

THE GREAT LAKES MARSHES OF MARQUETTE ISLAND, MICHIGAN

A Report Submitted to  
The Michigan Chapter of the Nature Conservancy

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## Introduction

The Duck Bay and Peck Bay marshes located on Marquette Island represent two natural extremes that exist in Great Lakes marshes. Duck Bay is sheltered from prevailing winds, and this protection results in an extensive, well-developed marsh zone and the accumulation of organic soils along the shore. In contrast, the mouth of Peck Bay is in line with the prevailing winds out of the SE such that the bay is exposed to greater wind and wave action. The result is an eroded and more dynamic shoreline, a poorly developed marsh, and shoreline vegetation adapted to fluctuating water levels.

This report presents an analysis of these two distinct Great Lakes marshes found on Marquette Island. The report begins by briefly placing the marsh communities in the topographic context of Marquette Island. This is followed by a more detailed description of the characteristic vegetative zonation within the Duck Bay and Peck Bay marshes and the relation of those zones to abiotic factors and shoreline dynamics.

## Marquette Island

The island is relatively small, approximately 4 miles long, and relatively low, with a maximum elevation of only 50 ft above Lake Huron. Upland soils consist of rocky clay till, while soils of the embayments are primarily lacustrine clays. Embayments are relatively shallow: Duck Bay is approximately 10 ft deep at its center, while most of Peck Bay is less than 6 ft deep. As already noted, however, the two marshes differ significantly in their degree of exposure to prevailing winds off Lake Huron.

The relationship of these two Great Lakes marshes to upland plant communities of the island are illustrated in the figure entitled 'Vegetational Cross-Section of Marquette Island'. This schematic transect runs from Duck Bay (Point A), up the adjacent ridge (Point B), and down again to Peck Bay (Point C). The uplands are dominated by Northern Hardwoods forest, while between the emergent marsh and the uplands are zones of conifer swamp dominated by northern white-cedar.

#### Field Sampling of Great Lakes Marshes

The Duck Bay and Peck Marshes were sampled in 1989 as part of a comprehensive survey of Great Lakes marshes in the state of Michigan. Each marsh was evaluated using a sampling transect, along which biotic and abiotic data were recorded at 20-40 m intervals. Woody and herbaceous vegetation was recorded by species at each sampling location along the transect. Estimated coverage values for each species present were recorded within a 0.5 m<sup>2</sup> plot. Abiotic factors recorded for each sampling location included water depth, presence and depth of organic deposits, and texture of substrate.

The Duck Bay transect begins on the island at the edge of a broad, rich conifer swamp and extends N. into Duck Bay (see Detail of Duck Bay Transect). The transect includes 24 sampling points spaced 20 m. apart, for a total transect length of 480 m. Field workers encountered three main vegetation zones along the transect: (1) shrub swamp grading into a herbaceous wet meadow zone (80 m wide), (2) emergent marsh zone (120 m wide), and (3) submergent marsh (280+ m wide).

## Analyses

Vegetative differences along the marsh transects were evaluated using TWINSpan (Two-Way INdicator SPecies ANalysis), a polythetic divisive method of classification of samples based on the differential occurrence or abundance of one or more indicator species (Hill 1979). A key attribute of the analysis is the identification of these differential or "indicator" species, i.e. species with clear ecological preferences, so that the presence of the species can be used to identify particular environmental conditions. The program first ordinales the samples and then uses this ordination to obtain a classification of the species according to their ecological preferences. The two classifications are then presented together in an ordered two-way table that expresses the species' relations across a gradient defined by the ordering of the samples. The resulting ordered table is not simply an ordination, rather the arrangement displays the significant features of the data by grouping similar samples together and similar species together.

The dual classification of samples and species proceeds from several steps. TWINSpan begins by ordinating the samples based on all species using reciprocal averaging (Hill 1973). The program then identifies differential species that are preferential to one end or the other of this ordination; the samples are then ordinated again based on these differential species to obtain the "refined" ordination. Finally, the refined ordination of samples is subdivided to identify similar groups of samples, and the most strongly preferential species or "indicator species" associated

Myriophyllum exalbescens, and Potamogeton obtusifolius.

The TWINSPAN ordination does not recognize a division between an emergent and submergent marsh zone as identified by field workers. However, it does group sampling points within the marsh zone into two subsets that reflect their position along the transect. Sampling locations 6-12 are separated from 13-21, but vegetative differences between them are not strong. There thus appears to be considerable continuity in species composition throughout the marsh zone at Duck Bay. Sampling was terminated where the water depth was approximately 6 feet (183 cm). Just beyond this point, where the water depth increased to 7-10 feet (230-328 cm) deep, Scirpus acutus, the primary emergent species within this marsh, was no longer present, and the marsh contained only floating or submergent vegetation.

#### Results of TWINSPAN Analyses for the Peck Bay Transect

The Peck Bay transect is substantially shorter in length than Duck Bay, reflecting the truncation of the emergent and submergent marsh zone due to exposure to wave action. As in the preceding case, the TWINSPAN ordination makes a primary distinction between inundated and saturated sampling locations (Table 2). Only two sampling locations (1-2) were placed in standing water, and these are characterized by Eleocharis pauciflora and Chara globularis. Thus, in contrast with the diversity of marsh species present in Duck Bay, the Peck Bay marsh zone is depauperate indeed. This submergent marsh zone, however, contained rhizomes of Scirpus acutus, indicating that during years of lower water levels an emergent marsh existed. In a subsequent visit in 1992 after

with each subdivision are identified.

#### Results of TWINSPAN Analyses for the Duck Bay Transect

The two-way indicator species classification of vegetation and plots along the Duck Bay transect appears in Table 1. This classification identifies three groups of plots having distinct vegetative composition. A primary break separates Plots 1-5 from all other plots and corresponds to the transition from saturated conditions to the presence of standing water. Along the Duck Bay transect, the inland saturated zone contains components of both shrub swamp (characterized by Alnus rugosa) and wet meadow. The TWINSPAN ordination reveals that the species most consistently present are Carex lacustris and Scutellaria galericulata.

A single sampling plot (#6) crossed the narrow strand zone, containing wet meadow species. Three species (including Carex comosa, Juncus pelocarpus, and Scirpus validus) were encountered only in this plot.

The remaining 18 transect points, in contrast, were placed in standing water and are dominated by marsh species, of which Najas flexilis, Scirpus acutus, and Vallisneria americana are the best represented. A secondary break within the inundated plots separates the near-shore sampling locations (6-21) from deep water sampling locations (22-24). Shallower portions of the transect contain Chara globularis, Potamogeton berchtoldii, P. filiformis, P. gramineus, P. natans, Sagittaria latifolia, Nymphaea odorata and Zizania aquatica. In contrast, the deep-water portion is marked by a sharp decline in species diversity, and the appearance of several species restricted to this zone, including Heteranthera dubia,

several years of low water, the emergent marsh zone had begun to expand, with Scirpus acutus the primary emergent species. Overall marsh diversity remained low, even during low-water periods.

Inland plots (3-12) along the Peck Bay transect represent components of two distinct zones: northern fen on extensive clay or marly flats (3-7) and conifer swamp forest (8-12). There is, however, considerable intergradation between these two, so that it is difficult to delineate distinct zones. Near the shoreline, northern fen predominates, but further inland scattered islands of swamp conifers become increasingly prevalent. Near the upland end of the transect, conifer swamp dominates, but is open enough that fen species persist. Along the transect, the swamp forest was very open and the trees were small. Further inland, the depth of the organic material increased and a closed canopy swamp forest developed. Sampling was not conducted in the closed canopy portion of the swamp.

Species that occur throughout both fen and open swamp are Carex flava, C. viridula, Cladium mariscoides, Eleocharis rostellata, Potentilla fruticosa, Solidago uliginosa, Lobelia kalmii, Muhlenbergia glomerata, and Scirpus acutus. Species found near the shore (Plots 3-7) include Calamagrostis canadensis, Campanula aparinoides, Juncus pelocarpus, Lycopus uniflorus, Panicum columbianum, Phalaris arundinacea, Potentilla anserina, and Agalinis purpurea. Many of these species are calciphiles, and their presence corresponds to the absence of organic build-up and the presence of exposed clay at the surface due to cyclic inundation and wave activity.

Conifer swamp species include Larix laricina, Thuja occidentalis, and Picea mariana, along with the shrubs Juniperus horizontalis, Ledum groenlandicum, Myrica gale, Vaccinium macrocarpon, and V. oxycoccos. Herbaceous species commonly occurring in this zone are Juncus arcticus, Sarracenia purpurea, Parnassia glauca, Scirpus caespitosus, and Tofieldia glutinosa. These herbaceous species are found within or near the edges of the marly pools that occur throughout the open swamp zone.

#### Comparison of Peck and Duck Bays

In summary, the major abiotic factor distinguishing the marshes of Peck and Duck Bays is the degree of protection from wind and wave activity. Both marshes have clay substrates, but at Duck Bay, protection from prevailing winds has allowed extensive submergent and emergent marsh zones to develop. This protection has also led to the development of relatively thick organic soils above the mean high water level, characterized by the presence of wet meadow and shrub swamp communities.

In comparison, at Peck Bay, exposure to prevailing winds has scoured the shoreline, resulting in the development of a truncated and depauperate marsh zone. Similarly, periodic inundation has precluded the formation of organic soils and has exposed the clay substrate along the shore. These open clay flats host a diversity of fen species not found at the more protected Duck Bay site. Farther inland at Peck Bay, standing shallow water and warm temperatures support marl-producing algae and produce extensive marly deposits. The result is a mosaic of sparsely vegetated marl pools interspersed with islands of depauperate conifer swamp,

growing only where shrubs and roots of windthrown trees create slightly drier conditions.

The strong contrasts in abiotic conditions between Peck and Duck Bays are echoed in their low degree of species overlap. Out of 77 species found in the two marsh transects, only 6 species (8%) were shared by both. Shared species were those of the emergent marsh (Chara globularis and Scirpus acutus) or wet meadow zone (Calamagrostis canadensis, Campanula aparinoides, and Equisetum palustre).

INVOICE for work completed 4-23-93 for the Michigan Field Office:

Analyses and graphic presentation of Duck Bay and Peck Bay marsh transects (contract #MIFO 032493-1).

<u>Time</u>	<u>Service</u>
6 hrs.	input of vegetation and abiotic data
6 hrs.	quantitative analyses (TWINSPAN ordinations)
20 hrs.	CAD, technical drawing, and graphic layout
10 hrs.	botanical illustration
7 hrs.	ecological interpretation and report write-up
<hr/>	
49 hrs.	@ \$15/hr = \$735.00

Reproduction costs (estimated):

4 PMT's @ \$10.00 each .....	\$40.00
4 B&W slides @ 6.25 each.....	25.00
Misc. photo-copying.....	5.00
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	70.00

Copies of receipts will be provided when B&W slides are delivered to the Field Office.

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### References Cited

Hill, M. O. 1973. Reciprocal averaging: an eigenvector method of ordination. Journal of Ecology 61:237-249.

Hill, M. O. 1979. TWINSpan: A FORTRAN Program for Arranging Multivariate Data in an Ordered Two-Way Table by Classification of the Individuals and Attributes. Cornell Ecology Program 41. Section of Ecology and Systematics, Cornell University, Ithica, NY.

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2. TWINSpan Ordination of Peck Bay Plots and Species

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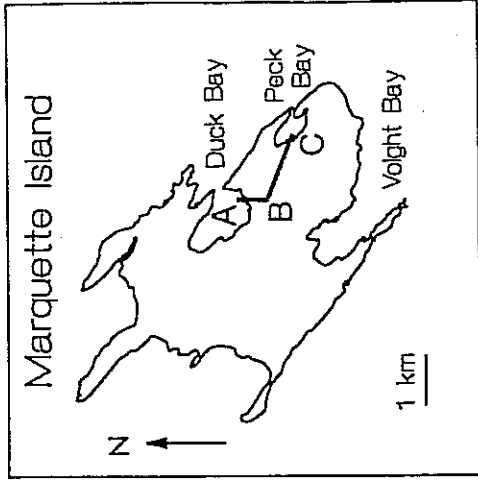
Table 1  
 TWINSPAN Ordination of Duck Bay Plots and Species

	PLOT #		
	222111111122	111	
	234456937801789012651234		
<i>Chara globularis</i>	---11-----1---212-----	00000	
<i>Potamogeton filiformis</i>	-----111-----	00000	
<i>Sagittaria graminea</i>	-----1--1-----	00000	
<i>Zizania aquatica</i>	-----1---1-111-----	00000	
<i>Nymphaea odorata</i>	---1--1-----1-1-----	00001	
<i>Bidens beckii</i>	-----1-----	00010	
<i>Pontederia cordata</i>	-----111-----	00010	EMERGENT
<i>Potamogeton natans</i>	-----211-----	00010	MARSH
<i>Najas flexilis</i>	11-111-222221-2-1-----	00011	
<i>Potamogeton berchtoldii</i>	-----1-----	00011	
<i>Potamogeton gramineus</i>	-----111-11-----	00011	
<i>Sagittaria latifolia</i>	-----1---1-1---1-----	001	
<i>Scirpus acutus</i>	11-1111111111211-----	001	
<i>Vallisneria americana</i>	112111111111--1--1-----	001	
<i>Potamogeton richardsonii</i>	--1-----1-----	0100	
<i>Elodea canadensis</i>	1-----	0101	SUBMERGENT/
<i>Heteranthera dubia</i>	122-----1-----	0101	EMERGENT
<i>Myriophyllum exalbescens</i>	--1-----	0101	MARSH
<i>Potamogeton obtusifolius</i>	1-----	0101	
<i>Carex comosa</i>	-----1-----	011	
<i>Juncus pelocarpus</i>	-----1-----	011	STRAND/
<i>Scirpus validus</i>	-----1-----	011	WET MEADOW
<i>Sparganium chlorocarpum</i>	-----1---1-----	011	
<i>Galium trifidum</i>	-----2-----	10	
<i>Lysimachia terrestris</i>	-----1-----	10	SHRUB
<i>Typha angustifolia</i>	-----1-----	10	SWAMP
<i>Typha latifolia</i>	-----12-----	10	
<i>Campanula aparinoides</i>	-----1-1-1	110	
<i>Carex aquatilis</i>	-----11---	110	
<i>Polygonum amphibium</i>	-----1---1	110	
<i>Scutellaria galericulata</i>	-----11111	1110	
<i>Carex lacustris</i>	-----12221	11110	
<i>Abies balsamea</i>	-----1---	11111	
<i>Alnus rugosa</i>	-----112-	11111	WET
<i>Calamagrostis canadensis</i>	-----1-11	11111	MEADOW
<i>Carex stricta</i>	-----1--2	11111	
<i>Galium aparine</i>	-----1---	11111	
<i>Impatiens capensis</i>	-----111-	11111	
<i>Lycopus americanus</i>	-----1---	11111	
<i>Equisetum palustre</i>	-----1---	11111	
	000000000000000000011111		
	0000000000000000000101111		
	00011111111111111111		
	000000000000111		

Table 2  
 TWINSPAN Ordination of Peck Bay Plots and Species

	PLOT #		
	111		
	901284673512		
<i>Drosera rotundifolia</i>	1--1-----	0000	
<i>Hypericum kalmianum</i>	1-1-----	0000	
<i>Larix laricina</i>	1111-----	0000	
<i>Ledum groenlandicum</i>	1111-----	0000	
<i>Myrica gale</i>	-11-----	0000	
<i>Picea mariana</i>	---1-----	0000	
<i>Senecio pauperculus</i>	--1-----	0000	
<i>Sphagnum fuscum</i>	---1-----	0000	OPEN CONIFER
<i>Thuja occidentalis</i>	1111-----	0000	SWAMP
<i>Utricularia cornuta</i>	1-----	0000	
<i>Vaccinium macrocarpon</i>	--1-----	0000	
<i>Vaccinium oxycoccos</i>	1-----	0000	
<i>Primula mistassinica</i>	1-----	0000	
<i>Equisetum palustre</i>	11-----	0000	
<i>Juniperus horizontalis</i>	---1-----	0000	
<i>Juncus arcticus</i>	11111-----	00010	Species
<i>Sarracenia purpurea</i>	11111-----	00010	associated
<i>Parnassia glauca</i>	11111-----	00010	with marly
<i>Scirpus caespitosus</i>	-1111-----	00010	pools
<i>Tofieldia glutinosa</i>	11-11-----	00010	
<i>Carex interior</i>	----1-----	00011	
<i>Satureja glabella</i>	----1-----	00011	
<i>Cladium mariscoides</i>	11111111----	00100	
<i>Eleocharis rostellata</i>	1221211111--	00100	
<i>Potentilla fruticosa</i>	11111111----	00100	
<i>Solidago uliginosa</i>	-111-1-1----	00100	
<i>Lobelia kalmii</i>	111-1111----	00101	
<i>Muhlenbergia glomerata</i>	----1--1----	00101	
<i>Scirpus acutus</i>	-1111111-1--	00101	
<i>Carex flava</i>	-1---1---1--	00110	
<i>Carex viridula</i>	-1--1111-1--	00110	NORTHERN FEN
<i>Rhynchospora capillacea</i>	----1-1--1--	00110	
<i>Triglochin palustre</i>	-----1--1--	00111	
<i>Calamagrostis canadensis</i>	-----112----	00111	
<i>Campanula aparinoides</i>	-----1-----	00111	
<i>Juncus pelocarpus</i>	-----1-----	00111	
<i>Lycopus uniflorus</i>	-----1-----	00111	
<i>Panicum columbianum</i>	-----11----	00111	
<i>Phalaris arundinacea</i>	-----1-----	00111	
<i>Potentilla anserina</i>	-----11-----	00111	
<i>Agalinis purpurea</i>	-----1-----	00111	
<i>Eleocharis pauciflora</i>	1111111-12-1	01	SUBMERGENT
<i>Chara globularis</i>	-----12	1	MARSH
	000000000011		
	0000011111		
	0000100011		

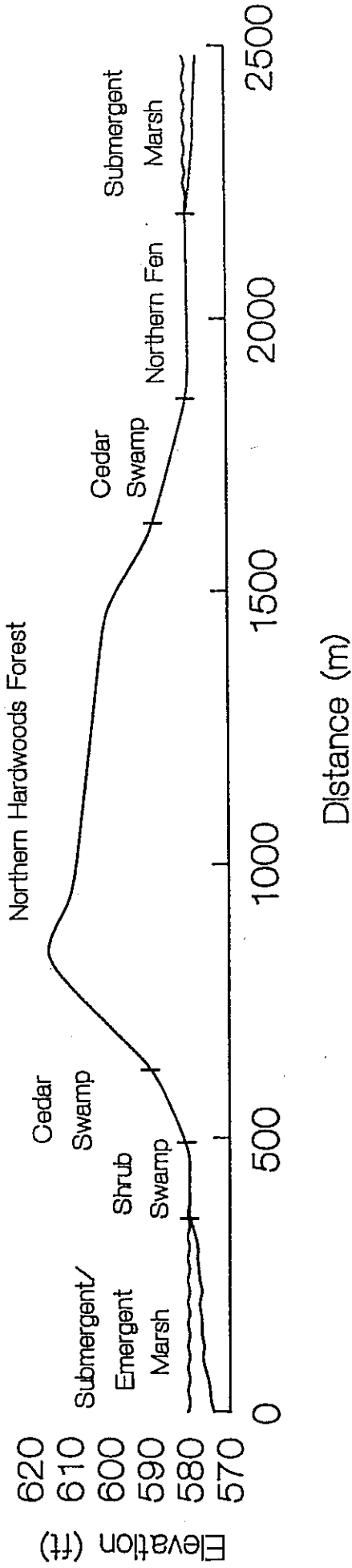
# Vegetational Cross-Section of Marquette Island



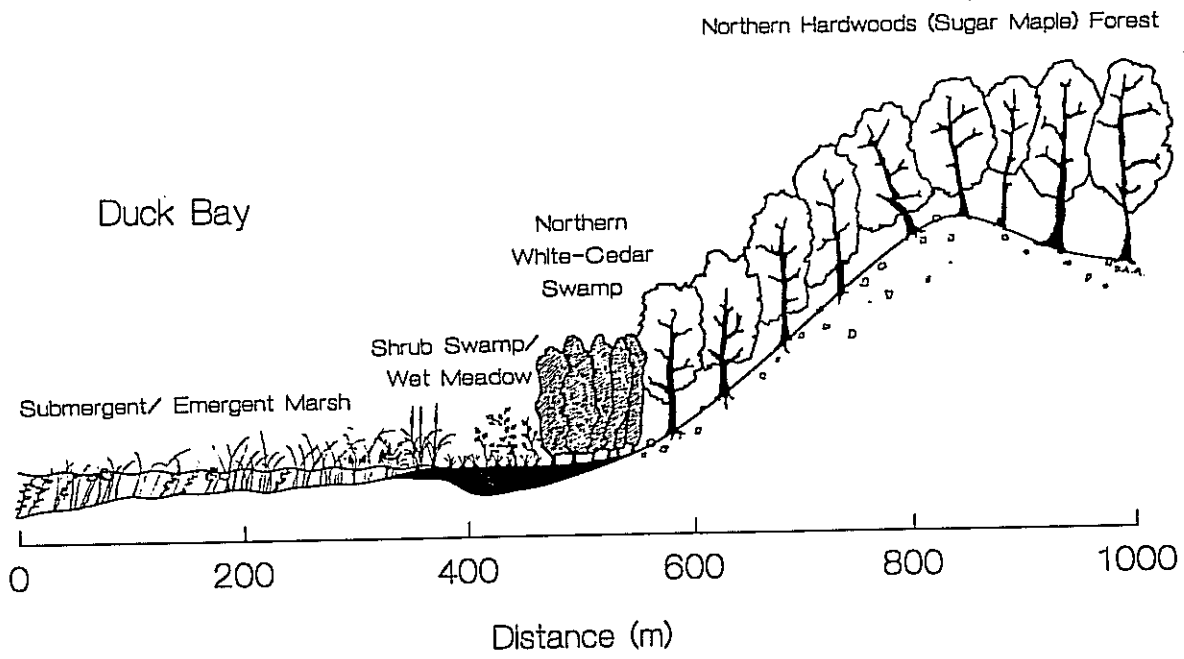
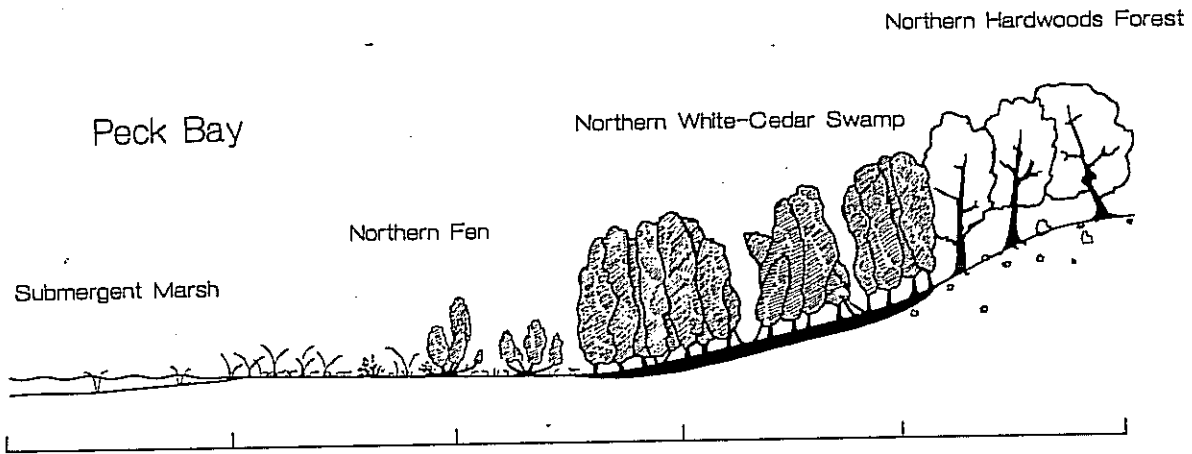
A. Duck Bay

B.

C. Peck Bay



Comparison of Plant Communities at Peck and Duck Bays,  
Marquette Island



# Detail of Peck Bay Transect

Northern White-Cedar Swamp

*Thuja occidentalis*

*Larix laricina*

*Ledum groenlandicum*

Northern Fen

*Cladium mariscoides*

*Potentilla fruticosa*

*Eleocharis rostellata*

*Sarracenia purpurea*

*Juncus arcticus*

*Scirpus acutus*

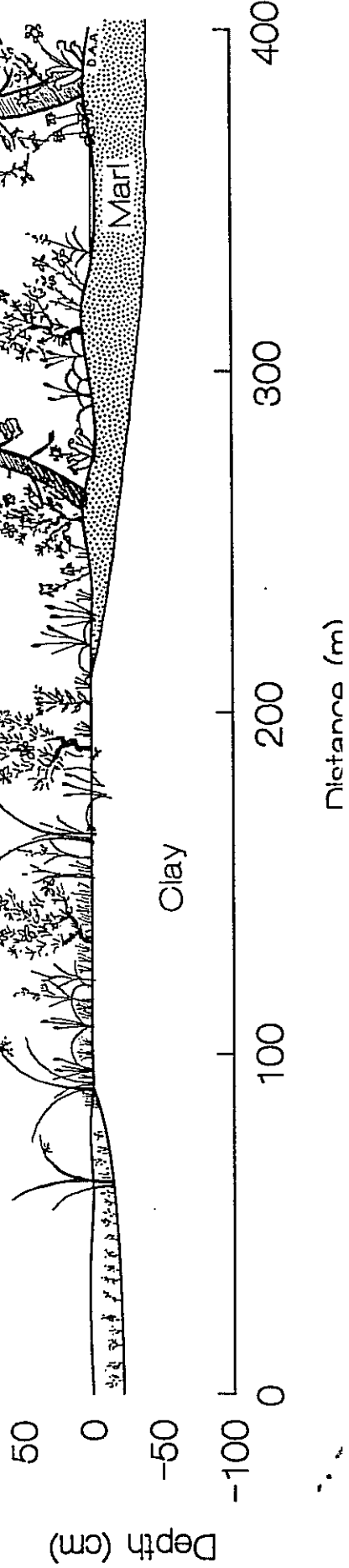
*Lobelia kalmii*

*Toffelia glutinosa*

Submergent Marsh

*Chara globularis*

*Eleocharis pauciflora*



# Detail of Duck Bay Transect

Shrub Swamp/  
Wet Meadow

Cedar Swamp  
*Thuja occidentalis*

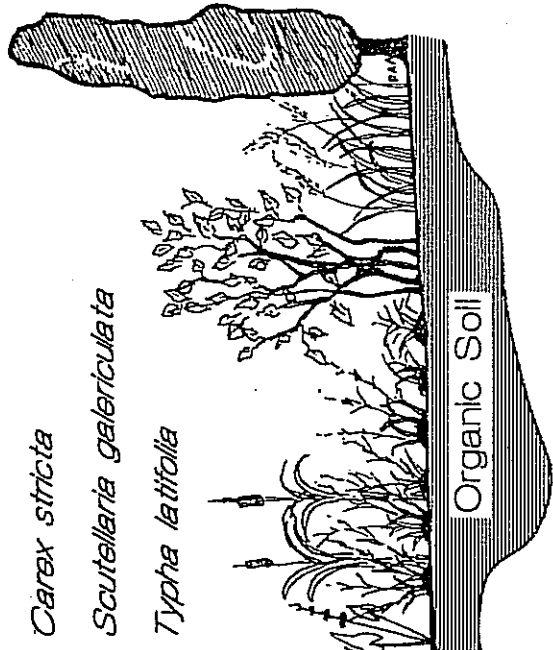
Emergent Marsh

*Chara globularis*  
*Najas flexilis*  
*Nymphaea odorata*  
*Potamogeton gramineus*  
*Scirpus acutus*  
*Vallisneria americana*

Submergent Marsh

*Heteranthera dubia*  
*Myriophyllum exalbescens*  
*Potamogeton obtusifolius*  
*Potamogeton richardsonii*  
*Vallisneria americana*

*Alnus rugosa*  
*Calamagrostis canadensis*  
*Carex lacustris*  
*Carex stricta*  
*Scutellaria galericulata*  
*Typha latifolia*



Depth (cm)

50  
0  
-50  
-100  
-150  
-200

Distance (m)

0 100 200 300 400 500

Clay

Organic Soil