

A SURVEY OF GREAT LAKES MARSHES IN THE SOUTHERN HALF OF
MICHIGAN'S LOWER PENINSULA

prepared by

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ABSTRACT

In 1987, a multi-year project to survey marshes along the Great Lakes shorelines of Michigan was initiated by the Michigan Natural Features Inventory (MNFI) and funded through Michigan Coastal Zone Management grant. Information from aerial photograph interpretation and data from intensive field surveys were compiled by MNFI in 1987 for the Upper Peninsula. In 1988, marshes along the shores of the southern half of the Lower Peninsula were surveyed. This report summarizes surveys completed in 1988 investigating the natural communities, abiotic factors, flora, observed fauna, and disturbances, both human and natural, within marshes along the shorelines and estuaries of Saginaw Bay, Lake St. Clair, Lake Erie and Lake Michigan.

INTRODUCTION

The importance of the marshes along the shores of the Great Lakes for wildlife, shoreline protection, and recreation has long been recognized. There is a need for additional data to supplement our understanding of these coastal marshes to allow us to more adequately make management decisions. This three year study conducted along Michigan's Great Lake shoreline will provide valuable baseline data on the vegetation, substrate, and disturbances characteristic of Great Lakes Marshes.

The primary purpose of this study was to inventory the marshes along the Great Lakes shoreline of the **southern** half of Michigan's Lower Peninsula. Biotic and abiotic data were collected and marshes of high natural-areas quality were identified. Identical inventory techniques were employed in the coastal marshes of the Upper Peninsula during the summer of 1987 (MNFI 1987).

The study had several other objectives as well. First, to document the type and extent of disturbances within the 32 marshes studied and to evaluate their impact on the natural communities. The least disturbed marshes can then be identified and appropriate management suggested to ensure preservation of these relatively undisturbed marsh ecosystems as natural areas for research, education, protection of native species and their habitats, and as examples of Michigan's natural heritage.

A second objective of the study was to contrast similarity or differences among marshes on different substrates or in different climatological areas. We assumed that the natural communities were determined by differing abiotic conditions, such as levels of wind and wave activity, water depth, distance from the shoreline, and soil or substrate

texture, composition, and chemistry. By identifying major differences among marshes, critical information can be provided for effective wildlife management, shoreline protection, and other values. The data collected during 1987 through 1989 will be analyzed following the 1989 field season.

Few studies which have dealt with both the biotic and abiotic components of marsh systems. Recently two such studies have been completed in Michigan, though both were limited in scope. A study of the St. Mary's River (Liston and McNabb 1987), provides detailed information on marshes along the St. Mary's River shipping channel. This study concentrated on permanently submerged portions of the marsh, therefore providing little information on the wet meadow and shrub swamp zones of the marsh. It also emphasized the vegetation of the submergent marsh zone (beyond the emergent marsh), a zone which the present study did not sample in detail.

Another recent study provides a community profile of the Lake St. Clair Wetlands (Herdendorf, Raphael, and Jaworski 1986). That study also has a detailed section on the vegetation of the marshes and the factors, both biotic and abiotic, which determine and alter the plant communities. The marsh studies we have completed in this area during 1988 draw on this study for a preliminary background and add to the information it provides.

A third objective of surveying the vegetation of the coastal marshes in the southern half of the Lower Peninsula was to determine the ecological zones and vegetational composition of each marsh.

METHODS

Great Lakes Marshes in the southern part of Michigan's Lower Peninsula (Figure 1 and Appendix I) were identified for this study on the basis of size and quality, as determined through aerial photograph interpretation. Only marshes greater than 100 acres in area with minimal disturbance were initially selected for sampling. Additional marshes, most of which were identified as Environmental Areas, were suggested for sampling by Michigan Department of Natural Resources Shorelands Protection Program staff.

Remote-sensing data were used to identify the natural communities and transects for sampling at each of the 32 marshes. Prior to field sampling, the natural communities at each marsh were identified and their boundaries determined from aerial photo and topographic map interpretation. The major plant communities delineated were Swamp Forest, Shrub Swamp, Floodplain Forest, Wet Meadow, Emergent Marsh, and Submergent Marsh. Transects were then selected to include all natural communities and to minimize sampling within areas disturbed by human activities such as wildlife management, road construction, etc. Community boundaries and sampling transects were mapped on mylar overlays, and both mylar overlays and black and white copies of 1978 color infra-red aerial photographs were used during the field surveys to improve accuracy and to verify community boundaries.

Vegetation typically was sampled along the transects at 20 meter intervals. Sampling points were occasionally shortened to 10 meters where natural community zones were narrow and lengthened to 40 or 60 meters where natural community zones were broad. A nylon rope, marked at 5 meter intervals, was used to measure the distance between sampling points. The direction of the transect line was maintained using a magnetic compass.

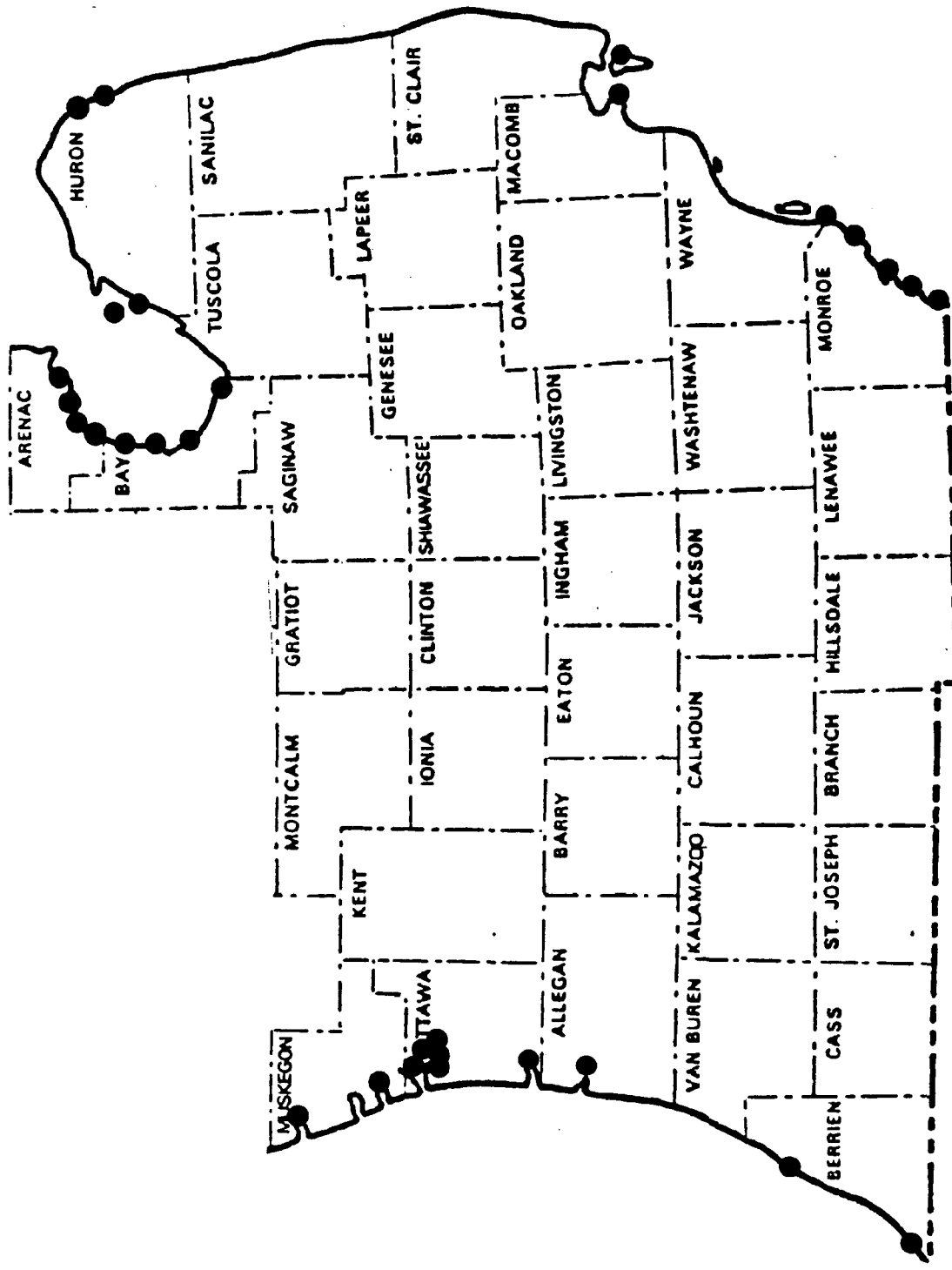


Figure 1. Location of Great Lakes Marshes surveyed in the lower half of the Lower Peninsula.

The transects typically began at the boundary between swamp or upland forest and the shrub swamp. The shrub swamp and all herbaceous zones along the transect were sampled. Sample points were taken along the transect until water depth reached approximately 5 feet.

The vegetation within a 0.5 meter circular area was sampled using a circle of plastic tubing as a sampling frame. Coverage values were recorded on a sampling form (Appendix II) for each plant species within the sampling frame, including submerged aquatic plants beneath the sampling frame. Coverage values of 1-5 were used to denote 1-20%, 21-40%, 41-60%, 61-80%, and 81-100% coverage, respectively. Unknown species were collected for later identification.

Sampling at each point also included determination of the natural community, soil texture of the substrate, depth of organic material, and water depth. At sampling points where these designations were inadequate, the surveyors had the option to code other information. Soil textures were recorded as sand, loam, or clay. Additional modifiers, such as silty, rocky, or gravelly could be added by the surveyors. Depths of water and organic material were both recorded in inches. Additional notes on fauna and disturbance were recorded on the sampling form. Notes describing the location of the transect and distances between sampling points were also included. Natural community boundaries (on the mylar overlay) were refined following sampling using the latest available aerial photography. Natural communities were classified according to the Michigan Natural Features Inventory (MNFI) draft Natural Community Classification (MNFI, 1986). For four plant communities, Wet Meadow, Shrub Swamp, Treed Swamp, and Floodplain Forest, no distinction was made between "Northern" and

"Southern" plant communities. The grade of each marsh was determined using MNFI natural quality and condition grading criteria (MNFI, 1987; APPENDIX III).

Tobico Marsh in Bay County requires further survey work in 1989. Ford Marsh, in Monroe, was also not sampled, but our recommendation is not to sample the marsh due to heavy disturbance. Surveying of this marsh in 1989 would require several weeks of advanced notice to the owners.

RESULTS

Natural Communities

The locations of the 32 Great Lakes Marshes visited and/or sampled during the 1988 field season are identified in Figure 1. The data collected pertaining to these sites are presented in Tables 1-3. Table 1 summarizes the geographic, political, and physical characteristics of the marshes sampled, while Tables 2 and 3 characterize the biota of these marshes.

Most of the marshes contained a very predictable assemblage of species, which have distributions limited by the depth of water, amount of wave energy, and protection from wave activity by other vegetation. The most common sequence of zones was 1) Submergent Marsh, 2) Emergent Marsh, 3) Wet Meadow, 4) Shrub Swamp, and 5) Swamp Forest.

The Emergent Marsh zone consisted of Scirpus validus (softstem bulrush), S. americanus (threesquare), and less commonly S. acutus (hardstem bulrush), with some Typha ssp. (cat-tail). Within the Emergent Marsh common submergent species included Elodea canadensis (water-weed), Najas flexilis (naiad), Vallisneria americana (wild-celery or tape-grass), Potamogeton ssp. (pondweed), and Myriophyllum ssp. (water-milfoil). In the shallow waters near the shoreline, where wave action is weaker, the Emergent Marsh supports a greater diversity of plants. These include the above mentioned species of Emergent Marsh, as well as others such as Pontederia cordata (pickerel-weed), Sagittaria latifolia (wapato or duck-potato), Sparganium eurycarpum (bur-reed), S. chlorocarpum, Nuphar advena (spatterdock), N. variegata, and Nymphaea odorata (water-lily). During low water years some species, such as Sagittaria graminea (arrowhead) and

Table 1. Geographical, political and physical characteristics of Great Lakes Marshes of the southern half of Michigan's Lower Peninsula.

#	Marsh	County	Body of water	Acreage (Total/ Natural)	Landform						Ownership			
					Estuary	Narrow Coast	River Mouth	Bay	River Island	Inter- dunal Swale	Private	State Gov't	Local Gov't	
1	Erie	Monroe	Lake Erie	550/100		X		X				X		X
2	Otter Creek	Monroe	Lake Erie	40/0			X					X		
3	Monroe-Detroit Edison	Monroe	Lake Erie	140/0			X					X		
4	Monroe-Ford	Monroe	Lake Erie	180/0			X					X		
5	Swan Creek	Monroe	Lake Erie	110/80			X		X			X		
6	Pointe Mouillee	Monroe	Lake Erie	1150/400			X		X			X		X
		Wayne	Lake Erie	280/120			X		X			X		X
7	Clinton River Delta	Macomb	Lake St. Clair	260/---	X		X					X		
8	St. Clair River Delta	St. Clair	Lake St. Clair	8000+/2500+	X		X			X		X		X
9	Hardwood Point	Huron	Lake Huron	150/0		X						X		
10	Whiskey Harbor	Huron	Lake Huron	7/0					X			X		
11	Wildfowl Bay Islands	Huron	Saginaw Bay	3500/3500		X			X			X		X
12	Wildfowl Bay	Huron	Saginaw Bay	410/300		X			X			X		X
13	Coryeone Point	Bay-Tuscola	Saginaw Bay	1325/1325		X						X		X
14	Tobico	Bay	Saginaw Bay	?						X		X		X
15	Nayanquing Pt.	Bay	Saginaw Bay	700/140		X			X			X		X
16	Pinconning	Bay	Saginaw Bay	150/150		X			X			X		X
17	Saganing River Delta	Arenac	Saginaw Bay	50/50			X					X		
18	Pine River Delta	Arenac	Saginaw Bay	300/200		X			X			X		X
19	Wigvam Bay-Rifle River	Arenac	Saginaw Bay	825+/0			X		X			X		X

Table 1. (continued).

#	Marsh	County	Body of water	Acreage (Total/ Natural)	Landform					Ownership			
					Estuary	Narrow Coast	River Mouth	Bay	River Island	Inter- dunal Swale	Private	State Gov't	Local Gov't
20	Au Gres River Delta	Arenac	Saginaw Bay	125/0			X				X		
21	Galien River Estuary	Berrien	Lake Michigan	325/275	X						X		
22	Paw Paw River Estuary	Berrien	Lake Michigan	160/125	X						X		X
23	Kalamazoo River Estuary	Allegan	Lake Michigan	1050/1050	X				X		X		
24	Macatawa River Estuary	Ottawa	Lake Michigan	0/0	X						X		
25	South Lloyd Island	Ottawa	Lake Michigan- Grand River	85/30					X		X		
26	Dermo Island	Ottawa	Lake Michigan- Grand River	200/100					X		X		
27	Indian Channel	Ottawa	Lake Michigan- Grand River	650/500	X				X		X		
28	Pottawattomie Bayou	Ottawa	Lake Michigan- Grand River	125/125	X						X		X
29	Millhouse Bayou	Ottawa	Lake Michigan- Grand River	50/50	X						X		
30	Bruce Bayou	Ottawa	Lake Michigan- Grand River	425/375	X						X		
31	Muskegon River Estuary	Muskegon	Lake Michigan	950+0	X						X		X
32	White River Estuary	Muskegon	Lake Michigan	1200+/650	X						X		X

Table 2. Biotic characteristics of Great Lakes Marshes of the southern half of Michigan's Lower Peninsula.

#	Marsh	EO Rank	# Plant Species	Emerg. Marsh				Wet Meadow				Natural Communities				Disturbance Codes ¹	
				Submerg. Marsh	Emerg. Marsh	Wet Meadow	Floodplain Forest	Cobble Beach	Treed Swamp	Lakeplain Prairie	Shrub Swamp	Natural	Artificial				
1	Erie	B-D	42	X	X	X									HI	A,D,DT,W	
2	Otter Creek	D	36		X										HI	DR,S	
3	Monroe-Detroit Edison*	D	05			X									HI	DR,F	
4	Monroe-Ford*	D	--	X	X	X									HI	D,DT	
5	Swan Creek	B-D	44	X	X	X		X							HI	D,DR,DT	
6	Pointe Mouillee	B-D	44	X	X	X		X			X				HI	D,DR,DT	
7	Clinton River Delta	B-D	25	X	X	X		X			X				HI,M	D,DT,DT,F,S	
8	St. Clair River Delta	A-D	79	X	X	X		X			X	X			HI,M	A,DR,DT,F,W	
9	Hardwood Point	CD	42		X	X		X			X				HI		
10	Whiskey Harbor	C	52		X				X		X				HI		
11	Wildfowl Bay Islands	AB	72	X	X	X		X			X				HI	DR	
12	Wildfowl Bay	AB-D	105	X	X	X		X			X	X			HI	A,DT	
13	Coryeone Point	B-CD	44	X	X	X		X			X	X			HI,M	A,D,DT	
14	Tobico	?	14?	X	X	X		X			X	X				A,D,DT,W	
15	Nayanquing Pt.	B-D	32	X	X	X		X			X				HI	D,DT,W	
16	Pinconning	C	60	X	X	X		X			X				HI	DT	
17	Saganing River Delta	C	47		X	X		X			X				HI	A,DT,H	
18	Pine River Delta	B-D	51	X	X	X		X			X	?			HI	A,F	
19	Wigwam Bay-Rifle River	CD	72	X	X	X		X			X				HI	C,DR,DT,H	

Table 2. (continued).

#	Marsh	EO Rank	# Plant Species	Natural Communities										Disturbance Codes ¹	
				Submerg. Marsh	Emerg. Marsh	Wet Meadow	Floodplain Forest	Cobble Beach	Treed Swamp	Lakeplain Prairie	Shrub Swamp	Natural	Artificial		
20	Au Gres River Delta	CD	37		X	X						X	HI	A,C,DT,H	
21	Galien River Estuary	B	42		X	X					X			A,B,H,S	
22	Paw Paw River Estuary	AB-C	47		X	X								H,S	
23	Kalamazoo River Estuary	AB	98		X	X	X					X	HI	H,S	
24	Macatawa River Estuary*	D	--			X	X							B,F,S	
25	South Lloyd Island	C	08		X	X							HI	H,S	
26	Dermo Island*	C	--		X	X							HI	H,S	
27	Indian Channel	B	34		X	X	X					X		H,S	
28	Pottawattomie Bayou	A	73	X	X	X						X		H,R	
29	Millhouse Bayou*	B	--	X	X	X						X		DT,H,S	
30	Bruce Bayou	B	29	X	X	X						X	HI	A,D,DT, F,H,S	
31	Muskegon River Estuary	CD-D	47		X		X							A,C,D, DT,H,S	
32	White River Estuary	B-C	85	X	X	X	X					X	HI	A,C,D, DT,H,S	

¹ A = agriculture field(s); B = small boat slip(s); C = channelization; D = dike(s); DI = ditch(es); DR = dredging; F = fill; H = hay; HI = high water; M = muskrat ponds; R = railroad right-of-way; S = ship or boat wakes; W = wildlife openings.

* = not sampled

Table 3. Special plants, special animals and selected other animals from Great Lakes Marshes of the southern half of the Lower Peninsula.

#	Marsh	Special plant(s)	Special animal(s)	Other animals
1	Erie	Justicia americana Hibiscus moscheutos Nelumbo lutea Rumex maritimus Sagittaria montevidensis	Yellow-headed Blackbird Eastern fox snake Bald Eagle	
5	Swan Creek	Sagittaria montevidensis		Muskrat
6	Pointe Mouillee	Hibiscus moscheutos Sagittaria montevidensis Nelumbo lutea Thalictrum revolutum	King rail Forster's tern Bald eagle	Muskrat
7	Clinton River Delta		Forster's tern Northern harrier Eastern fox snake Spotted turtle	Muskrat
8	St. Clair River Delta		King rail Common tern Great blue heron rookery Forster's tern Eastern fox snake	Muskrat Great egret
9	Hardwood Point	Rumex maritimus		
11	Wildfowl Bay Islands	Rumex maritimus	Great blue heron rookery Forster's tern Bald eagle	Muskrat
12	Wildfowl Bay	Asclepias hirtella Cacalia plantaginea Rumex maritimus	Yellow-headed blackbird	
13	Coryeon Point	Astragalus neglectus Rumex maritimus		Muskrat
14	Tobico		Yellow-headed blackbird Bald Eagle	Muskrat
15	Nayanquing Pt.		Black-crowned night-heron Yellow-headed blackbird	
16	Pinconning	Rumex maritimus		
17	Saganing River Delta	Rumex maritimus		
19	Wigwam Bay-Rifle River	Rumex maritimus		
20	Au Gres River Delta	Rumex maritimus		

Table 3. (continued).

<u>#</u>	<u>Marsh</u>	<u>Special plant(s)</u>	<u>Special animal(s)</u>	<u>Other animals</u>
21	Galien River Estuary	Zizania aquatica var. aquatica Hibiscus moscheutos Silphium perfoliatum Cuscuta campestris Sabatia angularis		
22	Paw Paw River Estuary	Hibiscus moscheutos Silphium integrifolium		
23	Kalamazoo River Estuary		Purple wartyback Black buffalo	
24	Macatawa River Estuary	Zizania aquatica var. a.	Kirtland's snake	
25	South Lloyd Island	Nelumbo lutea		
27	Indian Channel		River redhorse	
28	Pottawattomie Bayou	Zizania aquatica var. a.		Muskrat
29	Millhouse Bayou	Zizania aquatica var. a.		
30	Bruce Bayou	Zizania aquatica var. a.		Muskrat
32	White River Estuary		Lake floater	

Sagittaria montevidensis, appear to be more numerous, probably indicating that they do not tolerate the erosive forces present when water levels are higher.

Shoreward of the Emergent Marsh, where flooding is only occasional, lies the Wet Meadow zone, typically dominated by grasses and sedges. The common dominants, both in Upper Michigan and southern Lower Michigan are Calamagrostis canadensis (bluejoint) and Carex stricta (sedge). Clumps of Salix ssp. (willow), Cornus ssp. (dogwood), and Cephalanthus occidentalis (buttonbush) are scattered within this zone. Past human disturbance was common within this zone, in the form of haying and row cropping. Whereas farming was unsuccessful in most Wet Meadows in Upper Michigan, more extensive drainage coupled with a longer growing season have resulted in continued agricultural use of these lands in southern Lower Michigan. Only the wettest of the meadows were abandoned or never farmed.

Shrub Swamp and Swamp Forest occupy the higher lands adjacent to the Wet Meadow, where flooding is less severe. It was noted that the trees and sometimes the shrubs nearest to the shore were killed by the high water levels of 1986-7. Whereas Hardwood-Conifer Swamp was common along the marshes in Upper Michigan, those in southern Lower Michigan are characterized by Southern Swamp dominated by hardwoods. Common species include Populus deltoides (cottonwood), Fraxinus pensylvanica (red ash), Acer saccharinum (silver maple), Ulmus americanus (American elm), Quercus bicolor (swamp white oak), Quercus macrocarpa (bur oak), and Quercus palustris (pin oak).

Physiographic Features

The type of physiographic feature upon or within which a marsh develops appears to be important in determining the nature of the vegetative zonation. The landforms noted in this study include estuaries, river mouths, narrow, unprotected shorelines, bays, islands, and interdunal swales.

Estuaries are located along streams which are influenced by the Great Lakes water levels. Estuaries protected from wave action often have thick deposits of organic soil, capable of supporting Wet Meadow, Shrub Swamp, and Swamp Forest. Estuaries often contain large, unstable areas of floating aquatic vegetation, including Peltandra virginica (arrow-alum), Nymphaea odorata, Decodon verticillata (water-willow), and Nuphar advena. Among the best estuaries sampled in 1988 were the Pottawattomie Bayou tributary to the Grand River and the Kalamazoo River Estuary.

River mouths typically support a broad Wet Meadow zone, with an equally well developed Emergent Marsh zone. Swamp Forest and Shrub Swamp zones are usually present. Many of the rivers surveyed had major deltas where they entered the Great Lakes. The changing course of the river across the delta typically resulted in the formation of abandoned oxbow lakes, which initially supported submergent or floating vegetation, but eventually succeeded to Wet Meadow, Shrub Swamp, or Swamp Forest. The best examples of this are the St. Clair River Delta and portions of Pointe Mouillee Marsh on the Huron River.

Most of the **Bays** occupy erosional depressions or basins in the shoreline where a river or creek entered into one of the Great Lakes or into a larger river. Some of the depressions are pre-glacial valleys which

were not completely destroyed by glacial erosion. Other basins were formed by glacial outwash streams and are now occupied by post-glacial streams. Still other basins were formed by post-glacial streams eroding into glacial drift. The previous discussion of river mouths describes the vegetation zones of these bays adequately. Most of the larger bays contain the mouth of one or more rivers, and typically are the sites of the larger marshes. Saginaw Bay, which contains several of the marshes sampled, receives waters from a number of rivers, including the Rifle, Pine, Saginaw, Kawkawlin, Quanicassee, and Sebewaing. Marshes were sampled at the mouths of many of these rivers. Some of the larger of these rivers, such as the Saginaw, occupy pre-glacial channels in the underlying bedrock. These pre-glacial channels are partially filled with glacial deposits, which, in the case of the Saginaw River, consist of tens of feet of lacustrine clays and sands.

Prevailing winds can move sands along a coastline, often forming sandspits which enclose a small bay. Some of the smaller bays consist merely of a section of curved shoreline protected from the prevailing winds. These small areas of protected shoreline allow the development of Emergent Marsh, but the Swamp Forest, Shrub Swamp, and Wet Meadow zones are often absent or poorly developed. Portions of the Wildfowl Bay Wildlife Area, consists of small protected bays on the lee side of Manisou, Heisterman, and Middle Grounds Islands.

Unprotected shoreline sometimes supported aquatic vegetation, typically a narrow band of Emergent Marsh consisting of Scirpus acutus, S. validus, S. americanus, and Eleocharis smallii. Behind this narrow band there was usually a low beach ridge, with an **Interdunal Swale** farther towards the shore. The swale sometimes contained another narrow band of

Emergent Marsh or Submergent Marsh with both submergent and floating species. The marshes south of the Pine River in Arenac County are good examples of marsh along a relatively unprotected shoreline.

Special Plants

Two special plants, Sagittaria montevidensis (Arrowhead, State Threatened) and Rumex maritimus (State Special Concern), appeared to respond to lowering water levels. Sagittaria montevidensis was found growing on highly decomposed organic materials in saturated to shallowly flooded conditions (generally less than 12 inches of water) along the mouths of small streams and along the edge of the open water. Rumex maritimus, in contrast, grew on recently exposed organic materials or sand, where the soil was moist to saturated, but not flooded. It often occupied areas of Emergent Marsh or Wet Meadow, where beds of bulrushes or sedges were partially eroded away by high water, leaving a mat of partially decomposed organic material, roots, and rhizomes.

Another State Threatened species, Zizania aquatica var. aquatica (wild rice), was found in several of the estuaries in southwestern Michigan growing on muck soil. Among the estuaries containing this species are those along the Macatawa River and the Grand River.

Hibiscus moscheutos (swamp rose-mallow), a State Special Concern species, was found along the Paw Paw River, Erie Marsh, and Tobico Marsh. At both the Erie and Tobico Marsh sites swamp mallow was growing primarily on disturbed habitats such as dikes and previously plowed land.

SITE SUMMARIES

A short discussion of each marsh sampled or visited during the 1988 field season follows. All marshes were sampled, with the exception of Macatawa River Estuary (Ottawa Co.) and Monroe Marsh (Monroe Co.), which were highly disturbed. Each sampled marsh was mapped to show plant communities, sampling transect, and usually adjacent land use (Appendix IV).

Lake Erie

1. **Erie (Monroe Co.)** The Erie Marsh, located at the southeastern corner of Michigan along Lake Erie, has generally undergone major manipulation. Most of the marsh was diked and channelled for waterfowl management. As a result of these manipulations, Lythrum salicaria, an aggressive exotic species, has created dense monocultures in portions of the marsh. Another species which appears to have responded aggressively to the disturbance is the Michigan Special Concern plant, Hibiscus moscheutos, which grows in dense patches on the edges of some of the dikes, road edges, and some abandoned fields. Farming is conducted to the west, extending to the edge of the marsh. A drainage channel typically separates the marsh from farmed fields. The drainage channels assist in the drainage of the fields, but probably have little impact on the moisture conditions within the marsh, which are much more strongly influenced by the underlying clay soils and the fluctuations of Lake Erie water levels.

Sampling was not conducted within the larger diked portion of the marsh, but instead, was conducted in two undiked portions of the marsh where water levels were free to fluctuate along with those of Lake Erie.

The first transect (A) was conducted with the permission of the Bay City Hunt Club on their land. The second (B) was conducted on lands managed by the Wildlife Division of the DNR.

Two special plants were noted in the sampling, Sagittaria montevidensis (State Threatened) and Rumex maritimus (State Special Concern). Both are species which appear to respond to lowering water levels, probably persisting in the seed bank during high-water periods.

Both transects contained Wet Meadow adjacent to the farmed fields and Emergent Marsh, which extended into shallow water. Vegetation was quite sparse in the shallow water, apparently as a result of severe erosion during high water years. The Wet Meadow on both transects consisted of a broad zone, approximately 80-100 meters wide, dominated by dense, 1.5 m (5-6 ft) high Polygonum lapathifolium.

The Emergent Marsh zone, approximately 120 meters wide, was dominated by Scirpus validus, but with low water conditions, only the lower 60 meters was saturated or flooded. The drier portions of the Scirpus bed are being colonized by species such as Polygonum lapathifolium, which are more characteristic of the Wet Meadow.

A narrow zone of the Emergent Marsh, near the present beach line, contained large numbers of Sagittaria montevidensis (State Threatened Species). The plants were growing in loose mud, rich in organic material. The species appears to tolerate saturated to shallowly inundated conditions (to 6-12 inches water depth). A small colony (approximately 30 meters in diameter) of Nelumbo lutea (American lotus, State Threatened) was also growing in shallow water a few hundred yards north of the transect. This small colony, not previously noted in our data base, may have established

from a previously surveyed colony which is located to the north on Bay Creek, just northwest of the railroad trestle.

The amount of unmodified marsh present in this complex is too small to qualify it as a significant Natural Area on the basis of plant communities alone. However, it is recognized that even the most heavily diked portion of the Erie State Game Area is of great importance for waterfowl. The two relatively undisturbed areas where the transects were located lacked the zones of Shrub Swamp and Swamp Forest, which had been converted to agriculture. The remaining zones of Wet Meadow and Emergent Marsh were of good quality and contain good colonies of three Special Plants, Sagittaria montevidensis, Rumex maritimus, and Nelumbo lutea. Because of these Special Plant occurrences, it is recommended that no alteration of the shoreline occur in these areas. The western tract surveyed is owned by the Bay City Hunt Club, while most of the eastern tract is owned by the Wildlife Division of the Department of Natural Resources.

2. **Otter Creek (Monroe Co.)** This marsh is a small, highly disturbed remnant of a Wet Meadow located at the mouth of Otter Creek. The entire marsh, which was ditched and hayed, is less than 40 acres in area. The embayment at the mouth of Otter Creek is protected from storms by a long sand spit, thus inspiring human alteration of the shoreline to form a harbor. Most of the marsh vegetation which undoubtedly grew in the shallow waters of the bay has probably been removed by dredging. The present shoreline, eroded by boat wakes, is bare of vegetation over large stretches. Although the marsh is probably significant for production of waterfowl and muskrat, it will not be included in MNFI's data base, due

both to small size and high levels of disturbance.

3. **Monroe-Detroit Edison (Monroe Co.)** Two potential areas of marsh near the city of Monroe were identified from the aerial photographs. One lies directly to the southeast of Detroit Edison's fly-ash pond. We were provided access to this marsh by a Detroit Edison employee, who valiantly accompanied us on our 1/8 mile trek through a dense monoculture of Phragmites communis. The shoreline, consisting of a thin layer of loose organic material over clay, was highly eroded by shipping traffic. It supported no visible vegetation. This was probably the lowest diversity wetland encountered during the field season.

4. **Monroe-Ford (Monroe Co.)** This marsh is located on the north side of the River Raisin and is owned by Ford Motor Company. Permission could not be obtained to sample the marsh at the time when MNFI biologists were working in Monroe County. Aerial photographs show highly altered drainage, which has probably greatly altered the plant communities. The marsh has either dikes, ditches, or fill on all sides. Its primary significance is that of waterfowl habitat, but it also supports a population of Nelumbo lutea (State Threatened). We do not recommend returning to sample the site.

5. **Swan Creek (Monroe Co.)** The marsh occupies a portion of a small embayment north of the mouth of Swan Creek. A sand spit, which separates the bay from Lake Erie, has been stabilized and several homes have been built on it. The marsh is bordered on the west and north by agricultural

lands, and to the east by a broad drainage and boat access channel. The marsh itself contains two ditches which drain the fields to the north. These ditches appear to have had little effect on the marsh vegetation, but a row of trees has established on the dredging spoils. The marsh grades from Southern Swamp Forest in the north, to a narrow zone of Wet Meadow and finally a broad Emergent Marsh along the shoreline. Scattered submergent vegetation continues far out into the shallow bay. Among the more common submergent species are Potamogeton pectinatus, P. gramineus, Myriophyllum spicatum (exotic), and Najas flexilis. Scattered Scirpus validus and Sagittaria latifolia occur close to shore.

The Emergent Marsh zone, although saturated, had almost no standing water at the time of sampling in late July. The dominant species was Scirpus validus, except near the beachline where Sagittaria latifolia was common. Sagittaria montevidensis, a State Threatened plant, was scattered in the organic-rich clay mud at the shoreline where the water was shallow, only 3-6 inches deep. The mud was loose, causing one to sink in above the knee. Back from the shoreline in the Emergent Marsh, Leersia oryzoides, Bidens cernua, Polygonum lapathifolium, and Echinochloa walteri were scattered among the Scirpus.

A narrow band, located upland from the Scirpus validus zone, was dominated by a near-monoculture of Polygonum lapathifolium. The soil was saturated clay. This zone is being treated as Wet Meadow. The vegetation gradually changes to an open Southern Swamp Forest as one progresses away from the lake. The elevation change is too gradual to be visually perceived. Fraxinus pensylvanica is the dominant tree of the swamp, but there are also scattered Acer saccharinum, Acer negundo, Quercus bicolor,

Populus deltoides, and Ulmus americana. The high water levels during 1986-7 appears to have killed many of the red ash. The ground cover beneath the open canopy of red ash is dominated by Bidens cernua, Leersia oryzoides, Typha X glauca, and other grasses and forbs tolerant of seasonal flooding.

In general, the natural quality of the marsh is good, with a moderate number of species (44 noted in sampling transect). Unfortunately, buffering is poor. All of the marsh is privately owned. Owners include C. Tishkoe, H. Masserant, and Peter Kaminski.

6. Point Mouillee (Monroe and Wayne Cos.) The marsh at Point Mouillee, located where the Huron River and Mouille Creek enter Lake Erie, is quite extensive, however at least fifty percent of it has been heavily manipulated for improvement of waterfowl habitat. These alterations include ditching, diking, potholes, and planting of grain. Patches of lightly altered or unaltered shoreline persist, supporting Sagittaria montevidensis (State Threatened).

Prior to development, Southern Swamp Forest bordered the shrub- and herb-dominated Shrub Swamp and Southern Wet Meadow zones of the marsh. All of the Swamp Forest and probably much of the Shrub Swamp has been cleared and drained for agriculture. Some Shrub Swamp and most of the Wet Meadow, Emergent Marsh, and Submergent Marsh zones remain, but, as previously mentioned, most of this has been greatly altered by ditching and diking. The least disturbed portions of marsh are located in the one mile long stretch between Laudenschlager Drain and Bathdate Drain (Sections 26 and 35), which includes the mouth of Mouillee Creek, and an area east of the mouth of the Huron River, in Sections 24 and 25. These areas are marked on

the map of the Point Mouillee Wildlife Area in Appendix IV. Sagittaria montevidensis is common in the shallow mud flats located along the shoreline of both these areas. Hibiscus moscheutos (Swamp rose-mallow- State Special Concern) also grows scattered in the Wet Meadow and Shrub Swamp zones of the marsh, but appeared to be concentrated in areas of human disturbance, along with the Eurasian weed, Lythrum salicaria.

The underlying soil in the marsh is primarily clay. Near the bay's shoreline this mixes with decomposed organic material to produce a thick, soft mud in which Sagittaria montevidensis is common. The Emergent Marsh vegetation growing in this mud is not particularly diverse; among the more common species in the shallow water were Scirpus validus, Sagittaria latifolia, Sparganium sp., Potamogeton pectinatus, and Potamogeton crispus (exotic). The portions of the Emergent Marsh above the present water level support Scirpus validus, Scirpus fluviatilis, Leersia oryzoides, Polygonum lapathifolium, Phalaris arundinacea, and Lythrum salicaria. Presence of P. arundinacea and L. salicaria is indicative of human disturbance.

Dominant species within the Wet Meadow zone were Calamogrostis canadensis and L. salicaria. Several other sedges were also present in the zone.

Although no sampling was conducted east of the Huron River, a large population of Sagittaria montevidensis was found just east of Pointe Mouillee Road. The plant communities along the shoreline there, where a small, unnamed stream enters the lake, showed little sign of human disturbance. The organic-rich clay mud along the stream mouth, where the S. montevidensis grew, was almost impossible to walk through. Proceeding upslope from the stream edge, one passed through a narrow zone of

Sagittaria latifolia and Scirpus validus, and then entered a broad zone of dense Bidens cernua and Polygonum lapathifolium. On aerial photographs, this area of marsh appears to be one of the least disturbed parts of the Pointe Mouillee Marsh complex.

It is recommended that no alterations of the marsh for waterfowl management be done in the two areas of highest natural quality plant communities (see Appendix IV.06). The portion of marsh east of the Huron River appears to be the least disturbed of these two areas, but it is also relatively small, less than 100 acres. The population of Sagittaria montevidensis east of the Huron River is the largest encountered during the 1988 field season, and may be the largest population in Michigan.

Lake St. Clair

7. **Clinton River Delta (Macomb Co.)** The marsh consists of an estuary along a portion of the highly developed Clinton River Delta. Two areas were slated for survey, the first was an estuary to the south of the main channel of the Clinton River on a channel called "Black Creek", and the second was an area of Emergent Marsh to the north of the main channel. The second (northern) area was undergoing development as a marina and was therefore not sampled. Sampling was conducted on the southern estuary, one of the least diverse marshes sampled in 1988.

The estuary is a 400 acre block of wetland, surrounded by landfill to the west, a roadway to the north, and a channel and roadway to the south. The marsh consists of a narrow zone of Wet Meadow on the west, adjacent to the landfill, and a broad zone of cattail dominated Emergent Marsh which continues east to the edge of the channel. Submergent Marsh, dominated by

Nymphaea odorata, Myriophyllum spicatum, Potamogeton pectinatus and P. gramineus, and Lemna minor occupies the shallow water of the river channel. Although the Submergent Marsh continues across the river channel, degradation is severe to the east, where a roadway built upon landfill forms the bank of the channel. A combination of high water levels and boat wakes has eroded the edges of the Emergent and Submergent Marshes near the shoreline.

Although the quality of the plant communities as natural areas is low, there are many signs of wildlife within the marsh. Muskrat lodges, both abandoned and active, were common in the wetter portions of the cattail beds. Dozens of curious marsh wrens investigated our sampling activities. Great blue herons, northern harriers (State Special Concern), and numerous red-winged blackbirds were also noted. Common terns (State Threatened) have been noted from the marsh in a past survey. The marsh is already a mapped Element Occurrence within MNFI's data base, but is not one of the better marshes sampled. No special plants were noted during the survey. The entire marsh is owned by the Province of St. Joseph Capuchin.

8. St. Clair River Delta (St. Clair Co.) This marsh complex, occupying most of Dickinson Island, Harson's Island, and several small islands, is part of a large delta on the St. Clair River, between Lake Huron and Lake St. Clair. The marsh has been described in some detail in a report by Herdendorf, Raphael, and Jaworski (1986). MNFI's sampling was restricted to Dickinson Island and mapping was restricted to Dickinson Island and small islands west of Dickinson Island, where disturbance was least extensive. Harson's Island and St. John's Marsh, which have

undergone extensive alteration for waterfowl management, were not mapped, even though some portions of these marshes were not severely altered.

The St. Clair River Delta is the largest (greater than 8000 acres in area) and one of the highest natural quality marshes in Lower Michigan, containing broad expanses of Submergent Marsh, Emergent Marsh, and Shrub Swamp. Seventy-nine plant species were recorded on the single, long transect sampled. The soils encountered in the transect were all sand. Two small areas along the northern shore of Dickinson Island have been filled, but most of the marsh on this island has not been developed or greatly disturbed. A small residential area is located at the eastern end of the island, where the elevations are the highest. Shoreline and upland residential development is much more extensive on Harson's Island and on the mainland adjacent to St. John's Marsh.

With the exception of the eastern end, most of Dickinson Island is at or slightly below water when Great Lake levels are high. Along the shorelines of the main river channels, where the erosive forces of the river are the greatest, beds of Scirpus acutus extend into the shallow water, along with several submergent species, including Elodea canadensis, Myriophyllum spicatum, and Najas flexilis. Chara aspera (stonewort) covers the bottom. Approximately 60% of the bottom is covered with submergent vegetation to approximately 80 meters from the shoreline. Further out into the channel, the water depth and current increase rapidly and vegetation becomes quite sparse, with most of the bottom bare of vegetation.

Emergent marsh occupies shallow channels between very slight elevational rises in the delta. These channels are 1-2 feet deep in average-water years (1988) but 3-4 feet deep in high-water years (1986-

1987). It appears that ice scour and flooding probably occurs yearly in these channels. The courses of these channels are not stable, judging from the remains of portions of old channels, which are now merely isolated ponds. Some of these abandoned channels have been densely colonized by Cephalanthus occidentalis, forming almost impenetrable thickets. Potamogeton natans, Najas flexilis, Pontederia cordata, and Scirpus subterminalis are common in the open channels, along with several other floating and submergent species. The slight rises between the channels, saturated or shallowly flooded in many years, support Scirpus acutus, Typha angustifolia, T. X glauca, Phragmites communis, and other emergent marsh species. Muskrat lodges were common in this zone of the marsh. Adjacent to the channels on the more upland areas are broad expanses of Wet Meadow, dominated by Calamagrostis canadensis and Carex stricta. The high waters of 1986-1987 had partially eroded the hummocky grasses of this plant community, leaving only isolated hummocks. The root masses remained, preventing the erosion of most of the underlying organic soils, which averaged two feet in depth. Several herbaceous species, including Epilobium coloratum (willow-herb), Convolvulus arvensis (bindweed), and Taraxacum officinale (dandelion), were colonizing on the bare organic substrate.

At the south end of our transect, a less than one foot increase in elevation caused a vegetation change to Southern Shrub Swamp and Lakeplain Oak Opening (Southern Swamp). Both of these communities undergo seasonal flooding during the spring and fall. During high-water years most of the ground surface in these communities was probably saturated, and in shallow depressions, flooded throughout the growing season. The dominants in the

shrub swamp are Cephalanthus occidentalis, Salix eriocephala, Cornus amomum, C. racemosa, and C. drummondii. These same species are common in the open swamp forest, which is dominated by Quercus palustris and Populus deltoides, and locally by Quercus bicolor. The ground cover of the swamp forest is dominated by Calamagrostis canadensis and Carex stricta. This Lakeplain Oak Opening is probably the largest and best quality example of the plant community remaining in the state.

Dickinson Island contains several Special Plants and Animals, as well as highly significant examples of several plant communities. Special Animals include Rallus elegans (king rail, State Endangered), Sterna forsteri (Forster's tern, State Special Concern), Sterna hirundo (State Threatened), Elaphe vulpina gloydi (eastern fox snake, State Threatened), and Clemmys guttata (spotted turtle, State Special Concern). A small occurrence of Lakeplain Wet-Mesic Prairie, a high-ranking plant community, located at the eastern end of the island, contains Asclepias sullivantii (Sullivant's milkweed, State Threatened), Panicum leibergii (Leiberg's panic-grass, State Threatened), and Polygala incarnata (cross-leaved milkwort, State Special Concern). There are also historical record for two State Extirpated species from this site, Fimbristylis puberula (chestnut sedge) and Polygala incarnata (pink milkwort). The Lakeplain Oak Opening is an excellent example of a high-ranking plant community. The Great Lake Marsh occurrence is one of the largest and best in the state.

Most of Dickinson Island is part of the St. Clair Flats Game Area, but the eastern end of the island is owned by several individuals. The eastern end of Harsen's Island is also privately owned, with many full and part-time residences. Many of the smaller, unnamed islands of the delta are

also privately owned and have cottages built upon them.

Lake Huron

9. **Hardwood Point (Huron Co.)** This approximately 160 acre marsh lies 1.5 miles south of Port Hope, on an unprotected shoreline of Lake Huron. The Great Lakes Marsh is characterized by a relatively small and narrow band of Emergent Marsh and early successional, herbaceous vegetation on a gravel beach, an unvegetated lake bottom, and a cut-over Fraxinus nigra-Populus spp.-Cornus stolonifera forest with wet meadow openings dominated by Calamagrostis canadensis. A soil catena of loam-sand-clay-gravel is present along a landward to lakeward slope, but associated vegetal changes are poorly expressed, reflecting the general early successional nature of the site. Plant diversity is high due to early successional status of the forest and the recolonization of the marsh following high water. However, the Great Lakes Marsh lacks good zonation, is predominately Typha-dominated marsh, and is poorly representative of its type. It has been designated as the Hardwood Point Environmental Area and is owned by Walter and Helen Morrison, G. McCarroll, Gilbert Thomas, and Albert & Doris Thomas. One Special Concern plant, Rumex maritimus, was encountered in this survey. No other Special Plants or Special Animals were encountered, or are known from this marsh.

10. **Whiskey Harbor (Huron Co.)** This seven acre marsh is located on the east side of Huron County, approximately four miles northwest of Port Hope. The Great Lakes Marsh occupies a small, rocky bay with exposed bedrock, boulders and extensive gravel shores, but with poor plant diversity and limited community zonation. An Emergent Marsh zone of low

density and diversity, dominated by Scirpus americanus, appears to have been heavily disturbed by wave action and previous high water levels. A narrow zone of early successional Emergent Marsh occupies recently exposed gravel beds. Much of this zone, now dominated by Bidens cernua and S. validus with a wide variety of weedy species, was inundated and unable to re-establish in the narrow Northern Shrub Thicket (Alnus rugosa) zone immediately west. Farther west, there is a narrow, low sandy dune that has been heavily disturbed by vehicles, behind which is a young, cut-over forest.

This marsh is not significant as an element occurrence in the MNFI database, primarily due to small size. It lies within the Whiskey Harbor Environmental Area and is owned by I. & V. Moore as well as a number of small tract owners. No Special Plants or Special Animals were encountered, or are known from this marsh.

Saginaw Bay

11. **Wildfowl Bay Islands (Huron Co.)** This group of marshes, one of the largest in Southern Michigan, is part of the Wildfowl Bay State Wildlife Area. The marshes occupy interdunal swales between low beach ridges on Heisterman, Maisou, and Middle Grounds Islands, and shallow embayments between the islands. Broad expanses of Emergent and Submergent Marsh occupy the shallow waters between the islands and the mainland to the south and west.

Disturbance levels are generally low, but several channels have been cut through and between the low islands to provide boater access.

Historically, the islands already supported fishing huts when the original forest surveys (GLO) were conducted in the 1830s. Commercial fishermen were encountered in the shallow waters of the bay east of the islands during our 1988 field surveys. Sport hunters and fishermen use the islands regularly, as evidenced by hunting platforms, blinds, and general debris. However, the level of disturbance remains generally low.

Emergent and Submergent Marsh, Shrub Swamp, Wet Meadow, and Southern Swamp Forest are the common plant communities within the complex. A typical sequence of plant communities is Dry and Dry-Mesic Southern Forest on the beach ridges and low dunes of the islands, Southern Swamp Forest and Southern Shrub Swamp in the intervening swales, Southern Wet Meadows between the Shrub Swamps and the beach, Emergent Marsh in the shallow embayments between the islands, and both Emergent and Submergent Marsh in the shallow waters between the islands and the mainland. The Dry and Dry-Mesic Southern Forests (or Lakeplain Oak Openings) of the beach ridges are dominated by white, red, black, and bur oaks. Locally basswood is also a dominant on the ridges.

The swales between the beach ridges are variously occupied by either Southern Swamp Forest, Wet Meadow, or Southern Shrub Swamp. The Southern Swamp Forests are typically dominated by red ash, American elm, swamp white oak, and silver maple. Some of the more poorly-drained swamps in some of the intervening swales are dominated by black ash, with scattered buttonbush and almost no herbaceous vegetation.

The Southern Shrub Swamps typically occupies a narrow band between the Southern Swamp Forest and the broad Southern Wet Meadow. Dominants include Salix bebbii, Salix petiolaris, Cornus stolonifera, Cornus amomum, Cornus

racemosa, and Cephalanthus occidentalis.

The Southern Wet Meadow occupies a broad zone. Dominants there include Calamagrostis canadensis and Carex stricta, both forming hummocks. High water levels have eroded some of the hummocks, providing irregular trails and openings. With the low water levels in 1988, the openings in the wet meadow are being colonized by several herbaceous annuals. Near the present shoreline, wave action during recent high-water years had been heavy enough to expose the rhizomes of the graminoids and decayed organic material. One of the plants colonizing the moist organic soils along the shoreline is Rumex maritimus, a State Special Concern species. Locally it is the dominant ground cover species. Other common species on the recently exposed organic soils are Eleocharis acicularis, E. elliptica, Bidens cernua, and Rorippa palustris.

The Emergent Marsh, which begins at the shoreline and continues into 4-5 feet of water, is dominated by Scirpus americanus, S. validus, and Eleocharis smallii. Scirpus acutus is locally present, but is in general much less common than either of the other two bulrushes. Several pondweeds and other submergent plants are common within the emergent zone.

The Submergent Marsh generally occurs as small pockets within the broad expanses of Emergent Marsh, usually where the water is too deep for emergent vegetation to survive. Beds of Vallisneria americana, Heteranthera dubia, Potamogeton spp., and Myriophyllum spp. are also common in shallow water east of the islands, possibly where wave action is too strong for the bulrushes to establish or survive.

A bald eagle (Federally and State Threatened) was sighted over the marshes during survey work. A great blue heron rookery was also sighted on

Heisterman Island during spring aerial reconnaissance and common terns (State Threatened) are known from the islands. Several Special Fish are known from the shallow waters surrounding these and several smaller islands to the west. Rumex maritimus was the only Special Plant seen during the survey and no other Special Plants are known from the islands. This is one of the most significant Natural Areas surveyed on Saginaw Bay based on its large size, the high diversity of both plant species and communities, and overall low level of human disturbance.

12. **Wildfowl Bay (Huron Co.)** This marsh, the most diverse sampled during 1988 (105 species), is located along Saginaw Bay, in southwestern Huron County. The Lakeplain Wet and Wet-Mesic Prairies adjacent to the marsh contain several special plants, including Cacalia plantaginea (State Threatened) and Asclepias hirtella (State Threatened).

The original survey notes (GLO) indicate that the marsh and associated wetland communities, broken periodically by narrow beach ridges, extended several miles inland. The wetlands, occupying the swales between the beach ridges, supported a variety of plant communities, from Emergent Marsh and Wet Meadow in the deeper swales, to Shrub Swamp and Swamp Forest in the more shallow, better drained swales. The beach ridges were described as supporting prairies or "oak openings" of scattered black and white oak. Indian trails were common along the beach ridges, and the prairies and open oak openings were probably the result of Indian fires, used both for game management and for maintenance of the open conditions desirable for travel.

Following the intense fires in 1888 which destroyed most of the forests in Huron, Tuscola, and Sanilac Counties, a large part of the

coastal lands were cleared for agricultural use. An extensive system of drains was developed in the coastal counties in the late 1800s, prompting the agricultural development of many coastal lands which had previously been too poorly drained to farm. Portions of this marsh were drained and farmed, but the areas closest to Saginaw Bay were probably too poorly drained for successful agriculture, and were soon abandoned. Agricultural use may have consisted primarily of haying or pasturing. If row cropping was practiced, it was soon abandoned, based on the prevalence of native plant species.

The marsh consists of broad zones of Emergent Marsh and Wet Meadow, which extend into the shallow waters of Saginaw Bay, and Lake Plain Wet Prairie and Wet Mesic Prairie, located immediately inland from the Wet Meadow and also on the upland side of the foredune (first beach ridge). Dry Southern Forest (or Lakeplain Oak Opening) of black oak occupies the foredune. Two drainage ditches cut the marsh perpendicular to the shoreline. These ditches have little impact on the drainage conditions of the marsh communities, functioning primarily to drain the agricultural lands further from the lake shore.

The Emergent Marsh zone was typical of those along Saginaw Bay—typically low in diversity, with Scirpus validus dominant. Because of the low water levels during 1988, Polygonum spp. and Bidens cernua had established in great numbers along the moist shoreline where only emergent and submergent species were present during the preceding high water years. The soils of the Emergent Marsh consist of several inches of organic material underlain by sand or clay. Based on samples taken near the shoreline, the sand forms only a thin veneer overlain on glacial-lacustrine

clay deposits by wave and current action.

Dominants in the broad Wet Meadow zone were Calamagrostis canadensis, Carex aquatilis, and C. stricta. Several other sedges were also present in this zone, including C. lanuginosa, C. bebbii, and Cladium mariscoides. The soils in this zone also consist of organic material underlain by sand or clay.

The most diverse plant communities at the site are the Lake Plain Wet and Wet-Mesic Prairies; the occurrences are high quality examples of very rare plant communities. The Wet Prairie, located between the Wet Meadow and the first beach ridge, has shallow organic soils underlain by sandy clay. Those of the Wet-Mesic Prairie, located between the foredune and a second beach ridge, are a thin veneer of sand over clay. The soils of the prairies are calcareous, accounting for the predominance of fen species, which are tolerant of calcareous, saturated soils.

The site is recognized as one of the best remaining areas of Lake Plain Wet and Wet-Mesic Prairie in the state. The Emergent Marsh and Wet Meadow are also of high natural quality.

13. Coryeon Point (Bay and Tuscola Cos.) This marsh of approximately 1300 acres is located approximately two miles northwest of Quanicassee and seven miles east of Bay City. It is mostly within the boundaries of the Quanicassee Wildlife Area and includes two Environmental Areas: Quanicassee and Coryeon Point. Ownership is by the State of Michigan, Raymond and Mary Jacobs, E.&B. Jacobs, and Consumers Power Company.

During recent high water levels, this marsh was flooded over approximately 98% of its acreage. Saginaw Bay reached the base of the

levees which border the marsh along its entire length. The only unflooded parts of the marsh were the dune ridges and the high sandy knolls within the Southern Wet Meadow. Lakeplain Wet Prairie occupies some of the knolls, however, it was not encountered in the transect sampling done for this study. Receding waters in 1987-1988 exposed extensive flats which have been colonized by newly emerging vegetation. Landward of the sand ridges were dense Southern Wet Meadows that had invaded shallow muck on probable abandoned agricultural fields. Dominants on the shallow muck included Bidens cernua, Rumex maritimus (a Special Concern species), and Scirpus validus. Localized patches of Emergent Marsh occurred on sand bars lakeward of a relatively wide zone of Submergent Marsh. These Emergent Marshes had a low density and diversity of plant species, primarily Typha X glauca, T. angustifolia, and Nymphae odorata. High water has markedly decreased the number and acreage of these colonies.

Coryeon Point is habitat for a number of Special Plants, including Astragalus neglectus (Cooper's milk-vetch; Special Concern) and Rumex maritimus. No other Special Plants or Special Animals were encountered in this survey.

14. **Tobico (Bay Co.)** Part of the Tobico Marsh State Game Area, occupies a broad depression, this marsh probably formed when a sandspit formed to entrap a small embayment, forming a pond. Although the area has undergone management by the DNR, which possibly includes some water-level manipulation, the pond is a natural feature which was mentioned by General Land Office (GLO) surveyors in the early 1800's. The northern portion of the marsh complex is dominated by a broad Emergent Marsh of cat-tails.

This portion is low in plant diversity, but is probably of significance for waterfowl and muskrat production. East and west of the pond the zonation of the marsh is better and plant diversity is probably higher. On the eastern shoreline low beach ridges and sand spits separate Saginaw Bay from the pond. Black oak dominates the tops of the dry sand spits, while the ground cover consists of drought-tolerant grasses and sedges.

Between the oak-dominated sand spits, swales (which are part of the pond) support broad expanses of Wet Meadow. Although no sampling was done, the Wet Meadow community is typical of that found in most of the embayments along Saginaw Bay, with Calamagrostis canadensis and Carex stricta dominating. The emergent marsh is probably dominated by Scirpus spp. Similar zonation exists along the western shore of the pond, where Southern Swamp Forest dominates a series of parallel beach ridges and swales. Some of the larger swales are dominated by Wet Meadow. A second small, shallow embayment was trapped further to the southwest by these beach ridges. This embayment was completely occupied by Emergent Marsh and Southern Wet Meadow.

Extensive sand mining has occurred at the south end of this embayment, but the Emergent Marsh, Shrub Swamp, and Wet Meadow at the northern end do not appear to have been greatly impacted by this activity. Several other types of disturbance have occurred within the marsh complex. At least 4 ditches enter the pond along its western shore. These ditches drain adjacent fields to the west and probably had little impact upon the water levels or vegetation of the pond. Fields abut the marsh on the west, these fields were previously occupied by Swamp Forest, Shrub Swamp, and Lakeplain Wet-Mesic Prairie. ORV damage is apparent in portions of the marsh. A

railroad line runs along the eastern edge of the marsh, possibly causing ground fires which mimic the effect of Indian-set fires upon the natural vegetation. A road and residential development along Saginaw Bay have degraded the Natural Area value of the shoreline.

The transect sampled in this marsh was one of the least diverse of the 1988 field season, with a near-monoculture of cat-tails (Typha X glauca) and only 14 plant species encountered in the 300 meter transect. Unfortunately this transect was not characteristic of other portions of the marsh, which could be expected to be more diverse.

The field survey conducted in 1988 was inadequate to determine the ecological significance of the plant communities at the southern end of the marsh, thus necessitating revisit in the 1989 field season.

15. **Nayanquing Point (Bay Co.)** This marsh consists of aquatic vegetation on low offshore sand bars and in a small embayment separated from Saginaw Bay by Nayanquing Point, a long sand spit. Most of the marsh has been altered by diking, ditching, and the creation of waterfowl potholes within the aquatic vegetation.

Within the diked embayments, human-altered zones of Shrub Swamp, Wet Meadow, and Emergent Marsh are present. No sampling was conducted within the diked portions of the marsh.

Sampling was conducted in the Emergent Marsh outside of the dikes to sample an area more representative of the original vegetation of the marsh. With the exception of the first sampling point, which was on the edge of the sandy dike, the transect was located exclusively within the Emergent Marsh zone. The substrate of the entire Emergent Marsh zone was sand. Plant diversity was relatively low, with only 11 species noted in the

Emergent Marsh zone. One of the more common species was Myriophyllum spicatum (Eurasian water-milfoil), an exotic. Twenty-three species were noted on the sandy dike, many of which were exotics.

Typha angustifolia was the most common emergent species within the marsh, forming extensive, dense beds. Within the cat-tail beds were openings, probably formed both by muskrat activities and wave action, which supported Elodea canadensis, Heteranthera dubia (mud-plantain), Myriophyllum spicatum, and Vallisneria americana. The Vallisneria, commonly known as wild-celery, was probably introduced as a waterfowl food. These submergent species were scattered in low density throughout the Emergent Marsh.

Due to the high levels of human disturbance, the low native plant diversity, and the high number of exotic plants, the site is not considered by MNFI to be significant as a natural area.

16. Pinconning (Bay Co.) This 154 acre marsh lies within Pinconning State Park, one mile north of the mouth of the Pinconning River. It is comprised of two distinctly different Emergent Marshes: a Scirpus americanus marsh that opens to Saginaw Bay, and a more diverse marsh which is protected by a highly disturbed ridge of Lakeplain Oak Opening (Quercus macrocarpa-Q. bicolor). The latter marsh has been heavily impacted by high water levels, as evidenced by extensive dead Typha roots. It is presently succeeding to an Emergent Marsh dominated by Bidens cernua and S. validus. A road on the north has blocked the natural drainage of more upland portions of this marsh. In contrast, the bay-ward marsh is essentially undisturbed, but much poorer in plant species richness and total plant

density.

This area lies partly within the Pinconning Environmental Area and is owned by the State of Michigan with small parcels within the Pinconning Park Plat. One Special Concern plant, Rumex maritimus was encountered in this survey. No other Special Plants or Special Animals are known from, or were encountered from this marsh.

17. Saganing River Delta (Arenac Co.) This small delta is located at the mouth of the Saganing River, immediately southwest of Whites Beach and 6 miles southeast of Standish. The majority of this 46 acre marsh is Typha marsh, except for a narrow zone of early successional Emergent Marsh along the shore. Small and localized Scirpus americanus colonies lie quite distant from the shore, but were probably more widespread prior to high water periods. A Submergent Marsh with very low plant density lies between these colonies and the present shore. Most of the present land that is not underwater was cropped in the 1930s, as evidenced on historical aerial photography. There was evidence of recent fire in the vicinity of a small area of Wet Meadow, where it borders old field on the north.

Overall, Saganing River Delta is a relatively poor example of a Great Lakes Marsh and represents an occurrence of marginal natural area quality in the MNFI database. It does, however, retain value for wildlife habitat and flood control. It is within the Whites Beach Environmental Area and is owned by Walter & Mary Roney and T.V. One Special Plant, Rumex maritimus (Special Concern), was encountered in this survey. No other Special Plants or Special Animals are known from this marsh.

18. **Pine River (Arenac Co.)** This marsh, located at the mouth of the Pine River, contains several wetland zones, including Swamp Forest, Shrub Swamp, Wet Meadow, Emergent Marsh, and possibly highly degraded Lake Plain Wet-Mesic and Wet Prairie. Sampling was conducted just south of the river, where sand was the substrate encountered throughout the transect. The zonation of plant communities encountered began with Emergent Marsh in the shallow offshore waters of Saginaw Bay. At the shoreline is a narrow sand beach which supported shrubs and scattered cottonwood and willows. Farther inland is a broad interdunal swale with both Shrub Swamp and Wet Meadow. Low beach ridges within the swale support linear bands of Shrub Swamp, and deeper portions of the swale support Emergent Marsh dominated by cat-tails. Portions of the swale were ditched and farmed. These old fields are now dominated by shrubs and herbs, many of which are calciphiles which may have originally occupied the drier parts of the swale. A combination of flooding and occasional fires may have resulted in the presence of a Lake Plain Wet-Mesic or Wet Prairie community at the boundary between the low beach ridges and swales, but the flora is too disturbed, both by previous farming and recent high water levels, to determine this with certainty. A parking lot and the old field interrupt the transition to upland. Small, uncleared areas support Swamp Forest.

Sampling of a second transect was conducted about 1/2 mile to the south, where the vegetation zones consist of Emergent Marsh in the shallow waters of Saginaw Bay and Swamp Forest immediately behind the foredune. Clay soils underlay the marsh, but a 3 to 18 inch layer of sand, probably washed in by bay currents, blanket the surface. Diversity of the Emergent Marsh is relatively low (14 species), as is typical in Emergent Marsh

zones, such as this one, which are subject to direct wave action of Saginaw Bay. Scirpus americanus and Eleocharis smallii were the dominant emergents of the marsh. Myriophyllum exalbescens, Nymphaea odorata, Vallisneria americana, and Najas flexilis were common submergent and floating plants. The dominant species of the Swamp Forest is Fraxinus pennsylvanica near the lake edge, most of which had been killed by the high water levels of Saginaw Bay during recent years. Further inland the diversity of the Swamp Forest increases as drainage conditions improve. Among the species of the Swamp Forest noted further inland were Quercus bicolor, Quercus macrocarpa, Ulmus americanus, Acer saccharinum, and Populus deltoides. Most of these tree species are characteristic of Southern Swamp Forest rather than Northern Swamp Forest.

The overall quality of the marsh is high, with the exception of the Shrub Swamp and Swamp Forest near the Pine River. Both the Southern Swamp Forest (1/2 mile south of the river) and the Great Lakes Marsh are of high enough quality to recognize as element occurrences in the MNFI data base.

19. **Wigwam Bay-Rifle River (Arenac Co.)** This approximately 814 acre marsh is located on a delta of the channelized branch of the Rifle River, approximately four miles south-southeast of the town of Omer. The majority of the area is a Typha X glauca dominated Emergent Marsh on shallow muck. (Typha X glauca is a hybrid between T. angustifolia (narrow-leaved cat-tail) and T. latifolia (common cat-tail)). Channelization of the Rifle River (prior to 1938) has presently resulted in heavy soil accumulation in what was historically a continuous band of offshore emergent marshes. This artificial delta has undergone plant succession to Hardwood Swamp and Salix

amygdaloides dominated Shrub Swamp over a large area. These natural communities are on various mineral soils, including loam, sandy loam, and clay. Adjacent to Saginaw Bay is a zone of Wet Meadow (Bidens cernua-Calamagrostis canadensis which was newly emerged in 1988 following a period of high water. The substrate is sandy where it grades into Shrub Swamp and shallow muck where it grades into Submergent Marsh. There are large areas of low density Submergent Marsh on deep silt, dominated by Myriophyllum spicatum, Heteranthera dubia, and Vallisneria americanum. Silt depths are greater here than for other marshes sampled in Saginaw Bay, reflecting the continuing buildup of the delta. A number of off-shore colonies of T. X glauca or Scirpus americanus are also present beyond the Submergent Marsh on submerged sand bars.

In addition to the channelization of the Rifle River, a number of long boat slips were excavated prior to 1938 and portions of the Hardwood Swamp were logged just prior to that time. While this marsh is of higher natural quality than adjacent levied marsh to the east, it is relatively low in diversity of both plant communities and total species, reflecting its early successional nature. Since the marsh is mostly of non-natural origin, it is not included as an element occurrence in the MNFI database. Ownership is unknown for much of the newly formed delta. Other owners include (in order of acreage): Green Point Farms; Leroy and Eugene Robinson; and K. & S. W.

One Special Plant, Rumex maritimus (Special Concern), was encountered in this survey. No other Special Plants or Special Animals are known from this marsh.

20. **Au Gres River Delta (Arenac Co.)** This 114 acre marsh occupies the delta at the mouth of the Au Gres River, approximately 1½ miles south-southeast of Au Gres. Only a small area of this delta, lying northeast of a new access road to a boat ramp, remains in a natural state, consisting of a marsh/meadow/shrub swamp complex. The Emergent Marsh is dominated by a very low density of Scirpus americanus. High water levels have likely reduced plant densities in this zone. The Wet Meadow/Emergent Marsh zone is early successional due to die back from high water. A closed to semi-closed canopy Salix petiolaris dominated Shrub Swamp lies above the high water mark. This swamp, less than 50 years old, was formerly a hayfield. In addition to being historically hayed, this area has also been disturbed by ditches along the northern boundary as well as the northern side of a new highway leading to the boat access.

The Au Gres River Delta has been designated as the Au Gres River Environmental Area and is owned by Anna Badoun, et al.; Riverside Subdivision; State of Michigan; and Carl Schramm. One Special Plant (Rumex maritimus, Special Concern) was encountered in this survey; no other Special Plants or Special Animals are known from this marsh. The natural community is not of high enough natural-areas significance to qualify for inclusion in the MNFI database.

Lake Michigan

21. **Galien River Estuary (Berrien Co.)** This 269 acre marsh, located along the floodplain of the Galien River in southwestern Berrien County (northeast of New Buffalo), is an estuary with deep, watery muck. The muck is deepest immediately adjacent to the river, where Peltandra virginica dominates in a near-monoculture. In the wettest areas it is co-dominant

with Nuphar advena. Hybrid cat-tails (Typha X glauca) dominate along the natural levees of the river and in a relatively diverse Southern Wet Meadow zone along the upland margins of the marsh. To the north, a subdivision occupies an old coastal dune that separates the marsh from Lake Michigan.

The primary use of this marsh is for private hunting. Portions were historically hayed, including two islands which have succeeded to young Southern Swamp. Ownership is primarily by Louis and Madeline Sima, with additional acreage in Riviera Home Owners, M.T. Kerhoulas, and C.S. The western portion of the marsh is within the city limits of New Buffalo. Compared to other marshes along the lower Lake Michigan coast, this site exhibits relatively low diversity of natural community types, is moderately small, and has low species richness and equitability (i.e., is dominated by a few major species to the exclusion of others).

A number of Special Plants are known from this marsh, none of which were encountered in this field survey. These include Zizania aquatica var. aquatica (State Threatened), Hibiscus moscheutos (Special Concern), Silphium perfoliatum (Cup-plant; State Threatened), Cuscuta campestris (field dodder; Special Concern), and Sabatia angularis (rose pink; State Threatened).

22. Paw Paw River Estuary (Berrien Co.) This 122 acre marsh located within urban Benton Harbor in northwestern Berrien County, is comprised of three more or less contiguous wetlands. The first, immediately west of a landfill and north of an airport, is dominated by Typha X glauca with or without Epilobium hirsutum. These grow on a very loose root mat in a substrate of greater than two feet of soft, watery muck. There has been

minor hydrologic impact from the adjacent landfill and access road. The wetland is low in species richness and equitability, but high in plant vigor and density. It is poorly buffered and lacks a diversity of natural community types. The second area, with similar zonation, was not sampled.

The third area, located west of the Paw Paw River, was sampled and is comprised of firm muck over sand with a natural community mosaic of Southern Wet Meadow dominated by Calamagrostis canadensis, Emergent Marsh dominated by Typha X glauca and Peltandra virginica, and both Southern Shrub Carr dominated by Cornus sp. and Inundated Shrub Swamp dominated by Cephalanthus occidentalis. It is relatively high in species richness, density and equitability; has intact hydrology although a railroad embankment impedes downslope movement of water; is buffered from adjacent urban development by the railroad embankment, and has a fairly diverse mix of natural community types. Some recent woody invasion of the meadows is taking place, probably due to a cessation of historical haying. A number of bird houses have been erected in this wetland. The majority of the area is within the city limits of Benton Harbor, with additional acreage owned by Jack and Joyce Imbordino as well as the Chesapeake and Ohio Railroad.

Two Special Plants - Hibiscus moschentos (Special Concern) and Silphium integrifolium (rosinweed; State Threatened) - are known from this marsh, neither of which were encountered in this field survey.

23. Kalamazoo River Estuary (Allegan Co.) This 1045 acre estuary lies approximately three miles southeast of Saugatuck in the floodplain of the Kalamazoo River. It is an extensive marsh complex with a good diversity of natural community types. Muck greater than 3 feet thick

characterizes much of the area; most of the remaining acreage is 1-3 feet of muck underlain by sand.

Extensive areas of the marsh were dominated by Peltandra virginica, with Nuphar advena and Nymphaea odorata in pools and Scirpus fluviatilis-Carex lacustris on shallow muck over sand. In the northeastern areas of the marsh, shrub swamp (Cephalanthus occidentalis) and trees (Salix nigra and Fraxinus pennsylvanica) occurred in a mosaic with marsh and wet meadow (Phalaris arundinacea). Also occurring were limited areas of Southern Floodplain Forest (F. pennsylvanica-Acer saccharinum) with three distinct age classes: mature to old second-growth, young to mature, and regrowth to young. A former vegetated emergent marsh in Section 14 (vicinity of Transect A) is now unvegetated submerged silt with up to 42 inches of saturated, unstable muck, probably due to recent high-water conditions.

The Kalamazoo River Estuary is essentially unaltered by man, with the exception of localized edge disturbances and occasional duck blinds, and a long cut immediately east of the natural quality marsh. There has been probable impact from increased siltation and herbicide accumulation from the watershed. Siltation would have naturally occurred, but has undoubtedly increased due to agricultural activities throughout the Kalamazoo River watershed. Species richness is high in all except the Emergent Marsh communities. The Emergent Marsh zone is often low in diversity even in marshes unaltered by human activity.

This site is a natural quality Great Lakes Marsh of state significance. Most of the area is owned by the Pottawattomie Club. Lesser acreage is in multiple-private ownership.

There are two historical occurrences of Special Animals from this

marsh: Cyclonaias tuberculata (purple wartyback; Special Concern) and Ictiobus niger (black buffalo; Special Concern). Neither of these species were searched for in this study and no other Special Animals or Special Plants were encountered.

24. **Macatawa River Estuary (Ottawa Co.)** The Macatawa River is highly altered where it passes through Holland at the eastern extent of Lake Macatawa. There is very limited and highly disturbed acreage of Emergent Marsh and Southern Wet Meadow, with no evidence of Submergent Marsh due to basin siltation. Because of these conditions, this site was not sampled in the present survey.

One Special Animal, Clonophis kirtlandi (Kirtland's snake; State Endangered and Federal C2), and one Special Plant, Zizania aquatica var. aquatica (wild-rice; State Threatened), are known from this site.

25. **South Lloyd Island (Ottawa Co.)** This 31 acre marsh, approximately one mile due south of Spring Lake, is one in a series of natural-quality marshes located on islands within the Grand River. Natural-quality marsh occupies approximately one-half of the island which is owned by Twin Lakes Farms, Incorporated. The other half of the island was previously plowed.

This island is a mosaic of Southern Wet Meadow and Emergent Marsh (including tall emergent, broad-leaved emergent, and floating-leaved zones), with Submergent Marsh (Ceratophyllum demersum-Myriophyllum sp.) restricted to small protected bayous. The meadow is dominated by Calamagrostis canadensis and Phalaris arundinacea, and occupies the south,

southeast, southwest, and west sides of the island. These areas were heavily disturbed in 1938 aerial photographs, perhaps the result of either agriculture and/or use as river dredging spoil sites. Salix sp. and Lythrum salicaria are locally dominant both here and on the Southern Wet Meadow. The Emergent Marsh is of natural quality and was locally dominated by either Typha X glauca, Pontederia cordata, or Peltandra virginica. The substrate is a deep silt, generally under 1-2 feet of water in 1988.

Nelumbo lutea (State Threatened) was discovered at the eastern-most point of the island. No Special Animals are known from, or were encountered while surveying this marsh.

26. Dermo Island (Ottawa Co.) This 88 acre marsh lies approximately two miles east of Grand Haven and is one in a series of natural marshes on islands within the Grand River. Approximately one-half of this island was determined to be natural quality Great Lakes Marsh; the remainder (at the north and south ends of the island) was either former agricultural land and/or river dredge spoil sites. These latter areas are dominated by Typha X glauca, Salix sp., Phalaris arundinacea and Lythrum salicaria. The island is owned by the State of Michigan and is part of the Grand Haven State Game Area.

The natural marsh consists of a mixture of Southern Wet Meadow, Emergent Marsh (including tall emergent, broad-leaved emergent, and floating-leaved zones), and Submergent Marsh. Atypical of other marshes along the Grand River is the importance of Scirpus fluviatilis in the Emergent Marsh. This portion of the island (on the south and west sides) is essentially undisturbed, in contrast to the south end which has an old

road and power transmission lines.

27. **Indian Channel (Ottawa Co.)** This 500 acre marsh consists of three sites including an island west and south of Indian Channel, the wetland portion of a peninsula immediately east of the channel, and marsh east of these areas and immediately south of the main channel of the Grand River. These sites are approximately three miles southeast of Grand Haven. The entire wetland acreage north of the Grand River was determined to be a Great Lakes Marsh of natural quality. The site south of the river is natural quality except immediately alongside the river, where dredging spoils may have been deposited. The majority of the area is within Grand Haven State Game Area. Significant private tracts include Felix Pytlinske, Marc & Leona Crum, and Walter Maciejewski.

The island west of Indian Channel consisted of either Typha X glauca on exposed, sandy ground, or Peltandra virginica on thick, unstable muck. High recent water levels have significantly lowered plant diversity at this site. The area east of the channel was primarily Peltandra, with Ceratophyllum demersum and Spirodella polyrhiza in the Submergent Marsh. The marsh south of the Grand River is dominated by floating-leaved Emergent Marsh species (Nymphaea odorata, Nuphar advena, and Potamogeton nodosus). This plant community exists where water depths exceed three feet. The emergent-leaved plant community of Typha X glauca, T. latifolia, Sparganium eurycarpum, and Scirpus validus occurs on slightly more elevated sites (0.5 to 2.5 feet of water depth). Between these two zones (in depths from 2.5 to 3 feet) are Pontederia cordata and Peltandra virginica. A submergent zone was found in deeper water throughout the site and is dominated by

Lemna trisulca, Elodia nuttallii, and Ceratophyllum demersum.

One Special Animal is known from the Indian Channel of the Grand River: Moxostoma carinatum (river redhorse; State Threatened), but was not searched for in this survey. No other Special Animals or Special Plants were encountered in this survey.

28. Pottawattomie Bayou (Ottawa Co.) This 122 acre marsh, located on a tributary of the Grand River, was determined to be one of the highest quality estuary-type marshes surveyed. In addition, it has a population of a state threatened plant species (Zizania aquatica var. aquatica). The majority of the site is owned and protected by the Township of Grand Haven, with significant additional unprotected acreage in A.H.R. Investments, Pitcher Investment Company, Ester D. Witteveen, McBeath & Kule, Nicholas Wolf, and the Airpark Industrial Plat.

Highly diverse Emergent Marsh and Southern Wet Meadow dominate most of the area, with moderately diverse Submergent Marsh (Ceratophyllum demersum-Spirodela polyrhiza) restricted to the main channel and the deeper, northern portions of the marsh. The Emergent Marsh is dominated by Peltandra virginica and Nuphar advena and gradually grades into an atypical Southern Wet Meadow (Carex aquatilis-Decodon verticillata-Bidens cernua) community as the floating peat mat become more stable. Meadows on unstable mats were rarely encountered in this study. A narrow zone of Southern Shrub-Carr (Cornus stolonifera-Alnus rugosa-Leersia oryzoides) occurs at the base of the uplands. The only major disturbance to this marsh is a former railroad right-of-way which crosses through the center of the site. It is now occupied by a suspended boardwalk which allows a natural

hydrologic regime.

29. Millhouse Bayou (Ottawa Co.) This 57 acre marsh lies approximately four miles southeast of Grand Haven, on a tributary of the Grand River. A population of a state threatened plant, Zizania aquatica var. aquatica), occurs here; no other Special Plants or Special Animals are known from this marsh. The vegetation is similar to Potawattomie Bayou one mile west, but the zonation is much narrower due to the smaller size of the site. The exotic weed Lythrum salicaria is abundant in localized areas within this marsh, making this a lower natural quality community than Potawattomie Bayou (see below), despite less artificial disturbance. This site is owned by Floyd Payne, Ruth Kube, George Unger, and Martin Zimonick.

30. Bruce Bayou (Ottawa Co.) This 380 acre marsh lies along the Grand River, approximately three miles southwest of Nunica. A population of a state threatened plant (Zizania aquatica var. aquatica) was found; no other Special Plants or Special Animals are known to occur in this marsh. The majority of the site is within the boundaries of the Grand Haven State Game Area, with private ownership by the Spoonville Gun Club, John Leavitt, Clinton Peterson, and Arn. Johnson.

This marsh is characterized by extensive Emergent zone dominated by Peltandra virginica and Nymphaea odorata on 3.5 to 6 feet of unstable muck. Submergent Marsh is restricted to protected embayments and is dominated by Ceratophyllum demersum. The site is underlaid by sand which is only locally exposed, supporting Southern Wet Meadow dominated by Phalaris arundinacea and Polygonum lapathifolium.

31. **Muskegon River Estuary (Muskegon Co.)** The Muskegon River Estuary lies immediately north of Muskegon. It is an example of a highly disturbed and altered Great Lakes Marsh which coexists with heavy urban and industrial development. Much of the Emergent Marsh and Southern Wet Meadow communities have been subject to hydrologic changes from channelization and numerous highway and powerline access roads lacking culverts. In the southwest portion, the marsh lies at the base of an approximately 20' high landfill, which has been listed by the Michigan Department of Natural Resources as a former toxic waste disposal site. Other areas have been levied for agriculture. The persisting Emergent Marsh is characterized by 20 inches of unstable muck under approximately one foot of water. It is dominated primarily by Peltandra virginica, with Typha X glauca (hybrid cat-tails) on shallower muck over sand. Southern Floodplain Forest (Fraxinus pensylvanica-Acer saccharinum) is found where sand is exposed. Extensive tree kill occurred in former Southern Swamp, as the result of a large-scale, poorly-timed water release from up-river sewage treatment ponds. These areas are now succeeding to Inundated Shrub Swamp (dominated by Cephalanthus occidentalis) or Emergent Marsh (P. virginica).

This 950 acre marsh is under multiple ownership, including (in order of acreage): State of Michigan (Muskegon State Game Area); City of Muskegon; Consumers Power Co.; Muskegon Township; Ernest Figgs, Jr.; Michigan National Bank; Zephyr, Inc.; and J.S. The northwestern and southern portions of the marsh are within the city limits of North Muskegon and Muskegon. No Special Plants or Special Animals are known from this marsh, nor were any encountered during this study.

32. **White River Estuary (Muskegon Co.)** The White River Estuary lies immediately northeast of Montague and Whitehall, where the floodplain of the White River opens into White Lake. Historically, extensive Southern Wet Meadows occurred throughout the floodplain, grading into Emergent Marsh near White Lake. These meadows are now largely levied and converted to agricultural use. Where still in natural condition, they are dominated by Calamagrostis canadensis-Carex lacustris-C. stricta. Recent high water levels have resulted in Emergent Marsh (dominated by Bidens cernua-Sparganium eurycarpon) succession onto the formerly inundated wet meadow. Causeway construction prior to 1938 at the confluence of White River and White Lake resulted in permanently damming and created Submergent Marsh immediately up-river of the causeway.

Most of this estuary is characterized by three or more feet of muck over sand. In the southern part of the area (SW $\frac{1}{4}$, section 21), this muck was very unstable to a depth of approximately one and one-half feet. In the northeastern reaches of the site, the natural levees along the river banks were sandy, supporting a lightly stocked Fraxinus pensylvanica-dominated forest. The Southern Wet Meadows in the eastern part of the site showed no evidence of haying on 1938 aerial photography, and were found to be more diverse than historically hayed meadows. Nevertheless, the White River Estuary is characterized by relatively low plant species richness coupled with high density.

This 650 acre marsh is under multiple ownership, including (in order of acreage): Weesies Brothers Farm, Inc.; John Pawolski; Muskegon County; Eleanor Fleming; William Workman, et ux.; George Ulman, et al.; Anthony

Petrilli, et ux. Portions of the western extent of the marsh are within the city limits of Montague and Whitehall.

A historic occurrence of Anodonta subgibbosa (lake floater; State Threatened) has been recorded from this marsh, but was not searched for during this survey. No other Special Animals or Plants are known from, or were encountered in this marsh.

DISCUSSION AND RECOMMENDATIONS

Response of Marsh Vegetation to High Water Levels

The importance of coastal marshes and their resiliency in response to high water levels was discussed in the 1987 Survey of Great Lakes Marshes in Michigan's Upper Peninsula (MNFI 1987). During the 1987 survey, it was noted that portions of the marshes which had suffered heavy erosion during the high water levels of 1986 were already beginning to be recolonized in the summer of 1987, when the water levels had just begun to drop. The 1988 surveys served to further demonstrate the resiliency of coastal marshes to high water levels. Signs of erosion resulting from high water levels were still evident in most of the marshes sampled in 1988, but recolonization, primarily by native vegetation, was occurring in all zones of the marsh. The greatest amount of erosion typically occurred at the high water beach line, where both beach ridges and thick organic deposits were eroded away by wave and current action. In both cases revegetation was swift as the water level dropped, indicating that the buried seeds of typical heavily-fruited annual aquatics (Keddy and Reznicek, 1986) or densely rhizomatous perennial aquatics recolonized relatively rapidly after a drop in water level. The colonizers included Eleocharis acicularis (spike-rush), Eleocharis obtusa, Rorippa palustris (yellow cress), Juncus dudleyi (rush), Verbena hastata (vervain), Rumex maritima (dock), Bidens cernua (beggar-tick), Boehmeria cylindrica (false nettle), and many others.

Changes in the vegetation of the offshore portions of the Emergent Marsh zone also occurred due to high water levels. In 1988, species of the Emergent Marsh zone typically grew in water less than 36" in depth. In contrast, during 1987, when water levels were higher, the emergent species

were typically growing in water as deep as 60". It appears that during high water levels the emergent vegetation in deep water begins to die, both because of the reduced amount of available oxygen and because increased wave action breaks the stems and erodes the rhizomes. When water levels drop there is a lag time before the emergent vegetation expands outward into deeper water. By the summer of 1988 the emergent vegetation had not yet had time to recover from the high water years of 1986 and 1987, and was only found in up to 3 feet of water. Two species with limited vertical growth potential, Eleocharis smallii (Small's spike-rush) and Equisetum fluviatile (horsetail), were found in greater numbers during 1988 than in 1987 due to shallower waters.

The location of muskrat houses, common within the Great Lakes marshes surveyed, also changed as a result of water level changes. In the marshes sampled in 1987, muskrat houses were located in one to two foot deep water among emergent vegetation, typically cat-tails or bulrushes. Upon returning to sample two marshes in 1988, it was found that the houses, which were above the water level at the time of the revisit, had been abandoned and new houses had been constructed further from shore in shallow water. Thus, with changing lake levels, new openings are continually being made by muskrats in the emergent marsh beds.

Plant Community Composition

Major vegetational differences between the marshes in the Upper Peninsula and southern Lower Peninsula were evident in some of the plant community zones. The Emergent Marshes in the southern Lower Peninsula were dominated by Scirpus validus and S. americanus, while S. acutus was much

more common in Upper Michigan. Eleocharis smallii and Cladium mariscoides were also more common in the Upper Peninsula. Diversity of Potamogeton spp. appears to be higher in coastal marshes of the Upper Peninsula than those surveyed in the Lower Peninsula during 1988.

At the beach line, the muddy zone of the Emergent Marsh on Lake Erie supported Sagittaria montevidensis, a State Threatened plant. This species is restricted to Lake Erie shorelines in Michigan. Sagittaria graminea was commonly present in this same zone in some Upper Peninsula marshes following the drop in water level.

The Wet Meadow zones of both the northern and southern marshes are very similar. It appears that Bidens cernua, Polygonum lapathifolium, and Rumex maritimus establish commonly on the exposed organic material of the Wet Meadow zone in the southern Lower Peninsula, whereas they are not as common in Upper Michigan.

The estuaries of the two peninsulas differ greatly. Both have thick organic soils, but the vegetation of the Upper Peninsula estuaries contains many species characteristic of Bogs or Northern Fens. Those of the southern Lower Peninsula are often dominated by dense colonies of Peltandra virginica, a species restricted to southern Michigan. Cephalanthus occidentalis and Decodon verticillata are common shrubs in the southern Michigan estuaries which are absent in Upper Peninsula estuaries, where Alnus rugosa (tag-alder), Chamaedaphne calyculata (leatherleaf), and Myrica gale (sweet gale).

Human Disturbances

Dike and channel construction caused the greatest amount of marsh alteration in the southern half of Lower Michigan. A large amount of diking and channel construction has been done on State Game Areas, primarily to produce waterfowl habitat. The consequences of this alteration is the destruction of large expanses of natural plant communities. This probably also has severe long-term impacts for waterfowl, as at least two introduced plant species, purple loosestrife and Eurasian water-milfoil, often establish after dredging. Both species form dense monocultures which exclude native plant species. Unfortunately, neither species produces seeds or other edible parts of importance as food for waterfowl. Purple loosestrife, once established, is almost impossible to eradicate.

Dredging has occurred at the mouths of most of the large rivers entering the Great Lakes. The dredging allows the passage of either commercial or recreational ships and boats. The wakes generated by these vessels cause further erosion of both emergent and submergent vegetation. As a result, the best examples of high quality marshes are typically located where water depths are too shallow for pleasure boat or ship traffic.

Boat docks and slips were common sources of Emergent Marsh degradation. Single slips created narrow channels through the emergents, with little sign of active degradation along the edges of the channel, as long as boat traffic was restricted to the channel. In the vicinity of marinas, or where there were several nearby slips, degradation was more severe, with the potential for complete destruction of the emergent beds.

Natural Area Recommendations

Several marshes sampled are of high natural quality and will be entered in MNFI's database as representative natural areas (Table 1). Among the highest quality of these are Indian Channel, Pottawattomie Bayou, and Millhouse Bayou all estuaries of the Grand River, Kalamazoo River Estuary, St. Clair River Delta, Wildfowl Bay, Wildfowl Bay Islands, and parts of Coryeon Point, Pointe Mouillee, and the Pine River Delta. We would recommend the maintenance of these large, diverse, and well-buffered marshes in their present condition, without further manipulation, in order to ensure preservation of their natural ecological functions and species/habitat diversity.

St. Clair River Delta Marsh, occupying the majority of Dickinson Island, Harsen's Island, and the St. Johns Marsh, is one of the highest quality marshes of the southern Lower Peninsula. The marshes on Dickinson Island have been the least manipulated for waterfowl habitat, and are thus the marshes we most highly recommend for management as Natural Areas. Dickinson Island, which makes up a large part of the St. Clair Flats Wildlife Area, is managed by the Wildlife Division of the Michigan DNR.

The most noteworthy marshes found along Lake Erie were the natural portions of Pointe Mouillee Marsh, especially the area east of the Huron River. MNFI recommends that the management plan of the Pointe Mouillee State Game Area denote for protection the higher quality portions of this wetland as the last remaining high quality natural marshes on the Michigan shores of Lake Erie.

On Saginaw Bay, an important complex of wetlands, Wildfowl Bay, is located in Huron Co. north of Sebewaing, between Geiger and Haist Roads.

This wetland contains Emergent Marsh, Wet Meadow, and Lakeplain Wet and Wet-Mesic Prairie. These are among the best remaining examples of Lakeplain Prairie, a very rare plant community in Michigan and the rest of the Great Lakes States. Protection and management of this site is of extreme importance. A portion of this wetland complex is owned by the Michigan DNR and the remaining parcels are under private ownership.

Another nearby area on Saginaw Bay, the Wildfowl Bay Wildlife Area, including Heisterman, Manisou, and Middle Grounds Islands, is a large and minimally disturbed complex of marshes. The Dry and Dry-Mesic Southern Forests on the beach ridges of the islands, are high quality Lakeplain Oak Openings. MNFI recommends that the management plans for this Wildlife Area recognize and maintain the natural condition of these wetlands.

Among the most significant estuaries along rivers entering into Lake Michigan are Pottawattomie Bayou (along a tributary of the Grand River), and the Kalamazoo River Marsh. Portions of the Pottawattomie Bayou are being managed as a park by the township of Grand Haven, while several other parcels are under private ownership. Ownership of the Kalamazoo River Marsh is primarily by the Pottawattomie Club.

Protection of the highest natural-quality marshes identified in this survey is integral to conservation of Michigan's natural diversity. Marshes have long been recognized for the diversity of living organisms which they sustain. They also trap and utilize silt and nutrients, slowing the degradation of the Great Lakes. If the perpetuation of Michigan's natural heritage in all its diversity is to be ensured, the best representative marshes from each natural region of the state should be adequately protected. Other, more disturbed marshes are also of importance

for their ecological functions and as wildlife habitat.

Protection of these marshes as natural areas helps to ensure for future generations the opportunity to experience, appreciate, and learn about the natural landscape and the ecological processes which maintain it and its inhabitants. These marshes serve as scientific resources for study of system functions and for baseline data on relatively natural ecosystems and potentially as monitoring sites for detection and study of environmental degradation. The opportunities to protect high natural-quality marshes continue to decline each year, especially in the more urbanized and developed portions of the Lower Peninsula, making it imperative that we act now to protect this valuable natural resource for future generations.

ACKNOWLEDGEMENTS

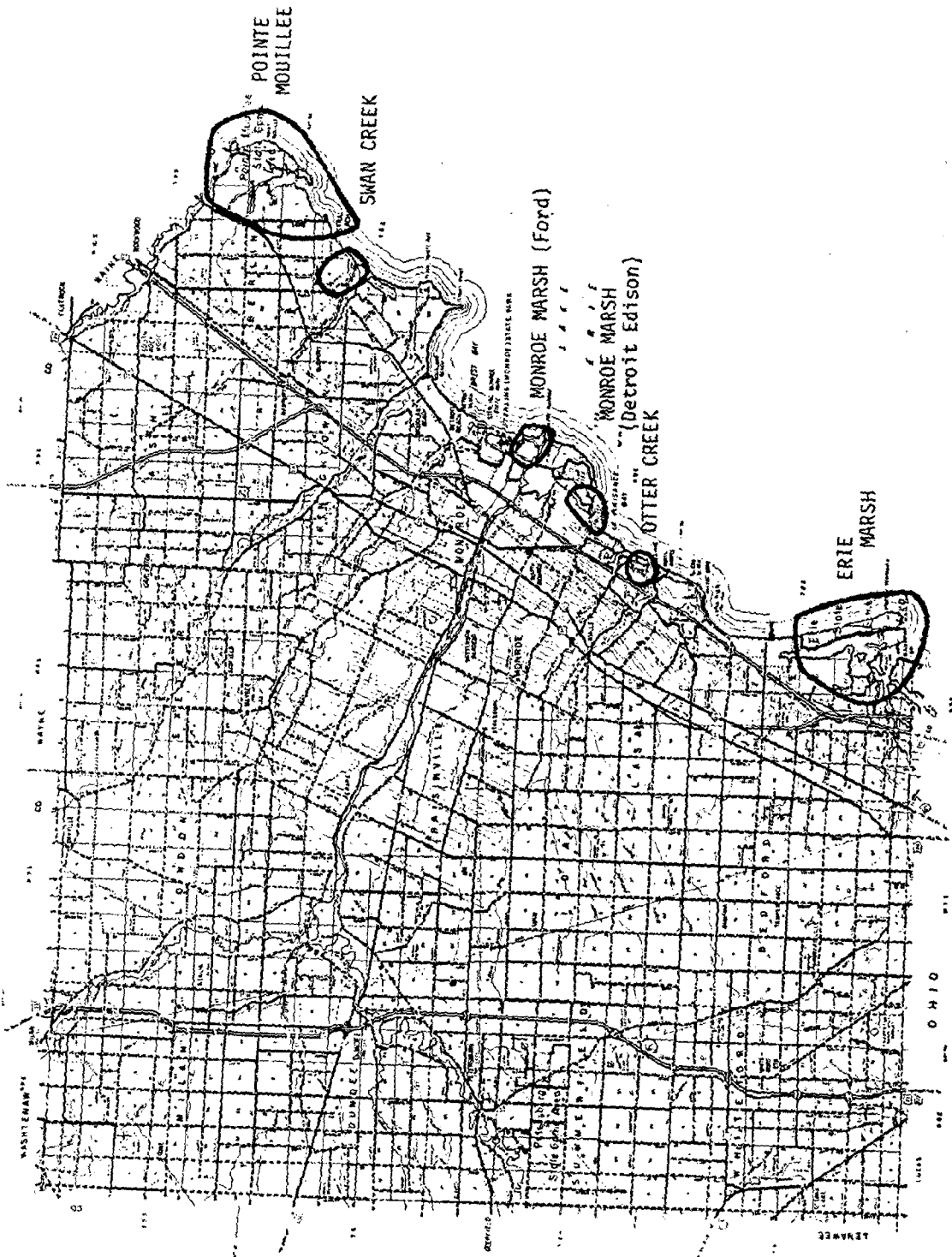
Many thanks to Bill Brodowicz, Elaine Chittenden, and Larry "Muck-walk" Brewer for their enthusiastic participation in the rigorous field surveys and plant identification. Thanks to the Remote Sensing Lab at Michigan State University for allowing us the use of photos from their photo archives. A final thanks to the landowners who so graciously allowed us to sample on their property or to cross their property to more easily reach the marshes.

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- Michigan Natural Features Inventory. 1986. Draft Description of Michigan Natural Community Types. (Unpublished manuscript, revised 6 March 1986).
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- Michigan Natural Features Inventory. 1987. A Survey of Great Lakes Marshes in Michigan's Upper Peninsula. A report for Land and Water Management Division (CZM Grant 9C-10).

APPENDIX I
LOCATION OF MARSHES SAMPLED

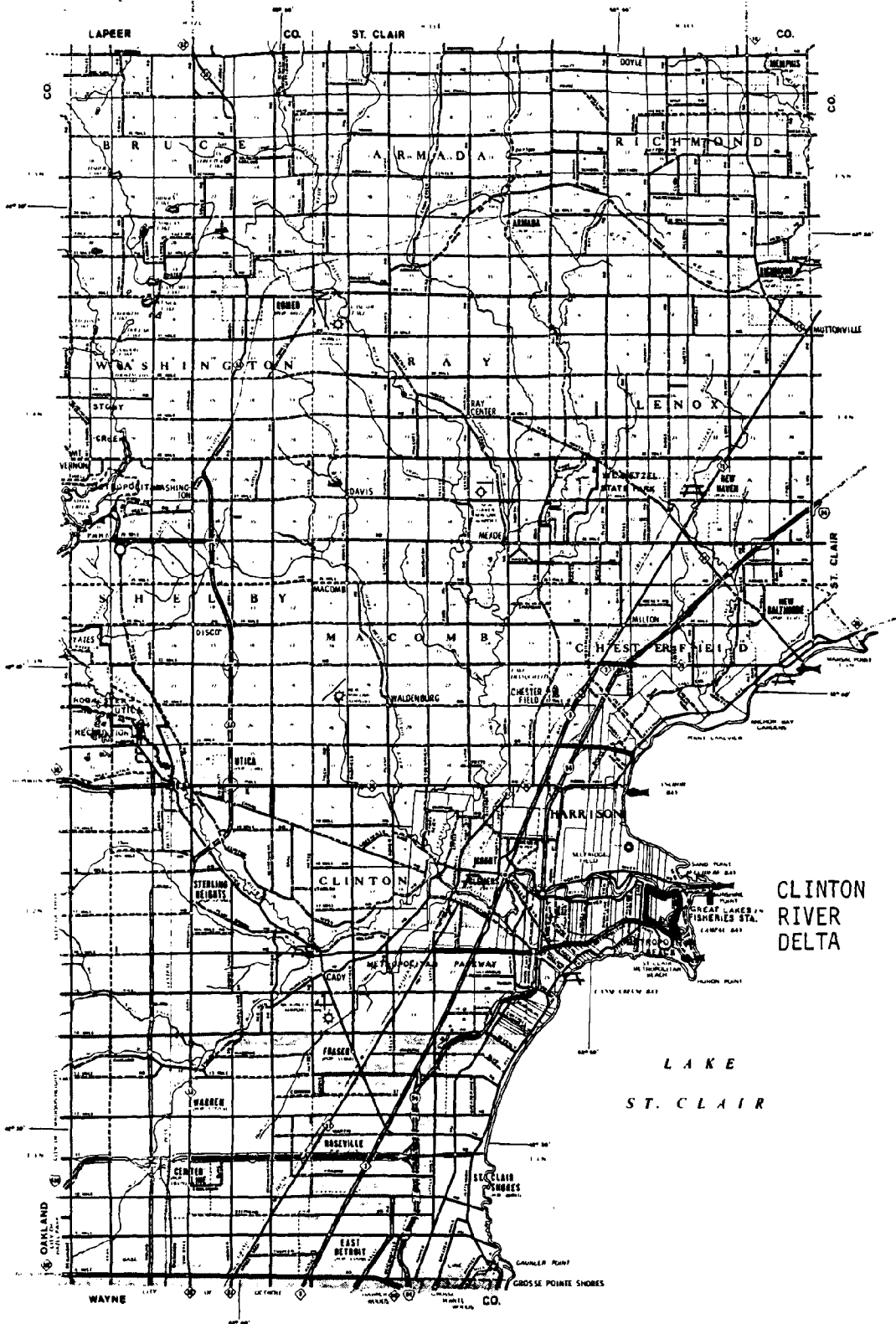
APPENDIX I.01
Great Lakes Marshes sampled in Monroe County



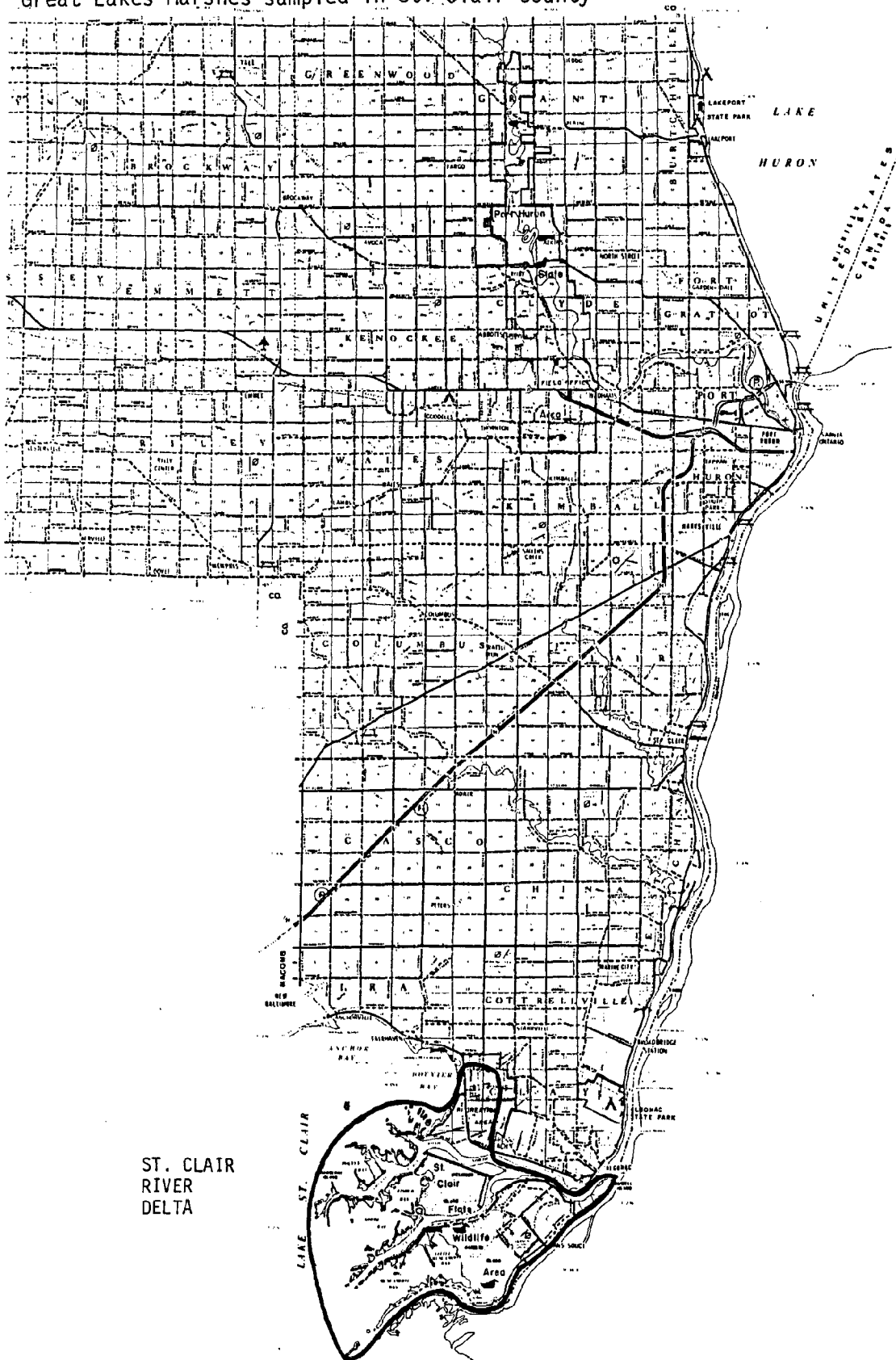
APPENDIX I.02
Great Lakes Marshes surveyed in Wayne County



APPENDIX I.03
Great Lakes Marshes sampled in Macomb County

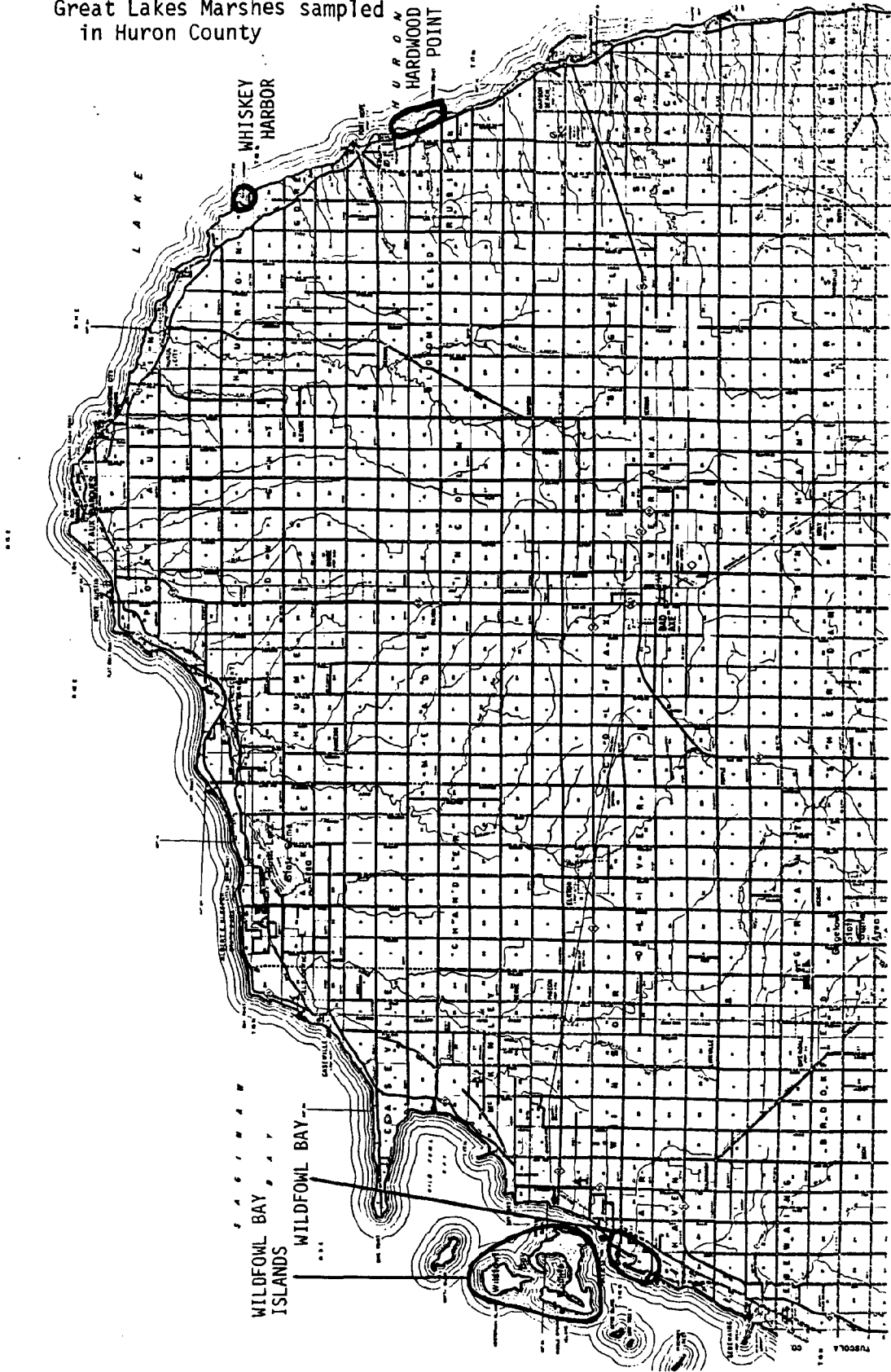


APPENDIX I.04
Great Lakes Marshes sampled in St. Clair County

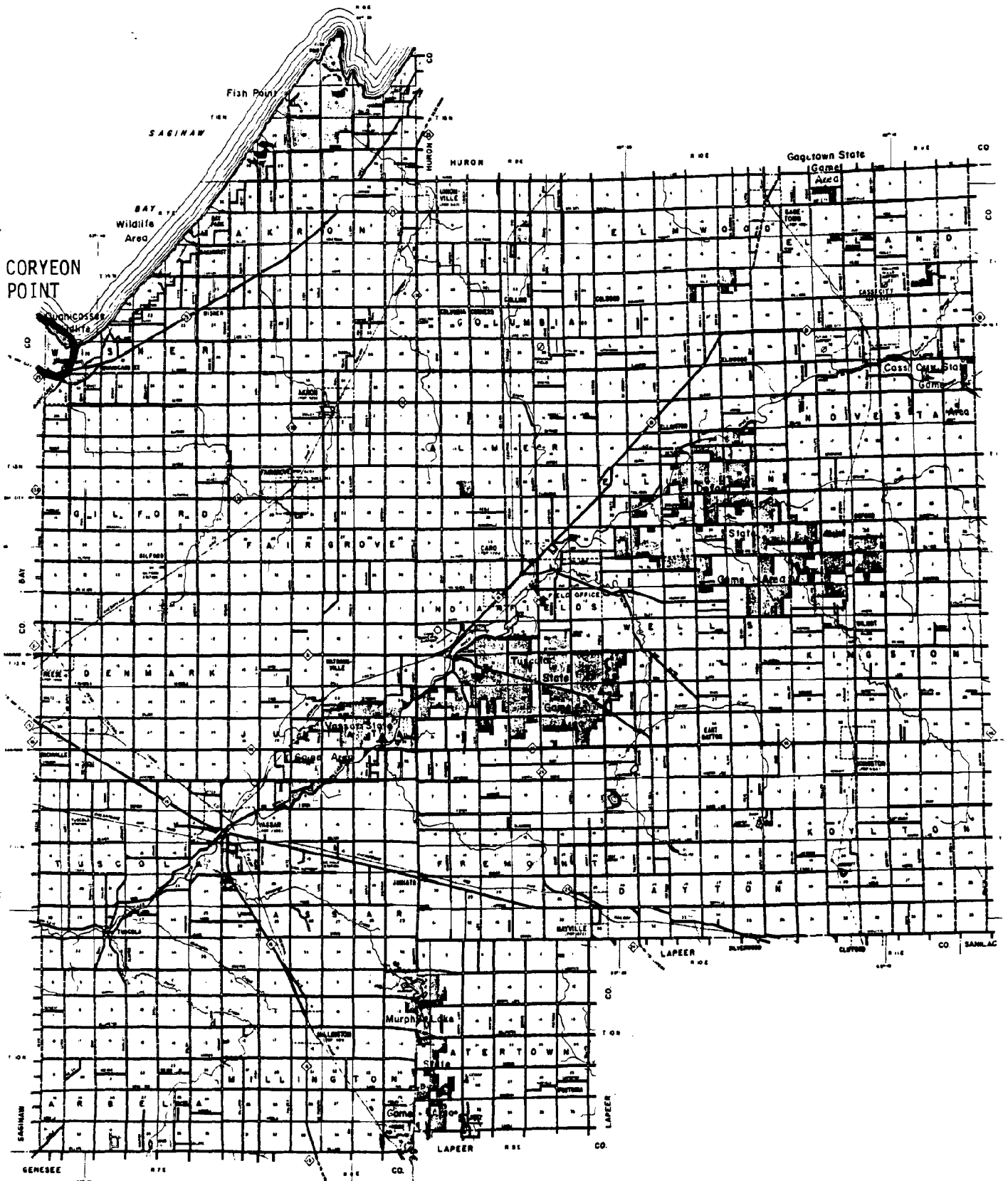


ST. CLAIR
RIVER
DELTA

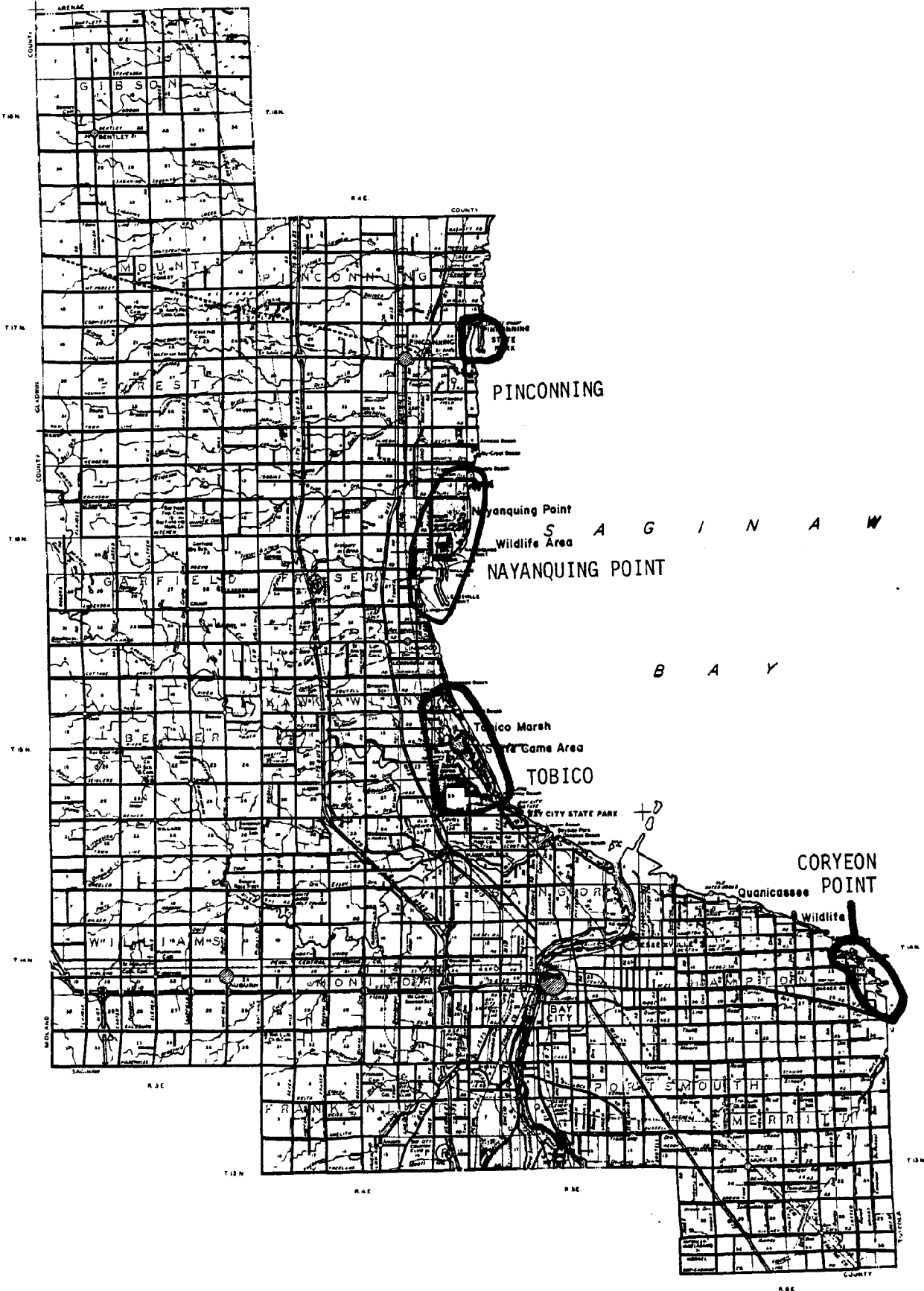
APPENDIX I.05
Great Lakes Marshes sampled
in Huron County



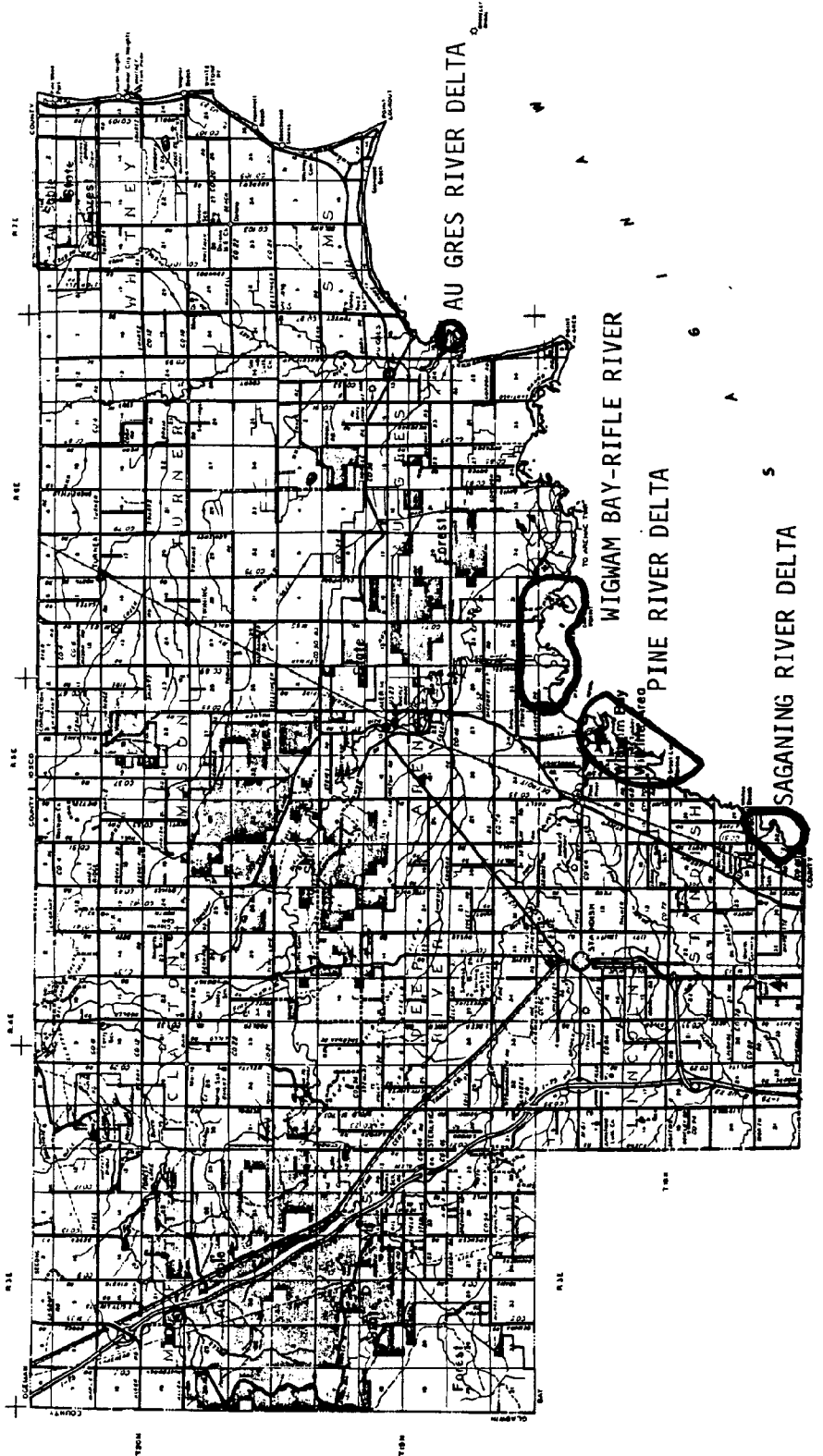
APPENDIX I.06
Great Lakes Marshes sampled in Tuscola County



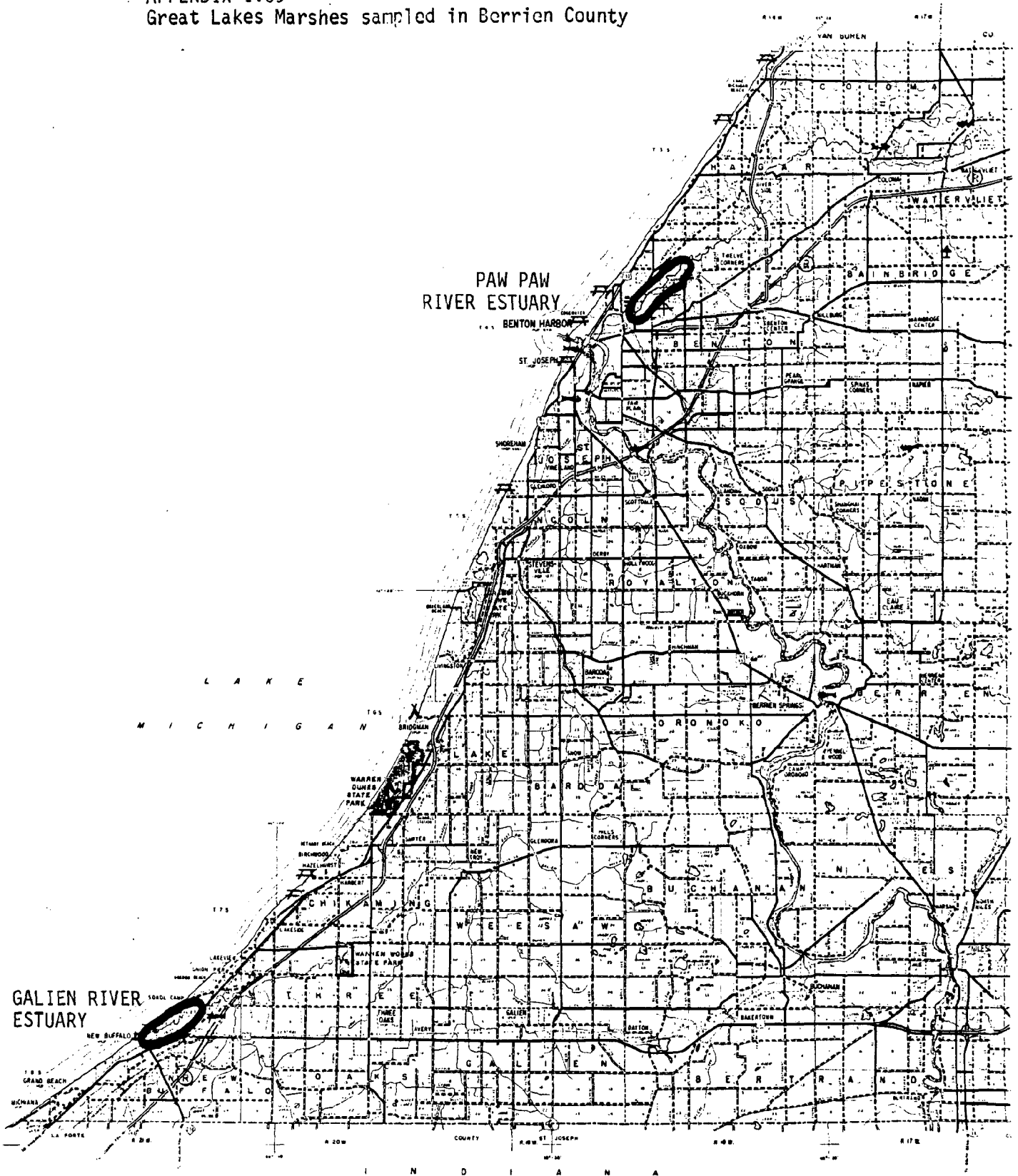
APPENDIX I.07
Great Lakes Marshes sampled in Bay County



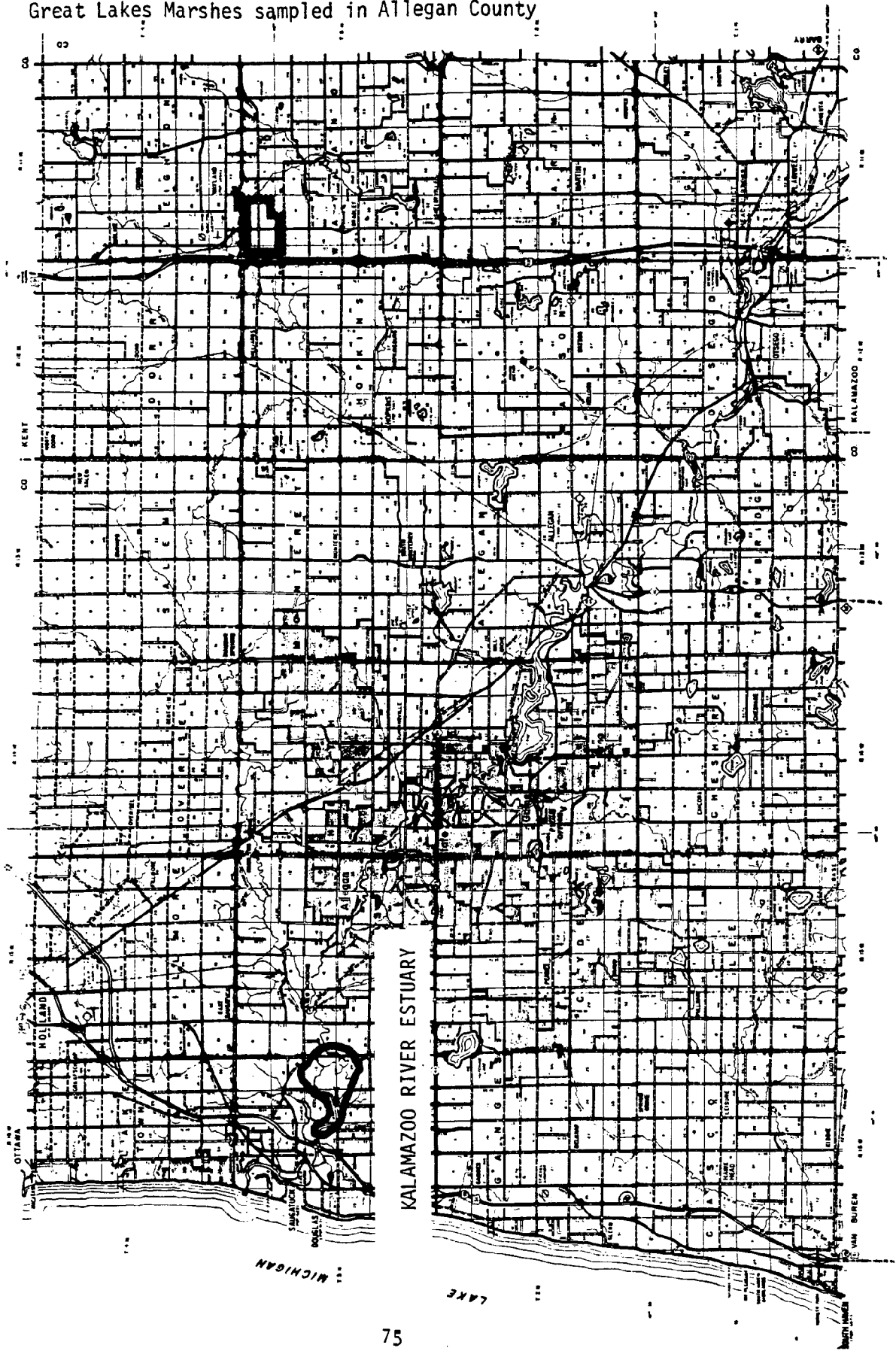
APPENDIX I.08
 Great Lakes Marshes surveyed
 in Arenac County



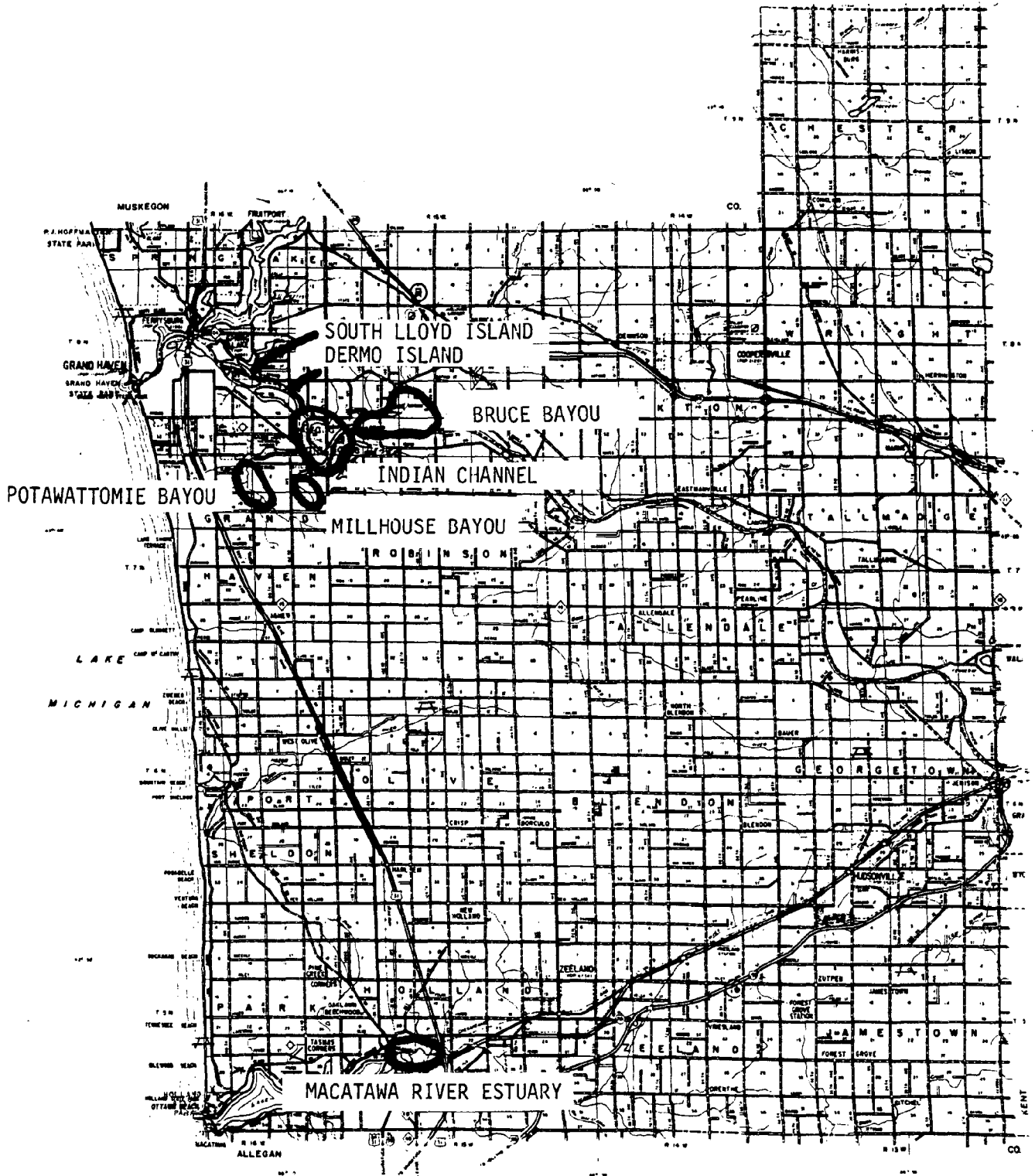
APPENDIX I.09
Great Lakes Marshes sampled in Berrien County



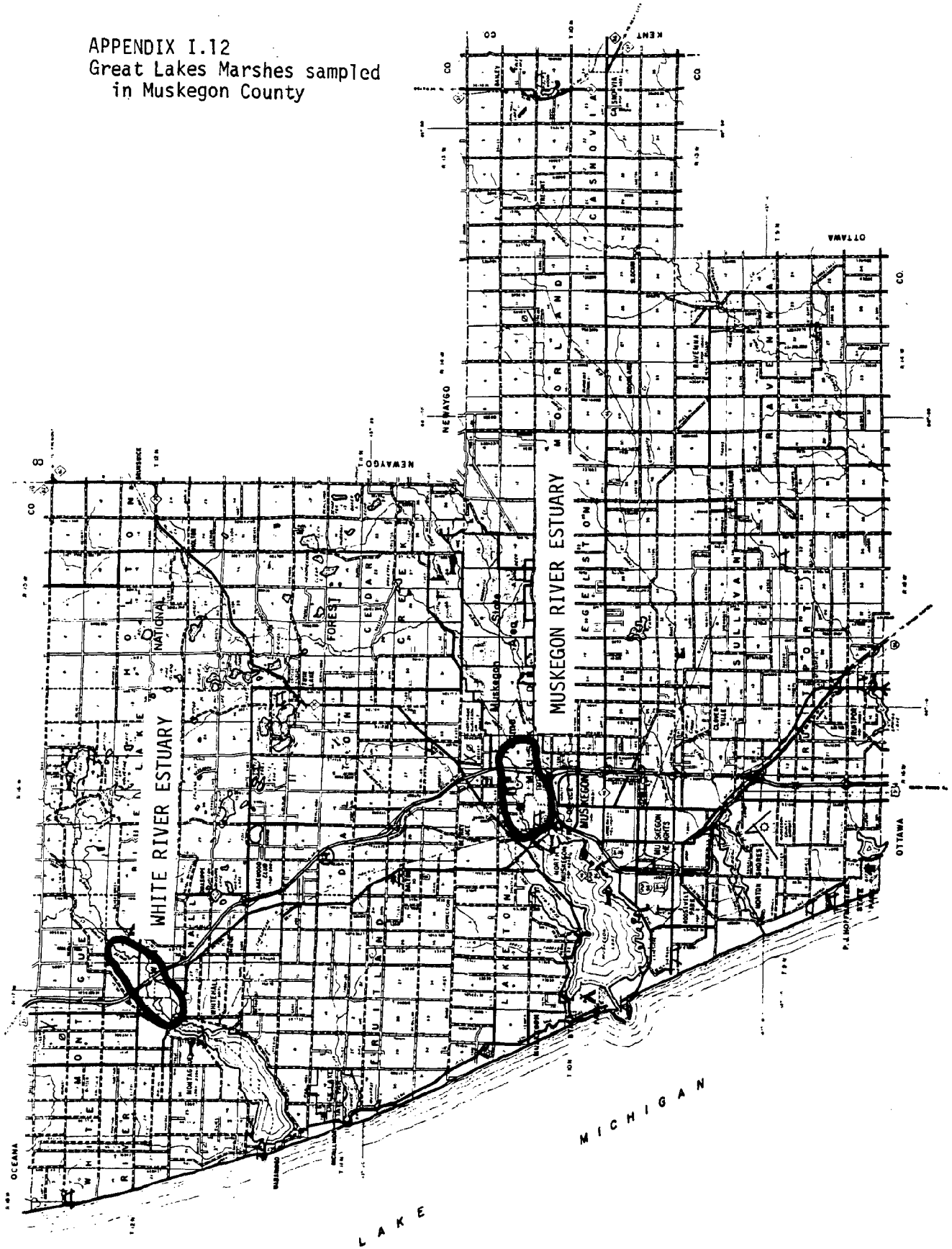
APPENDIX I.10
Great Lakes Marshes sampled in Allegan County



APPENDIX I.11
Great Lakes Marshes sampled in Ottawa County



APPENDIX I.12
Great Lakes Marshes sampled
in Muskegon County



APPENDIX II
GREAT LAKES MARSH SAMPLING FORM

APPENDIX III

EXPLANATION OF NATURAL QUALITY AND CONDITION RANKS

Great Lakes Marsh Must be big enough to sustain breeding waterfowl, shorebirds, fish spawning grounds, and some medium-sized mammals (e.g. muskrat, fox). Must exhibit typical zonation, preferably with natural vegetation at upland edge. Increase quality-grade for marshes with several cover types and many native vascular plant species (40+). Decrease quality-grade for presence of exotics, especially if major vegetative composition changes result. Water control structures are a major disturbance and lower condition-grade relative to severity of hydrological change. Boat slips, jetties, etc. are minor disturbances unless associated with heavy human use, which disturbs animals and destroys submergent vegetation. [See also: Submergent Marsh, Emergent Marsh, Northern Wet Meadow, Southern Wet Meadow, Northern Shrub Thicket, Southern Shrub-Carr, and Inundated Shrub Swamp criteria.]

Benchmark Quality Standard: High native plant species density and diversity (equitability and richness) relative to environmental conditions; heterogenous plant community zonation; presence of full range of natural communities expected for site; well developed natural vegetative buffer if exposed to open water; good buffer of associated natural communities on upland side; and unaltered natural disturbance regime.

Minimum Element Occurrence Specifications: Exceptional significance: EO Rank B and 100 acres. Notable significance: EO Rank B and 30 acres.

Element Occurrence Size-Classes: Large: 300 or more acres; Moderate: 100-299 acres; Small: 30-99 acres; Very Small: under 30 acres.

Boundary Mapping: Wetlands associated with a single coastal feature (a bay, a delta) constitute one occurrence even if interrupted by fields, forest, fill, or channels. Highly managed portions of marshes, even if they sustain animals, should be excluded.

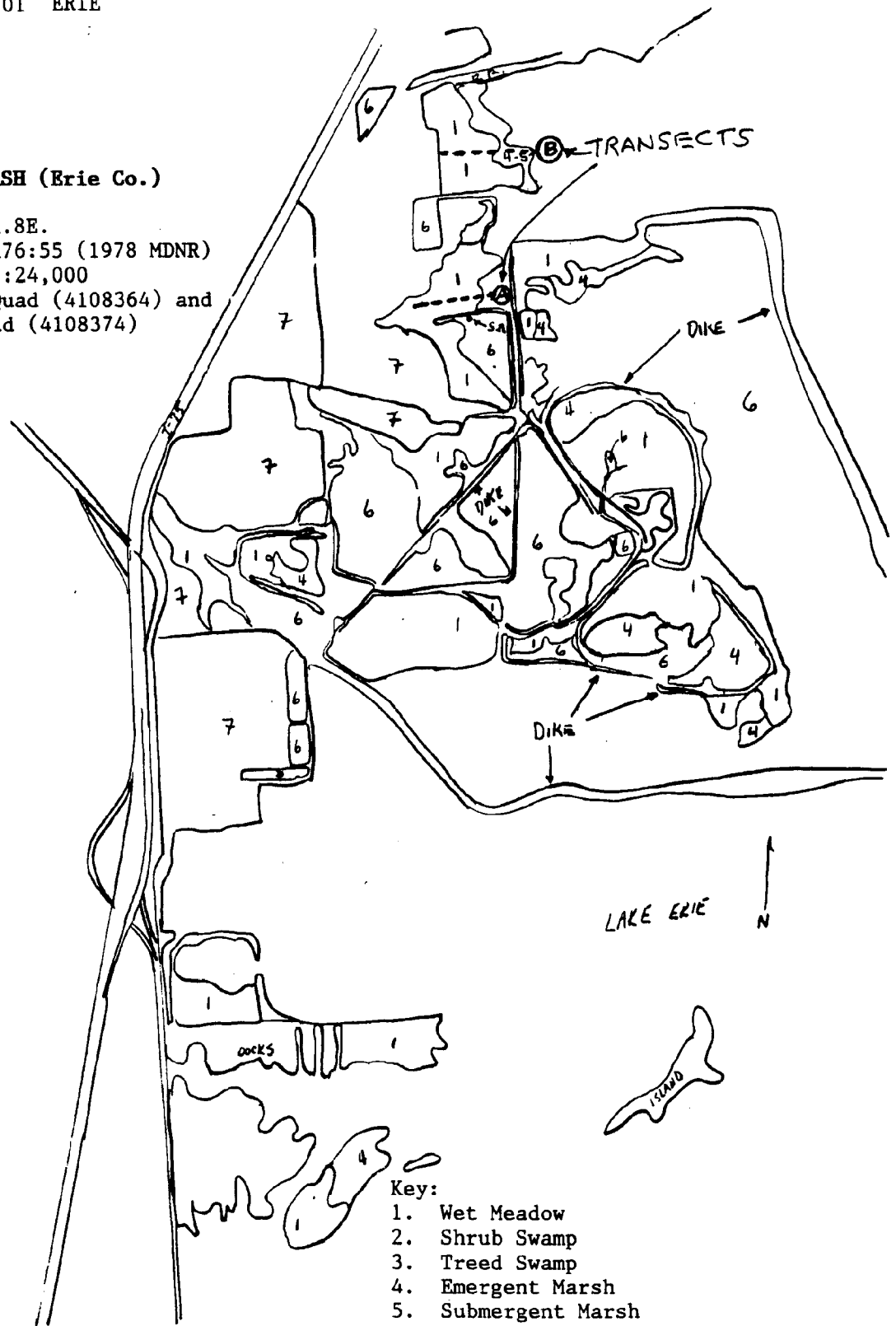
Exemplary Occurrences: St. Clair River Delta, St. Clair Co. (southern type); Munuscong River Delta, Chippewa Co. (northern type); Pottawattomie Bayou, Ottawa Co. (estuary).

APPENDIX IV
NATURAL COMMUNITY MAPS OF MARSHES SAMPLED

APPENDIX IV.01 ERIE

ERIE MARSH (Erie Co.)

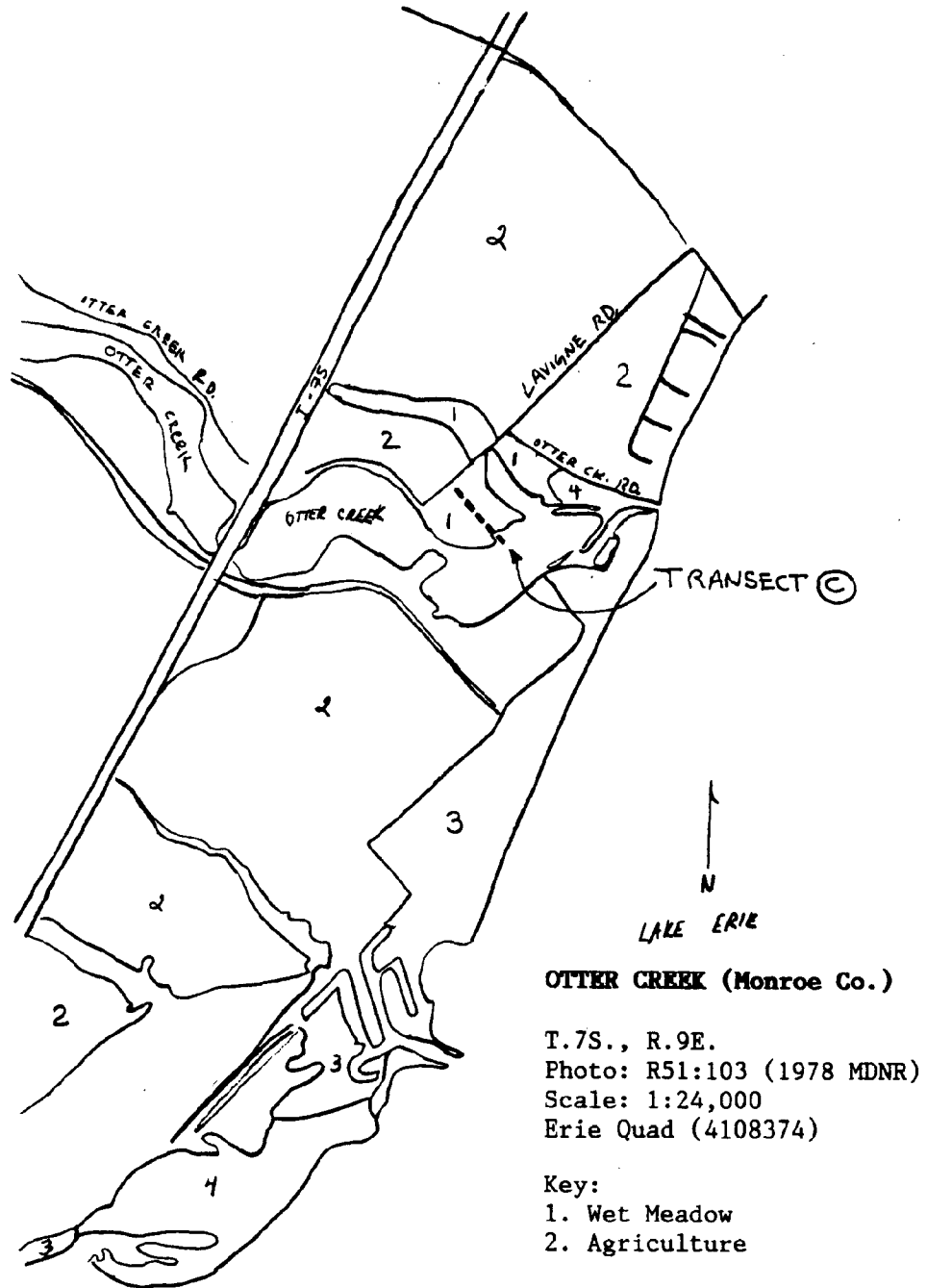
T.8S., R.8E.
 Photo: R76:55 (1978 MDNR)
 Scale: 1:24,000
 Oregon Quad (4108364) and
 Erie Quad (4108374)



- Key:
- 1. Wet Meadow
 - 2. Shrub Swamp
 - 3. Treed Swamp
 - 4. Emergent Marsh
 - 5. Submergent Marsh
 - 6. Pond
 - 7. Agriculture

Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.02 OTTER CREEK



Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.03 MONROE-DETROIT EDISON

MONROE MARSHES (Monroe Co.)

T.7S., R.9E.

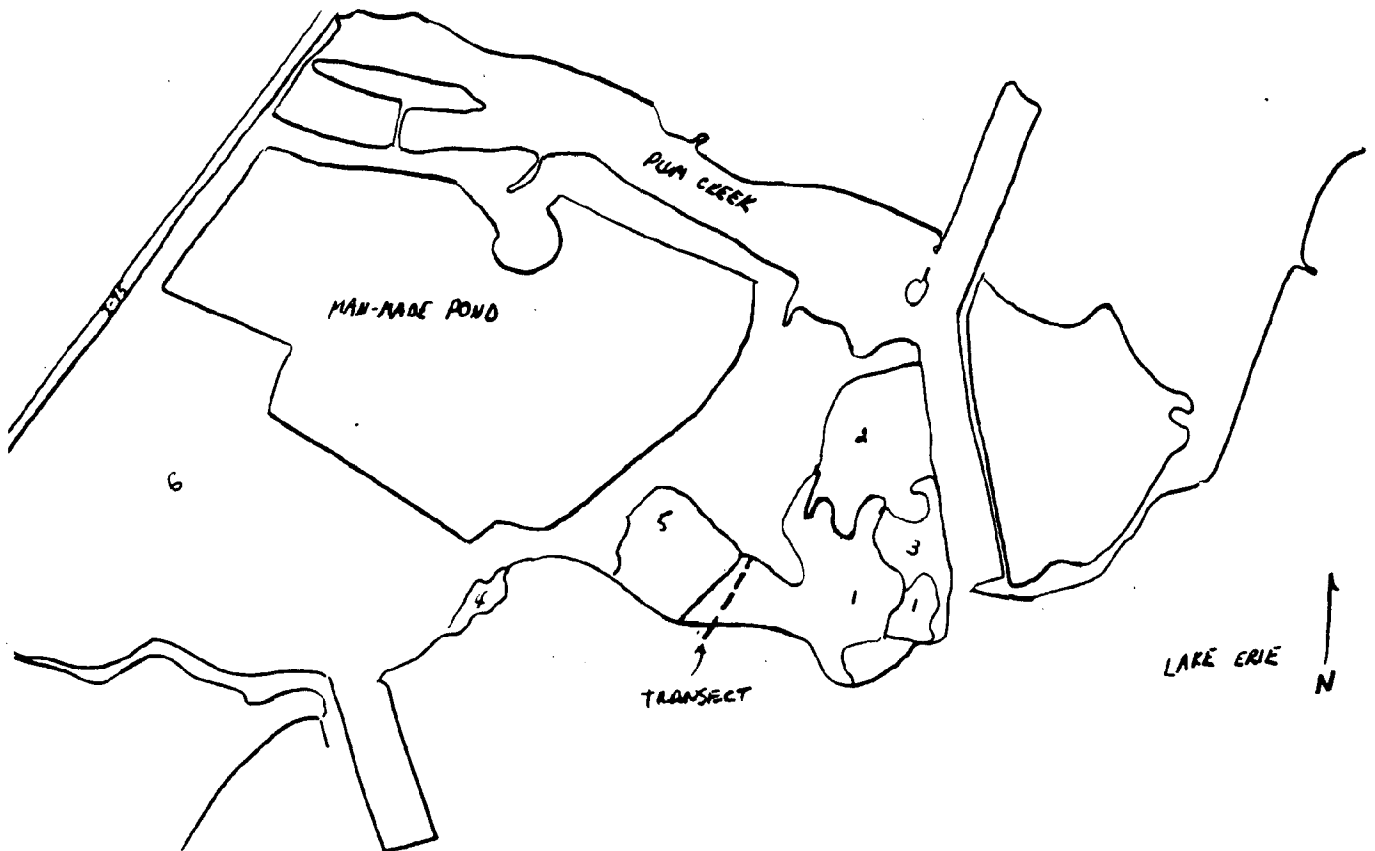
Photo: R51:26,63 (1978 MDNR)

Scale: 1:24,000

Stony Point Quad (4108383)

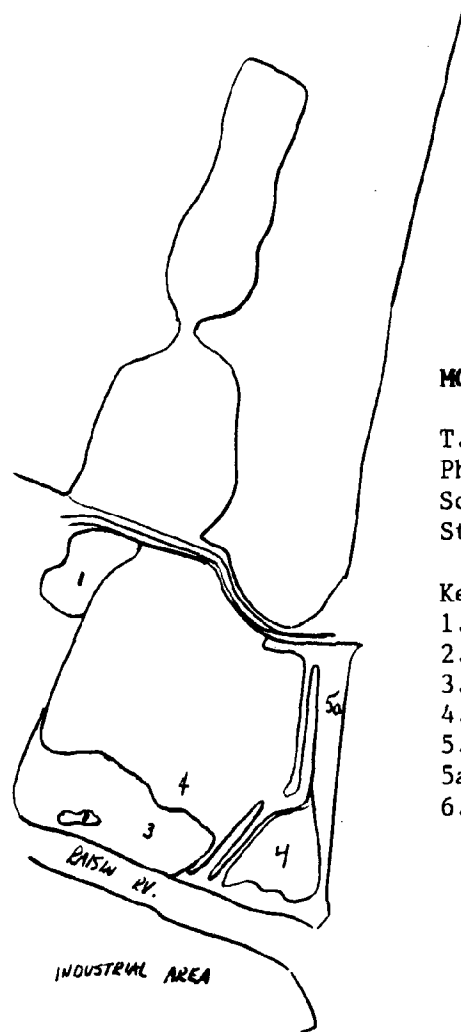
Key:

1. Wet Meadow
2. Shrub Swamp
3. Treed Swamp
4. Emergent Marsh
5. Upland Forest
- 5a. Upland Forest on dike
6. Agriculture



Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.04 MONROE-FORD



LAKE ERIE



MONROE MARSHES (Monroe Co.)

T.7S., R.9E.

Photo: R51:26,63 (1978 MDNR)

Scale: 1:24,000

Stony Point Quad (4108383)

Key:

- 1. Wet Meadow
- 2. Shrub Swamp
- 3. Treed Swamp
- 4. Emergent Marsh
- 5. Upland Forest
- 5a. Upland Forest on dike
- 6. Agriculture

Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

SWAN CREEK (Monroe Co.)

APPENDIX IV.05 SWAN CREEK

T.6S., R.10E.

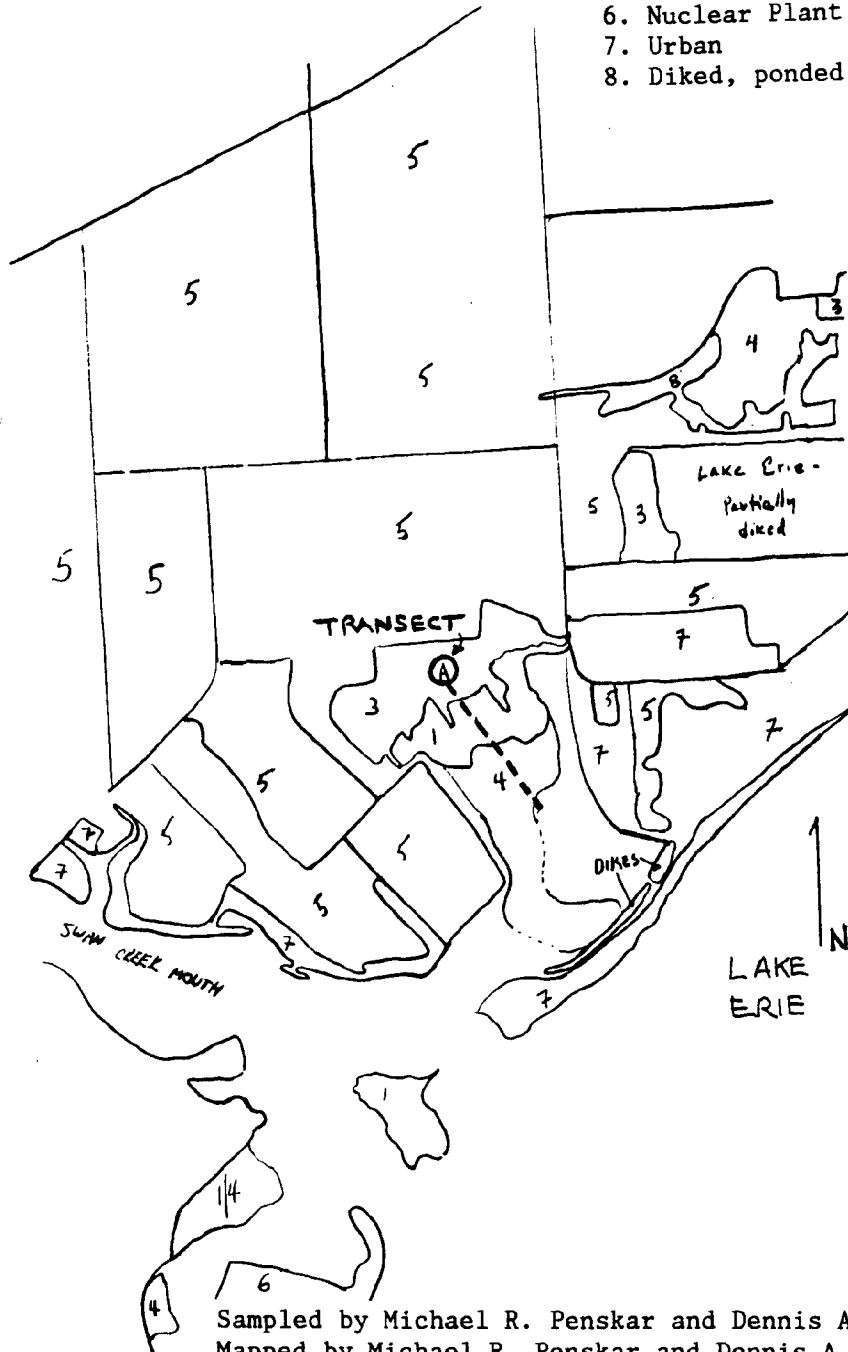
Photo: R51:05 (1978 MDNR)

Scale: 1:24,000

Stony Point Quad (4108383)

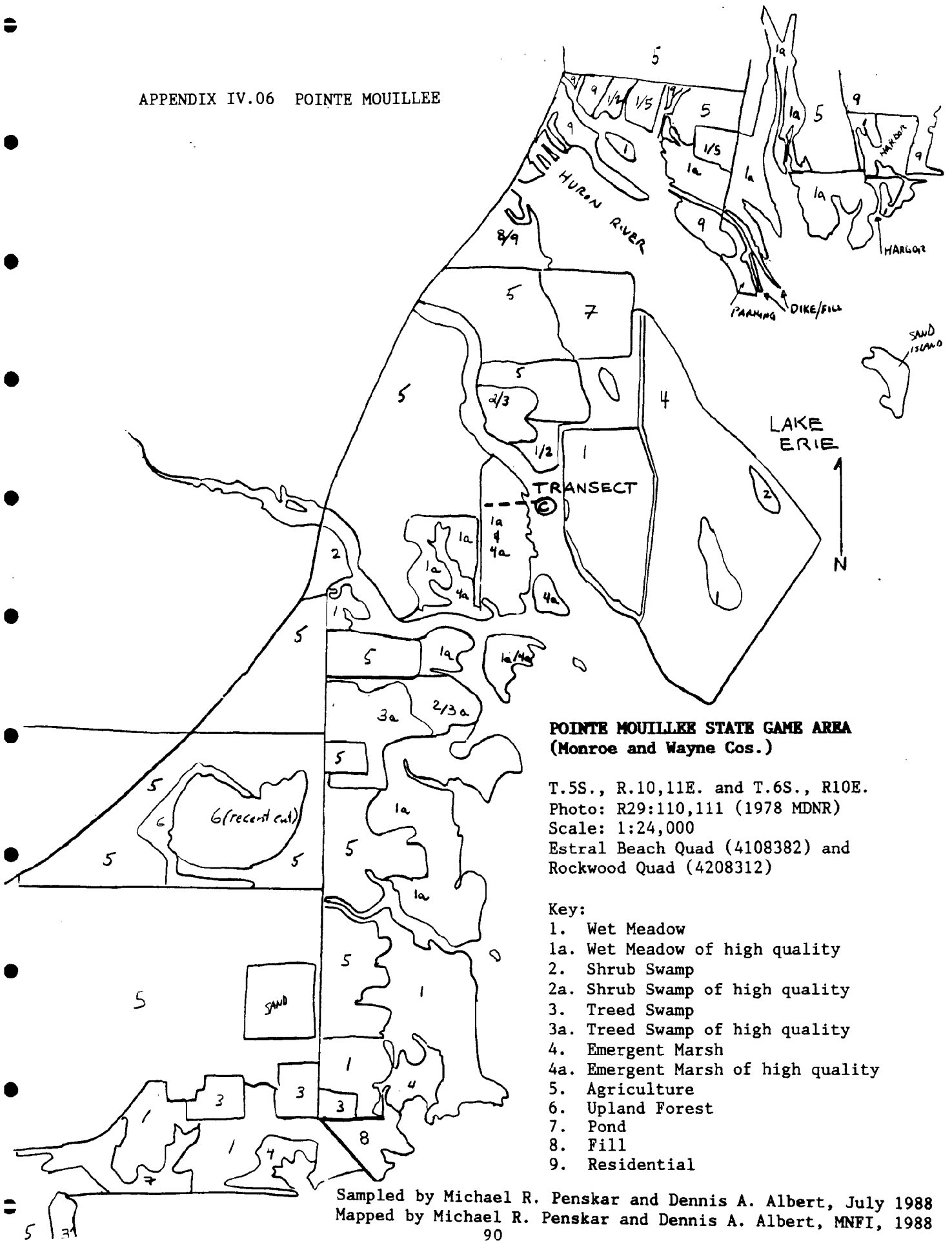
Key:

- 1. Wet Meadow
- 2. Shrub Swamp
- 3. Treed Forest
- 4. Emergent Marsh
- 5. Agriculture
- 6. Nuclear Plant
- 7. Urban
- 8. Diked, ponded



Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.06 POINTE MOUILLEE



**POINTE MOUILLEE STATE GAME AREA
(Monroe and Wayne Cos.)**

T.5S., R.10,11E. and T.6S., R10E.
 Photo: R29:110,111 (1978 MDNR)
 Scale: 1:24,000
 Estral Beach Quad (4108382) and
 Rockwood Quad (4208312)

Key:

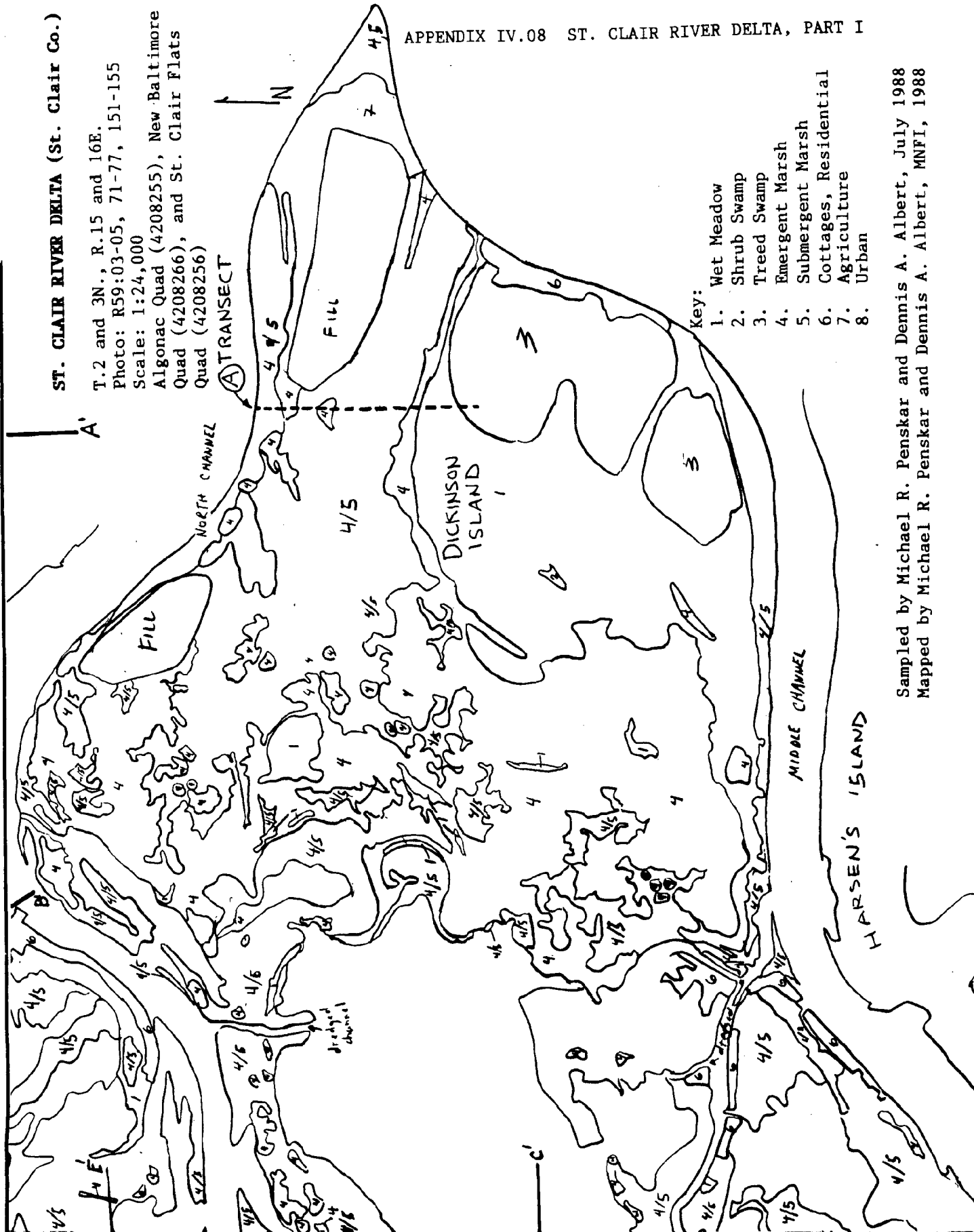
- 1. Wet Meadow
- 1a. Wet Meadow of high quality
- 2. Shrub Swamp
- 2a. Shrub Swamp of high quality
- 3. Treed Swamp
- 3a. Treed Swamp of high quality
- 4. Emergent Marsh
- 4a. Emergent Marsh of high quality
- 5. Agriculture
- 6. Upland Forest
- 7. Pond
- 8. Fill
- 9. Residential

Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

ST. CLAIR RIVER DELTA (St. Clair Co.)

T.2 and 3N., R.15 and 16E.
 Photo: R59:03-05, 71-77, 151-155
 Scale: 1:24,000
 Algonac Quad (4208255), New Baltimore
 Quad (4208266), and St. Clair Flats
 Quad (4208256)

APPENDIX IV.08 ST. CLAIR RIVER DELTA, PART I



Key:

1. Wet Meadow
2. Shrub Swamp
3. Treed Swamp
4. Emergent Marsh
5. Submergent Marsh
6. Cottages, Residential
7. Agriculture
8. Urban

Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.08 ST. CLAIR RIVER DELTA, PART II

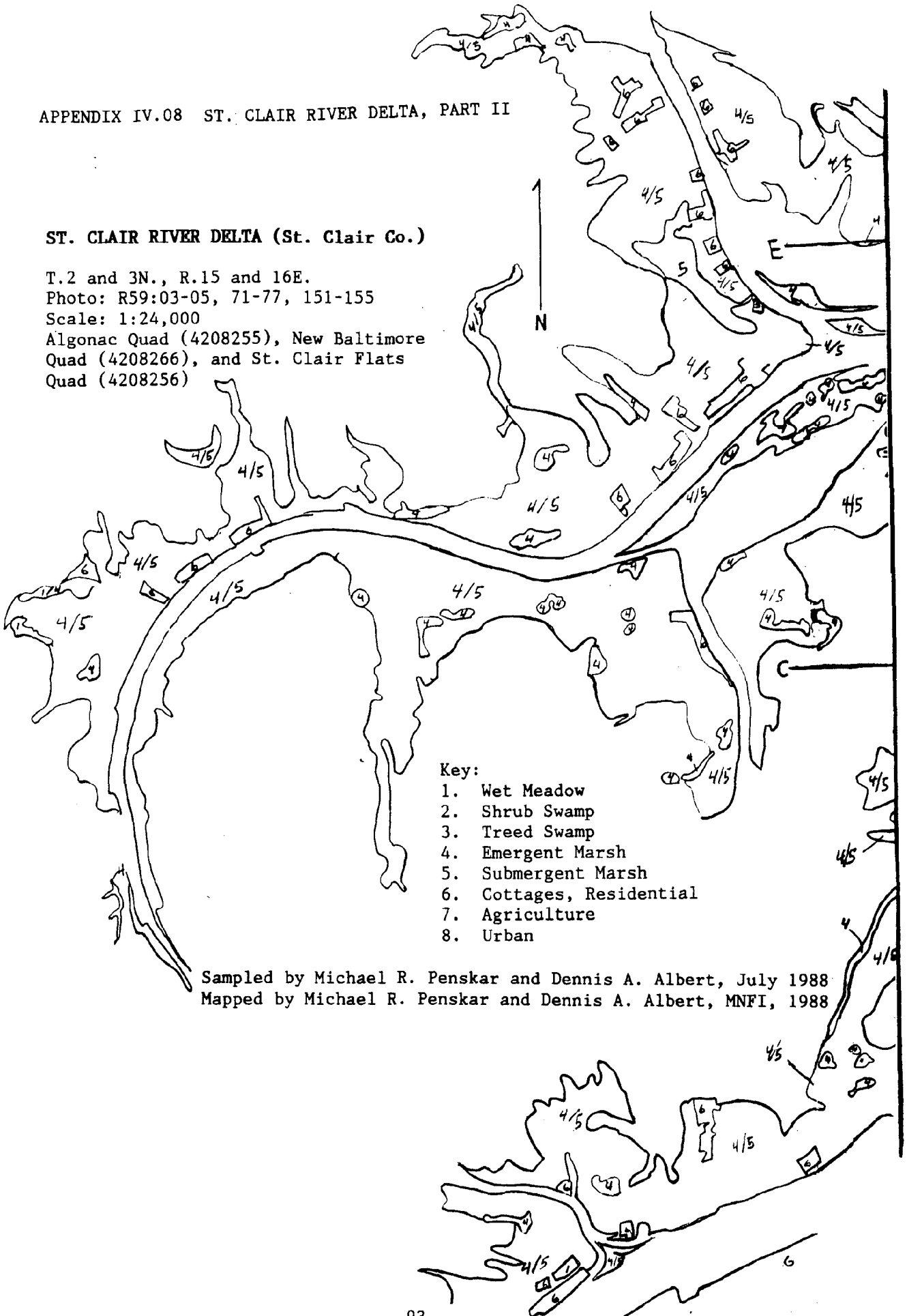
ST. CLAIR RIVER DELTA (St. Clair Co.)

T.2 and 3N., R.15 and 16E.

Photo: R59:03-05, 71-77, 151-155

Scale: 1:24,000

Algonac Quad (4208255), New Baltimore Quad (4208266), and St. Clair Flats Quad (4208256)



Key:

1. Wet Meadow
2. Shrub Swamp
3. Treed Swamp
4. Emergent Marsh
5. Submergent Marsh
6. Cottages, Residential
7. Agriculture
8. Urban

Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.08 ST: CLAIR RIVER DELTA, PART III

ST. CLAIR RIVER DELTA (St. Clair Co.)

T.2 and 3N., R.15 and 16E.

Photo: R59:03-05, 71-77, 151-155

Scale: 1:24,000

Algonac Quad (4208255), New Baltimore Quad (4208266), and St. Clair Flats Quad (4208256)

Key:

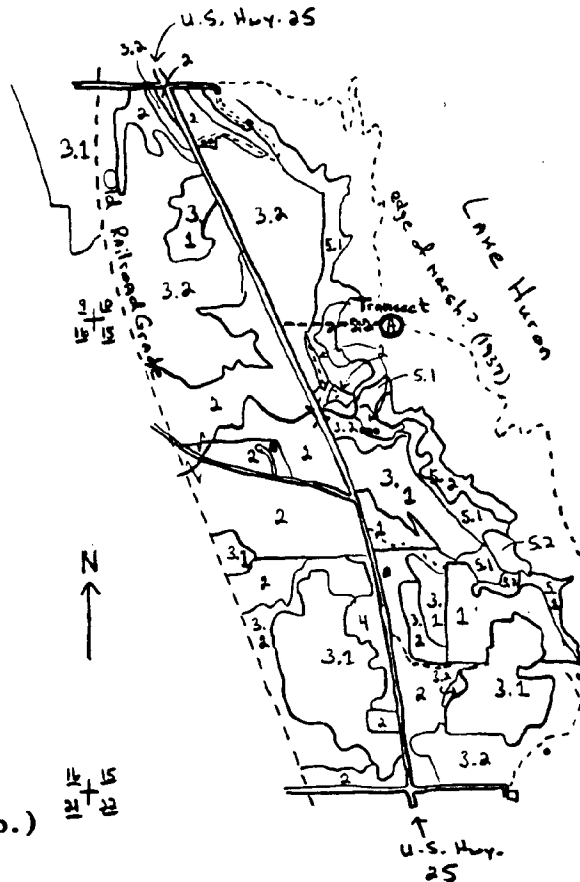
1. Wet Meadow
2. Shrub Swamp
3. Treed Swamp
4. Emergent Marsh
5. Submergent Marsh
6. Cottages, Residential
7. Agriculture
8. Urban



Sampled by Michael R. Penskar and Dennis A. Albert, July 1988
Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.09 HARDWOOD POINT

qT1g



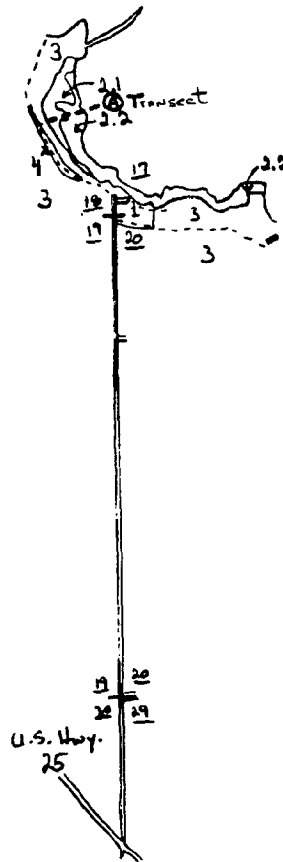
HARDWOOD POINT (Huron Co.)

T.17S., R15E.
 Photo: R59:143 (1978 MDNR)
 Scale: 1:24,000 (approx.)
 Port Hope Quad (4308286)

- Key:
- 1. Agricultural fields
 - 2. Old fields
 - 3.1 Treed Swamp (mature)
 - 3.2 Treed Swamp (young with Wet Meadow openings)
 - 4. Residential
 - 5.1 Great Lakes Marsh complex:
 (Emergent Marsh/Wet Meadow/
 Shrub Swamp)
 - 5.2 Emergent Marsh (Typha)

Sampled by Gary A. Reese and Elaine M. Chittenden, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.10 WHISKEY HARBOR



WHISKEY HARBOR (Huron Co.)

T.18N., R.15E.

Photo: R95:82 (1978 MNDR)

Scale: 1:24,000 (approx.)

Port Hope and Redman Quads

(4308286 and 4308287)

Key:

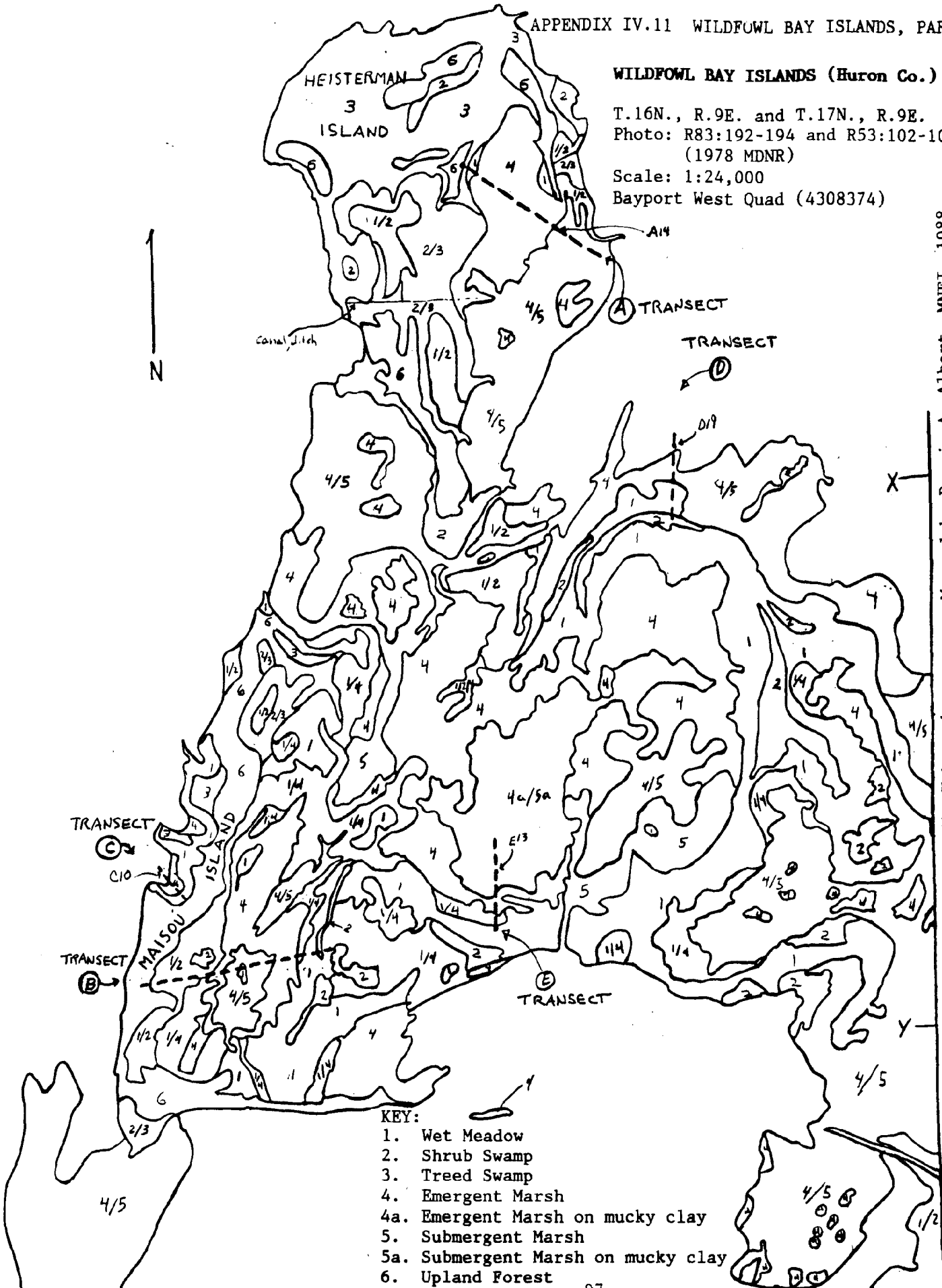
- 1. Old field
- 2.1 Emergent Marsh (Scirpus americanus)
- 2.2 Emergent Marsh/Cobble Beach
- 3. Treed Swamp
- 4. Open Dune

Sampled by Gary A. Reese and Elaine M. Chittenden, July 1988
Mapped by Gary A. Reese, MNFI, 1988

WILDFOWL BAY ISLANDS (Huron Co.)

T.16N., R.9E. and T.17N., R.9E.
 Photo: R83:192-194 and R53:102-103
 (1978 MDNR)

Scale: 1:24,000
 Bayport West Quad (4308374)

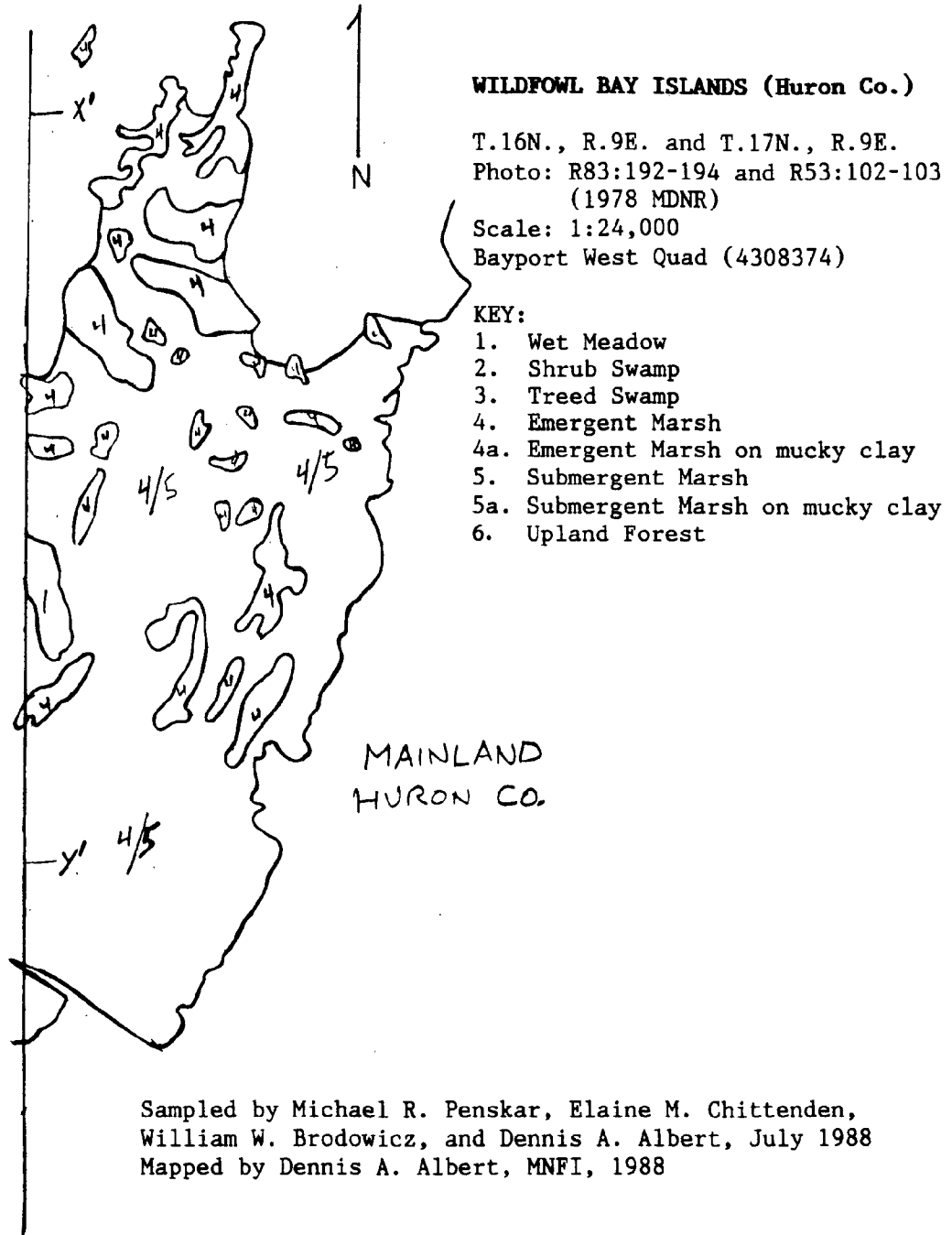


- KEY:
1. Wet Meadow
 2. Shrub Swamp
 3. Treed Swamp
 4. Emergent Marsh
 - 4a. Emergent Marsh on mucky clay
 5. Submergent Marsh
 - 5a. Submergent Marsh on mucky clay
 6. Upland Forest

Mapped by Dennis A. Albert, MNFI, 1988

Sampled by Michael R. Penskar, Elaine M. Chittenden,
 William W. Brodowicz, and Dennis A. Albert, July 1988

APPENDIX IV.11 WILDFOWL BAY ISLANDS, PART II



APPENDIX IV.12 WILDFOWL BAY

WILDFOWL BAY (Huron Co.)

T.16N., R.9E.

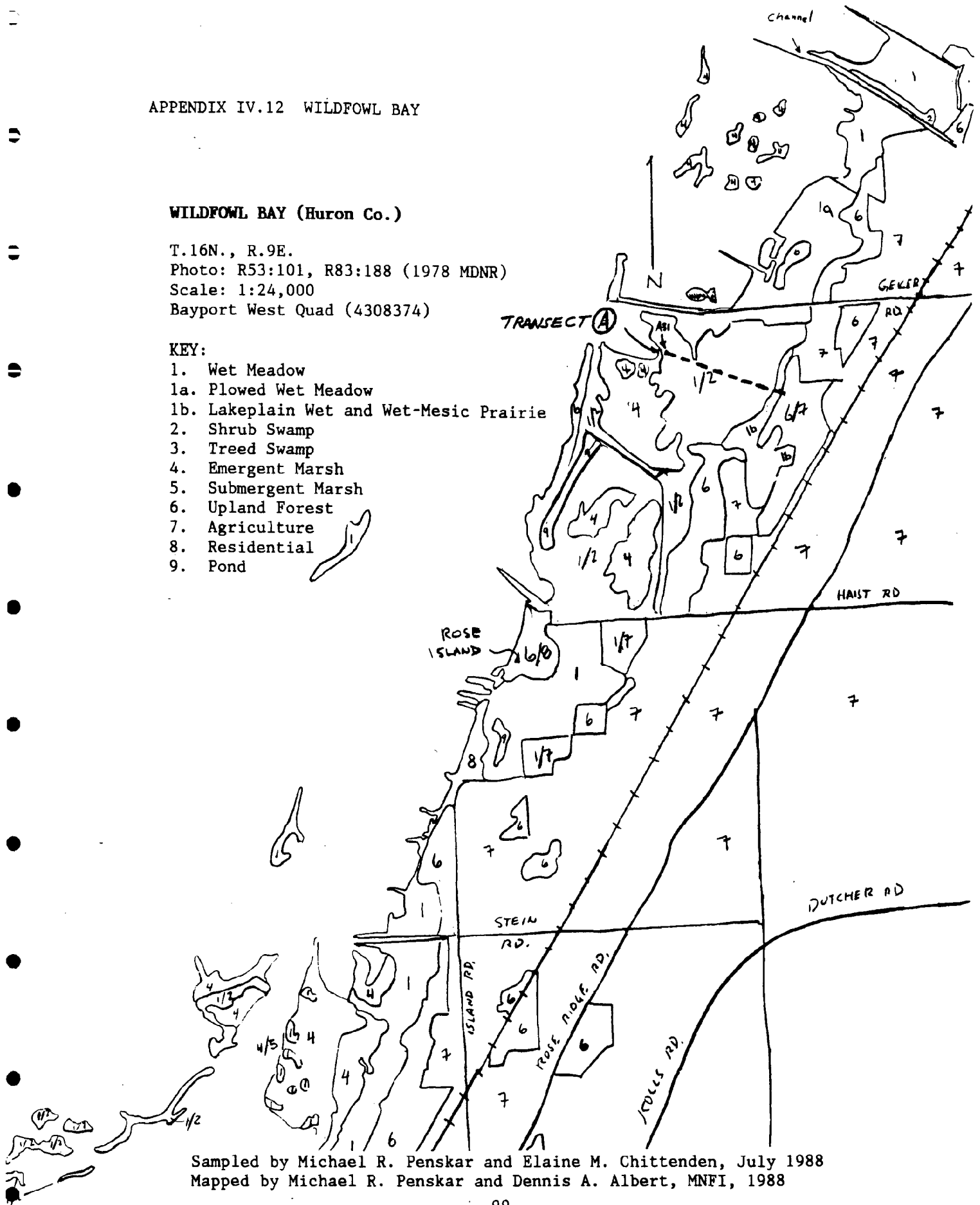
Photo: R53:101, R83:188 (1978 MDNR)

Scale: 1:24,000

Bayport West Quad (4308374)

KEY:

- 1. Wet Meadow
- 1a. Plowed Wet Meadow
- 1b. Lakeplain Wet and Wet-Mesic Prairie
- 2. Shrub Swamp
- 3. Treed Swamp
- 4. Emergent Marsh
- 5. Submergent Marsh
- 6. Upland Forest
- 7. Agriculture
- 8. Residential
- 9. Pond



Sampled by Michael R. Penskar and Elaine M. Chittenden, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

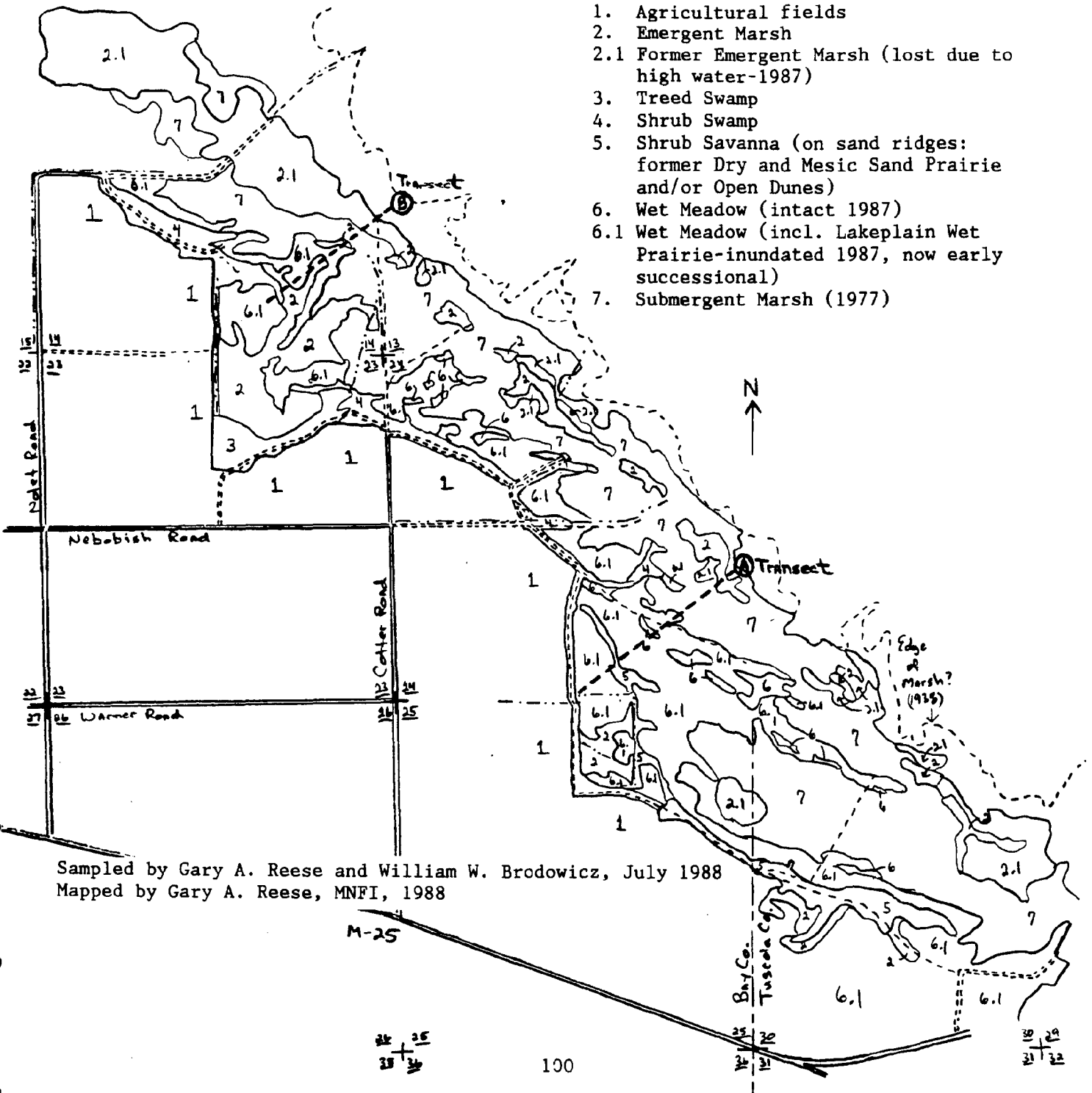
CORYEON POINT (Bay and Tuscola Co.)

APPENDIX IV.13 CORYEON POINT

T.14N., R.6&7E.
 Photo: R3:11,20 (1977 MDNR)
 Scale: 1:24,000
 Quinicassee Quad (4308356)

Key:

- 1. Agricultural fields
- 2. Emergent Marsh
- 2.1 Former Emergent Marsh (lost due to high water-1987)
- 3. Treed Swamp
- 4. Shrub Swamp
- 5. Shrub Savanna (on sand ridges: former Dry and Mesic Sand Prairie and/or Open Dunes)
- 6. Wet Meadow (intact 1987)
- 6.1 Wet Meadow (incl. Lakeplain Wet Prairie-inundated 1987, now early successional)
- 7. Submergent Marsh (1977)



Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.14 TOBICO

LAKE HURON



TOBICO MARSH (Bay Co.)

T.15N., R.4E. and R.5E.

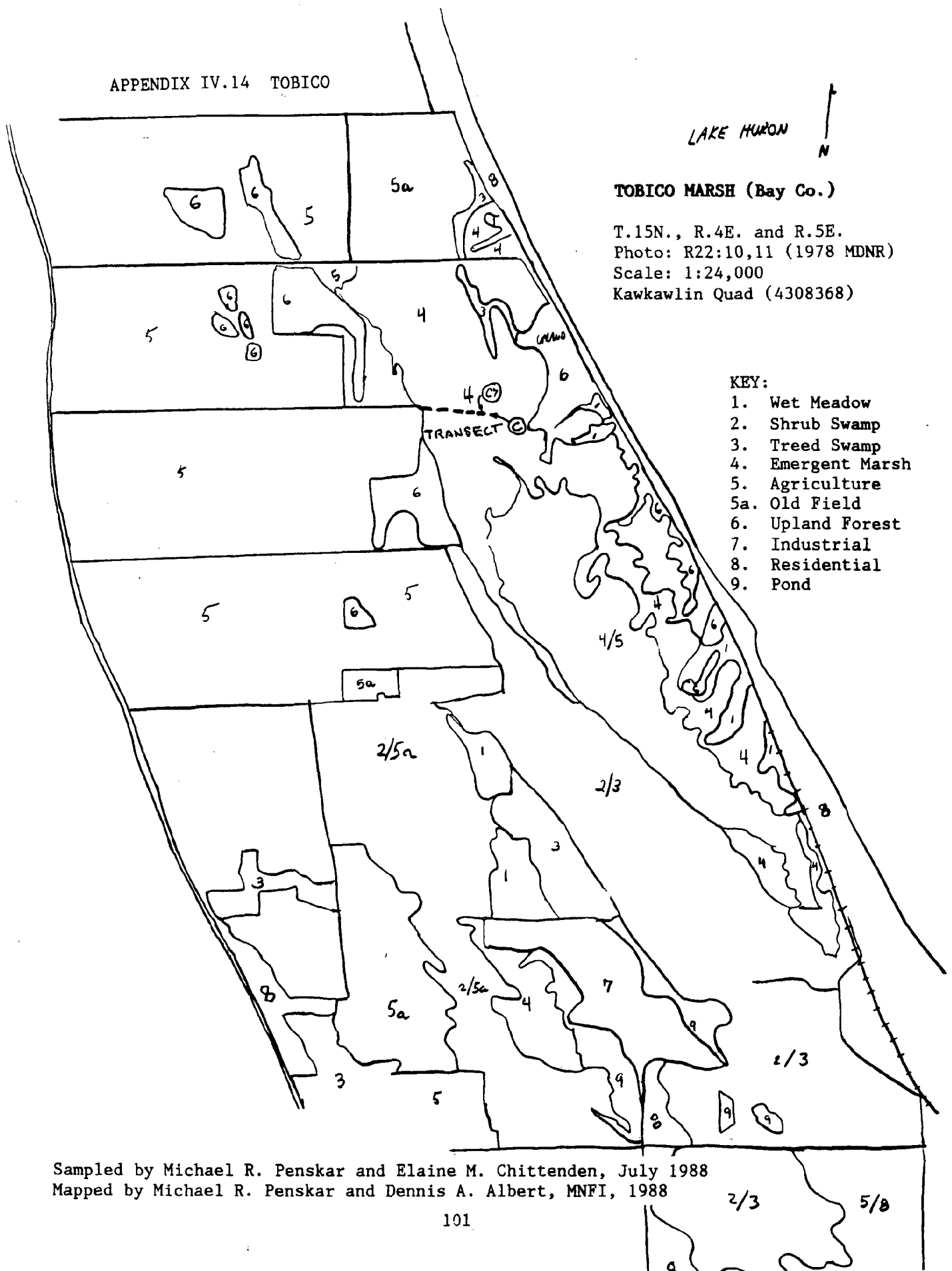
Photo: R22:10,11 (1978 MDNR)

Scale: 1:24,000

Kawkawlin Quad (4308368)

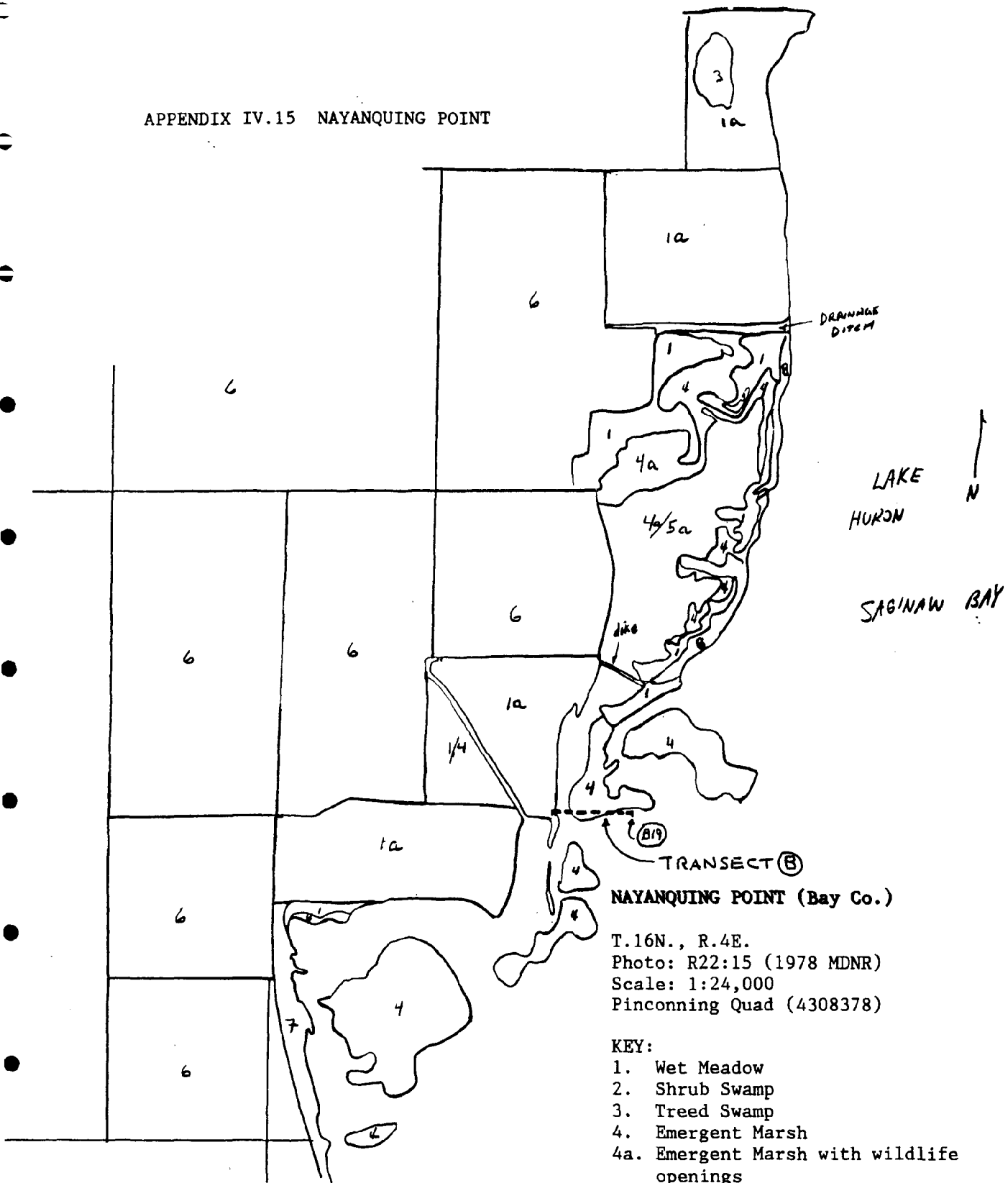
KEY:

- 1. Wet Meadow
- 2. Shrub Swamp
- 3. Treed Swamp
- 4. Emergent Marsh
- 5. Agriculture
- 5a. Old Field
- 6. Upland Forest
- 7. Industrial
- 8. Residential
- 9. Pond



Sampled by Michael R. Penskar and Elaine M. Chittenden, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.15 NAYANQUING POINT



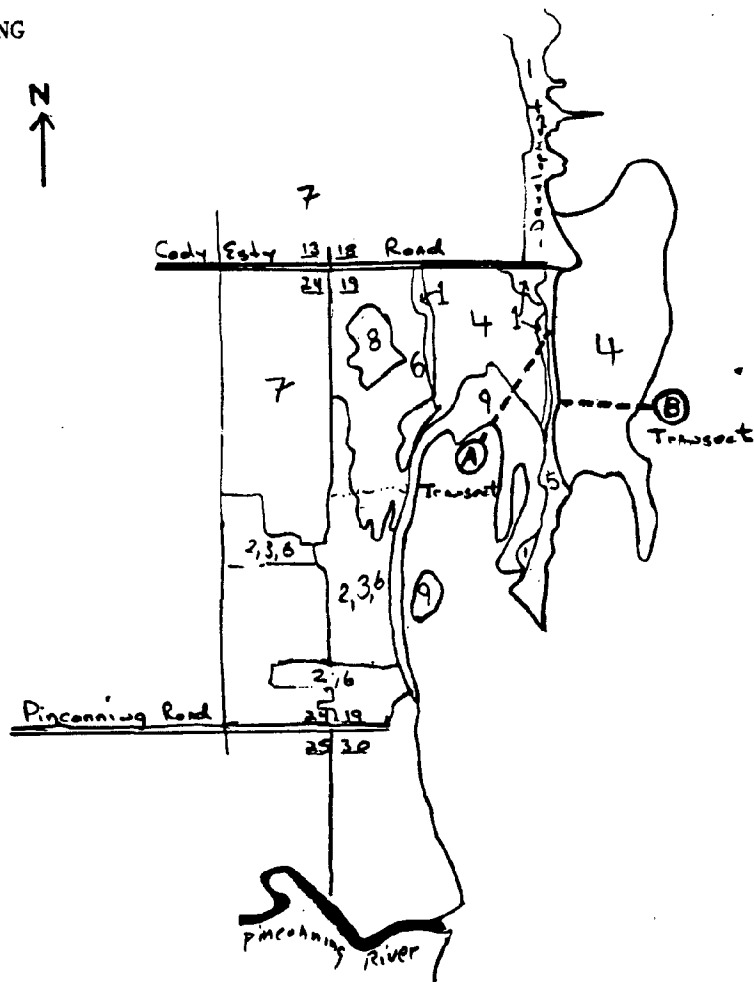
NAYANQUING POINT (Bay Co.)

T.16N., R.4E.
 Photo: R22:15 (1978 MDNR)
 Scale: 1:24,000
 Pinconning Quad (4308378)

- KEY:**
- 1. Wet Meadow
 - 2. Shrub Swamp
 - 3. Treed Swamp
 - 4. Emergent Marsh
 - 4a. Emergent Marsh with wildlife openings
 - 5. Submergent Marsh
 - 6. Agriculture
 - 7. Residential
 - 8. Sand Beach Ridge

Sampled by Michael R. Penskar and Elaine M. Chittenden, July 1988
 Mapped by Michael R. Penskar and Dennis A. Albert, MNFI, 1988

APPENDIX IV.16 PINCONNING



PINCONNING MARSH (Bay Co.)

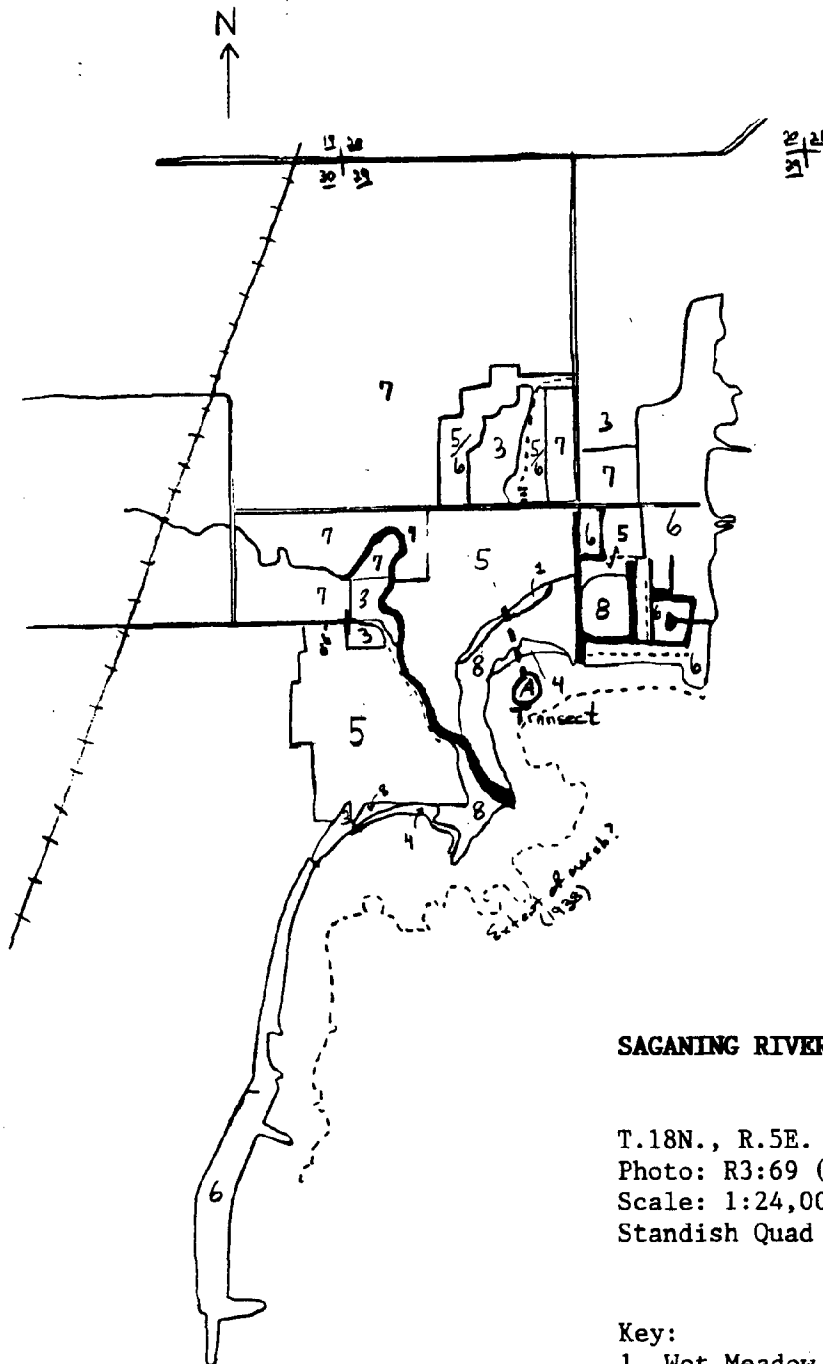
T.17N., R.4 and 5E.
 Photo: R25:2,3 (1978 MDNR)
 Scale: 1:24,000 (approx.)
 Pinconning Quad (4308378)

Key:

1. Wet Meadow
2. Shrub Swamp
3. Treed Swamp
4. Emergent Marsh
5. Lakeplain Oak Opening
6. Old field
7. Agriculture
8. Shrub Swamp
9. Submergent Marsh

Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.17 SAGANING RIVER DELTA



SAGANING RIVER DELTA (Arenac Co.)

T.18N., R.5E.

Photo: R3:69 (1978 MDNR)

Scale: 1:24,000 (approx.)

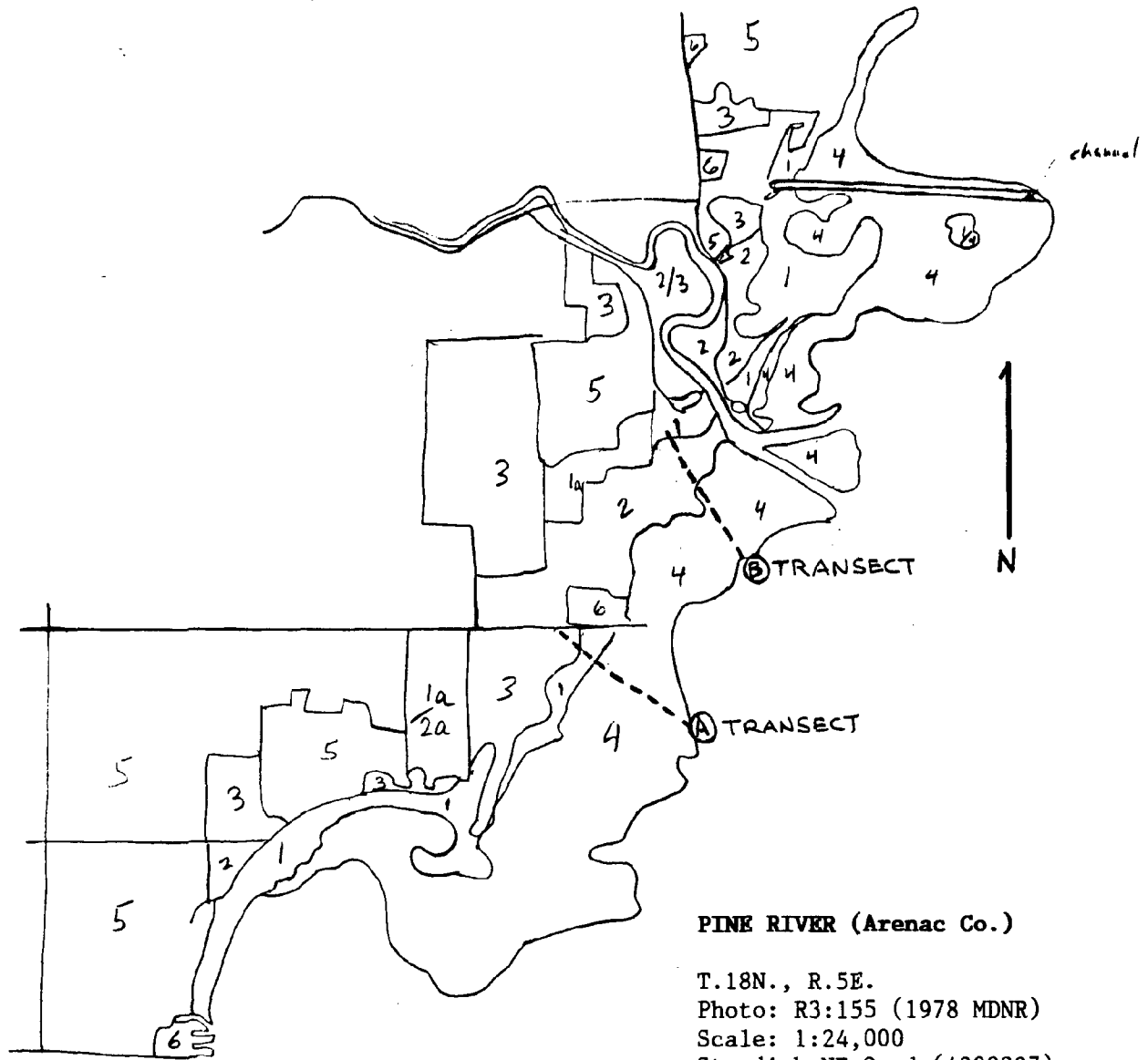
Standish Quad (4308388)

Key:

- 1. Wet Meadow
- 3. Treed Swamp
- 4. Emergent Marsh (Scirpus)
- 5. Old field
- 6. Residential
- 7. Agricultural field
- 8. Emergent marsh (Typha)

Sampled by Gary A. Reese and Elaine M. Chittenden, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.18 PINE RIVER DELTA



PINE RIVER (Arenac Co.)

T.18N., R.5E.

Photo: R3:155 (1978 MDNR)

Scale: 1:24,000

Standish NE Quad (4308387)

Key:

- 1. Wet Meadow
- 2. Shrub Swamp
- 3. Treed Swamp
- 4. Emergent Marsh
- 5. Agriculture
- 6. Residential

Sampled by Michael R. Penskar, William W. Brodowicz, Lawrence Brewer,
and Dennis A. Albert, June 1988

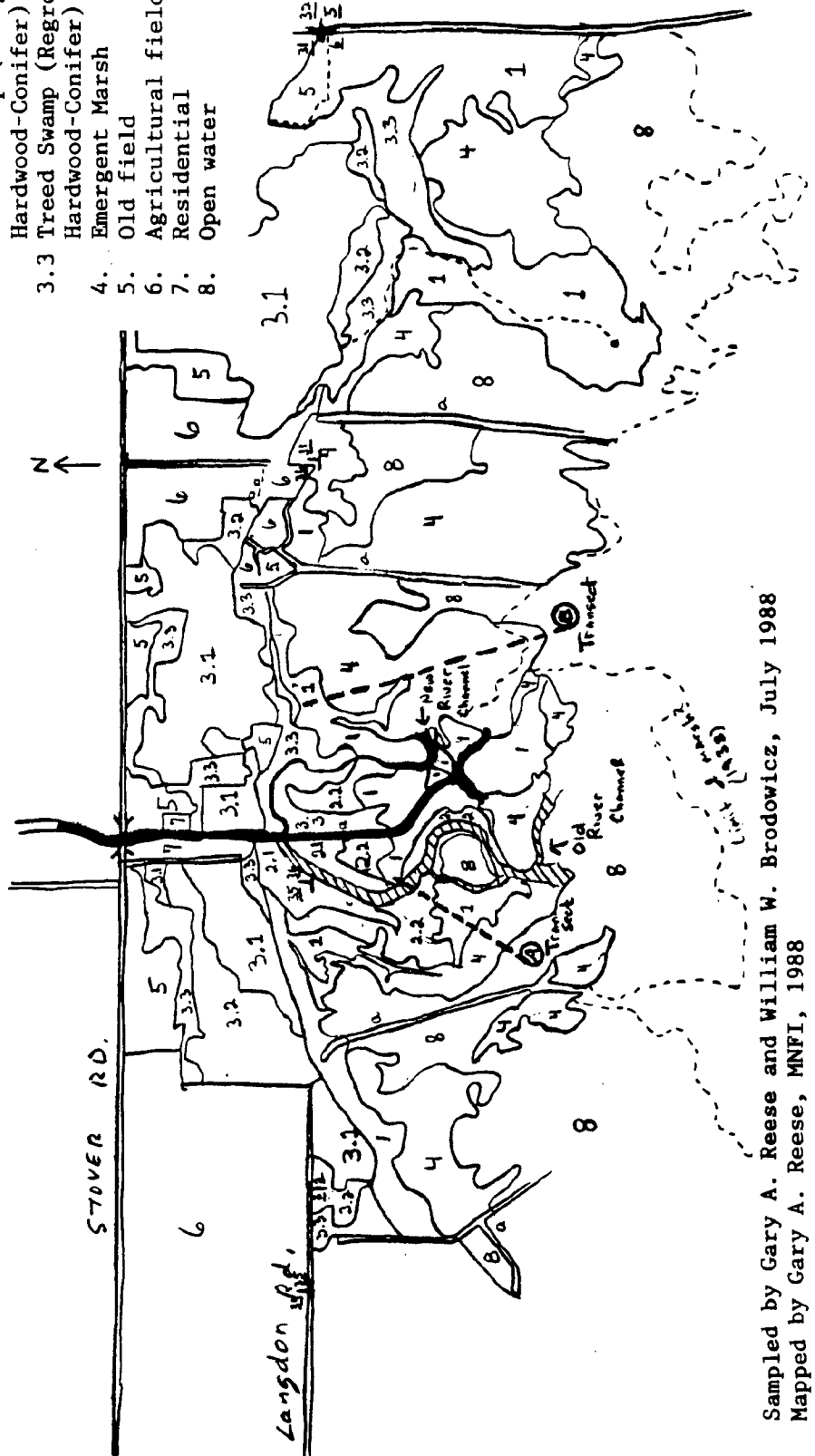
Mapped by Dennis A. Albert, MNFI, 1988

WIGWAM BAY-RIFLE RIVER (Arenac Co.)

T.18&19N., R.5&6E.
 Photo: R3:156 and R6:18 (1977 MDNR)
 Scale: 1:24,000 (approx.)
 Standish NE and Omer Quads (4308387 and 4408317)

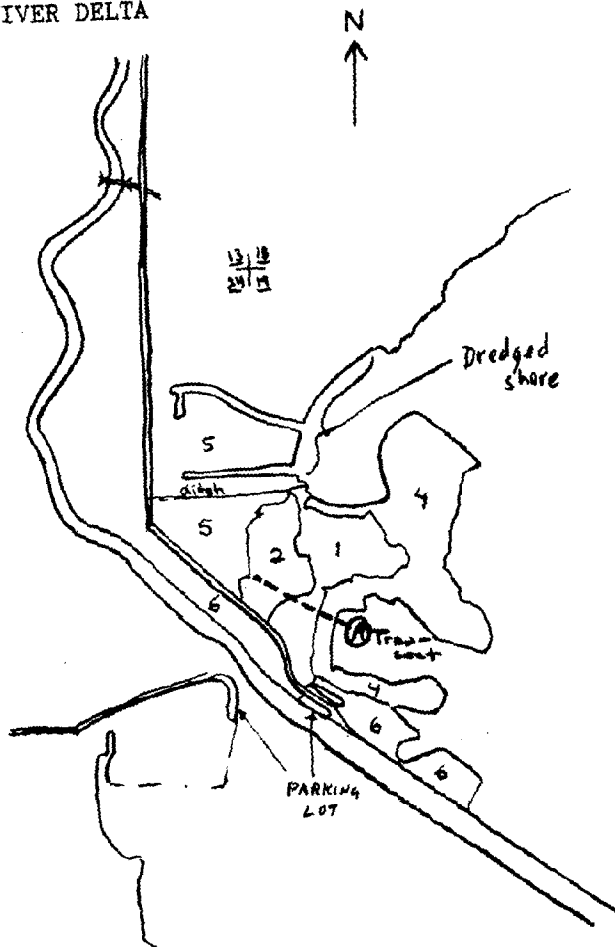
APPENDIX IV.19 WIGWAM BAY-RIFLE RIVER

- Key:
- 1. Wet Meadow
 - 2.1 Shrub Swamp (Mature)
 - 2.2 Shrub Swamp (Young)
 - 3.1 Treed Swamp (Mature Hardwood)
 - 3.2 Treed Swamp (Young Hardwood or Hardwood-Conifer)
 - 3.3 Treed Swamp (Regrowth Hardwood or Hardwood-Conifer)
 - 4. Emergent Marsh
 - 5. Old field
 - 6. Agricultural fields
 - 7. Residential
 - 8. Open water



Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.20 AU GRES RIVER DELTA



AU GRES RIVER DELTA (Arenac Co.)

T.19N., R.6&7E.

Photo: R11:122 (1978 MDNR)

Scale: 1:24,000 (approx.)

Au Gres Quad (4408316)

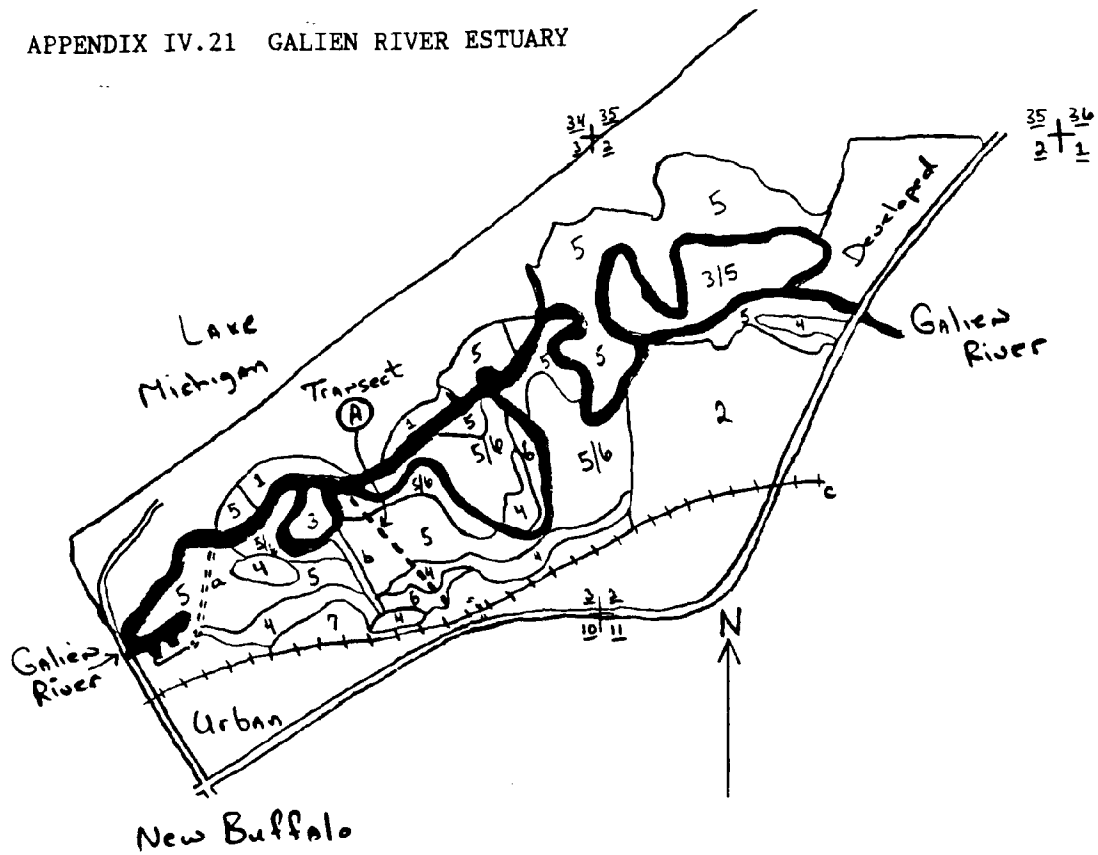
Key:

- 1. Wet Meadow
- 2. Shrub Swamp
- 4. Emergent Marsh (Scirpus)
- 5. Old field (Typha)
- 6. Residential or fill

Sampled by Gary A. Reese and William W. Brodowicz, July 1988

Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.21 GALIEN RIVER ESTUARY



GALIEN RIVER ESTUARY (Berrien Co.)

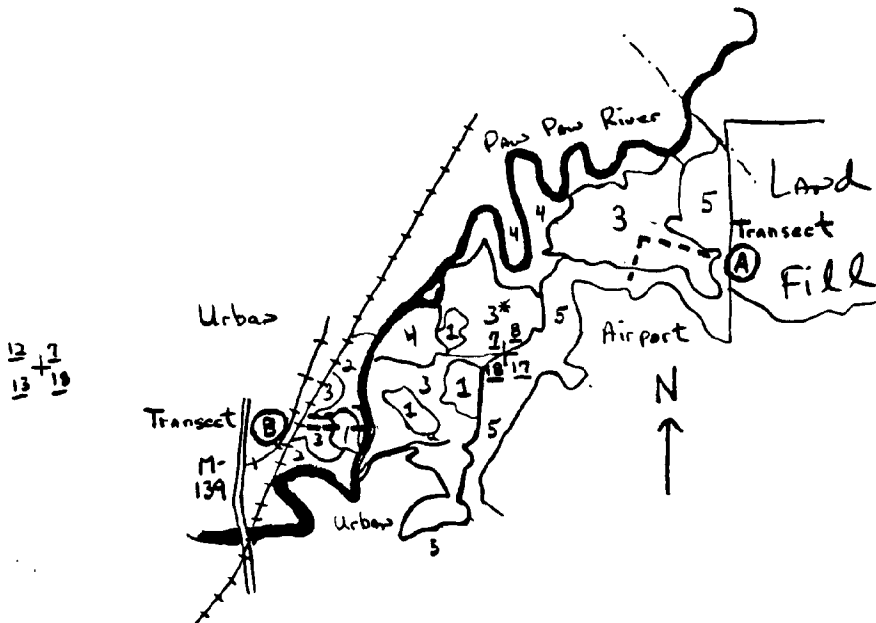
T.8S., R.21W.
 Photo: R69:13 (1978 MDNR)
 Scale: 1:24,000 (approx.)
 New Buffalo East Quad (4108676)

- Key:
1. Wet Meadow (with boat slips)
 2. Upland Forest/Old field mosaic
 3. Treed Swamp
 4. Emergent Marsh (Typha dominated)
 5. Emergent Marsh
 6. Wet Meadow
 7. Upland Forest

Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.22 PAW PAW RIVER ESTUARY

615
119



PAW PAW RIVER ESTUARY (Berrien Co.)

T.4S., R.18W.

Photo: R69:108 (1978 MDNR)

Scale 1:24,000 (approx.)

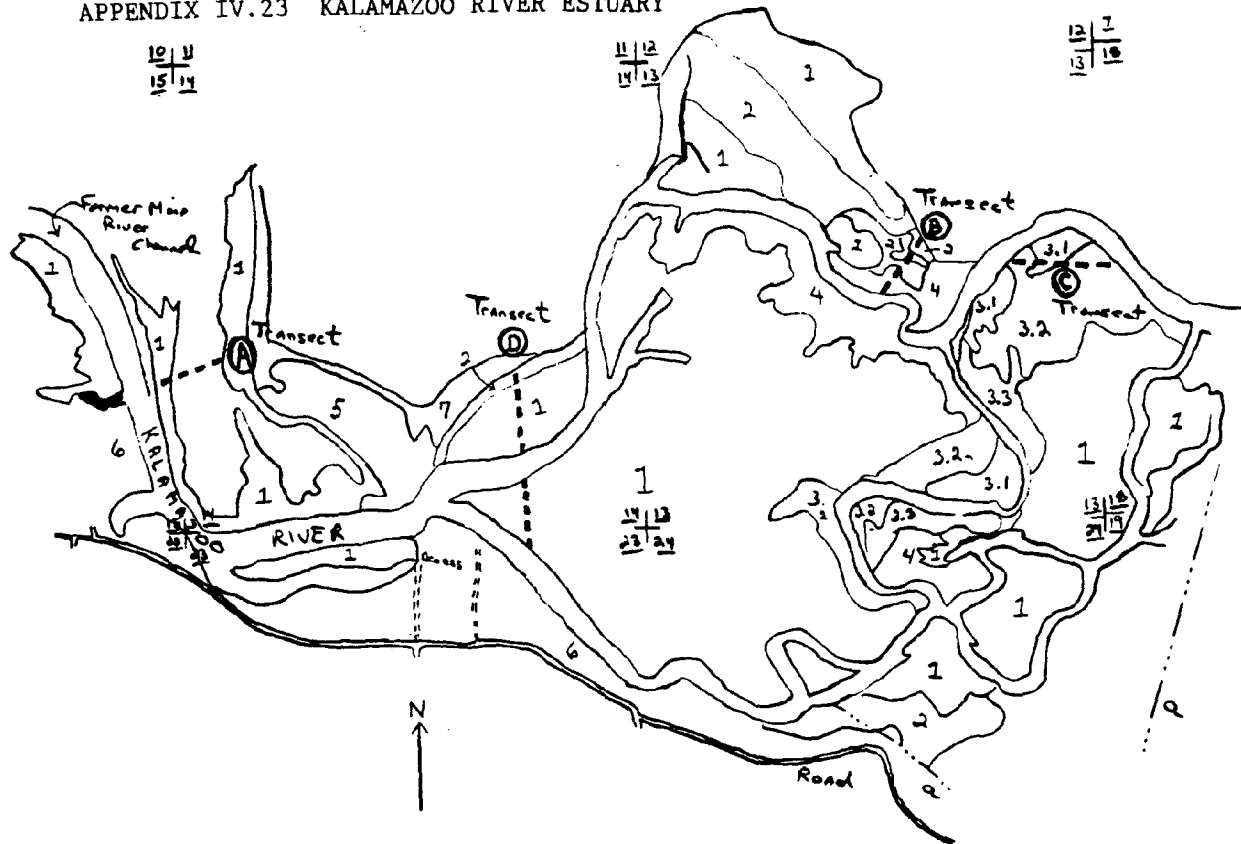
Benton Heights Quad (4208624)

Key:

1. Emergent Marsh (Typha dominated)
2. Southern Wet Meadow
3. Emergent Marsh
4. Southern Swamp (young growth)
5. Forest (young growth)
- a. Ditch (pre-1938)

Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.23 KALAMAZOO RIVER ESTUARY



KALAMAZOO RIVER ESTUARY (Allegan Co.)

T.3S., R.16 & 15W.

Photo: R93:74 (1978 MDNR)

Scale: 1:24,960

Saugatuck Quad (4208662)

Key:

- 1. Emergent Marsh
- 2. Wet Meadow
- 3.1 Floodplain Forest (mature to old second growth)
- 3.2 Floodplain Forest (young to mature)
- 3.3 Floodplain Forest (regrowth to young)
- 4. Shrub Swamp
- 5. Old field
- 6. Residential (developed)
- 7. Upland Forest (young)
- a. ditch

Sampled by Gary A. Reese and William W. Brodowicz, July 1988

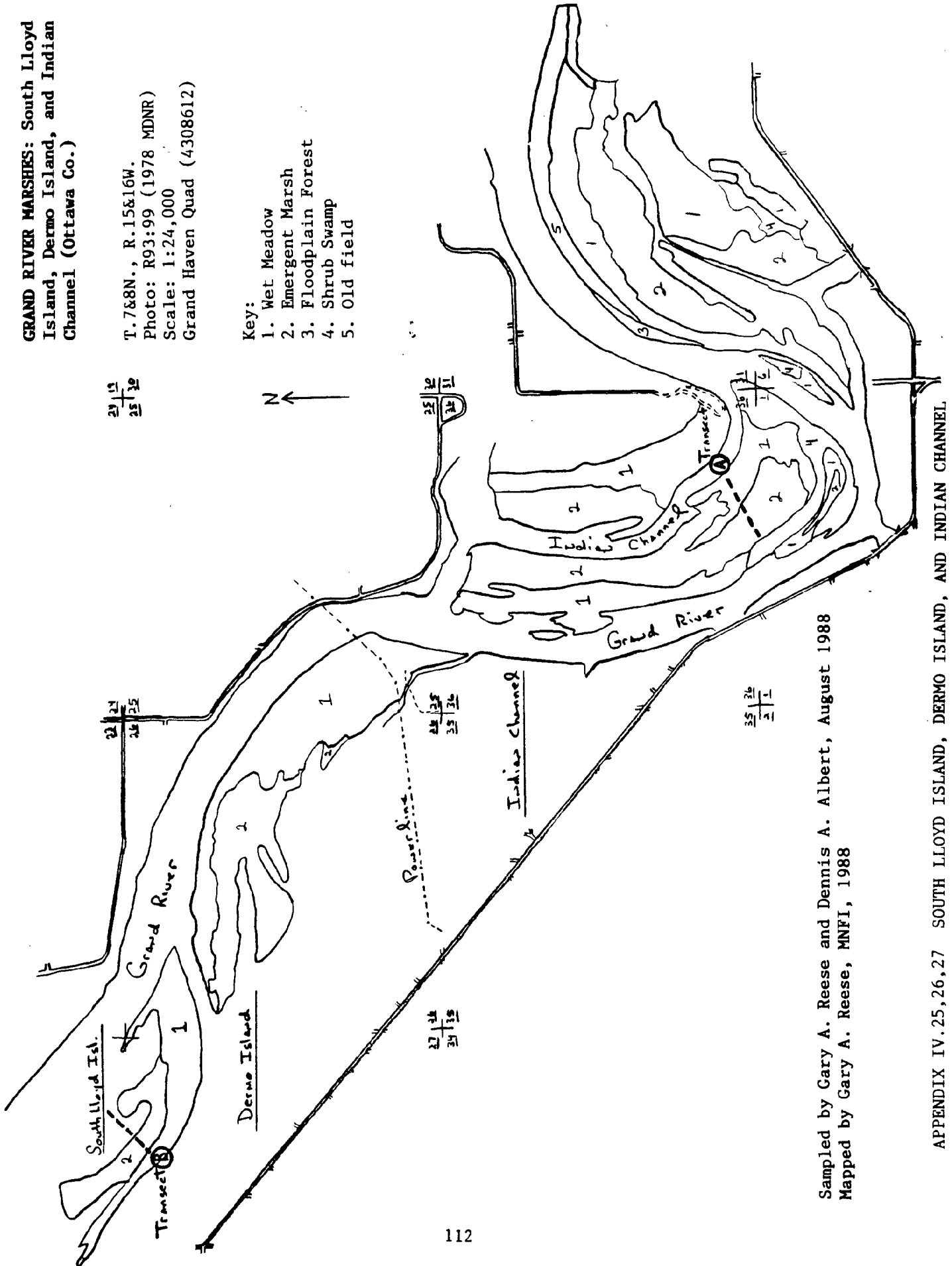
Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.24 MACATAWA RIVER ESTUARY (NOT SURVEYED OR MAPPED)

GRAND RIVER MARSHES: South Lloyd Island, Dermo Island, and Indian Channel (Ottawa Co.)

T.7&8N., R.15&16W.
 Photo: R93:99 (1978 MDNR)
 Scale: 1:24,000
 Grand Haven Quad (4308612)

- Key:
1. Wet Meadow
 2. Emergent Marsh
 3. Floodplain Forest
 4. Shrub Swamp
 5. Old field



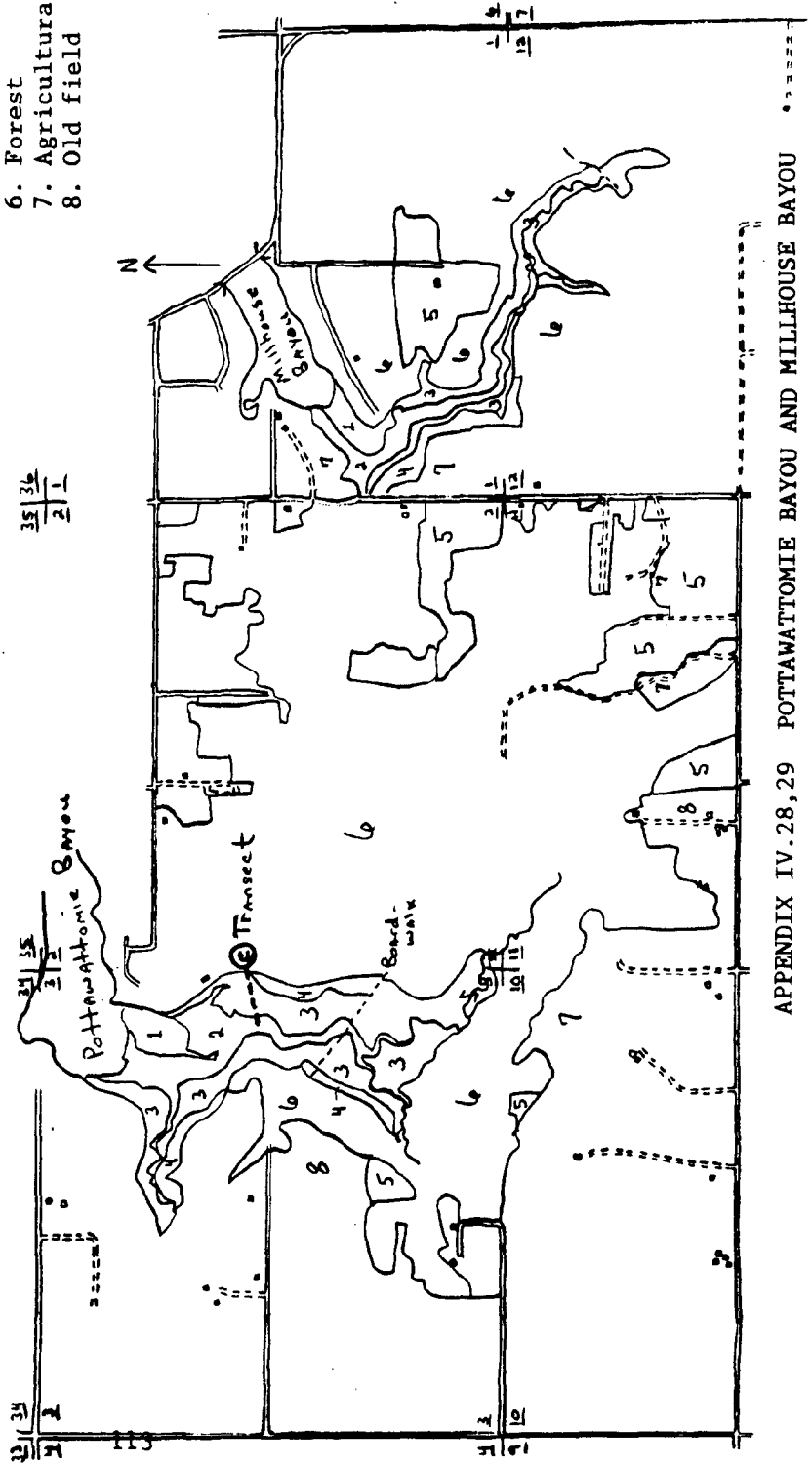
Sampled by Gary A. Reese and Dennis A. Albert, August 1988
 Mapped by Gary A. Reese, MNFI, 1988

POTTAWATTOMIE AND MILLHOUSE BAYOUS
(Ottawa Co.)

T. 7&8N., R. 16W.
Photo: R93:97 (1978 MDNR)
Scale: 1:24,000
Grand Haven Quad (4308612)

- Key:
1. Submergent Marsh
 2. Emergent Marsh
 3. Wet Meadow
 4. Shrub Swamp
 5. Pine plantation
 6. Forest
 7. Agricultural fields
 8. Old field

Sampled by Gary A. Reese and Dennis A. Albert, August 1988
Mapped by Gary A. Reese, MNFI, 1988

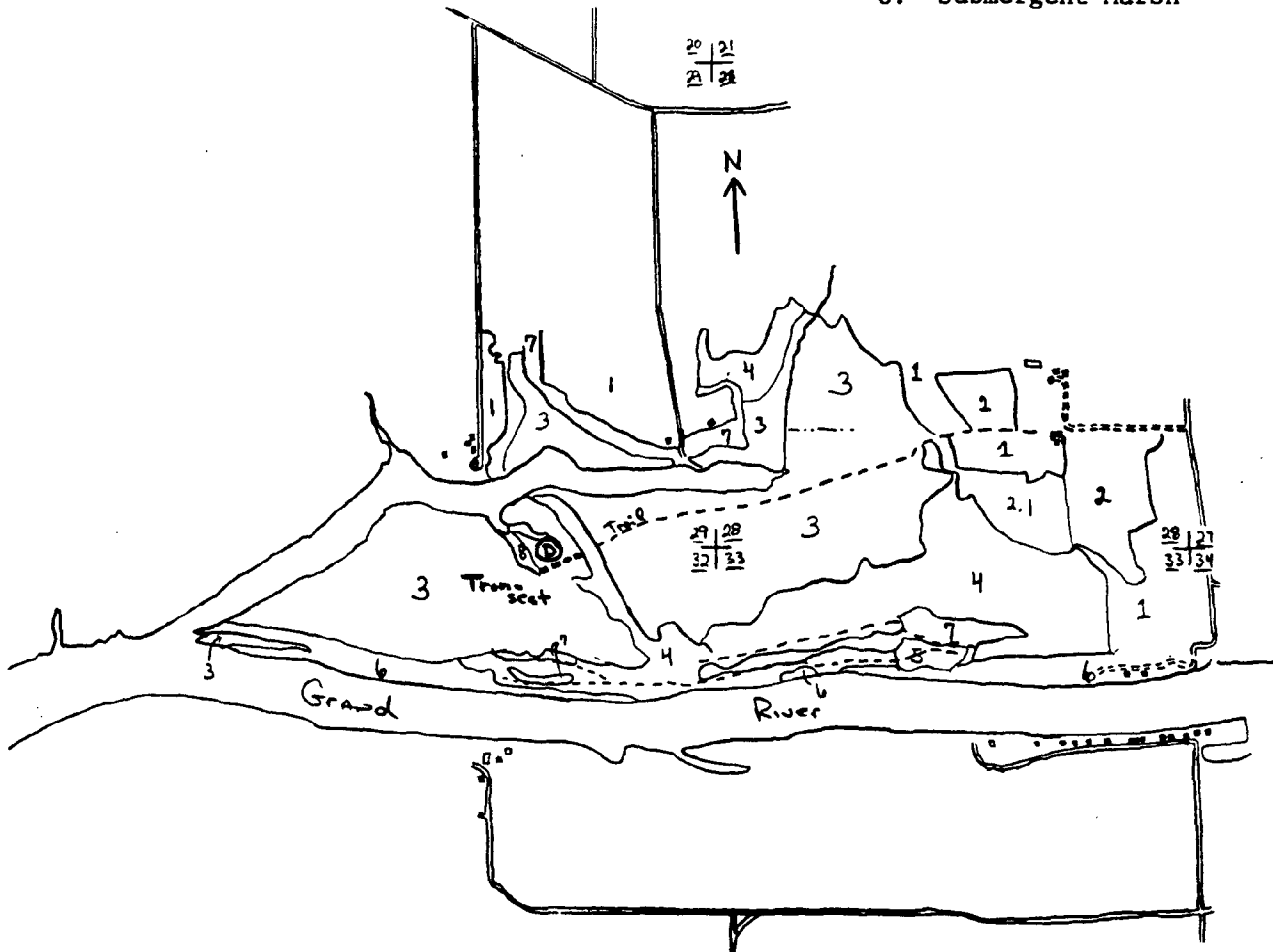


BRUCE BAYOU (Ottawa Co.)

T.8N., R.15W.
Photo:R87:255 (1978 MDNR)
Scale: 1:24,000
Nunica Quad (4308611)

Key:

- 1. Agricultural fields
- 2. Forest
- 2.1 Forest-heavy tree kill
- 3. Emergent Marsh
- 4. Wet Meadow
- 5. Old field
- 6. Floodplain Forest
- 7. Shrub Swamp
- 8. Submergent Marsh



Sampled by Gary A. Reese and Dennis A. Albert, August 1988
Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.31 MUSKEGON RIVER ESTUARY

MUSKEGON RIVER ESTUARY (Muskegon Co.)

T.10N., R.16W.

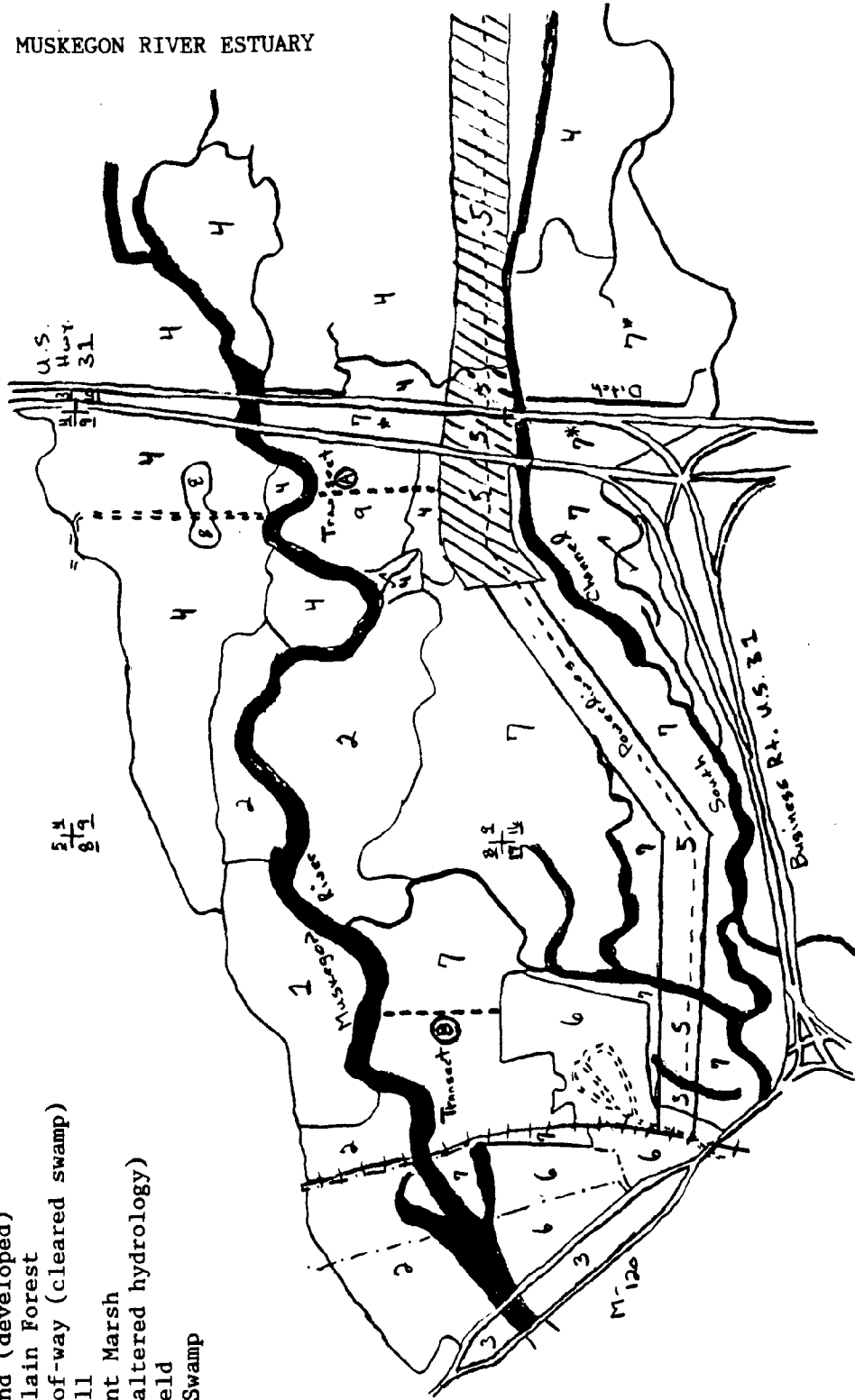
Photo: R95:156 (1978 MDNR)

Scale 1:24,000 (approx.)

Twin Lakes Quad (4308632)

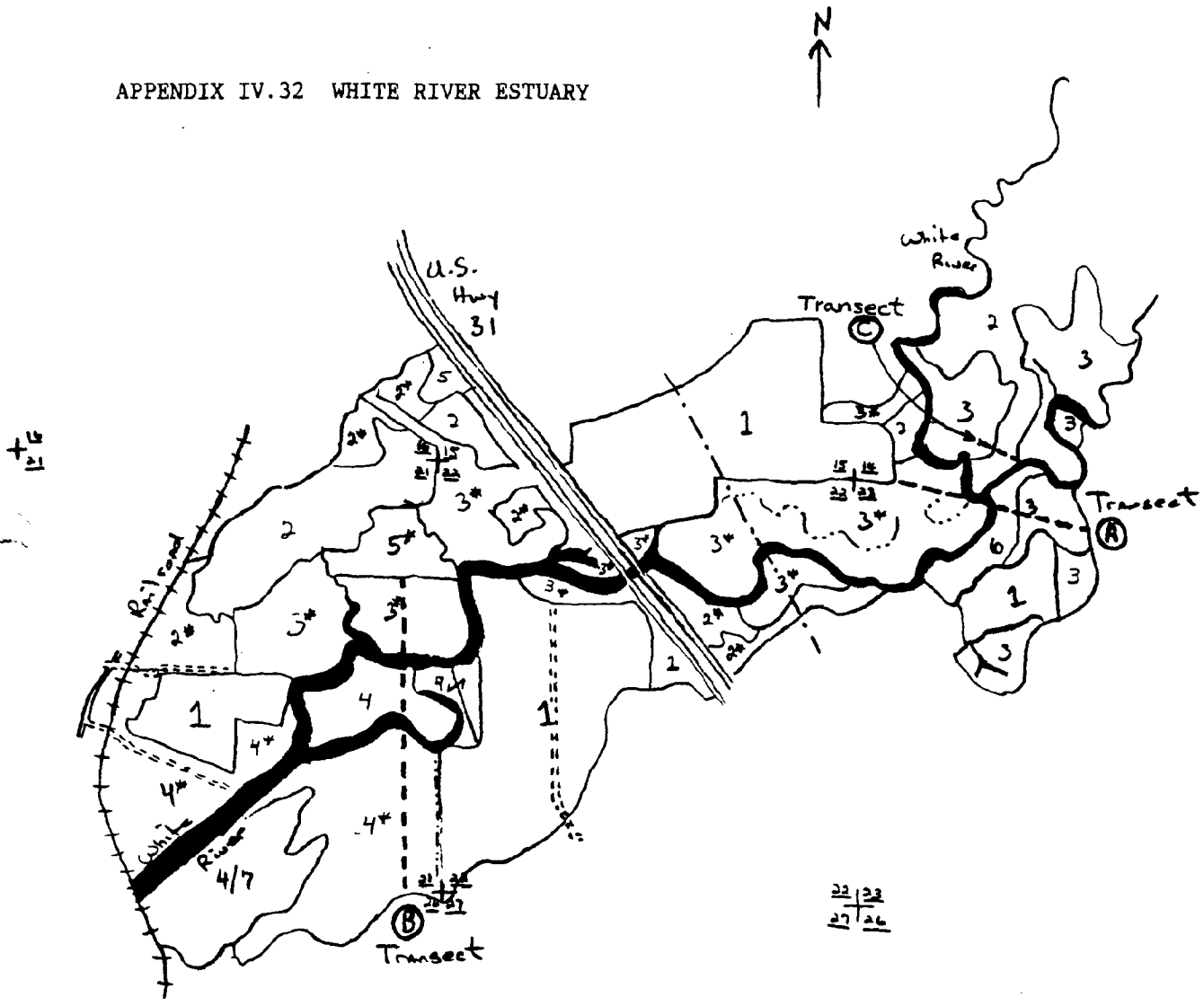
Key:

1. Agricultural land
2. 1938 Hayfield/1978 Herbaceous
3. Parkland (developed)
4. Floodplain Forest
5. Right-of-way (cleared swamp)
6. Landfill
7. Emergent Marsh
(7* = altered hydrology)
8. Old field
9. Shrub Swamp



Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

APPENDIX IV.32 WHITE RIVER ESTUARY



WHITE RIVER ESTUARY (Muskegon Co.)

T.12N., R.17W.
 Photo: R70:79 (1978 MDNR)
 Scale: 1:24,000 (approx.)
 Montague Quad (4308643)

Key:

- 1. Agricultural land (leveed)
- 2. Floodplain Forest
- 3. Wet Meadow (*historically hayed)
- 4. Emergent Marsh
- 5. Old field
- 6. Shrub Swamp
- 7. Submergent Marsh

Sampled by Gary A. Reese and William W. Brodowicz, July 1988
 Mapped by Gary A. Reese, MNFI, 1988

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