A SURVEY OF WOODED DUNE AND SWALE COMPLEXES IN MICHIGAN

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ABSTRACT

In 1991, a two year project to survey the Wooded Dune and Swale Complexes along Michigan's Great Lakes shoreline was initiated by the Michigan Natural Features Inventory (MNFI) with funding through the Michigan Coastal Management Program. The primary objective of the survey was to inventory, classify, and characterize these complexes in Michigan using both biotic and abiotic factors. Additional objectives included 1) determining appropriate natural-area boundaries for protection planning, 2) ranking each complex by natural-area quality and priority for protection, and 3) to develop a plant species list from these complexes indicating the relative frequency of occurrence for each species in upland vs. wetland.

Of the 90 to 95 Wooded Dune and Swale Complexes that once occurred within the Great Lakes Region, 70 were located in Michigan. Of these, 40 examples that retain significant undisturbed natural character were quantitatively sampled for this study. Elevations measured along numerous transects indicated that, for the most part, water found within the wet swales of these complexes are of inland origin. In a few examples, the sandy bottoms of several swales was found to be below the current Great Lakes water levels. However, the hydrology of many Wooded Dune and Swale Complexes is directly tied to adjacent rivers which flow through, or immediately adjacent to, many complexes. A tremendous diversity of plant species and communities within Michigan's Wooded Dune and Swale Complexes was documented by this study. The vegetation of Michigan's complexes was used to establish five complex sub-types, which reflect the north-south variation in plant distributions within Michigan, and the relative extent of wind-sorting vs. water-lain processes which formed each complex. In complexes where water-lain processes were predominant, wetland plant communities were more abundant than in complexes where wind-sorting processes were predominant.

This report summarizes findings for the complexes throughout the state, describing distinguishing factors for the five complex sub-types. A list of the 631 vascular plant, moss, and algae species, along with their relative frequencies in upland and wetland is included. Summaries and natural area boundary maps for complexes sampled during 1992 are also included.

INTRODUCTION

The current pressure for development along Michigan's Great Lakes shorelines calls for careful resource planning based on thorough ecological analysis. There is a need for additional information to supplement our understanding of Great Lakes shoreline ecosystems and their dynamics. Detailed studies of Great Lakes ecosystems can provide the basis for shoreline conservation and protection as development proceeds.

Wooded Dune and Swale Complexes, considered a distinctive natural community composed of upland and wetland features, are found in embayments and sand spits along the Great Lakes shorelines. Most were formed in two stages, with progressively dropping lake water levels and post-glacial uplift beginning with the glacial Lake Algonquin levels approximately 12,000 years ago, and again with the Lake Nipissing water levels 3-4000 years ago. (Dorr and Eschman 1970). The receding lake levels deposited a series of sandy beach ridges ranging from 0.5 to 4 meters high. From the air, these ridges appear as a series of arcs, extending inland up to 2 miles, generally parallel to the present shoreline. In several examples, beach ridges were also built up and re-sorted by wind, creating higher, somewhat irregular dune ridges.

These complexes are often best developed where post-glacial streams entered an embayment. The flow of surface and ground water through these ridge complexes to the Great Lakes often results in the development of wet swales between each beach ridge. In a few of Michigan's complexes, the bottoms of the first few swales lie below current Great Lakes water levels. The water levels in these swales are therefore directly tied to

Great Lakes water level fluctuations. With time, plant succession has proceeded to the point where the beach ridges are now forested while the wet swales are either forested or open wetlands.

Using criteria established by the network of Conservation Data Centers established by The Nature Conservancy, these natural communities are not considered to be globally imperiled. But, they are considered globally rare, and are limited to the Great Lakes region in North America. In Michigan, where they are characteristic shoreline communities, there are 40 examples with significant undisturbed natural character remaining.

OBJECTIVES:

The primary purpose of this study was to inventory, classify, and characterize the Wooded Dune and Swale Complexes along Michigan's Great Lakes shoreline. Complexes of high natural-area quality were identified, and both biotic and abiotic data were collected.

The study had several additional objectives, including 1) to rank each complex by natural quality and priority for protection, 2) to determine appropriate boundaries for all areas of high natural-area quality for the purpose of their eventual protection, and 3) to develop a plant species list from these complexes indicating the frequency of occurrence for each species in uplands vs. wetlands.

FORMAT:

This report first documents the methods used for identifying and sampling each

complex. This will be followed by a discussion of known historical distribution of these complexes in Michigan, and throughout the Great Lakes region. The preliminary classification of Wooded Dune and Swale Complexes will follow, with descriptions of the plant communities and species associated with each complex type, and ranked listings of complexes for developing protection priorities. This is followed by a brief analysis of plant species associated with the upland/wetland ecotone in these complexes. Appendices I, II, and III include site summaries, natural area boundary maps, and county location maps for each of the 22 sites of high natural-area quality sampled during 1992 (equivalent site summaries and maps for complexes sampled during 1991 are found in P. Comer and D. Albert 1991). Appendix IV includes floristic data from three representative complexes. Appendix V includes a complete listing of vascular plants and mosses found within the complexes state-wide, along with their relative frequencies in upland and wetland. And finally, Appendix VI provides a summary of criteria for ranking the natural-area qualities of each complex.

METHODS

During 1991 and 1992, 70 Wooded Dune and Swale Complexes located along the Lake Huron, Lake Michigan, and Lake Superior shorelines were identified for this study based on aerial photograph interpretation and analysis of topographic maps. The field notes of the original land surveys of Michigan conducted by the General Land Office between 1816 and 1855 were analyzed to determine the dominant presettlement vegetation of each complex. Disturbance history was then determined using 1938, 1978, and 1986-88 aerial photographs (Figure 1). Highly developed or recently disturbed sites were not sampled. For sites where little disturbance was apparent, potential natural-area boundaries were established using aerial photographs, and land ownership information was also gathered. Sites were visited during May of each year to collect qualitative data related to the amount of recent human disturbance and to determine optimal transect locations for quantitative sampling of natural-area quality sites.

Of the 70 sites initially identified for the study, 20 were determined not to be of natural-area quality and 10 could not be sampled because permission to enter the property could not be obtained from the landowner. The remaining 40 sites were determined to be of natural-area quality and were quantitatively sampled during July and August of 1991 and 1992.

One sampling transect was taken at each site. Transects were located so as to cover a representative cross-section of ridges and swales and to minimize sampling within areas disturbed by human activities such as timber/wildlife management, road construction, etc. The exact location of the transect, within the above constraints was

Figure 1: Wooded Dune & Swale Complexes in Michigan

established randomly. Where no constraints existed, the starting point along the shoreline was chosen randomly. Transects were aligned perpendicular to the prevailing orientation of the beach ridges using aerial photographs and a magnetic compass. At sites where roads exist parallel to the shoreline, the transect was begun from the first ridge inland from the road.

A 30 meter Poly-Clad Rope Chain was used to measure the distance between sample points to the closest meter. Alignment of the transect was maintained with a magnetic compass. The width of each swale was measured and sample points were located at the center of each ridge and each swale along the transect. The number of sample points varied with the size of the complex, but 15-20 ridges and 15-20 swales were sampled for each transect.

Vegetation was sampled using a 1 square meter frame constructed with 3/4" diameter plastic (PVC) tubing. For each plant species within the sampling frame, coverage values were recorded. Coverage values of 1-5 were estimated, denoting 1-20%, 21-40%, 41-60%, 61-80% and 81-100% coverage classes, respectively. Plant species occurring outside of the sampling frame, but within 2 meters of the sample point were noted as present with a check mark. Plants not identified in the field were collected for later identification. Using the same coverage classes, plant groups classified as submerged vegetation, emergent vegetation and moss cover were estimated within the sampling frame and recorded. Overstory tree species (greater than 4.5" diameter at breast height) were sampled from each sample point using a Basal Area Factor 10 prism and recorded using a dot tally on the sampling form.

Sampling at each point also included determination of the wetland/upland type, water depth of swales (both in May and in August where possible), depth of soil organic material (in centimeters) and soil texture. The determination that each sample point was either upland or wetland was made using The Michigan Department of Natural Resources Wetland Determination Manual Draft for Field Testing. Samples of organic material and sub-soil were collected from 3 swales distributed along the transect. One sample of sub-soil from a ridge was also collected. Samples were stored under refrigeration and pH was measured using a digital Beckman pH meter within two weeks of collection.

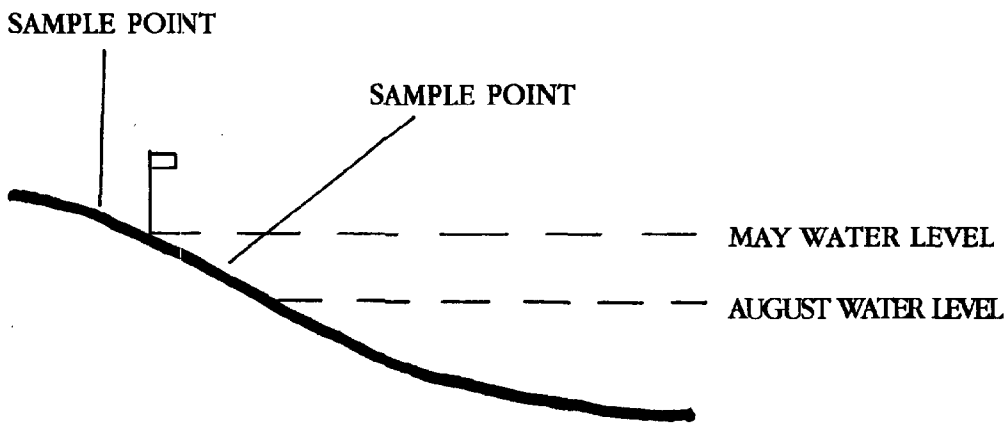
At 9 sites, 3 swales along the transect were flagged at the water's edge during May. During quantitative sampling in August, additional sample points were located on the high and the low side of the flags to sample vegetation along the upland/wetland ecotone (Figure 2). Only plant species found within the sampling frame were noted and depths of organic material were measured.

At 17 sites, where no shoreline road exists and transects were started at the lake water's edge, elevations of each ridge and swale were estimated, using a Suunto clinometer and a 10 foot story pole. Elevations were later plotted using SYSTAT/SYGRAPH software.

DATA ANALYSIS:

The funding for this project prohibited the complete analysis of the data collected. However, a listing of all vascular plants and mosses found within these complexes, showing their relative frequency of occurrence in upland vs. wetland communities, was calculated. This was completed using Lotus spread-sheet software.

Figure 2. Location of sample points for selected flagged swales for sampling of upland/wetland ecotone.



A preliminary classification of Wooded Dune and Swale Complexes in Michigan was completed using a similarity index program made available to MNFI by Dr. Gerould Wilhelm and Linda Weistein of the Morton Arboretum. This program utilizes presence/absence information to compare floristic data between complexes. A table was then generated showing the relative floristic similarity of each complex to all others in Michigan. From this table, a preliminary clustering of sites can be determined for classification purposes. This same similarity index was used for analysis of the upland/wetland ecotone. For this analysis, samples from all "high" plots were pooled and compared with pooled samples from the "low" plots to establish a percentage of similarity in plant species on either side of the spring high-water line.

A more complete analysis of three representative transects was completed using transect software also provided to MNFI by Dr. Wilhelm and Linda Wetstein. This software allows for rapid calculations of relative frequency, importance values, and cumulative wetland coefficients for each sample plot along the transect, as well as transect summary information. These sample analyses are provided in Appendix IV.

RESULTS AND DISCUSSION

OCCURRENCES IN MICHIGAN AND THE GREAT LAKES REGION

Because the processes responsible for the development of Wooded Dune and Swale Complexes are directly related to very large bodies of fresh water and post-Pleistocene geology, their occurrences are limited to the Great Lakes region in North America. Through communications with specialists from throughout the region it is estimated that 90 to 95 complexes once occurred throughout the Great Lakes basin. The vast majority were found in Michigan, with perhaps 10 or 12 along the Ontario shoreline. The remainder were found in Wisconsin, Illinois, Indiana, Ohio, and Pennsylvania. From descriptions of extant examples of these complexes in Illinois and Indiana (Bacone 1979; Hedge, pers. com.; and Wilhelm, pers. com.) they appear to differ significantly from all Michigan complexes, both in species composition and abundance. Due to a lack of available information on the species composition of most complexes in Ontario, no direct comparisons could yet be made with Michigan complexes.

As already noted, approximately 70 Wooded Dune and Swale Complexes once occurred in Michigan. They were located along Lake Huron, Lake Michigan, and Lake Superior. No complexes are known to have existed along Michigan's Lake Erie shoreline (see Figure 1, page 5). Unlike many other complexes throughout the Great Lakes basin which have been eliminated during heavy industrial development, very few of the original 70 complexes have been entirely destroyed. However, most complexes have been impacted by road construction, agricultural drainage, and intensive residential

development along the shoreline. One complex on the Mackinac and Schoolcraft County line was eliminated by strip mining for limestone and dolomite. Complexes which have been most seriously degraded by shoreline development occur along southern Lake Huron (Huron, Bay, Arenac, Iosco, and Alcona counties), along northern Lake Michigan (Mackinac and Schoolcraft counties), and along Lake Superior (Marquette County). All of the largest, least disturbed complexes in Michigan were quantitatively sampled for this study. High quality examples of these complexes are found in highest concentrations in Mackinac, Schoolcraft, and northern Marquette counties. Table 1 provides a brief summary of the location, presettlement vegetation, and current condition of all 70 complexes found in Michigan.

PLANT COMMUNITIES

Because they contain a unique assemblage of physiographic, soil, and vegetative components, and provide a high quality habitat for numerous shoreline animal species, the Wooded Dune and Swale Complex is considered a distinct natural community in Michigan (MNFI 1990). However, it is illustrative to describe the various zones of plant communities encountered in these complexes. The following descriptions can be applied to nearly all complexes in the state. Distinctions between complex sub-types will be detailed under later discussions of community classification.

The comparison of elevations along each transect with the mean wetland coefficients for species from corresponding ridges and swales helps to clarify the relationships between landforms and vegetation within these complexes (Herman et al.

Table 1 : Site Name, Location, Presettlement Vegetation, and Comments on Current Condition for 70 Historical Wooded Dune and Swale Complex Occurrences in Michigan.

SITE NAME	COUNTY	TOWNSHIP/RANGE	PRESETTLEMENT VEGETATION	CURRENT CONDITION
Harbor Beach	Huron	T16N R15-16E	Red/White pine forest, Black ash swamp	Mostly eliminated; homes, roads throughout.
Pointe Aux Barques*	Huron	T19N R13E	Hemlock, White pine, Cedar, Black ash swamp	Private preserve.
Port Crescent State Park*	Huron	T18N R13E	Hemlock, White pine, Birch, Black ash, Tamarack	Portion in State Park and County Park; roads and homes elsewhere, recent development.
Sleeper State Park*	Huron	T18N R10-11E	White pine, Oak/Pine barrens, Tamarack swamp, Black ash swamp Emergent marsh, Lakes	Portion within State Park; roads and homes along shoreline.
Wildfowl Bay	Huron	T17-18N R10E	White pine, Lowland conifers, Great Lakes marsh, Lakes	Many drains, roads, homes throughout.
Tobico Marsh	Bay	T15N R4-5E	Tamarack swamp, American elm, Black ash, Great Lakes marsh	Developed portion of State Park, manipulated water levels.
Au Gres*	Arenac	T19N R7E	Red/White pine, Cedar swamp, Tamarack, Yellow birch, Balsam fir	US-23, many homes along shoreline, recently established golf course.
Whitestone Point	Arenac	T20N R7E	Black ash swamp, Tamarack, Hemlock, Northern hardwoods along the shoreline	US-23, many smaller roads and homes throughout.
Lake Solitude	Iosco	T22N R8E	Oak-Pine Barrens, Conifer swamp, Lakes; White Pine, Red pine, Black oak, Paper birch, Tamarack, Cedar, Red maple, Black ash, Aspen	US-23 passes along back ridges, many roads, homes along the shoreline.
Spencer Lake	Iosco	T22-23N R9E	Pine Barrens, Red pine, Black oak, Tamarack, Black spruce, Cedar	US-23 passes through complex; many homes along the shoreline.
Cedar Lake	Alcona	T25N R9E	Cedar swamp, Red pine, Hemlock, Black ash	US-23, many smaller roads and homes throughout.
Sturgeon Point	Alcona	T26-27N R9-10E	Cedar swamp, Hemlock, Black spruce, Tamarack, Paper birch, Balsam fir	Roads, drains, railroad tracks, several homes within complex.
Black River*	Alcona	T28N R9E	Cedar swamp, Tamarack, Hemlock, Balsam fir, Paper birch	Road along shoreline, several homes; National Forest land included in complex.
Negwegon State Park*	Alcona	T28N R9E	Cedar swamp, White pine, Hemlock, Tamarack, Balsam fir, Paper birch	Railroad tracks, park entrance road, roadside drains, timber harvest on State Forest land within complex.
Thunder Bay*	Alpena	T29-31N R8E	Cedar swamp, Great Lakes marsh, Lakes, Tamarack, White pine, Red pine, Black spruce, Paper birch	City of Alpena built on north end; US-23, many roads, homes, ORV damage common.

* QUANTITATIVELY SAMPLED

TABLE 1 : CONTINUED

SITE NAME	COUNTY	TOWNSHIP/RANGE	PRESETTLEMENT VEGETATION	CURRENT CONDITION
Long Point	Alpena	T31N R9E	Hemlock, White pine, Cedar swamp,	Road and several homes along the shoreline, otherwise undisturbed.
Hammond Bay*	Presque Isle	T36-37N R2-3E	Red pine, Jack pine, Hardwood-Conifer swamp, Cedar swamp	US-23, several other roads, homes along the shoreline.
Evergreen Beach	Presque Isle	T36N R4E	Red pine, White pine, Tamarack swamp	Roads, homes long the shoreline.
Grass Bay*	Cheboygan	T38N R1W T38N R1E	White pine, Hemlock, Cedar swamp	Private preserve, homes along the shoreline to the east.
Horseshoe Bay*	Mackinac	T41-42N R3-4W	Cedar swamp, Tamarack, Black spruce, Balsam fir, White pine, Paper birch, Speckled alder	I-75 passes through complex; portion east of highway USFS Wilderness Area.
Saint Martin's Bay	Mackinac	T42N R3W	Cedar swamp, Black spruce, balsam fir, White pine, Paper birch	I-75 passes through complex; Hiawatha National Forest, timber management.
Saint Vital Bay*	Chippewa	T41N R3E	White spruce, Balsam fir, Cedar swamp, Great Lakes marsh	M-134 passes through, homes along the shoreline.
Platte River Point*	Benzie	T27N R15-16W	Open dunes, White pine, Red pine, Tamarack swamp, Lakes	Nominated as National Natural Landmark, USPS plans for marina development.
Platte Bay*	Benzie	T27N R15W	Red pine, White pine, Jack pine, Open dunes, Lakes, Speckled alder swamps	Also nominated for N.Natural landmark; USPS plans for marina development
Crystal River*	Leelanau	T29N R14W	Hemlock, White pine, Cedar swamp, Tamarack swamp, Lakes, Crystal River	Roads, homes along the shoreline, and in Glen Arbor; recent plans for golf course at NW end.
Good Harbor Bay*	Leelanau	T29-30N R12-13W	Hemlock, White pine, Open dunes, Balsam poplar swamp	Homes along shoreline, part of National Lakeshore.
Bower's Harbor	Grand Traverse	T29N R11W	Hemlock, White pine, Cedar swamp	Road, homes along shoreline; surrounded by agricultural land.
Grand Traverse East Arm	Grand Traverse	T27N R10W	White pine, Red pine, Cedar swamp	Roads, urban development throughout.
Sturgeon Bay*	Emmet	T38-39N R5W	White pine, Red pine, Black spruce, Tamarack, Cedar swamp, Aspen, Birch, Emergent marsh, Bog	Part of complex state designated Natural Area, remainder on public land.
Big Stone Bay*	Emmet	T38N R5W	White pine, Red pine, Cedar swamp, Tamarack, Paper birch, Aspen	Park road, office, and parking lot located within complex.

* QUANITTATIVELY SAMPLED

TABLE 1 : CONTINUED

SITE NAME	COUNTY	TOWNSHIP/RANGE	PRESETTLEMENT VEGETATION	CURRENT CONDITION
Trails End Bay*	Emmet	T39N R4W	Cedar, Balsam fir, White pine, Hemlock, White pine forest on high, back dune ridges.	Road, many homes along shoreline, powerline corridor through complex.
Pointe Aux Chenes*	Mackinac	T41-42N R4-6W	Hemlock, White pine, Open dunes, Cedar swamp, Tamarack swamp, Great Lakes marsh	US-2 along shoreline, remainder within Hiawatha National Forest.
Epoufette Bay West*	Mackinac	T42N R7-8W	White pine, Balsam fir, White spruce, Tamarack, Cedar swamp, Red maple, Paper birch	US-2 passes through complex, clear-cuts on State Forest land.
Naubinway	Mackinac	T43N R9-10W	Jack pine, Red pine, White pine, Shrub swamps, small ponds	US-2 passes through complex, many homes along the shoreline.
Rock River	Mackinac	T42-43N R10W	Tamarack swamp, Cedar swamp, Black spruce	Undisturbed except for narrow road and homes along the shoreline.
Big Knob Campground*	Mackinac	T42N R10W	Hemlock, White pine, Jack pine, Tamarack swamp, Aspen, Black ash, ponds	All State Forest with campground roads, some recent clear-cuts.
Crow River Mouth*	Mackinac	T42N R10-11W	Tamarack, Black spruce, Red maple, White pine, Paper birch, Aspen, Black ash	One owner, one narrow road to shoreline, recently proposed for state acquisition.
Point Patterson	Mackinac	T41N R11W	Cedar swamp, Balsam fir, Black/White spruce, White pine, Tamarack, Aspen	ORV scramble area along shoreline, otherwise intact.
Scott Point*	Mackinac	T41N R11W	Balsam fir, Black spruce, Cedar swamp	Just two homes along shoreline, remainder part of proposed state designated Natural Area.
Seiners Point*	Mackinac	T41-42N R12W	Hemlock, Tamarack, Black spruce, Balsam fir, Aspen, Cedar swamp	Intact. Part of proposed state designated Natural Area.
Seul Choix Bay	Schoolcraft	T41N R12-13W	Tamarack swamp, Black spruce, White pine, Red pine on ridges	Mostly destroyed by limestone/dolomite quarry.
Gulliver Lake Dunes*	Schoolcraft	T41N R13-15W	Paper birch swamp, Cedar swamp, White pine, Hemlock, Black/White spruce	Homes, roads along shoreline, much potential for future subdivisions.
Thompson*	Schoolcraft	T41N R16W	Cedar swamp, Black spruce, Balsam fir, Hemlock, Red pine	Urban development from Manistique, US-2 along shoreline.
Portage Bay*	Delta	T39N R18W	Cedar swamp, Great Lakes marsh, Lake	Intact; recent road construction along northern margins.
Kregg Bay	Delta	T38N R18W	Cedar swamp, American beech, Sugar maple	Roads, homes along the shoreline.
Gillnet Haven	Delta	T38N R19W	Cedar swamp, Beech/maple forest	Intact, new owner plans to develop.

* QUANTITATIVELY SAMPLED

TABLE 1 : CONTINUED

SITE NAME	COUNTY	TOWNSHIP/RANGE	PRESETTLEMENT VEGETATION	CURRENT CONDITION
Big Bay de Noc*	Delta	T40N R18W	White pine, Red pine, Hemlock, Cedar swamp, Tamarack swamp	Roads, railroad tracks along the shoreline; mostly public land.
Ogontz Bay*	Delta	T40N R20W	Cedar swamp, Tamarack swamp	Intact; roads, clear-cuts at north end.
Tahquamenon Bay*	Chippewa	T47N R5-6W	White pine, Hemlock, White/black spruce, Tamarack swamp	Road along shoreline, clear-cuts on private land at southwest end.
Whitefish Point	Chippewa	T50-51N R5-7W	Jack pine forest, Black spruce swamp, Tamarack, Lakes	Roads along shore and on ridges, cranberry farming, fisheries impoundments, clear-cuts on State Forest.
Two Hearted River Mouth	Luce	T49-50N R9-10W	Mostly upland; Red pine, White pine on ridges; Black spruce, Balsam fir Red maple in few swales	Several narrow roads, clear-cuts on State Forest land.
Muskallonge Lake West	Luce	T49-50N R11W	Mostly upland; White pine/Red pine on ridges, White spruce, Balsam fir, Paper birch	Several narrow roads, otherwise intact.
Trout Bay	Alger	T47N R19W	Mostly Great Lakes marsh, Cedar, Black ash, Red pine, White pine	Several narrow roads, otherwise intact.
Christmas	Alger	T47N R19W	Cedar, Tamarack, Black spruce, Great Lakes marsh	M-28 passes through complex along shoreline, County Park/campground also along shoreline.
Au Train*	Alger	T46-47N R20-21W	White pine, Red pine, Jack pine, Cedar swamp, Great Lakes marsh along Au Train River	M-28, railroad tracks pass along shoreline, Town of Au Train located within the complex.
Sand River	Marquette	T47N R22-23W	Mostly upland; Red pine, Jack pine, Hemlock	M-28, many other roads pass though complex, homes along shoreline.
Chocolay River	Marquette	T47N R23-24W	Mostly upland; Red pine/Jack pine forest	M-28, subdivisions, railroad tracks along shoreline.
Little Presque Isle Point*	Marquette	T49N R25-26W	Mostly upland; Hemlock, Red pine, White pine, Cedar, Balsam fir	CO. 550 passes through complex; State Forest campground, private part intact.
Iron River*	Marquette	T51N R26-27W	Mostly upland; Red pine, White pine, Great Lakes marsh along Iron River	Narrow road; otherwise intact; recent re-zoning for subdivision may cause threat to complex.
Big Bay	Marquette	T51N R27W	White pine, Tamarack, Cedar, Black spruce, Speckled alder, Great Lakes marsh	Homes along the shoreline.

* QUANTITATIVELY SAMPLED

TABLE 1 : CONTINUED

SITE NAME	COUNTY	TOWNSHIP/RANGE	PRESETTLEMENT VEGETATION	CURRENT CONDITION
Salmon Trout Bay*	Marquette	T51-52N R27-28W	Cedar swamp, Speckled alder swamp, Black ash, White pine, Tamarack	Pristine; contained within the Huron Mountain Club.
Pine River*	Marquette	T52N R28W	Mostly upland; Red pine, Jack pine	Narrow roads, homes along the Pine River.
Huron River	Baraga	T52N R29-20W	Mostly upland; Jack pine, Red pine, Paper birch, Aspen, Balsam fir, Black spruce, Speckled alder	Intact.
L'Anse Bay	Baraga	T50N R33-34W	Black spruce, Balsam fir, Tamarack	US-41, railroad tracks along the shoreline.
Little Traverse Bay*	Houghton	T55N R31W	Tamarack swamp, Red pine, Black spruce, Shrub swamp, Great Lakes marsh,	Narrow road, homes along the shoreline.
Grand Traverse Bay*	Houghton/ Keweenaw	T55-56N R31W	White pine on ridges, Tamarack swamp, Black spruce	Narrow road, homes along southern shoreline; Town of Traverse Bay, mine tailings along northern shoreline.
Oliver Bay*	Keweenaw	T57N R29W	White pine on ridges, Balsam fir, Black spruce, Cedar, Paper birch	Homes, road along the shoreline; possible future subdivision of large land holdings.
Lac La Belle	Keweenaw	T58N R29W	Great Lakes marsh, White pine, Cedar, Balsam fir, Speckled alder	Road along shoreline; possible subdivision and resort development at north end.
Eagle Harbor	Keweenaw	T58N R31W	Tamarack, Black spruce, Cedar, Balsam fir, Great Lakes marsh, Speckled alder, Willow swamp, Lakes	Road along the shoreline.
Flint Steel River*	Ontonagon	T52N R39W	White pine, Hemlock, Shrub swamp	Narrow roads, homes along the shoreline.

* QUANTITATIVELY SAMPLED

in press). Of the 17 sites where elevations were measured from the shoreline inland, only 3 sites contained swales where the sandy bottoms lay below the current Great Lakes water levels. This suggests that, except in a few examples, the influence of Great Lakes water level fluctuations is probably limited to the first few swales inland from the shoreline. Most of the water occupying the swales of these complexes is of inland lakes and streams.

Because plant communities in these complexes were formed through primary succession from low, Open Dune and Interdunal Wetland communities, the transition from the open shoreline dunes to forested dune ridges is usually gradual (Figure 3). For this reason, where possible, transects were started at the water's edge. Species common to the first swale along the shoreline include the rushes (*Juncus balticus*, *J. pelocarpus*, *J. nodosus*), spike rush, (*Eleocharis acicularis*), and Threesquare (*Scirpus americanus*). This is a very unstable area most often impacted by short-term variation in lake levels. The foredunes of these sites are commonly 1-2 meters high, with Beach grass (*Ammophila breviligulata*), Dune grass (*Calamovilfa longifolia*), Autumn willow (*Salix serissima*), Dune willow (*S. cordata)*, and Balsam poplar (*Populus balsamifera*) most common. Within their ranges, federally threatened Pitcher's thistle (*Cirsium pitcheri*) and state threatened Lake Huron Tansy (*Tanacetum huronense*) are also found on the foredunes. Immediately behind the foredune, where lake-influenced, calcareous sands are most common, a shallow swale often contains Twig-rush (*Cladium mariscoides)*, Sweet gale (*Myrica gale*), Shrubby cinquefoil (*Potentilla fruticosa*), Blue joint grass (*Calamagrostis canadensis*), Kalm's lobelia (*Lobelia kalmii*), False asphodel

FIGURE 3: Aerial photograph of the Grand Traverse Bay Wooded Dune and Swale Complex Illustrating the transition from low, open dunes to regular, forested beach ridges.

(*Tofieldia glutinosa*), and Grass-of-Parnassus (*Parnassia glauca*). Less commonly, in the Straitsarea, federally threatened Houghton's goldenrod (*Solidago houghtonii*) is found in these swales. A low dune field with more advanced plant succession often follows the first few swales. Jack pine (*Pinus banksiana*), White pine (*P. strobus*), and Red pine (*P. resinosa*) often form a scattered overstory canopy, while Ground juniper (*Juniperus communis*), Creeping juniper (*J. horizontalis*), Bear berry (*Arctostaphylos uva-ursi*), Beach grass, and June grass (*Koeleria macrantha*) form a scattered ground layer.

Following the dune field zone, swales are more often forested and soil organic material has often begun to accumulate. Northern white cedar (*Thuja occidentalis*), Speckled alder (*Alnus rugosa*), willows (*Salix spp.*), and Red maple (*Acer rubrum*) dominate the partial overstory canopy and understory. Sedges (*Carex aquatilis*) and (*C. stricta*), Twigrush, Marsh marigold (*Caltha palustris*), Swamp candles (*Lysimachia terrestris*), and Swamp cinquefoil (*Potentilla palustris*) commonly dominate the ground layer where standing water is present through most of the year. In northern Lake Michigan and Lake Huron, where these swales are better drained, and Northern white cedar forms the overstory, federally threatened Dwarf lake iris (*Iris lacustris*) may be found in large non-flowering populations. Dwarf lake iris typically flowers only where windthrows have opened the forest canopy.

Forested beach ridges, with soils of medium to course sand, tend to be dominated by species common to Dry-Mesic and Mesic Northern Forest (MNFI 1990). Soil moisture conditions appear to change dramatically with slight elevational changes and are reflected in the development of soil organic material and plant species. On higher, drier ridges,

soils often have less than 3 cm of organic material. Red pine (*Pinus resinosa*), White pine (*P. strobus*) and Red oak (*Quercus rubra*) often are co-dominant, while Paper birch (*Betula papyrifera*), Bigtooth aspen (*Populus grandidentata*), Balsam fir (*Abies balsamea*), and Red maple are sub-dominant or understory species. Bracken fern (*Pteridium aquilinum*), Black huckleberry (*Gaylussacia baccata*), Blueberry (*Vaccinium myrtilloides*), Bunchberry (*Cornus canadensis*), and Wintergreen (*Gaultheria procumbens*) often dominate the shrub and ground layers. Figures 4a and 4b illustrate this situation at Sturgeon Bay, where high, wind-sorted dune ridges support upland vegetation clearly distinguishable from adjacent swales. On lower ridges, moisture conditions may be markedly improved and soil organic material accumulation is greater (4-25 cm). White pine may still dominate the overstory, but often White spruce, Black spruce, Red maple, Balsam fir, Northern white cedar, and occasionally Tamarack (*Larix laricina*) are co-dominant. Canada honeysuckle (*Lonicera canadensis*), Mountain holly (*Nemopanthus mucronatus*), Twinflower (*Linnaea borealis*), Dwarf blackberry (*Rubus pubescens*), Canada mayflower (*Maianthemum canadensis*), and Starflower (*Trientalis borealis*) dominate the shrub and ground layers. Complexes located in embayments protected from prevailing winds tended to be formed entirely by low, water-lain beach ridges. As a result, most beach ridges within these complexes would be considered wetland in character. Figures 5a and 5b illustrate this situation at Ogontz Bay, where on most of the very low beach ridges, mean wetland coefficients are mostly less than zero.

Because of irregularities in shoreline configuration, sand source, wind strength and direction, and seasonal climatic variation that influenced the deposition of the beach

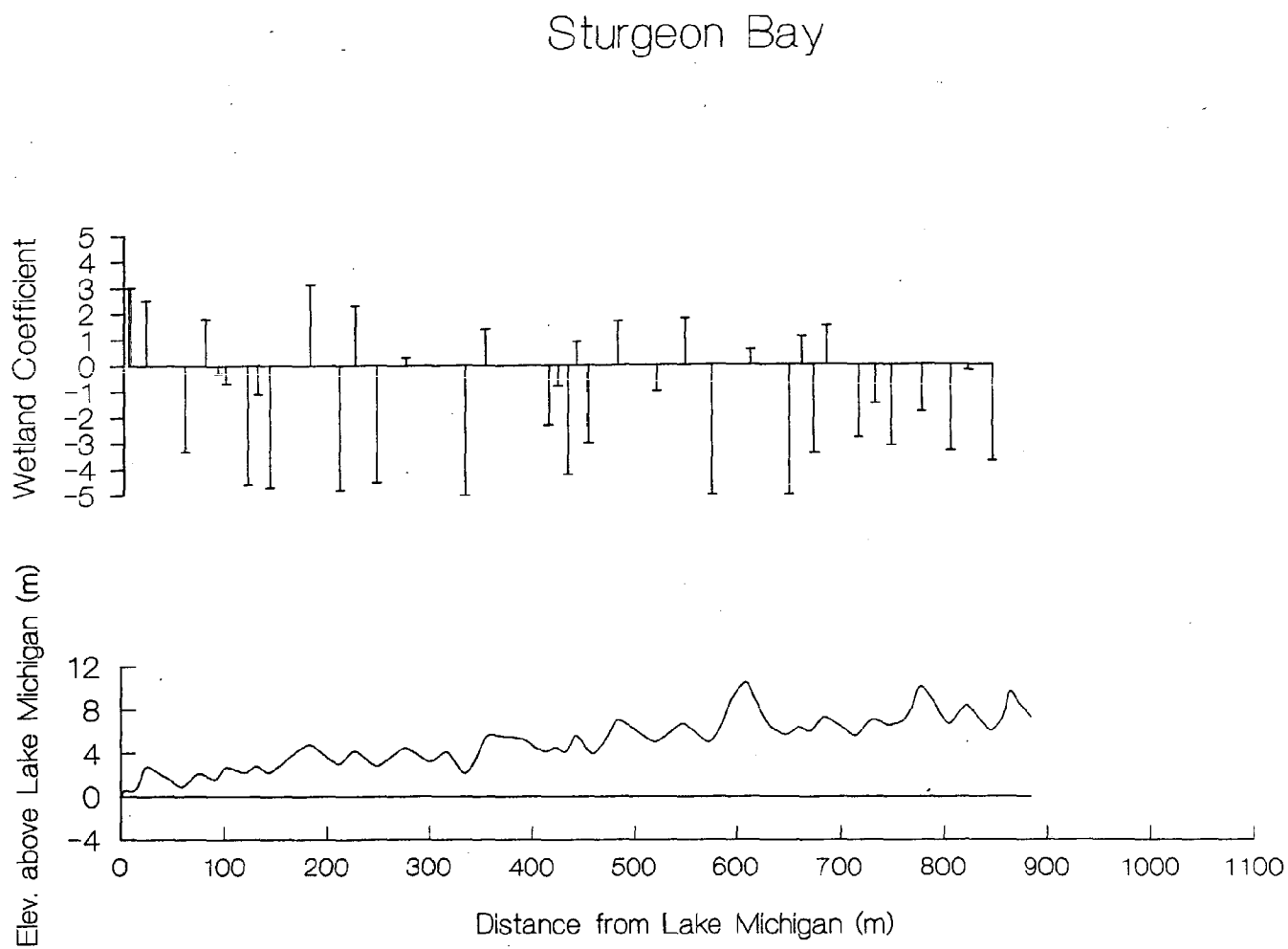


FIGURE 4a: Elevational transect and corresponding Wetland Coefficients for the Sturgeon Bay Wooded Dune and Swale Complex.

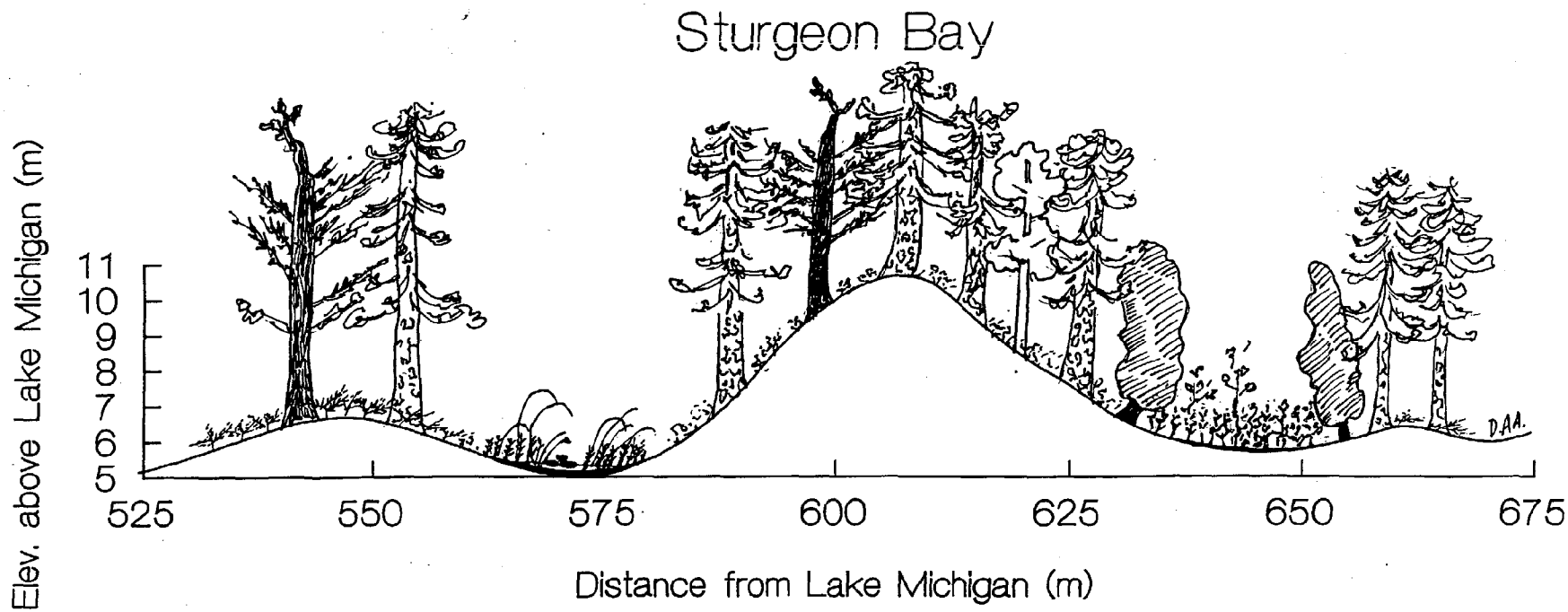


FIGURE 4b: Illustration of the vegetation associated with a 150 meter portion of the transect at Sturgeon Bay.

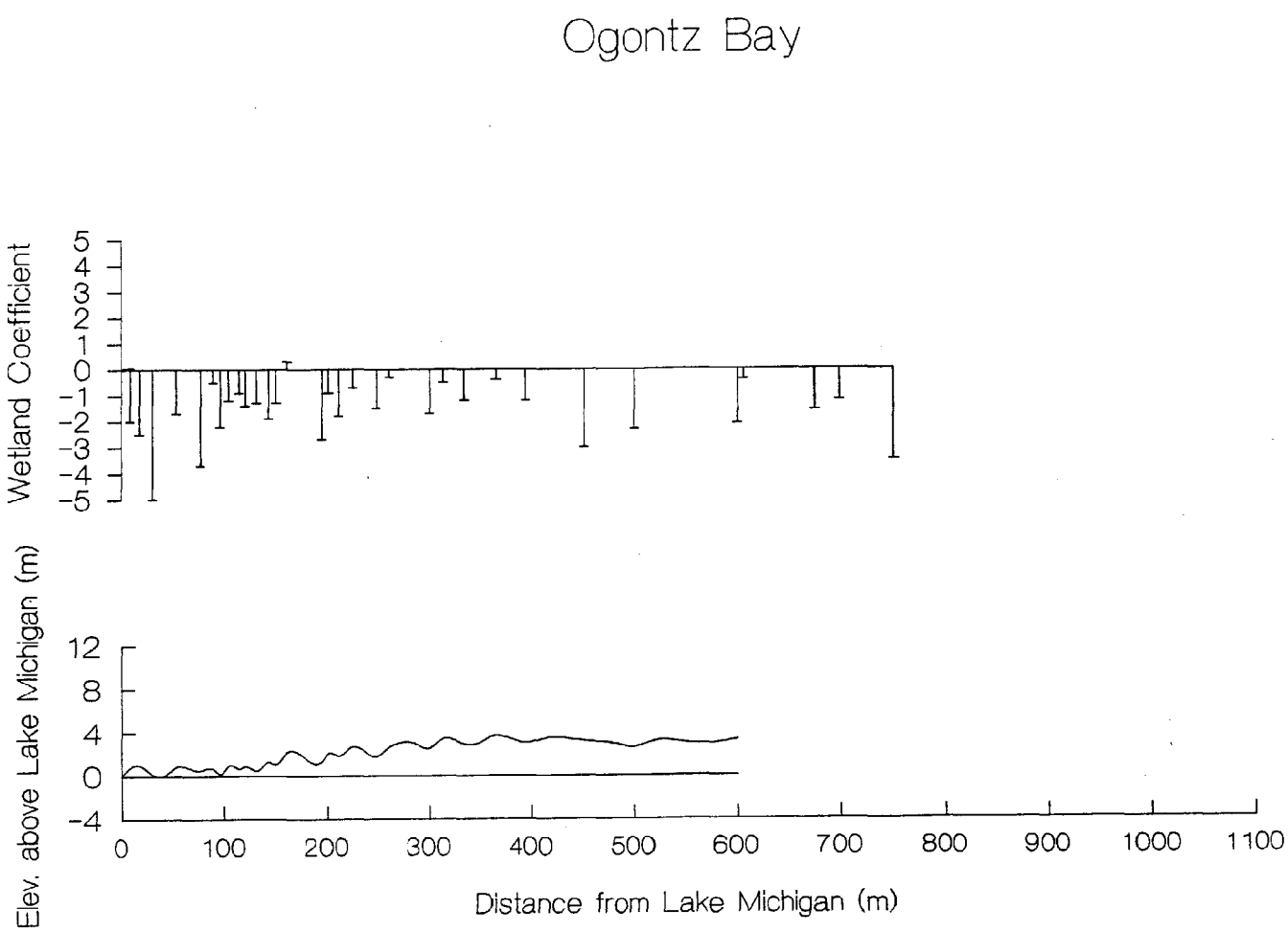


FIGURE 5a: Elevational transect and corresponding Wetland Coefficients for the Ogontz Bay Wooded dune and Swale Complex.

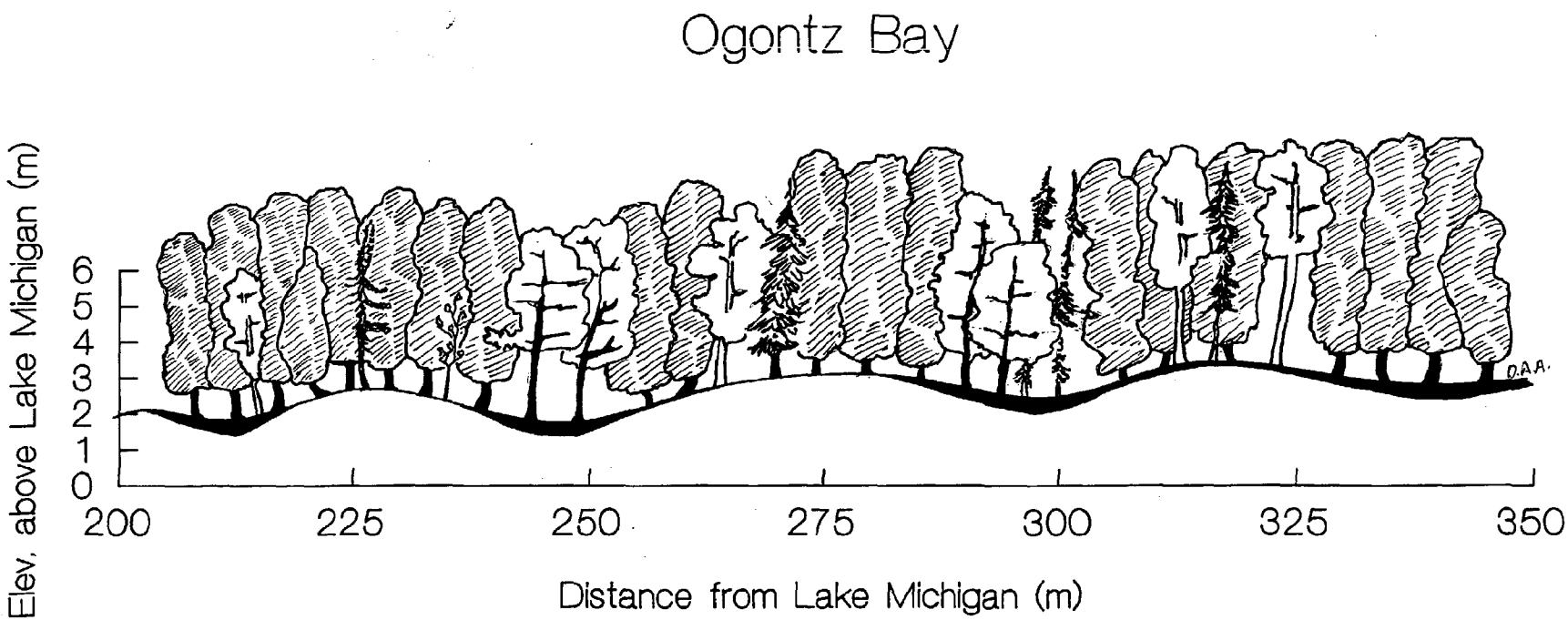


FIGURE 5b: Illustration of the vegetation associated with a 150 portion of the transect at Ogontz Bay.

ridges, no discernable pattern in the width and depth of the adjacent swales was apparentalong the transects from the shoreline inland. Swales ranged from 1-30 m wide and 0.5-3 m deep. Many narrow, shallow swales are forested, with Northern white cedar, Black spruce, and Red maple the most common dominants. Speckled alder and willows commonly dominate the understory and shrub layers. Sedges (*Carex disperma*), (*C. trisperma*), (*C. leptalea*), (*C. interior*), (*C. cryptolepis*), (*C. flava*), (*C. intumescens*), Blue joint grass, Fowl manna grass (*Glyceria striata*), Water horehound (*Lycopus uniflorus*), and Sphagnum mosses (*Sphagnum spp.*) dominate the ground layer. Wider, deeper swales are more often unforested, with Chokeberry (*Aronia prunifolia*), Red osier dogwood (*Cornus stolonifera*), Bog birch (*Betula pumila*), and Speckled alder forming a shrubby ecotone and sedges (*Carex lasiocarpa*), (*C. oligosperma*), (*C. aquatilis*), (*C. stricta*), Woolgrass (*Scirpus cyperinus*), Marsh fern (*Thelypteris palustris*), and Horned bladderwort (*Utricularia cornuta*) dominate the sedge mat. Where sedge mats are not well developed, Bur-reed (*Sparganium minimum*), Pond-lily (*Nuphar variegata*), Pondweeds (*Potamogeton berchtoldii*) and (*P. natans*) are more commonly found.

Reflecting the passage of time and plant succession, a steady, though irregular, increase in soil organic matter accumulation in swales from the shoreline inland was clearly noted along the transects. Often within 300 meters of the water's edge, organic material in swales reached a depth of 30-75 cm. Also, vegetation in swales tended to reflect more acid conditions and peat accumulation increases with distance from the shoreline. Leatherleaf (*Chamaedaphne calyculata*), Bog rosemary (*Andromeda glaucophylla*), Labrador tea (*Ledum groenlandicum*), Bog laurel (*Kalmia polifolia*),

Large cranberry (*Vaccinium macrocarpon*), Cottongrass (*Eriophorum virginicum*), Pitcher-plant (*Sarracenia purpurea*), Sphagnum mosses (*Sphagnum centrale*), (*S. wulfianum*), (*S. warnstorfii*), (*S. magellanicum*), and (*S. squarrosum*) were more commonly found in the swales farthest from the shoreline.

A similar pattern of increased organic matter accumulation exists with complexes located further north along Lake Superior. Figures 6a and 6b illustrate the elevational cross-section of Grand Traverse Bay in Keweenaw County, where very low beach ridges and swales show high levels of organic matter accumulation, moist, acid conditions, and support Bog-like vegetation within a short distance from the shoreline.

A PRELIMINARY CLASSIFICATION OF MICHIGAN WOODED DUNE AND SWALE COMPLEXES

General north-south trends in plant species occurrences were clearly reflected in the upland and wetland components Michigan's Wooded Dune and Swale Complexes. Extremes are in evidence between the complexes along Saginaw Bay, which contain species of southern character, and those of the Keweenaw Peninsula, with a distinctive Boreal character. Along this general north-south trend, complexes were broken into five sub-types based primarily on the processes of beach ridge formation which have resulted in significantly different assemblages of plant species.

A similarity index was utilized to compare all species (vascular plants and mosses) present within each complex with those of all other complexes. The formula used was: SIM (% similarity) = 2C/A+B, where C = the number of species in common, and A and

FIGURE 6a: Elevational transect and corresponding Wetland Coefficients for the Grand Traverse Bay Wooded Dune and Swale Complex.

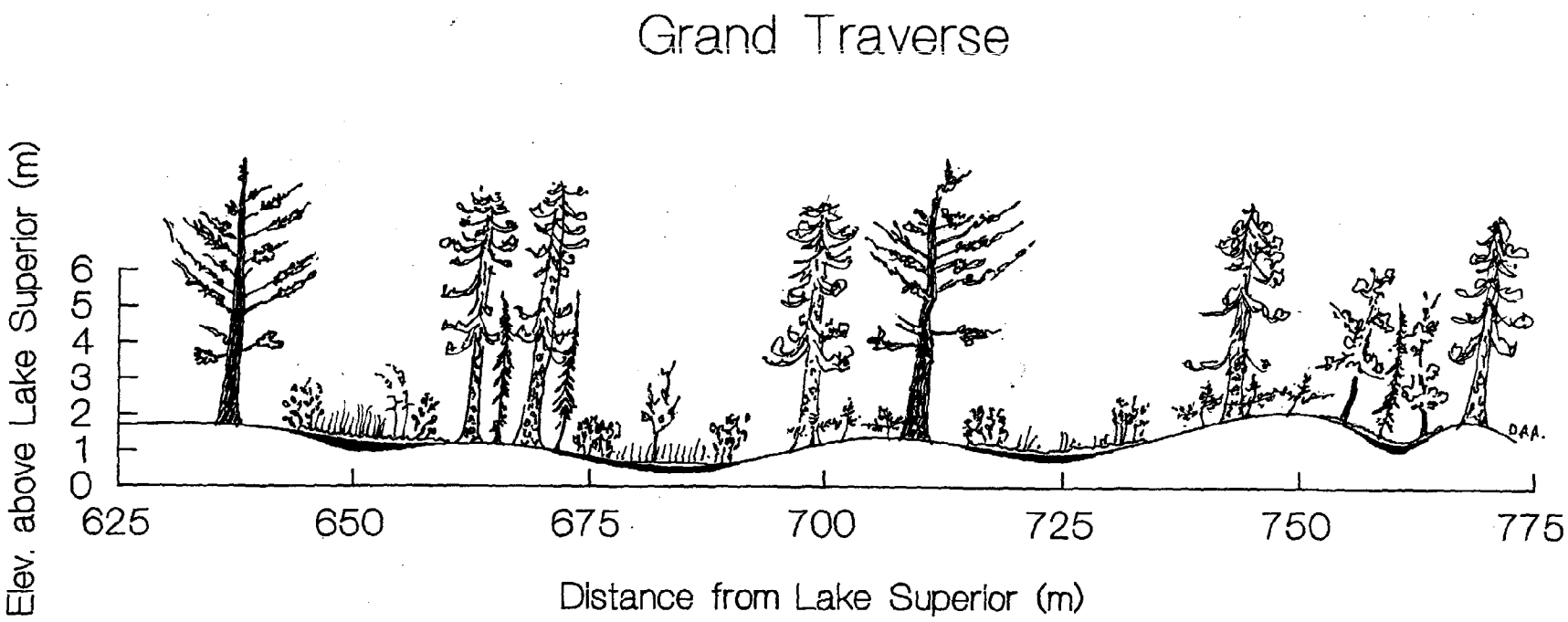


FIGURE 6b: Illustration of the vegetation associated with a 150 meter portion of the transect at Grand Traverse Bay.

B are the number of species in the two compared lists. From the resulting table, a preliminary breakdown of complex sub-types was derived. The five sub-types were named using their general location and landform features responsible for their distinctive vegetation. They include the Southern Lake Huron sub-type, the Northern Lake Huron/Lake Michigan-Low Dune sub-type, the Northern Lake Michigan-High Dune sub-type, the Lake Superior-High Dune sub-type, and the Lake Superior-Low Dune sub-type. Table 2 includes a sub-set of the larger table of similarity indices to illustrate the basic breakdown of Wooded Dune and Swale Complex sub-types.

First, it should be noted that there were relatively low percentages of similar species, even within complexes of each sub-type. This reflects the highly variable nature of these complexes, which is logical given that they are made up of numerous upland and wetland plant communities. Based purely on the analysis of vegetation, it would not be difficult to argue that each one of these complexes is unique.

The general trend of decreasing similarity is clear when comparing the complexes of the Southern Lake Huron sub-type to the other sub-types further north, where the Pointe Aux Barques complex shares 50% of the species with nearby Au Gres, but as little as 19% of plant species with Grand Traverse Bay.

The Southern Lake Huron sub-type was not separated by landform type, primarily because few intact examples exist to be used for that comparison. Within this sub-type, elevations were only taken along the transect at Point Aux Barques. Figure 7 illustrates the change in elevation along that 478 meter transect. Rather abrupt increases in elevations of several beach ridges indicates those that were re-worked by wind prior to

TABLE 2: Similarity Indices of Plant Species from Representative Sites for each Wooded Dune and Swale Complex sub-type using a similarity index.

SUB-TYPE	SITE NAME	SIM									
S. Lake Huron	(A) Pointe Aux Barques	(A)									
S. Lake Huron	(B) Au Gres	50	(B)								
N. Michigan/Huron Low Dune	(C) Crow River	30	31	(C)							
N. Huron/Michigan Low Dune	(D) Ogontz Bay	35	39	48	(D)						
N. Lake Michigan High Dune	(E) Gulliver Dunes	26	28	41	43	(E)					
N. Lake Michigan High Dune	(F) Platte River Point	27	35	42	41	43	(F)				
Lake Superior High Dune	(G) Iron River	28	31	37	34	36	37	(G)			
Lake Superior High Dune	(H) Presque Isle Point	28	41	38	38	36	39	41	(H)		
Lake Superior Low Dune	(I) Au Train Bay	18	20	28	29	40	33	46	32	(I)	
Lake Superior Low Dune	(J) Grand Traverse Bay	19	21	36	32	40	39	48	35	58	(J)

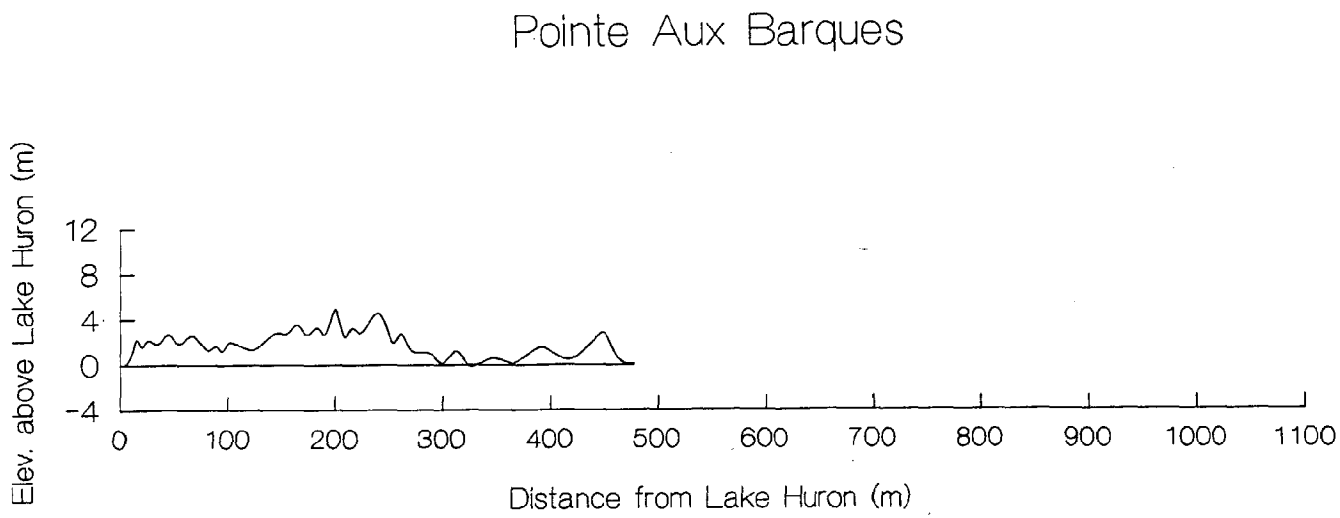


FIGURE 7: Elevational transect for the Pointe Aux Barques Wooded Dune and Swale Complex.

being stabilized by vegetation. This landform type may reflect a relatively slow decreasein lake water levels, when time for sand accumulation from long-shore winds, and dune formation could take place. Further inland, a series of very low, water-lain ridges lie at or just above the current Lake Huron water level. This probably reflects a period of relatively rapid decline in post-glacial lake water levels, which left little time for large beach ridge deposition and wind-sorting.

This sub-type is best distinguished by species of southern character, such as Cottonwood (*Populus deltoides*), Black walnut (*Juglans nigra*), and Buttonbush (*Cephalanthus occidentalis*) which are inter-mixed with other tree and shrub species more common further north.

Complexes within the Northern Lake Huron/Lake Michigan-Low Dune sub-type are commonly found in embayments with little exposure to prevailing westerly winds. As a result, the low beach ridges (0.5-1m) of these complexes are almost entirely water-lain. They generally support wetland vegetation in the swales and on many of the ridges. All complexes along the Northern Lake Huron shoreline fall into this category. Along the Northern Lake Michigan shoreline, complexes of this sub-type are found in portions of Mackinac, Schoolcraft, and Delta counties, where embayments are protected from westerly winds. Because the sandy soils along these shorelines are partly derived from limestones and dolomites of the underlying Niagran Escarpment, plant species associated with moist, calcareous conditions, including Great Lakes endemics such as Houghton's goldenrod and Dwarf lake iris, are most commonly found close to the shoreline. Figures 5a and 5b, in the previous section, illustrate the elevational cross-section at Ogontz Bay,

and is representative of complexes within this sub-type. A detailed listing of vegetation found within the complex at Ogontz Bay is found in Appendix IV. This can be consulted as a representative example of the species composition of the Wooded Dune and Swale Complexes within this sub-type.

The Northern Lake Michigan-High Dune sub-type is distinguished by high, often irregular dune ridges formed as prevailing westerly winds added to and re-sorted the sands of the beach ridges. As a result, clear distinctions can be made between the upland vegetation of the relatively high dune ridges (2-5 m) and the wetland vegetation in the swales. The dune ridges of these complexes tend to be dominated by White pine, Red pine, Red oak, and Paper birch. The swales of these complexes contain the widest variety of plant communities of any of the sub-types. Wetland plant communities include Emergent Marshes, Intermittent wetlands, Bogs, Northern Wet Meadows, as well as Speckled alder-dominated swamps and Northern white cedar-dominated swamps. Wooded Dune and Swale Complexes belonging to this sub-type are most common in Benzie, Leelanau, Emmet, Mackinac, and Schoolcraft counties. Figures 4a and 4b in the previous section illustrate a representative cross-section of elevations and wetland/upland vegetation as it occurs at Sturgeon Bay. Appendix IV contains a detailed listing of species at Sturgeon Bay that can be consulted as a representative of this sub-type.

The complexes along the Lake Superior shoreline are dominated by plant species of distinctly northern character. The Lake Superior-High Dune sub-type is represented by relatively few examples located in Marquette and Luce counties. Only 3 examples of this sub-type were quantitatively sampled for this project. The complexes of this sub-type

generally contain few swales which support wetland vegetation. This is due to well drained conditions resulting from relatively high, wind-sorted dune ridges (1-3 m), and by adjacent rivers that effectively drain off much of the complex. Figure 8 illustrates this situation at Iron River in Marquette County, where although the bottom of one of the first swales lies below current Lake Superior water levels (that swale is an abandoned stream channel), all other swales are high and well drained. These complexes are most often characterized by Dry Northern Forest with Jack pine and Red pine as dominants.

Complexes of the Lake Superior-Low Dune sub-type are generally found along the Lake Superior shoreline where the embayments are not directly exposed to prevailing westerly winds. The resulting low, water-lain beach ridges often support wetland vegetation dominated by White spruce, Black spruce, Tamarack, and Balsam fir. These complexes also contain numerous wet swales with highly acid peatlands and Bog-like vegetation. Figure 6 in the previous section illustrates the elevational cross-section at Grand Traverse Bay, where wetland vegetation dominates many beach ridges as well as the swales. A detailed listing of the vascular plant species found within this representative complex can be consulted in Appendix IV.

In order to further refine this classification of Wooded Dune and Swale Complex sub-types, comparisons could be made between the specific upland and wetland plant communities associated with each complex. The use of the similarity index has significant weaknesses, especially when comparing complexes which vary considerably in the numbers of species present. Multi-variate approaches may also provide a more efficient subdivision of sub-types by formally adding abiotic factors such as soil pH, average water

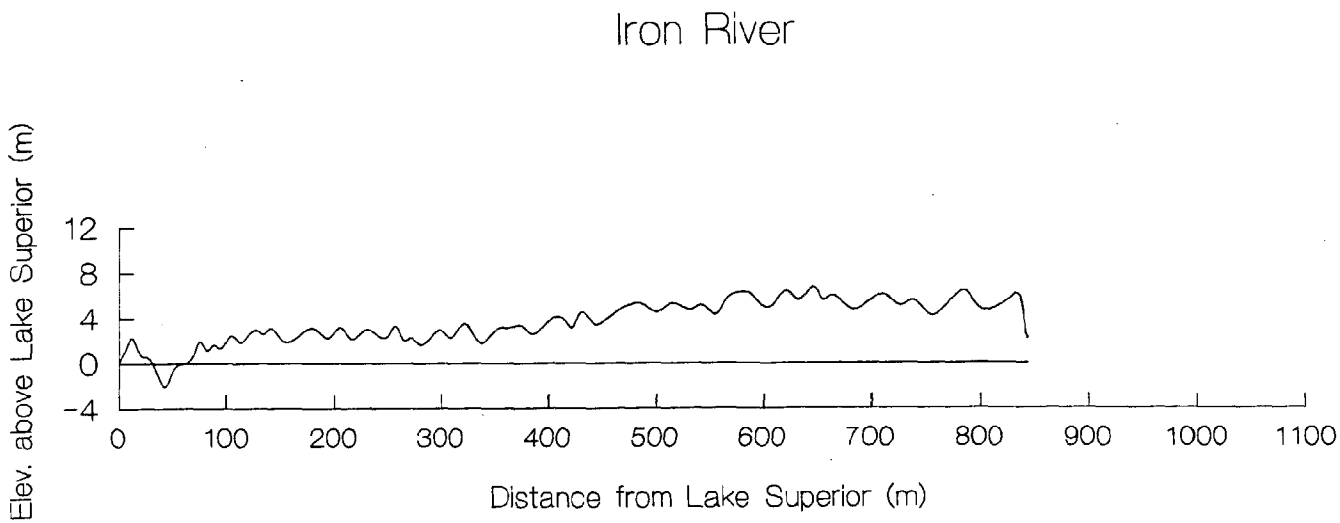


FIGURE 8: Elevational transect for the Iron River Wooded Dune and Swale Complex.

depths, organic matter depths, and beach ridge height to the classification.PROTECTION

STATUS AND PRIORITY RANKS

Land ownership of the highest quality complexes in Michigan is split between federal, state, and private sectors. Four high quality complexes are found within the Sleeping Bear Dunes National Lakeshore. Seven complexes are all or partly included within either the Huron-Manistee or Hiawatha National Forests. Eighteen complexes are all or partly included on State Forest and State Park lands. Three complexes, at Salmon Trout Bay (Marquette County), Pointe Aux Barques (Huron County), and Grass Bay (Cheboygan County) are maintained as private preserves. The eight remaining high quality complexes are found on private lands with no apparent plans for their long term protection.

The following tables (3a through 3e) provide a listing of high quality sites within each Wooded Dune and Swale Complex sub-type ranked in order of protection priority. The mechanism for establishing these ranking priorities does not take current protection plans into account. It does, however, attempt to incorporate significant biological factors and known disturbances into the ranking process. The three factors utilized in determining these priorities include the MNFI Element Occurrence Rank, the total size of the natural remnants of the complex, and the number of species encountered along the sampling transect. The Element Occurrence Rank, whose criteria are detailed in Appendix VI, incorporates significant hydrological alterations and other human-caused disturbances, along with more general characteristics of complex size and species diversity. This is the primary ranking factor in determining the priority list. Second in

TABLE 3a: Ranked Listing of Michigan Wooded Dune and Swale Complexes, Southern Lake Huron.

#	SITE NAME	COUNTY	RANK	ACRES	# SPECIES
1	Pointe Aux Barques	Huron	A	400	154
2	Au Gres	Arenac	BC	2600	100
3	Sleeper State Park	Huron	BC	2100	129
4	Port Crescent	Huron	C	2200	126

TABLE 3b: Ranked Listing of Michigan Wooded Dune and Swale Complexes, Northern Lakes Huron/Michigan - Low Dunes.

#	SITE NAME	COUNTY	RANK	ACRES	# SPECIES
1	Ogontz Bay	Delta	A	2100	150
2	Crow River	Mackinac	A	1600	117
3	Portage Bay	Delta	A	1160	151
4	Epoufette Bay West	Mackinac	A	350	129
5	Thompson	Schoolcraft	AB	9500	165
6	Big Bay de Noc	Delta	AB	7900	111
7	Big Knob Campground	Mackinac	AB	2100	91
8	Seiners Point	Mackinac	AB	1850	94
9	Horseshoe Bay	Mackinac	AB	1400	128
10	Scott Point	Mackinac	AB	800	95
11	Saint Vital Bay	Chippewa	B	960	101
12	Thunder Bay	Alpena	BC	1450	75
13	Black River	Alcona	BC	800	87
14	Crystal River	Leelanau	BC	580	87
15	Hammond Bay	Presque Isle	C	1300	62
16	Negwegon State Park	Alcona/Alpena	C	1000	116
17	Trail's End Bay	Emmet	C	480	53
18	Grass Bay	Cheboygan	C	360	99
19	Bower's Harbor	Grand Traverse	CD	175	50

TABLE 3c: Ranked Listing of Michigan Wooded Dune and Swale Complexes, Northern Lake Michigan - High Dunes.

#	SITE NAME	COUNTY	RANK	ACRES	# SPECIES
1	Pointe Aux Chenes	Mackinac	A	4600	170
2	Platte Bay	Benzie	A	2600	114
3	Platte River Point	Benzie	A	2400	142
4	Sturgeon Bay	Emmet	A	1400	141
5	Gulliver Lake Dunes	Schoolcraft	AB	2300	138
6	Good Harbor Bay	Leelanau	BC	2100	94
7	Big Stone Bay	Emmet	C	360	49

TABLE 3d: Ranked Listing of Michigan Wooded Dune and Swale Complexes, Lake Superior - High Dunes.

#	SITE NAME	COUNTY	RANK	ACRES	# SPECIES
1	Iron River	Marquette	A	880	86
2	Little Presque Isle Point	Marquette	B	600	75
3	Pine River	Marquette	BC	520	29

TABLE 3e: Ranked Listing of Michigan Wooded Dune and Swale Complexes, Lake Superior - Low Dunes.

#	SITE NAME	COUNTY	RANK	ACRES	# SPECIES
1	Salmon Trout Bay	Marquette	A	720	157
2	Grand Traverse Bay	Houghton/Keweenaw	AB	3500	96
3	Tahquamenon Bay	Chippewa	AB	2000	86
4	Oliver Bay	Keweenaw	AB	950	80
5	Little Traverse Bay	Houghton	AB	575	65
6	Flint Steel River	Ontonagon	AB	500	107
7	Au Train	Alger	BC	2800	102

importance for priority ranking is the complex size, which generally corresponds to thecomplexity and diversity of plant communities likely to be found. The third factor, species encountered along the sampling transect, is least significant of these three factors, but may help to identify species-rich complexes among the lower priority sites.

Again, these priority rankings are primarily based on biological criteria, and are meant to provide a guide to state-wide priorities. Actions aimed at providing protection to any of these complexes would, of course, take into account the amount of protection already provided by current ownership and management.

THE UPLAND/WETLAND ECOTONE

Data collected from 9 Wooded Dune and Swale Complexes scattered throughout the state was used to compare plant species located along the upland/wetland ecotone. Presence/absence information from pooled samples taken above the May water levels ("high" samples) was compared using the similarity index with the pooled samples taken from between the May and August water levels ("low" samples). 68% of the species were found in both the "high" and the "low" samples. This shows the value of many plant species for indicating wetland conditions where irregular fluctuations in water levels appear to be the norm. Although 1991-1992 water levels and soil characteristics were not, in all cases, indicative of true wetland conditions, the vegetation most often provided a clear indication of soil moisture content in the recent past.

PLANT SPECIES FREQUENCIES

A total of 631 species of vascular plants, mosses, and algae were found along the transects taken within the Wooded Dune and Swale Complexes during 1991 and 1992. Based on analysis of data collected at 39 complexes, where 470 sample points were taken in areas designated as wetland and 488 sample points were taken in areas designated as upland, species found to be most frequent in the wetlands included: Northern white cedar (*Thuja occidentalis*), Red maple (*Acer rubrum*), Balsam fir (*Abies balsamea*), Speckled alder (*Alnus rugosa*), Northern bugle weed (*Lycopus uniflorus*), Dwarf rasberry (*Rubus pubescens*), Starflower (*Trientalis borealis*), Blue flag (*Iris versicolor*), Fowl manna grass (*Glyceria striata*), Blue joint grass (*Calamagrostis canadensis*), Goldthread (*Coptis trifolia*), Paper birch (*Betula papyrifera*), Marsh fern (*Thelypteris palustris*), Black spruce (*Picea mariana*), and Labrador tea (*Ledum groenlandicum*).

A complete plant list with relative frequencies in both upland and wetland habitats, as well as a list of species ordered by their frequency of occurrence in wetland habitats, is found in Appendix V.

CONCLUSIONS

This inventory helped to demonstrate the diverse nature of the 40 high quality Wooded Dune and Swale Complexes along Michigan's Great Lakes shoreline. The specific geological processes which formed each complex, along with the extent of north-south variation in vegetation patterns, combine to create a diverse array of plant and animal habitats within each complex.

A preliminary classification of Michigan's Wooded Dune and Swale Complexes was established using presence/absence data for species of vascular plants and mosses from each complex. Distinguishing factors for the five complex sub-types include the general north-south trend in plant species distributions, from southern Lake Huron to western Lake Superior, along with the relative impact of wind-sorting vs. water-lain processes which formed the beach ridges of each complex. Complexes with predominantly water-lain beach ridges tended to support more wetland plant communities than complexes where wind-sorted ridges were common.

Elevational transects taken from the shoreline in a number of complexes indicated that, for the most part, the water found in the wet swales of these complexes is of inland origin. In a few examples, the sandy bottoms of the first few swales was found to be at or below the current Great Lakes water level. The relative influence of Great Lakes water level fluctuations on the hydrology of these complexes therefore appears to be limited to these first few swales. However, in many cases, the hydrology of the complex is directly impacted by a river flowing through the complex and into one of the Great Lakes.

Recent human disturbances were found in nearly all of Michigan's complexes. These typically took the form of impacts from the logging era, roads (some major highways) along the shoreline, agricultural drainage, and varying degrees of urban and dispersed residential development. Roads located along individual beach ridges certainly have significant local impacts, but generally have minimal impacts on the vegetation of the entire complex. Impacts on vegetation composition were most apparent where large roads cross over large, wet swales. Smaller roads, with culverts installed, tended to have less of an impact on associated wetland vegetation.

Priorities for actions to protect these complexes should be established by utilizing the preliminary classification as outlined in the previous section. The goals of state-wide protection efforts should be to address the long term threats to the highest quality complexes in each of the five sub-types. This approach attempts to gain protection for the full range of natural diversity found within the complexes of the state. These ranked listings represent the ecological values of each complex. Local considerations of land ownership and current protection efforts can then be taken into account with these ecologically-based priorities in hand.

The protection of these distinctive Great Lakes shoreline features 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. As with all coastal wetlands, these complexes provide an important buffer for maintaining Great Lakes water quality. They provide wetland habitat for waterfowl and fur-bearers, and upland habitat for game and non-game birds and mammals. They

serve as scientific resources for the study of Great Lakes system functions, for baseline data on relatively undisturbed natural systems, and as monitoring sites for environmental degradation. Because of the natural events directly responsible for their formation, these complexes may also be a resource for the study of long-term patterns of climate change. The opportunities to protect the high natural-quality complexes continues to decline each year, especially because many complexes are not currently protected under wetland protection laws and pressure for development along Michigan's shoreline continues to increase. It is therefore imperative that we act now to protect this valuable natural resource for current and future generations.

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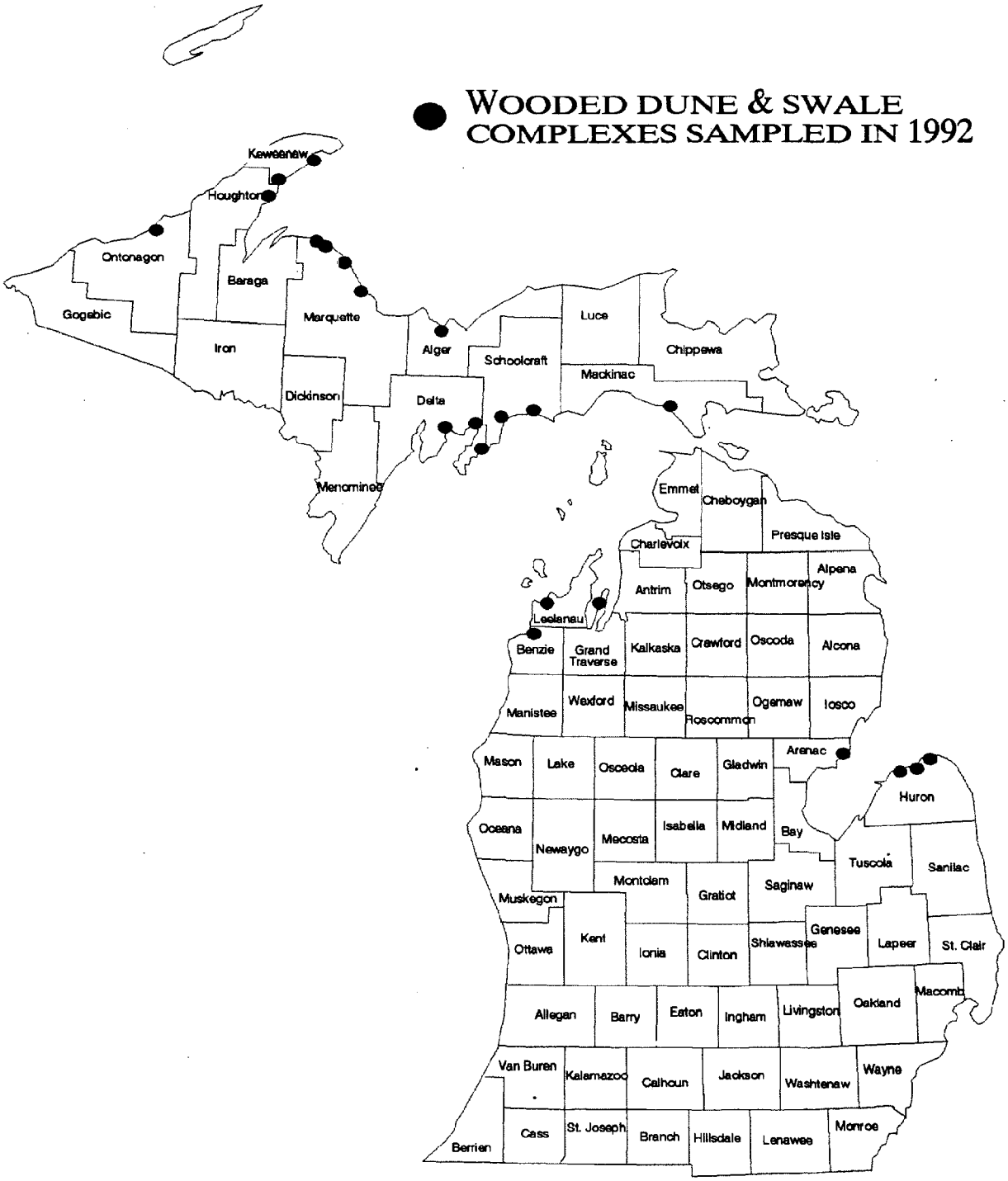
APPENDIX I

SITE SUMMARIES FOR COMPLEXES SAMPLED DURING 1992

WOODED DUNE & SWALE COMPLEXES SAMPLED IN 1992



SITE SUMMARIES

A short discussion follows for each Wooded Dune and Swale Complex that was quantitatively sampled during the 1992 field season. Topographic maps indicating natural-area boundaries and transect locations for each site are found in Appendix II. Data collected for each site are summarized in Tables 4 and 5. Table 4 summarizes geographic, biological, ownership and protection information, while Table 5 lists the special plants, special animals, and high quality natural communities associated with each site.

LAKE HURON

1. Pointe Aux Barques (Huron Co.) The Pointe Aux Barques complex lies just west of the northern tip of Huron County along Lake Huron. The complex is bounded along the south side by a low ridge along Pointe Aux Barques Road, and to the west by the town of Port Austin. The complex comprises approximately 400 acres. Although this area has been logged in the past, no significant disturbances or hydrological alterations were observed.

This complex is characterized by a series of low to moderately high ridges (0.5-4.0 m), with narrow, wet swales (4-20 m wide). Along the transect, the beach ridges reached a maximum elevation of 4.8 m above Lake Huron at a distance of 200 m inland from shore. Beyond this point, elevations steadily declined to only 9 cm above Lake Huron at a distance of 478 m inland from shore. The water source for the swales of this complex appear to be from groundwater flows from further inland. Organic matter depth

TABLE 4: Summary of Location, Acreage, Biological, Ownership, and Comments on Conservation for each complex sampled during 1992.

SITE NAME	COUNTY	RANK	# SPECIES	ACRES	RLE	OWNERSHIP	PROTECTION/MANAGEMENT COMMENTS
1. Pointe Aux Barques	Huron	A	154	400	1E1	Private	Private preserve, no apparent threat.
2. Port Crescent	Huron	C	126	2200	1E1	State Park, County, Private	County establishing preserve, further public acquisition between public tracts recommended.
3. Sleeper State Park	Huron	BC	129	2100	1E1	State Park, Private	Acquisition of tracts west of state park recommended to limit degradation to complex.
4. Au Gres	Arenac	BC	100	2800	2G1	Private	Land use agreements to protect the core of the complex recommended.
5. Platte Bay	Benzie	A	114	2600	2J1	Sleeping Bear Dunes National Lakeshore	Nominated as National Natural Landmark; NPS has plans to develop a marina in several swales. Proposal should be rejected.
6. Crystal River	Leelanau	BC	87	580	2J1	Private, National Lakeshore	Proposed golf course on one private tract; public acquisition of this tract recommended.
7. Bower's Harbor	Grand Traverse	CD	50	175	2K2	Private	Land use agreements in and around complex recommended.
8. Pointe Aux Chenes	Mackinac	A	170	4600	3M1	Hiawatha National Forest	USFS could consider expansion of current Research Natural Area boundaries to include entire complex.
9. Gulliver Lake Dunes	Schoolcraft	AB	138	2300	3M1	State Forest, Private	Public acquisition of additional tracts on east end of the complex strongly recommended.
10. Thompson	Schoolcraft	AB	165	9500	3M1	State Forest, Private	Land use agreements along shoreline, limited timber harvest on state land recommended.
11. Portage Bay	Delta	A	151	1160	3M1	State Forest, Private	State acquisitions of remaining private tracts within complex strongly recommended.
12. Big Bay de Noc	Delta	AB	111	7900	3M1	National Forest, State Forest, Private	Additional public acquisitions or land use agreements along the shoreline should be considered.

RANK = Natural Quality Rank (See Appendix VI)
RLE = Subdistrict of Regional Landscape Ecosystems of Michigan (Albert, et al. 1986)

TABLE 4: Summary of Location, Acreage, Biological, Ownership, and Comments on Conservation for each complex sampled during 1992.

SITE NAME	COUNTY	RANK	# SPECIES	ACRES	RLE	OWNERSHIP	PROTECTION/MANAGEMENT COMMENTS
13. Ogontz Bay	Delta	A	150	2100	3M1	National Forest, Private	No apparent conflicts with current land management.
14. Au Train Bay	Alger	BC	102	2800	3N2	National Forest, Private	Careful land use planning related to Town of Au Train, additional public acquisitions should be considered.
15. Little Presque Isle Point	Marquette	B	75	600	4P1	State Forest, Private	Additional public acquisitions should be considered; timber/recreational management on public land should be maintained at low intensities.
16. Iron River	Marquette	A	86	880	4P1	Private	Recent zoning changes for residential development along the shoreline should be reviewed.
17. Salmon Trout Bay	Marquette	A	157	720	4P1	Private	No apparent conflicts with current land management.
18. Pine River	Marquette	BC	29	520	4P1	Private	No apparent conflicts with current land management.
19. Little Traverse Bay	Houghton	AB	65	575	4T1	Private	Public acquisition of large private tracts should be considered.
20. Grand Traverse Bay	Houghton/ Keweenaw	AB	96	3500	4T1	Private	Public acquisitions along the shoreline recommended.
21. Oliver Bay	Keweenaw	AB	80	950	4T1	Private	Public acquisitions along the shoreline recommended.
22. Flint Steel River	Ontonagon	AB	107	500	4S2	Private	Public acquisitions along the shoreline recommended.

RANK = Natural Quality Rank (See Appendix VI)
RLE = Subdistrict of Regional Landscape Ecosystems of Michigan (Albert, et al. 1986)

TABLE 5: Special Plants, Special Animals, and High Quality Natural Communities Associated with Wooded Dune and Swale Complexes Sampled in 1992.

SITE NAME	SPECIAL PLANTS	SPECIAL ANIMALS	NATURAL COMMUNITIES
Pointe Aux Barques		*Haliaeetus leucocephalus*	
Port Crescent	*Cirsium pitcheri*		
Sleeper State Park	*Cirsium pitcheri*		Oak-Pine Barrens
Au Gres	*Cirsium pitcheri*		
Platte Bay	*Cirsium pitcheri* *Cypripedium arietinum* *Orobanche fasciculata* *Pterospora andromedea*	*Haliaeetus leucocephalus*	
Crystal River		*Acris crepitans blanchardii*	
Pointe Aux Chenes	*Calypso bulbosa* *Cirsium pitcheri* *Lycopodium appressum* *Solidago houghtonii* *Stellaria longipes*		Great Lakes Marsh Patterned Peatland
Gulliver Lake Dunes	*Cirsium pitcheri* *Pterospora andromedea* *Solidago houghtonii* *Stellaria longipes* *Tanacetum huronense*	*Charadrius melodus*	
Thompson	*Calypso bulbosa* *Carex albolutescens* *Cirsium pitcheri* *Iris lacustris* *Solidago houghtonii* *Stellaria longipes* *Tanacetum huronense*		
Portage Bay	*Iris lacustris*		
Big Bay de Noc	*Lycopodium selago*	*Haliaeetus leucocephalus*	
Ogontz Bay	*Ranunculus laponicus*	*Haliaeetus leucocephalus* *Pandion haliaetus*	
Au Train Bay		*Charadrius melodus*	Great Lakes Marsh
Little Presque Isle Point	*Pterospora andromedea*		
Iron River		*Haliaeetus leucocephalus*	
Salmon Trout Bay		*Haliaeetus leucocephalus*	
Pine River	*Armoracia aquatica* *Elymus mollis* *Salix pellita*	*Haliaeetus leucocephalus* *Martes americana*	
Grand Traverse Bay	*Crataegus douglasii*		
Oliver Bay	*Epilobium palustre*		
Flint Steel River		*Haliaeetus leucocephalus*	

in the swales ranged from 3 cm to 52 cm. Significant fluctuations (up to 42 cm) in swale water depths were recorded between May and August visits. Soil PH, for both sandy substrate and organic soils ranged between 5.64 and 6.03.

A mature, closed canopy of Red oak (*Quercus rubra*), Red maple (*Acer rubrum*), Paper birch (*Betula papyrifera*), and Big tooth aspen (*Populus grandidentata*) dominated the ridges. Eastern hemlock (*Tsuga canadensis*) and American beech (*Fagus grandifolia*) were also common on the beach ridges. Prior to European settlement, the beach ridges of this complex contained more hemlock and White pine (*Pinus strobus*) than exist today. Black ash (*Fraxinus nigra*) and Cottonwood (*Populus deltoides*) dominated many of the swales. Red maple, Paper birch, Northern white cedar (*Thuja occidentalis*), Red ash (*Fraxinus pennsylvanica*), Buttonbush (*Cephalanthus occidentalis*), Blue flag (*Iris virginica*), and Reed canary grass (*Phalaris arundinacea*) were also common in the swales. Many other swales, being shaded entirely by adjacent mature upland forest contained few herbaceous species. A total of 154 species of vascular plants and mosses were noted along the transect. A federally threatened Bald eagle (*Haliaeetus leucocephalus*) nest was discovered along the shoreline during this survey.

A similar, albeit smaller, complex occurs just east of this area in section 22. Sandstone cliffs are located just northeast of this complex along the shoreline. This area is managed as a natural area by Pointe Aux Barques Inc.

2. Port Crescent (Huron Co.) Located 5 miles west of Port Austin, the complex at Port Crescent contains the eastern half of a twelve mile-long series of complexes which

extend over to Caseville. The Pinnebog River forms much of the southern boundary of the 2200 acre complex, then cuts through to Lake Huron at the eastern end of the complex at Port Crescent State Park. M-25 cuts across this complex from east to west, as do several other unpaved roads. Many homes have been built throughout the shoreline area. The transect was taken in section 7, within the Wilderness Arboretum, owned by Huron County.

Beach ridges within this complex were generally low (0.5-1.0 m), with swales ranging from 7 to 40 m in width. Although elevations were not taken along this transect, it appears that the adjacent Pinnebog River is the source of water for the swales of this complex. organic matter depth in the swales varied considerably (10-90 cm) generally increasing with distance from the lake shore. PH of organic matter and sandy substrate within the swales ranged from 5.94 to 6.28. Water depth in the swales, measured only in August, ranged from 2 to 38 cm.

Prior to European settlement, this complex contained more White pine (*Pinus strobus*) and Eastern hemlock (*Tsuga canadensis*) than remain today. Beach ridges area now dominated by Red oak (*Quercus rubra*), Paper birch (*Betula papyrifera*), Red maple (*Acer rubrum*), and Black cherry (*Prunus serotina*). The swales are dominated by Red maple, Black ash (*Fraxinus nigra*), Cottonwood (*Populus deltoides*), Red-osier dogwood (*Cornus stolonifera*), Buttonbush (*Cephalanthus occidentalis*), Michigan holly (*Ilex verticillata*), Blue joint grass (*Calamagrostis canadensis*), and Fowl manna grass (*Glyceria striata*). Federally threatened Pitcher's thistle (*Cirsium pitcheri*) is found within this complex along the Pinnebog River near the Lake Huron shoreline. A total of

126 species of vascular plants and mosses were noted along the transect.

Intensive shoreline development and road construction have significantly altered the character of much of this complex. Long term protection efforts should include acquisition of private tracts between the Huron County park and the Port Crescent State Park. Opportunities may still exist to establish a permanent link between these two natural areas and maintain the overall natural integrity of this upland/wetland complex.

3. Albert E. Sleeper State Park (Huron Co.) This 2100 acre complex is located just west of the complex at Port Crescent, and is partially included within the Sleeper State Park. It is bounded to the southeast by glacial Lake Nipissing beach ridge and Rush Lake, and to the southwest by agricultural development. It is bisected by State Park Road and M-25 in several places. The transect was placed just west of the state park campground.

The beach ridges of this complex are low (0.5-1 m), with swales ranging from 3 to 48 m in width. Organic matter depth in the swales ranges from 5 to 117 cm deep, generally increasing with distance from the shore. PH of organic and and subsoils from the swales ranged from 5.19 to 5.94. Water depths in the swales varied from 2 to 55 cm deep when measured in August.

Prior to European settlement, more White pine (*Pinus strobus*) was probably present in this complex than appears today. There were also Oak-pine Barrens on a number of higher beach ridges along the shoreline, and along the glacial Lake Nipissing beach ridge. Today, Red oak (*Quercus rubra*), Black oak (*Quercus velutina*), and Big

tooth aspen (*Populus grandidentata*), dominate the beach ridges. Red pine (*Pinus resinosa*), Red maple (*Acer rubrum*) and Paper birch (*Betula papyrifera*) also dominate the ridges. Swales are dominated by Black ash (*Fraxinus nigra*), Red maple, and Big tooth aspen. Speckled alder (*Alnus rugosa*), Red-osier dogwood (*Cornus stolonifera*), Lake sedge (*Carex lacustris*), Blue joint grass (*Calamagrostis canadensis*), Pond sedge (*Dulichium arundinaceum*), and Marsh fern (*Thelyptris palustris*). A total of 129 species of vascular plants and mosses were noted along the transect. Federally threatened Pitcher's thistle (*Cirsium pitcheri*) occurs along the shoreline of this complex.

Observations along State Park Road indicated that, although culverts were not placed under the road at every swale, the impact of the road on the vegetation of the swales did not appear to extend a great distance from the road (10-15 m). This suggests that ground water flow under and through the beach ridges may play a more significant influence on vegetation than lateral, surface flow in each swale of this complex.

As already noted, significant portions of this complex are included within the state park. State acquisition of additional tracts to the west in sections 19, 24 and 25 is recommended to stem further degradation of this complex.

4. Au Gres (Arenac Co.) This 2800 acre complex is located in eastern Arenac County, three miles east of the town of Au Gres. It is bisected by US-23 and Delano Road. Much of the Lake Huron shoreline of this complex is intensively developed for residential housing. A golf course is now located at the northeast end of the complex. Cleared agricultural land forms the north and west boundaries of the complex, above the

glacial Lake Nipissing beach ridge. This complex is contained entirely on private land. The transect was taken north of US-23 in section 10.

This complex is characterized by low beach ridges (0.5-1 m) and numerous wet swales. Swales average 16 m in width, varying from 3 to 119 m. Organic matter depths in the swales ranged from 10 to 80 cm. August water depths in the swales varied from 2 to 10 cm, with many saturated at the surface. Soil and organic matter pH in the swales ranged from 4.58 to 5.60.

Prior to European settlement, this complex was dominated by Red pine (*Pinus resinosa*), White pine (*Pinus strobus*), Northern white cedar (*Thuja occidentalis*), and Yellow birch (*Betula allegheniensis*). Red maple (*Acer rubrum*), Paper birch (*Betula papyrifera*), and Red oak (*Quercus rubra*), Black cherry (*Prunus serotina*), and Red ash (*Fraxinus pennsylvanica*) dominate the ridges today. Swales are dominated by cedar, Paper birch, Black ash (*Fraxinus nigra*), Big tooth aspen (*Populus grandidentata*), and American elm (*Ulmus americana*). Other common species in the swales area Sensitive fern (*Onoclea sensibilis*), Speckled alder (*Alnus rugosa*), Lake sedge (*Carex lacustris*), willow (*Salix eriocephala*), False nettle (*Boehmeria cylindrica*), Fowl manna grass (*Glyceria striata*), and Lady fern (*Athyrium filix-femina*). A total of 100 species of vascular plants and mosses were noted along the transect. Federally threatened Pitcher's thistle (*Cirsium pitcheri*) is found along the shoreline at Lookout Point, at the eastern edge of this complex.

Shoreline development, highways, and agricultural drainage have all degraded this complex. However, the central core of the complex remains relatively intact. Easements,

land use agreements, or public acquisition should be considered for long term protection of this complex.

LAKE MICHIGAN

5. Platte Bay (Benzie Co.) This 2600 acre complex lies entirely within the Sleeping Bear Dunes National Lakeshore. It is bounded on the east and south by high parabolic dunes and M-22. Peterson Road, Lasso Road, and a park campground represent the only disturbances in this complex. The transect was taken from the shoreline in section 23.

Elevations were not taken along this transect, but the wind-sorted beach ridges and swales clearly lie above the Lake Michigan water levels. The beach ridges are generally quite high, ranging from 2 to 15 m high. Swale widths vary considerably, from 3 to 45 m wide; averaging 19 m in width. Organic matter depth in the swales ranged from 2 to 73 cm; averaging 24 cm in depth. Most swales were either dry or saturated at the surface during August. In wet swales, water depths ranging from 2 to 5 cm. PH of organic and sub-soils from the swales ranged between 6.13 and 6.54.

Prior to European settlement, this complex was dominated by more Red pine and White pine than occurs today. Wetland communities currently found in this complex probably reflect the presettlement condition. Today, Jack pine (*Pinus banksiana*), Red pine (*Pinus resinosa*), White pine (*Pinus strobus*), White oak (*Quercus alba*), Red oak (*Quercus rubra*), and Big tooth aspen (*Populus grandidentata*) dominate the beach ridges. The swales tend to be open marshes with Northern manna grass (*Glyceria borealis*), Blue joint grass (*Calamagrostis canadensis*), sedge (*Carex pseudo-cyperus*),

Water knotweed (*Polygonum amphibium*), Marsh fern (*Thelyptris palustris*), and Water parsnip (*Sium suave*). A total of 114 species of vascular plants and mosses were encountered along the transect.

One federally threatened Bald eagle (*Haliaeetus leucocephalus*) nest is located within this complex. Federally threatened Pitcher's thistle (*Cirsium pitcheri*) is also found along the shoreline of this complex. State threatened Fascicled broom-rape (*Orobanche fasciculata*), Pine-drops (*Pterospora andromedea*), and state special concern Rams head lady's-slipper (*Cypripedium arietinum*) are all found within this complex.

This complex has been proposed for designation as a National Natural Landmark, along with the adjacent complex to the southwest. More recently National Park Service proposals called for the development of a marina in the swales of this complex. This latter proposal would undoubtedly result in significant degradation to this portion of the National Lakeshore, and should be strongly discouraged.

6. Crystal River (Leelanau Co.) Located at Glen Arbor, this 580 acre complex lies between Glen Lake and Lake Michigan, with the Crystal River flowing through, and between the beach ridges. County road 875 cuts across the complex, and several other roads pass along several beach ridges. Intensive residential and commercial development occurs at Glen Arbor, along the north shore of Glen Lake, and on the Lake Michigan shoreline. Portions of the complex are part of the Sleeping Bear Dunes National Lakeshore. A transect was taken on National Lakeshore property in section 23.

The beach ridges of this complex are generally low, ranging from 0.5 to 1 m high.

Swales in this complex are somewhat wide, ranging from 9 to 59 m wide; averaging 39 m. Organic matter depth in the swales is quite variable, from 8 to 150 cm. The pH of the organic matter and sub-soils from the swales ranged from 5.91 to 6.31. Most swales in August were saturated, with standing water (5 cm deep) in just one swale.

Prior to European settlement, this complex probably contained more White pine (*Pinus strobus*) and Eastern hemlock (*Tsuga canadensis*) than it does today. Today, hemlock and White pine are still abundant on the low ridges and in the swales, but Northern white cedar (*Thuja occidentalis*) and American ash (*Fraxinus americana*) are dominant, along with Tamarack (*Larix laricina*), Balsam fir (*Abies balsamea*) and Red maple (*Acer rubrum*). Alder buckthorn (*Rhamnus alnifolia*), Swamp rose (*Rosa palustris*), Northern bugle weed (*Lycopus uniflorus*), sedge (*Carex leptalea*), and Small bishop's cap (*Mitella nuda*) are all abundant in the swales. A total of 87 species of vascular plants and mosses were noted along the transect. State special concern Blanchard's cricket frog (*Acris crepitans blanchardi*) has been found in and around the Crystal River within this complex.

Road construction and residential development have caused significant degradation to this complex. However, remaining undeveloped portions retain a high natural quality. Recent proposals to develop a golf course within this complex would clearly cause significant degradation to the complex as a whole. Other more suitable locations for the golf course can and should be found.

7. Bower's Harbor (Grand Traverse Co.) This 175 acre complex is located

9 miles north of Traverse City along the west side of the Mission Peninsula. The complex is bounded in the east and south by cleared agricultural land and Peninsula Drive. Neah-Ta-Wanta Road, and a number of homes are along the shoreline. This complex is contained entirely on private land. No transect was taken within this complex, but previous visits by MNFI staff were used for characterization purposes.

The beach ridges of this complex are generally low (0.5-1 m high) with narrow swales most common. Organic matter within the swales varies in depth, reaching a maximum of 40 cm. PH of the organic matter from the swales was 6.70.

Red pine (*Pinus resinosa*), Eastern hemlock (*Tsuga canadensis*), and White pine (*Pinus strobus*) are dominant on the ridges, similar to the presettlement condition. Northern white cedar (*Thuja occidentalis*), Black ash (*Fraxinus nigra*), and Paper birch (*Betula papyrifera*) are dominant in the forested swales. Northern manna grass (*Glyceria borealis*), sedge (*Carex stricta*), Buttonbush (*Cephalanthus occidentalis*), sedge (*Carex aquatilis*), and Water knotweed (*Polygonum amphibium*) are found in the swales. A total of 50 species of vascular plants was noted within this complex.

Given the small size of this complex, additional adjacent parcels would need to be acquired in order to secure the long-term viability of the complex as a natural area.

8. Pointe Aux Chenes (Mackinac Co.) Located at Pointe Aux Chenes Bay, this area comprises 4600 acres when combined with the extensive adjacent complex north of the Pointe Aux Chenes marshes. It is bounded in the east by a series of high parabolic dunes, and in the north by Round Lake and Brevoort Lake. The Brevoort River passes

through the complex, draining Brevoort Lake into Lake Michigan. US-2 runs along the shoreline of this area, and Brevoort Lake Road passes through the complex in several places. Several power line corridors and natural gas pipelines also pass through this complex. Nearly all of the complex is located within the Hiawatha National Forest. The transect was taken from US-2 in section 9 (T41N R5W).

This complex is located behind several very high dunes running parallel to the shoreline. Behind this point, the beach ridges were moderate in height (1-3 m high). Swales varied from 3 to 43 m in width; averaging 22 m wide. Organic matter in the swales was deep, averaging 61 cm. PH of the organic matter and sub-soils within the swales ranged from 4.81 to 5.31. In August, most swales were either saturated, or contained standing water, which varied in depth from 5 to 30 cm.

Presettlement vegetation of this complex was a combination of White pine (*Pinus strobus*), Eastern hemlock (*Tsuga canadensis*), and northern hardwoods on the ridges, with Emergent marsh, Northern white cedar (*Thuja occidentalis*), Tamarack (*Larix laricina*), and Black spruce (*Picea mariana*) in the swales. Today, these species remain abundant, with Paper birch (*Betula papyrifera*), Big tooth aspen (*Populus grandidentata*), and Red ash (*Fraxinus pennsylvanica*) in addition. Also abundant in the swales are Speckled alder (*Alnus rugosa*), Small bur reed (*Sparganium minimum*), Leatherleaf (*Chamaedaphne calyculata*), Michigan holly (*Ilex verticillata*), sedges (*Carex lasiocarpa*),(*Carex trisperma*), and Blue flag (*Iris versicolor*). Federally threatened Pitcher's thistle (*Cirsium pitcheri*) is found throughout the open dunes along this shoreline. Within the complex, federally threatened Bald eagles (*Haliaeetus*

leucocephalus), and state threatened Osprey (*Pandoin haliaetus*) nest. Also, state threatened Calypso (*Calypso bulbosa*), and Appressed clubmoss (*Lycopodium appressum*), along with state special concern Stichwort (*Stellaria longipes*) are known to occur within the complex. Several high quality natural communities, including Great Lakes marsh and Dry-Mesic Northern Forest are associated with this complex. A total of 170 vascular plants and mosses were noted along this transect.

Much of the eastern end of this complex is within a designated Research Natural Area, as administered by the Hiawatha National Forest. Expansion of the RNA boundaries could be considered to provide for the long-term viability of this entire complex.

9. Gulliver Lake Dunes (Schoolcraft Co.) This 2300 acre complex is located just south of Gulliver Lake, six miles east of Manistique. It is bounded to the north by the lake, US-2, and County Road P432. Homesite development has taken place along much of the shoreline in the western half of the complex. The eastern end of the complex is included within the Lake Superior State Forest. The transect was taken on private land, just west of the State Forest land, in section 12.

Because this stretch of shoreline faces a southwesterly direction, strong prevailing winds have re-sorted the sands of the beach ridges, forming somewhat high (3-4 m), irregular dune ridges. Parabolic dunes are common in the northeastern end of this complex. Swales in this complex vary considerably in width, from 3 to 76 m; averaging 15 m. Organic matter depths in the swales varied considerably from one swale to another (3 to 98 cm); averaging 32 cm. PH of the swale organic matter and sub-soils

5.45 to 5.69. During August, most swales were dry or saturated at the surface. Several swales (at approximately 440 m from the shoreline) had up to 48 cm of standing water.

Prior to European settlement, this complex contained White pine (*Pinus strobus*), Paper birch (*Betula papyrifera*), and Eastern hemlock (*Tsuga canadensis*) on the high beach ridges, with Northern white cedar (*Thuja occidentalis*), Black spruce (*Picea mariana*), and Balsam fir (*Abies balsamea*) dominant in the swales. Today, Red pine (*Pinus resinosa*), White pine, Red oak (*Quercus rubra*), Paper birch, and Red maple (*Acer rubrum*) are dominant on the ridges. Cedar is the dominant tree species in the swales. Many of the swales of this complex contain Emergent Marshes and Intermittent Wetlands. Other common species in the swales include Aquatic bulrush (*Scirpus subterminalis*), Blue joint grass (*Calamagrostis canadensis*), Common marsh spikerush (*Eleocharis smallii*), Speckled alder (*Alnus rugosa*), Small bur reed (*Sparganium minimum*), Thin grass (*Agrostis perennans*), and Swamp thistle (*Cirsium muticum*). A total of 138 species of vascular plants and mosses were noted along the transect.

Federally endangered Piping plovers (*Charadrius melodus*) are known to nest along this stretch of shoreline. Federally threatened Pitcher's thistle (*Cirsium pitcheri*), and Houghton's goldenrod (*Solidago houghtonii*), state threatened Lake Huron tansy (*Tanacetum huronense*) and Pine-drops (*Pterospora andromedea*), and state special concern Stichwort (*Stellaria longipes*) are all found along the shoreline of this complex.

As already noted, much shoreline development has taken place in this rather large complex. Observations in the field during sampling indicated that much more development in the eastern half of the complex could be taking place in the near future.

Given the high quality nature of this complex, it should be considered of high priority for the state to acquire much more of the eastern half of the complex.

10. Thompson (Schoolcraft Co.) This 9500 acre complex, clearly one of the largest in the state, is located just west of Manistique. It is bounded on the northwest by Indian Lake. The Indian River passes through the northeast end of the complex, and it is drained at the south end by Thompson Creek. US-2 passes along the shoreline, and railroad tracks and County Road P442 also bisect this complex. Urban development from the west side of Manistique extends into this complex. Approximately one third of the complex is contained within the Superior State Forest, where a State Fish Hatchery is located. The transect was taken from the shoreline south of Stony Point.

High beach ridges in this complex are limited to the shoreline area. Further inland, the beach ridges are generally 0.5 to 2 m high. Swales vary in width from 13 to 100 m; averaging 34 m. Organic matter depth in the swales varies from 2 to over 175 cm; averaging 25 cm. PH of the swale organic matter and sub-soils ranged between 4.17 and 5.05. In August, most swales were saturated at the surface. Maximum depths of standing water in the swales was 10 cm.

Presettlement vegetation of this complex was predominantly spruce, (*Picea spp.*), Balsam fir (*Abies balsamea*), and Northern white cedar (*Thuja occidentalis*), White pine (*Pinus strobus*), and Eastern hemlock (*Tsuga canadensis*). Today, cedar, hemlock, White pine, Red pine (*Pinus resinosa*), Big tooth aspen (*Populus grandidentata*), Black spruce (*Picea mariana*), and Red maple (*Acer rubrum*) dominate the low beach ridges. Cedar,

Paper birch (*Betula papyrifera*), Black ash (*Fraxinus nigra*), and Balsam fir (*Abies balsamea*) dominate the swales. Also common in the swales are Sweet bay (*Myrica gale*), Michigan holly (*Ilex verticillata*), Downy yellow violet (*Viola rostrata*), Leatherleaf (*Chamaedaphne calyculata*), False mayflower (*Smilacina trifolia*), and numerous Sphagnum mosses (*Sphagnum spp.*). A total of 165 species of vascular plants and mosses were encountered along the transect.

Federally threatened Houghton's goldenrod (*Solidago houghtonii*), Pitcher's thistle (*Cirsium pitcheri*), Dwarf lake iris (*Iris lacustris*), and state threatened Lake Huron tansy (*Tanacetum huronense*), and state special concern Stichwort (*Stellaria longipes*) occur along this shoreline. State threatened Calypso (*Calypso bulbosa*) and state special concern Greenish-white sedge (*Carex albolutescens*) are also found within this complex.

Development along the shoreline appears to be accelerating to the west of Manistique. Several clearcuts were also encountered on both ridges and swales within the state forest lands. Care should be taken to avoid large clearcuts within this complex. consideration should also be given to state acquisition of additional tracts along US-2.

11. Portage Bay (Delta Co.) This 1160 acre complex is located 3 miles southeast of Garden along the east side of the Garden Peninsula. It is bounded on the north by Goldmine Road, and to the west by agricultural land. No development has taken place along this shoreline, as much of it being contained in the Lake Superior State Forest. The transect was taken from the shoreline in section 22.

Elevations measured along this transect indicated a rapid rise to nearly 4 m above

Lake Michigan water levels within 23 m of the shoreline. By 138 m from shore, elevations had gradually declined to their lowest level of 49 cm above the lake levels. Elevations steadily increased from this point to just over 5 m at a distance of 448 m from the shoreline. Ridges were 0.5-1.0 m in height. Swales varied in width from 5 to 36 m; averaging 10 m. Organic matter depths in the swales varied from 10 to 41 cm in depth; averaging 22 cm. PH of swale organic matter and sub-soil varied from 5.92 to 6.36. In August, most swales were saturated at the surface. Those with standing water measured from 15 to 25 cm in depth.

Prior to European settlement, this complex was dominated by White pine (*Pinus strobus*), Northern white cedar (*Thuja occidentalis*) and Tamarack (*Larix laricina*). Today, Balsam fir (*Abies balsamea*), White pine, Red pine (*Pinus resinosa*), and Paper birch (*Betula papyrifera*) are dominant on the beach ridges. Northern white cedar, Balsam fir, Paper birch, White spruce (*Picea glauca*), and Black spruce (*Picea mariana*) dominate the swales. Also common in the swales are False mayflower (*Smilacina trifolia*), Alder buckthorn (*Rhamnus alnifolia*), Goldthread (*Coptis trifoliata*), Speckled alder (*Alnus rugosa*), Labrador tea (*Ledum groenlandicum*), and sedge (*Carex eburnea*). A total of 151 species of vascular plants and mosses were encountered along the transect. A very large population of federally threatened Dwarf lake iris (*Iris lacustris*) occurs throughout the shoreline portion of this complex.

Recent road construction was observed on private land at the northeast end of this complex. Several recent clearcuts were also noted on State Forest land. Because of the high quality and sensitive nature of this complex, timber harvesting should be excluded

from state-owned portion. Additional state acquisitions along this extremely sensitive and high quality shoreline should be seriously considered.

12. Big Bay de Noc (Delta Co.) This 7900 acre complex is located approximately 12 miles west of Manistique at the northeast end of the bay. Both Fishdam River and the Little Fishdam River drain this large complex. US-2 passes through the complex, then along the shoreline. The Soo Line railroad tracks also cut across this area. Several homes are located close to the shoreline. Most of the land included within this area lies on either the Hiawatha National Forest or the Lake Superior State Forest. The transect was located in section 34.

Beach ridges within this complex are generally low to moderate in height (1-2 m). Swales vary considerably, but this complex includes the widest swales encountered during this study, ranging from 5 to 145 m wide. organic matter in the swales varied from 5 to 75 cm in depth. PH of the swale organic matter and sub-soils varied from 5.51 to 5.73. During August, water in the swales varied from saturated conditions to 7 cm of standing water.

Prior to European settlement, White pine (*Pinus strobus*), Red pine (*Pinus resinosa*), and Eastern hemlock (*Tsuga canadensis*) dominated the beach ridges. Northern white cedar (*Thuja occidentalis*), and Tamarack (*Larix laricina*) dominated the swales. Today, White pine, Red pine, and White spruce (*Picea glauca*) are dominate many of the ridges. The large swales contain shrub swamps and scattered Tamarack. Also common in the swales are Leatherleaf (*Chamaedaphne calyculata*), Bog birch (*Betula*

pumila), Speckled alder (*Alnus rugosa*), Labrador tea (*Ledum groenlandicum*), Small cranberry (*Vaccinium oxycoccos*), Black chokeberry (*Aronia prunifolia*), and sedge (*Carex stricta*). A total of 111 species of vascular plants and mosses were encountered along this transect.

Federally threatened Bald eagle (*Haliaeetus leucocephalus*) nests are located at the southwest and southeast extremes of the complex. A high quality Great Lakes marsh is located at the southwest end of the complex, at the mouth of the Fishdam River. State special concern Fir clubmoss (*Lycopodium selago*) is also found within this complex. As noted above, most of this complex is contained within public lands. Additional acquisitions along the shoreline could be considered to ensure the long-term viability of this complex.

13. Ogontz Bay (Delta Co.) This 2100 acre complex is located eight miles east of Rifle River. It is drained by the Ogontz River, which enters Lake Michigan at the west end of the bay. The area is bounded in the north by US-2 and the Soo Line railroad tracks, and to the east by County Road 499. Nearly all of the complex falls within the lands managed by the Hiawatha National Forest. The transect was taken from the shoreline in section 10.

The beach ridges of this complex are generally low (0.5-1.0 m). Measured elevations indicated that none of the swales were below Lake Michigan water levels, although several were fewer than 6 cm above lake level. Elevations gradually increased to 3.28 m at a distance of 600 m from the shoreline. Most of this complex, including

swales and ridges, is classified as wetland. Organic matter varied from 8 to 107 cm in depth; averaging 36 cm. PH of swale organic matter and sub-soil varied between 5.58 and 5.92. Both in June, and again in August, most swales were saturated, with 45 cm of standing water in only one swale, 31 m from the shoreline.

The presettlement vegetation of this complex appears to have been quite similar to what is found today, with Northern white cedar (*Thuja occidentalis*), White spruce (*Picea glauca*), Black spruce (*Picea mariana*), Paper birch (*Betula papyrifera*), and Tamarack (*Larix laricina*) dominant. Also common are Goldthread (*Coptis trifoliata*), Balsam fir (*Abies balsamea*), Three-seeded sedge (*Carex trisperma*), Creeping snowberry (*Gaultheria hispidula*), Small bishop's cap (*Mitella nuda*), Bunchberry (*Cornus canadensis*), and Ground pine (*Lycopodium annotinum*). A total of 150 species vascular plants and mosses were encountered along the transect.

Federally threatened Bald eagles (*Haliaeetus leucocephalus*) and state threatened Osprey (*Pandion haliaetus*) nest at the west end of this complex. State threatened Lapland buttercup (*Ranunculus laponicus*) is also found within this complex.

As already noted, most of this complex is located within National Forest lands. Current management does not appear to be in conflict with the long-term viability of this complex.

LAKE SUPERIOR

14. Au Train Bay (Alger Co.) This 2800 acre complex is located 9 miles west of Munising. The Au Train River snakes through this complex from the southeast extreme,

entering Lake Superior at the along the northeast end. The town of Au Train is built on top of this complex about 1/4 mile inland from the shoreline. M-28 and the Soo line railroad pass across the complex from east to west, cutting across a number of wet swales. A Number of tracts, along the south and west sides of the complex are included within the Hiawatha National Forest. The transect was located on public land in section 32, between M-28 and the railroad tracks.

The beach ridges of this complex are generally low to moderate in height (0.5-1.5 m). Swales vary in width from 2 to 32 m. Organic matter depth in the swales varied from 3 to 235 cm; averaging 68 cm. PH of swale organic matter and sub-soils ranged from 4.25 to 5.20. August water levels in the swales varied from saturated at the surface to 30 cm deep; averaging 5 cm.

Prior to European settlement, White pine (*Pinus strobus*), Red pine (*Pinus resinosa*), and Jack pine (*Pinus banksiana*) dominated the ridges, with Northern white cedar (*Thuja occidentalis*), and spruce (*Picea spp.*) in the swales. The large Great Lakes marsh noted by surveyors along the banks of the Au Train River remains today. The dominant tree species noted by the original land surveys are also present today. Red pine, Jack pine, White pine, Red oak (*Quercus rubra*), and White spruce (*Picea glauca*) dominate the beach ridges today. Black spruce (*Picea mariana*) and a number of shrubs dominate many of the Bog-like swales. Other species common in the swales are Leatherleaf (*Chamaedaphne calyculata*), Sweet gale (*Myrica gale*), Bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), Mountain holly (*Nemopanthus mucronata*), Large cranberry (*Vaccinium macrocarpon*), Running bog sedge (*Carex*

oligosperma), Slender woolly sedge (*Carex lasiocarpa*), and Flat-leaved bladderwort (*Utricularia intermedia*). A total of 102 species of vascular plants and mosses were encountered along the transect.

Federally endangered Piping plovers (*Charadrius melodus*) have been known to nest along shoreline of this complex. As noted earlier, a high quality Great Lakes marsh is located along the Au Train River within this complex. Many of the wet swales of this complex are directly connected to the river.

Current management of public and private lands, apart from the growth of the community of Au Train, does not appear to be in conflict with the long-term viability of this complex. However, additional public acquisitions should be considered, and careful land use planning is clearly called for within and around the town of Au Train.

15. Little Presque Isle Point (Marquette Co.) This 600 acre complex is located five miles northwest of Marquette, immediately west of Little Presque Isle. It is bounded along the south and east by Harlow Creek. County Road 550 passes through the complex along a beach ridge about 1/4 mile inland from the shoreline. Ownership of the complex is split between the state of Michigan (Escanaba River State Forest), and Clark properties. The transect was taken from the shoreline to the county road on the private tract in section 13.

Elevations taken along this transect, indicated a rapid rise above Lake Superior water levels. A maximum elevation along the transect of 5.25 m was reached at a distance of 201 m from the shoreline. The only moist swales along this transect, at

distances over 200 m from shore, were between 2.50 and 3.00 m above lake levels. Swale widths ranged from 3 to 19 m. Organic matter depth in the moist swales varied from 18 to 85 cm; averaging 39 cm deep. PH of swale organic matter and sub-soils ranged from 3.92 to 4.43. None of the swales held standing water, either in June or in August. Swales with organic matter accumulation and wetland vegetation had saturated soils at a average depth of 45 cm below the surface.

Prior to European settlement, this complex was dominated by Red pine (*Pinus resinosa*), White pine (*Pinus strobus*), Eastern hemlock (*Tsuga canadensis*), Northern white cedar (*Thuja occidentalis*), and Red maple (*Acer rubrum*). Today, significantly less hemlock, and much more Paper birch (*Betula papyrifera*), Red oak (*Quercus rubra*) are found within the complex. Red pine, White pine, and Balsam fir (*Abies balsamea*) remain as common species within the complex. Most swales within this complex are dry, containing upland vegetation. The few that contain wetlands are characterized as shrub swamps dominated by Speckled alder (*Alnus rugosa*), Leatherleaf (*Chamaedaphne calyculata*), Michigan holly (*Ilex verticillata*), Meadow sedge (*Carex stricta*), swollen sedge (*Carex intumescens*), sedge (*Carex vesicaria*), and Blue joint grass (*Calamagrostis canadensis*). A total of 75 species were noted along the transect. State special concern Pine-drops (*Pterospora andromedea*) was found within this complex.

Current management of the private portion of this complex does not appear to be in conflict with it's long-term viability. On state forest lands, timber management and recreational activities, if maintained at low intensity levels, would also be compatible with the natural values of this complex.

16. Iron River (Marquette Co.) This 880 acre complex is located three miles east of Big Bay. It is bounded in the southwest by Independence Lake. The Iron River winds through the complex, entering Lake Superior at it's northeast end. The complex is almost entirely owned by one private landowner. The transect was taken from the shoreline to the river in sections 18 and 13.

The elevations measured along the transect indicated that the sandy bottom of the first large swale lies just over 2 m below current Lake Superior water levels. This is partly due to the fact that this swale is an abandoned the river bottom of the Iron River. Beyond this first swale, elevations steadily increase through a series of ridges and dry swales to an elevation of 6.67 m above Lake Superior at a distance of 648 m from the shoreline. The Iron River was reached along the transect 840 m from the shoreline at an elevation of 2.07 m above Lake Superior. Swale widths varied from 3 to 43 m. Organic matter depth in the first large swale was 205 cm. Only one other swale could be considered a wetland, with organic matter accumulated to 5 cm. PH of swale organic matter and sub-soils varied from 4.33 to 4.97. The two wet swales were saturated at the surface both in June and August.

Prior to European settlement, this complex was dominated by Red pine (*Pinus resinosa*) and White pine (*Pinus strobus*), with an extensive Great Lakes marsh along the Iron River. Today, Jack pine (*Pinus banksiana*) is much more prevalent than in the presettlement condition, although Red pine and White pine remain present. Red oak (*Quercus rubra*) and Big tooth aspen (*Populus grandidentata*), and Paper birch (*Betula papyrifera*) are also common in the overstory. The large, wet swale is predominantly a

shrub swamp, with portions very Bog-like in character, dominated by Speckled alder (*Alnus rugosa*), Sweet gale (*Myrica gale*), Leatherleaf (*Chamaedaphne calyculata*), Michigan holly (*Ilex verticillata*), Bog laurel (*kalmia polifolia*), and willow (*Salix pedicellaris*). A total of 86 species of vascular plants and mosses were encountered along the transect. Federally threatened Bald eagles (*Haliaeetus leucocephalus*) have been known to nest within this complex.

Recently local zoning authorities proposed zoning the shoreline of this complex for residential uses. The stability of the narrow first beach ridge is clearly unsuitable for the construction of permanent structures. The fragmentation of this complex for residential development would also cause severe degradation to the area, as habitat for Bald eagles.

17. Salmon Trout River (Marquette Co.) This 720 acre complex is located approximately 35 miles northwest of Marquette, 3 miles north of Big Bay. Both the Salmon Trout River and Sullivan Creek pass through and drain this complex. The Salmon Trout River splits into a number of smaller streams as it passes through the complex in section 31. Although the upland portions of the complex may have experienced some logging at the turn of the century, the remainder is virtually pristine. This complex is entirely included within the Huron Mountain Club. The transect was taken from the shoreline in section 31.

Elevations taken along the transect indicate that the sandy bottoms of most of the swales lie as much as 4.63 m below current Lake Superior water levels. Depths of the

Salmon Trout River close to its mouth were not taken, but it is apparently quite deep as it enters Lake Superior, to enable it to drain this low complex. Only the first beach ridge along the entire 600 m elevational transect was measured as being above the Lake Superior levels. Organic matter in the swales of this complex varied between 15 and 152 cm deep. PH of swale organic matter ranged between 4.30 and 5.56. Water levels in the swales varied between 8 and 152 cm. Several swales were dry (presumably well above lake levels) near the end of the 900 m long vegetation transect.

The vegetation of this complex reflects what was encountered by the land surveyors in the 1850's, with Red pine (*Pinus resinosa*), White pine (*Pinus strobus*), White spruce (*Picea glauca*), Red maple (*Acer rubrum*), and Paper birch (*Betula papyrifera*) dominant on the ridges. Many of the swales are dominated by shrub swamps, with Speckled alder (*Alnus rugosa*), Michigan Holly (*Ilex verticillata*), Leatherleaf (*Chamaedaphne calyculata*), Sweet gale (*Myrica gale*), Red ash (*Fraxinus pensylvanica*), Black ash (*Fraxinus nigra*), Blue joint grass (*Calamagrostis canadensis*), Meadow sedge (*Carex stricta*), sedge (*Carex rostrata*), and Blue flag (*Iris versicolor*). A total of 157 species of vascular plants and mosses were encountered along the vegetation transect. Two active Bald eagle (*Haliaeetus leucocephalus*) nests are located within this complex.

Current management of this complex appears to ensure its long term viability as a natural area.

18. Pine River (Marquette Co.) This 520 acre complex is located approximately

40 miles northwest of Marquette. It is bounded on the southwest by Pine Lake. The Pine River winds through the complex, emptying into Lake Superior. This tract is entirely included within the Huron Mountain Club. A number of unpaved roads and seasonal residences are located within this complex. The transect was taken from the shoreline in section 22.

The beach ridges of this complex are 1-3 m high, with swales ranging from 1 to 10 m wide. All swales along the transect were dry, with upland vegetation. Organic matter depths in the dry swales varied from 1 to 3 cm deep. The pH of the organic matter and sub-soil ranged from 3.73 to 3.82.

The presettlement vegetation of this complex was similar to that found today, with Red pine (*Pinus resinosa*) and Jack pine (*Pinus banksiana*) dominating. other common species found along the transect included Huckleberry (*Gaylussacia baccata*), Bracken fern (*Pteridium aquilinum*), Low-bush blueberry (*Vaccinium angustifolium*), Cow wheat (*Melampyrum lineare*), Trailing arbutus (*Epigaea repens*), Pennsylvania sedge (*Carex pensylvanica*), and Ground cedar (*Lycopodium tristachyum*). Being the least species-rich complex sampled, only 29 species were encountered along the transect.

Federally threatened Bald eagles (*Haliaeetus leucocephalus*) are known to nest within this complex. State threatened Lake cress (*Armoracia aquatica*) and state special concern Satiny willow (*Salix pellita*) are known to occur in or near Pine Lake. State special concern American dune wild-rye (*Elymus mollis*) is found along the shoreline of this complex. And finally, state threatened Marten (*Martes americana*) has been seen within the complex.

Much of the housing for members of the Huron Mountain Club is concentrated along the Pine River near the shoreline. Given the limited nature of this residential development, no obvious threats to the long-term viability of this complex were observed.

19. Little Traverse Bay (Houghton Co.) This 575 acre complex is located 6 miles northeast of Portage Lake. It is bounded to the north by Rice Lake and several small county roads. Mud Lake is located just west of the complex, and Mud Lake Creek passes through the complex. Several homes are located along the county road which enters the complex on the southwest end, and passes along the shoreline. The transect was taken in section 20.

The beach ridges of this complex are generally low (0.5-1.0 m high), with wide, wet swales between (3 to 56 m wide). Organic matter depth in the swales ranged from 20 to 80 cm; averaging 38 cm. PH of swale organic matter and sub-soils varied from 3.72 to 4.20. In August, nearly all swales were saturated at the surface, with 3 cm of standing water in just one swale.

The presettlement vegetation of this complex appears to have been similar to what was noted along the transect, with a Great Lakes marsh and Northern Shrub Swamp at the confluence of Mud Lake Creek and the creek running from Little Rice Lake. Red pine (*Pinus resinosa*), Black spruce (*Picea mariana*), and Paper birch (*Betula papyrifera*). Scattered Black spruce and White pine (*Pinus strobus*) dominate many of the swales. Also common in the Bog-like swales are Leatherleaf (*Chamaedaphne calyculata*), Bog laurel (*Kalmia polifolia*), Black chokeberry (*Aronia prunifolia*), Labrador tea (*Ledum*

groenlandicum), Bog rosemary (*Andromedea glaucophylla*), Large cranberry (*Vaccinium macrocarpon*), Running bog sedge (*Carex oligosperma*), sedge (*Carex exilis*), Blue joint grass (*Calamagrostis canadensis*), and numerous Sphagnum mosses (*Sphagnum spp.*). A total of 65 species of vascular plants and mosses were encountered along this transect.

The subdivision and homesite development along this shoreline may create a long-term threat to the viability of this complex. State acquisition of parcels northeast of current homesites could be considered.

20. Grand Traverse Bay (Keweenaw Co.) This 3500 acre complex is located 3 miles south of Gay. The town of Traverse Bay is located along the shoreline at the northern end of the complex. The Traverse River passes through the complex from the northwest. A small creek also flows through the complex between Deer Lake and Lake Superior. Rice Lake, and a county road form the western boundary of the complex. Another road extends along the shoreline at the south end of the complex, where numerous homesites are located. The transect was taken from the shoreline on a private tract in section 16.

The beach ridges of this complex are generally low (0.5 to 1.0 m high). Elevation measurements from the shoreline indicated a rapid rise to 3 m above Lake Superior water levels at a distance of 26 m from the shoreline. At a distance of 400 m from the shoreline, elevations of the sandy swale bottoms declined to 10 cm <u>below</u> current Lake Superior water level. That particular swale was probably deepened as a stream bottom at some point in the past. From that point on, to a distance of 1084 m from the

shoreline, elevations steadily increase to 4 m above lake water levels. Organic matter depth in the swales ranged from 20 to 122 cm; averaging 42 cm. PH of swale organic matter and sub-soils varied between 4.61 to 5.49. Most swales were saturated during visits in both June and August. In August, 6 to 12 cm of standing water was measured in several swales.

Prior to European settlement, both White pine (*Pinus strobus*) and Red pine (*Pinus resinosa*) were found on the beach ridges. Today, Jack pine (*Pinus banksiana*) is dominant on the beach ridges along the shoreline. White pine was not encountered along the transect as an overstory tree on the beach ridges. Scattered Black spruce (*Picea mariana*) and occasionally, Tamarack (*Larix laricina*) were dominant in Bog-like swales. Other species common in the swales include Sweet bay (*Myrica gale*), Leatherleaf (*Chamaedaphne calyculata*), Bog birch (*Betula pumila*), Speckled alder (*Alnus rugosa*), Bog rosemary (*Andromedea glaucophylla*), Bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), willow (*Salix pedicellaris*), Running bog sedge (*Carex oligosperma*), Blue joint grass (*Calamagrostis canadensis*), Blue flag (*Iris versicolor*), Pitcher plant (*Sarracenia purpurea*), and numerous species of Sphagnum mosses (*Sphagnum spp.*). A total of 96 species of vascular plants and mosses were encountered along the transect. State special concern Douglas's hawthorn (*Crataegus douglasii*) occurs along the shoreline just south of the town of Traverse Bay.

Mine tailings dumped into Lake Superior at Gay extend along the shoreline at the northern end of this complex. Homesite development appears to be an increasing along the shoreline at the south end of the complex. A camp and firing range is located along

the county road near Rice Lake. State acquisition of shoreline parcels is recommended, given the size and quality of this complex.

21. Oliver Bay (Keweenaw Co.) This 950 acre complex is located just southeast of Lac La Belle at Point Isabelle. A series of small, post-glacial embayments, extending inland up to 1100 m from the shoreline, formed around Point Isabelle, depositing an irregular series of beach ridges. A County road passes along the shoreline of this complex, along which several homes are located. The transect was taken from the road inland in section 15 at Oliver Bay.

The beach ridges of this complex are generally low (0.5-0.75 m high). Swales of this complex vary considerably in width, from 2 to 56 m wide; averaging 44 m. Measurements of organic matter in the swales ranged from 28 to 102 cm; averaging 63 cm deep. PH of swale organic matter and sub-soils varied between 4.11 and 4.58. In August, most swales were saturated at the surface. Those swales with standing water had between 2 and 6 cm in August.

The original land surveys of this complex in the 1850's indicated tree species similar to those encountered today along the transect. Balsam fir (*Abies balsamea*), Black spruce (*Picea mariana*), and White pine (*Pinus strobus*) dominate the low beach ridges, while scattered Tamarack (*Larix laricina*) and Paper birch (*Betula papyrifera*) dominate the swales. Other species common in the Bog-like swales are Labrador tea (*Ledum groenlandicum*), Creeping snowberry (*Gaultheria hispidula*), Leatherleaf (*Chamaedaphne calyculata*), Bog laurel (*Kalmia polifolia*), False mayflower (*Smilacina*

trifolia), Three-seeded sedge (*Carex trisperma*), Goldthread (*Coptis trifoliata*), Graceful bog sedge (*Carex limosa*), and (*Cornus canadensis*). A total of 80 specie were encountered along the transect. State special concern Marsh willow-herb (*Epilobium palustre*) is found within this complex.

Although some logging activity has occurred historically throughout this tract, the extent of significant human caused disturbance to this complex is limited to the shoreline. However, numerous FOR SALE signs observed along this stretch of shoreline indicate the future subdivision of the larger private tracts. The vast majority of this area is clearly wetland, but there remains the possibility of homesite development on numerous beach ridges. The long-term viability of this complex would be best secured through public acquisition of tracts within this complex.

22. Flint Steel River (Ontonagon Co.) This 500 acre complex is located 4 miles northeast of the Ontonagon along a narrow stretch of shoreline, extending only 400-500 m inland on average. The Flint Steel River and Fire Steel River cut through the complex at its north end. The Flint Steel River bends around, forming the east and southeast boundary of the complex. A road built on an old narrow-gage railway right-of-way extends the entire length of the complex along a beach ridge 225 m inland from the shoreline. This road provides access for a number of shoreline cottages.

Beach ridges in this complex are moderate in height, ranging from 0.5 to 2.0 m high. Elevations measured along the transect indicated a rise in elevation from the shoreline inland. The lowest point along the transect, at 135 meters from the shoreline,

the sandy bottom of a large swale lies 21 cm above current Lake Superior water level. Beyond that point elevations steadily increase to a maximum of 11.89 m above lake level at a distance of 463 m from the shoreline. Wet swales were common along the transect up to a distance of 200 m from the shoreline. Swales ranged from 2 to 47 m in width; averaging 11 m wide. Organic matter in the swales varied in depth from 13 to 117 cm; averaging 38 cm deep. PH of swale organic matter and sub-soils ranged from 4.23 to 4.67. No standing water was recorded in the swales, either in June or in August. Most swales were moist or saturated at the surface in June.

The vegetation, as noted in the original land surveys, is similar to that found today along the transect. The beach ridges are dominated by White pine (*Pinus strobus*), Red pine (*Pinus resinosa*), Eastern hemlock (*Tsuga canadensis*), Red maple (*Acer rubrum*), Paper birch (*Betula papyrifera*), White spruce (*Picea glauca*), and Big tooth aspen (*Abies balsamea*). The swales, mostly Bog-like in character, are dominated by Leatherleaf (*Chamaedaphne calyculata*), Speckled alder (*Alnus rugosa*), Michigan holly (*Ilex verticillata*), and Bog rosemary (*Andromedea glaucophylla*). Other common species include Large cranberry (*Vaccinium macrocarpon*), Running bog sedge (*Carex oligosperma*), Round-leaved sundew (*Drosera rotundifolia*), Pond sedge (*Dulichium arundinaceum*), beak rush (*Rhynchospora fusca*), Rattlesnake grass (*Glyceria canadensis*), and Northern manna grass (*Glyceria borealis*). A total of 107 species of vascular plants and mosses were encountered along the transect. Two federally threatened Bald eagle (*Haliaeetus leucocephalus*) nests are located within this complex.

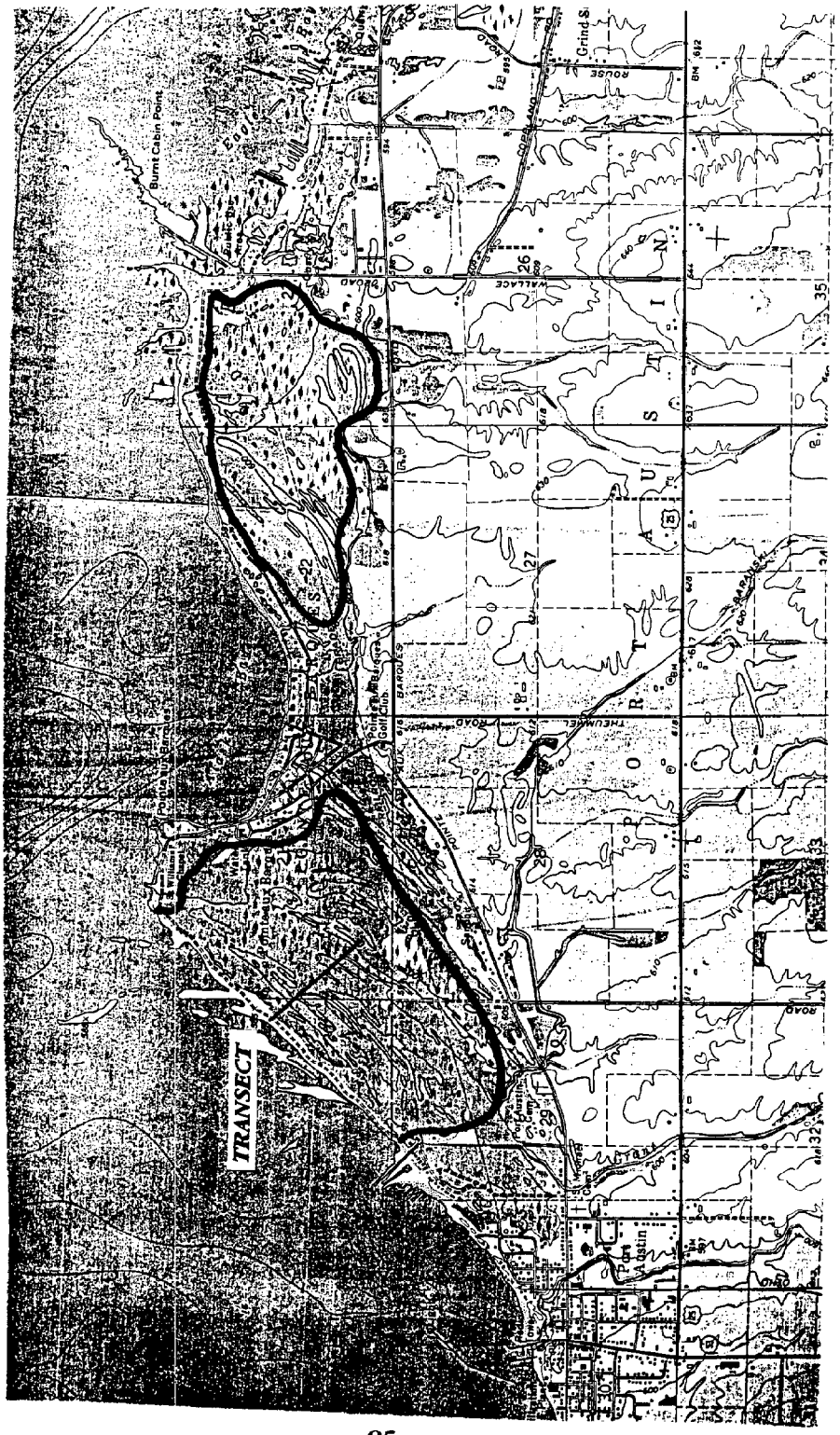
Although a number of cottages exist along this stretch of shoreline, the high quality

nature of this complex remains. Recent road improvements and related homesite development is occurring along the Flint Steel River, just inland of this complex. Public acquisition of tracts within this complex is recommended for the maintenance of Bald eagle habitat, as well as to ensure the long-term viability of this complex as a whole.

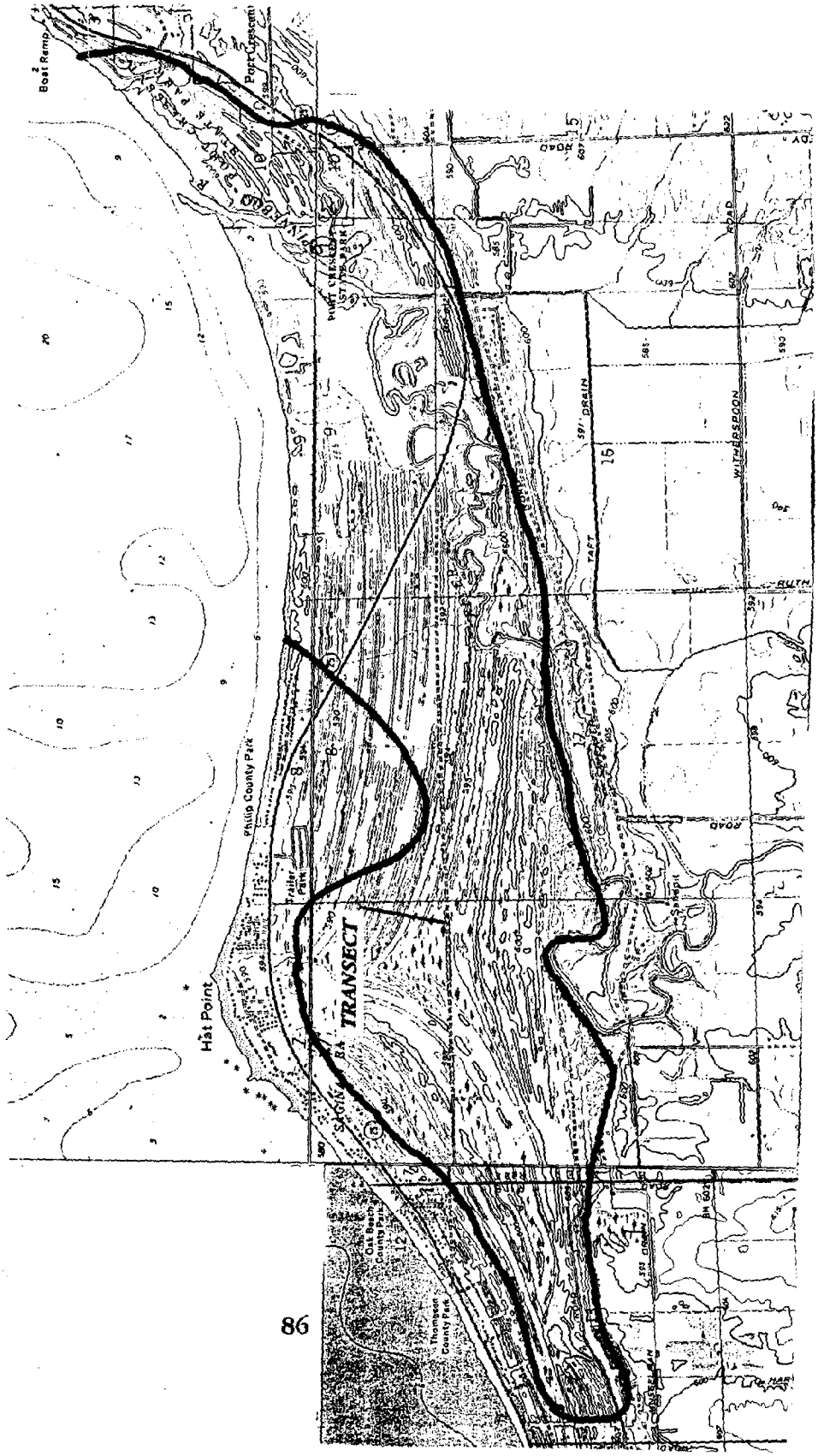
APPENDIX II

TOPOGRAPHIC/BOUNDARY MAPS OF HIGH NATURAL-QUALITY WOODED DUNE AND SWALE COMPLEXES SAMPLED DURING 1992

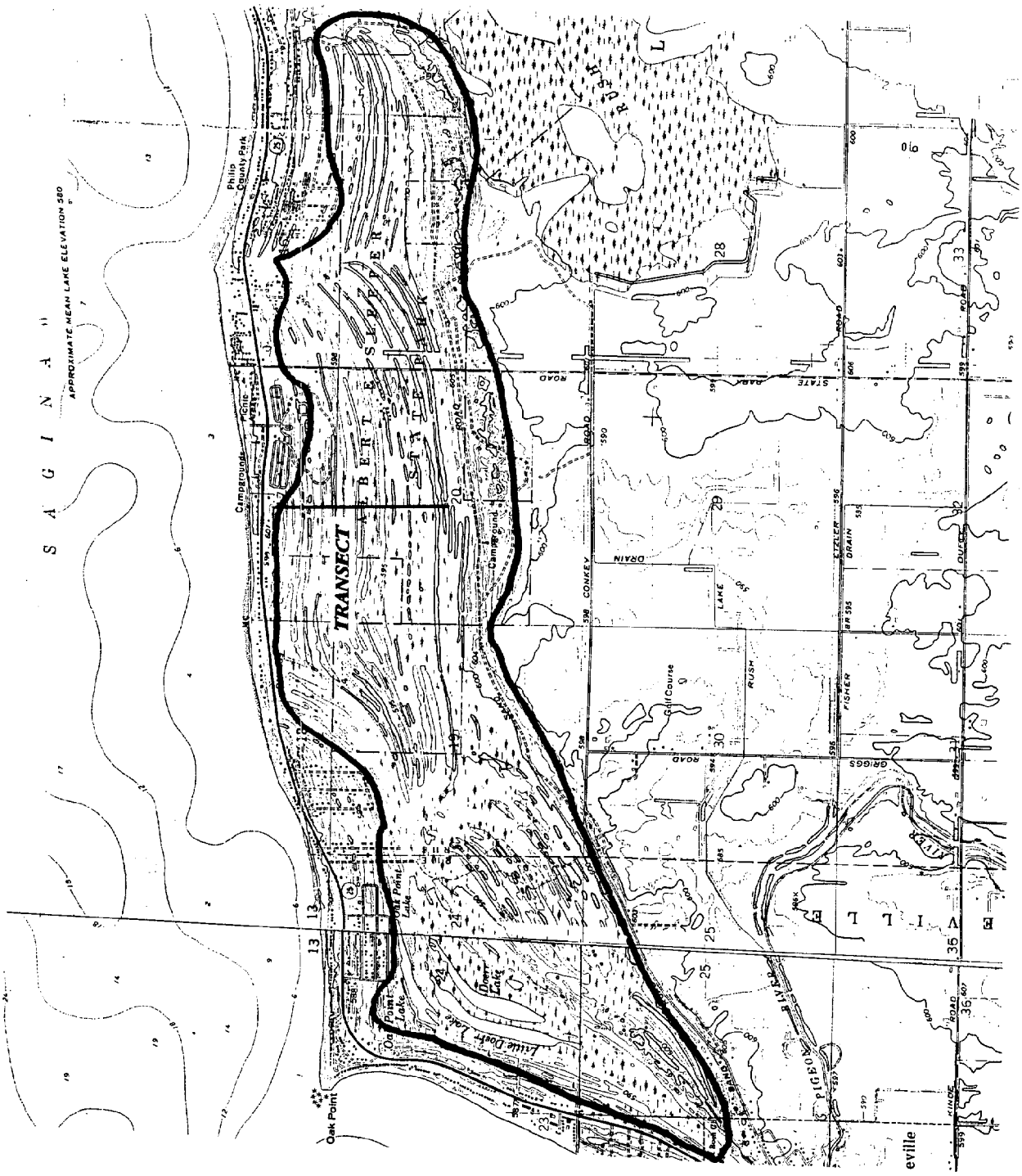
APPENDIX II.1 POINTE AUX BARQUES
HURON COUNTY T19N R13E Scale 1:40,000



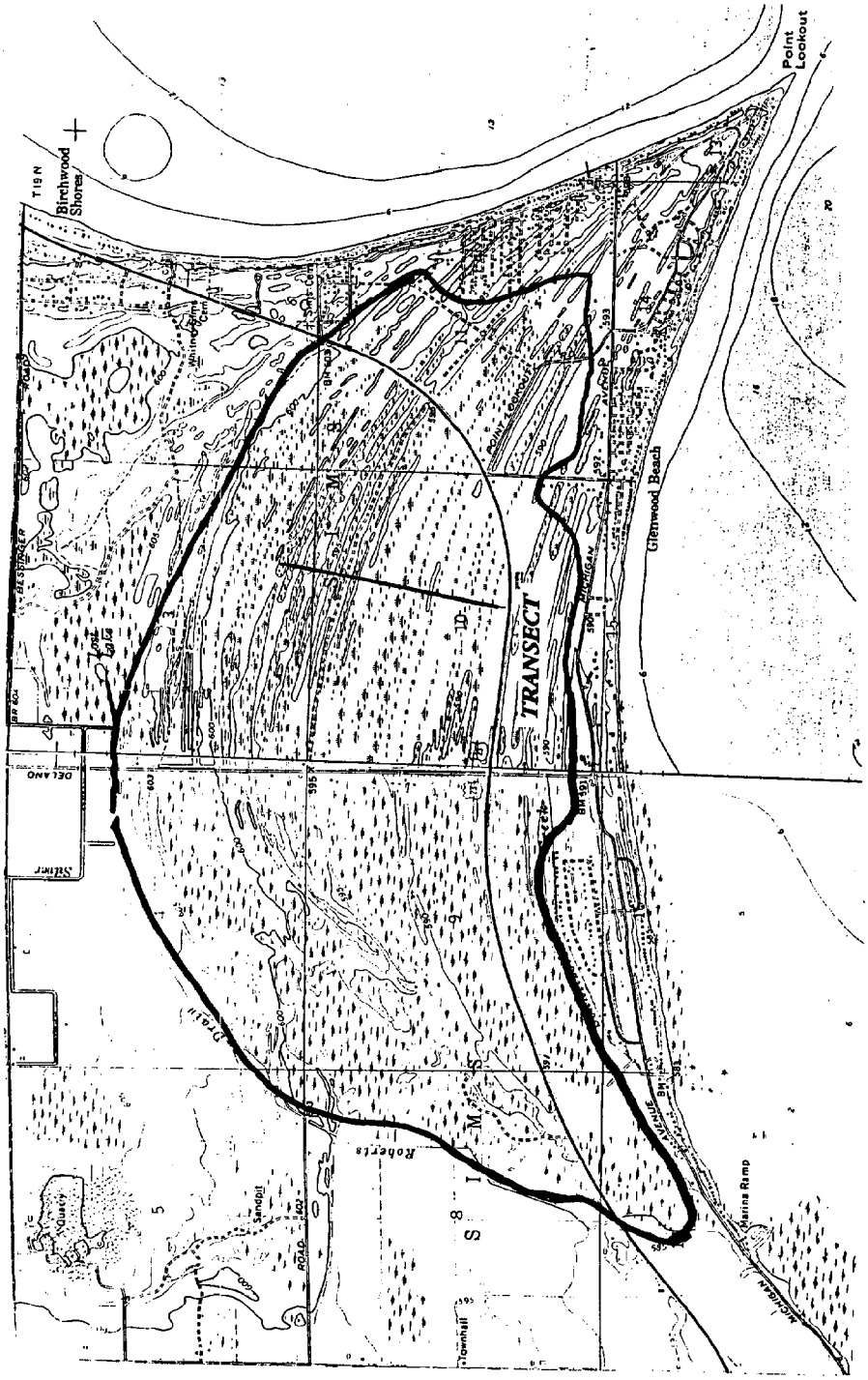
APPENDIX II.2 PORT CRESCENT STATE PARK
HURON COUNTY T18N R13E **Scale 1:48,000**



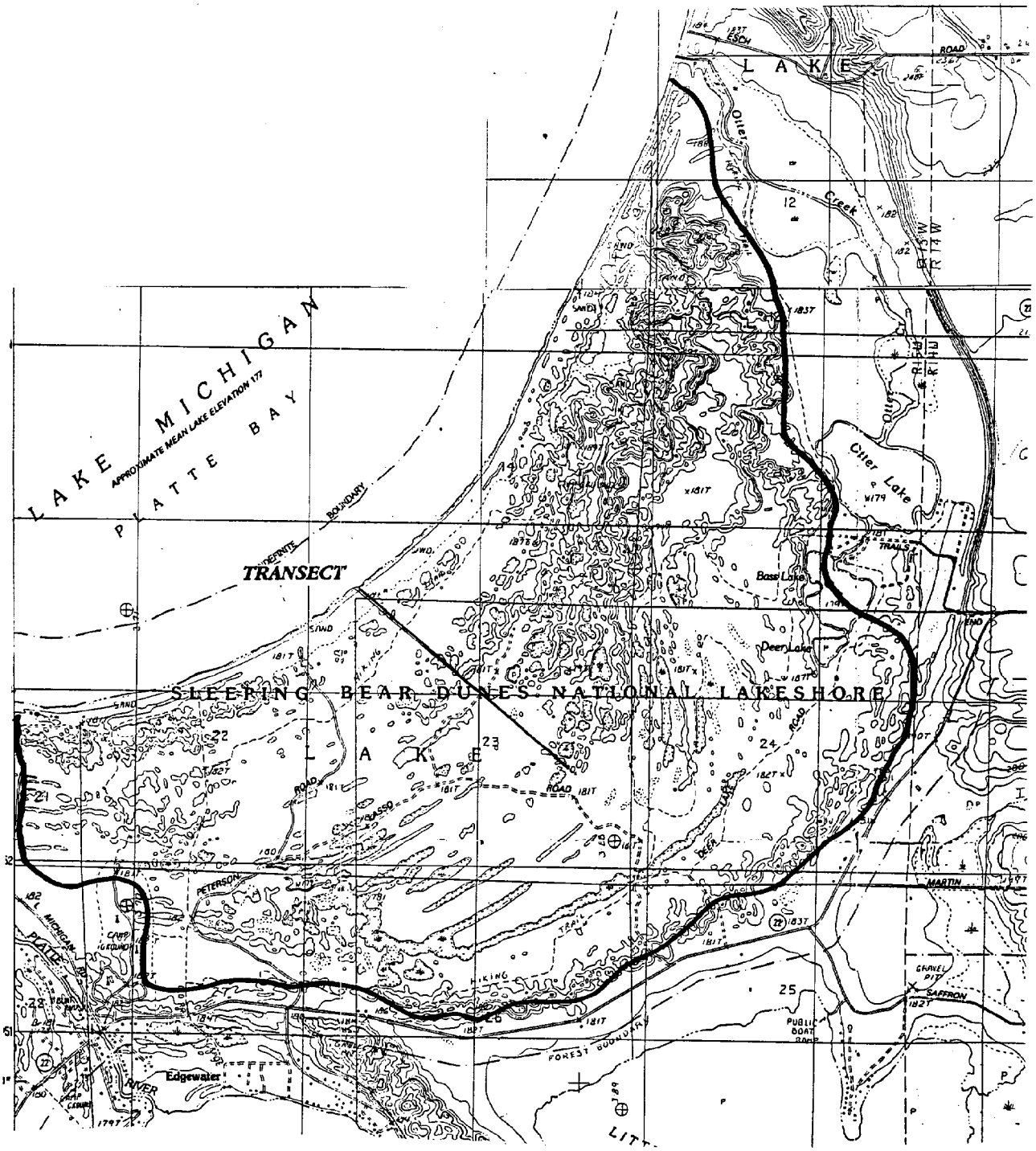
APPENDIX II.3 ALBERT E. SLEEPER STATE PARK
HURON COUNTY T18N R10-11E Scale 1:48,000



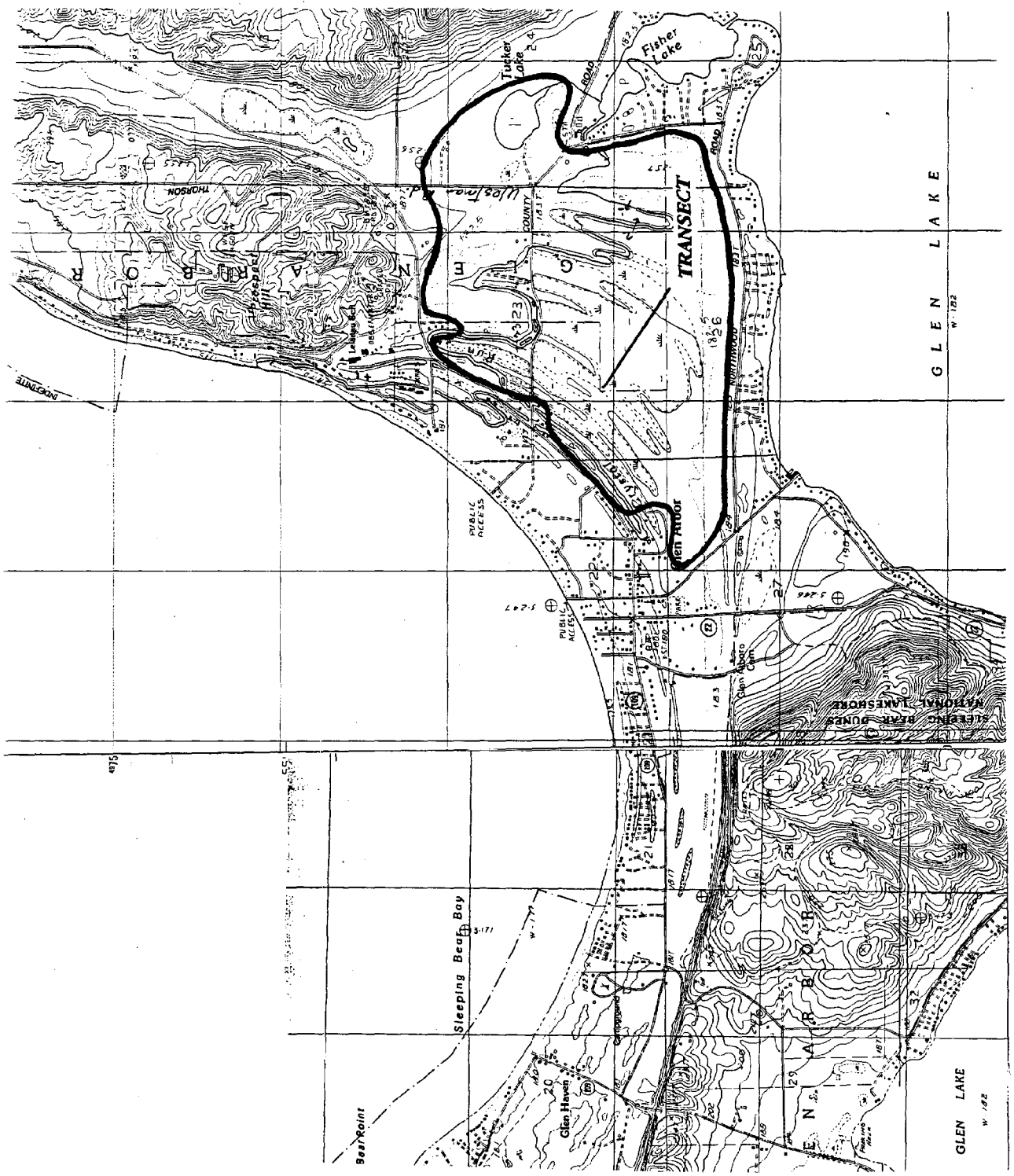
APPENDIX II.4 AU GRES
ARENAC COUNTY T19N R7E **Scale 1:36,923**



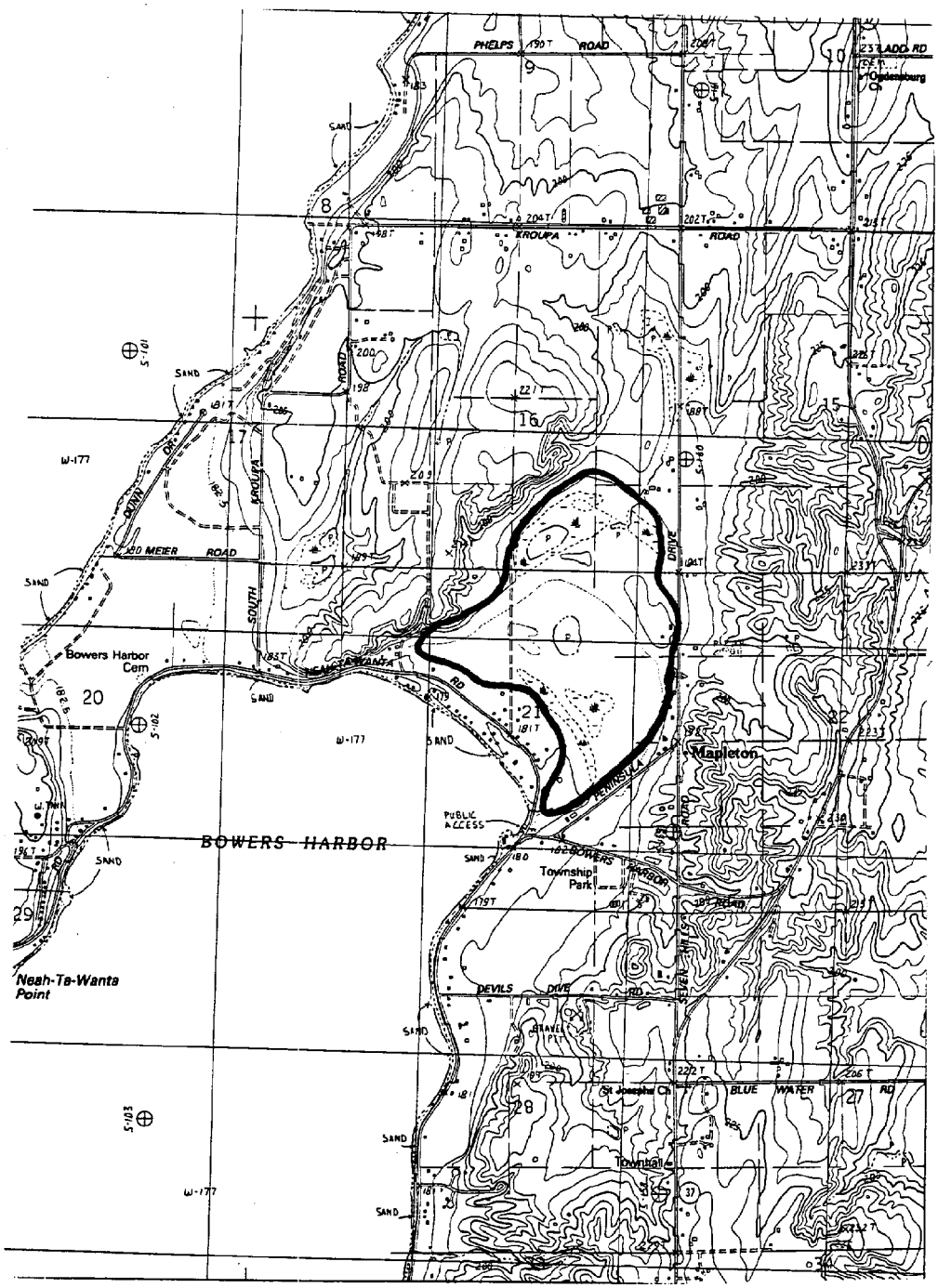
APPENDIX II.5 PLATTE BAY
BENZIE COUNTY T27N R15W **Scale 1:34,285**



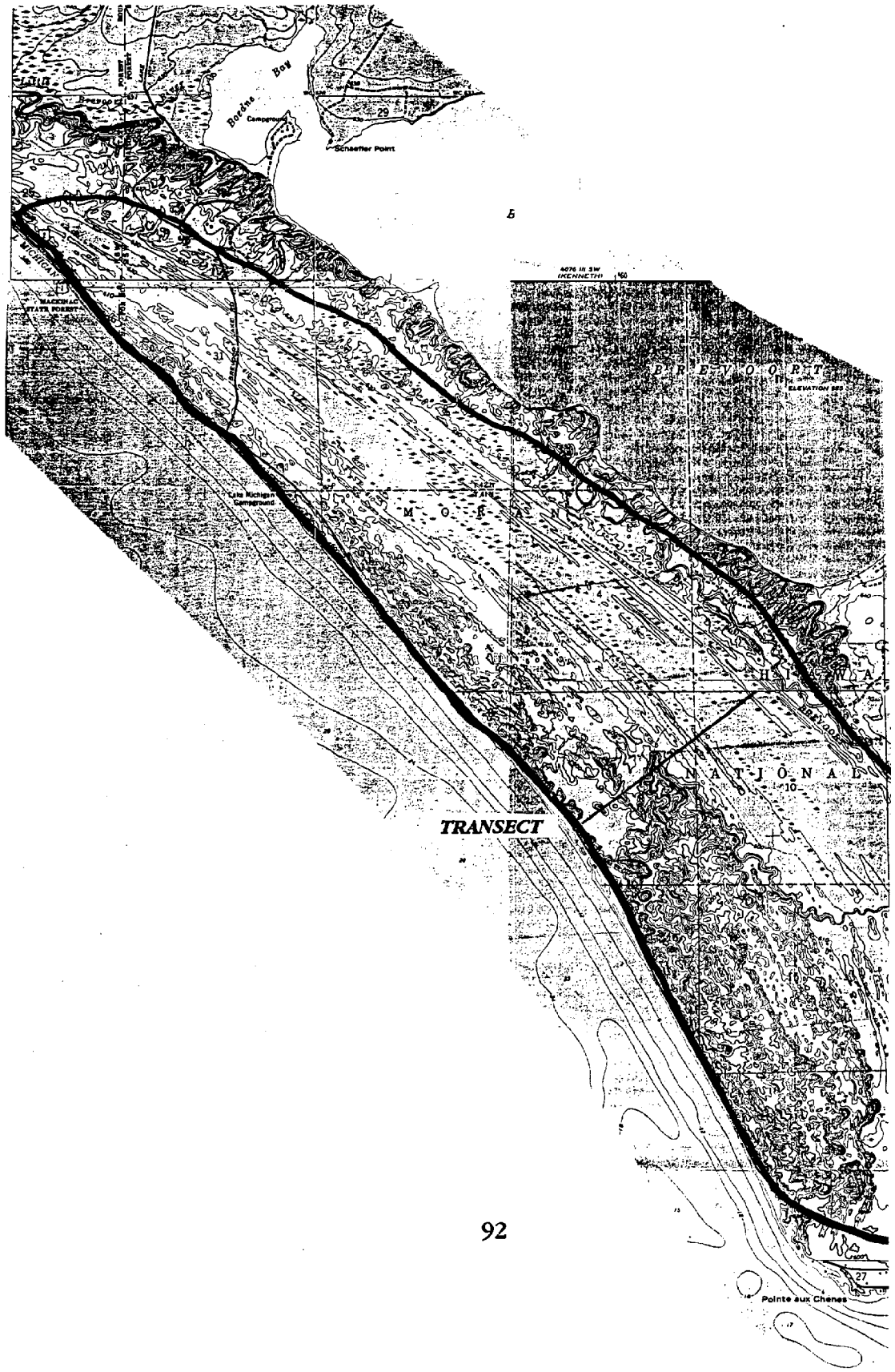
APPENDIX II.6 CRYSTAL RIVER
LEELANAU COUNTY T29N R14W **Scale 1:36,923**



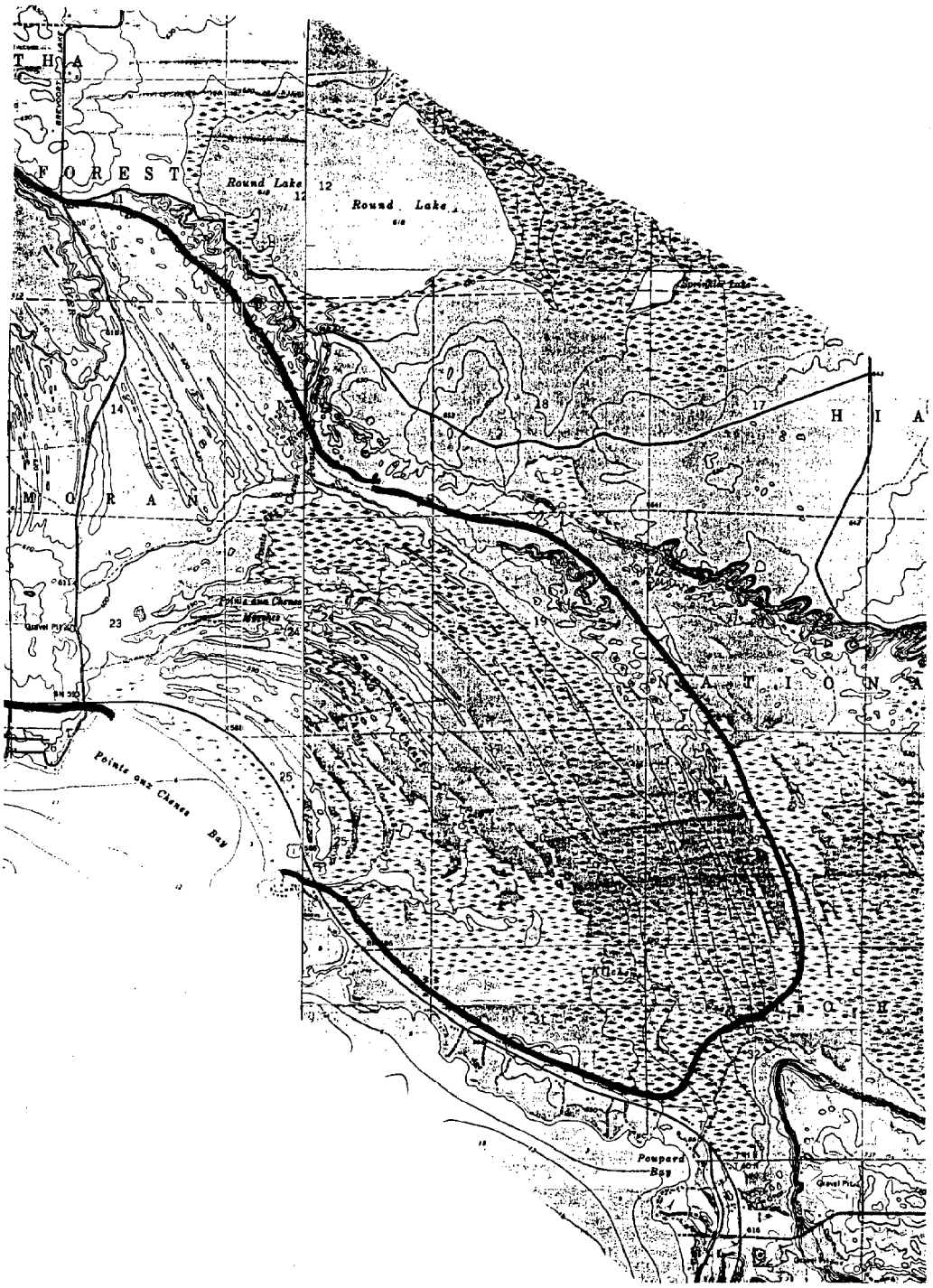
APPENDIX II.7 BOWER'S HARBOR
GRAND TRAVERSE T29N R11W **Scale 1:36,923**



APPENDIX II.8 POINTE AUX CHENES (WEST PORTION)
MACKINAC COUNTY T41-42N R4-6W Scale 1:48,000

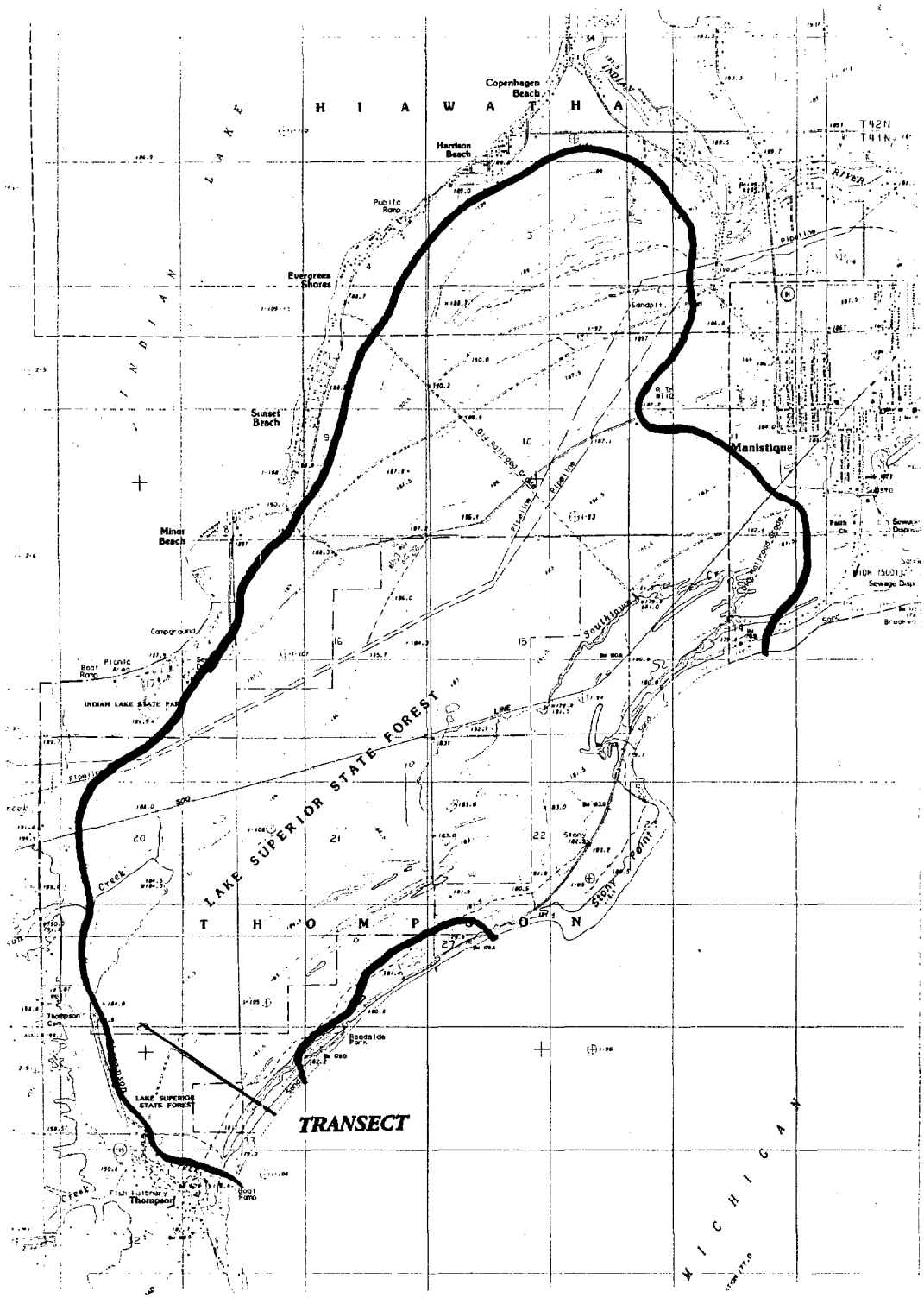


APPENDIX II.8 POINTE AUX CHENES (EAST PORTION) Scale 1: 48,000

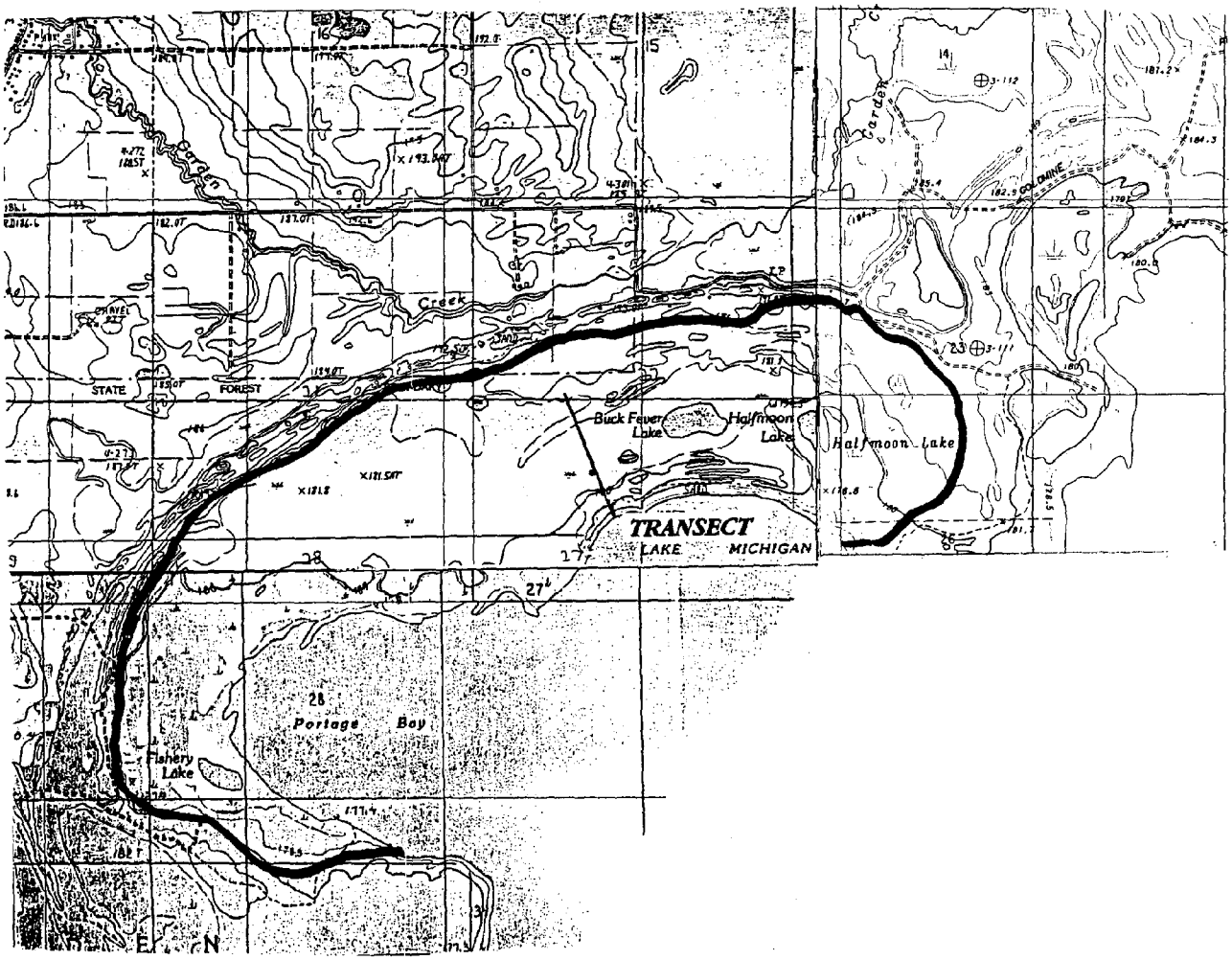


APPENDIX II.9 GULLIVER LAKE DUNES
SCHOOLCRAFT COUNTY T41N R13-15W Scale 1:80,000

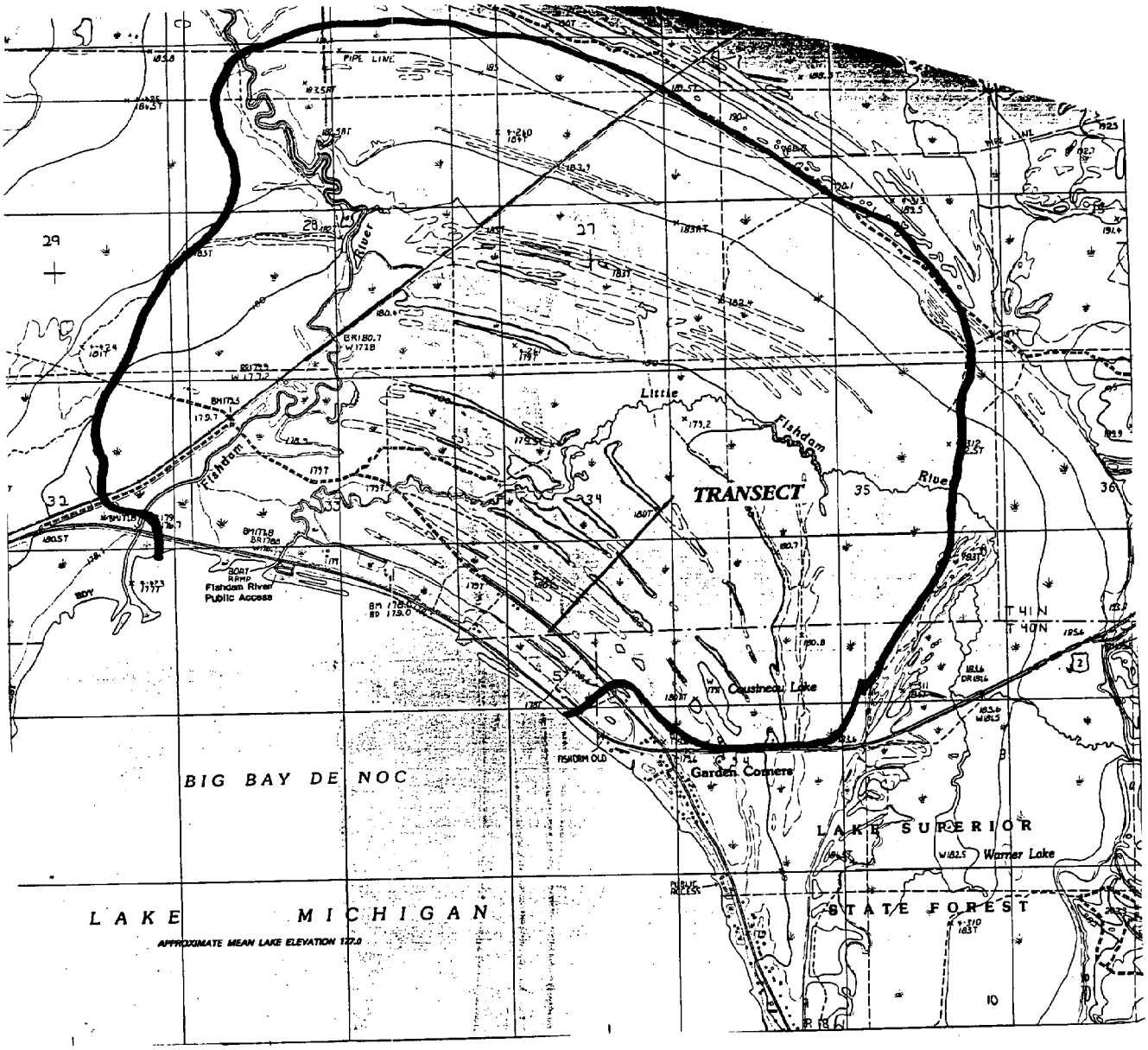
APPENDIX II.10 THOMPSON
SCHOOLCRAFT COUNTY T41N R16W **Scale 1:48,000**



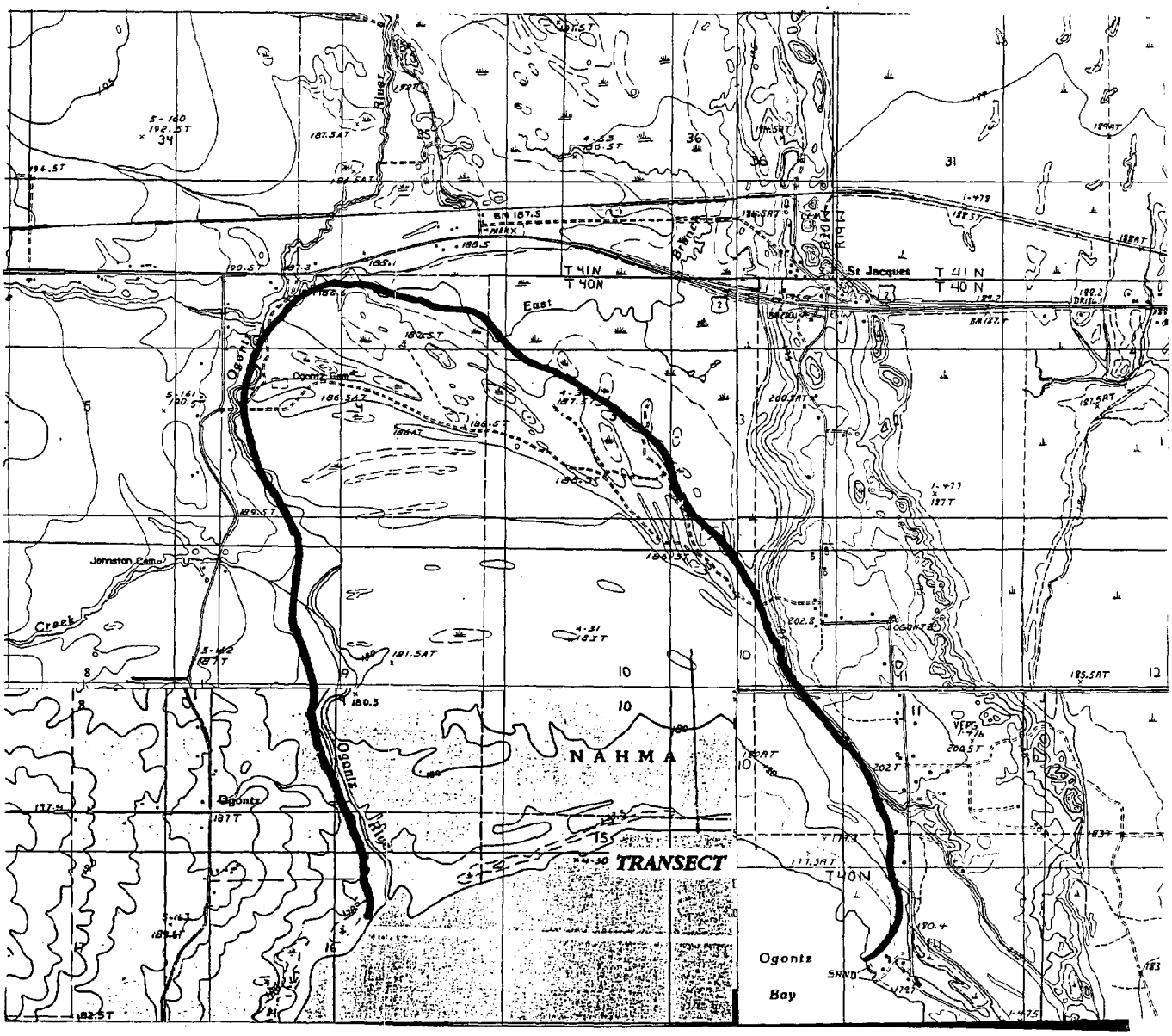
APPENDIX II.11 PORTAGE BAY
DELTA COUNTY T39N R18W Scale 1:34,285



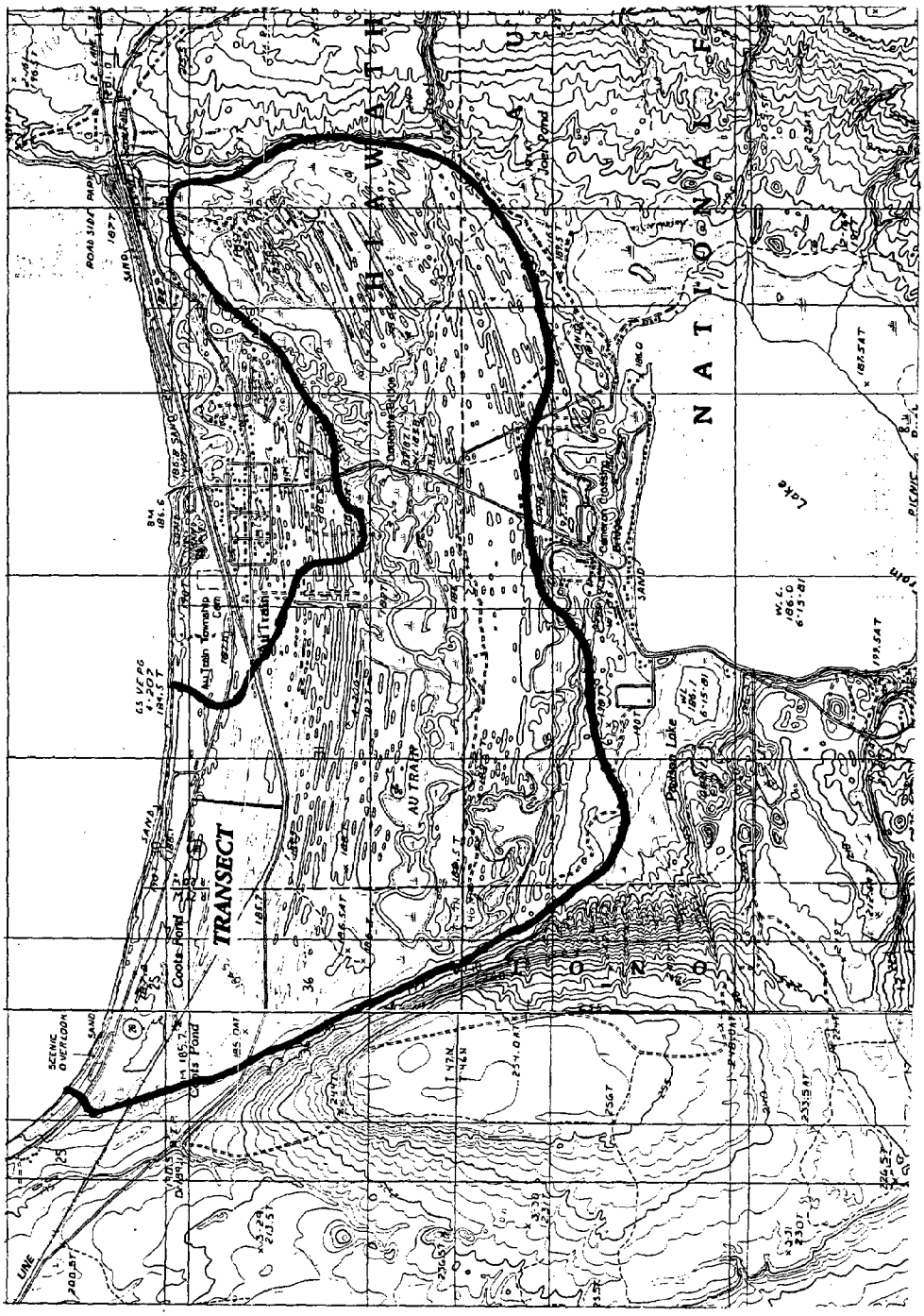
APPENDIX II.12 BIG BAY DE NOC
DELTA COUNTY T40N R18W Scale 1:36,923



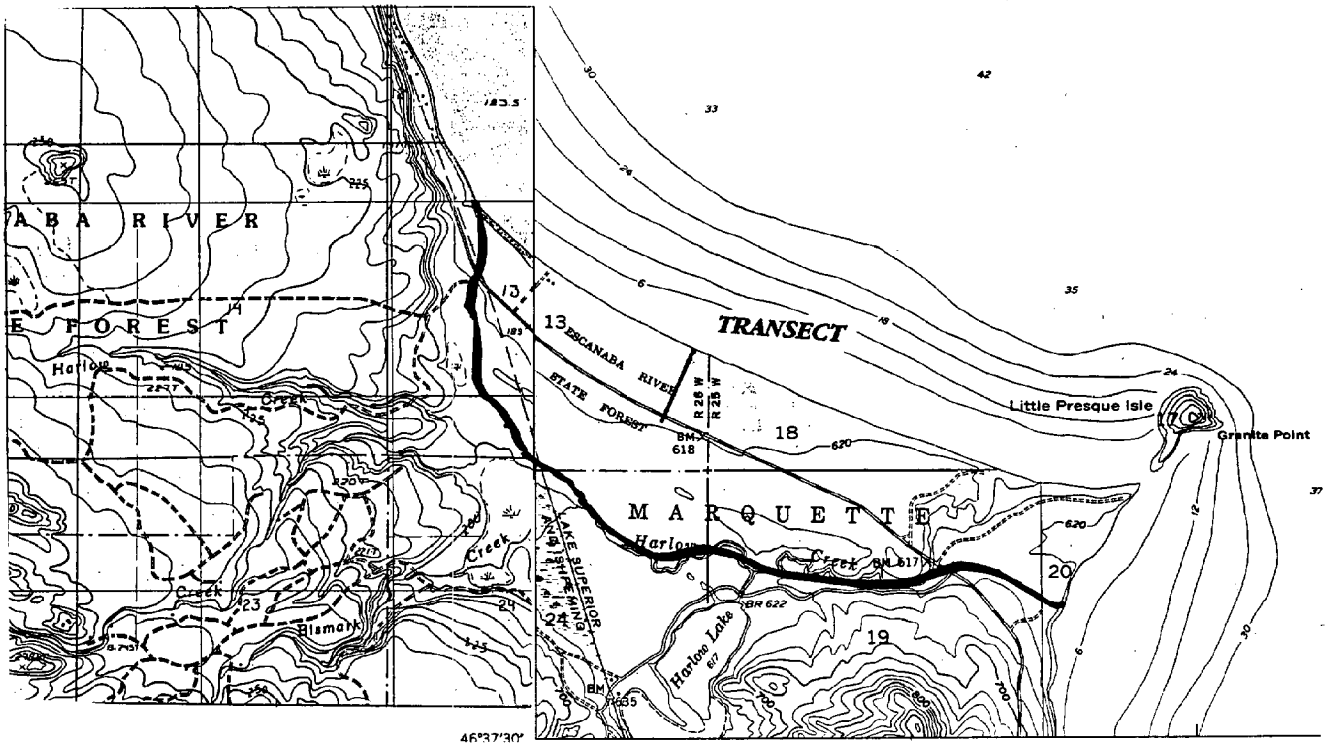
APPENDIX II.13 OGONTZ BAY
DELTA COUNTY T40N R20W Scale 1:36,923



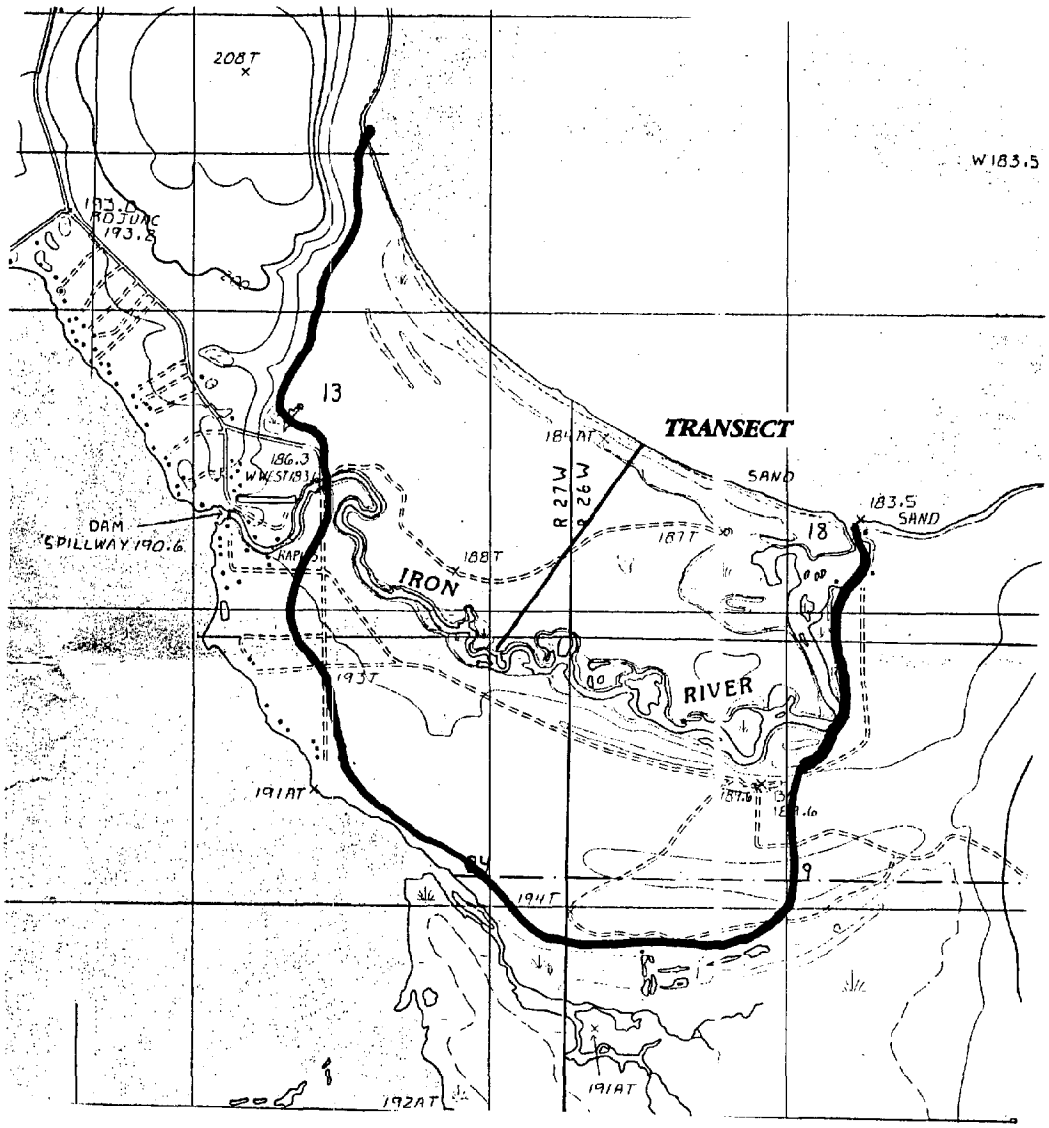
APPENDIX II.14 AU TRAIN BAY
ALGER COUNTY T46-47N R20-21W Scale 1:48,000



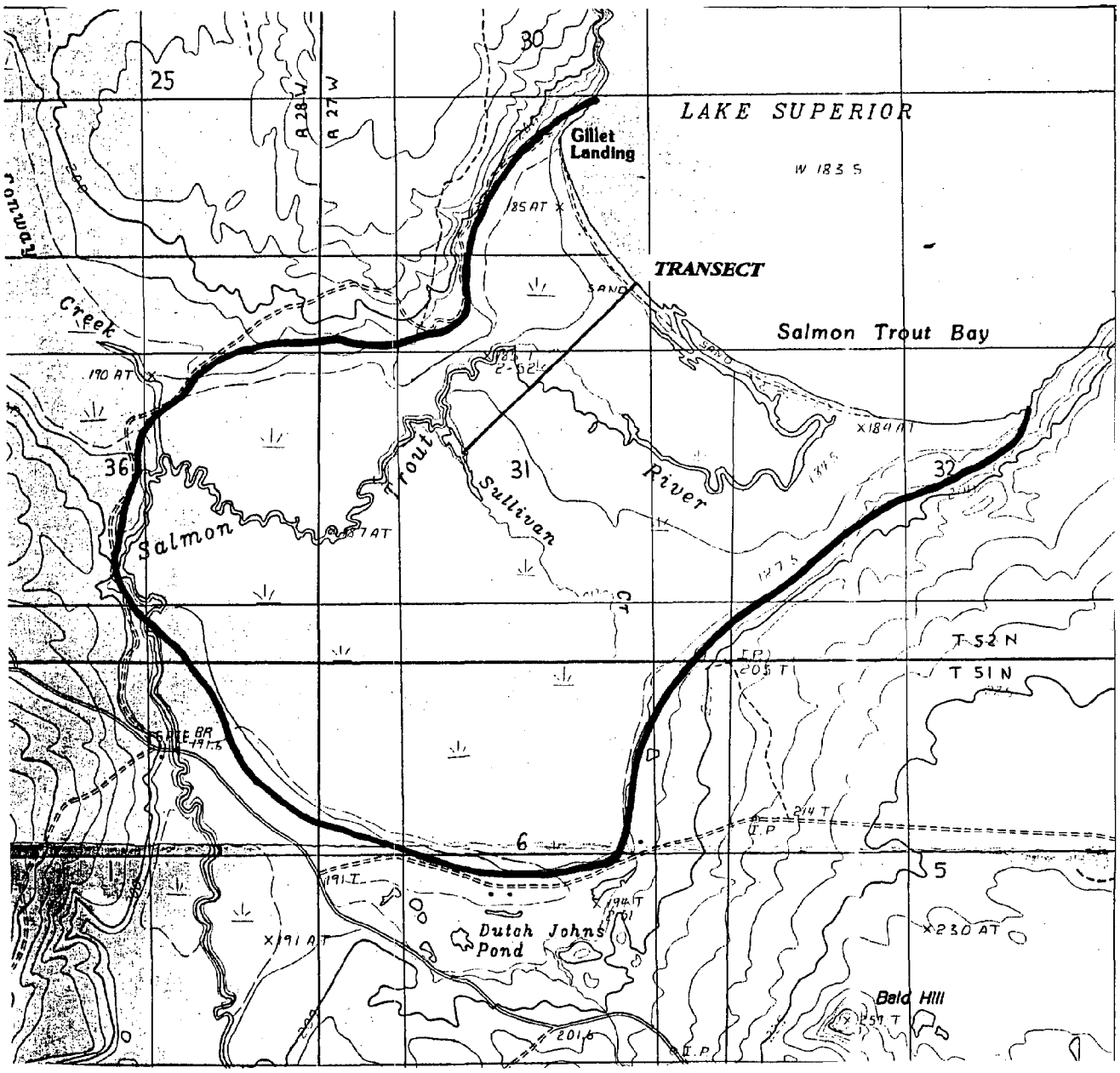
APPENDIX II.15 LITTLE PRESQUE ISLE POINT
MARQUETTE COUNTY T49N R25-26W **Scale 1:36,923**



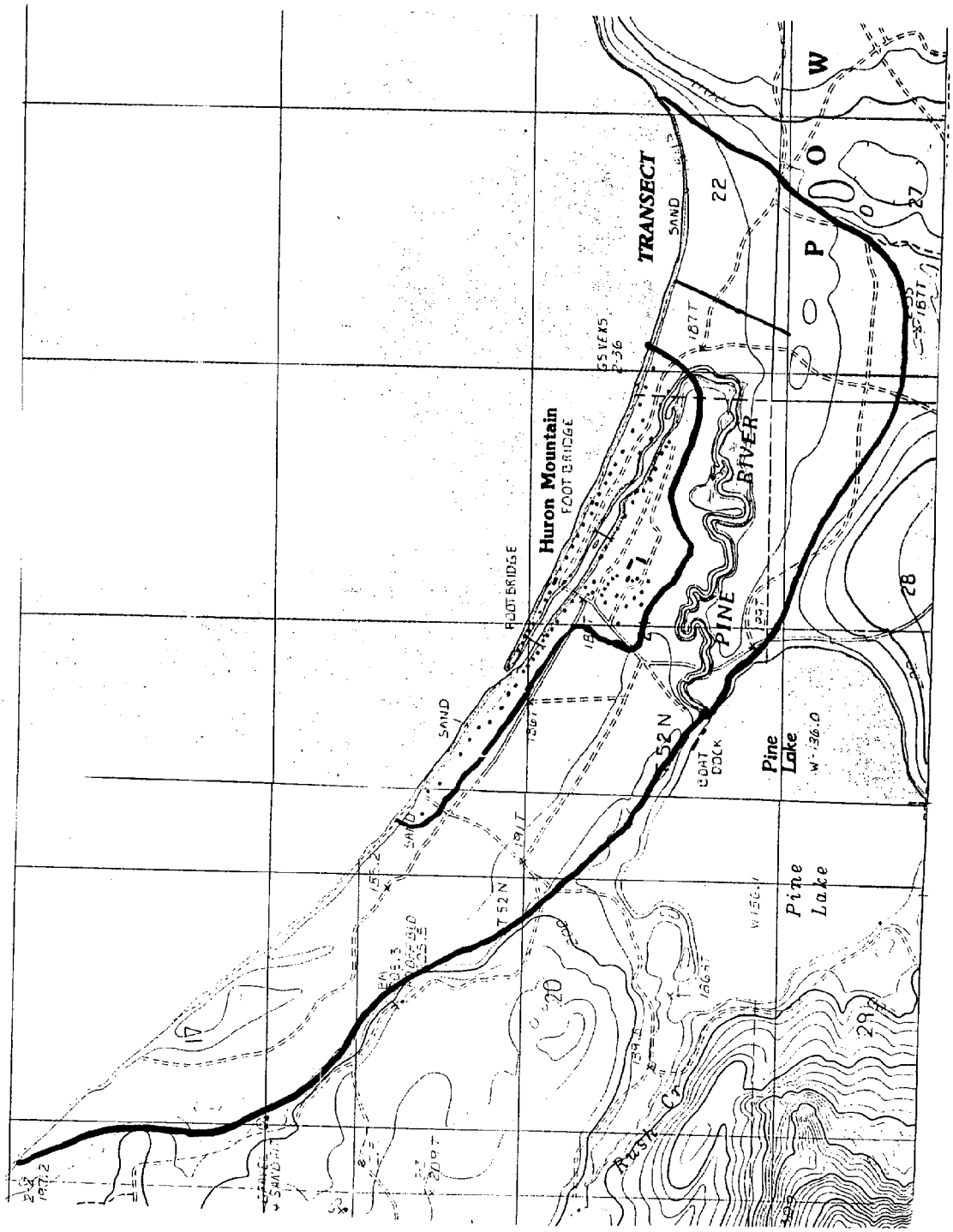
APPENDIX II.16 IRON RIVER
MARQUETTE COUNTY T51N R26-27W Scale 1:24,000



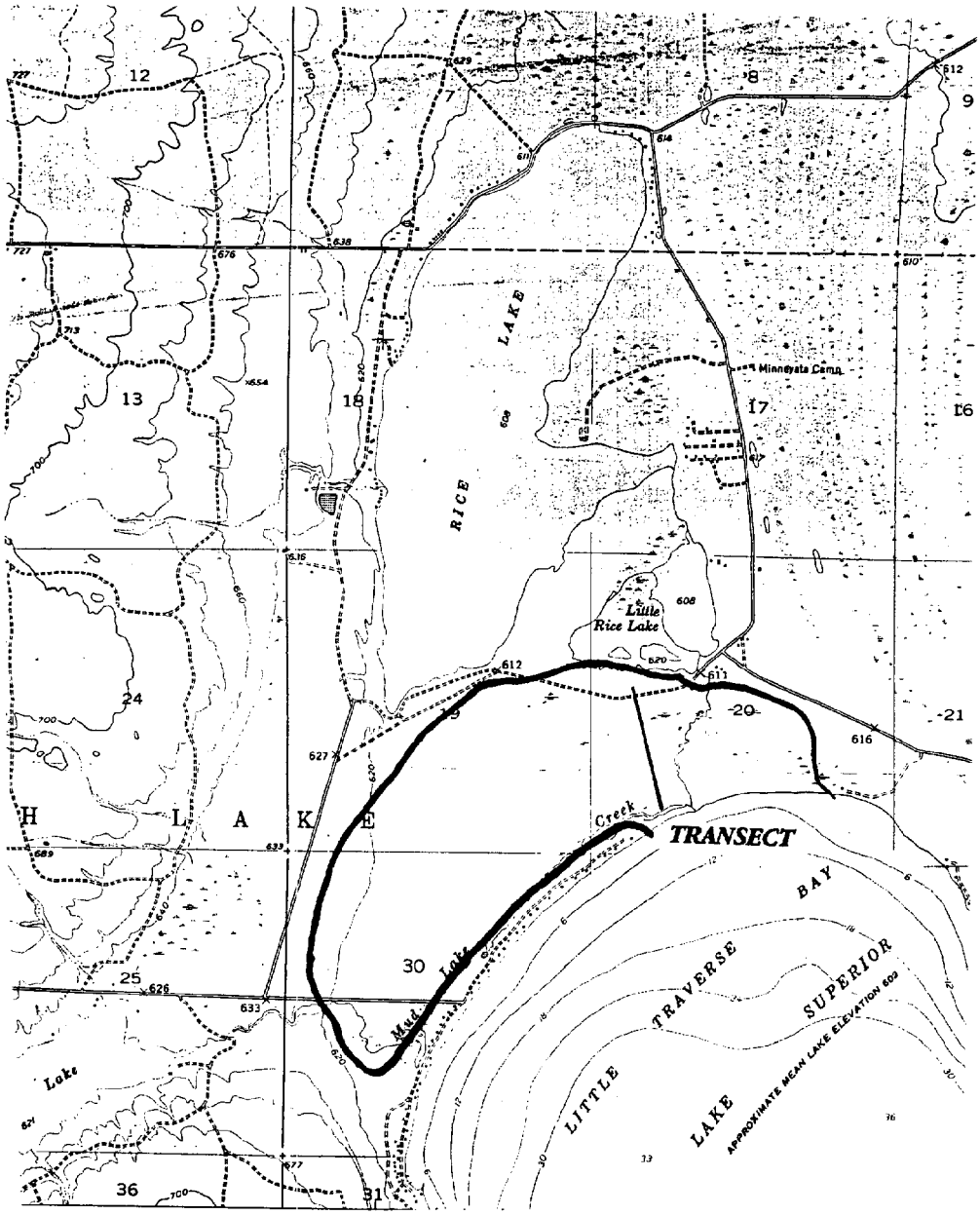
APPENDIX II.17 SALMON TROUT BAY
MARQUETTE COUNTY T51-52N R27-28W **Scale 1:24,000**



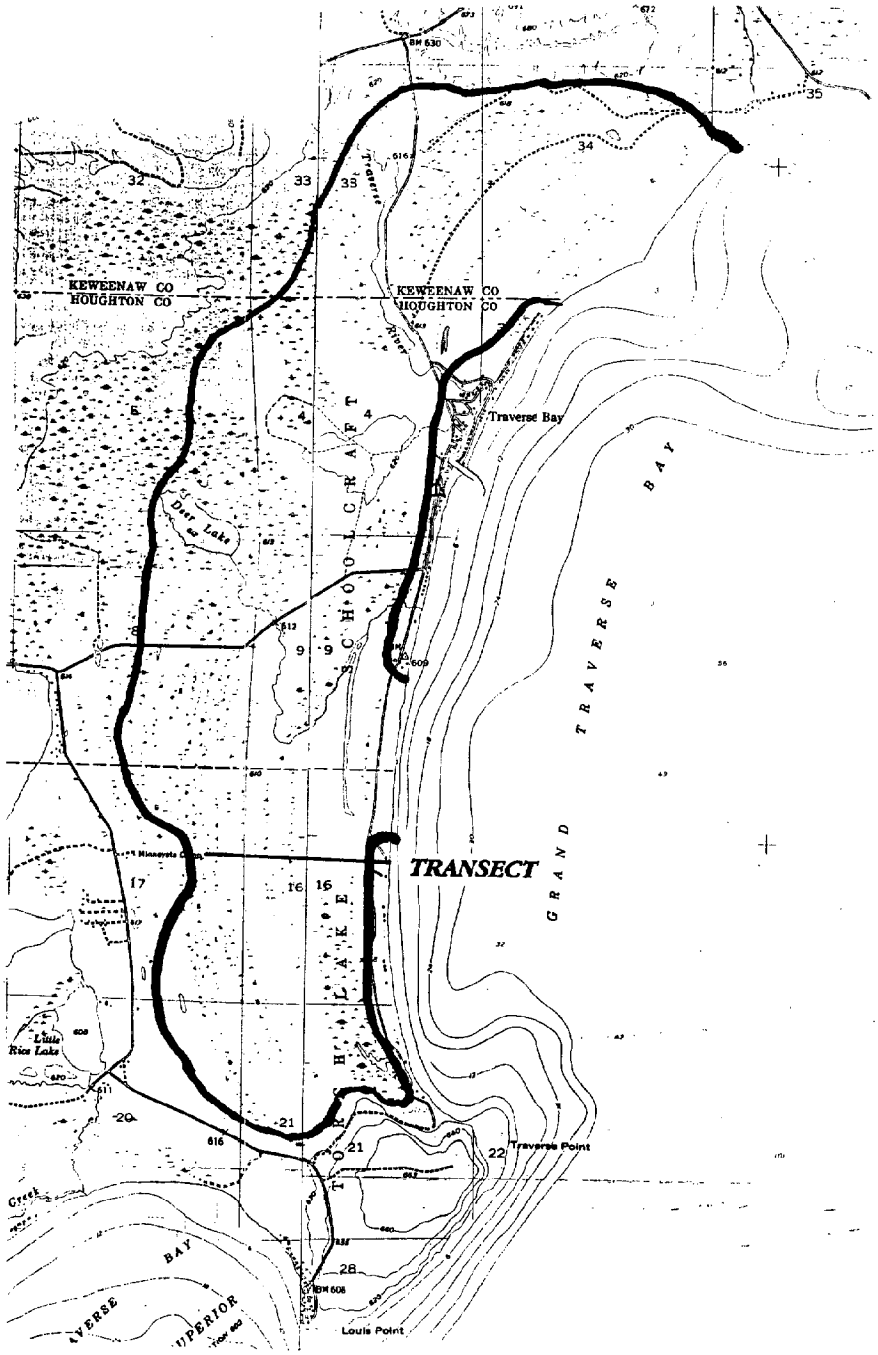
APPENDIX II.18 PINE RIVER
MARQUETTE COUNTY T52N R28W Scale 1:24,000



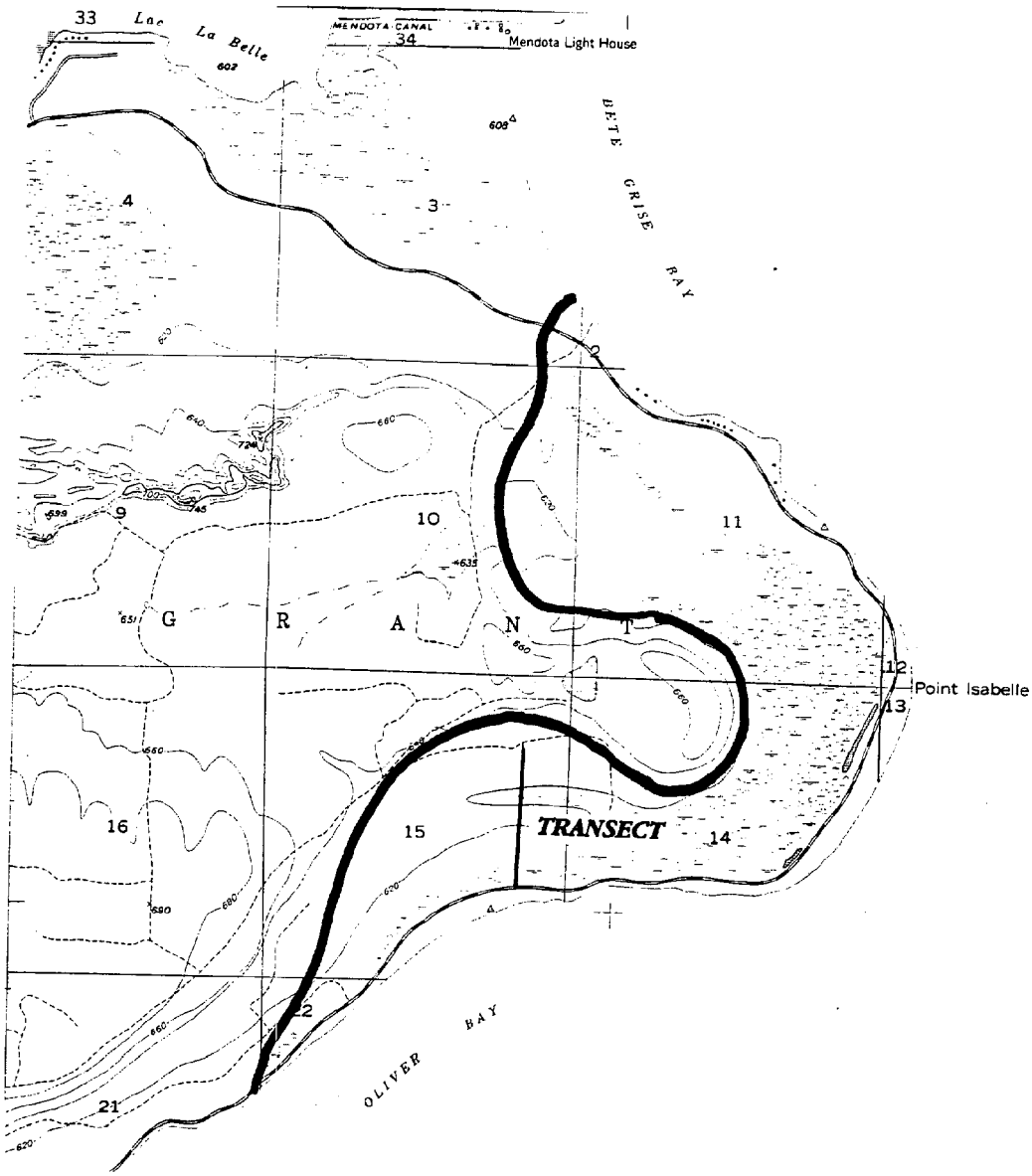
APPENDIX II.19 LITTLE TRAVERSE BAY
HOUGHTON COUNTY T55N R31W Scale 1:36,923



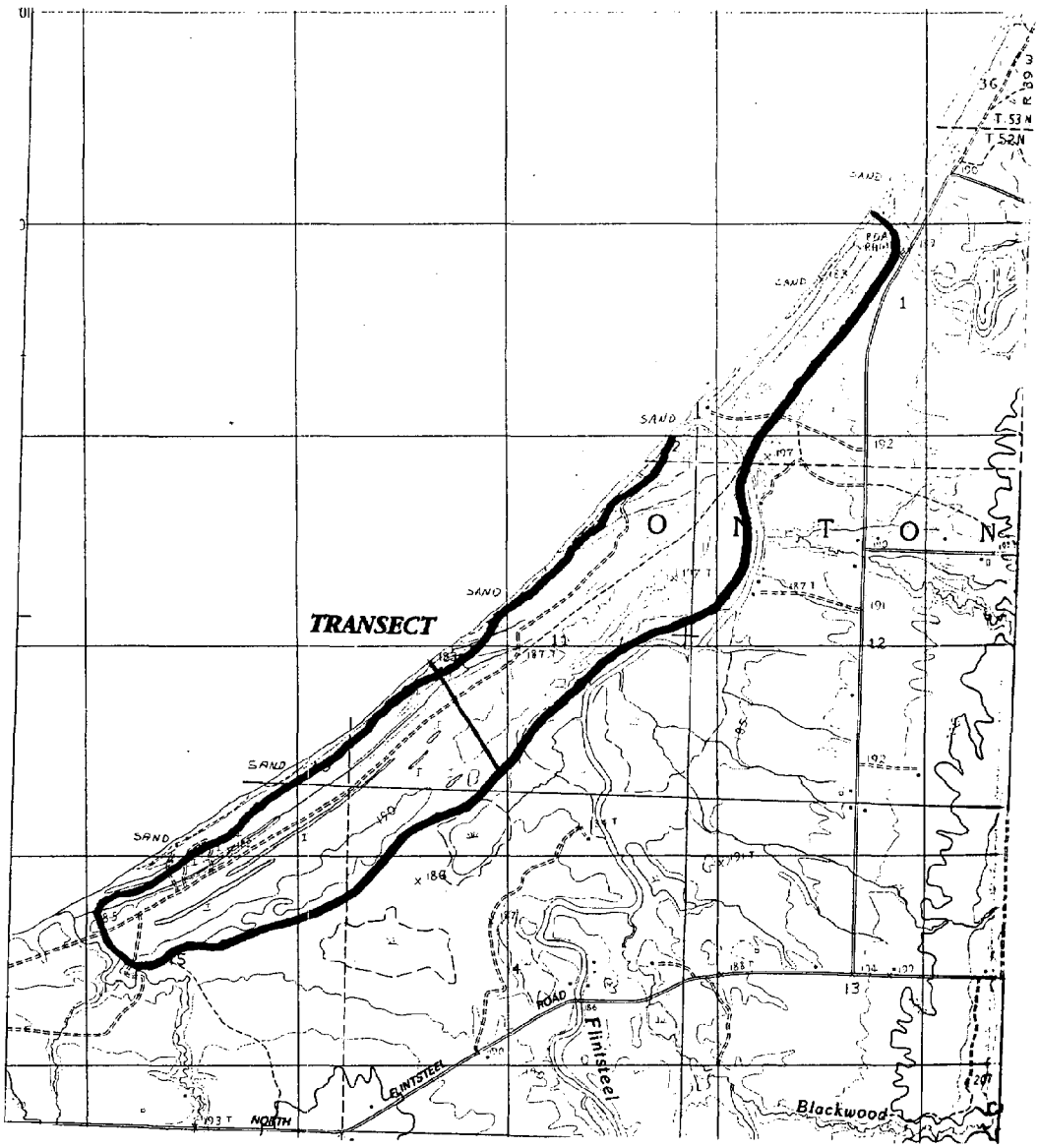
APPENDIX II.20 GRAND TRAVERSE BAY
HOUGHTON/KEWEENAW COUNTIES T55-56N R31W Scale 1:48,000



APPENDIX II.21 OLIVER BAY
KEWEENAW COUNTY T57N R29W Scale 1:36,923



APPENDIX II.22 FLINT STEEL RIVER
ONTONAGON COUNTY T52N R39W **Scale 1:32,000**

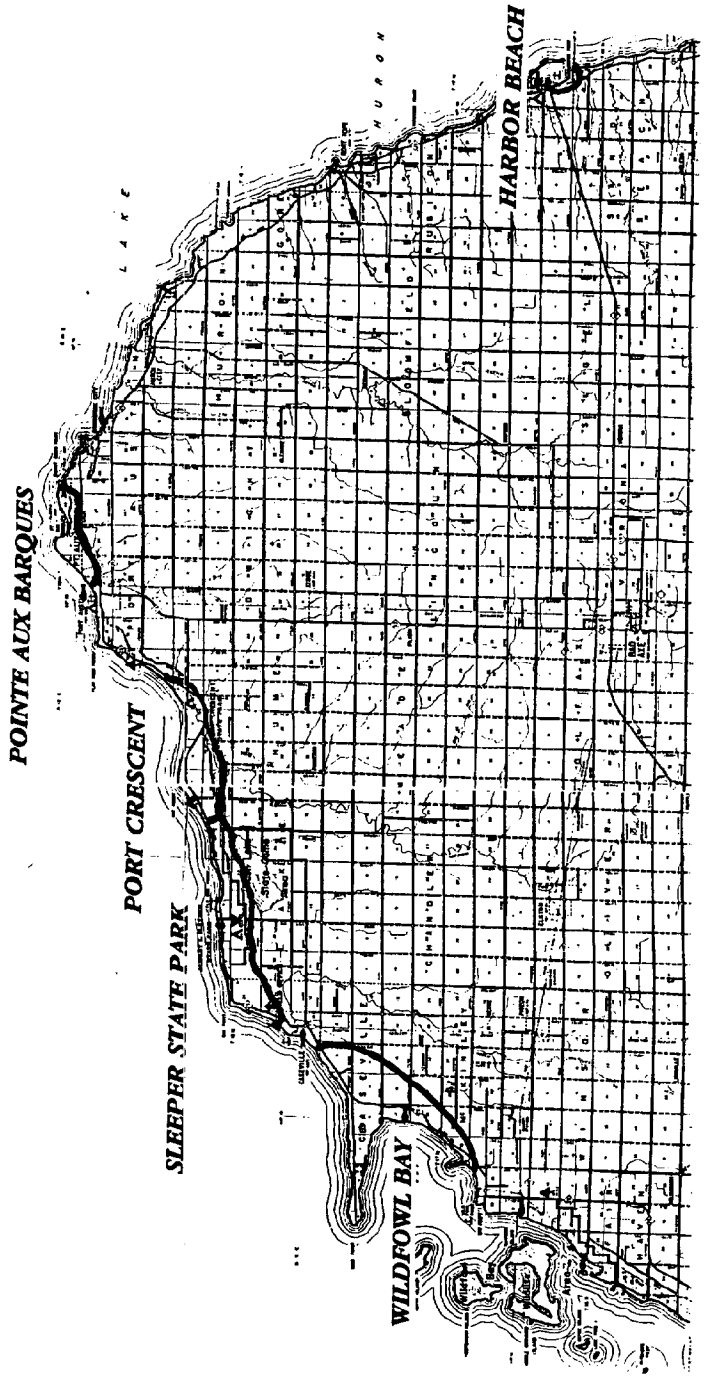


APPENDIX III

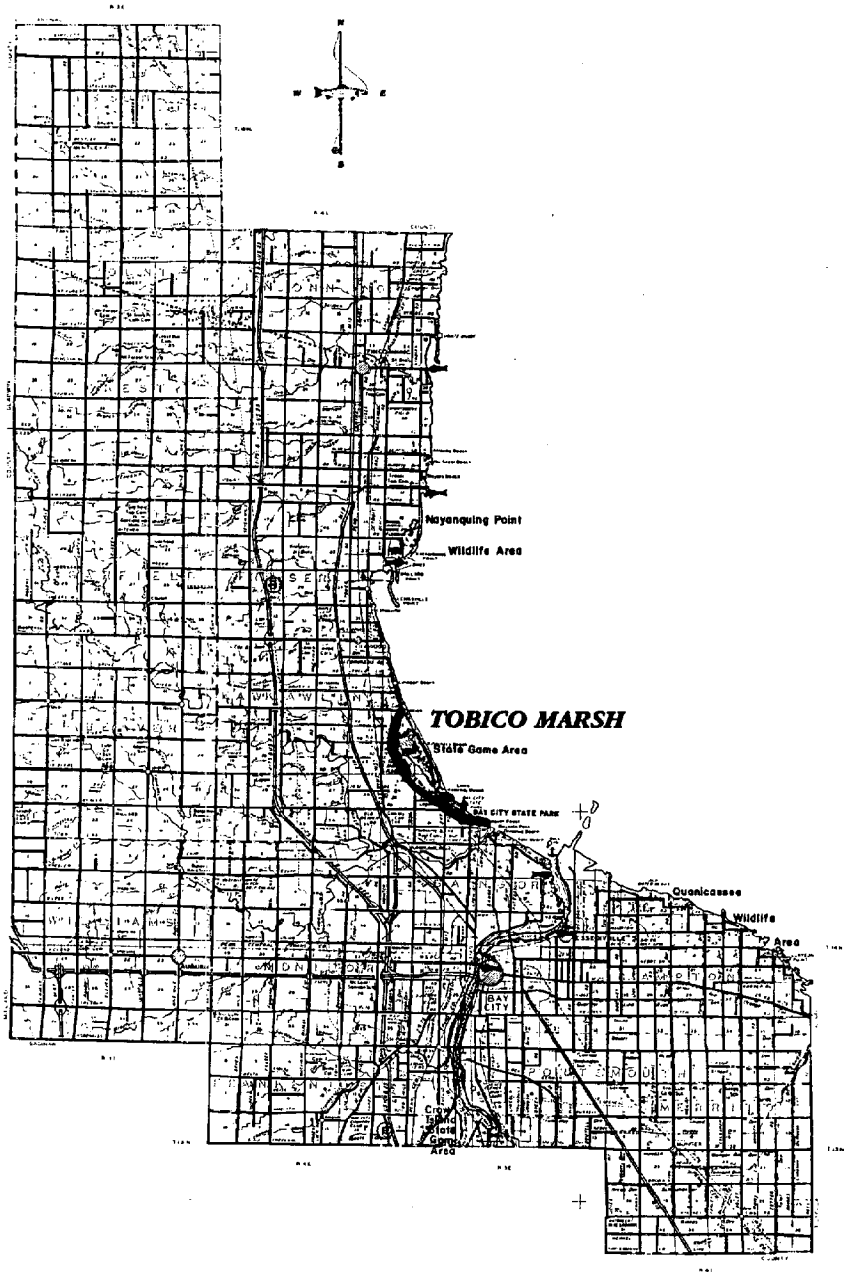
LOCATION MAPS FOR WOODED DUNE AND SWALE COMPLEXES

IN COUNTIES WHERE COMPLEXES WERE SAMPLED DURING 1992

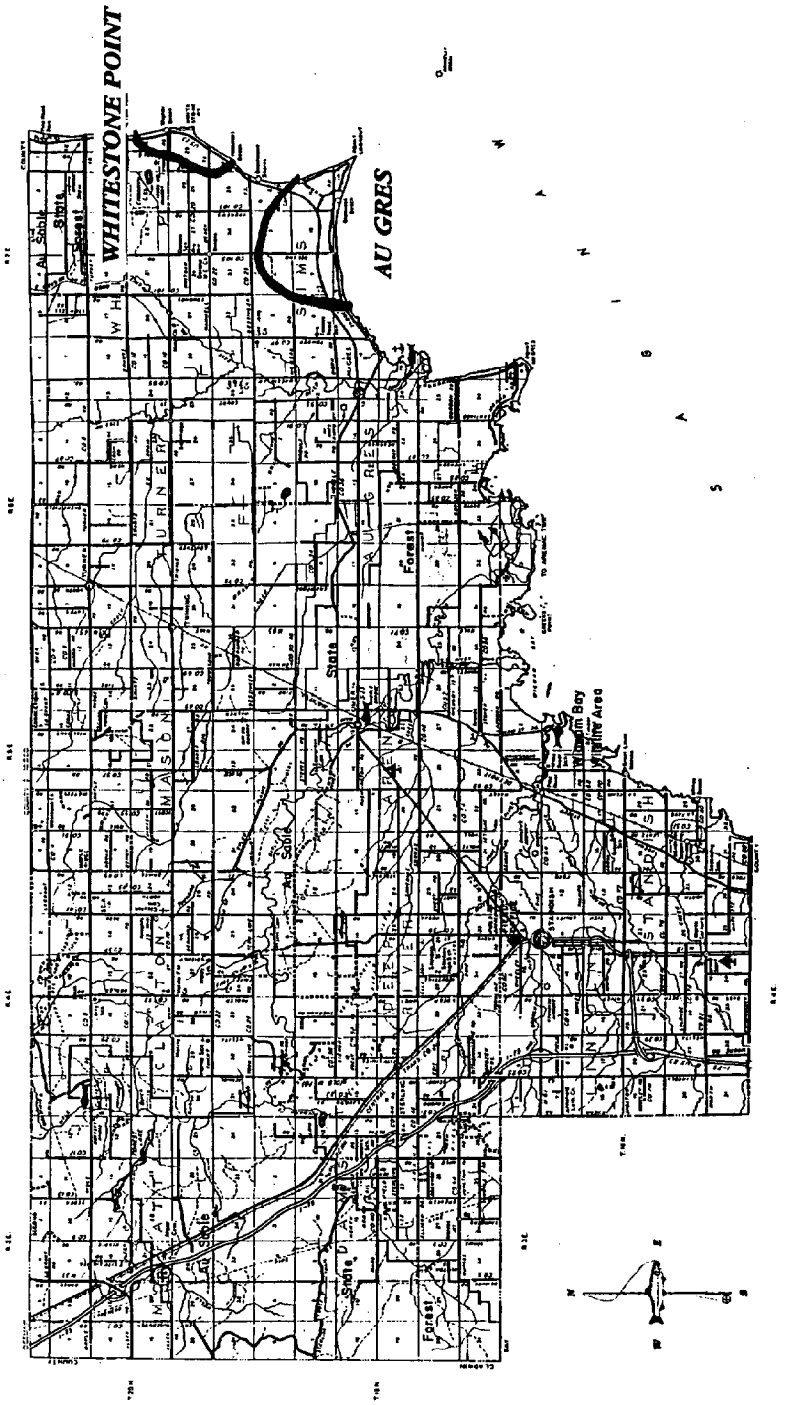
APPENDIX III.1 HURON COUNTY



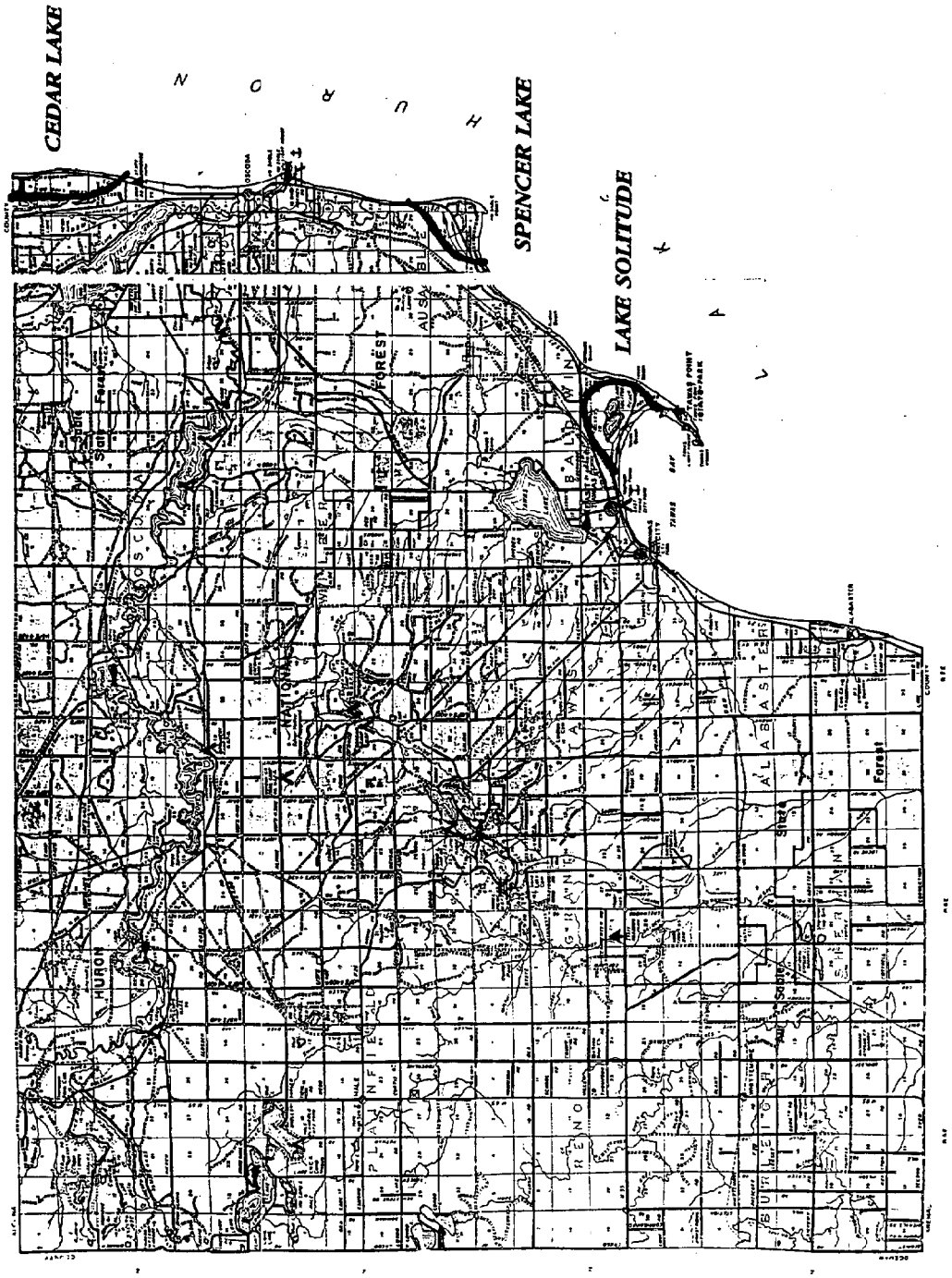
APPENDIX III.2 BAY COUNTY



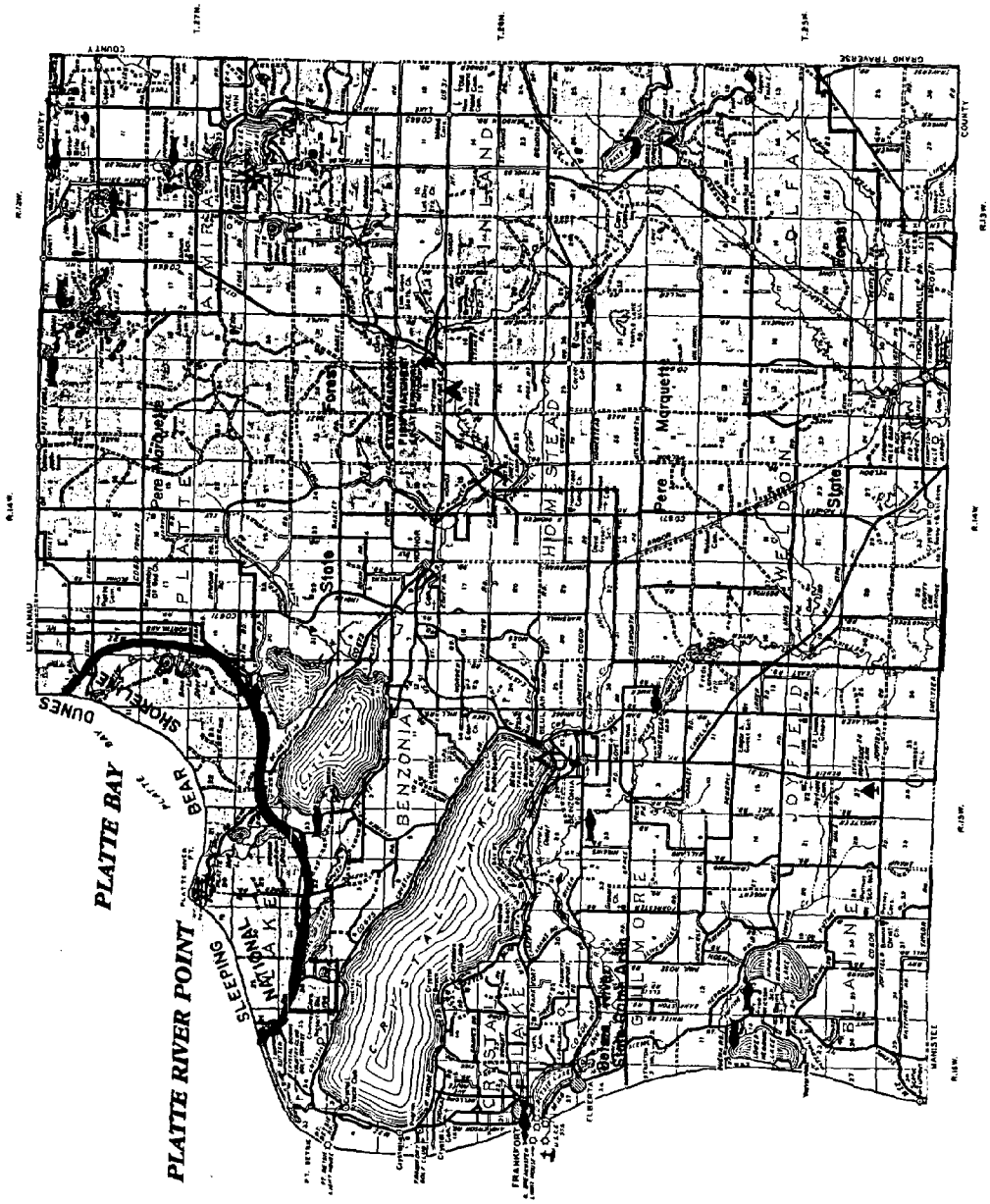
APPENDIX III.3 ARENAC COUNTY



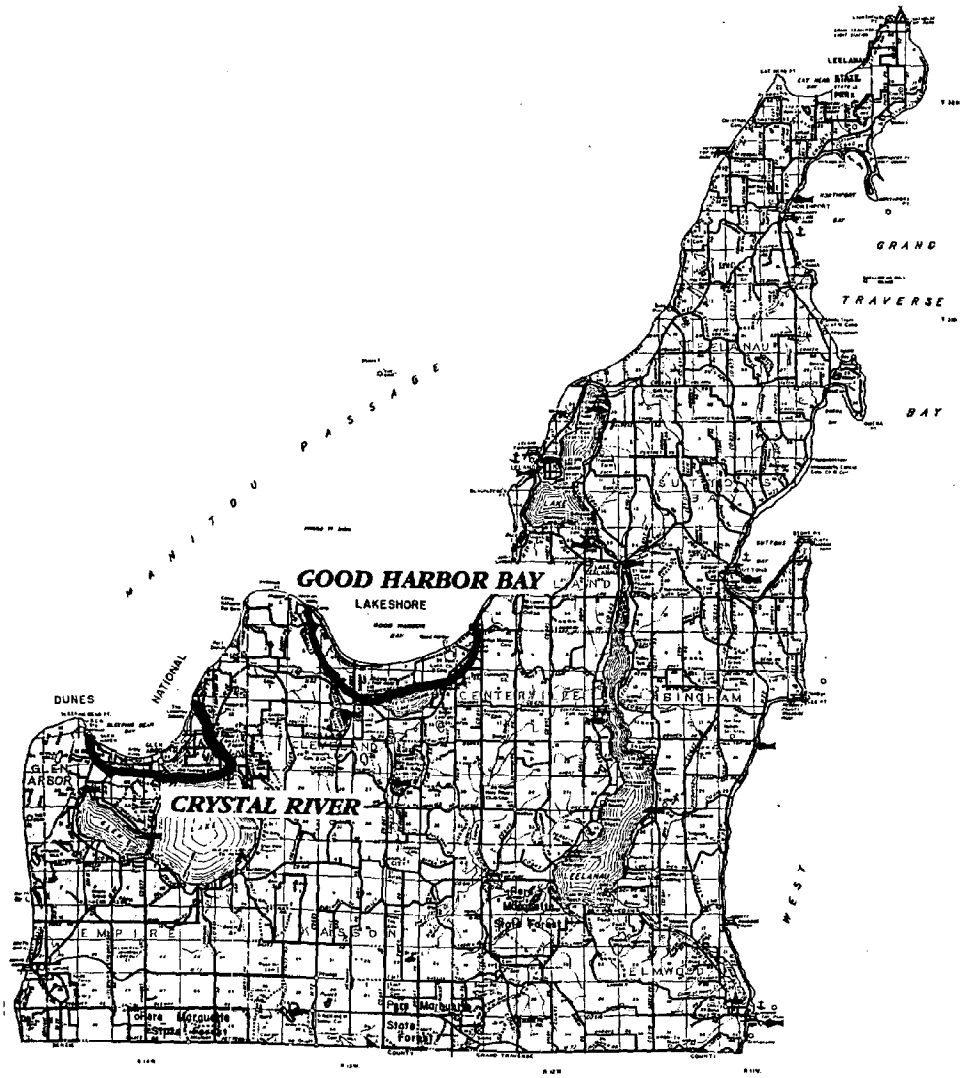
APPENDIX III.4 IOSCO COUNTY



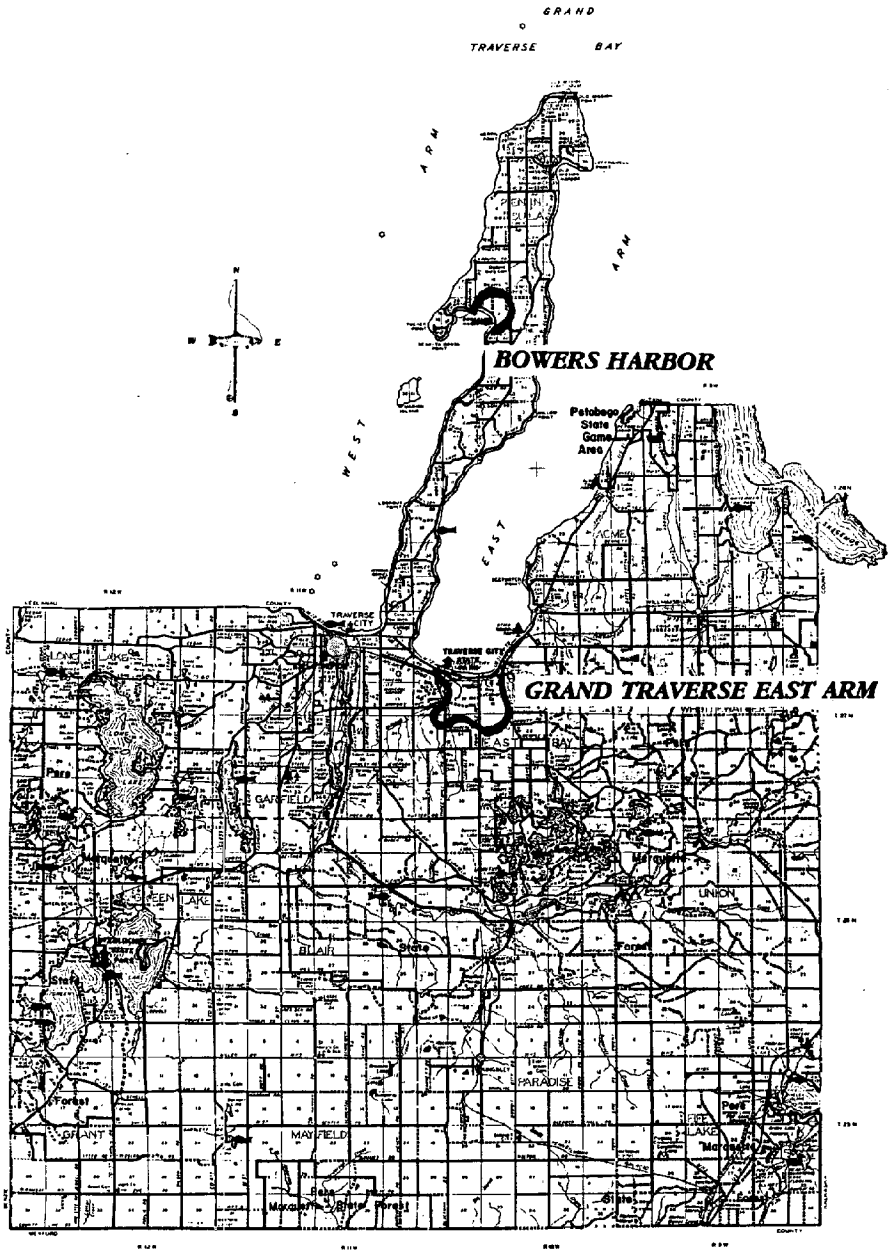
APPENDIX III.5 BENZIE COUNTY



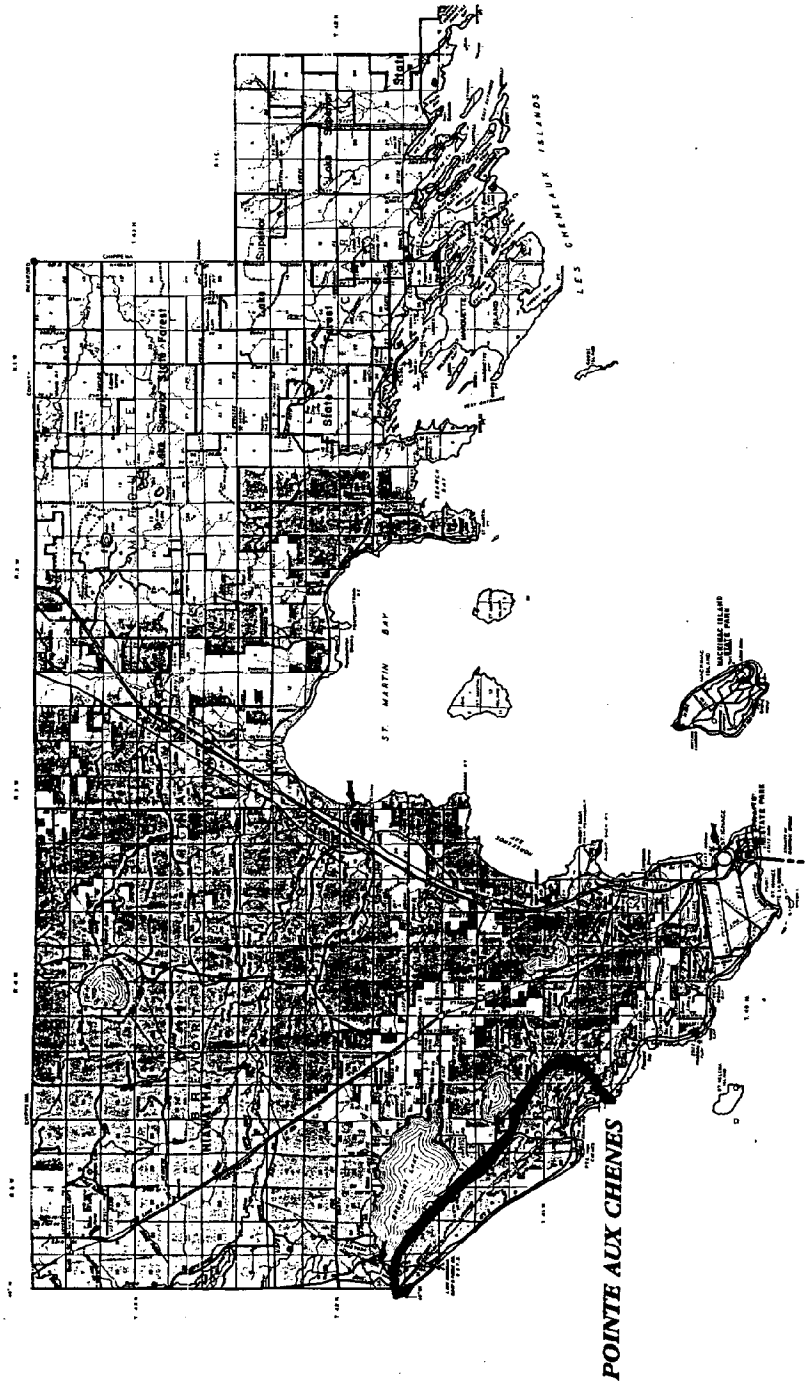
APPENDIX III.6 LEELANAU COUNTY



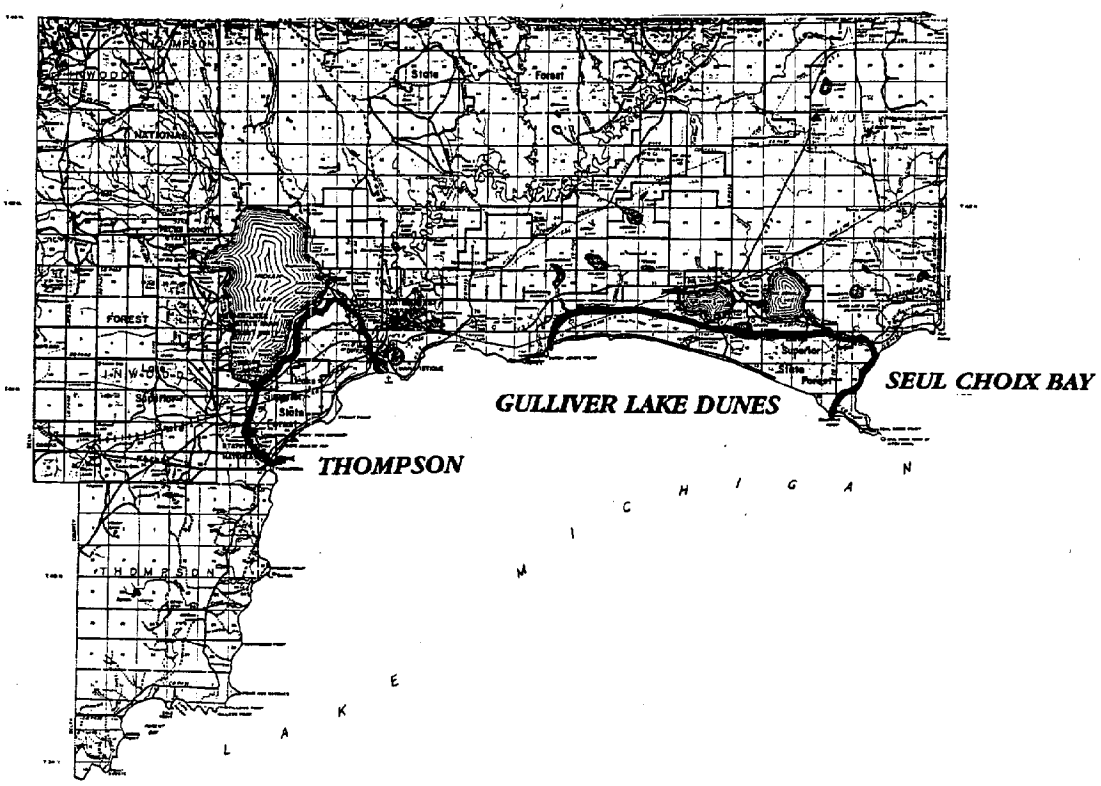
APPENDIX III.7 GRAND TRAVERSE COUNTY



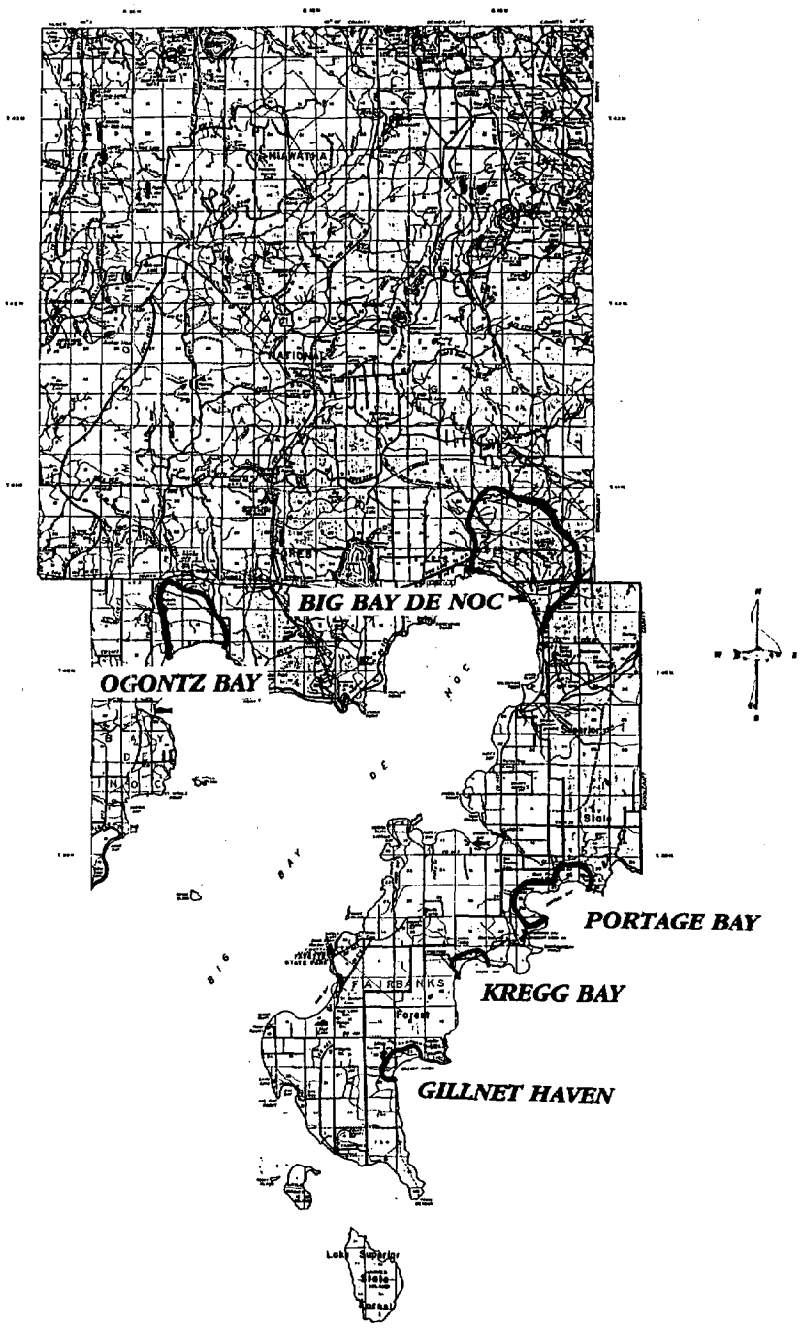
APPENDIX III.8 MACKINAC COUNTY (EAST)



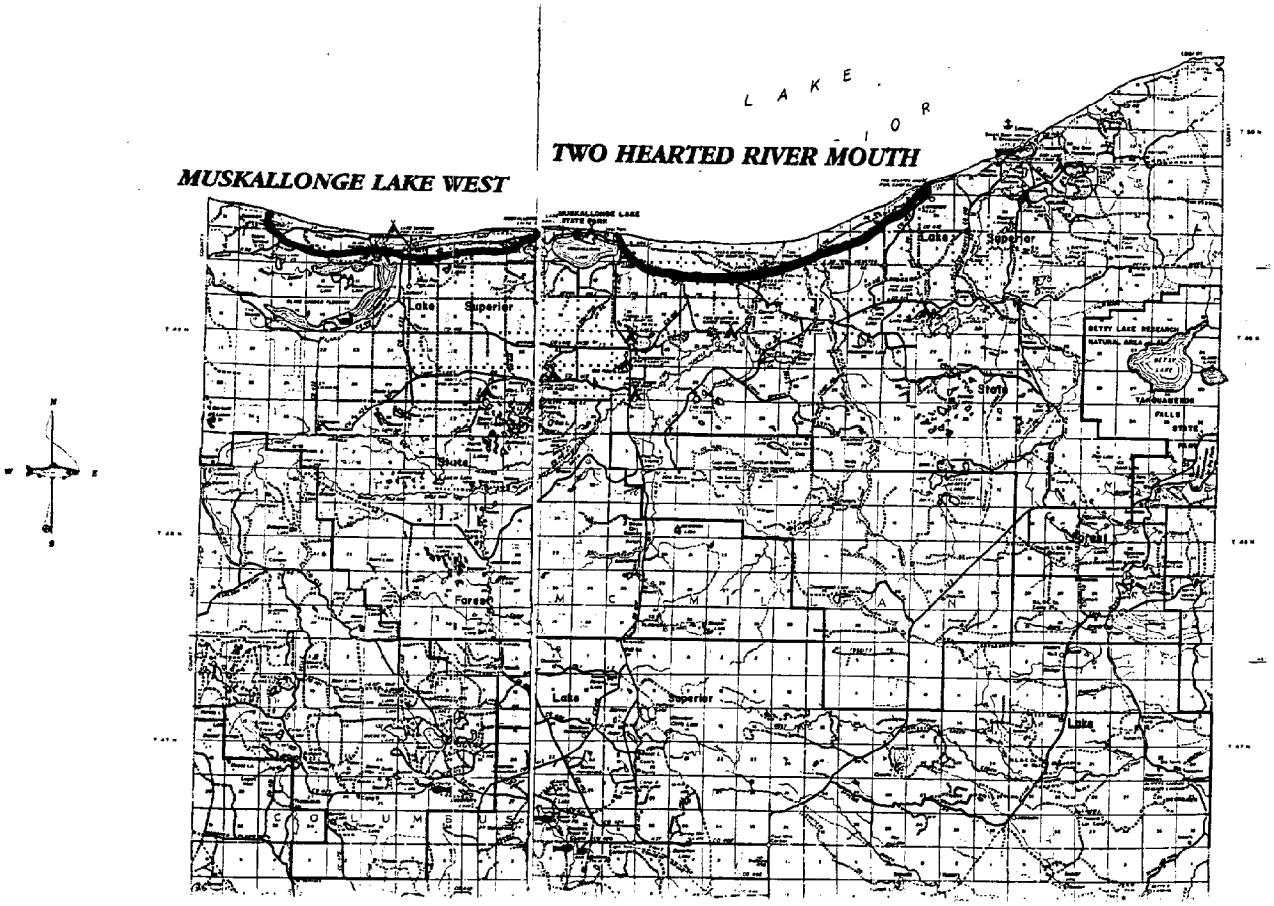
APPENDIX III.9 SCHOOLCRAFT COUNTY



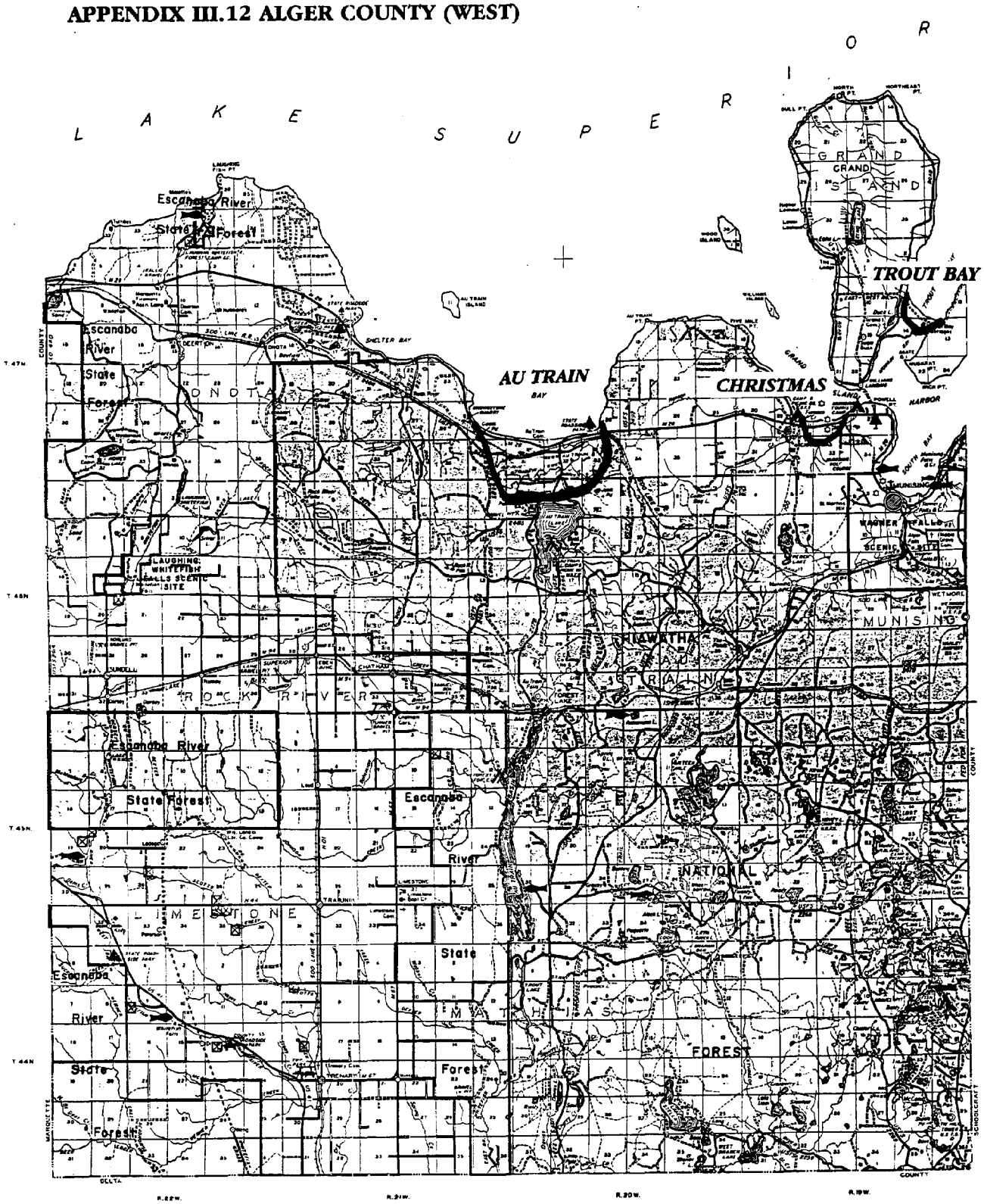
APPENDIX III.10 DELTA COUNTY



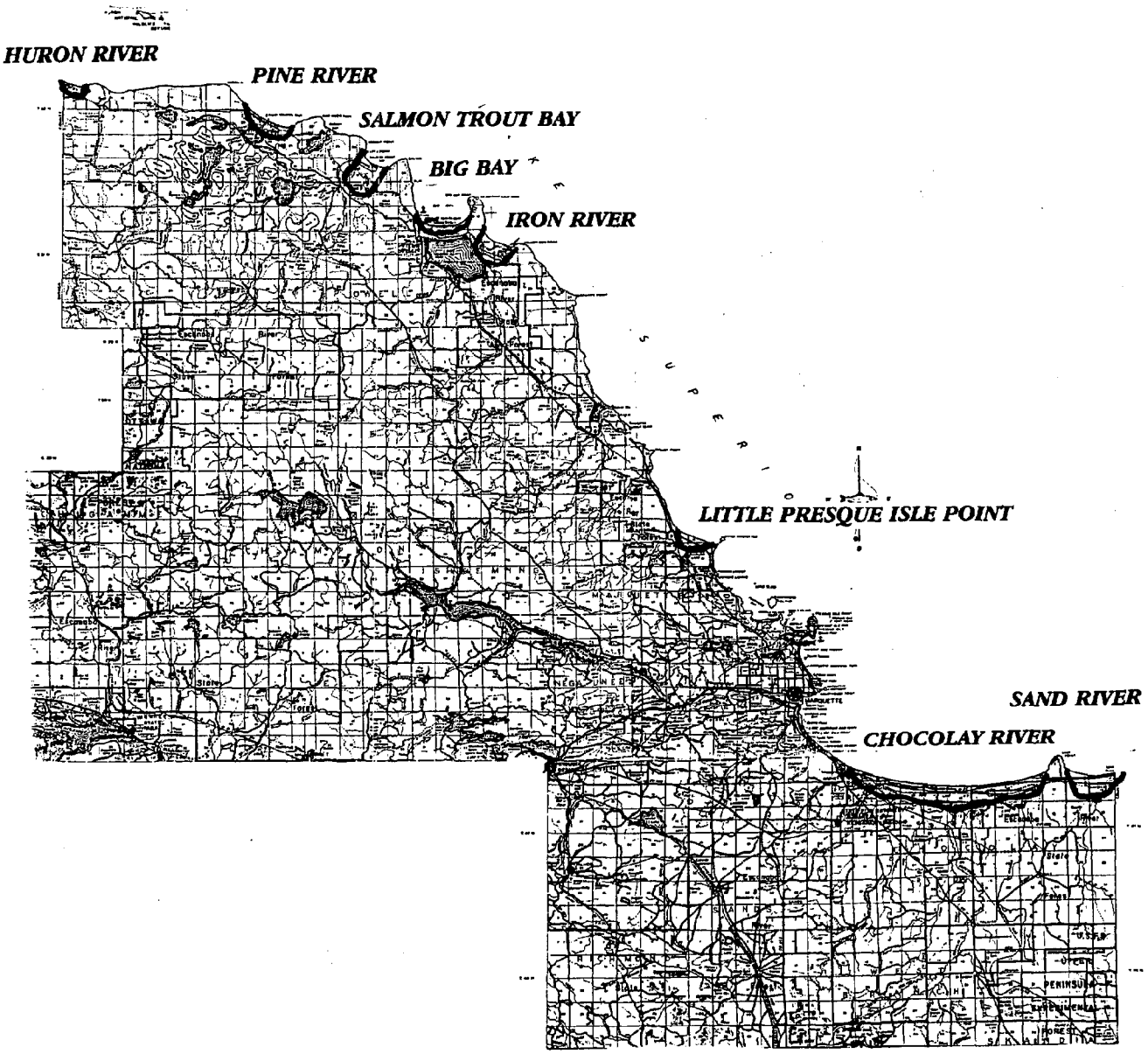
APPENDIX III.11 LUCE COUNTY



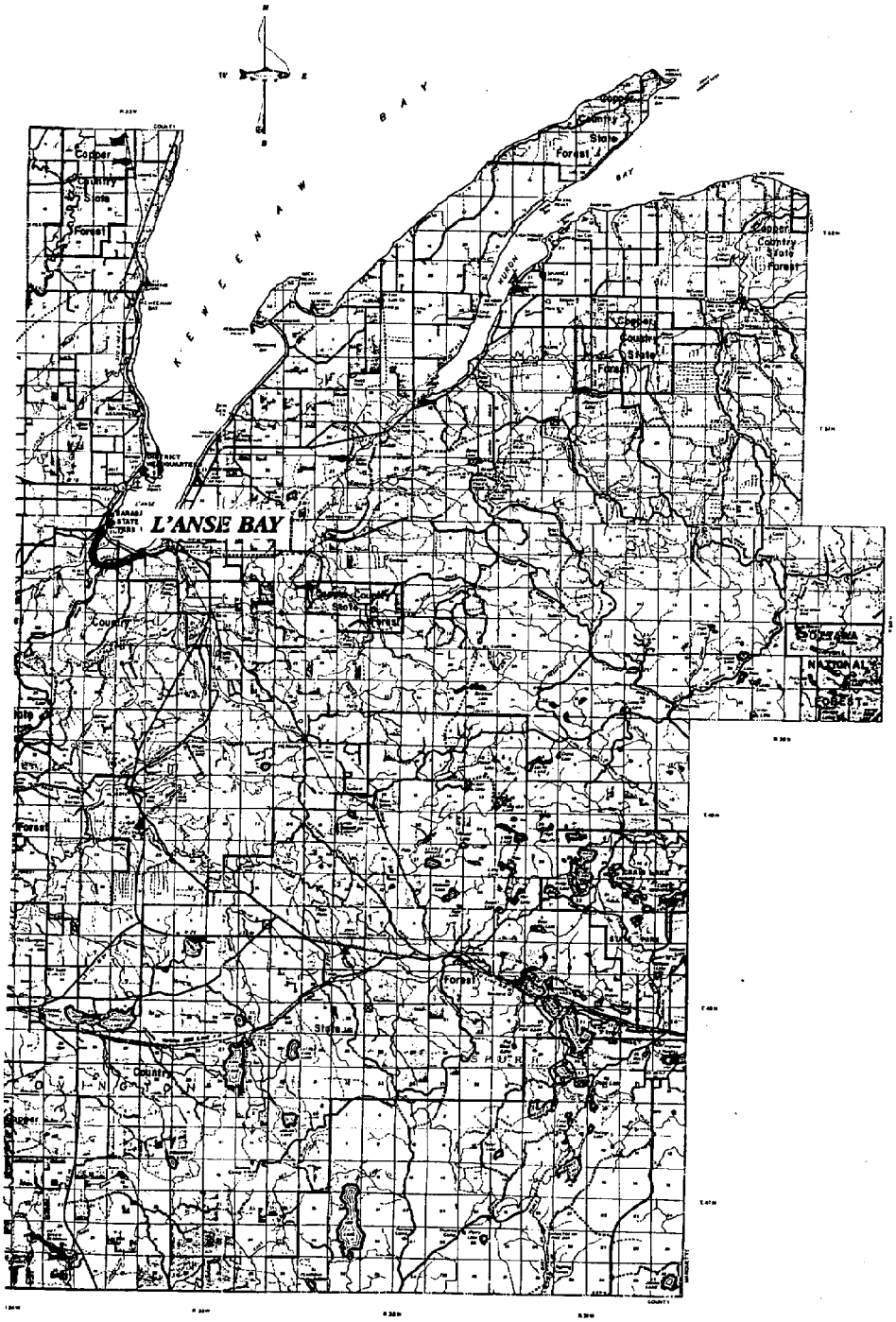
APPENDIX III.12 ALGER COUNTY (WEST)



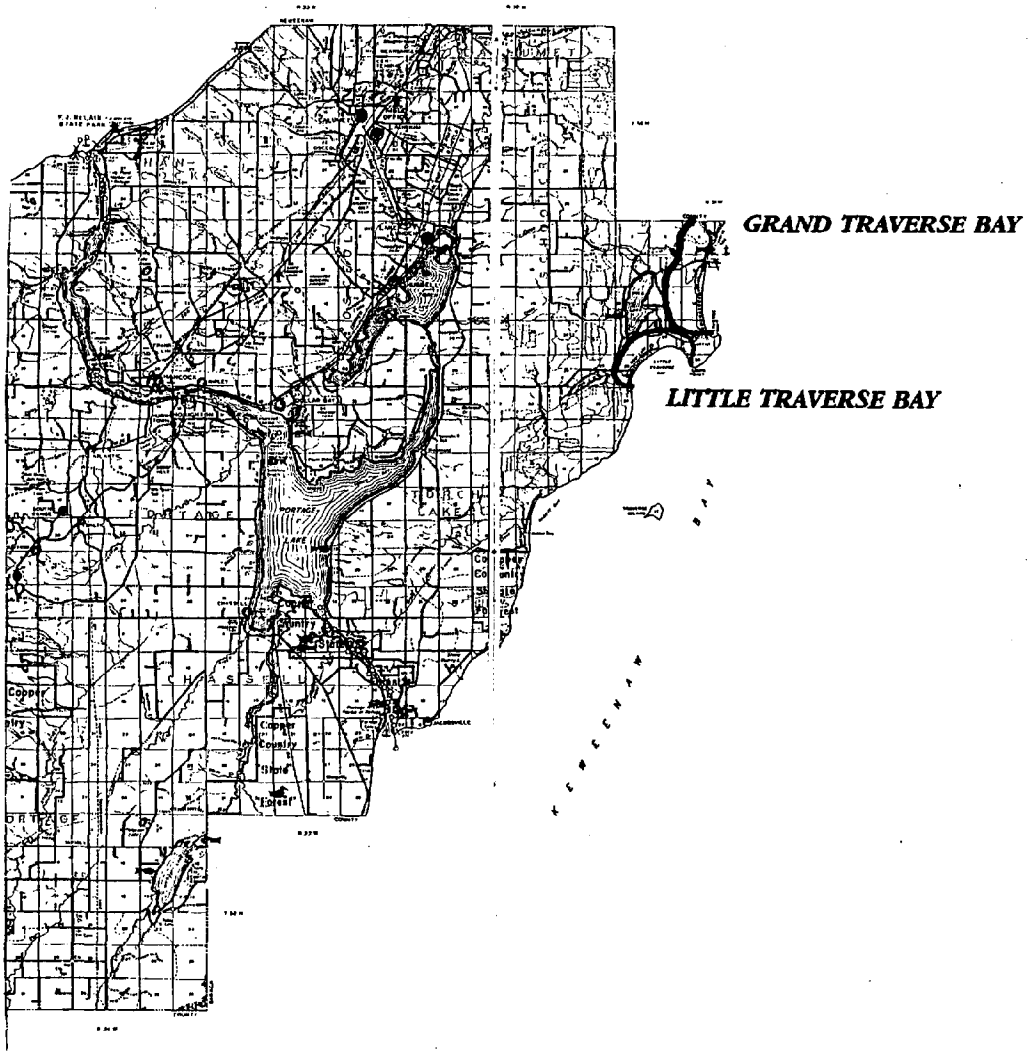
APPENDIX III.13 MARQUETTE COUNTY



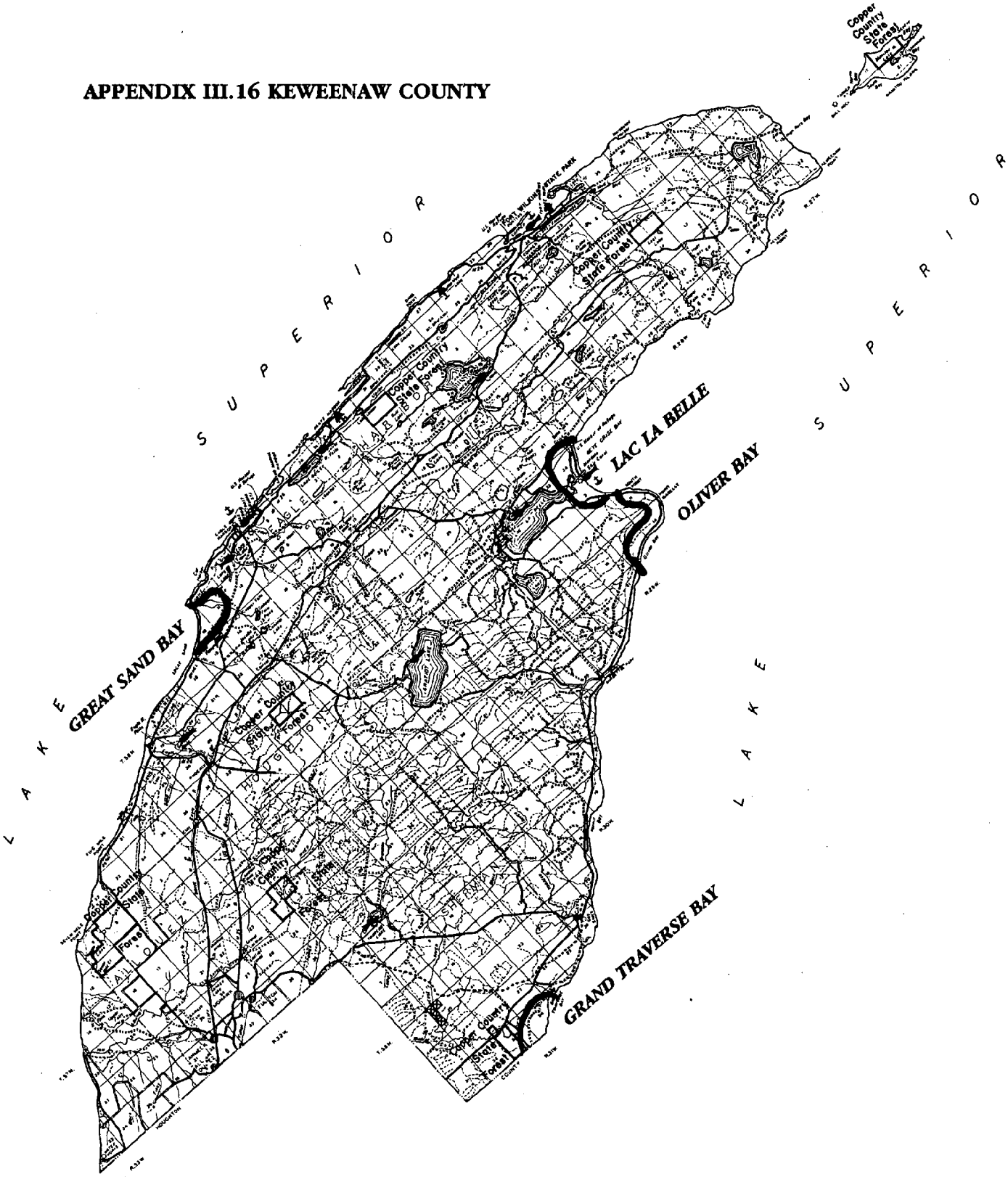
APPENDIX III.14 BARAGA COUNTY



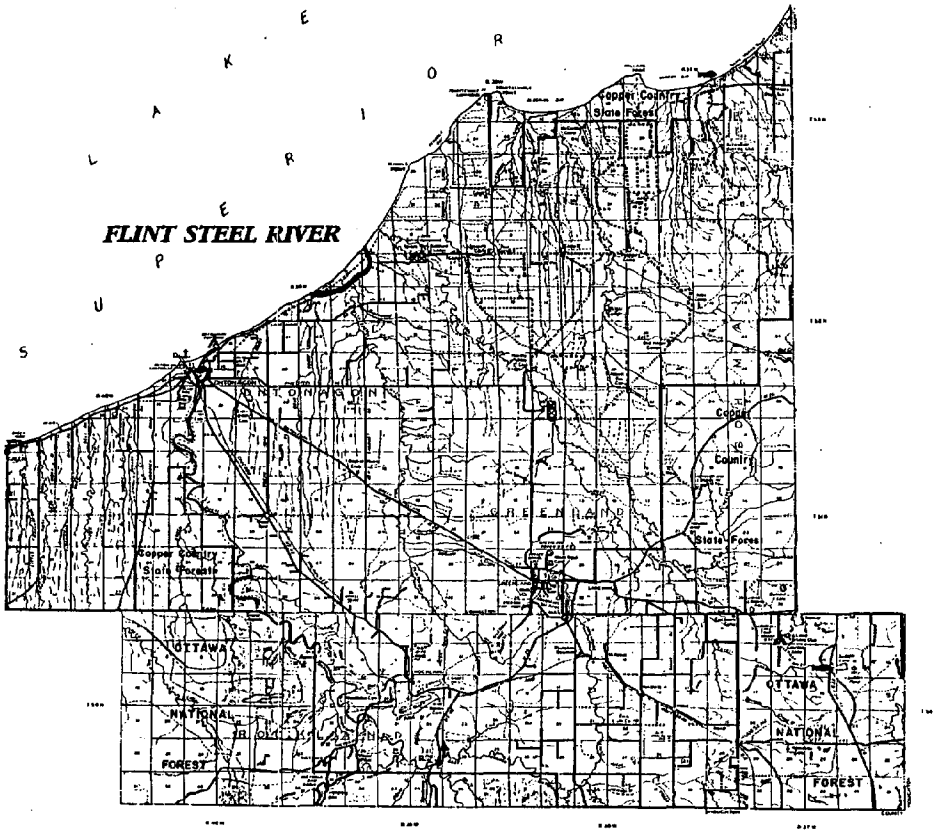
APPENDIX III.15 HOUGHTON COUNTY



APPENDIX III.16 KEWEENAW COUNTY



APPENDIX III.17 ONTONAGON COUNTY



APPENDIX IV

DATA SUMMARIES FOR THREE RERESENTATIVE WOODED DUNE AND SWALE COMPLEXES

STURGEON BAY : NORTHERN LAKE MICHIGAN-HIGH DUNE SUB-TYPE
OGONTZ BAY : NORTHERN LAKE HURON/MICHIGAN-LOW DUNE SUB-TYPE
GRAND TRAVERSE BAY : LAKE SUPERIOR-LOW DUNE SUB-TYPE

REPRESENTATIVE TRANSECT SUMMARIES

The following inventory, compiled by the Michigan Natural Heritage Program, follows in part the nomenclature given in Voss, 1972 and 1985, Michigan Flora Part I & II and Gleason & Cronquist, 1963, Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Each species is preceded by its Coefficient of Conservatism (Wilhelm and Ladd, 1988, Natural Area Assessment in the Chicago Region, Trans. 53rd N. A. Wildl. & Nat. Res. Conf.) (0 = weedy, 10 = conservative). Coefficients of Conservatism are followed by its wetness coefficient (-5 = wet, - 3 = facultative wet, 0 = faculative, 3 = facultative upland, 5 = upland) and corresponding National Wetland Category (OBL = obligate wetland species, FAC = facultative species, UPL = upland species. Native taxa (N) are those species believed to have been present in Michigan prior to European settlement. Adventives (A), shown in all ALL CAPS, INCLUDE those species which have entered Michigan since settlement and are therefore not integral to any natural community.

The first page of each of the following transect summaries contains mean values from each quadrat taken along the transect. Of particular interest for this study is the starred (*) column, indicating the mean for the wetland coefficients for all species found at that sample point. Values below zero indicate a wetland condition, while positive values indicate an upland condition.

Wetland Indicator Categories by Reed (1988) in the *National List of Plant Species that Occur in Wetlands: Michigan* and those assigned by Anton Reznicek and Michael Penskar in The Michigan Floristic Quality Assessment System with Wetland Categories (Herman and Penskar, et al. in prep.) were used for identifying wetland communities in this study. The wetland indicator category for any plant species defines the estimated probability for which a species occurs in wetlands (Reed, 1988; Wilhelm, 1989). Positive (+) and negative (-) signs are attached to the three "Facultative" categories to express exaggerated tendencies for those species (Reed, 1988; Wilhelm, 1989). Coefficients of Wetness (CofW) have been assigned by Wilhelm (1989) to the eleven wetland indicator categories: OBL= -5, FACW+= -4, FACW= -3, FACW-= -2, FAC+= -1, FAC= 0, FAC-= +1, FACU+= +2, FACU= +3, FACU-= +4, UPL= +5.

Individual wetland indicator categories should not be equated to degrees of wetness (Reed, 1988 in Wilhelm, 1989 in Herman and Penskar et. al. in prep). If the Sum of all the Coefficients of Wetness assigned to a constellation of species recorded in a site inventory is averaged, the mean can be regarded as a Wetness Index (Wilhelm, 1989). If the Wetness Index is 0 or below, the constellation of species indicates the site is a wetland based on presence of a predominance of wetland species at a particular site (Wilhelm, 1989). Similarly, mean wetness coefficients can also be calculated for sampling points along a transect within a site. The mean wetness coefficients for each quadrat are shown in Figures 4a, 5a and 6a (pages 21, 23 and 27), with the wetlands easily recognized by bars registering from -5 to 0. The Wetness Index does not take into

account dominance as measured by percent cover of any one species (Herman and Penskar et. al., in prep).

Definitions of Wetland Categories and Assigned Coefficients of Wetness after Reed, 1988 and Wilhelm, 1989.

CofW	Wetland Category	Symbol	Definition
-5	Obligate Wetland	OBL	Occurs almost always in wetlands under natural conditions (estimated > 99% probability).
-3	Facultative Wetland	FACW	Usually occurs in wetlands, but occasionally found in non-wetlands (estimated 67% - 99% probability).
0	Facultative	FAC	Equally likely to occur in wetlands or non-wetlands (estimated 34% - 66% probability).
+3	Facultative Upland	FACU	Occasionally occurs in wetlands, but usually occur in non-wetlands (estimated 1% - 33% probability).
+5	Upland	UPL	Almost never occurs in wetlands under natural conditions (estimated < 1%).

STURGEON BAY

SITE: Sturgeon Bay
COUNTY: Emmet
DATE: July, 1991
BY: P.Comer, K.Herman, M.Mang
FILE: QU_STURG

				TRANSECT DATA,		* QUADRAT				
QUAD	NC	W/Ad	NI	W/Ad	NW	W/Ad	NS	TS	N SEQ	O SEQ
1	5.0	5.0	5.0	5.0	3.0	3.0	1	1	3.0	3.0
2	5.0	5.0	5.0	5.0	3.0	3.0	1	1	2.8	2.8
3	9.8	9.8	19.5	19.5	2.5	2.5	4	4	0.7	0.7
4	8.1	8.1	26.8	26.8	-3.3	-3.3	11	11	0.3	0.3
5	7.9	7.9	23.7	23.7	1.8	1.8	9	9	-0.6	-0.6
6	6.1	6.1	25.0	25.0	-0.3	-0.3	17	17	0.3	0.3
7	6.9	6.9	21.8	21.8	-0.7	-0.7	10	10	-1.9	-1.9
8	8.5	8.5	28.3	28.3	-4.6	-4.6	11	11	-2.1	-2.1
9	6.8	6.8	26.3	26.3	-1.1	-1.1	15	15	-3.5	-3.5
10	8.2	8.2	24.7	24.7	-4.7	-4.7	9	9	-0.9	-0.9
11	7.1	7.1	18.9	18.9	3.1	3.1	7	7	-2.1	-2.1
12	6.7	6.7	16.3	16.3	-4.8	-4.8	6	6	0.2	0.2
13	5.0	5.0	8.7	8.7	2.3	2.3	3	3	-2.3	-2.3
14	8.3	8.3	16.5	16.5	-4.5	-4.5	4	4	-0.6	-0.6
15	7.1	7.1	21.3	21.3	0.3	0.3	9	9	-3.1	-3.1
16	5.0	5.0	5.0	5.0	-5.0	-5.0	1	1	-1.1	-1.1
17	6.2	6.2	18.7	18.7	1.4	1.4	9	9	-1.9	-1.9
18	3.9	3.9	14.4	14.4	-2.3	-2.3	14	14	-0.5	-0.5
19	4.6	4.6	15.9	15.9	-0.8	-0.8	12	12	-2.4	-2.4
20	6.8	6.8	16.7	16.7	-4.2	-4.2	6	6	-1.4	-1.4
21	4.3	4.3	11.3	11.3	0.9	0.9	7	7	-2.1	-2.1
22	4.9	4.9	17.0	17.0	-3.0	-3.0	12	12	-0.1	-0.1
23	4.8	4.8	15.2	15.2	1.7	1.7	10	10	-0.8	-0.8
24	4.7	4.7	12.5	12.5	-1.0	-1.0	7	7	0.8	0.8
25	4.6	4.6	15.4	15.4	1.8	1.8	11	11	-1.4	-1.4
26	6.0	6.0	13.4	13.4	-5.0	-5.0	5	5	-0.9	-0.9
27	4.4	4.4	13.3	13.3	0.6	0.6	9	9	-3.1	-3.1
28	6.0	6.0	6.0	6.0	-5.0	-5.0	1	1	-1.1	-1.1
29	4.9	4.9	12.9	12.9	1.1	1.1	7	7	-2.4	-2.4
30	4.4	4.4	16.6	16.6	-3.4	-3.4	14	14	-0.2	-0.2
31	4.7	4.7	14.9	14.9	1.5	1.5	10	10	-1.5	-1.5
32	5.9	5.9	22.2	22.2	-2.8	-2.8	14	14	-0.9	-0.9
33	5.7	5.7	13.9	13.9	-1.5	-1.5	6	6	-2.5	-2.5
34	5.7	5.7	21.9	21.9	-3.1	-3.1	15	15	-2.1	-2.1
35	5.5	5.5	11.0	11.0	-1.8	-1.8	4	4	-2.7	-2.7
36	5.8	5.8	25.5	25.5	-3.3	-3.3	19	19	-1.7	-1.7
37	4.8	4.8	11.8	11.8	-0.2	-0.2	6	6	-2.4	-2.4
38	6.5	6.5	25.0	25.0	-3.7	-3.7	15	15	-2.0	-2.0
AVG	6.0	6.0	16.8	16.8	-1.2	-1.2	8.7	8.7		
STD	1.4	1.4	6.3	6.3	2.7	2.7	4.6	4.6		

TRANSECT DATA, AGGREGATE

CC	NUMBER			
0	1		118	NATIVE SPECIES
1	2		118	TOTAL SPECIES
2	9	0 to 3	6.4	NATIVE QUALITY
3	8	16.9%	6.4	W/Adventives
4	10		69.1	NATIVE INDEX
5	19	4 to 6	69.1	W/Adventives
6	15	37.3%	-1.7	NATIVE WETNESS
7	7		-1.7	W/Adventives
8	18	7 to 9		
9	1	22.0%		
10	28	10		
		23.7%		

PHYSIOGNOMY

NATIVE	118	100.0%
Tree	12	10.2%
Shrub	25	21.2%
Vine	2	1.7%
Forb	51	43.2%
Fern	6	5.1%
Sedge	15	12.7%
Grass	7	5.9%
ADVENTIVE	0	0.0%
Tree	0	0.0%
Shrub	0	0.0%
Vine	0	0.0%
Forb	0	0.0%
Sedge	0	0.0%
Grass	0	0.0%

PHYSIOGNOMIC RELATIVE IMPORTANCE VALUES

PHYSIOG	FQ	COV	RFQ	RCOV	RIV
N Forb	112	65.5	33.8	25.7	29.8
N Shrub	93	71.5	28.1	28.0	28.1
N Tree	51	28.25	15.4	11.1	13.2
N Sedge	32	31.75	9.7	12.5	11.1
N Fern	21	15	6.3	5.9	6.1
N Grass	20	14.75	6.0	5.8	5.9
N Vine	2	1.25	0.6	0.5	0.5

SPECIES RELATIVE IMPORTANCE VALUES

SCIENTIFIC NAME	CC	WETNESS	FQ	COV	RFQ	RCOV	RIV
Gaylussacia baccata	7	FACU	11	16	1.6	3.5	2.5
Gaultheria procumbens	5	FACU	12	9.25	1.7	2.0	1.9
Vaccinium myrtilloides	4	FACW-	11	9	1.6	1.9	1.8
Picea mariana	6	FACW	9	10.25	1.3	2.2	1.8
Pteridium aquilinum	0	FACU	9	7.5	1.3	1.6	1.5
Carex aquatilis	7	OBL	6	7.25	0.9	1.6	1.2
Trientalis borealis	5	FAC+	9	5.25	1.3	1.1	1.2
Carex interior	3	OBL	6	5.5	0.9	1.2	1.0
Lycopus uniflorus	2	OBL	7	4.75	1.0	1.0	1.0
Juniperus communis	7	facu	2	8	0.3	1.7	1.0
Vaccinium oxycoccos	8	OBL	8	3.5	1.1	0.8	1.0
Abies balsamea	3	FACW	8	3.5	1.1	0.8	1.0
Pinus strobus	3	FACU	7	4	1.0	0.9	0.9
Calamovilfa longifolia	10	UPL	6	3.75	0.9	0.8	0.8
Potentilla palustris	10	OBL	5	4.25	0.7	0.9	0.8
Quercus rubra	5	FACU	6	3	0.9	0.6	0.8

Cladium mariscoides	10	OBL	4	4.25	0.6	0.9	0.7
Potentilla fruticosa	10	FACW	5	3.5	0.7	0.8	0.7
Ammophila breviligulata	10	UPL	3	4.25	0.4	0.9	0.7
Thuja occidentalis	4	FACW	6	2.25	0.9	0.5	0.7
Arctostaphylos uva-ursi	8	upl	5	2.75	0.7	0.6	0.7
Dulichium arundinaceum	8	OBL	3	4	0.4	0.9	0.6
Epigaea repens	7	upl	4	2.5	0.6	0.5	0.6
Calamagrostis canadensis	3	OBL	4	2.5	0.6	0.5	0.6
Thelypteris palustris	2	FACW+	4	2.5	0.6	0.5	0.6
Triglochin maritimum	8	OBL	4	2.5	0.6	0.5	0.6
Equisetum fluviatile	7	OBL	4	2.5	0.6	0.5	0.6
Juncus balticus	4	OBL	4	2.5	0.6	0.5	0.6
Salix cordata	10	FAC+	4	2.5	0.6	0.5	0.6
Andropogon scoparius	5	FACU	3	2.5	0.4	0.5	0.5
Salix myricoides (S. glaucophyl.)	9	FACW	4	1.75	0.6	0.4	0.5
Acer pensylvanicum	5	FACU	4	1.75	0.6	0.4	0.5
Ledum groenlandicum	8	OBL	4	1.75	0.6	0.4	0.5
Melampyrum lineare	6	FAC-	4	1.75	0.6	0.4	0.5
Sparganium minimum	8	OBL	2	3	0.3	0.6	0.5
Claytonia caroliniana	6	FACU	3	2.25	0.4	0.5	0.5
Smilacina stellata	5	FAC-	3	2.25	0.4	0.5	0.5
Potamogeton natans	5	OBL	3	2.25	0.4	0.5	0.5
Carex lasiocarpa	10	OBL	1	3	0.1	0.6	0.4
Utricularia vulgaris	6	OBL	1	3	0.1	0.6	0.4
Lycopus americanus	2	OBL	3	1.5	0.4	0.3	0.4
Rubus pubescens	4	FACW+	3	1.5	0.4	0.3	0.4
Tofieldia glutinosa	10	OBL	3	1.5	0.4	0.3	0.4
Artemisia campestris	5	fac	3	1.5	0.4	0.3	0.4
Linnaea borealis	6	FAC	3	1.5	0.4	0.3	0.4
Juniperus horizontalis	10	FAC-	2	2	0.3	0.4	0.4
Carex pseudo-cyperus	5	OBL	3	0.75	0.4	0.2	0.3
Myrica gale	6	OBL	3	0.75	0.4	0.2	0.3
Larix laricina	5	FACW	3	0.75	0.4	0.2	0.3
Betula papyrifera	2	FACU+	3	0.75	0.4	0.2	0.3
Carex oligosperma	10	OBL	1	2	0.1	0.4	0.3
Glyceria striata	4	OBL	2	1.25	0.3	0.3	0.3
Asclepias syriaca	1	UPL	2	1.25	0.3	0.3	0.3
Lithospermum canescens	10	UPL	2	1.25	0.3	0.3	0.3
Euthamia graminifolia (Solidago)	3	FACW-	2	1.25	0.3	0.3	0.3
Lobelia kalmii	10	OBL	2	1.25	0.3	0.3	0.3
Moneses uniflora	8	FAC	2	1.25	0.3	0.3	0.3
Acer rubrum	1	FAC	2	1.25	0.3	0.3	0.3
Triadenum fraseri (Hypericum)	6	OBL	2	1.25	0.3	0.3	0.3
Ilex verticillata	5	FACW+	2	1.25	0.3	0.3	0.3
Proserpinaca palustris	6	OBL	2	1.25	0.3	0.3	0.3
Gentianopsis crinita (Gentiana)	8	FACW+	2	0.5	0.3	0.1	0.2
Sarracenia purpurea	10	OBL	2	0.5	0.3	0.1	0.2
Iris versicolor	5	OBL	2	0.5	0.3	0.1	0.2
Solidago houghtonii **	10	OBL	2	0.5	0.3	0.1	0.2
Utricularia cornuta	10	OBL	2	0.5	0.3	0.1	0.2
Solidago uliginosa	4	OBL	2	0.5	0.3	0.1	0.2
Gaultheria hispidula	8	FACW	2	0.5	0.3	0.1	0.2
Clintonia borealis	5	FAC+	2	0.5	0.3	0.1	0.2
Andromeda glaucophylla	10	OBL	2	0.5	0.3	0.1	0.2

Cornus canadensis	6	FAC	2	0.5	0.3	0.1	0.2
Hypericum kalmianum	10	FACW-	2	0.5	0.3	0.1	0.2
Osmunda regalis	5	OBL	2	0.5	0.3	0.1	0.2
Campanula aparinoides	7	OBL	2	0.5	0.3	0.1	0.2
Cakile edentula	5	FACU	2	0.5	0.3	0.1	0.2
Maianthemum canadense	4	FAC	2	0.5	0.3	0.1	0.2
Cornus rugosa	6	UPL	2	0.5	0.3	0.1	0.2
Kalmia polifolia	10	OBL	1	1	0.1	0.2	0.2
Scirpus acutus	5	OBL	1	1	0.1	0.2	0.2
Eleocharis smallii	5	OBL	1	1	0.1	0.2	0.2
Equisetum palustre	10	FACW	1	1	0.1	0.2	0.2
Epilobium angustifolium	3	FAC	1	1	0.1	0.2	0.2
Chimaphila umbellata	8	upl	1	1	0.1	0.2	0.2
Fragaria virginiana	2	FAC-	1	1	0.1	0.2	0.2
Diervilla lonicera	4	UPL	1	1	0.1	0.2	0.2
Satureja arkansana	10	FACW	1	1	0.1	0.2	0.2
Drosera intermedia	8	OBL	1	1	0.1	0.2	0.2
Rosa palustris	5	OBL	1	1	0.1	0.2	0.2
Drosera linearis	10	OBL	1	1	0.1	0.2	0.2
Eupatorium maculatum	4	OBL	1	1	0.1	0.2	0.2
Carex stricta	4	OBL	1	1	0.1	0.2	0.2
Eriophorum virginicum	8	OBL	1	1	0.1	0.2	0.2
Prunus pumila	8	UPL	1	1	0.1	0.2	0.2
Lonicera dioica	5	FACU	1	1	0.1	0.2	0.2
Zigadenus glaucus	10	FACW	1	1	0.1	0.2	0.2
Equisetum scirpoides	7	FAC+	1	1	0.1	0.2	0.2
Pinus resinosa	6	FACU	1	0.25	0.1	0.1	0.1
Carex paupercula	8	OBL	1	0.25	0.1	0.1	0.1
Toxicodendron radicans	2	FAC+	1	0.25	0.1	0.1	0.1
Picea glauca	3	FACU	1	0.25	0.1	0.1	0.1
Carex lacustris	6	OBL	1	0.25	0.1	0.1	0.1
Smilacina trifolia	10	OBL	1	0.25	0.1	0.1	0.1
Carex cryptolepis	10	OBL	1	0.25	0.1	0.1	0.1
Juncus effusus	3	OBL	1	0.25	0.1	0.1	0.1
Carex canescens	8	OBL	1	0.25	0.1	0.1	0.1
Tanacetum huronense **	10	facu-	1	0.25	0.1	0.1	0.1
Cornus stolonifera	2	FACW	1	0.25	0.1	0.1	0.1
Oenothera biennis	2	FACU	1	0.25	0.1	0.1	0.1
Cirsium pitcheri **	10	UPL	1	0.25	0.1	0.1	0.1
Pyrola elliptica	6	UPL	1	0.25	0.1	0.1	0.1
Populus balsamifera	2	FACW	1	0.25	0.1	0.1	0.1
Lathyrus japonicus	10	FACU-	1	0.25	0.1	0.1	0.1
Calamagrostis inexpansa	8	FACW+	1	0.25	0.1	0.1	0.1
Rhamnus alnifolia	8	OBL	1	0.25	0.1	0.1	0.1
Muhlenbergia glomerata	10	FACW+	1	0.25	0.1	0.1	0.1
Pyrola chlorantha	8	FACU	1	0.25	0.1	0.1	0.1
Viola renifolia	6	FACW	1	0.25	0.1	0.1	0.1
Polygonum amphibium	6	OBL	1	0.25	0.1	0.1	0.1
			369	228			

TRANSECT INVENTORY

ACRONYM	SCIENTIFIC NAME	COMMON NAME
ABIBA	Abies balsamea	BALSAM FIR
ACEPN	Acer pensylvanicum	STRIPED MAPLE; MOOSEWOOD
ACERU	Acer rubrum	RED MAPLE
AMMBR	Ammophila breviligulata	MARRAM GRASS; BEACH GRASS
ANDGL	Andromeda glaucophylla	BOG ROSEMARY
ANDSC	Andropogon scoparius	LITTLE BLUESTEM GRASS
ARCUV	Arctostaphylos uva-ursi	BEARBERRY
ARTCA	Artemisia campestris	WORMWOOD
ASCSY	Asclepias syriaca	COMMON MILKWEED
BETPA	Betula papyrifera	PAPER BIRCH
CAKED	Cakile edentula	SEA ROCKET
CALCA	Calamagrostis canadensis	BLUE-JOINT GRASS
CALINB	Calamagrostis inexpansa	BOG REEDGRASS
CALLO	Calamovilfa longifolia	SAND REED; DUNE REED
CAMAP	Campanula aparinoides	MARSH BELLFLOWER
CXAQUA	Carex aquatilis	SEDGE
CXCANE	Carex canescens	SEDGE
CXCRYP	Carex cryptolepis	SEDGE
CXINTE	Carex interior	SEDGE
CXLACU	Carex lacustris	SEDGE
CXLASA	Carex lasiocarpa	SEDGE
CXOLGS	Carex oligosperma	SEDGE
CXPAUP	Carex paupercula	SEDGE
CXPSEU	Carex pseudo-cyperus	SEDGE
CXSTRI	Carex stricta	SEDGE
CHIUM	Chimaphila umbellata	PRINCE'S PINE; PIPSPSSEWA
CIRPI	Cirsium pitcheri **	PITCHER'S THISTLE
CLAMA	Cladium mariscoides	TWIG-RUSH
CLACA	Claytonia caroliniana	CAROLINA SPRING-BEAUTY
CLIBO	Clintonia borealis	BLUEBEAD-LILY; CORN-LILY
CORCAD	Cornus canadensis	BUNCHBERRY; DWARF CORNELL
CORRU	Cornus rugosa	ROUND-LEAVED DOGWOOD
CORSTO	Cornus stolonifera	RED-OSIER
DIELO	Diervilla lonicera	BUSH HONEYSUCKLE
DROIN	Drosera intermedia	SUNDEW
DROLI	Drosera linearis	LINEAR-LEAVED SUNDEW
DULAR	Dulichium arundinaceum	THREE-WAY SEDGE
ELESM	Eleocharis smallii	SPIKE-RUSH
EPIRE	Epigaea repens	TRAILING ARBUTUS; MAYFLOWER
EPIAN	Epilobium angustifolium	FIREWEED; GREAT WILLOW-HERB
EQUFL	Equisetum fluviatile	WATER HORSETAIL
EQUPA	Equisetum palustre	MARSH-HORSETAIL
EQUSC	Equisetum scirpoides	DWARF SCOURING RUSH
ERIVIG	Eriophorum virginicum	TAWNY COTTON-GRASS
EUPMAU	Eupatorium maculatum	JOE-PIE WEED
EUTGR	Euthamia graminifolia (Solidago)	GRASS-LEAVED GOLDENROD
FRAVI	Fragaria virginiana	WILD STRAWBERRY
GAUHI	Gaultheria hispidula	CREEPING SNOWBERRY
GAUPR	Gaultheria procumbens	WINTERGREEN
GAYBA	Gaylussacia baccata	HUCKLEBERRY
GENCR	Gentianopsis crinita (Gentiana)	FRINGED GENTIAN

GLYST	Glyceria striata	FOWL MANNA GRASS
HYPKA	Hypericum kalmianum	KALM'S ST. JOHN'S WORT
ILEVE	Ilex verticillata	WINTERBERRY; MICHIGAN HOLLY
IRIVE	Iris versicolor	WILD BLUE FLAG
JUNBA	Juncus balticus	RUSH
JUNEF	Juncus effusus	SOFT-STEMMED RUSH
JUNCOM	Juniperus communis	COMMON or GROUND JUNIPER
JUNHO	Juniperus horizontalis	CREEPING JUNIPER
KALPO	Kalmia polifolia	SWAMP-LAUREL
LARLA	Larix laricina	TAMARACK; LARCH
LATJAG	Lathyrus japonicus	BEACH PEA
LEDGR	Ledum groenlandicum	LABRADOR TEA
LINBO	Linnaea borealis	TWINFLOWER
LITCAN	Lithospermum canescens	HOARY PUCCOON
LOBKA	Lobelia kalmii	BOG LOBELIA
LONDI	Lonicera dioica	RED HONEYSUCKLE
LYCAM	Lycopus americanus	COMMON WATER HOREHOUND
LYCUN	Lycopus uniflorus	NORTHERN BUGLE WEED
MAICA	Maianthemum canadense	CANADA MAYFLOWER; WILD OR FALS
MELLI	Melampyrum lineare	COW-WHEAT
MONUNI	Moneses uniflora	ONE-FLOWERED PYROLA
MUHGL	Muhlenbergia glomerata	MARSH WILD-TIMOTHY
MYRGA	Myrica gale	SWEET GALE
OENBI	Oenothera biennis	COMMON EVENING-PRIMROSE
OSMRE	Osmunda regalis	ROYAL FERN
PICGL	Picea glauca	WHITE SPRUCE
PICMA	Picea mariana	BLACK SPRUCE
PINRE	Pinus resinosa	RED PINE
PINST	Pinus strobus	WHITE PINE
POLAME	Polygonum amphibium	WATER SMARTWEED
POPBA	Populus balsamifera	BALSAM POPLAR; HACKMATACK
POTNA	Potamogeton natans	PONDWEED
POTFRU	Potentilla fruticosa	SHRUBBY CINQUEFOIL
POTPAL	Potentilla palustris	MARSH CINQUEFOIL
PROPA	Proserpinaca palustris	MERMAID-WEED
PRUPU	Prunus pumila	SAND CHERRY
PTEAQ	Pteridium aquilinum	BRACKEN FERN
PYRCH	Pyrola chlorantha	SHINLEAF
PYREL	Pyrola elliptica	LARGE-LEAVED SHINLEAF
QUERU	Quercus rubra	RED OAK
RHAAL	Rhamnus alnifolia	ALDER-LEAVED BUCKTHORN
ROSPA	Rosa palustris	SWAMP ROSE
RUBPU	Rubus pubescens	DWARF RASPBERRY
SALCO	Salix cordata	SAND-DUNE or FURRY WILLOW
SALMY	Salix myricoides (S. glaucophylloides)	BLUELEAF WILLOW
SARPU	Sarracenia purpurea	PITCHER-PLANT
SATAR	Satureja arkansana	LOW CALAMINT
SCIAC	Scirpus acutus	HARDSTEM BULRUSH
SMIST	Smilacina stellata	STARRY FALSE SOLOMON SEAL
SMITR	Smilacina trifolia	FALSE MAYFLOWER
SOLHO	Solidago houghtonii **	HOUGHTON'S GOLDENROD
SOLULI	Solidago uliginosa	BOG GOLDENROD
SPAMI	Sparganium minimum	SMALL BUR-REED
TANHU	Tanacetum huronense **	LAKE HURON TANSY

THEPA	Thelypteris palustris	MARSH FERN
THUOC	Thuja occidentalis	ARBOR VITAE
TOFGL	Tofieldia glutinosa	FALSE ASPHODEL
TOXRA	Toxicodendron radicans	POISON-IVY
TRIFR	Triadenum fraseri (Hypericum)	MARSH ST. JOHN'S-WORT
TRIBO	Trientalis borealis	STARFLOWER
TRIMA	Triglochin maritimum	COMMON BOG ARROW-GRASS
UTRCO	Utricularia cornuta	HORNED BLADDERWORT
UTRVU	Utricularia vulgaris	GREAT BLADDERWORT
VACMY	Vaccinium myrtilloides	CANADA BLUEBERRY
VACOX	Vaccinium oxycoccos	SMALL CRANBERRY
VIORE	Viola renifolia	KIDNEY-LEAVED VIOLET
ZIGGL	Zigadenus glaucus	WHITE CAMAS

OGONTZ BAY

SITE: Ogontz Bay
COUNTY: Delta
DATE: August, 1992
BY: P.Comer, L.Mattei
FILE: qu_ogon

TRANSECT DATA, QUADRAT

QUAD	NC	W/Ad	NI	W/Ad	NW	W/Ad	NS	TS	N SEQ	O SEQ
1	5.7	5.3	21.4	20.7	-2.5	-2.0	14	15	-3.3	-2.3
2	4.4	3.7	9.8	9.0	-4.0	-2.5	5	6	-3.8	-3.2
3	5.3	5.3	9.2	9.2	-5.0	-5.0	3	3	-3.6	-3.1
4	4.3	4.3	13.0	13.0	-1.7	-1.7	9	9	-3.5	-3.5
5	5.3	5.3	23.5	23.5	-3.7	-3.7	20	20	-1.9	-1.9
6	5.2	5.2	22.5	22.5	-0.5	-0.5	19	19	-2.1	-2.1
7	4.6	4.6	18.5	18.5	-2.2	-2.2	16	16	-1.3	-1.3
8	5.2	5.2	22.2	22.2	-1.2	-1.2	18	18	-1.4	-1.4
9	5.3	5.3	24.2	24.2	-0.9	-0.9	21	21	-1.2	-1.2
10	5.0	5.0	22.9	22.9	-1.4	-1.4	21	21	-1.2	-1.2
11	5.1	5.1	22.8	22.8	-1.3	-1.3	20	20	-1.5	-1.5
12	5.6	5.6	20.8	20.8	-1.9	-1.9	14	14	-1.5	-1.5
13	5.3	5.3	19.1	19.1	-1.3	-1.3	13	13	-1.0	-1.0
14	4.3	4.3	12.0	12.0	0.3	0.3	8	8	-1.3	-1.3
15	4.6	4.6	17.4	17.4	-2.7	-2.7	14	14	-1.1	-1.1
16	5.7	5.7	21.9	21.9	-0.9	-0.9	15	15	-1.8	-1.8
17	5.0	5.0	20.0	20.0	-1.8	-1.8	16	16	-1.1	-1.1
18	4.7	4.7	17.6	17.6	-0.7	-0.7	14	14	-1.3	-1.3
19	5.1	5.1	20.3	20.3	-1.5	-1.5	16	16	-0.8	-0.8
20	4.2	4.2	14.4	14.4	-0.3	-0.3	12	12	-1.2	-1.2
21	5.1	5.1	19.6	19.6	-1.7	-1.7	15	15	-0.8	-0.8
22	4.5	4.5	15.1	15.1	-0.5	-0.5	11	11	-1.2	-1.1
23	5.4	5.1	22.3	21.7	-1.2	-1.2	17	18	-0.7	-0.7
24	4.8	4.8	15.2	15.2	-0.4	-0.4	10	10	-1.0	-1.0
25	4.8	4.8	17.2	17.2	-1.3	-1.3	13	13	-1.0	-1.0
26	5.5	5.5	20.6	20.6	-1.2	-1.2	14	14	-1.8	-1.8
27	5.3	5.3	21.3	21.3	-3.0	-3.0	16	16	-2.2	-2.2
28	5.0	5.0	21.8	21.8	-2.3	-2.3	19	19	-2.5	-2.5
29	5.0	5.0	15.8	15.8	-2.1	-2.1	10	10	-1.6	-1.6
30	5.4	5.4	20.0	20.0	-0.4	-0.4	14	14	-1.4	-1.4
31	4.8	4.8	21.1	21.1	-1.6	-1.6	19	19	-1.0	-1.0
32	5.5	5.5	19.7	19.7	-1.2	-1.2	13	13	-2.1	-2.1
33	6.6	6.6	25.6	25.6	-3.5	-3.5	15	15	-2.3	-2.3
AVG	5.1	5.0	19.1	19.0	-1.7	-1.6	14.4	14.5		
STD	0.5	0.5	4.0	4.0	1.2	1.1	4.2	4.2		

TRANSECT DATA, AGGREGATE

CC	NUMBER		
0	4		
1	3		
2	8	0 to 3	
3	9		22.4%
4	15		
5	25	4 to 6	
6	16		52.3%
7	6		
8	11	7 to 9	
9	4		19.6%
10	6	10	
			5.6%

104	NATIVE SPECIES
107	TOTAL SPECIES
5.3	NATIVE QUALITY
5.2	W/Adventives
54.2	NATIVE INDEX
53.5	W/Adventives
-1.9	NATIVE WETNESS
-1.8	W/Adventives

PHYSIOGNOMY

NATIVE	104	97.2%
Tree	10	9.3%
Shrub	17	15.9%
Vine	0	0.0%
Forb	47	43.9%
Fern	12	11.2%
Sedge	12	11.2%
Grass	6	5.6%
ADVENTIVE	3	2.8%
Tree	0	0.0%
Shrub	0	0.0%
Vine	0	0.0%
Forb	3	2.8%
Sedge	0	0.0%
Grass	0	0.0%

PHYSIOGNOMIC RELATIVE IMPORTANCE VALUES

PHYSIOG	FQ	COV	RFQ	RCOV	RIV
N Forb	187	148.75	39.2	34.4	36.8
N Tree	115	73	24.1	16.9	20.5
N Shrub	78	55.25	16.4	12.8	14.6
N Sedge	45	40.25	9.4	9.3	9.4
N Fern	37	24	7.8	5.5	6.6
N Grass	12	7.5	2.5	1.7	2.1
A Forb	3	2.25	0.6	0.5	0.6

SPECIES RELATIVE IMPORTANCE VALUES

SCIENTIFIC NAME	CC	WETNESS	FQ	COV	RFQ	RCOV	RIV
Abies balsamea	3	FACW	27	24.25	2.7	3.4	3.1
Coptis trifoliata (C. groenland	5	FACW	23	23.75	2.3	3.3	2.8
Thuja occidentalis	4	FACW	29	15.25	2.9	2.1	2.5
Trientalis borealis	5	FAC+	20	17.75	2.0	2.5	2.3
Gaultheria hispidula	8	FACW	19	14.75	1.9	2.1	2.0
Carex trisperma	9	OBL	17	14.75	1.7	2.1	1.9
Viola rostrata	6	FACU	14	15	1.4	2.1	1.8
Acer rubrum	1	FAC	17	12.5	1.7	1.8	1.7
Linnaea borealis	6	FAC	15	13.75	1.5	1.9	1.7
Betula papyrifera	2	FACU+	17	11	1.7	1.5	1.6
Cornus canadensis	6	FAC	15	10.5	1.5	1.5	1.5
Mitella nuda	8	FACW	13	10.75	1.3	1.5	1.4
Maianthemum canadense	4	FAC	13	8.5	1.3	1.2	1.3
Rubus pubescens	4	FACW+	12	8.25	1.2	1.2	1.2
Alnus rugosa	5	OBL	6	8.5	0.6	1.2	0.9
Aralia nudicaulis	5	FACU	10	5.5	1.0	0.8	0.9

Lycopodium annotinum	5	FAC	6	8	0.6	1.1	0.9
Carex disperma	10	OBL	6	8	0.6	1.1	0.9
Polygala paucifolia	7	FACU	8	5.75	0.8	0.8	0.8
Dryopteris spinulosa (D. carthu.)	5	FACW-	10	4	1.0	0.6	0.8
Carex leptalea	5	OBL	6	5.5	0.6	0.8	0.7
Ledum groenlandicum	8	OBL	7	4.75	0.7	0.7	0.7
Picea mariana	6	FACW	10	2.5	1.0	0.4	0.7
Picea glauca	3	FACU	7	3.25	0.7	0.5	0.6
Galium circaezans	4	FACU-	6	3.75	0.6	0.5	0.6
Clintonia borealis	5	FAC+	6	3	0.6	0.4	0.5
Calamagrostis canadensis	3	OBL	5	2.75	0.5	0.4	0.4
Rhamnus alnifolia	8	OBL	4	2.5	0.4	0.4	0.4
Solidago canadensis	1	FACU	4	2.5	0.4	0.4	0.4
Fraxinus nigra	6	FACW+	4	2.5	0.4	0.4	0.4
Gymnocarpium dryopteris	5	FAC	4	2.5	0.4	0.4	0.4
Lycopus uniflorus	2	OBL	3	3	0.3	0.4	0.4
Thelypteris palustris	2	FACW+	3	3	0.3	0.4	0.4
Goodyera repens ophioides	9	FACU	4	1.75	0.4	0.2	0.3
Cirsium muticum	6	OBL	4	1.75	0.4	0.2	0.3
Viola renifolia	6	FACW	3	2.25	0.3	0.3	0.3
Amelanchier spicata	4	FACU	3	2.25	0.3	0.3	0.3
Carex arctata	3	UPL	3	2.25	0.3	0.3	0.3
Carex interior	3	OBL	4	1	0.4	0.1	0.3
Carex stricta	4	OBL	1	3	0.1	0.4	0.3
Glyceria striata	4	OBL	3	1.5	0.3	0.2	0.3
Lycopodium clavatum	4	FAC	3	1.5	0.3	0.2	0.3
Smilacina trifolia	10	OBL	2	2	0.2	0.3	0.2
Potentilla anserina	5	FACW+	2	2	0.2	0.3	0.2
Moneses uniflora	8	FAC	2	2	0.2	0.3	0.2
Platanthera clavellata (Habenar.)	6	facw+	3	0.75	0.3	0.1	0.2
Botrychium virginianum	5	FACU	3	0.75	0.3	0.1	0.2
Vaccinium angustifolium	4	FACU	3	0.75	0.3	0.1	0.2
Utricularia intermedia	10	OBL	1	2	0.1	0.3	0.2
Cornus stolonifera	2	FACW	2	1.25	0.2	0.2	0.2
Equisetum palustre	10	FACW	2	1.25	0.2	0.2	0.2
Larix laricina	5	FACW	2	1.25	0.2	0.2	0.2
Euthamia graminifolia (Solidago)	3	FACW-	2	1.25	0.2	0.2	0.2
Carex paupercula	8	OBL	2	1.25	0.2	0.2	0.2
Carex canescens	8	OBL	2	1.25	0.2	0.2	0.2
Caltha palustris	6	OBL	2	1.25	0.2	0.2	0.2
Athyrium filix-femina	4	FAC	2	1.25	0.2	0.2	0.2
Diervilla lonicera	4	UPL	2	0.5	0.2	0.1	0.1
Impatiens capensis	2	FACW	1	1	0.1	0.1	0.1
Carex lacustris	6	OBL	1	1	0.1	0.1	0.1
Drosera rotundifolia	6	OBL	1	1	0.1	0.1	0.1
Listera cordata	10	FACW	1	1	0.1	0.1	0.1
Osmunda regalis	5	OBL	1	1	0.1	0.1	0.1
Bromus ciliatus	6	FACW	1	1	0.1	0.1	0.1
Eupatorium perfoliatum	4	FACW+	1	1	0.1	0.1	0.1
Juncus balticus	4	OBL	1	1	0.1	0.1	0.1
Scirpus americanus	5	OBL	1	1	0.1	0.1	0.1
Campanula aparinoides	7	OBL	1	1	0.1	0.1	0.1
Scirpus acutus	5	OBL	1	1	0.1	0.1	0.1
Triadenum fraseri (Hypericum)	6	OBL	1	1	0.1	0.1	0.1

Epigaea repens	7	upl	1	1	0.1	0.1	0.1
Cicuta bulbifera	5	OBL	1	1	0.1	0.1	0.1
Sagittaria latifolia	1	OBL	1	1	0.1	0.1	0.1
Lobelia kalmii	10	OBL	1	1	0.1	0.1	0.1
Elymus canadensis	7	FAC-	1	1	0.1	0.1	0.1
Vaccinium myrtilloides	4	FACW-	1	1	0.1	0.1	0.1
Prunus pumila	8	UPL	1	1	0.1	0.1	0.1
Fragaria virginiana	2	FAC-	1	1	0.1	0.1	0.1
PRUNELLA VULGARIS	0	FAC	1	1	0.1	0.1	0.1
Calamagrostis inexpansa	8	FACW+	1	1	0.1	0.1	0.1
Juncus pelocarpus	8	OBL	1	1	0.1	0.1	0.1
CHONDRILLA JUNCEA	0	upl	1	1	0.1	0.1	0.1
Epilobium angustifolium	3	FAC	1	1	0.1	0.1	0.1
Pyrola rotundifolia	7	FAC-	1	0.25	0.1	0.0	0.1
Osmunda cinnamomea	5	FACW	1	0.25	0.1	0.0	0.1
Onoclea sensibilis	2	FACW	1	0.25	0.1	0.0	0.1
Pyrola elliptica	6	UPL	1	0.25	0.1	0.0	0.1
Carex intumescens	3	FACW+	1	0.25	0.1	0.0	0.1
Rumex orbiculatus	9	OBL	1	0.25	0.1	0.0	0.1
Cinna latifolia	5	FACW+	1	0.25	0.1	0.0	0.1
Salix candida	9	OBL	1	0.25	0.1	0.0	0.1
Myrica gale	6	OBL	1	0.25	0.1	0.0	0.1
Eupatorium maculatum	4	OBL	1	0.25	0.1	0.0	0.1
Galium aparine	0	FACU	1	0.25	0.1	0.0	0.1
Smilacina racemosa	5	FACU	1	0.25	0.1	0.0	0.1
Galium labradoricum	8	OBL	1	0.25	0.1	0.0	0.1
Quercus rubra	5	FACU	1	0.25	0.1	0.0	0.1
Lysimachia thyrsiflora	6	OBL	1	0.25	0.1	0.0	0.1
Populus balsamifera	2	FACW	1	0.25	0.1	0.0	0.1
Gaultheria procumbens	5	FACU	1	0.25	0.1	0.0	0.1
Scutellaria galericulata	5	OBL	1	0.25	0.1	0.0	0.1
VERBENA CANADENSIS	0	upl	1	0.25	0.1	0.0	0.1
Epilobium ciliatum	3	FACU	1	0.25	0.1	0.0	0.1
Smilacina stellata	5	FAC-	1	0.25	0.1	0.0	0.1
Equisetum fluviatile	7	OBL	1	0.25	0.1	0.0	0.1
Juncus nodosus	5	OBL	1	0.25	0.1	0.0	0.1
Lonicera canadensis	5	FACU	1	0.25	0.1	0.0	0.1
			510	351			

TRANSECT INVENTORY

ACRONYM	SCIENTIFIC NAME	COMMON NAME
ABIBA	Abies balsamea	BALSAM FIR
ACERU	Acer rubrum	RED MAPLE
ALNRU	Alnus rugosa	SPECKLED ALDER; TAG ALDER
AMESP	Amelanchier spicata	SHADBUSH SERVICEBERRY
ARANU	Aralia nudicaulis	WILD SARSAPARILLA
ATHFI	Athyrium filix-femina	LADY FERN
BETPA	Betula papyrifera	PAPER BIRCH
BOTVI	Botrychium virginianum	RATTLESNAKE FERN
BROCI	Bromus ciliatus	FRINGED BROME
CALCA	Calamagrostis canadensis	BLUE-JOINT GRASS
CALINB	Calamagrostis inexpansa	BOG REEDGRASS
CALTPA	Caltha palustris	MARSH MARIGOLD; COWSLIP
CAMAP	Campanula aparinoides	MARSH BELLFLOWER

CXARTT	Carex arctata	SEDGE
CXCANE	Carex canescens	SEDGE
CXDISP	Carex disperma	SEDGE
CXINTE	Carex interior	SEDGE
CXINTU	Carex intumescens	SEDGE
CXLACU	Carex lacustris	SEDGE
CXLEPL	Carex leptalea	SEDGE
CXPAUP	Carex paupercula	SEDGE
CXSTRI	Carex stricta	SEDGE
CXTRIS	Carex trisperma	SEDGE
CHOJU	CHONDRILLA JUNCEA	SKELETON-WEED
CICBU	Cicuta bulbifera	WATER HEMLOCK
CINLA	Cinna latifolia	WOOD WEEDGRASS
CIRMU	Cirsium muticum	SWAMP-THISTLE
CLIBO	Clintonia borealis	BLUEBEAD-LILY; CORN-LILY
COPTRG	Coptis trifoliata (C. groenlandica)	GOLDTHREAD
CORCAD	Cornus canadensis	BUNCHBERRY; DWARF CORNELL
CORSTO	Cornus stolonifera	RED-OSIER
DIELO	Diervilla lonicera	BUSH HONEYSUCKLE
DRORO	Drosera rotundifolia	ROUND-LEAVED SUNDEW
DRYSP	Dryopteris spinulosa (D. carthusiana)	SPINULOSE WOODFERN
ELYCA	Elymus canadensis	CANADA WILD-RYE
EPIRE	Epigaea repens	TRAILING ARBUTUS; MAYFLOWER
EPIAN	Epilobium angustifolium	FIREWEED; GREAT WILLOW-HERB
EPICI	Epilobium ciliatum	WILLOW-HERB
EQUFL	Equisetum fluviatile	WATER HORSETAIL
EQUPA	Equisetum palustre	MARSH-HORSETAIL
EUPMAU	Eupatorium maculatum	JOE-PIE WEED
EUPPER	Eupatorium perfoliatum	COMMON BONESET
EUTGR	Euthamia graminifolia (Solidago)	GRASS-LEAVED GOLDENROD
FRAVI	Fragaria virginiana	WILD STRAWBERRY
FRANI	Fraxinus nigra	BLACK ASH
GALAP	Galium aparine	ANNUAL BEDSTRAW
GALCIR	Galium circaezans	WHITE WILD LICORICE
GALLAB	Galium labradoricum	BOG BEDSTRAW
GAUHI	Gaultheria hispidula	CREEPING SNOWBERRY
GAUPR	Gaultheria procumbens	WINTERGREEN
GLYST	Glyceria striata	FOWL MANNA GRASS
GOOREO	Goodyera repens ophioides	CREEPING or LESSER RATTLESNAKE PLA
GYMDR	Gymnocarpium dryopteris	OAK FERN
IMPCA	Impatiens capensis	SPOTTED TOUCH-ME-NOT
JUNBA	Juncus balticus	RUSH
JUNNO	Juncus nodosus	JOINT RUSH
JUNPE	Juncus pelocarpus	BROWN-FRUITED RUSH
LARLA	Larix laricina	TAMARACK; LARCH
LEDGR	Ledum groenlandicum	LABRADOR TEA
LINBO	Linnaea borealis	TWINFLOWER
LISCOR	Listera cordata	HEARTLEAF TWAYBLADE
LOBKA	Lobelia kalmii	BOG LOBELIA
LONCAN	Lonicera canadensis	AMERICAN FLY HONEYSUCKLE
LYCAN	Lycopodium annotinum	STIFF CLUBMOSS
LYCCL	Lycopodium clavatum	RUNNING GROUND PINE
LYCUN	Lycopus uniflorus	NORTHERN BUGLE WEED
LYSTH	Lysimachia thyrsiflora	TUFTED LOOSESTRIFE

MAICA	Maianthemum canadense	CANADA MAYFLOWER; WILD OR FALSE LI
MITNU	Mitella nuda	NAKED MITERWORT
MONUNI	Moneses uniflora	ONE-FLOWERED PYROLA
MYRGA	Myrica gale	SWEET GALE
ONOSE	Onoclea sensibilis	SENSITIVE FERN
OSMCI	Osmunda cinnamomea	CINNAMON FERN
OSMRE	Osmunda regalis	ROYAL FERN
PICGL	Picea glauca	WHITE SPRUCE
PICMA	Picea mariana	BLACK SPRUCE
PLACL	Platanthera clavellata (Habenaria)	CLUB-SPUR ORCHID; SM. GREEN WOOD-OR
POLPA	Polygala paucifolia	FLOWERING-WINTERGREEN; FRINGED POL
POPBA	Populus balsamifera	BALSAM POPLAR; HACKMATACK
POTAN	Potentilla anserina	SILVERWEED
PRUVU	PRUNELLA VULGARIS	LAWN PRUNELLA
PRUPU	Prunus pumila	SAND CHERRY
PYREL	Pyrola elliptica	LARGE-LEAVED SHINLEAF
PYRRO	Pyrola rotundifolia	ROUND-LEAVED PYROLA
QUERU	Quercus rubra	RED OAK
RHAAL	Rhamnus alnifolia	ALDER-LEAVED BUCKTHORN
RUBPU	Rubus pubescens	DWARF RASPBERRY
RUMOR	Rumex orbiculatus	GREAT WATER DOCK
SAGLA	Sagittaria latifolia	COMMON ARROWHEAD
SALCA	Salix candida	SAGE or HOARY WILLOW
SCIAC	Scirpus acutus	HARDSTEM BULRUSH
SCIAM	Scirpus americanus	THREE-SQUARE; BULRUSH
SCUGA	Scutellaria galericulata	COMMON SKULLCAP
SMIRA	Smilacina racemosa	FALSE SPIKENARD
SMIST	Smilacina stellata	STARRY FALSE SOLOMON SEAL
SMITR	Smilacina trifolia	FALSE MAYFLOWER
SOLCAN	Solidago canadensis	CANADA GOLDENROD
THEPA	Thelypteris palustris	MARSH FERN
THUOC	Thuja occidentalis	ARBOR VITAE
TRIFR	Triadenum fraseri (Hypericum)	MARSH ST. JOHN'S-WORT
TRIBO	Trientalis borealis	STARFLOWER
UTRINT	Utricularia intermedia	FLAT-LEAVED BLADDERWORT
VACAN	Vaccinium angustifolium	BLUEBERRY
VACMY	Vaccinium myrtilloides	CANADA BLUEBERRY
VERCA	VERBENA CANADENSIS	CANADIAN VERVAIN
VIORE	Viola renifolia	KIDNEY-LEAVED VIOLET
VIORO	Viola rostrata	LONG-SPURRED VIOLET

GRAND TRAVERSE BAY

SITE: Grand Traverse Bay
COUNTY: Houghton
DATE: August, 1992
BY: P.Comer, D.Albert
FILE: QU_GTRAV

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TRANSECT DATA, QUADRAT

QUAD	NC	W/Ad	NI	W/Ad	NW	W/Ad	NS	TS	N SEQ	O SEQ
1	7.6	7.6	17.0	17.0	4.6	4.6	5	5	3.8	3.7
2	5.1	4.3	16.9	15.5	2.9	2.8	11	13	3.6	3.5
3	5.1	5.1	16.9	16.9	3.2	3.2	11	11	2.5	2.5
4	3.9	3.9	11.7	11.7	1.6	1.6	9	9	0.9	0.9
5	4.2	4.2	14.4	14.4	-1.9	-1.9	12	12	-1.4	-1.4
6	5.6	5.6	16.7	16.7	-3.9	-3.9	9	9	-3.2	-3.0
7	7.1	6.3	20.2	19.0	-3.8	-3.1	8	9	-3.6	-3.4
8	6.8	6.8	16.7	16.7	-3.2	-3.2	6	6	-4.0	-3.8
9	6.6	6.6	18.7	18.7	-5.0	-5.0	8	8	-4.1	-3.9
10	8.2	7.5	27.1	26.0	-4.1	-3.6	11	12	-4.7	-4.5
11	7.7	7.7	20.4	20.4	-5.0	-5.0	7	7	-4.7	-4.5
12	7.7	7.7	25.6	25.6	-5.0	-5.0	11	11	-4.9	-4.9
13	7.8	7.8	21.9	21.9	-4.8	-4.8	8	8	-4.8	-4.8
14	8.3	8.3	26.2	26.2	-4.6	-4.6	10	10	-4.3	-4.3
15	6.6	6.6	24.9	24.9	-3.6	-3.6	14	14	-3.5	-3.5
16	5.8	5.8	21.1	21.1	-2.3	-2.3	13	13	-3.1	-3.1
17	6.6	6.6	18.7	18.7	-3.5	-3.5	8	8	-1.6	-1.6
18	5.0	5.0	15.0	15.0	1.1	1.1	9	9	-2.1	-2.1
19	8.6	8.6	27.2	27.2	-4.0	-4.0	10	10	-0.8	-0.8
20	5.1	5.1	15.3	15.3	0.6	0.6	9	9	-2.7	-2.7
21	7.8	7.8	30.2	30.2	-4.5	-4.5	15	15	-0.3	-0.3
22	4.7	4.7	12.5	12.5	3.0	3.0	7	7	-0.7	-0.7
23	8.0	8.0	16.0	16.0	-0.5	-0.5	4	4	-0.2	-0.2
24	7.5	7.5	18.4	18.4	-3.0	-3.0	6	6	-0.2	-0.2
25	4.4	4.4	9.8	9.8	2.8	2.8	5	5	-0.1	-0.1
26	8.0	8.0	11.3	11.3	0.0	0.0	2	2	0.2	0.2
27	5.5	5.5	18.1	18.1	-2.2	-2.2	11	11	-0.5	-0.5
28	5.0	5.0	15.8	15.8	0.8	0.8	10	10	-1.7	-1.7
29	6.5	6.5	18.4	18.4	-3.6	-3.6	8	8	-1.8	-1.8
30	7.3	7.3	14.5	14.5	-2.5	-2.5	4	4	-1.9	-1.9
31	5.3	5.3	16.0	16.0	0.3	0.3	9	9	-2.4	-2.4
32	7.0	7.0	18.5	18.5	-5.0	-5.0	7	7	-2.2	-2.2
33	6.1	6.1	16.3	16.3	-2.0	-2.0	7	7	-1.6	-1.6
34	5.0	5.0	15.0	15.0	2.3	2.3	9	9	-0.7	-0.7
35	7.3	7.3	14.5	14.5	-2.5	-2.5	4	4	-1.2	-1.2
36	8.5	8.5	20.8	20.8	-3.3	-3.3	6	6	-1.7	-1.7
37	5.7	5.7	18.0	18.0	0.8	0.8	10	10	-2.0	-2.0
38	8.0	8.0	19.6	19.6	-3.3	-3.3	6	6	-2.0	-2.0
39	6.6	6.6	17.4	17.4	-3.4	-3.4	7	7	-1.8	-1.8
40	5.2	5.2	15.7	15.7	1.3	1.3	9	9	-1.7	-1.7
41	8.2	8.2	24.7	24.7	-3.0	-3.0	9	9	-0.3	-0.3
42	5.0	5.0	14.1	14.1	0.9	0.9	8	8	-1.1	-1.1
AVG	6.5	6.4	18.3	18.2	-1.6	-1.6	8.4	8.5		
STD	1.3	1.3	4.5	4.5	2.8	2.7	2.7	2.8		

TRANSECT DATA, AGGREGATE

CC	NUMBER			
0	4		66	NATIVE SPECIES
1	2		69	TOTAL SPECIES
2	0	0 to 3	6.3	NATIVE QUALITY
3	5	15.9%	6.0	W/Adventives
4	9		51.2	NATIVE INDEX
5	11	4 to 6	50.1	W/Adventives
6	10	43.5%	-2.0	NATIVE WETNESS
7	4		-1.8	W/Adventives
8	10	7 to 9		
9	0	20.3%		
10	14	10		
		20.3%		

PHYSIOGNOMY

NATIVE	66	95.7%
Tree	6	8.7%
Shrub	20	29.0%
Vine	0	0.0%
Forb	20	29.0%
Fern	3	4.3%
Sedge	13	18.8%
Grass	4	5.8%
ADVENTIVE	3	4.3%
Tree	0	0.0%
Shrub	0	0.0%
Vine	0	0.0%
Forb	2	2.9%
Sedge	0	0.0%
Grass	1	1.4%

PHYSIOGNOMIC RELATIVE IMPORTANCE VALUES

PHYSIOG	FQ	COV	RFQ	RCOV	RIV
N Shrub	145	143.75	40.7	42.5	41.6
N Forb	71	47	19.9	13.9	16.9
N Sedge	51	59.75	14.3	17.7	16.0
N Tree	49	17.5	13.8	5.2	9.5
N Grass	22	18	6.2	5.3	5.8
N Fern	14	18.5	3.9	5.5	4.7
A Forb	2	1.25	0.6	0.4	0.5
A Grass	2	1.25	0.6	0.4	0.5

SPECIES RELATIVE IMPORTANCE VALUES

SCIENTIFIC NAME	CC	WETNESS	FQ	COV	RFQ	RCOV	RIV
Chamaedaphne calyculata	8	OBL	22	25.25	2.9	4.1	3.5
Carex oligocarpa *	8	UPL	16	27.25	2.1	4.4	3.3
Vaccinium angustifolium	4	FACU	14	25.25	1.9	4.1	3.0
Ledum groenlandicum	8	OBL	14	15	1.9	2.4	2.1
Pteridium aquilinum	0	FACU	11	16.25	1.5	2.6	2.0
Calamagrostis canadensis	3	OBL	14	11.25	1.9	1.8	1.8
Myrica gale	6	OBL	12	12.25	1.6	2.0	1.8
Betula pumila	10	OBL	15	9.25	2.0	1.5	1.7
Melampyrum lineare	6	FAC-	12	10.5	1.6	1.7	1.6
Gaultheria procumbens	5	FACU	9	9	1.2	1.4	1.3
Iris versicolor	5	OBL	11	7.25	1.5	1.2	1.3
Pinus banksiana	5	facu	15	3.75	2.0	0.6	1.3
Pinus resinosa	6	FACU	13	3.25	1.7	0.5	1.1
Carex exilis	10	OBL	6	9	0.8	1.4	1.1
Picea mariana	6	FACW	11	4.25	1.5	0.7	1.1
Andromeda glaucophylla	10	OBL	7	7	0.9	1.1	1.0
Alnus rugosa	5	OBL	8	6	1.1	1.0	1.0
Kalmia polifolia	10	OBL	8	5.75	1.1	0.9	1.0

Rubus pubescens	4	FACW+	8	5.75	1.1	0.9	1.0
Cornus canadensis	6	FAC	7	5.5	0.9	0.9	0.9
Epigaea repens	7	upl	8	4.25	1.1	0.7	0.9
Aster nemoralis	10	OBL	6	4.5	0.8	0.7	0.8
Aronia prunifolia (A. melanocar.)	5	FACW	6	4.5	0.8	0.7	0.8
Maianthemum canadense	4	FAC	5	5	0.7	0.8	0.7
Sarracenia purpurea	10	OBL	7	3.25	0.9	0.5	0.7
Salix pedicellaris	8	UPL,OBL	6	3.75	0.8	0.6	0.7
Arctostaphylos uva-ursi	8	upl	2	7	0.3	1.1	0.7
Amelanchier interior	4	UPL	5	4.25	0.7	0.7	0.7
Carex lasiocarpa	10	OBL	4	4.25	0.5	0.7	0.6
Carex stricta	4	OBL	3	4	0.4	0.6	0.5
Deschampsia flexuosa	6	upl	3	4	0.4	0.6	0.5
Rhynchospora alba	6	OBL	4	2.5	0.5	0.4	0.5
Carex interior	3	OBL	3	3	0.4	0.5	0.4
Carex michauxiana	10	OBL	4	1.75	0.5	0.3	0.4
Carex pensylvanica	4	UPL	3	2.25	0.4	0.4	0.4
Larix laricina	5	FACW	4	1	0.5	0.2	0.3
Danthonia spicata	4	UPL	3	1.5	0.4	0.2	0.3
Solidago uliginosa	4	OBL	3	1.5	0.4	0.2	0.3
Carex chordorrhiza	10	OBL	3	1.5	0.4	0.2	0.3
Carex retrorsa	3	OBL	2	2	0.3	0.3	0.3
Drosera rotundifolia	6	OBL	2	2	0.3	0.3	0.3
Trientalis borealis	5	FAC+	2	2	0.3	0.3	0.3
Potentilla palustris	10	OBL	3	0.75	0.4	0.1	0.3
Menyanthes trifoliata	8	OBL	2	1.25	0.3	0.2	0.2
POA COMPRESSA	0	FACU+	2	1.25	0.3	0.2	0.2
Ammophila breviligulata	10	UPL	2	1.25	0.3	0.2	0.2
Equisetum fluviatile	7	OBL	2	1.25	0.3	0.2	0.2
Spiraea alba	4	FACW+	2	0.5	0.3	0.1	0.2
Smilacina trifolia	10	OBL	2	0.5	0.3	0.1	0.2
Vaccinium macrocarpon	8	OBL	1	1	0.1	0.2	0.1
Lycopodium obscurum	5	FACU	1	1	0.1	0.2	0.1
RUMEX ACETOSELLA	0	FAC	1	1	0.1	0.2	0.1
Carex limosa	10	OBL	1	1	0.1	0.2	0.1
Coptis trifoliata (C. groenland.)	5	FACW	1	1	0.1	0.2	0.1
Rubus allegheniensis	1	FACU+	1	1	0.1	0.2	0.1
Vaccinium oxycoccos	8	OBL	1	1	0.1	0.2	0.1
Populus tremuloides	1	FAC	1	1	0.1	0.2	0.1
Carex aquatilis	7	OBL	1	1	0.1	0.2	0.1
Juncus articulatus	3	OBL	1	0.25	0.1	0.0	0.1
HIERACIUM AURANTIACUM	0	UPL	1	0.25	0.1	0.0	0.1
Scirpus cespitosus	10	OBL	1	0.25	0.1	0.0	0.1
Triadenum fraseri (Hypericum)	6	OBL	1	0.25	0.1	0.0	0.1
Solidago rugosa	3	FAC+	1	0.25	0.1	0.0	0.1
Comandra umbellata	5	FACU	1	0.25	0.1	0.0	0.1
Lysimachia thyrsiflora	6	OBL	1	0.25	0.1	0.0	0.1
Prunus pumila	8	UPL	1	0.25	0.1	0.0	0.1
Salix pyrifolia	8	FACW+	1	0.25	0.1	0.0	0.1
Campanula aparinoides	7	OBL	1	0.25	0.1	0.0	0.1
Artemisia campestris	5	fac	1	0.25	0.1	0.0	0.1
			398	307			

TRANSECT INVENTORY

ACRONYM	SCIENTIFIC NAME	COMMON NAME
ALNRU	Alnus rugosa	SPECKLED ALDER; TAG ALDER
AMEIN	Amelanchier interior	SERVICEBERRY
AMMBR	Ammophila breviligulata	MARRAM GRASS; BEACH GRASS
ANDGL	Andromeda glaucophylla	BOG ROSEMARY
ARCUV	Arctostaphylos uva-ursi	BEARBERRY
AROPR	Aronia prunifolia (A. melanocarpa)	BLACK CHOKEBERRY
ARTCA	Artemisia campestris	WORMWOOD
ASTNEM	Aster nemoralis	BOG ASTER
BETPU	Betula pumila	BOG BIRCH
CALCA	Calamagrostis canadensis	BLUE-JOINT GRASS
CAMAP	Campanula aparinoides	MARSH BELLFLOWER
CXAQUA	Carex aquatilis	SEDGE
CXCHOR	Carex chordorrhiza	SEDGE
CXEXIL	Carex exilis	SEDGE
CXINTE	Carex interior	SEDGE
CXLASA	Carex lasiocarpa	SEDGE
CXLIMO	Carex limosa	BOG SEDGE
CXMICH	Carex michauxiana	SEDGE
CXOLGC	Carex oligocarpa *	SEDGE
CXPENS	Carex pensylvanica	SEDGE
CXRETS	Carex retrorsa	SEDGE
CXSTRI	Carex stricta	SEDGE
CHACA	Chamaedaphne calyculata	LEATHERLEAF
COMUM	Comandra umbellata	BASTARD-TOADFLAX; STAR-TOAD FLAX
COPTRG	Coptis trifoliata (C. groenlandica)	GOLDTHREAD
CORCAD	Cornus canadensis	BUNCHBERRY; DWARF CORNELL
DANSP	Danthonia spicata	POVERTY GRASS; OATGRASS
DESFL	Deschampsia flexuosa	HAIR GRASS
DRORO	Drosera rotundifolia	ROUND-LEAVED SUNDEW
EPIRE	Epigaea repens	TRAILING ARBUTUS; MAYFLOWER
EQUFL	Equisetum fluviatile	WATER HORSETAIL
GAUPR	Gaultheria procumbens	WINTERGREEN
HIEAU	HIERACIUM AURANTIACUM	ORANGE HAWKWEED
IRIVE	Iris versicolor	WILD BLUE FLAG
JUNAR	Juncus articulatus	JOINTED RUSH
KALPO	Kalmia polifolia	SWAMP-LAUREL
LARLA	Larix laricina	TAMARACK; LARCH
LEDGR	Ledum groenlandicum	LABRADOR TEA
LYCOB	Lycopodium obscurum	GROUND-PINE
LYSTH	Lysimachia thyrsiflora	TUFTED LOOSESTRIFE
MAICA	Maianthemum canadense	CANADA MAYFLOWER; WILD OR FALSE LI
MELLI	Melampyrum lineare	COW-WHEAT
MENTR	Menyanthes trifoliata	BUCKBEAN
MYRGA	Myrica gale	SWEET GALE
PICMA	Picea mariana	BLACK SPRUCE
PINBA	Pinus banksiana	JACK PINE
PINRE	Pinus resinosa	RED PINE
POACO	POA COMPRESSA	CANADA BLUEGRASS
POPTR	Populus tremuloides	QUAKING ASPEN
POTPAL	Potentilla palustris	MARSH CINQUEFOIL
PRUPU	Prunus pumila	SAND CHERRY
PTEAQ	Pteridium aquilinum	BRACKEN FERN
RHYAL	Rhynchospora alba	BEAK-RUSH

RUBAL	Rubus allegheniensis	COMMON BLACKBERRY
RUBPU	Rubus pubescens	DWARF RASPBERRY
RUMACL	RUMEX ACETOSELLA	SHEEP or RED SORREL
SALPED	Salix pedicellaris	BOG WILLOW
SALPY	Salix pyrifolia	BALSAM WILLOW
SARPU	Sarracenia purpurea	PITCHER-PLANT
SCICE	Scirpus cespitosus	BULRUSH
SMITR	Smilacina trifolia	FALSE MAYFLOWER
SOLRU	Solidago rugosa	ROUGH GOLDENROD
SOLULI	Solidago uliginosa	BOG GOLDENROD
SPIAL	Spiraea alba	MEADOWSWEET
TRIFR	Triadenum fraseri (Hypericum)	MARSH ST. JOHN'S-WORT
TRIBO	Trientalis borealis	STARFLOWER
VACAN	Vaccinium angustifolium	BLUEBERRY
VACMA	Vaccinium macrocarpon	LARGE CRANBERRY
VACOX	Vaccinium oxycoccos	SMALL CRANBERRY

APPENDIX V

MEAN FREQUENCY DATA FOR VASCULAR PLANTS AND MOSSES FOUND IN MICHIGAN'S WOODED DUNE AND SWALE COMPLEXES

RELATIVE FREQUENCY FOR VASCULAR PLANTS AND MOSSES IN WETLAND AND UPLAND

The following list includes all vasular plants, bryophytes, and algae found within Michigan's Wooded Dune and Swale Complexes, along with their relative frequency in wetland and upland sample points. State-wide, a total of 470 sample points were designated as wetland, while 488 sample points were designated as upland. Species which contain no values for either category were recorded as present within a complex, but were not encountered within a specific sample point.

	WETLAND	UPLAND
VASCULAR PLANTS:		
Abies balsamea	0.170517322	0.293959678
Acer pensylvanicum	0.0132104737	0.0239455879
Acer rubrum	0.2101164212	0.3980279994
Acer saccharum	0.0023310023	0.0023310023
Acer spicatum	0.0066391941	0.0020066294
Achillea millefolium	0.0004930966	0.0009157509
Actaea rubra	0	0
Actaea spp.	0.0010683761	0
Adiantum pedatum	0.0010683761	0
Agalinis purpurea	0.0010683761	0
Agrimonia gryposepala	0	0
Agropyron dasystachyum	0.0026298488	0.0019723866
Agropyron trachycaulum	0	0.0028693529
Agropyron repens	0	0.0002374169
Agrostis gigantea	0	0.0042735043
Agrostis hyemalis	0	0.0032051282
Agrostis perennans	0.0139374514	0.0005827506
Alisima plantago-aquatica	0.0018243615	0
Alnus rugosa	0.3638709155	0.0590467113
Alopercurus aequalis	0	0
Ambrosia artemisiifolia	0.0009157509	0.000400641
Amelanchier arborea	0.0032288699	0.0231707965
Amelanchier interior	0.0040750916	0.035952554
Amelanchier laevis	0	0.0004930966
Anelanchier spicata	0.0072140039	0.0223836105
Amelanchier spp.	0.000534188	0.0118587058
Ammophila breviligulata	0.001215131	0.0242676068
Anaphalis margaritacea	0	0
Andromeda glaucophylla	0.0371835998	0.002014652
Andropogon gerardii	0	0
Andropogon scoparius	0	0.0007777149
Andropogon virginica	0	0.0042735043
Anemone canadensis	0	0.0002374169
Apocynum cannabinum	0	0.0005426672
Aquilegia canadensis	0	0.0003770739
Arabis lyrata	0.0019723866	0.0028425571
Aralia nudicaulis	0.0574338125	0.1727481548
Arctostaphylos uva-ursi	0.0029996713	0.0376669772
Arethusa bulbosa	0	0
Arisaema triphyllum	0.0036630037	0
Aronia melano	0.0107174989	0.0074786325
Aronia prunifolia	0.0211775878	0.0067460317
Artemisia campestris	0.0019723866	0.0087950244
Asclepias incarnata	0	0
Asclepias syriaca	0	0
Aster borealis	0	0
Aster ericoides	0.0082417582	0
Aster laevis	0	0
Aster longifolius	0.0019723866	0
Aster macrophyllus	0.0145792242	0.0559689629
Aster nemoralis	0.0074946983	0
Aster pilosus	0.002374169	0.0006410256
Aster puniceus	0.0042900164	0.0003373819
Aster umbellatus	0.0040084185	0.0048076923
Aster spp.	0.0137342287	0
Athyrium filix-femina	0.0436409935	0.0017806268

Athyrium thelypteroides	0.000534188	0
Berberis thunbergii	0	0
Betula alleghaniansis	0.0020242915	0.0036130536
Betula papyrifera	0.0450811008	0.0528067931
Betula pumila	0.03204259	0
Bidens cernua	0.0207961554	0.0008012821
Bidens spp.	0.0026709402	0
Boehmeria cylindrica	0.0114678531	0
Botrychium dissectum	0.0005827506	0
Botrychium multifidum	0.0027472527	0
Botrychium virginianum	0.0129212454	0.002107075
Brachyelytrum erectum	0.0005827506	0
Brasenia schreberi	0	0
Bromus ciliatus	0.0015598291	0
Bromus inermus	0	0
Cakile edentula	0	0.0007058913
Calamagrostis canadensis	0.2087808003	0.0402372528
Calamagrostis inexpansa	0.0041971917	0
Calamovilfa longifolia	0.0004930966	0.0053003324
Calla palustris	0.0108736942	0.0026362526
Callitriche verna	0.0002374169	0
Caltha palustris	0.0196865575	0
Campanula aparinoides	0.0312857952	0
Campanula rotundifolia	0.0039447732	0.0071225071
Cardamine pensylvanica	0.0009157509	0
Carex alata	0.0011870845	0
Carex aquatilis	0.0480157129	0.0071807199
Carex arctata	0.0057988166	0.0344966762
Carex atlantica	0.0009861933	0
Carex aurea	0.0042324129	0
Carex bebbii	0.0112942613	0
Carex bromoides	0	0
Carex brunnescens	0.0064853641	0.0006410256
Carex buxbaumii	0.00087157	0
Carex canescens	0.0198662093	0.0026362526
Carex chordorrhiza	0.0067592414	0
Carex communis	0	0
Carex comosa	0.0079183103	0.0008012821
Carex crinita	0.0068659411	0
Carex cristatella	0.0014792899	0
Carex cryptolepis	0.0298640462	0.004040404
Carex cupulina	0	0
Carex debilis rudgei	0.0009496676	0
Carex deweyana	0.0014792899	0.0004930966
Carex diandra	0.0044871795	0.0046620047
Carex disperma	0.0463253208	0.0081908832
Carex eburnea	0.0064102564	0
Carex exilis	0.0179246192	0
Carex flava	0.0048076923	0
Carex folliculata	0.0023097685	0
Carex grasillima	0.0028846154	0
Carex gynandra	0.0106357967	0
Carex gynocrates	0.0025641026	0.0003052503
Carex howei	0.0009861933	0
Carex hystericina	0	0
Carex interior	0.057128531	0.008974359
Carex intumescens	0.0201994201	0.0069383833
Carex lacustris	0.0633335254	0.0007122507
Carex lasiocarpa	0.0823773021	0
Carex leptalea	0.0780648431	0.004985755
Carex leptonervia	0.0042735043	0.0019723866
Carex limosa	0.0155881156	0
Carex lupilina	0.0015689439	0
Carex michauxiana	0.0016025641	0
Carex normalis	0.0016619183	0.0003052503
Carex oligosperma	0.1267119901	0.0023310023
Carex paupercula	0.0186506083	0
Carex pedunculata	0.0192307692	0.0036309844
Carex pensylvanica	0.0106567578	0.0600481488

Carex pseudo-cyperus	0.0325316659	0
Carex retrorsa	0.0330205289	0.0003052503
Carex rostrata	0.0171341005	0
Carex spp.	0.0068490537	0.0014245014
Carex sprengelii	0.0009157509	0.0004273504
Carex sterilis	0	0
Carex stipata	0.0069338781	0.0003052503
Carex stricta	0.1065647456	0.0255393167
Carex tenera	0.0029083571	0
Carex tenuiflora	0	0
Carex trisperma	0.1096289598	0.0213043901
Carex tuckermanii	0.0045234168	0
Carex vesicaria	0.0258784425	0
Carex viridula	0	0.001405758
Carex vulpinoidea	0.0014985015	0
Celastrus scandens	0	0
Centauria maculosa	0	0
Centaurea spp.	0	0
Cephalanthus occidentalis	0.0066343912	0
Cerastium arvense	0.0019723866	0
Chamaedaphne calyculata	0.2312781401	0.006990232
Chelone glabra	0.0002374169	0
Chimaphila umbellata	0.0021367521	0.0140726648
Chondrilla juncea	0	0
Chrysanthemum leucanthemum	0	0
Cicuta bulbifera	0.0230754217	0.0005827506
Cicuta maculata	0.0022435897	0
Cinna latifolia	0.0032370716	0
Circaea alpina	0.0079178538	0
Cirsium arvense	0.0003373819	0
Cirsium muticum	0.0100620676	0
Cirsium pitcheri	0	0
Cladium mariscoides	0.0252095661	0.0048076923
Clematis virginiana	0.0021367521	0
Clintonia borealis	0.0481724463	0.0623051981
Comandra umbellata	0	0.0166825277
Conopholis americana	0	0
Coptis trifolia	0.1011482812	0.1258524735
Corallorhiza maculata	0.0028490028	0
Corallorhiza trifida	0	0
Coreopsis lanceolata	0	0.0010683761
Coreopsis palmata	0	0.0019723866
Cornus amomum	0.0007122507	0.0021367521
Cornus canadensis	0.1051167081	0.2458971617
Cornus rugosa	0.0040701019	0.0119391026
Cornus stolonifera	0.0505887394	0.0077382494
Corylus americana	0.0004930966	0
Corylus cornuta	0	0
Cypripedium acaule	0	0.0107577183
Cypripedium calceolus pubescens	0	0.0032051282
Cystopteris bulbifera	0.002518315	0
Danthonia spicata	0	0.0181516667
Deschampsia cespitosa	0.002374169	0.0120332883
Deschampsia flexuosa	0	0.0402548738
Diervilla lonicera	0.0050152625	0.0123411133
Drosera intermedia	0.0025641026	0
Drosera linearis	0	0
Drosera rotundifolia	0.0169525144	0.0042735043
Dryopteris spinulosa (carthusiana)	0.0211896588	0.0058346624
Dryopteris cristata	0.0056668118	0
Dryopteris intermedia	0.0041561003	0
Dulichium arundinacium	0.0554197346	0
Eleocharis acicularis	0.0003373819	0
Eleocharis elliptica	0.0103692604	0.0008012821
Eleocharis equisetoides	0.0023310023	0.000400641
Eleocharis obtusa	0	0
Eleocharis pauciflora	0	0
Eleacharis smallii	0.0128510379	0.0058760684
Elodea canadensis	0.0040064103	0.0017094017

Elymus canadensis	0.0002374169	0.0016244172
Elymus mollus	0	0
Epifagus virginiana	0	0.0009496676
Epigea repens	0.0135291631	0.1295553916
Epilobium angustifolium	0.001025641	0
Epilobium ciliatum	0.0002564103	0
Epilobium coloratum	0.0042311084	0
Epilobium leptophyllum	0.000534188	0
Epilobium palustre	0.0047720798	0
Equisetum arvense	0.0046620047	0.0052231719
Equisetum fluviatile	0.0111832433	0.0010683761
Equisetum hymale	0.0009496676	0.0030864198
Equisetum palustre	0.0281601124	0.0007122507
Equisetum pratense	0.002302944	0.0006410256
Equisetum scirpoidea	0.0047666009	0.0138176638
Equisetum sylvaticum	0.0124764883	0.0261118511
Eragrostis spp.	0	0
Erigeron spp.	0.0010683761	0
Eriocaulon septangulare	0	0
Eriophorum tenellum	0	0
Eriophorum virginicum	0.0030364372	0
Eriophorum viridi-carinatum	0.0025641026	0
Erucastrum gallicum	0	0.000400641
Eupatorium maculatum	0.0169659637	0.0008012821
Eupatorium perforatum	0.002785409	0
Fagus grandifolia	0	0.0061188811
Festuca saximontana	0	0.0032496439
Fragaria virginiana	0.022512947	0.026033623
Fraxinus americana	0.0311355311	0.0071499014
Fraxinus nigra	0.05008879	0.0027128554
Fraxinus pennsylvanica	0.0180396764	0.0016025641
Galium aparine	0.0164533306	0.0175688509
Galium circaezans	0.0059081944	0.0031594711
Galium labradoricum	0.0451672769	0.004888701
Galium trifidum	0.0247210351	0.0003052503
Galium triflorum	0.0183566434	0.0056706114
Gaultheria hispidula	0.0607239307	0.0670562545
Gaultheria procumbens	0.055592044	0.3851107177
Gaylussacia baccata	0.0230310875	0.2738210519
Gentiana crinita	0.0009496676	0.0030364372
Gentianopsis procura	0	0
Geocaulon lividum	0.0025684192	0.0244584087
Geum canadense	0	0
Geum rivale	0	0
Glyceria borealis	0.0594828011	0
Glyceria canadensis	0.0131578947	0.0008880009
Glyceria grandis	0	0
Glyceria septentrionalis	0.0021367521	0
Glyceria striata	0.079663834	0.0077797203
Goodyera oblongifolia	0.0034455128	0.000798347
Goodyera repens	0.0015384615	0.0030226658
Goodyera tesselata	0	0.0031542532
Gymnocarpium dryopteris	0.0207556922	0
Gypsophila muralis	0	0
Gypsophila paniculata	0	0
Hamamelis virginiana	0.0048994216	0.0036268556
Halenia deflexa	0.000534188	0.005519943
Hieracium aurantiacum	0.0023730276	0.0076077768
Hieracium maximum	0	0
Hieracium spp.	0.0009157509	0.0047666009
Hieracium vulgatum	0	0
Hudsonia tomentosa	0	0.000400641
Hypericum spp.	0.0004578755	0
Hypericum kalmianum	0.0034281957	0.0057425214
Hypericum majus	0.0006410256	0
Hypericum perforatum	0	0
Hypericum punctatum	0	0
Hystrix patula	0	0
Ilex verticillata	0.078937068	0.0217769622

Impatiens capensis	0.0133735495	0
Iris lacustris	0.0056891026	0.0188746439
Iris versicolor	0.1051536302	0.0038600289
Iris virginica	0.000534188	0
Juglans nigra	0.0004930966	0
Juncus acuminatus	0.0023310023	0
Juncus articulatus	0.0002289377	0
Juncus balticus	0.0032125994	0.0071170283
Juncus brevicaudatus	0.0136021386	0
Juncus canadensis	0.0064620565	0
Juncus effusus	0.0036630037	0.0024420024
Juncus filiformis	0	0
Juncus greenei	0.0004578755	0
Juncus nodosus	0.0091575092	0
Juncus pelocarpus	0	0
Juniperus communis	0.0010272847	0.0577213237
Juniperis horizontalis	0	0.0220704258
Kalmia angustifolia	0.0175002348	0
Kalmia polifolia	0.0530965398	0.0010989011
Koeleria macrantha	0.0009861933	0.0015082956
Lactuca spp.	0.0007122507	0
Laportea canadensis	0.0018993352	0
Larix laricina	0.0137914967	0.0003052503
Lathyrus japonicus glab.	0.0065581854	0.0051775148
Lathyrus palustris	0.0025641026	0
Ledum groenlandicum	0.1143621121	0.1135150345
Leersia oryzoides	0.0015324182	0
Lemna minor	0.0192469567	0
Lemna trisulca	0.0026709402	0
Lillium philadelphicum	0.000534188	0.0008012821
Linnaea borealis	0.0762124036	0.1298715492
Listera cordata	0.001025641	0
Lithospermum canescens	0	0.0004930966
Lithospermum carolinien.	0	0
Lobelia cardinalis	0	0
Lobelia kalmii	0.0041163004	0.0014690171
Lonicera canadensis	0.0154829319	0.0160119657
Lonicera dioica	0.0027472527	0.0027512429
Lonicera tatarica	0	0.0011870845
Lotus corniculatus	0.0005827506	0
Lycopodium annotinum	0.0171167842	0.0382687825
Lycopodium clavatum	0.0076023392	0.0453922858
Lycopodium dendroideum	0.0025641026	0.0006410256
Lycopodium inundatum	0.0011341223	0
Lycopodium lucidulum	0.0036198268	0.003715035
Lycopodium obscurum	0.0003373819	0.0103558479
Lycopodium tristachyum	0	0.0041885198
Lycopus americanus	0.0331991879	0
Lycopus uniflorus	0.193010998	0.0106976357
Lysimachia terrestris	0.04242373	0.0031322844
Lysimachia thyrsiflora	0.0451289463	0.0003052503
Maianthemum canadense	0.1489012208	0.4124688543
Matricaria matricarioid.	0	0
Matteuccia struthiopteris	0.0047483381	0
Medeola virginiana	0.0005827506	0.0003373819
Melampyrum lineare	0.018162494	0.1772393024
Mentha arvensis	0.0187508479	0.0019723866
Menyanthes trifoliata	0.030260391	0.0003052503
Mimulus ringens	0	0
Mitchella repens	0.0094627595	0.0162356637
Mitella diphylla	0.0179525336	0
Mitella nuda	0.0530316051	0.0068554131
Monarda punctata	0	0
Moneses uniflora	0.0053344187	0.0228378103
Monotropa hypopithys	0	0
Monotropa uniflora	0.0053817977	0.0020542548
Muhlenbergia glomerata	0.0004578755	0
Myrica gale	0.121807697	0.013616683
Nasturtium officinale	0.006333173	0

Nemopanthes mucronata	0.0224118324	0.0165399322
Nuphar spp	0.0044261294	0
Nuphar variegata	0.0035131535	0
Nymphaea odorata	0.0036477411	0
Oenothera biennis	0.0019723866	0
Oenothera oakesiana	0	0.0007058913
Onoclea sensibilis	0.0586482849	0.0032763533
Ophioglossum pusillum	0	0
Orobanche uniflora	0	0.0003052503
Orthilia secunda (Pyrola)	0.0051282051	0.0008012821
Oryzopsis asperifolia	0.0072982573	0.0238288446
Oryzopsis pungens	0.0016025641	0.0185404339
Osmorhiza claytonii	0.0003205128	0.014861136
Osmunda cinnamomea	0.0144228188	0.0090980657
Osmunda regalis	0.0750094532	0.001410742
Oxalis montana	0.0009861933	0.0012820513
Panicum columbianum	0.0028490028	0.0085556594
Panicum virgatum	0.0005827506	0.0007305136
Parnassia glauca	0.0051481638	0
Parthenocissus inserta	0.0018819855	0.0007122507
Pedicularis canadensis	0	0.0019723866
Petisites palmatus	0.0011752137	0.0008012821
Phalaris arundinacea	0.006189027	0.0035612536
Phleum pratense	0	0.0002374169
Phleum spp.	0	0
Phragmites australis	0.0057997558	0.0053418803
Physocarpus opulifolius	0	0.0053418803
Picea glauca	0.0051340468	0.0107261062
Picea mariana	0.0328624142	0.0936299236
Pinus banksiana	0.0006295788	0.0068343782
Pinus resinosa	0.000534188	0.0096939062
Pinus strobus	0.0171528907	0.1039664401
Plantago rugelii	0.0005827506	0
Platanthera clavellata	0.0020512821	0.0008012821
Platanthera dilitata	0.0022321429	0
Platanthera hookeri	0	0.0025065746
Platanthera hyperborea	0.0012820513	0.0009157509
Platanthera obtusata	0.0013495277	0
Platanthera orbiculata	0	0.0032051282
Platanthera psycodes	0	0
Poa compressa	0.0032255108	0.014199261
Poa glauca	0	0.0028490028
Poa palustris	0.0005827506	0
Poa saltuensis	0	0.0006410256
Poa spp.	0.000534188	0
Podophyllum peltatum	0	0
Pogonia ophioglossoides	0.0006410256	0
Polygala paucifolia	0.0225448483	0.0518104996
Polygonatum pubescens	0.0004930966	0.0148266857
Polygonum amphibium	0.019211107	0.00368053
Polygonum sagittatum	0.0009496676	0
Polygonum scandens	0	0.0003052503
Populus balsamifera	0.0027014652	0.0032051282
Populus deltoides	0.0008201675	0
Populus grandidentata	0.0002374169	0.006884129
Populus tremuloides	0.0196608947	0.0118543434
Potamogeton berchtoldii	0.0017094017	0
Potamogeton gramineus	0.0091880342	0
Potamogeton natans	0.0129376559	0.0005827506
Potamogeton oakesianum	0.0033653846	0
Potamogeton pusillus	0	0
Potamogeton richardsonii	0	0
Potentilla anserina	0.0081307581	0
Potentilla fruticosa	0.0188071366	0.0132211538
Potentilla norvegica	0	0
Potentilla palustris	0.0485679918	0.0003052503
Potentilla recta	0.0018315018	0
Prenanthes alba	0	0.0124843805
Prenanthes spp.	0	0.0015082956

Primula mistassinica	0	0
Proserpinaca palustris	0.0082417582	0
Prunella vulgaris	0.0162905044	0.0042735043
Prunus pensylvanica	0	0
Prunus pumila	0	0.0006952924
Prunus serotina	0.002374169	0.0234038279
Prunus virginiana	0.0043773742	0.0158927885
Pteridium aquilinum	0.0806599644	0.7796134993
Pterospora andromedea	0	0.0021367521
Pyrola elliptica	0.0335048439	0.0088035184
Pyrola obtusa	0	0
Pyrola rotundifolia	0.0081810473	0.0081634889
Pyrola chlorantha (P. virens)	0.0281364469	0.0206391399
Pyrola spp.	0.000534188	0
Quercus alba	0.0007305136	0.0127090699
Quercus ellipsoidalis	0	0.0164365549
Quercus rubra	0.0241357598	0.1556700176
Quercus velutina	0.0019723866	0.0039136302
Ranunculus abortinus	0	0.0028490028
Ranunculus flabellaris	0.0014838557	0
Ranunculus gmelini	0.006993007	0
Ranunculus sceleratus	0.0064441731	0
Ranunculus recurvatus	0.0005827506	0
Ranunculus reptans	0	0
Rhamnus alnifolia	0.0471005134	0.0010683761
Rhamnus cathartica	0.0009157509	0
Rhamnus frangula	0.0023504274	0.0021367521
Rhynchospora alba	0.0067765568	0.000400641
Rhynchospora fusca	0.0051282051	0
Ribes americanum	0	0.0003052503
Ribes cynosbati	0.0032955293	0
Ribes lacustre	0	0
Ribes triste	0.0104099159	0
Rorippa palustris	0	0
Rosa acicularis	0	0.0032051282
Rosa blanda	0	0.0008012821
Rosa carolina	0	0.0027316434
Rosa palustris	0.0180108798	0.0033577534
Rosa spp.	0	0.0015082956
Rubus alleghaniensis	0.0012531328	0.015877712
Rubus flagellaris	0.0023310023	0
Rubus hispidus	0.004502442	0.0007305136
Rubus occidentalis	0.0007716049	0.0219673114
Rubus parviflorus	0	0
Rubus pubescens	0.1832725717	0.0381236759
Rubus setosus	0	0
Rubus strigosus	0.0069444444	0.012262844
Rudbeckia hirta	0	0.0015614727
Rumex acetosella	0	0.0018315018
Rumex orbiculatus	0.0062080204	0
Rumex verticillatus	0	0
Sagittaria latifolia	0.001025641	0
Sagittaria spp.	0.0039173789	0
Salix bebbiana	0.0050213675	0.0039215171
Salix candida	0.0048213894	0
Salix cordata	0.0004578755	0
Salix discolor	0.0060897436	0
Salix eriocephala	0.0019230769	0
Salix exigua	0.0011870845	0
Salix lucida	0	0
Salix myricoides	0.0023310023	0.0002374169
Salix pedicellaris	0.0311321395	0
Salix petiolaris	0	0
Salix pyrifolia	0.008820249	0
Salix serissima	0.0037393162	0
Salix spp.	0.000400641	0
Sambucus pubens	0.0009496676	0
Sanicula marilandica	0.000534188	0
Saponaria officinalis	0	0.0037986705

Sarracenia purpurea	0.0252514916	0
Satureja acinos	0	0
Satureja arkansana	0	0
Scheuchzeria plaustris	0.0076923077	0
Schizachne spp.	0	0
Scirpus acutus	0.0318355718	0
Scirpus americanus	0.0044677545	0.0032051282
Scirpus cespitosus	0.0002289377	0
Scirpus cyperinus	0.0204405874	0.0003052503
Scirpus hudsonianus	0.0022652786	0
Scirpus subterinalis	0.0151098901	0
Scirpus spp.	0.0004578755	0
Scutellaria galericulata	0.0245962442	0.0032051282
Scutellaria incana	0	0
Scutellaria lateriflora	0.0072199387	0
Sedum acre	0	0
Selaginella selaginoides	0.0009157509	0
Senecio pauperculus	0	0
Shepherdia canadensis	0	0.0008012821
Silene vulgaris	0	0
Sium suave	0.0430741327	0
Smilacina rac	0.0002564103	0.0019230769
Smilacina stellata	0.0063244015	0.0215475408
Smilacina trifolia	0.103701715	0.0036706349
Smilax tamnoides hispida	0.0004930966	0.0013532764
Solanum dulcamara	0.0083104099	0.0025641026
Solidago caesia	0.0041625042	0.004985755
Solidago canadensis	0.0073352526	0.0244355101
Solidago gigantea	0	0
Solidago graminifolia	0.0046652422	0.0016619183
Solidago houghtonii	0.0019723866	0
Solidago juncea	0	0
Solidago ohioensis	0.0016511267	0.0050747863
Solidago rugosa	0.0110969707	0.0023760961
Solidago spathulata	0	0
Solidago uliginosa	0.0077209584	0.0018315018
Sonchus arvensis	0.0023310023	0
Sonchus uliginosus	0	0
Sorbus americana	0.001138664	0.0068681319
Sorbus decora	0.0031476003	0.0017751479
Sparganium chlorocarpum	0.0028490028	0
Sparganium eurycarpum	0.0009496676	0
Sparganium minimum	0.0623869957	0
Spiranthes cernua	0	0.0004930966
Spiranthes lacera	0	0.0010893246
Spiranthes lucida	0	0
Spiranthes romanzoffiana	0	0
Spiraea alba	0.0072666531	0
Stellaria longifolia	0.0029137529	0
Stellaria longpipes	0	0
Streptopus roseus	0.0030864198	0.0003373819
Symphoricarpos albus	0	0.0023095777
Tanacetum huronense	0	0.0008012821
Tanacetum vulgare	0	0
Taraxacum officinale	0	0.0002374169
Taxus canadensis	0	0.006993007
Thalictrum dasycarpum	0.0047666009	0.0003052503
Thelyptris palustris	0.1202008156	0.0042360174
Tiarella cordifolia	0.0003205128	0.0028490028
Thuja occidentalis	0.1039358074	0.0862822953
Tilia americana	0	0
Tofieldia glutinosa	0.0035866911	0.0085470085
Toxicodendron	0.0021853147	0.0103282969
Toxicodendron radicans	0.0067155067	0.0023310023
Triadenum fraseri	0.0313014994	0.0032190032
Triadenum spp.	0.0023310023	0
Trientalis borealis	0.1163627817	0.3413286027
Triglochin maritima	0.0030525031	0.000400641
Triglochin palustris	0.004985755	0

Trillium cernuum	0.0010683761	0.0007122507
Trillium grandiflorum	0	0
Tsuga canadensis	0.0051053114	0.016064786
Typha angustifolia	0.0054131054	0.0042735043
Typha latifolia	0.0222642327	0.0066045066
Typha X glauca	0.0007122507	0
Ulmus americana	0.0032790927	0
Utica dioica procera	0	0
Utricularia spp.	0.0018315018	0.0016025641
Utricularia cornuta	0.0037698413	0.0032496439
Utricularia intermedia	0.0312569529	0
Utricularia minor	0.0021367521	0
Utricularia vulgaris	0.0165140415	0
Vaccinium angustifolium	0.034966432	0.293458207
Vaccinium macrocarpon	0.0360140434	0.0032772783
Vaccinium membranaceum	0.0004930966	0.0025641026
Vaccinium myrtilloides	0.0694451345	0.3522365892
Vaccinium ovalifolium	0.0023730276	0.0051282051
Vaccinium oxycoccos	0.0227467689	0.0069711538
Vallisneria americana	0	0.0003373819
Verbascum thapsus	0	0
Verbena canadensis	0	0
Veronica americana	0	0
Viburnum acerifolium	0.0004930966	0.0013495277
Viburnum cassinoides	0.0038176979	0.0039335664
Viburnum lentago	0.0050607287	0.0032051282
Viburnum trilobum	0	0
Viola blanda palustriformis	0.0211606888	0.021300613
Viola conspersa	0.0044705295	0.0008012821
Viola pubescens	0	0
Viola renifolia	0.0353243284	0.0207547083
Viola rostrata	0.0338868539	0.0183998101
Viola sororia	0	0
Viola spp.	0.0442270959	0.0140439082
Vitis riparia	0.0128501247	0.0013267415
Xyris montana	0.0006410256	0
Zigadenus glaucus	0	0.0026709402
BRYOPHYTES and ALGAE:		
Aulacomnium palustris	0.0085192585	0
Bazzania trilobata	0.0092185592	0.0071872572
Bazzania spp.	0.0026990553	0.0043016194
Brachythecium spp.	0.0203570504	0.1048389382
Brotherella recurvans	0	0
Brotherella spp.	0.0236850138	0.0053432861
Calacladium spp.	0	0.0009496676
Caliergon spp.	0.0078895464	0
Chara aspera	0.0051282051	0
Chara globularis	0.0331959707	0.000400641
Chara vulgaris	0.0108404558	0.0048076923
Climacium dendroides	0.0021367521	0
Climacium spp.	0.0250581627	0.0205783495
Conocephalum con.	0	0
Cratoneuron spp.	0.032967033	0
Dicranum flag.	0	0.0005827506
Dicranum scoparium	0.0214861049	0.2426862396
Dicranum viride	0.0039447732	0.0019723866
Dicranum spp.	0.0061240842	0.0443603782
Fissidens spp.	0.0079365079	0
Hylocomnium splendens	0.0235042735	0
Leucobryum glaucum	0.0028146055	0.0110127553
Mnium cuspidatum	0.0350926503	0.0032051282
Mnium punctatum	0.0293592555	0.0023310023
Mnium spp.	0.0681229027	0
Pleurosium schreberi	0.0338663473	0.0794055757
Polytrichum com.	0.0023310023	0
Polytrichum juniperinum	0.0221440241	0.0225690976
Polytrichum piliforum	0.000534188	0
Polytrichum spp.	0.0003373819	0.0042735043

Ptilia crista-castr.	0	0
Ptilium spp.	0.0276602564	0.0066150954
Sphagnum fimbreatum	0.0057109557	0
Sphagnum centrale	0.062234457	0.0120332883
Sphagnum cuspidatum	0.0426352494	0
Sphagnum compactum	0.004048583	0
Sphagnum delicado	0.0019723866	0
Sphagnum fuscum	0.025171466	0.0010683761
Sphagnum girghensonii	0.2320118209	0.0320360195
Sphagnum magellanicum	0.0823009346	0.0051282051
Sphagnum papillosum	0.0104612493	0
Sphagnum squarrosum	0.0392319227	0.0058404558
Sphagnum subsecundum	0.0025641026	0.0003052503
Sphagnum warnstorfii	0.1011381163	0.0233974359
Sphagnum wulfianum	0.0225022382	0.0285409035

APPENDIX VI

EXPLANATION OF ELEMENT RANKING CRITERIA USED FOR MICHIGAN WOODED DUNE AND SWALE COMPLEXES

ELEMENT RANKING CRITERIA

Wooded Dune and Swale Complex: The majority of degrading impacts to these complexes are related to significant alterations in hyrdrology. Un-obstructed flow of surface and ground water from the upland to the adjacent lake is essential to the maintenance of their natural character. Flow is sometimes maintained with roads placed along the beach ridge, depending on local conditions. Plant community zonation from Open Dunes inland, if present, raises species/habitat diversity and rank.

Benchmark Quality Standard: The entire complex must be intact with little or no significant human-caused alterations in hydrology. No minimum size, although most well developed complexes are no smaller than 150 acres in size. Species diversity is quite variable among complexes; (i.e. intact, well drained complexes may have lower diversity than other manipulated, but poorly drained complexes). Species diversity should be considered after hydrology in ranking.

Element Occurrence Size-Classes: Large: 3000 or more acres; Moderate: 1000-3000 acres; Small 300-1000 acres; Very small: less than 300 acres.

Boundary Mapping: Portions of the complex below the Nipissing beach ridge typically contain wet swales. Portions above the Nipissing ridge and below the Algonquin beach ridge should be included if they include distinct ridges and swales.

Exemplary Occurrences: Pointe Aux Chenes, Hiawatha National Forest, Mackinac County; Sturgeon Bay, Wilderness State Park, Emmet County; Platte River Point, Sleeping Bear Dunes National Lakeshore, Benzie County; Pointe Aux Barques, Huron County; Ogontz Bay, Hiawatha National Forest, Delta County; Iron River, Marquette County; Salmon Trout Bay, Marquette County; Grand Traverse Bay, Houghton/Keweenaw counties.

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