cattail acreage in DeFoe did not change significantly during the subsequent ten years.

Bur Reed Expansion

Large areas of the East and Warner Marshes show increasing stands of bur reed (*Sparganium eurycarpum*). These were first observed during 1983 field studies. Black and white photography cannot be used to distinguish bur reed from cattail, so stands may have been present well before 1983. Ground truth surveys by MDNR personnel in 1970 and by Enslin and McIntosh (ca. 1982) did not report bur reed.

Bur reed populations for 1985 were located by ground truth during August, and by low-level color aerial photography in October. Bur reed stands develop a dark, red-brown color in October, while cattails turn to a light tan. Major beds of bur reed are shown in Figure 17. Other, small stands are now found near Dynamite Cut and in the Boxcar Marsh.

Breaches

High water levels and wave action are causing several sections of barrier strand to breach, opening embayment marshes to increased waves and siltation. Four such areas are shown in Figure 17. Continued high water will likely cause destruction of the ridge separating the East and West Marshes. The East Marsh will also be broadly exposed to Sebewaing Bay. It is very unlikely that these breaches will close naturally until water levels drop significantly.

Suspended Solids Loading

Discharge rates and total suspended solids (TSS) samples were collected during May, July, and August, 1985. These data are summarized in Table 5. Discharge and TSS values were used to calculate the solids loading on a per-day basis. Given southerly winds, Boxcar and Dynamite Cuts reach very high flow velocities, sometimes in excess of one foot per second. During May, influent loads reached 150,000 pounds dry weight per day. With effluent loads at 68,000 lbs/day, net deposition in the West Marsh was 82,000 lbs/day.

North winds caused flow reversals with flows again exceeding one foot per second. Under these conditions, there was a small net export of TSS from the marsh. But the prevailing southerly winds cause the embayment marshes to gain sediment much more frequently.

Rocking seiche conditions were observed during the July and August samplings. Flow reversals occurred over periods of several minutes. During August, these reversals prevented calculation of loading estimates.

Sediment Texture Analysis

Particle size analysis was conducted on hydrosoil samples

Table 5. Results of suspended sediment and water discharge analysis in the Maisou Island complex, May through August, 1985. Positive values indicate flow or loading into marsh; negative values show output from marsh. Replicate values TSS are given; mean value indicated parenthetically.

Sampling Location	Date	Total Suspended Solids mg/l	Discharge Rate (cfs)	Loading Rate (lbs/day)
Boxcar Cut	May 16	45.8, 45.0, 45.3(45.4)	+136	+33,076
	July 17	10, 15, 15(13.3)	-88	-6,270
	August 22	14, 12(13)	+61	+4,248
Dynamite Cut	May 16	40.0, 40.8, 46.0(42.3)	+517	+117,152
	July 17	10, 10, 10(10)	-548	-29,356
	August 22	7.0, 5.0(6)	-414	-13,307
Bayport Cut	May 16	18.2, 20.3, 19.8(19.4)	-653	-67,864
	July 17	10, 10, 10(10)	+636	+34,071
	August 22	7.5, 7.0(7.3)	*	*
Net Loading (Σ inlets - outlets)	May 16			+82,364
	July 17			-1,555
	August 22			*
Blind Pass (by-passing marshes)	May 16	49.0, 55.3, 49.0(51.1)		
	July 17	30, 30, 30(30)		
	August 22	16, 17(16.5)		

*Variable winds caused frequent flow reversals.

from six locations, shown in Figure 6. Significant differences were found between sites, as given in Table 6.

All samples from West Marsh (sites 1, 2, 5, and 6) had very high clay/silt content; values ranged from 44 to 93 percent. Boxcar Marsh samples showed moderate clay content, approximately 30 percent. The clay/silt content of these hydrosoils is caused by suspended solids loading discussed above.

Hydrosoil samples from DeFoe Reef were very sandy, with clay/silt levels well below ten percent. Wave action on DeFoe Reef keeps clay/silt-sized particles in suspension, preventing deposition.

Clay/silt particles give us concern for three reasons: 1. Deposition of small particulates likely increases oxygen stress on cattail rhizome systems, especially during winter months; 2. Soil particles may carry contaminants such as herbicides and metals; and, 3. Silt/clay loads decrease light penetration into the water, lowering productivity of submersed plants.

Heavy Metals

Heavy metals derived from natural sources and industrial discharges can influence aquatic life forms, including emergent plants. Sediment samples from each of the six locations shown in Figure 6 were screened for heavy metal content. Results of these tests are shown in Table 7. None of the observed values exceeded the range of natural variability of hydrosoils, especially in view of the high clay/silt

Table 6. Results of soil particle size analysis for six sites in the Maisou complex. Results are given for upper (U), middle (M), and lower (L) portions of 24-inch hammer-driven Shelby tube samples. Sample locations are shown in Figure 6.

Depth	% Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Silt/Clay	Notes
[SITE 1]						
U	--	--	--	--	--	Root Mat/Peat
M	0.30	6.12	4.89	6.04	81.76	
L	0.15	2.72	14.38	16.42	65.56	
[SITE 2]						
U	--	--	--	--	--	Root Mat/Peat
M	--	--	--	--	--	Fibrous Peat
L	1.49	8.30	18.37	19.02	51.23	
[SITE 3]						
U	--	--	--	--	--	Root Mat
M	5.54	8.80	35.98	41.67	6.96	
L	1.22	2.43	30.64	61.14	2.78	
[SITE 4]						
U	--	--	--	--	--	Root Mat/Peat
M	7.06	15.34	18.90	23.04	34.52	
L	19.97	11.05	18.73	25.83	23.49	
[SITE 5]						
U	--	--	--	--	--	Root Mat/Peat
M	0.10	0.48	2.36	6.85	88.05	
L	0.0	0.26	0.55	4.90	93.30	
[SITE 6]						
U	--	--	--	--	--	Root Mat/Peat
M	0.20	11.61	10.00	30.60	44.01	
L	0.36	8.33	15.50	17.38	56.00	

Table 7. Results of Chemistry Analysis on 18-inch Sediment Cores Collected at Six Sites in the Maisou Island Complex. Analysis was Conducted for Materials Collected in Both the Upper and Lower Portion of Each Core. All Values are Reported as mg/kg dry weight. Detection Limits are Given Parenthetically; These Limits Vary with Sample Moisture Content.

ANALYSIS RESULTS†

Site	Segment	Al	Cd	Ca	Cu	Fe	Pb	Mg	Mn	Ni	Zn
1	Upper	2800 (0.23)	0.45 (0.23)	19000 (0.23)	6.1 (0.47)	3500 (0.47)	23.0 (2.4)	8900 (0.23)	93 (0.23)	4.7 (0.94)	30 (0.19)
	Lower	4500 (0.33)	0.79 (0.33)	96000 (0.33)	6.4 (0.66)	11000 (0.66)	9.3 (3.3)	25000 (0.33)	280 (0.33)	11 (1.3)	40 (0.26)
2	Upper	1900 (0.37)	<0.33 (0.33)	2800 (0.33)	4.3 (0.74)	3700 (0.74)	4.4 (3.7)	920 (0.33)	37 (0.33)	3.5 (1.5)	34 (0.30)
	Lower	2700 (0.25)	0.33 (0.33)	18000 (0.33)	2.4 (0.51)	4400 (0.51)	<2.5 (2.5)	11000 (0.25)	98 (0.25)	5.1 (1.0)	35 (0.20)
3	Upper	1900 (0.27)	0.33 (0.27)	12000 (0.27)	3.3 (0.54)	3300 (0.54)	<2.7 (2.7)	6100 (0.27)	35 (0.27)	4.5 (1.1)	34 (0.22)
	Lower	900 (0.25)	<0.25 (0.25)	8300 (0.25)	0.80 (0.50)	1800 (0.50)	<2.5 (2.5)	3400 (0.25)	29 (0.25)	1.4 (1.0)	16 (0.20)
4	Upper	4900 (0.28)	0.74 (0.28)	64000 (0.28)	3.6 (0.56)	7800 (0.56)	<2.8 (2.8)	27000 (0.28)	94 (0.28)	9.2 (1.1)	59 (0.23)
	Lower#1	930 (0.13)	<0.13 (0.13)	15000 (0.13)	0.36 (0.26)	1300 (0.26)	3.0 (1.3)	5000 (0.13)	27 (0.13)	1.5 (0.51)	10 (0.10)
	Lower #2	1100 (0.11)	0.20 (0.11)	40000 (0.11)	1.8 (0.22)	1700 (0.22)	1.6 (1.1)	12000 (0.11)	38 (0.11)	2.0 (0.44)	11 (0.09)
5	Upper	3700 (0.39)	0.43 (0.39)	28000 (0.39)	3.1 (0.78)	4700 (0.78)	<3.9 (3.9)	11000 (0.39)	79 (0.39)	6.0 (1.6)	55 (0.31)
	Lower	1900 (0.15)	0.24 (0.15)	32000 (0.15)	0.66 (0.30)	3800 (0.30)	<1.5 (1.5)	15000 (0.15)	72 (0.15)	3.4 (0.60)	19 (0.12)
6	Upper	5200 (0.39)	0.59 (0.39)	8500 (0.39)	7.8 (0.59)	6400 (0.59)	5.1 (3.9)	4100 (0.39)	80 (0.39)	9.2 (1.6)	64 (0.31)
	Lower	8200 (0.48)	0.76 (0.48)	22000 (0.48)	6.3 (0.95)	9300 (0.95)	<4.8 (4.8)	15000 (0.48)	91 (0.48)	13 (1.9)	61 (0.38)

† Key to the elements: Al = Aluminum; Cd = Cadmium; Ca = Calcium; Cu = Copper; Fe = Iron; Pb = Lead; Mg = Magnesium; Mn = Manganese; Ni = Nickel; and Zn = Zinc.

content of sediment loads. However, heavy metal sampling by MDNR personnel (1974) at offshore locations in Saginaw Bay showed generally lower levels than were found in our studies (see Appendix IV). Although Maisou sediment heavy metals were slightly elevated, we do not expect heavy metals to significantly impact aquatic plant growth.

Herbicides

MWRM staff developed concern over potential herbicide damage to Maisou Island cattail stands following observations of unusual die-back patterns in 1983 (see Preliminary Field Studies, pp. 7-8). Sediment samples were collected for herbicide analysis during FY 84 studies, and delivered to U.S. Fish and Wildlife Service, East Lansing, Michigan, for analysis.

Analysis was performed for the following herbicides:

1. Atrazine
2. Simazine
3. Propazine
4. Prometon

All values were reported to be below detection levels of 0.02 mg/kg. These herbicides are expected to have relatively long half-lives in sediments (eg. 150-385 days for atrazine). Therefore, we must discount the important of herbicides in causing the observed die-backs. No additional samples were collected during FY 85 studies due to lack of available funding.

Taxonomy of Cattail Marshes

Representative samples of cattails from the marshes of DeFoe Reef, Dynamite Cut and Box Car were examined. Morphological characteristics of both floral and vegetative structures were studied.

Flowers of plants from each of the three sites showed characteristics common to Typha angustifolia. These include the presence of small hairlike bracts, stigmas filiform in shape, and a flattened aborted pistil. Flowers of T. latifolia are distinguished from those of T. angustifolia by the absence of bracts, stigmas that are flattened, and club or pear-shaped aborted pistils that are rounded at the apex (after Fassett and Calhoun, 1952). Samples collected from the three sites, however, differed considerably with respect to stature of the plant body and the pistillate spikes. Characteristics observed are given in Table 8.

Plants collected from DeFoe Reef differed considerably in stature than plants collected from the marshes of Dynamite Cut and Box Car. These plants are characterized by a slender base, tall and narrow leaves, and short, narrow pistillate spikes that are much overtopped by the leaves (Table 8). On the basis of both floral and vegetative structures, plants from DeFoe Reef are identified as Typha angustifolia (Table 1).

Plants collected from Dynamite Cut and Box Car are more robust in stature than those of DeFoe Reef, producing broader stems and leaves and larger pistillate spikes, moderately

Table **8**. Descriptive characteristics of _Typha_ sp. collected in Maisou Island complex, August 22, 1985.

Character	DeFoe Reef	Dynamite Cut	Box Car
VEGETATIVE STRUCTURES			
A. Height	x = 2.15 m (2.0 - 2.4)	x = 1.9 m (1.8 - 2.0)	x = 1.9 m (1.5 - 2.2)
B. Stem	x = 20 mm (17 - 24)	x = 23 mm (16 - 29)	x = 28 mm (17 - 40)
C. Leaf			
1. Width	x = 7.5 mm (7 - 8)	x = 10.8 mm (8 - 13)	x = 12 mm (11 - 13)
2. Shape	Convex on Back	Convex on Back	Convex on Back
REPRODUCTIVE STRUCTURES			
A. Mature Pistillate Spikes			
1. Color	Reddish Brown	Light Brown, Becoming Whitish	Reddish Brown And Buff
2. Height of Spikes in Relation to Leaves	Much Overtopped by Leaves	Moderately Overtopped by Leaves	Moderately Overtopped by Leaves
3. Size			
a) Length	x = 14 cm	x = 26 cm	x = 23 cm
b) Width	x = 17 mm (14 - 19)	x = 23 mm (21 - 25)	x = 15 mm (14 - 18)
4. Distance between pistillate & staminate spikes	2.4 - 4.2 cm	0.9 - 2.8 cm	2 - 10 cm

overtopped by the leaves (Table 8). However, cattails of Dynamite Cut and Box Car also showed many differences. Those from Dynamite Cut are intermediate in vegetative structure, but produce larger pistillate spikes. Plants from Box Car are more robust in stature, but produce somewhat smaller pistillate spikes. These plants show many features of the hybrid, T. glauca (Table 1). Differences between these two populations may be the result of ecotypic variation, which commonly occurs in hybrid populations.

RECOMMENDATIONS

MWRM staff has developed three sets of recommendations for consideration by MDNR, NOAA, Saginaw Valley Waterfowlers and other potential funding sources:

IMMEDIATE REMEDIAL ACTIONS -

1. Muskrat control: Muskrat populations have invaded nearly all remaining cattail stands in the Maisou/ Middle Grounds area. Lodge densities exceeded 7/acre over large areas. Personal communication with local trappers indicates that trapping pressure is very low to nonexistent at this time. We recommend immediate removal of muskrats, to the extent possible. This will require special experimental regulations for muskrat control.

2. Breach repair: Areas of protective barrier which have breached during recent storms should be repaired as soon as possible. These zones are shown in Figure 17. If protective barrier strands are not re-established, wind and wave action will dismember remaining stands and sediment deposition will increase.

DEMONSTRATION PROJECTS FOR LONG-TERM REMEDIAL ACTION -

1. Islet construction: Cattail re-establishment requires very shallow water. Once growing, a healthy stand will invade water up to 2 to 4 foot depths. We recommend construction of shallow flats or small islets to act as centers of re-invasion by cattails.

2. Channel construction: Suspended solids loads to the embayment marshes have dramatically altered sediment textures. Channelization of Dynamite Cut flows, through the West Marsh to Bay Port Cut, will channel sediment loads through the marsh and reduce deposition. Spoils from channelization can be utilized for islet construction.

ADDITIONAL STUDIES -

1. Exclosures: The late start date for FY 85 studies precluded construction of exclosures. These structures are designed to eliminate muskrat and carp damage from sensitive cattail stands. We recommend testing exclosures for effectiveness, particularly to assist in development of new cattail stands or islets. These new stands would be extremely sensitive to animal damage.

2. Seedling germination: Transplant of cattail rhizomes is impractical for large-scale marsh renovation. Because water levels remain high, MWRM staff recommends repopulation of islets and the Maisou marshes by the narrow-leaved cattail, _Typha_ _angustifolia_. To insure proper genetic composition, we suggest that a seedling germination pilot study be conducted, using seed heads collected at DeFoe Reef. Once established in the laboratory, many thousands of seedlings can be distributed in shallows and on mud flats or islets with a minimal effort.

ACKNOWLEDGEMENTS

The Maisou Island project stands as an example of the rewards generated by cooperation between dedicated private groups, state and Federal governments. These efforts have been successful largely through the vision and persistance of the Saginaw Valley Waterfowlers Association, especially its Maisou Island Project Committee, including Mark Gregson, Joseph Corp, David Ostrander, Michael Butz and Robert Hunkins. The on-site support of Tom, Pat and Todd Wyniecki was essential for completion of field tasks.

Staff of the Michigan Department of Natural Resources has provided encouragement and assistance throughout the Maisou Project. Jerry Martz, Wildlife Division, Jim Ribbons, and the late Hugh Sellick, Division of Land Resource Programs, all provided technical and administrative assistance necessary for completion of this project.

We further wish to thank State Representative Tom Scott, Congressman Bob Traxler and his staff representative Mary Wood for their support since the inception of the Maisou Project. This document was prepared, in part, through financial assistance provided by the Coastal Zone Management Act of 1972, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Without the assistance of these elected representatives, the Maisou Project would have been delayed or possibly not initiated.

MAISOU ISLAND PROJECT

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APPENDIX I

Vegetation Analysis for Five Study Zones in the Maisou Island Complex, 1941-1982

Table A1. Marsh vegetation of the Heisterman Island/Bay Port Cut region. A. Marsh coverage of the three wetland categories (expressed in acres) during the period of 1941-1982. B. Change in marsh coverage (expressed in acres) from previous year. Positive number indicates marsh expansion; negative number indicates marsh loss.

	YEAR								
VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
A.									
Cattail Marsh	395	327	260	450	333	230	183	150	
Grasses and Sedges	115	80	38	100	88	47	49	38	
Bulrushes and Mixed Emergents	78	94	79	90	64	99	92	60	
Total	588	501	377	640	485	376	324	248	
B.									
Cattail Marsh		-68	-67	+190	-117	-103	-47	-33	-245
Grasses and Sedges		-35	-42	+62	-12	-41	+2	-11	-77
Bulrushes and Mixed Emergents		+16	-15	+11	-26	+35	-7	-32	-18
Total		-87	-124	+263	-155	-109	-52	-76	-340

Table A2. Marsh vegetation of the Box Car/Black Rush region. A. Marsh coverage of the three wetland categories (expressed in acres) during the period of 1941-1982. B. Change in marsh coverage (expressed in acres) from previous year. Positive number indicates marsh expansion; negative number indicates marsh loss.

	YEAR								
VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
A.									
Cattail Marsh	78	67	68	83	73	65	85	78	
Grasses and Sedges	167	211	119	213	110	110	85	83	
Bulrushes and Mixed Emergents	457	372	448	264	106	103	101	100	
Total	702	650	635	560	289	278	271	261	
B.									
Cattail Marsh		-11	+1	+15	-10	-8	+20	-7	0
Grasses and Sedges		+44	-92	+94	-103	--	-25	-2	-84
Bulrushes and Mixed Emergents		-85	+76	-184	-158	-3	-2	-1	-357
Total		-52	-15	-75	-271	-11	-7	-10	-441

Table A3. Marsh vegetation of the West Marsh region. A. Marsh coverage of the three wetland categories (expressed in acres) during the period of 1941-1982. B. Change in marsh coverage (expressed in acres) from previous year. Positive number indicates marsh expansion; negative number indicates marsh loss.

A.

VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
Cattail Marsh	365	423	481	441	415	311	210	118	
Grasses and Sedges	94	82	51	76	57	21	26	60	
Bulrushes and Mixed Emergents	193	60	60	66	29	19	0	5	
Total	652	565	592	583	501	351	236	183	

B.

VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
Cattail Marsh		+58	+58	-40	-26	-104	-101	-92	-247
Grasses and Sedges		-12	-31	+25	-19	-36	+5	+34	-34
Bulrushes and Mixed Emergents		-133	0	+6	-37	-10	-19	+5	-188
Totals		-87	+27	-9	-82	-150	-115	-53	-469

Table A4. Marsh vegetation of the East Marsh/Warner Marsh/Blind Pass Region. A. Marsh coverage of the three wetland categories (expressed in acres) during the period of 1941-1982. B. Change in marsh coverage (expressed in acres) from previous year. Positive number indicates marsh expansion; negative number indicates marsh loss.

VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
A.									
Cattail Marsh	732	971	682	1046	918	520	375	388	
Grasses and Sedges	261	144	53	181	196	84	73	83	
Bulrushes and Mixed Emergents	404	193	477	128	150	7	0	0	
Total	1397	1308	1212	1355	1264	611	448	471	
B.									
Cattail Marsh		+239	-289	+364	-128	-398	-145	+13	-344
Grasses and Sedges		-117	-91	+128	+15	-112	-11	+10	-178
Bulrushes and Mixed Emergents		-211	+284	-349	+22	-143	-7	0	-404
Total		-89	-96	+143	-91	-653	-163	+23	-926

MIDWEST WATER RESOURCE MANAGEMENT
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Table A5. Marsh vegetation of the DeFoe Reef region. A. Marsh coverage of the three wetland categories (expressed in acres) during the period of 1941-1982. B. Change in marsh coverage (expressed in acres) from previous year. Positive number indicates marsh expansion; negative number indicates marsh loss.

A.

VEGETATION CATEGORY	YEAR 1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
Cattail Marsh	454	445	223	447	236	176	77	83	
Crasses and Sedges	18	0	0	0	0	0	0	0	
Bulrushes and Mixed Emergents	14	6	0	7	7	0	0	0	
Total	486	451	223	454	243	176	77	83	

B.

VEGETATION CATEGORY	1941	1949	1955	1964	1968	1972	1978	1982	NET CHANGE
Cattail Marsh		-9	-222	+224	-211	-60	-99	+6	-371
Grasses and Sedges		-18	0	0	0	0	0	0	-18
Bulrushes and Mixed Emergents		-8	-6	+7	0	-7	0	0	-14
Total		-35	-228	+231	-211	-67	-99	+6	-403

APPENDIX II

Soil Particle Size Analysis

Procedures

A. Sieve Analysis

1. Weigh 100 to 200 grams of soil.

2. Crush all aggregates in soil to ensure that fine particle sizes are free to be sieved.

3. Prepare dispersion solution for soil sample by weighing out 35.95 g of sodium metaphosphate and 7.94 g of sodium bicarbonate. Add one liter of distilled water.

4. Once soil has been dispersed, oven dry the soil to a constant weight. Record weight of dry soil.

5. Prepare a sieve stack with screen numbers 4, 10, 40, 60, 100, and 200. An alternative screen stack for fine-grained soils can be 10, 35, 60, 120, and 230.

6. Pre-weigh oven dry soil (at least 100 grams) and pour into the top of the sieve stack. Place sieve stack in mechanical shaker for 10 to 15 minutes.

7. Compute the percent retained for each sieve by dividing weight retained on sieve by the original oven-dried weight.

8. Compute the percent passing by starting with 100 percent and <u>subtracting</u> the percent retained on each sieve as a cumulative procedure (ie., % passing = 100 - Σ% retained).

9. If more than 12 percent of soil sample passes the number 200 sieve, hydrometer analysis can be performed to determine the percent of clay size particles.

10. Using semilogarithmic paper (4 cycle), plot grain size versus percent passing. This graph will help in distinguishing between gravels, sands, silts and clays.

B. Classification of Soil: Unified Soil Classification System

1. A soil is <u>coarse-grained</u> if more than 50% is retained on the number 200 sieve.

   A soil is <u>fine-grained</u> if more than 50% passes the number 200 sieve.

2. If soil is coarse-grained, then it is either a:

   <u>Gravel</u> if more than ½ of the coarse fraction is retained on the number 4 sieve.

OR

Sand if more than ½ of the coarse fraction is between the number 4 and 2 sieves.

3. Fine-grained soils are silts and clays. They are identified by using the Atterberg limits through calculation of the liquid and plastic limits of the soil.

4. Overall, gravel-sized particles are represented by the number 4 and larger sieves. Sand-sized particles lie between the number 4 and 200 sieves. Silt and clay lie below the number 200 sieve.

APPENDIX III

Memorandum of Agreement

between

Wildlife Division, Michigan Department of Natural Resource
Saginaw Valley Chapter, Michigan Duck Hunters Association
Midwest Water Resource Management

Cattail Marsh Loss Evaluation - Maisou Island Complex

MEMORANDUM OF AGREEMENT

This agreement confirms the intent of the Department of Natural Resources, Wildlife Division (MDNR) and Saginaw Valley Chapter, Michigan Duck Hunters Association (MDHA) to cooperatively examine the probable causes and potential solutions to cattail marsh losses in the Maisou Island group, Saginaw Bay as described in detail in the attached Exhibit A. This agreement extends from November 1, 1984 to September 30, 1985. This project will be conducted in a manner consistent with the general contract of Exhibit B (attached). The project will be supported up to 50 percent by federal funds through the Coastal Management Program for a sum not to exceed $15,000. Matching funds will be provided by the local interest group for at least 50 percent of total project expenses, in the form of cash and/or in-kind services. Midwest Water Resource Management (MWRM), a professional consulting firm, has been hired by the Saginaw Valley Chapter MDHA as the Subgrantee for this study.

The MDNR will manage the project. This will include providing instructions to and coordinating work of the MDHA and MWRM for the MDNR. The MDNR will review and approve output of the MWRM grantee. The MDNR will authorize payment of funds to the MDHA, for 50 percent of documented costs as accepted phases of the project are completed and upon filing of appropriate receipts for food and lodging and a written description of equipment rental rates for in-kind match. If requested in writing, the MDNR will approve advance payments to the MDHA, not to exceed 25 percent of the matching federal grant at any time as long as satisfactory progress on this project is being achieved. The project must be in progress before advances can be granted to MDHA. Any interest earned on these advances must be returned to MDNR.

The MDHA will be responsible for the output of MWRM, Midwest Water Resources Management, the subgrantee conducting the investigation of the probable causes and potential solutions to the marsh loss in the Maisou Island area of Saginaw Bay. This will include literature review, photographic review and site visits necessary to complete Phase I. An interim report, summarizing results and findings of tasks 1-5, Phase 1, will be filed with MDNR on or about May 15, 1985.

Phase 2 studies will be conducted as soon after May 15, 1985 as MWRM and MDNR staff agree on the program to be pursued. Monthly progress reports will be filed with MDNR on Phase 2 activities. The MDHA, MWRM, and MDNR staff will consult periodically throughout the project as deemed appropriate.

Phase 2 will be completed no later than September 30, 1985. MWRM will conduct one formal briefing for MDHA and MDNR prior to submission of a final report. Ten (10) copies of a final report will be submitted to MDNR no later than October 31, 1985. Ten percent of this grant will be withheld until receipt and acceptance of the final report. All requests for financial reimbursement must be submitted by October 31, 1985.

FOR WILDLIFE DIVISION, MICHIGAN DEPARTMENT OF NATURAL RESOURCES

January 1, 1985 — Edward J. Mikula 5/2/85

FOR SAGINAW VALLEY CHAPTER, MICHIGAN DUCK HUNTERS ASSOCIATION

January 1, 1985 — Dan Money

FOR MIDWEST WATER RESOURCE MANAGEMENT

January 1, 1985 — Frederick C. Payne

APPENDIX IV

Sediment Heavy Metals Analysis for
Mid-Saginaw Bay Stations

MDNR, BWM, 1974

Table A6. Results of heavy metals analysis on sediment samples collected from offshore stations in Saginaw Bay. Collection and analysis by MDRN, Bureau of Water Management, 1974 (unpublished data).

Analysis	Mean Value (mg/kg)	Maximum Value (mg/kg)
Cd	0.4	0.4
Cu	1.66	2.8
Fe	4,600.	7,800.
Pb	1	1
Mn	63.3	100
Ni	5.6	8
Zn	8.3	12