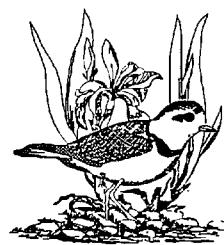


A Survey of the Lake Huron and Lake Michigan Coastal Zones for Great Lakes Endemic Plant Species



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January 31, 1997



**A SURVEY OF THE LAKE HURON
AND LAKE MICHIGAN COASTAL ZONES
FOR GREAT LAKES ENDEMIC PLANT SPECIES**

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Executive Summary

This report contains the results of a 1996 inventory conducted to complete a comprehensive inventory of the Lower Michigan coastal zone for rare plants. The inventory was directed primarily at achieving a more complete statewide database for the federally listed Houghton's goldenrod, Michigan monkey-flower, dwarf lake iris, and Pitcher's thistle, the Great Lakes endemics whose best or only populations occur on Michigan's shores. These well known global rarities are often associated with high quality natural communities such as sand dunes, coastal wetlands, and several types of shoreline forests, where a number of other rare species -- both plant and animal -- occur as well.

Impetus for this inventory was due to the discovery of a population of Pitcher's thistle in the midst of the construction of a large marina-condominium complex at the mouth of the Manistee River in 1991. Owing to the delays and subsequent controversy that the late discovery of this population caused, MNFI initiated a systematic survey of similar drowned river mouth sites along the Lake Michigan coast in 1992. That inventory resulted in the identification of significant new occurrences of endemics and other rare plants, as well as several new natural community occurrences within a number of critical dune areas. In addition, numerous previously documented populations, many of which had been tracked with virtually no habitat and population status data, were significantly updated with current information. As part of the 1992 survey, a map and aerial photo analysis was conducted for the entire coastal zone of Lake Michigan within the Lower Peninsula, resulting in the targeting of numerous areas of probable rare plant habitat for which either no records or very dated records lacking status data were known.

Based on the compelling urgency to continue to compile a comprehensive statewide natural features database for Michigan's coastal zone, largely to facilitate environmental review and enhance conservation planning decisions, we initiated the present study with the following objectives: 1) to complete the inventory of the Lake Michigan coastal zone (excluding most islands) based on the gap areas identified via analyses following the 1992 inventory, 2) systematically assess the entire mainland shore of Lake Huron in the Lower Peninsula and conduct inventories in all targeted gaps and historical record sites within a single field season, 3) tally exotic plant species within each survey site and classify and compare their degree of invasiveness in shoreline natural communities, and 4) use the newly updated MNFI Biological and Conservation Database (BCD) to provide a comprehensive listing of all nature feature occurrences (i.e. rare plants, rare animals, and exemplary natural communities) within designated Critical Dune areas of the Lower Peninsula for consultation by regulatory staff in the Coastal Zone Management (CZM) Program of the Department of Environmental Quality (MDEQ).

Map and aerial photo interpretation of both the Lake Huron and Lake Michigan shorelines in the Lower Peninsula resulted in the delineation of 44 potential survey sites. In the field some sites were combined or augmented, and several additional sites were added, resulting in a total of 52 discrete sites (28 for Lake Huron and 24 Lake Michigan) ultimately surveyed. Surveys were conducted from May through October 1996, targeting endemic plant species as well as other shoreline rarities and high quality natural communities. In addition, the general quality of the sites including type(s) and extent of disturbance(s) was described, and the presence of exotic species was recorded, with the assignment of an invasiveness rank to each species identified. More than 114 miles of Lower Michigan shoreline were covered in field surveys.

A total of 24 new rare plant occurrences was identified, consisting of 23 occurrences of threatened plant species and one occurrence of a special concern species. One potentially new occurrence (i.e. suspected but not identifiable) of the federal and state endangered Michigan monkey-flower was found. Two new natural community occurrences were identified, consisting of one occurrence of Great Lakes marsh and one occurrence of boreal forest. Updated status information was obtained for 54 occurrences of previously documented plant species. Many of these updates included significant range extensions to historically documented colonies. The locations of two previously documented plant occurrences, one of Houghton's goldenrod and one of Pitcher's thistle, were

determined to be extirpated. In addition, one previously identified natural community of cobble beach was re-surveyed and significantly extended. Collectively, a total of 66 different exotic species was identified, and of these, 23 species were found at least once on both shorelines. Significant invasive species included spotted knapweed, yarrow, sweet white clover, Canada bluegrass, smooth brome grass, bouncing bet, Lombardy poplar, Autumn olive, and bladder campion.

Plant and animal element occurrence (EO) data was extracted from the BCD for a subset of coastal sections in which critical dunes (CD) occur, and was manually checked against the MNFI occurrence maps. This process revealed that the database files did not always reflect the entire extent of an occurrence and corrections will be necessary to reconcile discrepancies. While completion of the quality checking of the list (to be completed with other funding sources) may reveal a few more EO's or extensions of the range of some EO's, a fairly good picture of the significance of coastal habitats for natural features was obtained from the current data. Altogether, the list includes 290 EO's in the state's CD, which represents about 13% of the total coastal plant and animal EO's in the MNFI database. This is approximately proportional to the portion of the coast that is designated as CD (about 12% of coastal sections). Since many of the shoreline plants occur in sparse populations scattered over extensive habitat, these EO's frequently occur in more than one section. In addition, many sections have EO's of several different species. The total number of CD sections with plant or animal EO's is about 220, or about 48% of all the CD sections.

Specific recommendations resulting from this study are provided under the following categories: 1) further survey work, 2) land owner contact and education, 3) exotic species control, and 4) research.

TABLE OF CONTENTS

ABSTRACT	i
LIST OF TABLES	v
LIST OF FIGURES	v
LIST OF APPENDICES	v
INTRODUCTION.....	1
METHODS	3
THE STUDY AREA.....	3
ENDEMIC PLANTS INVENTORY	3
LAKE HURON INVENTORIES.....	3
Field Survey Preparation.....	3
Field Surveys.....	5
Data Analysis, Transcription, and Updating.....	6
LAKE MICHIGAN INVENTORIES	6
Field Survey Preparation.....	6
Field Surveys.....	7
Data Analysis, Transcription, and Updating.....	8
CRITICAL DUNES ELEMENT OCCURRENCE LIST	8
RESULTS	10
ENDEMIC PLANTS INVENTORY	10
Grand Summary	10
LAKE HURON INVENTORIES.....	13
Survey Site Identification	13
Rare Plant Occurrences.....	14
Exotic Plant Species.....	16
LAKE MICHIGAN INVENTORIES	19
Survey Site Identification	19
Rare Plant Natural Community Occurrences.....	20
Exotic Plant Species.....	21
SITE SUMMARIES.....	24
Lake Huron Survey Sites	24
Lake Michigan Survey Sites	46
CRITICAL DUNES ELEMENT OCCURRENCE LIST	64
DISCUSSION	67
ENDEMIC PLANTS INVENTORY	67
Lake Huron	67
Lake Michigan	70
CRITICAL DUNES ELEMENT OCCURRENCE LIST	74

SUMMARY AND RECOMMENDATIONS	75
SUMMARY	75
RECOMMENDATIONS	75
Further Survey work	76
Landowner Contact and Education.....	77
Exotic Species.....	78
Research.....	78
ACKNOWLEDGMENTS	79
LITERATURE CITED.....	80
APPENDICES	A-1

LIST OF TABLES

Table 1. Criteria for assignment of invasiveness ranks for exotic plant species	5
Table 2. Coastal zone survey sites listed from north to south by county	12
Table 3. Rare species that have been reported within the Lower Lake Huron coastal zone	13
Table 4. Rare plant occurrences identified during the 1996 Lake Huron coastal zone survey	15
Table 5. Exotic plant species identified during the Lake Huron coastal zone survey for endemic plants	17
Table 6. Rare plant and natural community occurrences identified during the 1996 Lake Michigan coastal zone survey	20
Table 7. Exotic plant species identified during the Lake Michigan coastal zone survey for endemic plants	22
Table 8. Plant and Animal Element Occurrences in Coastal Sections - Sample Output	65

LIST OF FIGURES

Figure 1. Study area for Lake Huron and Lake Michigan coastal zone survey for endemic plants	4
Figure 2. Coastal zone survey sites delineated and inventoried for endemic plants	11

LIST OF APPENDICES

Appendix A. Maps of survey sites for Lake Huron and specific shoreline areas inventoried	A-1
Appendix B. Maps of survey sites for Lake Michigan and specific shoreline areas inventoried.....	B-1

Introduction

In 1992, a systematic botanical survey of 15 drowned river mouth sites along the Lake Michigan shore of the Lower Peninsula was conducted by Michigan Natural Features Inventory (MNFI) (Penskar et al. 1993). This wide-ranging inventory targeted endemic plant species, focusing on Pitcher's thistle (*Cirsium pitcheri*), Houghton's goldenrod (*Solidago houghtonii*), dwarf lake iris (*Iris lacustris*), and Michigan monkey-flower (*Mimulus glabratus* var. *michiganensis*), all of which are federal and state listed species. These species are well known Great Lakes rarities whose best populations, both in size and number, are found in Michigan. The majority of these populations also occur largely within the state's coastal zone, usually in association with significant natural communities such as sand dunes, Great Lakes marshes, interdunal wetlands, and wooded dune-swale complexes, where they often occur with a number of other rare plants and animals. Rare associates may include such species as the federal and state endangered piping plover (*Charadrius melanotos*), the state threatened Lake Huron tansy (*Tanacetum huronense*), the state threatened and western disjunct, fascicled broom-rape (*Orobanche fasciculata*), the tiny, state threatened grape-fern known as dunewort or prairie moonwort (*Botrychium campestre*), and the state special concern and endemic Lake Huron locust (*Trimerotropis huroniana*), to name only a few. The Great Lakes plant endemics are therefore critically important barometers of the ecological condition and environmental health of Michigan's more than 3,000 miles of shoreline landscapes.

Impetus for the 1992 inventory was primarily due to the discovery of a previously unknown occurrence of Pitcher's thistle near the mouth of the Manistee River in the City of Manistee, where a condominium and marina complex was in the initial stages of construction. The discovery caused many delays while the status and viability of this new plant population was assessed, a monitoring plan was prepared, and federal and state permits were arranged. Because several other drowned river mouths and similar channels along the Lake Michigan shoreline are vulnerable to the same, unabating development scenario, a rare plant inventory of these sites was proposed and ultimately conducted by MNFI. The inventory resulted in the discovery of significant new occurrences for endemic and other rare plant species, as well as the unexpected identification of several new natural community occurrences within designated critical dune areas and elsewhere. The surveys also provided important data on several previously documented rare plant populations, including many dated records, for which status information (e.g. size, extent, condition) had been minimal or virtually nonexistent, thus further enhancing the state natural features database for environmental reviews and conservation planning decisions.

Following field surveys, the 1992 investigation included a complete aerial photo and topographic map analysis of the Lake Michigan coastal zone for Lower Michigan, including significant islands, utilizing recent (1992) coastal aerial photo imagery. This analysis was conducted to identify the best potential rare plant sites for areas not known to be inventoried previously or for which there were no recorded rare plant occurrences in apparently suitable habitat. Relatively dated and historical record sites requiring status updates were also targeted. The analysis subsequently resulted in the delineation of nearly 30 specific areas or "gaps" of shoreline, including several Lake Michigan islands, where there was strong merit for future field inventories (Penskar et al. 1993).

During this same period, the Environmental Review staff of MNFI (J. Soule et al.) were continuing efforts to improve consideration of natural features concerns in the Critical Dunes permitting program. The process was hampered by the lack of a good tool for screening projects for potential protected species prior to field visits by CZM staff. With the completion of the 1996 Lower Peninsula shoreline plant surveys, the database would finally be quite comprehensive for rare plant occurrences in Lower Peninsula dune communities. We thus perceived an opportunity to define much more precisely the zones where construction in dunes habitat would be likely to impact natural features, and also those zones where no natural features were of probable concern. Eventually the aforementioned zones could be extended to include the entire shoreline, as well as to cover animals and natural communities, as surveys are completed.

Based on the urgency to compile a comprehensive statewide database for Michigan's endemic plant species of the coastal zone, largely to facilitate environmental review and enhance conservation planning decisions, we initiated the present study. Our objectives were to: 1) complete the inventory of the Lake Michigan coastal zone, excluding most islands, based on the gap areas identified via analyses following the 1992 inventory, 2) systematically assess the entire mainland shore of Lake Huron in the Lower Peninsula and conduct inventories in all targeted gaps and historical record sites within a single field season, 3) tally exotic plant species within each survey site and classify and compare their degree of invasiveness in shoreline natural communities, and 4) use the newly updated MNFI Biological and Conservation Database (BCD) to provide a comprehensive listing of all nature feature occurrences (i.e. rare plants, rare animals, and exemplary natural communities) within designated Critical Dune areas of the Lower Peninsula for consultation by regulatory staff in the Coastal Zone Management (CZM) Program of the Department of Environmental Quality (MDEQ).

Methods

Endemic Plants Inventory

The Study Area

The extent of the study areas identified for the Lake Huron and Lake Michigan coastal zones are presented in Figure 1. For Lake Huron, the study area extended from the Straits of Mackinac to approximately the middle of St. Clair County. For Lake Michigan, all of the mainland coast of the Lower Peninsula was included as the study area, in addition to two significant near-shore islands (Temperance and Waugoshance) within Wilderness State Park in Emmet County¹.

Lake Huron Inventories

Field Survey Preparation

The USGS topographic quadrangles used by MNFI for mapping element occurrence records (EOR's) were reviewed for the entire Lake Huron shoreline in the Lower Peninsula. Rare plants documented in the MNFI statewide database for the coastal zone were identified as the principal target species. Gaps in survey areas, i.e. areas not known to be inventoried previously but comprising apparently suitable habitat, were identified. Following this review, 1:24,000 scale color infrared aerial photos were then examined systematically, focusing primarily on these gaps. Based upon the known habitat and distribution of the target species, and the condition of the shoreline communities as revealed by the aerial photos, high priority areas were ultimately identified for survey. In addition, several sites were identified where previous surveys were very dated, or where the level of threat to particularly significant occurrences was thought to be quite high. Topographic quadrangles were obtained for all priority sites and the locations of all rare plant and natural community records shown on the MNFI maps were copied onto them. Field packets for each identified survey site were prepared, including the quad, matching 1:24,000 scale black and white aerial photos, and, in some cases, occurrence record data, to be carried into the field during surveys.

¹ Nearly 30 sites for future survey were identified following the 1992 drowned river mouth inventory of the Lake Michigan coast; these sites included several significant islands. For the 1996 survey, mainland sites were targeted *a priori*, with the exceptions noted, owing to the logistical difficulty of attempting to inventory the majority of the island sites within the same field season.

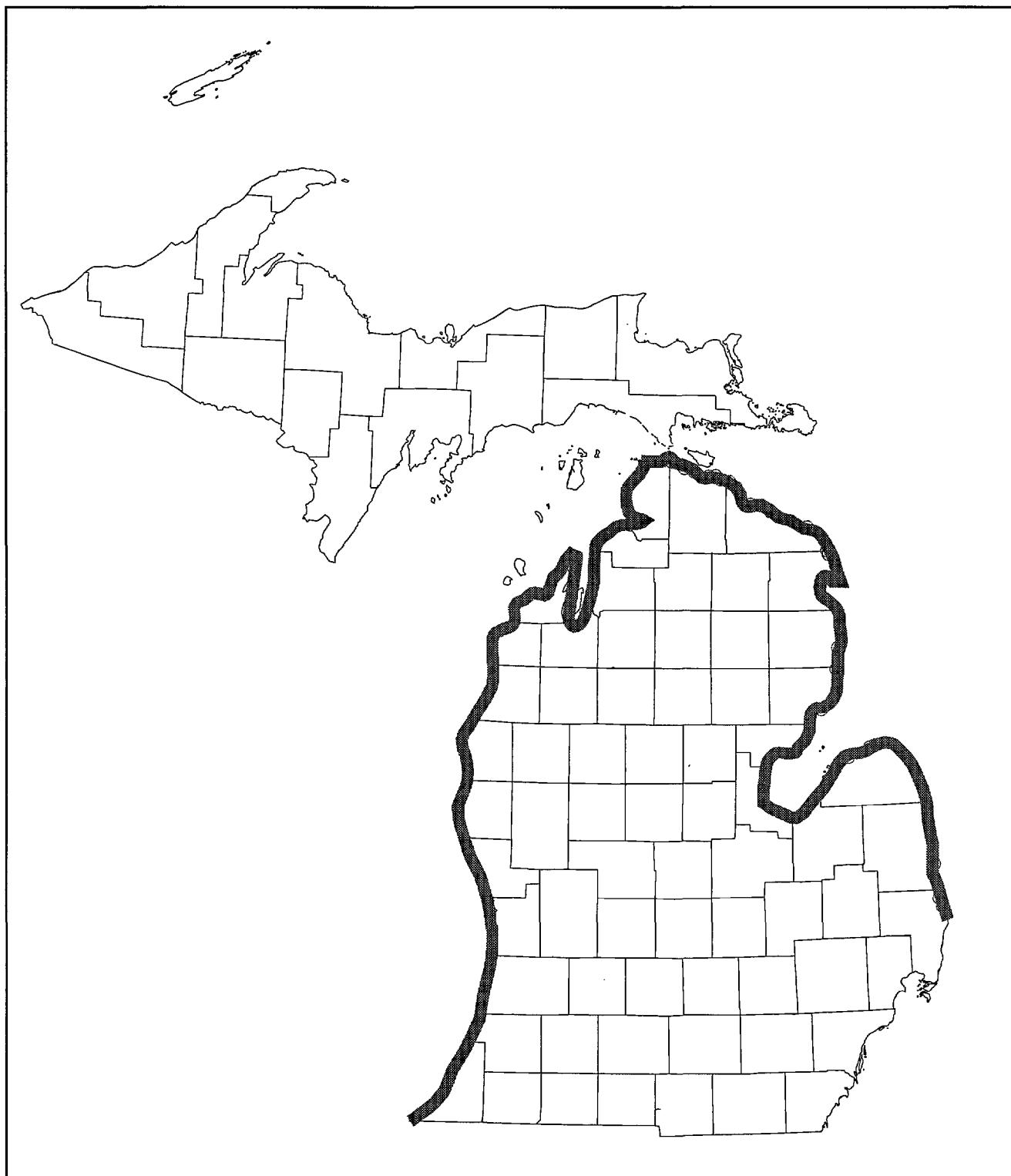


Figure 1. Study area for Lake Huron and Lake Michigan coastal zone survey for endemic plants.

Field Surveys

Field surveys were conducted from June 24 to September 20, 1996 by P. Higman. Although not all of the sites could be surveyed during the early, middle, and late portions of the field season, an attempt was made to time the surveys for early blooming species in at least some of the sites, as well as for later blooming species. Surveys were conducted systematically by traversing and meander-searching all potential shoreline habitat for the target species at each site that was identified. In several cases, where access points were limited, a kayak was used to get to the survey site. Every attempt was made to thoroughly explore each site with the aid of aerial photos, in order to maximize the encounter of significant microhabitats. However, many of the identified priority sites included a large component of private lands and inland access was not always possible. In such cases, the shoreline was surveyed from the waters edge where at least some of the target species and potential habitat could be identified. In some cases, it became apparent that appropriate habitat was not likely present, and further survey work was aborted at that site. All surveyed areas were marked and dated on the field topographic maps.

At each site, descriptions indicating the natural communities present, their general quality, and extent of disturbance were made, with an emphasis on artificial disturbance features, such as off-road-vehicle (ORV) impacts from excessive recreational activities. Thorough species lists were also compiled, with notes made of invasive exotic species. Such exotic species were assigned a numerical rank from 1 to 3, indicating the extent of invasiveness based on the qualitative criteria shown in Table 1. In several instances, when species did not clearly fit one of these arbitrary categories, a "range-rank" was given, such as "1-2" or "2-3".

Table 1. Criteria for assignment of invasiveness ranks for exotic plant species.

Rank	Description of invasiveness
1	present but relatively scarce and non-invasive
2	moderately abundant, fairly widespread in site, and appearing invasive
3	well established throughout most of site, abundant, and appearing highly invasive, displacing native vegetation

Careful attempts were made to locate any rare species occurrences that were previously known from a site, particularly with regard to very dated or historical records, as well as any new occurrences. When rare plants were encountered, standard MNFI field forms were completed and, where practical, tallies were recorded for adult and juvenile (non-flowering) plants. Otherwise, estimates of population size were made. In addition, the extent and of populations was clearly delineated and identified on topographic map. An endangered-threatened species permit was issued by the MDNR Wildlife Division,

and where appropriate, voucher specimens for verification and submission to the University of Michigan Herbarium (MICH) were collected. The location and extent of each rare species occurrence was marked on the field topographic maps. Lastly, photos to document representative portions of shorelines indicating natural community types, selected species of interest, or examples of characteristic exotic species and disturbance regimes were taken as necessary.

Data Analysis, Transcription, and Updating

Following field surveys, inventory data (MNFI field forms, field notes, photos, and topographic map notations) were compiled, reviewed, and summarized. Any unidentified specimens that had been collected during the study were keyed, and in several cases confirmation of the identity was requested from Dr. Anton A. Reznicek, Assistant Curator of the University of Michigan Herbarium in Ann Arbor. Field forms were finished with additional data from specimens, field notes, and maps. New plant records were evaluated, given an element occurrence rank², and then transcribed. If specimens had been collected, they were prepared and submitted to the University of Michigan Herbarium. Field notes were used to update and expand the data for previously known occurrences that were encountered, for both plant and natural community records. Data for several potential new community occurrences encountered during the surveys were also compiled and presented to MNFI staff ecologists D. A. Albert and P. J. Comer for determination and transcription. Following data analysis, all field forms and updated and transcribed records were submitted for mapping and entry into the MNFI heritage database, from which the data will eventually be exported to the statewide MIRIS (Michigan Resource Information System) and CIWPIS (Coastal Inland Water Permit Information System) databases.

Lake Michigan Inventories

Field Survey Preparation

Field inventories required little preparation, as map and aerial photo interpretation from the 1992 study (Penskar et al. 1993) had previously delineated the specific shoreline gaps for investigation in future surveys. Most islands were excluded for this survey, owing to the logistical difficulties of attempting to inventory these sites within the same field season. Both Waugoshance Island and Temperance Island, however, based on their relative proximity to the mainland, were selected for field

² "Element occurrence rank", noted basically as A, B, C, or D, is a natural heritage evaluation of the quality of the occurrence; an A-ranked occurrence is considered an exemplary, viable population, whereas D-ranked occurrences are those that are generally small, occur in degraded sites, and have poor viability.

survey, and thus aerial photos were re-examined to determine the best access and survey routes. Staff of Wilderness State Park were also consulted just prior to the inventory for guidance on accessing these sites. Topographic quadrangles were obtained where necessary for the identified shoreline areas. These maps were then annotated with current information from the MNFI database for any previously known natural feature occurrences, particularly for any natural community occurrences that might benefit and direct rare plant inventory efforts. Selected 1:24,000 scale aerial photographs were examined and then compiled for use in field inventories.

Field Surveys

As in 1992, field work was targeted for late summer to early fall inventories, as there would be virtually no opportunities for repeat visits to sites, in contrast to the more extensive work required for the Lake Huron surveys. Because earlier blooming species such as Pitcher's thistle, dwarf lake iris, and Lake Huron tansy could be easily recognized until early fall, surveys were conducted from August through late October. This gave us the potential to seek several additional rare plant species, such as Houghton's goldenrod, northern appressed clubmosses (*Lycopodiella* spp.), and zigzag bladderwort (*Utricularia subulata*), among others, that could be sought in shoreline natural communities (e.g. interdunal wetlands) and enable definitive identification to be made. It was recognized that certain rare plant species, such as the prairie dunewort (*Botrychium campestre*), are visible only until about mid-June, and could not be sought in several potential sites for this taxon. Field surveys, nonetheless, were targeted for recognizing the optimal number of Great Lakes endemics and other associated shoreline rarities.

Field surveys were not initiated until August 15, and were conducted until October 29, primarily by M. Penskar, with assistance from P. Higman for selected Emmet County sites. Because of the emphasis on late season inventory, Lake Michigan sites were inventoried from north to south, beginning in Emmet County and ending in Berrien County. Field survey sites were based on the specifically delineated regions of shoreline from the 1992 investigation (see Appendix B in Penskar et al. 1993), although in some cases not all of a broadly defined shoreline area could be practically done nor reasonably accessed, though this was atypical. When it was apparent after cursory reconnaissance or limited survey that a site, or portions of it, had little merit, the inventory was concluded or abandoned outright. This enabled more time to be spent elsewhere. Occasionally, areas beyond those originally delineated were recognized while in the field, and these were investigated where possible to attempt to identify additional discoveries. In several instances, access to sites was necessarily gained by asking for permission from private landowners, none of whom denied entry. These landowners also provided

guidance on walking the shoreline in areas of multiple small ownerships, such as in subdivisions or other similar clusters of residences.

Field surveys were conducted essentially as described above for the Lake Huron localities, usually employing a meander-search technique to cover as much of a potential habitat as possible to optimize the encountering of rare plant populations. When found, a population tally was made if numbers of plants were relatively low, with special emphasis given to colonies of Pitcher's thistle. When colonies were large, numbering above a few hundred individuals, population size was estimated. The area covered in the field was marked on a topographic map, in addition to the specific localities of rare plant colonies. MNFI data forms were completed for each survey sites, including at least a site summary form for each site, with natural community forms and special plant forms completed as needed. A species list of all vascular plants observed was completed, including exotic plant species and their respective invasiveness rating as applied above, and notes were taken to compile any additional ecological data and descriptions of artificial disturbance features and threats. Finally, a selected series of photos were taken to record examples of shorelines areas surveyed and depict some of the rare species documented.

Data Analysis, Transcription, and Updating

Following the field season, field forms and notes were compiled and organized by survey site. Field forms were finished with additional data gleaned from field notes and maps. The MNFI data base was again compared with the survey results. This was done to determine if new localities for rare species were best represented as extensions of known occurrences or could be distinguished as discrete, new populations. New plant records were evaluated, assigned element occurrence ranks, and then transcribed for entry into the state BCD. Field notes were used to update and enhance the data for previously known occurrences that were encountered, for both plant and natural community records. Subsequent consultation with MNFI staff ecologists D.A. Albert and P.J. Comer resulted in the recognition of new natural community occurrences; these were also transcribed and given to ecology staff for assignment of occurrence rank. Following data analysis, all field forms and updated and transcribed records were submitted for mapping and entry into the MNFI heritage database, from where the data will eventually be exported to the statewide MIRIS and CIWPIS databases.

Critical Dunes Element Occurrence List

A list of all plant and animal element occurrences (“EOs”) that fall in coastal sections, including all designated Critical Dunes (CD), was extracted from the MNFI statewide database, Biological and Conservation Database (BCD). From this list, we derived a subset of the CD sections with associated EOs for use as a screening tool for CD permitting staff. Natural community occurrences were not included in this list, because of technical difficulties in translating community boundaries to the database product, and because in nearly all cases natural communities occurrences within CD areas also include plant EOs. We expect the MNFI database to be translated to a Geographic Information System (GIS) environment in the next 1-3 years, and at that time, the natural community element occurrences can be added to this product.

The list of plant and animal element occurrences within designated CD is stored as a Microsoft Excel file that can be sorted by Town, Range, and Section into regions of interest for easy reference during project screening. Elements are referenced by scientific name, MNFI EO code number, and a letter code (S, M, or G) that indicates the extent of the occurrence. A code of S indicates a very local occurrence, whereas M indicates an occurrence extending up to 1.5 miles from the mapped location; G indicates an occurrence extending up to 5 miles.

To quality test the list we manually checked EOs with an extent label of M or G against occurrence maps. This process revealed that the database files did not always reflect the entire extent of an occurrence. This grant did not include enough funding to complete the process of correcting these discrepancies. We expect to complete this work under other funding within the next 6 months.

Results

Endemic Plants Inventory

Grand Summary

Analyses of potential rare species habitats and distributions, in conjunction with aerial photo review of the entire designated coastal zones for both lakes, resulted in the identification of 52 specific survey sites inventoried in 1996 (Figure 2, Table 2). Overall, it was estimated that approximately 114 lineal miles of shoreline were collectively covered during these inventories³. A total of 24 new rare plant occurrences was identified, consisting of 23 occurrences of threatened plant species and one occurrence of a special concern species. One potentially new occurrence (i.e. suspected but not identifiable) of the federal and state endangered Michigan monkey-flower was found. Two new natural community occurrences were identified, consisting of one occurrence of Great Lakes marsh and one occurrence of boreal forest (MNFI 1990). Updated status information was obtained for 54 occurrences of previously documented plant species. Many of these updates included significant range extensions to known or historically documented colonies. The locations of two previously documented plant occurrences, one of Houghton's goldenrod and one of Pitcher's thistle, were inventoried sufficiently to determine that populations at these sites were extirpated. In addition, one previously identified natural community of cobble beach was re-surveyed and significantly extended.

Numerous exotic plant species were observed and recorded from both the Lake Huron and Lake Michigan shorelines. Collectively, a total of 66 different species was identified, and of these, 23 species were found at least once on both shorelines. For Lake Huron, a total of 38 exotic species was observed, whereas on Lake Michigan a significantly higher total of 51 species was encountered.

Although not specifically targeted during inventories, some data were compiled for listed animal species. Observations of a pair of immature bald eagles (*Haliaeetus leucocephalus*, federal and state threatened) for a possible nesting site and a sighting of a Northern harrier (*Circus cyaneus*, state special concern) were made, as well as the apparent identification of an historical site for Lake Huron locust (*Trimerotropis huroniana*, state threatened and former federal candidate species), the latter an insect endemic to the Great Lakes.

The following sections detail the results for the different shorelines that were inventoried.

³ The collective mileage estimate for the shoreline area covered can be considered a highly conservative one, as it is drawn from freehand measurements of survey site inventory routes on topographic maps. Moreover, since survey sites were often assessed by walking out and then back in different areas, and typically included meander-searches to traverse as much of each site as possible, the actual distance covered, albeit difficult to precisely compute, was easily more than double the figure provided.

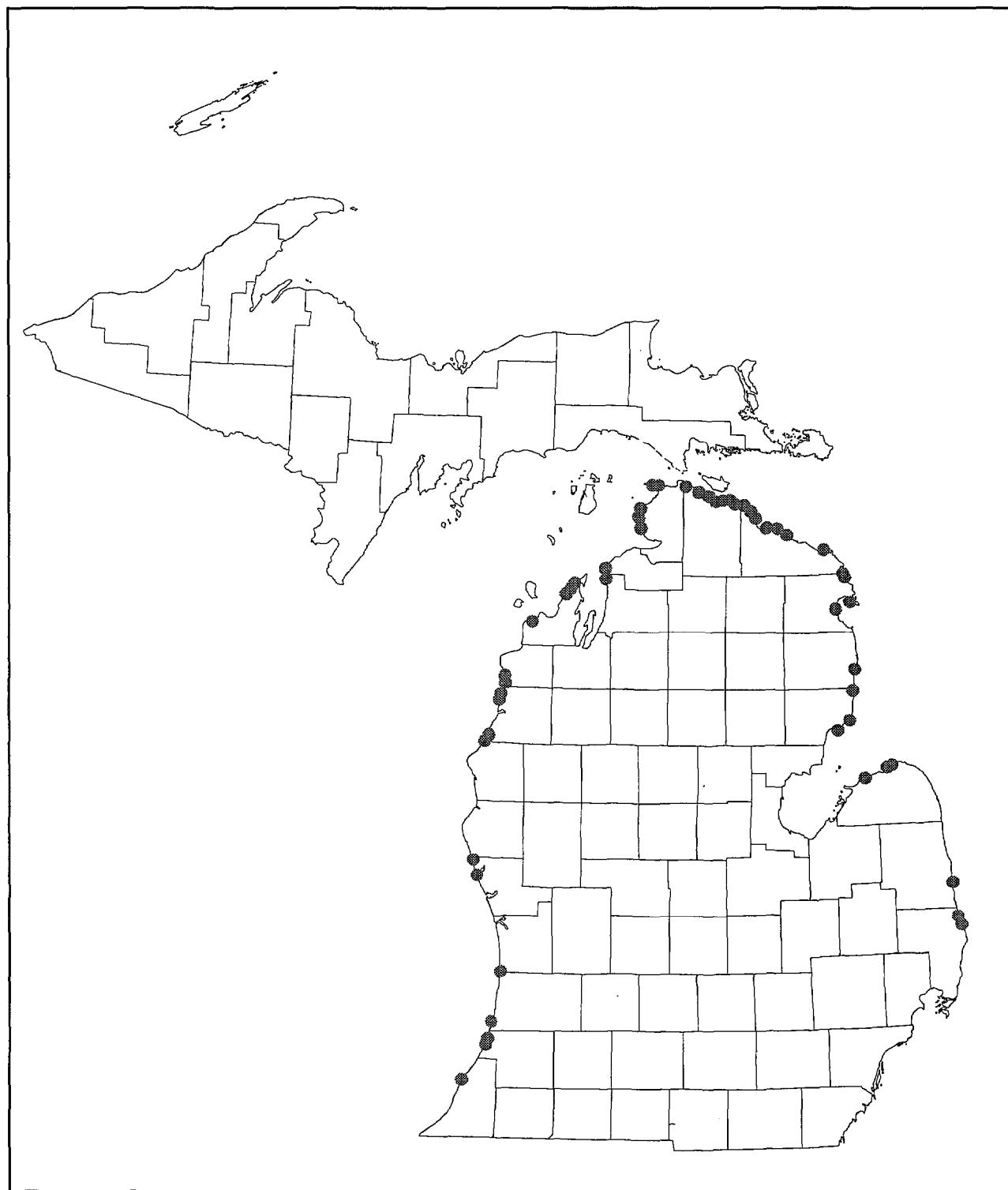


Figure 2. Coastal zone survey sites delineated and inventoried for endemic plants.

Table 2. Coastal zone survey sites listed from north to south by county.

Lake Michigan		Lake Huron	
County	Survey Site	County	Survey Site
Emmet	1. Waugoshance Island	Cheboygan	1. Mackinac City to Cadottes Point
	2. Temperance Island		2. Mill Creek
	3. M-119 to Pike Road		3. Nipigon Point to Pries Landing
	4. Good Hart		4. Stoney Point
	5. Middle Village South		5. Cheboygan State Park West
Charlevoix	6. Fisherman's Island S.P.		6. Cheboygan State Park East
Antrim	7. Banks Township Park		7. Cordwood Point
Leelanau	8. Peterson Park North		8. High Banks
	9. Peterson Park	Presque Isle	9. Huron Beach
	10. Gills Pier		10. Mast Point
	11. Glen Arbor		11. Hammond Bay East
Benzie	12. Herring Lake Embayment		12. Evergreen Beach
	13. Watervale South		13. Hoeft State Park
Manistee	14. Bishop Road		14. Black Point
	15. Pierport West		15. Bolton Point to Rockport (in part)
	16. Merkey Road	Alpena	15. Bolton Point to Rockport (in part)
	17. Magoon Creek North		16. Rockport South
Muskegon	18. Meinert Park		17. North Point
	19. Sadony Bayou		18. Partridge Point
Allegan	20. Lake Macatawa South	Alcona	19. Harrisville State Park
	21. Miami Park	Iosco	20. Oscoda North
Van Buren	22. Ruggles Road		21. Au Sable Point
	23. Linden Hills South		22. Tawas Point
Berrien	24. Mizpah Park	Huron	23. Sleeper State Park
			24. Port Crescent State Park
			25. Port Austin
		Sanilac	26. New London Point
		St. Clair	27. Lake Huron Camp
			28. Lakport State Park

Lake Huron Inventories

Survey Site Identification

Review of the MNFI maps revealed that a total of 24 state listed species has been documented along the Lower Lake Huron shoreline. Seven of these species were noted from the southern Saginaw Bay region where a high concentration of lakeplain prairie habitat occurs. This region, however, was recently targeted during a statewide lakeplain prairie survey (Comer et al. 1995), and has been thoroughly covered during status surveys for high priority plants, such as the federal threatened and state endangered Eastern prairie fringed orchid, *Platanthera leucophaea* (Case & Case 1990), and through other statewide community inventories (see Albert et al. 1988 for the results of a Great Lakes marsh survey). Given the intensive coverage of this region, southern Saginaw Bay and its associated rare species were not considered for the current study.

Among the remaining species considered, those that are known in greatest abundance along the Lake Huron coastal zone are Great Lakes endemics such as dwarf lake iris, Houghton's goldenrod, and Pitcher's thistle, as well as Lake Huron tansy, the latter a non-endemic but rare shoreline associate. Because of their abundance and restricted habitat, these four species were considered high priority target species for this study. The four high priority target species and all other potential target species are shown in Table 3.

Table 3. Rare species that have been reported within the Lower Lake Huron coastal zone.

Species Name	Common Name	Species Name	Common Name
<i>Adlumia fungosa</i>	climbing fumitory (SC) ⁴	<i>Drosera anglica</i>	English sundew (SC)
<i>Armoracia aquatica</i>	lake cress (T)	<i>Iris lacustris</i>	dwarf lake iris (T/T)
<i>Calypso bulbosa</i>	calypso orchid (T)	<i>Pinguicula vulgaris</i>	butterwort (SC)
<i>Carex nigra</i>	black sedge (E)	<i>Polygonum careyi</i>	Carey's smartweed (T)
<i>Carex richardsonis</i>	Richardson's sedge (SC)	<i>Pterospora andromedea</i>	pine drops (T)
<i>Carex scirpoidea</i>	bulrush sedge (T)	<i>Pycnanthemum verticillatum</i>	whorled mountain mint (SC)
<i>Cirsium pitcheri</i>	Pitcher's thistle (T/LT)	<i>Solidago houghtonii</i>	Houghton's goldenrod (T/LT)
<i>Crataegus douglasii</i>	black hawthorn (SC)	<i>Tanacetum huronense</i>	Lake Huron tansy (T/T)
<i>Cypripedium arietinum</i>	ram's head orchid (SC)		

Based upon the known habitats and distributions of all species shown, the gap analysis of previous survey work, and systematic aerial photo review, a total of 28 sites was ultimately delineated for field surveys (Figure 2). A review of the distributions of the target species revealed that only one of the

⁴ State status followed by federal status, where appropriate. SC=special concern; T=threatened; E=endangered

priority species, Pitcher's thistle, was known to occur south of Partridge Point in Alpena County. The vast majority of the other noted species were also known mostly from this northern region. Therefore, the majority of survey sites identified, 18 of them, were delineated north of Partridge Point. A considerable amount of survey work has already been conducted in the northern portion of the Lake Huron coastal zone. Thus for the most part, the new survey sites identified here were in areas that tended to be contiguous with former survey sites where concentrations of rarities and high quality natural communities had been previously found. The potential extensions of known occurrences were therefore well anticipated.

Several southern survey sites were also identified for inventory. To our knowledge, no systematic rare plant survey has ever been conducted along the entire Lake Huron shoreline, the known records resulting either from relatively recent surveys of specific sites, or from herbarium records where a collector happened to prepare a voucher specimen. Therefore, the true southern limit for Pitcher's thistle had not been established and the entire Lake Huron shoreline was considered to constitute potential habitat for this species. Several of the southern sites that were identified were chosen because of known historical occurrences of Pitcher's thistle. These included Port Austin, Albert E. Sleeper State Park, Port Crescent State Park, Au Sable Point, and Oscoda North (Table 2). Several additional southern sites were chosen for survey because aerial photo review revealed at least some dune habitat with the potential, however slim, to harbor the thistle. These sites included Lakeport State Park, Lake Huron Camp, New London Pt., Tawas Pt., and Harrisville State Park. Although *Cirsium pitcheri* was the prime target in these southern sites, complete species lists were compiled, such that should any other rarity occur there it would also be uncovered. In addition, Harrisville State Park was the site of a previously documented occurrence of black sedge (*Carex nigra*), an unusual, state endangered boreal disjunct, and this species was also specifically targeted there for a status inventory. Maps of all specific survey sites, indicating the extent of field coverage, are provided in Appendix A. Accompanying detailed descriptions of each survey site are also provided in the site summary section. From the topographic maps, it was calculated that a minimum of 67 miles of lineal shoreline was inventoried.

Rare plant occurrences

A total of 52 rare plant occurrences representing eight species was located during the Lake Huron coastal zone surveys (Table 4). Twelve of these were new occurrences, including three of Pitcher's thistle, one of ram's head orchid, four of Lake Huron tansy, and four of dwarf lake iris. Twenty-five significant extensions of known occurrences, including ten of Pitcher's thistle, six of Lake Huron tansy, three of dwarf lake iris, five of Houghton's goldenrod, and one of beauty sedge, were documented.

Three known occurrences of dwarf lake iris, one each of black sedge and butterwort, and two each of Pitcher's thistle, Lake Huron tansy, and Houghton's goldenrod were relocated but showed little significant change in status from earlier observations. Two occurrences of Pitcher's thistle, one in Huron County and another in Iosco County, showed a significant decline from their previous status, while one occurrence of this species in Iosco County was determined to be extirpated. One occurrence of Houghton's goldenrod in Cheboygan County was also been determined to be extirpated. Table 4 summarizes the rare plant occurrences found at each survey site.

Table 4. Rare plant occurrences identified during the 1996 MNFI Lake Huron coastal zone survey.

Site Name	Known Element Occurrences Relocated and Updated ⁵	New Element Documented Occurrences
1. Mackinac City to Cadottes Point	<i>Iris lacustris</i> (#.052) ⁶ <i>Solidago houghtonii</i> (#.057) [extirpated]	
2. Mill Creek	None	
3. Nipigon Point to Pries Landing	<i>Cirsium pitcheri</i> (#.120) <i>Iris lacustris</i> (#.011) <i>Solidago houghtonii</i> (#.050) <i>Solidago houghtonii</i> (#.024)	
4. Stoney Point	<i>Iris lacustris</i> (#.011) <i>Solidago houghtonii</i> (#.036) <i>Tanacetum huronense</i> (#.027)	
5. Cheboygan State Park West	<i>Solidago houghtonii</i> (#.022) <i>Tanacetum huronense</i> (#.016)	
6. Cheboygan State Park East	<i>Cirsium pitcheri</i> (#.106) <i>Iris lacustris</i> (#.024, .033) <i>Solidago houghtonii</i> (#.003)	<i>Tanacetum huronense</i>
7. Cordwood Point	<i>Cirsium pitcheri</i> (#.024) <i>Tanacetum huronense</i> (#.015)	
8. High Banks		<i>Cirsium pitcheri</i> <i>Tanacetum huronense</i> <i>Tanacetum huronense</i>
9. Huron Beach	<i>Cirsium pitcheri</i> (#.071) <i>Tanacetum huronense</i> (#.089)	
10. Mast Point	<i>Cirsium pitcheri</i> (#.080) <i>Potamogeton hillii</i> (#.009) <i>Solidago houghtonii</i> (#.006, .025) <i>Tanacetum huronense</i> (#.024)	<i>Tanacetum huronense</i>
11. Hammond Bay East	<i>Cirsium pitcheri</i> (#.081)	

⁵ Because of the large coastline areas surveyed along Lake Michigan, multiple occurrences of some elements within the same survey site are identified in the table. Distinct occurrences are those that are sufficiently distant from one another such that they can be considered two different populations.

⁶ Element occurrence number assigned by MNFI.

Site Name	Known Element Occurrences Relocated and Updated ⁵	New Element Occurrences Documented
11. Hammond Bay East (cont'd)	<i>Solidago houghtonii</i> (#.005) <i>Tanacetum huronense</i> (#.047)	
12. Evergreen Beach	<i>Cirsium pitcheri</i> (#.078, .082) <i>Pinguicula vulgaris</i> (#.010) <i>Solidago houghtonii</i> (#.029) <i>Tanacetum huronense</i> (#.067 & .068)	
13. Hoeft State Park	<i>Cirsium pitcheri</i> (#.083) <i>Tanacetum huronense</i> (#.046)	<i>Iris lacustris</i>
14. Black Point	<i>Carex concinna</i> (#.019) <i>Cirsium pitcheri</i> (#.087) <i>Iris lacustris</i> (#.003) Cobble beach (#.006)	
15. Bolton Point to Rockport (in part)	<i>Cirsium pitcheri</i> (#.141) <i>Iris lacustris</i> (#.017)	<i>Cirsium pitcheri</i> <i>Cirsium pitcheri</i> <i>Iris lacustris</i>
16. Rockport South		<i>Iris lacustris</i>
17. North Point	<i>Cirsium pitcheri</i> (#095)	<i>Cypripedium arietinum</i> <i>Iris lacustris</i>
18. Partridge Point	None	
19. Harrisville State Park	<i>Carex nigra</i> (#.002)	
20. Oscoda North	<i>Cirsium pitcheri</i> (#036) [extirpated]	
21. Au Sable Point	<i>Cirsium pitcheri</i> (#.035)	
22. Tawas Point	None	
23. Sleeper State Park	None	
24. Port Crescent State Park	<i>Cirsium pitcheri</i> (#.089)	
25. Port Austin	None	
26. New London Point	None	
27. Lake Huron Camp	None	
28. Lakeport State Park	None	

Exotic plant species

Numerous exotic species were encountered during the survey and the general amount of each that was present at each site was noted and rated according to our arbitrary "invasiveness" rank. These species are compiled in Table 5. A total of 38 exotic species was identified during shoreline surveys. Many common exotic species, such as wild carrot (*Daucus carota*) and timothy (*Phleum pratense*), were recorded from widely scattered sites, where they were rarely rated as invasive. Several other common species, however, were particularly notable, occurring in high numbers at a large number of survey sites. These included such plants as yarrow (*Achillea millefolium*), spotted knapweed (*Centaurea maculosa*),

Table 5. Exotic plant species identified during the Lake Huron coastal zone survey for endemic plants.

		1. Mackinac City - Cadots Pt.	2. Mill Creek	3. Point Nipigon - Pries Landing	4. Stoney Point	5. Cheboygan State Park West	6. Cheboygan State Park East	7. Cordwood Point	8. High Banks	9. Huron Beach	10. Mast Point	11. Hammond Bay East	12. Evergreen Beach	13. Hoeft State Park	14. Black Point	15. Bolton Point South	16. Rockport South	17. North Point	18. Partridge Point	19. Harrisville State Park	20. Oscoda North	21. Au Sable Point	22. Tawas Point	23. Sleeper State Park	24. Port Crescent State Park	25. Pott Austin	26. New London Point	27. Lake Huron Camp	28. Lakeport State Park
<i>Achillea millefolium</i>	yarrow	2	3	3	3		1		2-3	1-3	2-3	2	1-2	1-3		1	1-2	1-2	1-3		3				2	3		2	
<i>Agropyron repens</i>	quack grass	2	2						1				1-2									2	2	2	2			2	
<i>Agrostis gigantea</i>	redtop	1	2	1	1	1			1	1	1	3																	
<i>Arctium minus</i>	common burdock																												
<i>Barbarea vulgaris</i>	yellow rocket	1	1																										
<i>Betula incana</i>	hoary allysum	2	1																										
<i>Bromus inermis</i>	smooth brome	2	2	2		1		2					1-3																
<i>Centaurea maculosa</i>	spotted knapweed	2	3	3		2	1	1-2	3	1-3	1-3	2	1-3	1-3		1-3	1-2	3	1-3	3	3	2	3	1	3	2			
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy	2	3				1							1-2	1					2					3				
<i>Cichorium intybus</i>	chicory	2	1	1																					1	1			
<i>Cirsium vulgare</i>	bull-thistle		2		1							1	1															2	
<i>Coronilla varia</i>	crown vetch																											1	
<i>Daucus carota</i>	queen-Anne's lace	1	1										1	1														1	
<i>Elaeagnus umbellata</i>	autumn-olive																											1	
<i>Epipactis helleborine</i>	helleborine												1															1	
<i>Festuca arundinacea</i>	tall fescue		2	2																								3	
<i>Gypsophila scorzoneraefolia</i>	baby's breath																											2	
<i>Hieracium caespitosum</i>	king-devil	1	2	2						1	2	1	1					1-2		1-2							3		
<i>Lonicera sp.</i>	honeysuckle	1		2											1-3		1-2										3		
<i>Melilotis alba</i>	white sweet-clover	2	2	2		1		1-2	1	1	1-3	1	1-2												2	2	1		
<i>Pastinaca sativa</i>	wild parsnip	2	3																										
<i>Phleum pratense</i>	timothy	1	1	1		2			1	1																			
<i>Plantago major</i>	common plantain																			3									
<i>Poa annua</i>	annual bluegrass																			3									
<i>Poa compressa</i>	Canada bluegrass	3	3	2		2			1	3	3	1-3	3	2	1-3	2	2	2	2	3	3	3	3	3	2		2		
<i>Prunella vulgaris</i>	self-heal	2	1	2																									

Table 5. Exotic plant species identified during the Lake Huron coastal zone survey for endemic plants.

		1. Mackinac City - Cadotts Ft.	2. Mill Creek	3. Point Nipigon - Pries Landing	4. Stoney Point	5. Cheboygan State Park West	6. Cheboygan State Park East	7. Cordwood Point	8. High Banks	9. Huron Beach	10. Mast Point	11. Hammond Bay East	12. Evergreen Beach	13. Hoelt State Park	14. Black Point	15. Bolton Point South	16. Rockport South	17. North Point	18. Partridge Point	19. Harrisville State Park	20. Oscoda North	21. Au Sable Point	22. Tawas Point	23. Sleeper State Park	24. Port Crescent State Park	25. Port Austin	26. New London Point	27. Lake Huron Camp	28. Lakeport State Park
<i>Rhamnus frangula</i>	glossy buckthorn																												
<i>Rosa multiflora</i>	multiflora rose																												
<i>Rumex crispus</i>	curly dock	1																											
<i>Saponaria officinalis</i>	bouncing bet	2	3																										
<i>Sedum acre</i>	mossy stonecrop																												
<i>Silene vulgaris</i>	bladder campion	2				1-2	3	2	2	2	1																		
<i>Sonchus</i> sp.	sow thistle					1	1																						
<i>Tanacetum vulgare</i>	garden tansy																		1										
<i>Taraxacum officinale</i>	common dandelion	1						1		1								1	1	1	3								
<i>Tragopogon</i> sp.	goat's beard		1																2										
<i>Trifolium</i> spp.	clover	2	1						1		1							1	1-2		3								
<i>Verbascus thapsus</i>	mullein	1	1																										1

and Canada bluegrass (*Poa compressa*), which comprised the most widespread and invasive taxa. Of somewhat lesser frequency with regard to the number of survey sites but found to be relatively invasive were such species as redtop (*Agrostis gigantea*), smooth brome grass (*Bromus inermis*), ox-eye daisy (*Chrysanthemum leucanthemum*), white sweet clover (*Melilotus alba*), and bouncing bet (*Saponaria officinalis*).

In terms of a breakdown by life-form, the vast majority of the exotics consisted of forbs and herbs, as only four woody plant species were recorded. However, all of the woody plant taxa found, which included autumn olive (*Elaeagnus umbellata*), honeysuckle (*Lonicera* sp.), glossy buckthorn (*Rhamnus frangula*), and multiflora rose (*Rosa multiflora*), are well-known, notoriously invasive species. Nearly one-half of the total species recorded consisted of grasses and composites (18 species), with the remainder consisting primarily of mustards (Cruciferae), pinks (Caryophyllaceae), and mints (Lamiaceae). Interestingly, a non-native orchid species, European helleborine (*Epipactis helleborine*) was noted in two widely scattered sites, indicative of its rapid spread in the state in recent years, especially along coastal areas, although this species is not currently thought of as problematical nor invasive.

Lake Michigan Inventories

Survey Site Identification

For the Lake Michigan coastal zone in Lower Michigan, numerous potential survey sites had been identified following the 1992 inventory of drowned river mouth areas (Penskar et al. 1993). These sites were well scattered along the Lower Peninsula coast, ranging from Wilderness State Park in Emmet County to Berrien County in southwestern Lower Michigan. In addition, a number of sites had been delineated following the analysis of significant island groups, including portions of Beaver Island, Garden Island, High Island, Gull Island, and Hog Island. Because of the difficulty in accessing the majority of the islands, these were excluded *a priori* from this inventory, with the exception of Waugoshance and Temperance islands, which occur in close proximity to Wilderness Point in Wilderness State Park. Of the numerous areas delineated on maps B1-B16 in the 1993 CZM report (i.e. representing the 16 general survey regions of shoreline targeted for this inventory, including all of the mainland areas and the two above islands), a total of 24 discrete survey sites was ultimately identified and inventoried (Figure 2, Table 2). Some of the broad shoreline areas identified in 1993 were later determined to comprise, for practical purposes, two or more distinct survey sites. In addition, other sites not previously detected were found fortuitously during field surveys, typically while conducting

reconnaissance to determine how to best access a targeted site. Maps of all specific survey sites, indicating the extent of field coverage, are provided in Appendix B. Accompanying detailed descriptions of each survey site are also provided in the site summary section. From the topographic maps, it was calculated that a minimum of 47 miles of lineal shoreline was inventoried.

Rare Plant and Natural Community Occurrences

For the 24 sites inventoried along the Lake Michigan coastal zone, a total of 20 rare plant occurrences representing four species was documented, summarized in Table 6. Twelve of these were new occurrences, consisting of eight of Pitcher's thistle, two of Lake Huron tansy, one of Houghton's goldenrod, and one of fascicled broom-rape. In Leelanau County, a site was discovered that potentially represents a new occurrence for Michigan monkey-flower, based on suspected but unidentifiable sterile plants occurring in suitable habitat for this species. In addition to the several new rare plant occurrences, two significant natural community occurrences were identified, consisting of an exemplary occurrence of boreal forest on Waugoshance Island and a similarly high quality occurrence of Great Lakes marsh on both Waugoshance and Temperance islands. Temperance Island was particularly noteworthy, as it was also found to support two of the aforementioned rare plant occurrences, including one of Pitcher's thistle and the only new population of Houghton's goldenrod discovered during the Lake Michigan inventory.

Of the eight previously known occurrences relocated during surveys, significant new status information was obtained for three occurrences of Lake Huron tansy and three of Pitcher's thistle; inventories of these populations also resulted in significant extensions of their localities as well. Of the two remaining relocated occurrences, a site for Pitcher's thistle in Muskegon County indicated a possible significant decline, and the periphery of a known occurrence in Van Buren County was unsuccessfully searched to determine if the population extended further in apparently suitable habitat.

Table 6. Element occurrences identified during the 1996 MNFI Lake Michigan coastal zone survey.

Site Name	Known Element Occurrences Relocated and Updated ⁷	New Element Occurrences Documented
1. Waugoshance Island		Boreal Forest Great Lakes marsh
2. Temperance Island		<i>Cirsium pitcheri</i> <i>Solidago houghtonii</i> Great Lakes marsh

⁷ Because of the large coastline areas surveyed along Lake Michigan, multiple occurrences of some elements are identified in the table. Distinct occurrences are those that are sufficiently distant from one another such that they can be considered two different populations.

Site Name	Known Element Occurrences Relocated and Updated ⁷	New Element Occurrences Documented
3. M-119 to Pike Road		<i>Cirsium pitcheri</i> <i>Tanacetum huronense</i>
4. Good Hart	<i>Tanacetum huronense</i> (#.063)	
5. Middle Village South	<i>Tanacetum huronense</i> (#.063)	<i>Cirsium pitcheri</i>
6. Fisherman's Island State Park	<i>Cirsium pitcheri</i> (#.093)	<i>Tanacetum huronense</i>
7. Banks Township Park	<i>Tanacetum huronense</i> (#.059)	<i>Cirsium pitcheri</i>
8. Peterson Park North		<i>Cirsium pitcheri</i>
9. Peterson Park		
10. Gills Pier	<i>Cirsium pitcheri</i> (#.041)	<i>Mimulus glabratus</i> var. <i>michiganensis</i> (potential new site)
11. Glen Arbor		<i>Cirsium pitcheri</i>
12. Herring Lake Embayment	<i>Cirsium pitcheri</i> (#.051)	
13. Watervale South		<i>Cirsium pitcheri</i>
14. Bishop Road		
15. Pierport West		<i>Orobanche fasciculata</i>
16. Merkey Road		
17. Magoon Creek Natural Area		<i>Cirsium pitcheri</i>
18. Meinert Park	<i>Cirsium pitcheri</i> (#.026)	
19. Sadony Bayou		
20. Lake Macatawa South		
21. Miami Park		
22. Ruggles Road		
23. Linden Hills South	<i>Cirsium pitcheri</i> (#.109)	
24. Mizpah Park		

Exotic Plant Species

A large number of exotic plant species were identified during Lake Michigan shoreline surveys, with a total of 51 observed. These species are compiled and presented in Table 6. A significant number of these species, approximately 50% of the list, were observed at four or fewer sites, where they were rarely considered invasive. These species included such common and widespread plants as yellow rocket (*Barbarea vulgaris*), ox-eye daisy (*Chrysanthemum leucanthemum*), bull thistle (*Cirsium vulgare*), winged pigweed (*Cycloloma atriplicifolium*), orange hawkweed (*Hieracium aurantiacum*), motherwort (*Leonurus cardiaca*), black medick (*Medicago lupulina*), dandelion (*Taraxacum officinale*), and mullein (*Verbascum thapsus*). The most notable and widespread invasive species recorded were smooth brome grass (*Bromus inermis*), spotted knapweed (*Centaurea maculosa*), autumn olive (*Elaeagnus umbellata*), white sweet clover (*Melilotus alba*), Canada bluegrass (*Poa compressa*), Lombardy poplar (*Populus nigra* var. *italica*), bouncing bet (*Saponaria officinalis*), and bladder campion (*Silene vulgaris*).

Table 7. Exotic plant species identified during the Lake Michigan coastal zone survey for endemic plants.

		1. Waugoshance Island	2. Temperance Island	3. M-119 to Pike Road	4. Good Hart	5. Middle Village South	6. Fisherman's Island State Park	7. Banks Township Park	8. Peterson Park North	9. Peterson Park	10. Gills Pier	11. Glen Arbor	12. Heming Lake Embayment	13. Watervale South	14. Bishop Road	15. Pierport West	16. Merkey Road	17. Magoon Creek North	18. Meiner Park	19. Sadony Bayou	20. Lake Macatawa South	21. Miamin Park	22. Ridgeles Road	23. Littleden Hills South	24. Mizpah Park	
<i>Achillea millefolium</i>	yarrow	1	1	1	1																					
<i>Agropyron repens</i>	quack grass			1	1-2	1-2																				
<i>Agrostis gigantea</i>	redtop	1				1				1-2																
<i>Barbarea vulgaris</i>	yellow rocket		1																							
<i>Brassica</i> sp.	mustard																									
<i>Bromus inermus</i>	smooth brome			1-2	1	1	1-2	1	1	1									1	2						
<i>Centaurea maculosa</i>	spotted knapweed	2	1	2		1-2	1-2	1-2	2-3	1-2	3	1-2	1				1	2-3	3	1	2					
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy			1																						
<i>Cirsium palustre</i>	marsh-thistle			1	1																					
<i>Cirsium vulgare</i>	bull thistle			1				1																		
<i>Cycloloma atriplicifolium</i>	winged pigweed																			1	1					
<i>Daucus carota</i>	wild carrot							1	1	1	1						1	1-2		1	1					
<i>Elaeagnus umbellata</i>	autumn olive									1									3	1				1		
<i>Elymus arenarius</i>	Lyme grass																									
<i>Epipactis helleborine</i>	helleborine		1			1				2-3																
<i>Euphorbia cyparissias</i>	Cypress spurge																									
<i>Gypsophila paniculata</i>	baby's-breath																1									
<i>Hibiscus palustris</i>	swamp rose-mallow											1														
<i>Hieracium aurantiacum</i>	orange hawkweed		1																							
<i>Hieracium caespitosum</i>	hawkweed		1																							
<i>Hypericum perforatum</i>	St. John's-wort	1	1				1																			
<i>Leonurus cardiaca</i>	motherwort	1	1																							
<i>Linaria vulgaris</i>	butter-and-eggs	1						1																		
<i>Lythrum salicaria</i>	purple loosestrife								1																	
<i>Malus pumila</i>	common apple									1																

Table 7. Exotic plant species identified during the Lake Michigan coastal zone survey for endemic plants.

		1. Waugoshance Island	2. Temperance Island	3. M-119 to Pike Road	4. Good Hart	5. Middle Village South	6. Fisherman's Island State Park	7. Banks Township Park	8. Peterson Park North	9. Peterson Park	10. Gills Pier	11. Glen Arbor	12. Herring Lake Embayment	13. Watervale South	14. Bishop Road	15. Pierport West	16. Merkey Road	17. Magoona Creek North	18. Meinert Park	19. Sadoony Bayou	20. Lake Macatawa South	21. Manu Park	22. Ruggles road	23. Llinden Hills South	24. Mizpah Park
<i>Medicago lupulina</i>	black medick	1															1		1	3	1	1-2		2	
<i>Medicago sativa</i>	alfalfa																								
<i>Melilotus alba</i>	white sweet clover	1				1			1	2	1				2	1									
<i>Nepeta cataria</i>	catnip	1																							
<i>Pastinaca sativa</i>	wild parsnip	1-2																							
<i>Phleum pratense</i>	timothy	1				1																		2	
<i>Pinus sylvestris</i>	Scotch pine																								
<i>Poa compressa</i>	Canada bluegrass	1	2-3	1	1		1	1	1	2	2			1	2	1		2	1-2		1				
<i>Polygonum cuspidatum</i>	Japanese knotweed																			1					
<i>Polygonum persicaria</i>	lady's thumb	1	1				1																		
<i>Populus alba</i>	white poplar																1								
<i>Populus nigra</i> var. <i>italica</i>	Lombardy popular							3			2					1		1	1	1-2		1	2		
<i>Potentilla fruticosa</i>	shrubby cinquefoil																								
<i>Prunella vulgaris</i>	heal-all	1				1																			
<i>Robinia pseudoacacia</i>	black locust				2																1	2			
<i>Rumex crispus</i>	curly dock																1								
<i>Salix purpurea</i>	basket willow		2		2																				
<i>Salix</i> sp.	willow		1																		1				
<i>Saponaria officinalis</i>	bouncing bet						1	1		1	1					1	1	2	1	3	1	2	2	1	
<i>Silene vulgaris</i>	bladder campion	1	1	1			1	1	1	1-2	1				1	1	2		1						
<i>Solanum dulcamara</i>	bittersweet nightshade																			1					
<i>Taraxacum officinale</i>	dandelion	1		1	1																				
<i>Tragopogon</i> sp.	oyster plant		1																						
<i>Verbascum thapsus</i>	mullein	1	1													1					1				
<i>Veronica officinalis</i>	common speedwell	1													1										
<i>Viburnum opulus</i>	highbush cranberry																				1				

Two species of particular note, although they were each recorded from only one site, were baby's breath (*Gypsophila paniculata*) and Cypress spurge (*Euphorbia cyparissias*). These exotics, especially baby's breath, have the potential to spread very rapidly in coastal dune systems. Similarly, a single occurrence of purple loosestrife (*Lythrum salicaria*) along a marshy shore near Fisherman's Island State Park in Charlevoix County was duly noted (after which the only observed clump was pulled out).

With regard to life-form, approximately 20% of the list was comprised of woody plants, with nearly equal numbers of trees and shrubs. These included many well-known invasive species, such as Lombardy poplar, black locust (*Robinia pseudoacacia*), white poplar (*Populus alba*), Scotch pine (*Pinus sylvestris*), and basket willow (*Salix purpurea*). Of the herbs and forbs, which dominated the list, a significant portion (25%) was comprised of grasses and composites (13 species), with the remainder representing of a wide variety of plant families, especially legumes (Fabaceae), pinks (Caryophyllaceae), mints (Lamiaceae),parsleys (Apiaceae), nightshades (Solanaceae), snapdragons (Scrophulariaceae), and smartweeds (Polygonaceae).

Site Summaries

As established in the format of several previous MNFI reports regarding inventories with the Michigan coastal zone, we provide here a similarly detailed summary description of the specific sites covered. Our intention for this section is to provide a summary of each site in a commentary format that can be used for meaningful consultation and reference in the future. Because sites are very likely to be considered in a stand-alone sense, we have followed our previous format protocol of repeatedly giving the scientific names for all the species referenced in each summary.

Lake Huron Survey Sites

1. Mackinac to Cadottes Point (Cheboygan Co.): Several old records for shoreline endemics and Lake Huron tansy were noted in the vicinity of Mackinac City east and south to Cadottes Point. Since this area has experienced and continues to experience considerable development pressure, it was deemed important to confirm the presence of these occurrences in order to revitalize protection measures should they still persist there. The shoreline was walked from the bridge approximately 0.4 miles east and from the southern edge of Edgewater Beach to Cadottes Point. The public shoreline park near the bridge is highly disturbed as evidenced by the manicured lawn projecting to the edge of a narrow sand beach dominated by weedy species such as spotted knapweed (*Centaurea maculosa*), bouncing bet (*Saponaria*

officinalis), white sweet clover (*Melilotis alba*), Canada bluegrass (*Poa compressa*) and many others. Some remnants of the native vegetation can be found here and there in small patches including such species as marram grass (*Ammophila breviligulata*), sand cherry (*Prunus pumila*), silverweed (*Potentilla anserina*), and rush (*Juncus balticus*).

The sand beach eventually gives way to large rocky boulders fronting private residences. From here south to Edgewater Beach the shoreline is mostly private property, primarily residences, motels, hotels, and boat docks. It was apparent that extensive modification of the shoreline here precluded the presence of any of the endemics or other rare species and thus this portion was not surveyed. Much of the shoreline south of here is typified by marly swales and moist sands dominated by species such as rushes (*Juncus balticus*, *J. nodosus*), Kalm's lobelia (*Lobelia kalmii*), silverweed (*Potentilla anserina*), (*Mentha arvensis*), and purple gerardia (*Agalinis purpurea*), or in some areas, extensive emergent marshes. Further inland are shoreline boreal forests typical of the northern Great Lakes region, dominated by Northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and paper birch (*Betula papyrifera*). Scattered along the edge of the woods, in openings and in some areas extending under the canopy, a previously documented *Iris lacustris* population still persists, albeit highly fragmented. Although difficult to quantify, this fragmented population has undoubtedly experienced further reduction since last observations. This was the only rare plant occurrence documented at this survey site. It is recommended that landowner contact activities be pursued actively in this region.

2. Mill Creek (Cheboygan Co.): Access to this portion of the shoreline was gained at Mill Creek Historic Site and surveys were conducted from the north boundary of the Historic Site to approximately 0.5 miles south of the town of Freedom. Much of the relatively narrow and rocky/gravely shoreline in these region is comprised of shallow depressions characterized by widely scattered vegetation such as bulrushes (*Scirpus acutus*, *S. americanus*), silverweed (*Potentilla anserina*), rush (*Juncus balticus*), sedge (*Carex viridula*), water-horehound (*Lycopus americanus*), Kalm's lobelia (*Lobelia kalmii*), and grass-leaved goldenrod (*Euthamia graminifolia*). Dryer zones typically border the residential lots which are heavily disturbed with a marked invasion of weedy species such as white sweet clover (*Melilotis alba*), ox-eye daisy (*Chrysanthemum leucanthemum*), bladder campion (*Silene vulgaris*), chicory (*Cichorium intybus*), and tall fescue (*Festuca arundinacea*) which far outnumber native species. Several fast flowing streamlets flow into Lake Huron along this stretch with typical emergent species lining their shores such as rice grass (*Glyceria striata*), marsh-marigold (*Caltha palustris*), rushes (*Juncus* spp.), swamp buttercup (*Ranunculus hispidus*), wild mint (*Mentha arvensis*), sensitive fern (*Onoclea sensibilis*), and ostrich fern (*Matteuccia struthiopteris*). Spot checks were taken further down the

shoreline by Grand View and just north of Point Nipigon with similar results. South of Grand View, the shoreline develops a steep bluff with rising from the still very narrow strip of rocky shoreline. This is about the only undeveloped stretch of shoreline in the survey site, however, it has already been platted and lots are advertised for sale. No shoreline endemics or other rare species were found throughout this entire survey site.

3. Nipigon Point to Pries Landing (Cheboygan Co.): Access to the shoreline was gained at Pries Landing through private property at the site of a previously documented Houghton's goldenrod occurrence. The shoreline was surveyed from this point northward to Nipigon Point. The Houghton's population flourishes at Pries Landing on a flat, moist, sand beach with co-dominants silverweed (*Potentilla anserina*), bulrush (*Scirpus americanus*), and rush (*Juncus balticus*). Several weedy species are also common including yarrow (*Achillea millefolium*), spotted knapweed (*Centaurea maculosa*), and white sweet clover (*Melilotis alba*). Not noted in the original occurrence, Houghton's goldenrod is also found less than 0.25 miles north in a disturbed, rocky field behind which is a house under construction. Here, it grows with Ohio goldenrod (*Solidago ohioensis*) forming a dense golden stand. Northward, the shoreline remains somewhat rocky with scattered emergent wetlands at the water's edge and several inland fens typified by sweet gale (*Myrica gale*), shrubby cinquefoil (*Potentilla fruticosa*), sedges (*Carex flava* C. *lasiocarpa*), spike-rush (*Eleocharis rostellata*), pitcher-plant (*Sarracenia purpurea*), and twig-rush (*Cladium mariscoides*). Dwarf lake iris (*Iris lacustris*) was found scattered at the edges of the fens and the surrounding Northern white cedar (*Thuja occidentalis*) dominated woods. Cottages are found throughout.

The coastal zone maintains its rocky sand character all the way to Nipigon Point where it widens into a significant dune complex with a sand beach backed by a low foredune, and then onto flats with sparse conifer cover. Near the point itself the beach becomes a series of cobble and sand ridges, finally narrowing to the end of the point where it is dominated by large boulders with little vegetation. The dune complex appears to be relatively high quality habitat dominated by native dune vegetation including creeping and common juniper (*Juniperus horizontalis*, *J. communis*), wormwood (*Artemisia campestris*), marram grass (*Ammophila breviligulata*), and white camus (*Zigadenus glauca*). A small population (<100 individual stems) of Houghton's goldenrod (*Solidago houghtonii*) occurs on a sandy bluff south of the point on a residential lot and a single flowering plant and one rosette of Pitcher's thistle (*Cirsium pitcheri*) were found growing on the foredune just slightly north of this. Only small numbers of exotic species were apparent from the shoreline including, most notably, populations of bouncing bet (*Saponaria officinalis*) and bladder campion (*Silene vulgaris*). We were unable to locate the owners to

obtain permission to explore this complex further during this study, however, it is quite possible that additional numbers of at least some of the shoreline endemics may be found. There appears to be development pressures leading toward increased use and fragmentation of the dunes at Nipigon Point. Landowner contact encouraging thoughtful planning and conservation easements is advised.

4. Stoney Point (Cheboygan Co.): Access to Stoney Point was gained at Turner Park on the north side of Cheboygan River via kayak. Emergent marsh dominates the shoreline just east of the mouth of the river and appropriate habitat for the target species was lacking. Further east towards Stoney Point it becomes rocky and sandy and numerous stops were made such that the entire survey site from this point westward was traversed on foot. In many places the shoreline has been heavily disturbed by private beach use by the local residents, and numerous weedy species such as spotted knapweed (*Centaurea maculosa*), white sweet clover (*Melilotis alba*), and bird's-foot trefoil (*Lotus corniculata*) are common.

The Point itself extends out into the lake forming a rocky and sandy spit dominated by 3-4" diameter trembling aspen (*Populus tremuloides*) and willow (*Salix* spp.) shrubs in conjunction with wet sand-beach herbs such as silverweed (*Potentilla anserina*), rush (*Juncus balticus*), Kalm's lobelia (*Lobelia kalmii*), goldenrod (*Solidago altissima*), and Eastern lined aster (*Aster lanceolatus*). Along the west side of the point the shoreline is rocky with emergent wetlands that grade into a long shoreline swale occupied by Houghton's goldenrod (*Solidago houghtonii*). This shoreline depression widens westward to approximately 30 ft with a likewise increase in Houghton's goldenrod. Just inland from the swale is a sandy foredune ridge with a small population of Lake Huron tansy (*Tanacetum huronense*). Other species on the ridge include willow (*Salix* spp.), balsam poplar (*Populus balsamifera*), rush (*Juncus balticus*), wormwood (*Artemisia campestris*), and marram grass (*Ammophila breviligulata*). Further inland, dwarf lake iris (*Iris lacustris*) is found in the Northern white cedar (*Thuja occidentalis*) and birch (*Betula papyrifera*) dominated woods. These rare plant populations are restricted to a small region around the Point with the exception of Houghton's goldenrod which was found growing considerably inland in wetland depressions bordering Stoney Point Rd.

Further west past Stoney Point Bay, the shoreline broadens to a foredune ridge and flat extending inland to large, widely spaced residences. The shoreline communities here, in contrast to those encountered earlier, remain relatively natural, dominated by such species as marram grass (*Ammophila breviligulata*), beach grass (*Calamovilfa longifolia*), and wormwood (*Artemisia campestris*). Several properties do not appear to have been used for several years and moderately-sized populations of both Lake Huron tansy (*Tanacetum huronense*) and dwarf lake iris (*Iris lacustris*) were encountered.

5. Cheboygan State Park West (Cheboygan Co.): The west edge of Cheboygan State Park along the shoreline is composed of a sandy beach and foredune behind which lies a wide interdunal wetland with approximately 6" of standing water during the time of survey. The inland edge of the wetland was bordered with such species such as larch (*Larix laricina*), Northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), buffaloberry (*Shepherdia canadensis*), and sweet gale (*Myrica gale*), while twig-rush (*Cladium mariscoides*), bluejoint grass (*Calamagrostis canadensis*), sedge (*Carex stricta*), bulrush (*Scirpus americanus*), and Kalm's St. John's-wort (*Hypericum kalmianum*) predominated in the wetland. Towards the lakeside edge, as the wetland grades into the foredune, grass leaved goldenrod (*Euthamia graminifolia*), Kalm's lobelia (*Lobelia kalmii*), water-horehound (*Lycopus* spp.), little bluestem (*Andropogon scoparius*), and silverweed (*Potentilla anserina*), were dominant. A large population of Houghton's goldenrod (*Solidago houghtonii*) numbering in the hundreds was found in this zone. This population is a continuation of a larger population extending east along the shoreline interdunal wetlands well into Cheboygan State Park. The interdunal wetland gradually tapers off westward towards private property where the shoreline consists of a relatively narrow strip of wet sand beach, which in most places appears to be heavily used by residents. A single population of Lake Huron tansy (*Tanacetum huronense*) consisting of 3 flowering stems and 2 sterile rosettes was observed just west of the park boundary. As the shoreline arches northwestward, emergent marsh becomes the dominant community. The interdunal wetland itself was free of exotics for the most part with the exception of a small amount of redtop (*Agrostis gigantea*). The sand beach, however especially along the private property zone, has experienced a considerable invasion of Canada bluegrass (*Poa compressa*) and smaller amounts of spotted knapweed (*Centaurea maculosa*) and white sweet clover (*Melilotis alba*).

6. Cheboygan State Park East (Cheboygan Co.): The shoreline near the east border of Cheboygan State Park consists of a narrow zone of bare sand beach grading to a vegetated foredune zone backed up against a cedar and pine forest or, in many places, interdunal wetlands and then forest. The foredune was dominated by beach grass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), Canada wild-rye (*Elymus canadensis*), evening primrose (*Oenothera biennis*) and scattered clumps of Lake Huron tansy (*Tanacetum huronense*). In addition, 84 Pitcher's thistle plants were counted in this region, forming an extension of a previously documented population found in the dunes to the west. The sand beach zone narrows southeastward toward Grass Bay finally giving way to wet sand with scattered, shallow interdunal flats. These depressions are dominated by bulrush (*Scirpus americanus*), with other common associates such as bluejoint grass (*Calamagrostis canadensis*), sedge (*Carex lasiocarpa*),

buckbean (*Menyanthes trifoliata*), bladderworts (*Utricularia cornuta*, *U. intermedia*), pitcher-plant (*Sarracenia purpurea*), and grass-of-Parnassus (*Parnassia glauca*). Towards Grass Bay, black spruce (*Picea mariana*) becomes a dominant species in the inland forest which now forms an extensive dune and swale complex, ultimately forming a steep bluff to U.S. 23. Houghton's goldenrod (*Solidago houghtonii*) is common along the edges of the depressions in an almost continuous band from well within Cheboygan State Park all the way to Grass Bay. Likewise dwarf lake iris (*Iris lacustris*) is found in abundance along this entire stretch at the interface with the forested zone.

7. Cordwood Point (Cheboygan Co.): From High Banks Drive to the tip of Cordwood Point the shoreline consists of only a narrow strip of wet sand beach backed by a steep wooded rocky bluff occupied by private residences. The woods is dominated by white pine (*Pinus strobus*), red pine (*Pinus resinosa*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). The shoreline is characterized by scattered clumps of marram grass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), evening primrose (*Oenothera biennis*), eastern lined aster (*Aster lanceolatus*), goldenrod (*Solidago altissima*), and grass-leaved goldenrod (*Euthamia graminifolia*), in addition to the exotic species white sweet clover (*Melilotis alba*) and spotted knapweed (*Centaurea maculosa*) which are occasional to common.

The west side of the point, also occupied by residences, has a broader beach zone and lacks the steep bluff found on the east. Typical open dune species dominate this area including the marram grass (*Ammophila breviligulata*), beach grass (*Calamovilfa longifolia*), wormwood (*Artemisia campestris*), beach pea (*Lathyrus japonicus*), sand cherry (*Prunus pumila*), wheatgrass (*Agropyron dasystachyum*) and white camus (*Zigadenus glauca*). Although unable to survey the private properties in detail, numerous plants of Pitcher's thistle (*Cirsium pitcheri*) and Lake Huron tansy (*Tanacetum huronense*) were spotted from the shoreline along this portion of the point all the way to Grass Bay where both species are known to occur in abundance. Although residential use and development of these properties has most likely been responsible for decline of these species in this area, the fact that the populations still persist along with other native dune species, makes this area a prime target for landowner contact activities. The only exotic species observed from the water's edge on the west side of the point were Canada blue-grass (*Poa compressa*) and spotted knapweed (*Centaurea maculosa*), both in small numbers.

8. High Banks (Cheboygan Co.): Access to this region of the shoreline was gained at a roadside park just north along M-23 from Nine Mile Point. The shoreline was surveyed from this point approximately one mile south to the beginning of dense residential lots of Huron Beach, and north approximately 3.5-4

miles. The park itself is on a sandy bluff with scattered trees and directly accessible from the highway. Just south of the park, open shoreline is for the most part very limited, comprised of a rocky strip immediately adjacent to a dense spruce (*Picea glauca*) and Northern white cedar (*Thuja occidentalis*) dominated woods, in many places unpassable without wading in the water. The area is apparently too dense to support dwarf lake iris (*Iris lacustris*) since no populations were found. The woods diminish further east with the open beach zone once again extending inland to the heavily traveled U.S.-23 highway. That the direct access from the road has served to form a seed transport corridor is evidenced by the heavy invasion of such weedy species as Canada bluegrass (*Poa compressa*), bladder campion (*Silene vulgaris*), and yarrow (*Achillea millefolium*).

The region immediately north of the park begins similarly rocky, but once around the first point opens up into a shallow dune flat with a wooded bluff set well back from the water's edge. Here the most extensive open dune development along this stretch of shoreline occurs. Canada wild rye (*Elymus canadensis*), marram grass (*Ammophila breviligulata*), and wormwood (*Artemisia campestris*) are frequent dominants occurring in association with many other common dune plants. Exotics are widespread in places including sow thistle (*Sonchus* sp.), yarrow (*Achillea millefolium*), spotted knapweed (*Centaurea maculosa*), bladder campion (*Silene vulgaris*), Canada bluegrass (*Poa compressa*), white sweet clover (*Melilotis alba*), and brome grass (*Bromus inermis*). As the shoreline curves further northward the wooded bluff once again nears the water's edge. Most of this stretch is divided into residential lots and there is little open dune development. Two small sandy coves were discovered that harbor shoreline rarities. One of these contained small populations of Pitcher's thistle (*Cirsium pitcheri*; 15 plants) and Lake Huron tansy (*Tanacetum huronense*; ~50 plants), and the other a sizable (250+) population of Lake Huron tansy. The latter site has an unusually high component of exotic species including yarrow (*Achillea millefolium*), spotted knapweed (*Centaurea maculosa*), bladder campion (*Silene vulgaris*), and Canada bluegrass (*Poa compressa*). This is likely due to the proximity of a two track road. These occurrences were the only rare plant discoveries at this survey site and may be the only remaining seed source along this stretch of the shoreline.

9. Huron Beach (Presque Isle Co.): To complete the survey gap between Cordwood Point and Barnard E. Jarvis State Roadside Park, the shoreline was surveyed from the park north along Huron Beach to Lone Pine Creek. The northern portion of this site is residential with widely spaced, large houses set well back from the water, and an open dune zone that is generally broad especially on the points that define the numerous small coves that occur here. Surveys in this area were conducted from the water's edge. For the most part there are several low dune ridges supporting typical dune species such as marram

grass (*Ammophila breviligulata*), beach grass (*Calamovilfa longifolia*), wheatgrass (*Agropyron dasystachyum*), wormwood (*Artemisia campestris*), Canada wild rye (*Elymus canadensis*), white camus (*Zigadenus glauca*), Gillman's goldenrod (*Solidago simplex*), Eastern lined aster (*Aster lanceolatus*), sand cherry (*Prunus pumila*), common juniper (*Juniperus communis*), and creeping juniper (*J. horizontalis*). Occasionally the beach area narrows and becomes rocky.

At the south end of the residential area lies Barnard E. Jarvis State Roadside Park, which supports a diverse dune community that, despite its proximity to the heavily traveled US-23, retains much of its native character. The same species noted above dominate here with a larger component of common and creeping juniper. In addition, a several shallow interdunal depressions supporting grass-of-Parnassus (*Parnassia glauca*), false asphodel (*Tofieldia glutinosa*), round-leaved sundew (*Drosera rotundifolia*), small fringed gentian (*Gentianopsis procera*), and beak-rush (*Rhynchospora capillacea*) amongst others occurs here. A large population of Houghton's goldenrod is found in these depressions at the park and continues south into the next survey site (see Mast Point below). Lake Huron tansy (*Tanacetum huronense*) is abundant at the north end of the park and is scattered in pockets northward along the entire survey site. Pitcher's thistle (*Cirsium pitcheri*) is also scattered along the entire survey site becoming common, but not abundant, at the roadside park where it merges with a previously well documented occurrence of this species.

Exotic species along the residential portion of this survey site are minimal with small amounts of timothy grass (*Phleum pratense*), white sweet clover (*Melilotis alba*), and yarrow (*Achillea millefolium*) scattered here and there. Spotted knapweed (*Centaurea maculosa*) was common on several properties, but appeared to be absent from most. Exotic species were more widespread at the park in localized areas and included quackgrass (*Agropyron repens*), bladder campion (*Silene vulgaris*), redtop (*Agrostis gigantea*), and Canada bluegrass (*Poa compressa*) in addition to those already mentioned above. Due to the apparent sensitivity of landowners in the residential area, as witnessed by the subtle character and placement of homes in the landscape, and to the continuous populations of species, this area should be given high priority for landowner contact.

10. Mast Point (Presque Isle Co.): This survey site extends from the Harbor of Refuge and boat launch at the south end of Barnard E. Jarvis State Roadside Park, south past Black Mallard Creek approximately 0.5 miles to north Hammond Bay. Parallel elongate interdunal wetlands begin to dominate the shoreline immediately south of the Harbor of Refuge, interspersed with and often lying behind narrow dune ridges. These wetlands support characteristic species such as twig-rush (*Cladium mariscoides*), small fringed gentian (*Gentianopsis procera*), Kalm's St. John's-wort (*Hypericum kalmianum*), purple gerardia

(*Agalinis purpurea*), lady's-tresses orchid (*Spiranthes* sp.), false asphodel (*Tofieldia glutinosa*), grass-of-Parnassus (*Parnassia glauca*), and silverweed (*Potentilla anserina*). Typical species on the dune ridges include marram grass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), and sand cherry (*Prunus pumila*). U.S. 23 parallels the shoreline quite closely throughout the survey site, in some areas directly abutting the open dune ridges and wetlands, while in other areas, especially further south, a cedar (*Thuja occidentalis*) and spruce (*Picea glauca*) dominated forest develops between the road and the open shoreline communities. The extent of open dune increases in places, particularly at Grace and Black Mallard Creeks where there are two sizable ridges, portions of which have developed considerable topography. Even in these areas, interdunal wetlands can be seen behind the dunes ridges.

The most striking feature of this coastal zone area is the abundant population of Houghton's goldenrod (*Solidago houghtonii*). The goldenrod occurs in high numbers in the interdunal depressions all the way to Mallard Creek and on into residential properties in north Hammond Bay. It is also abundant immediately north of the Harbor of Refuge in the previous survey site (see Huron Beach above). Further survey may show it to continue even further south into Hammond Bay. In several places where US-23 runs especially close to the shoreline, the goldenrod is found across the highway on the west side. It can be safely said that this population of Houghton's goldenrod, which covers close to five miles of shoreline, is the most significant occurrence of this species along the entire Lower Peninsula Lake Huron shoreline.

Several small populations of Lake Huron tansy (*Tanacetum huronense*) were found between the Harbor of Refuge and Mast Point, and it becomes common approximately 0.75 miles south of Mast Point in both the sandy dune ridge and wet sand beach areas. Pitcher's thistle (*Cirsium pitcheri*) was also found in the dunes north and south of Black Mallard Creek. Although not counted in high numbers, detailed survey could not be conducted on private property. It is likely that *Cirsium* occurs in higher numbers than actually seen. A previously known occurrence of Hill's pondweed (*Potamogeton hillii*) was also reconfirmed at the mouth of Black Mallard Creek where it was found among other pondweeds (*P. pectinatus*, *P. richardsonii*, *P. amplifolius*, *P. gramineus*) and waterweed (*Elodea canadensis*).

Weedy species are evident to a greater or lesser extent throughout this survey site, the most problematic including yarrow (*Achillea millefolium*), white sweet clover (*Melilotis alba*), redtop (*Agrostis gigantea*), spotted knapweed (*Centaurea maculosa*), and Canada bluegrass (*Poa compressa*). Due to the significant extent of these element occurrences, especially Houghton's goldenrod, high priority should be placed on landowner contact and exotic weed control on both public and private lands. Surveys are also recommended further south into Hammond Bay.

11. Hammond Bay East (Presque Isle Co.): The shoreline was surveyed westward from Hammond to Bell's Landing and east of Hammond approximately one mile. Shrub wetlands occur on the west side of Hammond Point gradually grading to emergent marsh and finally to a wet, rocky sand beach dominated by bulrush (*Scirpus americanus*) and common horsetail (*Equisetum arvense*). Other species occurring frequently here include small fringed gentian (*Gentianopsis procera*), silverweed (*Potentilla anserina*), water-horehound (*Lycopus americanus*), purple gerardia (*Agalinis purpurea*), grass-of-Parnassus (*Parnassia glauca*), and hooded lady's-tresses (*Spiranthes romanzoffiana*). Large interdunal wetlands lie behind the rocky shoreline characterized by shrubby cinquefoil (*Potentilla fruticosa*), twig-rush (*Cladium mariscoides*), cat-tail (*Typha latifolia*), sweet gale (*Myrica gale*), bluejoint grass (*Calamagrostis canadensis*), Kalm's St. John's-wort (*Hypericum kalmianum*), and pitcher-plant (*Sarracenia purpurea*), and bordered inland by cedar (*Thuja occidentalis*) and larch (*Larix laricina*). Further west the beach widens to a low dune ridge dominated by marram grass (*Ammophila breviligulata*) followed by an extensive complex of graminoid-dominated interdunal swales interspersed with narrow upland ridges.

Much of the area is private with cottages and residences occurring on most lots, and beach use appears to be heavy. Despite this, Houghton's goldenrod (*Solidago houghtonii*) is abundant along the edges of the wetlands and along the wet rocky beach for approximately one mile west of the Point. Lake Huron tansy (*Tanacetum huronense*) is common along the rocky beach and dune areas all the way to Bell's Landing as is Pitcher's thistle (*Cirsium pitcheri*). These two species are particularly abundant in one section of undeveloped lots which lacks much of the wetland component. Exotics are fairly common along much of the shoreline here and include Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea maculosa*), yarrow (*Achillea millefolium*), bladder campion (*Silene vulgaris*), and white sweet clover (*Melilotis alba*).

Immediately west of Hammond lies an interdunal swale dominated by sedges and rushes, grading to shallow depressions and a wet, rocky sand beach. The species composition is similar to that on the west side of the point including significant numbers of Houghton's goldenrod. Further west, the open shoreline narrows to a rocky strip with sparse vegetation, and scattered emergent wetlands along the water's edge. Directly inland lies a thick Northern white cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*) dominated forest which has been subdivided into residential lots, only some of which are already occupied. A large component of the sparse vegetation along this portion of the survey site is comprised of weedy exotic species including Canada bluegrass (*Poa compressa*), yarrow (*Achillea millefolium*), spotted knapweed, and (*Centaurea maculosa*).

12. Evergreen Beach (Presque Isle Co.): This survey site begins just southeast of Forty Mile Point and continues west past Evergreen Beach to the end of Range 4 East. An historic lighthouse is located at Forty Mile Point and the area has been heavily disturbed by visitors. There is a shallow sandy beach with scattered clumps of vegetation comprised almost solely of weedy exotics including brome grass (*Bromus inermis*), quackgrass (*Agropyron repens*), spotted knapweed (*Centaurea maculosa*), and bladder campion (*Silene vulgaris*). The beach retains a similar weedy character to the southeast. Just past the western boundary of the lighthouse property, a single small population of Lake Huron tansy (*Tanacetum huronense*) was found. Although some weedy component remains northwest, dune development increases all the way to its peak at Evergreen beach including several significant blowout regions. The predominance of weedy species at 40 miles point gradually gives way to native dune species. Lake Huron tansy (*Tanacetum huronense*) and Pitcher's thistle (*Cirsium pitcheri*) were found in fair numbers all along this portion.

A series of marly interdunal pools commences at Evergreen beach and continues westward around the point backed by a lowland forest dominated by cedar (*Thuja occidentalis*), larch (*Larix laricina*) and black spruce (*Picea glauca*). Species diversity in the interdunal pools is high including such species as Kalm's lobelia (*Lobelia kalmii*), small fringed gentian (*Gentianopsis procera*), round-leaved sundew (*Drosera rotundifolia*), twig-rush (*Cladium mariscoides*), pitcher-plant (*Sarracenia purpurea*), bladderwort (*Utricularia cornuta*), bird's-eye primrose (*Primula mistassinica*), and purple gerardia (*Agalinis purpurea*). In addition, huge populations of two rarities, Houghton's goldenrod (*Solidago houghtonii*) and butterwort (*Pinguicula vulgaris*) form a striking presence. Further west, the pools diminish giving way to a relatively high dune and eventually narrowing to a sandy strip with a steep forested bluff rising above. Approximately 2.0 miles west of Evergreen Beach, the narrow open shoreline strip becomes rocky where it merges with the previous survey site (see Hammond Bay East above).

For most of western portion of the survey site, sizable cottages are set well back in the dunes at the interface with inland woods. Lake Huron tansy and Pitcher's thistle were also found scattered all the way to the extreme west edge of the rocky shoreline where one final population of Lake Huron tansy was discovered. The tansy was abundant near the water's edge, while the thistle was seen in low numbers, primarily on the foredune ridge. However, since this region was private property and was not surveyed inland, it is highly likely that the thistle is actually present in much higher numbers. This is further supported by the fact that this site was surveyed near the tail end of the season, and the thistle was particularly hard to pick out. Exotic weeds were not particularly troublesome here, with bouncing bet

(*Saponaria officinale*), Canada bluegrass (*Poa compressa*), and bladder campion (*Silene vulgaris*) being the most notable.

13. Hoeft State Park (Presque Isle Co.): Access to this portion of the shoreline was gained from the Driftwood Motel in Rogers City which opens up directly onto a flat, wide, sandy beach dominated in places by marram grass (*Ammophila breviligulata*). Other portions of the beach have been cleared of most vegetation in order to provide sunbathing spots and a nice "sand" beach. From here west to the docks of Rogers City docks is a sand and gravel strip dominated by marram grass and a multitude of weedy species. To the west of the access point, the shore is rocky becoming sandy and weedy again at Seagull Point. West of Seagull Point is a small bay bordering a shallow dune community which broadens inland. Despite the proximity to roads and the presence of a parking area directly inland from this community, it supports a diversity of native dune species such as common and creeping juniper (*Juniperus communis*, *J. horizontalis*), bearberry (*Arctostaphylos uva-ursi*), marram grass, wormwood (*Artemisia campestris*), wheatgrass (*Agropyron dasystachyum*), and white camus (*Zigadenus glauca*). It also harbors a sizable population (159 individuals counted, 55 of which were in bud) of Pitcher's thistle (*Cirsium pitcheri*) as well as a fair sized population (over 265 individual shoots) of Lake Huron tansy (*Tanacetum huronense*).

The dune system narrows northwestward all the way to Hoeft State Park where it once again extends broadly inland. Pitcher's thistle and Lake Huron tansy occur all along this section with the exception of an approximately 0.33 mile residential stretch immediately west of Hoeft State Park. Hundreds of Pitcher's thistle plants were seen within the park itself, while only a small amount of tansy was observed near the southeastern boundary. US-23 parallels the shoreline closely for much of this portion of the survey site, sitting on top of a shallow, but steep, dune bluff. Just southwest of the state park, inland on the west side of US-23, a small population of dwarf lake iris (*Iris lacustris*) was also found in a small interdunal depression; a remnant of a larger wetland system disrupted and fragmented by the building of US-23. North of the park the open dune community narrows once again, although retaining a sizable foredune area with large well set-back homes. Pitcher's thistle becomes sparse and eventually ends approximately 0.5 miles south of Forty Mile Point, while tansy is common just north of the park, becoming sparse but persisting almost all the way to the Point. In contrast to the initial portions of this survey site, much of the more highly developed open dune areas are relatively free from exotics.

14. Black Point (Presque Isle Co.): The shoreline was accessed here by a foot trail at the eastern edge of Black Lake State Forest and was traversed westward to Thompson's Harbor State Park and north and

east to the edge of Range 7 East, beyond which is heavily posted private property. The foot trail opens up onto a fairly extensive open dune system characterized by scattered cedar (*Thuja occidentalis*), common and creeping juniper (*Juniperus communis*, *J. horizontalis*), bearberry (*Arctostaphylos uva-ursi*), Canada wild rye (*Elymus canadensis*), white camus (*Zigadenus glaucus*), wormwood (*Artemisia campestris*), marram grass (*Ammophila breviligulata*), and beach grass (*Calamovilfa longifolius*). A sizable population of Pitcher's thistle (*Cirsium pitcheri*) is found throughout the open dune. Further west the open shoreline narrows to a shallow sand beach backed by a boreal woods dominated by cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), and white spruce (*Picea glauca*). Dwarf lake iris (*Iris lacustris*) is found in abundance at the edges and in openings of the woods and extends even into portions of the open dune especially near the top of the slope. Small amounts of iris were also noted in the woods behind the dune and it becomes abundant once again well inland (approximately 0.5 mile) where the foot trail comes out to State Road.

Traveling eastward from the open dune, the shoreline becomes a series of parallel ridges of limestone cobble, and glades characterized by Indian paintbrush (*Castilleja coccinea*), blue-eyed grass (*Sisyrinchium* spp.), bluejoint grass (*Calamagrostis canadensis*), Kalm's St. John's-wort (*Hypericum kalmianum*), false asphodel (*Tofieldia glutinosa*), sedge (*Carex capillaris*), bird's-eye primrose (*Primula mistassinica*), and in many places dense beds of dwarf lake iris (*Iris lacustris*). Also found in abundance here at the interface with the inland boreal forest was beauty sedge (*Carex concinna*). For the most part this survey site was fairly free from exotics. Small amounts of Canada bluegrass (*Poa compressa*), stonecrop (*Sedum acre*), spotted knapweed (*Centaurea maculosa*), and ox-eye daisy (*Chrysanthemum leucanthemum*) were noted.

15. Bolton Point to Rockport (Presque Isle, Alpena Co.): Survey of this site began at Besser Natural Area just south of Bolton Point and continued south to Rockport public boat launch. Besser Natural Area contains a good quality shoreline dune community defined by a small foredune near the water and an upland dry conifer forest inland. A known occurrence of Pitcher's thistle (*Cirsium pitcheri*) persists in the dunes. Near the southern edge of Besser Natural Area the inland woods transitions to boreal forest, dominated by Northern white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), and white spruce (*Picea glauca*), and a series of shallow marly flats occurs along the shore exhibiting a diversity of species including Indian paintbrush (*Castilleja coccinea*), purple gerardia (*Agalinis purpurea*), Ohio goldenrod (*Solidago ohioensis*), and yellow ladyslipper orchid (*Cypripedium calceolus*). From this point south, the open dune shoreline narrow and widen to various extents forming a mosaic with the forest that extends quite far inland much of the way to Rockport. Two additional small populations of Pitcher's thistle were

found along the shoreline, the first approximately one mile south, and the second another mile south, just past Ferron Point. In addition, two individual Pitcher's thistle plants were found several hundred feet inland in the dune mosaic just south of Besser Natural Area. Scattered extensively throughout the boreal forest in openings and along the edges (especially evident along roadsides), extending almost to Ferron Point is dwarf lake iris (*Iris lacustris*).

Several sizable calcareous wetlands occur at Ferron Point, none of which provide habitat for shoreline rarities. A previously documented occurrence of Houghton's goldenrod (*Solidago houghtonii*) was not relocated on the wet sandy shore here. The survey of this site was not conducted at the optimal time for this species, however, and it is possible that the goldenrod still occurs there. Further south the shoreline becomes rocky and the wooded area gradually nears the water. The topography also begins to rise reaching its highest point at the quarry north of Rockport boat launch. One additional population of dwarf lake iris was found approximately 0.5 miles south of Ferron Point, comprised of thousands of shoots, but covering a relatively small area. Exotic species were not particularly prevalent at this survey site. The most notable presence was the fairly widespread population of spotted knapweed (*Centaurea maculosa*) in the dunes of Besser Natural Area.

16. Rockport South (Alpena Co.): The shoreline was accessed from the public boat launch at Rockport and was traversed approximately 1.5 miles to the south, extending survey work that had been previously conducted further south. The shoreline here is comprised of several cobble beach ridges behind which is a very steep and high bluff which gradually lessens to the south. The cobble beach is quite weedy near the boat launch with numerous exotic species including honeysuckle (*Lonicera* sp.), Canada bluegrass (*Poa compressa*), hawkweed (*Hieracium* sp.), yarrow (*Achillea millefolium*), dandelion (*Taraxacum officinale*), and spotted knapweed (*Centaurea maculosa*). Further south, exotic species grow smaller in number but still maintain a presence.

As the topography gradually decreases southward, shallow swales containing such species as spike-rushes (*Eleocharis* spp.), rice grass (*Glyceria striata*), sedges (*Carex viridula*, *C. aquatilis*), silverweed (*Potentilla anserina*), and golden ragwort (*Senecio aureus*) were seen behind the cobble ridges. Boreal forest dominated by Northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and paper birch (*Betula papyrifera*) occur inland. A moderately sized and somewhat fragmented population of dwarf lake iris (*Iris lacustris*) was found near the southern end of the survey area in openings and along the edges of the inland woods.

17. North Point (Alpena Co.): Approximately three miles of shoreline were surveyed eastward from the end of the paved portion of North Point Road along the southern shore of North Point. Cobble beach and a small foredune ridge characterizes the initial stretch, behind which several interdunal wetland pockets are found ultimately giving way to woods dominated by Northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and white pine (*Pinus strobus*). Dwarf lake iris (*Iris lacustris*) is found in abundance in openings and along the edges of the forested area extending almost continuously to the end of the point. A single ram's-head orchid (*Cypripedium arietinum*) was discovered in the wooded area near the starting point of the survey, and on the sandy foredune seven Pitcher's thistle (*Cirsium pitcheri*) plants were found, reconfirming a previously documented occurrence there. Other vegetation is sparse on the beach; however, at this particular spot, a considerable amount of the exotic spotted knapweed (*Centaurea maculosa*) was noted.

The open beach area varies in width and character eastward toward the point, with a steep wooded inland bluff (now upland red oak) nearing the waters edge in some places, and sizable emergent wetlands occurring in others. Spotted knapweed becomes much rarer and other vegetation remains sparse, with the exception of several areas where a significant amount of marram grass (*Ammophila breviligulata*) was observed. Pitcher's thistle was scattered in low density along the entire three mile stretch, extending this previously known occurrence considerably. A total of 94 plants was observed, 23 of which were in bud. Other typical species included Canada wild rye (*Elymus glauca*), little bluestem (*Andropogon scoparius*), wormwood (*Artemisia campestris*), milkweed (*Asclepias syriaca*), bearberry (*Arctostaphylos uva-ursi*), sand cherry (*Prunus pumila*), and evening primrose (*Oenothera biennis*). Exotic species found at this survey site, other than the knapweed, included mossy stonecrop (*Sedum acre*), common tansy (*Tanacetum vulgare*), ox-eye daisy (*Chrysanthemum leucanthemum*), Canada bluegrass (*Poa compressa*), common mullein (*Verbascum thapsus*), and self-heal (*Prunella vulgaris*).

Although somewhat remote, and mostly free from buildings and homes, this site has experienced some disturbance as evidenced by the exotic species, and the numerous trails, roads and stumps seen inland in the woods. Time did not permit further exploration, however, it is recommended that permission be obtained for access to the shoreline along the northern side of the point where further populations of the iris, and possibly the thistle and/or the orchid are likely to occur. A previously documented occurrence of climbing fumitory (*Adlumia fungosa*) may also be extant at the tip of the point.

18. Partridge Point (Alpena Co.): Historical (1912) occurrences of Lake Huron tansy (*Tanacetum huronense*) and butterwort (*Pinguicula vulgaris*) are noted south of Alpena along the shoreline. Data for

these occurrences are not very precise, however their locations can be narrowed down to areas that have experienced extensive development since 1912. Aerial photo review of the shoreline in the vicinity area of these records revealed that one of the few areas retaining any potential for harboring these species was Partridge Point. Potential was also noted here for dwarf lake iris (*Iris lacustris*) which is known inland, and Houghton's goldenrod (*Solidago houghtonii*), which although not yet documented this far south, could possibly occur here. In an effort to locate potentially overlooked populations of any of these species, several portions of Partridge Point were surveyed. The first, a marly wetland complex occurring on the easternmost portion of the north side of the Point, is characterized by a mosaic of calcareous, herbaceous openings amongst tree and shrub zones. Dominant trees species include larch (*Larix laricina*), Northern white cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*), while common shrubs included sandbar willow (*Salix exigua*), balsam poplar (*Populus balsamifera*), red-osier dogwood (*Cornus stolonifera*), tag alder (*Alnus rugosa*), and sweet gale (*Myrica gale*). The openings are densely vegetated with a multitude of species including Indian paintbrush (*Castilleja coccinea*), silverweed (*Potentilla anserina*), golden ragwort (*Senecio aureus*), swamp betony (*Pedicularis lanceolata*), blue-eyed grass (*Sisyrinchium* sp.), bastard toadflax, (*Comandra umbellata*), false asphodel (*Tofieldia glutinosa*), sedges (*Carex buxbaumii*, *C. cramei*, *C. viridula*), bird's-eye primrose (*Primula mistassinica*), Ohio goldenrod (*Solidago ohioensis*), and many others. Towards Lake Huron, this complex grades into a sedge meadow and finally to an extensive emergent marsh at the water's edge. No rare species were found here.

The point was explored further along the eastern and southern portions of the tip, which are characterized by a rocky, calcareous substrate with many weedy species including (*Sedum acre*), spotted knapweed (*Centaurea maculosa*), Canada bluegrass (*Poa compressa*), hawkweeds (*Hieracium* spp.), and clovers (*Trifolium* spp.), amongst several common native graminoids such as spike-rushes (*Eleocharis* spp.), rushes (*Juncus* spp.) and sedges (*Carex* spp.), and several goldenrods, including Ohio goldenrod (*Solidago ohioensis*) and grass-leaved goldenrod (*Euthamia graminifolia*). Some pockets occur here and there with a species composition more similar to the openings of the northern site. Although much of this habitat was appropriate for the targeted species none were found in the areas surveyed.

19. Harrisville State Park (Alcona Co.): The state endangered black sedge, (*Carex nigra*), was discovered in a campsite at Harrisville State Park in 1985. This site was re-visited during this study in order to assess the current status of the population. The sedge was found growing in a slight depression at the bases of several Northern white cedar (*Thuja occidentalis*) trees in an actively used campsite in the Park. Associates included orange hawkweed (*Hieracium aurantiacum*), tall buttercup (*Ranunculus*

acris), red clover (*Trifolium pratense*), dandelion (*Taraxacum officinale*), and common plantain (*Plantago major*), all of which are weedy, exotic species. This seems like an unlikely spot to find a very rare, but apparently bona fide native Michigan species, which in the heart of its range along the Atlantic coast, normally inhabiting wet meadows and salt marshes. One other occurrence of *Carex nigra* has been documented in Michigan, in a remote site described as a "relict glacial shoreline", in Schoolcraft County in the central Upper Peninsula. Due to its occurrence in what appears to be a higher quality and more typical habitat in Michigan, the population at Harrisville State Park has not been simply dismissed as a waif. More intensive survey in the vicinity is warranted.

20. Oscoda North (Iosco Co.): Pitcher's thistle (*Cirsium pitcheri*) was documented in 1981 along the Lake Huron shoreline approximately four miles north of Oscoda. Development in this area has increased significantly, and this site was resurveyed during this study in order to determine the current status of the population. The shoreline was accessed at a roadside park south of the described location and traversed northward for approximately 1.5 miles. The shoreline here can be similarly characterized as it was in 1981, as a "low foredunes fronting on a beach" (MNFI 1981a). U.S. 23 runs immediately adjacent to it, and once beyond the roadside park, the road divides the residential lots, running between the homes and their associated beach area. Much of the beach zone is bare sand, almost completely devoid of vegetation, having been cleared by the landowners to provide an open sand beach. A few areas are overrun with weeds, and in some places dense patches of marram grass (*Ammophila breviligulata*) are found. Exotic species in the area include Canada bluegrass (*Poa compressa*), quackgrass (*Agropyron repens*), spotted knapweed (*Centaurea maculosa*), ox-eye daisy (*Chrysanthemum leucanthemum*), and sow thistle (*Sonchus* sp.). No evidence of Pitcher's thistle was found, nor any likely habitat and this population can be considered extirpated.

21. Au Sable Point (Iosco Co.): An occurrence of Pitcher's thistle (*Cirsium pitcheri*) was documented in 1981 at Au Sable Point, just north of Tawas City, where the species was described as "frequent on the foredune and flat" (MFNI 1981b). An effort was made during this study to assess the status of this population. The shoreline was accessed by a pathway leading through the residential area immediately west of the point and was walked from here to the end of the point. Fronting the homes in the residential area, the shoreline consists of heavily used, relatively flat, and mostly vegetation free, sand beach dotted with various watercraft, picnic areas, and beach furniture. This contrasts strikingly with the south side of the point which harbors a comparatively undisturbed dune community dominated by unusually dense natural vegetation. Usage of this portion of beach appears to have been regulated for some time. This is

supported by a sign which highlights the importance of the dune community and the impact that disturbance has on it. The region is characterized by a beach and foredune backed by a 30-40 foot wide flat which slopes to an interdunal wetland. The foredune is dominated by densely growing marram grass (*Ammophila breviligulata*), beach grass (*Calamovilfa longifolius*), and wheatgrass (*Andropogon dasystachyum*), with lesser amounts of slender wheatgrass (*Agropyron trachycaulum*), Canada wild rye (*Elymus canadensis*), and little bluestem (*Andropogon scoparius*). Young paper birch (*Betula papyrifera*) and dune willow (*Salix cordata*) were common at the peak of the foredune ridge, with little bluestem becoming dominant on the flat. Several gazebos are present at the top of the foredune with bridges leading inland over the swale to a cedar (*Thuja occidentalis*), juniper (*Juniperus communis*, *J. horizontalis*), and pine (*Pinus* sp.) dominated forest. Although not visible from the shoreline, homes are presumably located further inland.

Pitcher's thistle was no longer frequent on the point; and in fact it proved difficult to find at all. A total of 29 individuals was finally discovered in two local concentrations just over the foredune rise near several of the gazebos. The region where the plants were found was more open than much of the remainder of the dune, a condition known to be necessary for successful establishment of Pitcher's thistle (Bowles et al. 1993). It is ironic that the apparent enforced lack of disturbance to the foredune has ultimately allowed the growth of vegetation to flourish, thus diminishing potential habitat for the thistle. This site lends itself to experimental clearing to see if the Pitcher's thistle numbers can be increased by providing more open colonization sites.

22. Tawas Point (Iosco Co.): Aerial photo review indicated a significant stretch of low dunes around the point of Tawas Point State Park. Although no occurrences of Pitcher's thistle (*Cirsium pitcheri*) are known from here, no record of a systematic survey of the area was found. Therefore a survey of the point was conducted during this study. The area experiences high usage due to the location of a campground, public swimming beach area, light house with a gravel road leading to it, and numerous trails throughout the point including an extensive boardwalk system. The greatest dune development is on the east side where species such as marram grass (*Ammophila breviligulata*), beach pea (*Lathyrus japonicus*), milkweed (*Asclepias syriaca*), wormwood (*Artemisia campestris*), Canada wild rye (*Elymus canadensis*), sand cherry (*Prunus pumila*), and several willows (*Salix cordata*, *S. exigua*) occur. Pitcher's thistle was not found. Towards the point are many sand flats typified by species such as grass-leaved goldenrod (*Euthamia graminifolia*), silverweed (*Potentilla anserina*), and rush (*Juncus balticus*). Much of the remainder of the point is unsuitable habitat for the thistle. The west side of the point is generally wetter with little dune or sand beach development while several large wetlands with standing water lie

further inland. Many exotic species occur on the point including spotted knapweed (*Centaurea maculosa*), redtop (*Agrostis gigantea*), and Canada bluegrass (*Poa compressa*).

23. Sleeper State Park (Huron Co.): The shoreline area of Sleeper State Park and Philip County Park to the west were surveyed for Pitcher's thistle which historically was common in this region (see #24 below). The park itself is part of a large wooded dune and swale complex, as described by Comer et al. (1993) in a report on the inventory and status of these complexes in Michigan. The beach ridge is wooded with red oak (*Quercus rubra*), white pine (*Pinus strobus*) and jack pine (*Pinus banksiana*). Other species include wormwood (*Artemisia campestris*), starry false Solomon's-seal (*Smilacina stellata*), riverbank grape (*Vitis riparia*), and chokecherry (*Prunus virginiana*). The exotic species Canada bluegrass (*Poa compressa*), quackgrass (*Agropyron repens*), spotted knapweed (*Centaurea maculosa*), and bouncing bet (*Saponaria officinale*) are also common. Several stairways lead to the heavily used sand beach which is virtually barren of vegetation over much of its length. Patches of very dense marram grass can be seen here and there with wormwood and beach pea (*Lathyrus japonicus*), as well as the exotic species spotted knapweed and bouncing bet, which are scattered within. Other exotic species noted along the shoreline include brome grass (*Bromus inermis*), chicory (*Cichorium intybus*), yarrow (*Achillea millefolium*), and goat's beard (*Tragopogon* sp.). Immediately east and west of the Park are cottages and houses with manicured "lawns" fronting the water. Little hope remains for Pitcher's thistle along this portion of the shoreline.

24. Port Crescent State Park (Huron Co.): Review of MNFI occurrence records revealed that the southernmost known location for Pitcher's thistle (*Cirsium pitcheri*) was from Port Crescent State Park Known historically from the region as early as 1896 it was described as "common from Sand Point [on Wild Fowl Bay] to Port Austin" by Dodge in 1909 (MNFI 1990). A MNFI survey conducted in 1981 at Port Crescent State Park and nearby Flat Rock Point did not turn up the species. However, in 1990 a small population was subsequently found in the park by William Collins (MNFI 1990). He observed a total of seven individuals, three of which were flowering. They were located "along the edge of an old backdune oak forest and an sparsely vegetated open sand area" that had apparently been recently excavated. Interestingly, this remnant population is approximately 0.25 to 0.5 miles inland from where early records place the original population along the shoreline. Collins postulated that disturbance caused by excavation may have provided the appropriate condition for seed germination and seedling establishment.

The dune system at Port Crescent State Park was surveyed extensively in order to determine if the 1990 documented population still persists, or if other remnant populations could be discovered. The extreme east portion of the park is heavily used by campers as reflected by the disturbed sandy shoreline which is very sparsely vegetated with such species as marram grass (*Ammophila breviligulata*), beach grass (*Calamovilfa breviligulata*), riverbank grape (*Vitis riparia*), wormwood (*Artemisia campestris*), beach pea (*Lathyrus japonicus*), wheatgrass (*Agropyron dasystachyum*), and various willows (*Salix* spp.). Behind this are remnants of the presettlement oak forest that has been highly fragmented by the campground. Numerous exotic species were found here including spotted knapweed (*Centaurea maculosa*), chicory (*Cichorium intybus*), burdock (*Arctium minus*), and autumn olive (*Elaeagnus umbellata*).

Further west of this region between the east side of the Pinnebog River and an unnamed branch, the open dune zone is highly developed consisting of a sand beach zone and foredune ridge followed by a high and steeply sloping backdune. The foredune ridge area is dominated by 4-5 foot cottonwood (*Populus deltoides*) with little other vegetation occurring towards the water. Behind the foredune, marram and beach grass dominate in extensive, dense patches with other typical open dune species scattered throughout. This grades eventually to an oak forest covering much of the back dune. The open dune system along Lake Huron and in front of the wooded zone was thoroughly scoured and only two Pitcher's thistle plants were found, one of which was flowering. This portion of the park was relatively free from exotics with the exception of the edge of the woods where a significant invasion of Canada bluegrass (*Poa compressa*), bouncing bet (*Saponaria officinalis*), goat's beard (*Tragopogon* sp.), white sweet clover (*Melilotis alba*), and spotted knapweed was observed. Canada bluegrass and spotted knapweed were particularly abundant.

The open dunes continue inland along the east side of the Pinnebog River to the cleared area where Pitcher's thistle was discovered in 1990. This area was also thoroughly scoured and two more Pitcher's thistle plants, one of which was also in flower, were found. Associated species in the clearing include little bluestem (*Andropogon scoparius*), milkweeds (*Asclepias syriaca*, *A. tuberosa*), Pennsylvania sedge (*Carex pensylvanica*), hairy puccoon (*Lithospermum caroliniense*), wormwood (*Artemisia campestris*), marram grass and beach grass, however the clearing is being overtaken by the invasive exotics spotted knapweed and Canada bluegrass.

The open dune system also extends west of the Pinnebog River eventually grading into a dune and swale system at the far west edge of the Park. The dune ridges here are dominated by jack pine while common species in the wetlands include beak-rush (*Rhynchospora capillacea*), twig-rush (*Cladium mariscoides*), ragwort (*Senecio* sp.), and panic grass (*Panicum* sp.) Along the shoreline,

marram grass and beach grass again dominate, forming patches similar to those in other portions of the shoreline. This area was searched extensively, however no Pitcher's thistle was found.

Although it is possible that more Pitcher's thistle plants could be present at Port Crescent State Park, it is obvious that the population(s) have declined dramatically since the records of the late 1800's and early 1900's. Whether this is due simply to human impact by heavy use, indirect effects of extensive shoreline development nearby, or other more subtle reasons is uncertain. The density of the beachgrass in much of the park is likely a factor since Pitcher's thistle requires 70% bare sand substrate for successful germination and establishment (Bowles et al. 1993). It would be interesting to conduct some experimental clearing and plantings of this species to see if populations can be augmented at the Park.

25. Port Austin (Huron Co.): As noted in #24 above, Pitcher's thistle was known historically from the thumb region as early as 1896 and was described as "common from Sand Point [on Wild Fowl Bay] to Port Austin" by Dodge in 1909 (MNFI 1990). Although aerial photo review did not reveal much remaining potential habitat due to the heavily populated coastal zone, stops were made at as many easily accessed points as possible during this study in order to better assess the potential for the persistence of this species in this region. Sleeper State Park and Port Crescent State Park are described separately above. This survey site included a stop at the end of Larned Road of near Port Austin and in the subdivision just west of it, as well as further south at Jenks County Park. Each of these locations provided fairly long views of the coastal zone.

Approximately 30 feet of sandy shoreline dominated by weedy species occurs at the end of Larned Rd. To the east, the shoreline is dotted with private cottages and homes with manicured lawns extending to the water's edge. Immediately to the west, the shoreline is rocky and then becomes similar to the eastern portion with cottages and homes dotted all the way to Flat Rock Point. Jenks County Park occurs on a sandy bluff with an upland forest dominated by hemlock (*Tsuga canadensis*), red and white pine (*Pinus resinosa*, *P. strobus*), and paper birch (*Betula papyrifera*). The slope down to the water opens up into a low diversity dune community dominated by marram grass (*Ammophila breviligulata*) and beach grass (*Calamovilfa longifolius*), gradually grading to a sand beach mostly devoid of vegetation. Several native species are scattered sparsely amongst the beach grasses including milkweed (*Asclepias syriaca*), beach pea (*Lathyrus japonicus*), wormwood (*Artemisia campestris*), poison ivy (*Toxicodendron radicans*), stunted red oak (*Quercus rubra*), and chokecherry (*Prunus virginiana*). In addition, a large component of weedy exotics were present such as quackgrass (*Agropyron repens*), Canada bluegrass (*Poa compressa*), bouncing bet (*Saponaria officinalis*), and a small amount of spotted knapweed (*Centaurea maculosa*) and curly dock (*Rumex crispus*). Several stairways lead down to the

beach and many paths crisscross the dune slope itself. North and south of the Park, cottages and homes line the shoreline. The potential for Pitcher's thistle habitat was slim, and further survey in this region was determined to be low priority.

26. New London Point (Sanilac Co.): Aerial photo review revealed a sandy point with potential for dune habitat in the region of New London Point and Camp Ozanam, approximately three miles south of Port Sanilac. Access was sought here, in order to determine if there was any quality dune habitat that might harbor Pitcher's thistle (*Cirsium pitcheri*). Permission was granted to access the shoreline at New London and approximately 0.75 mile was traversed. An additional a stop at a roadside park immediately north of this point was also made. At New London Point, the shoreline consisted of heavily used sandy beach rising slightly from the water's edge with scattered vegetation dominated by staghorn sumac (*Rhus typhina*), riverbank grape (*Vitis riparia*), willow (*Salix* sp.), poplars (*Populus* spp.), and the exotic species ox-eye daisy (*Chrysanthemum leucanthemum*), tall fescue (*Festuca arundinacea*), yarrow (*Achillea millefolium*), quackgrass (*Agropyron repens*), and honeysuckle (*Lonicera* sp.). Further north at the roadside park the shoreline narrows to a rocky strip dominated by paper birch, riverbank grape, and staghorn sumac. No evidence of Pitcher's thistle or quality habitat was found here and further survey was discontinued.

27. Lake Huron Camp (St. Clair Co.): Aerial photo review revealed a sandy point with potential for dune habitat in the region of Lake Huron Camp just north of North Lakeport. Permission was granted to access the shoreline here and approximately 0.5 mile was traversed. Survey revealed a sandy shoreline that experiences heavy use as evidenced by numerous picnic areas, recently used fire pits, and the predominance of weedy exotic species. These included spotted knapweed (*Centaurea maculosa*), bouncing bet (*Saponaria officinalis*), white sweet clover (*Melilotis alba*), crown vetch (*Coronilla varia*), and mossy stonecrop (*Sedum acre*). No evidence of Pitcher's thistle or quality habitat was found here and further survey was aborted.

28. Lakeport State Park (St. Clair Co.): Lakeport State Park was the southernmost portion of the Lake Huron shoreline that was surveyed during this study. Although numerous county, city, and township parks occur along the extreme southern coastal zone, Lakeport State Park is one of the few public land areas with a significant stretch of undeveloped beach and woodland. Surveys were conducted here primarily to characterize the lower Huron shoreline, and to gain a sense if any potential for Pitcher's thistle habitat exists this far south. Most of the wooded portion of the park is lowland

hardwoods dominated by silver maple (*Acer saccharinum*), paper birch (*Betula papyrifera*), red oak (*Quercus rubra*), basswood (*Tilia americana*), and occasional pockets of hemlock (*Tsuga canadensis*). Red maple (*Acer rubrum*), blue-beech (*Carpinus caroliniana*), and black cherry (*Prunus serotina*) dominate the understory and common ground cover species include sensitive fern (*Onoclea sensibilis*), Virginia creeper (*Parthenocissus quinquefolia*), baneberry (*Actaea* sp.), enchanter's nightshade (*Circaea lutetiana*), and nodding trillium (*Trillium cernuum*). No rare species were found here. The shoreline consists of a narrow beach zone that varies from cobble to cobbly sand with widely scattered pockets of shrubs and herbs such as willows (*Salix* sp.), box elder (*Acer negundo*), cottonwood (*Populus deltoides*), riverbank grape (*Vitis riparia*), bulrush (*Scirpus cyperinus*), sedge (*Carex vulpinoidea*), rushes (*Juncus* sp.), milkweed (*Asclepias syriaca*), and goldenrod (*Solidago altissima*). In addition, a large component of weedy exotics were observed, including Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea maculosa*), bouncing bet (*Saponaria officinalis*), and yarrow (*Achillea millefolium*), among many others. No evidence of Pitcher's thistle or potential habitat was found and further survey in this region of the coastal zone was abandoned.

Lake Michigan Survey Sites

1. **Waugoshance Island (Emmet Co.).** This island, located approximately two miles west of Waugoshance Point, comprises the westernmost portion of Wilderness State Park. The more than one and a half-mile-long island is dominated by an extensive boreal forest over the western two-thirds, with Great Lakes marsh forming the principal habitat in the eastern one-third. The boreal forest was surveyed only via brief reconnaissance, but sufficiently to identify it as a significant natural community occurrence for the statewide database, based on its structure, the largely undisturbed condition, and its extent of approximately 200 acres. Northern white-cedar (*Thuja occidentalis*) was observed to dominate the periphery of the forest, giving way to balsam fir (*Abies balsamea*), trembling aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*) in the interior. Since the inventory was very cursory, there are likely other co-dominant trees present such as balsam poplar (*Populus balsamifera*) and white spruce (*Picea glauca*). Many blowdowns and gnarled cedars were observed along portions of the forest edge on a faint series of cobbly storm beach ridges where there is greater exposure to wind. Within the interior of the eastern portion of the forest, a large shallow lake/marl pond occurs, where the first of several sightings of the same presumed pair of immature bald eagles were recorded. It is possible that these eagles originated from a nest on the island, although no eagle nest records have been recorded from this island, Temperance Island, nor the tip of Waugoshance Point on the mainland.

The Great Lakes marsh is essentially contiguous with the much more extensive marsh of the adjacent Temperance Island, forming a series of meadows, cobbly marl flats, and emergent marsh zones. Within the more or less contiguous marsh areas are low dune and storm ridges with narrow strings of woody vegetation, including trees. The vegetation of the marsh zones undoubtedly changes markedly with year to year fluctuations in lake levels, which is the primary abiotic influence in this community. Dominant species here included bluejoint grass (*Calamagrostis canadensis*), hardstem bulrush (*Scirpus acutus*), rush (*Juncus balticus*), twig-rush (*Cladium mariscoides*), beak-rush (*Rhynchospora capillacea*), and many other species typical of marl flats, cobble shores, shoreline fens, and beaches in this region. Several common exotic plant species were recorded, with only spotted knapweed (*Centaurea maculosa*) found to be moderately invasive in some areas.

2. Temperance Island (Emmet Co.). Located between Waugoshance Island and the tip of Waugoshance Point, this island was found to be comprised primarily of Great Lakes marsh, consisting of broad areas of loosely connected marl flats, cobble shores, and submergent to emergent marsh zones. The marsh is more or less contiguous with marsh comprising the eastern portion of Waugoshance Island. Relatively small areas of woody vegetation were found on the localized ridges and other isolated sites of low relief scattered across the north shore, the western portion of the island, and intermittently on the south side. Although best described as being comprised of Great Lakes marsh, the island was observed to be very heterogeneous in community structure, ranging from emergent marsh zones to shallow, inundated marl flats to cobble and small boulder areas. In some portions of the island, these wetland zones gave way abruptly to cobble-sand dune ridges and low dunes supporting upland vegetation. Typical vegetation of these zones included hardstem bulrush (*Scirpus acutus*), spike-rush (*Eleocharis elliptica*), bluejoint grass (*Calamagrostis canadensis*), giant bulrush (*Phragmites australis*), arrow-grass (*Triglochin maritimum* and *T. palustre*), Arkansas mint (*Calamintha arkansana*), sedge (*Carex cratensis*), and many other species. Upland vegetation included such species as Northern white-cedar (*Thuja occidentalis*), common juniper (*Juniperus communis*), creeping juniper (*J. horizontalis*), Canada rye grass (*Elymus canadensis*), Gillman's goldenrod (*Solidago simplex*), beach pea (*Lathyrus japonicus*), and wormwood (*Artemisia campestris*). Overall, it is likely that the vegetation of this island changes dramatically in response to the lake level, with the marsh areas in particular expanding in low water years and contracting in extent during high water years. High water years result in the reduction of the limited upland habitats as well.

On the northeast shore of the island, a local but large population of Pitcher's thistle (*Cirsium pitcheri*) was discovered on a low, cobbly dune ridge. Large numbers of juvenile and adult plants were

observed, composing a population estimated to be at least 2000 individuals or more. Adjacent to this area a colony of Houghton's goldenrod (*Solidago houghtonii*) was found, occurring in somewhat dry back dunes and interdunal depressions. Subsequent survey of the entire island resulted in identifying numerous patches of this species, occurring primarily along the edges of shoreline marl flats and other interdunal sites. Several exotic species were noted on this island, the most troublesome being Canada bluegrass (*Poa compressa*) and wild parsnip (*Pastinaca sativa*). Canada bluegrass was found to be locally dominant in some dune areas, with parsnip occurring in numbers in meadow zones.

3. M-119 to Pike Road (Emmet Co.). This section of Lake Michigan shoreline is relatively remote and difficult to access, with the few existing roads consisting of private drives to widely scattered seasonal homes built along the abrupt shoreline bluff. The shoreline is fronted by a relatively narrow beach strand and a broad, low, well developed foredune dominated by marram grass (*Ammophila breviligulata*), with scattered colonies of beach grass (*Calamovilfa longifolia*) and such typical dune species as wormwood (*Artemisia campestris*), milkweed (*Asclepias syriaca*), balsam poplar (*Populus balsamifera*), starry false Solomon's-seal (*Smilacina stellata*), wheatgrass (*Agropyron dasystachyum*), beach pea (*Lathyrus japonicus*), Eastern cottonwood (*Populus deltoides*), Canada rye grass (*Elymus canadensis*), and beach pea (*Lathyrus japonicus*), among several other species. Along portions of the shoreline, the foredune is followed by poorly developed back dunes of very limited extent; in all sections of the shore in this survey area the narrow dunes are backed by an abrupt, steep, forested slope. Despite the limited nature of the dunes, they were found to be of good quality. Survey of more than one mile of shoreline resulted in the discovery of small new population of Pitcher's thistle (*Cirsium pitcheri*) and also several widely scattered colonies of a new population of Lake Huron tansy (*Tanacetum huronense*). Relatively few exotics were recorded, including such common and ubiquitous species as spotted knapweed (*Centaurea maculosa*), smooth brome (*Bromus inermis*), and quackgrass (*Agropyron repens*), all evaluated as being insignificant at this time.

4. Good Hart (Emmet Co.). The more than three miles of shoreline north of Good Hart, extending to the edge of the above M-119 to Pike Road site, comprised this survey site. The shoreline consists of a narrow beach strand throughout, backed by very limited open sand areas and sparse patches of dunes and dune vegetation. In vegetated areas, the dominant species was marram grass (*Ammophila breviligulata*), with other typical species such as Canada rye grass (*Elymus canadensis*), riverbank grape (*Vitis riparia*), Gillman's goldenrod (*Solidago simplex*), red osier dogwood (*Cornus stolonifera*), wormwood (*Artemisia campestris*), balsam poplar (*Populus balsamifera*), sea rocket (*Cakile edentula*), and sandbar willow

(*Salix exigua*). The shore is mostly developed with an uninterrupted series of large, seasonal, and permanent homes for more than two miles north of Good Hart. Little available dune habitat was found that could support colonies of Pitcher's thistle (*Cirsium pitcheri*), which was carefully sought but not found. A few limited colonies of Lake Huron tansy (*Tanacetum huronense*) were documented, all occurring within the range of a previously documented occurrence last observed in 1981. Occasional tracks from off-road-vehicles (ORVs) were noted, although this activity did not appear to be extensive, and the shoreline in general appeared to be well cared for by the residents, as evidenced by a lack of refuse and the sensitive use of beach access trails and the like. The shoreline, however, was somewhat more disturbed here than in stretches to the north, with several potentially serious exotic plant species noted. Basket willow (*Salix purpurea*), a tall shrubby willow, was found along the shore in several large colonies, and was rated as moderately invasive. Lombardy poplar (*Populus nigra* var. *italica*), a frequent introduced species found along most of the Lake Michigan shore, was also found to be moderately invasive, as was black locust (*Robinia pseudoacacia*), a species often planted for erosion control, and the widespread spotted knapweed (*Centaurea maculosa*). Both of the aforementioned tree species are clone formers and are thus potentially aggressive wherever found.

5. Middle Village South (Emmet Co.). This site is comprised of the approximately three-mile stretch of shoreline immediately south of the Middle Village cemetery. The shore consists of a beach strand that is relatively wide in portions, backed by a discontinuous series of foredunes abruptly backed by a steep forested bluff. Largely seasonal homes occur in a densely developed area for about one and a half miles south of Middle Village. The shoreline in this area demonstrates recreational use of the shore with relatively little overt artificial disturbance, although numerous homes are built virtually at the edge of the beach and foredune. Where present, the foredune is dominated by marram grass (*Ammophila breviligulata*), with small amounts of dune grass (*Calamovilfa longifolia*) and such typical associates as wormwood (*Artemisia campestris*), beach pea (*Lathyrus japonicus*), balsam poplar (*Populus balsamifera*), milkweed (*Asclepias syriaca*), Canada rye grass (*Elymus canadensis*), red osier dogwood (*Cornus stolonifera*), and sand cherry (*Prunus pumila*). New colonies of Lake Huron tansy were discovered, extending the distribution of the known occurrence noted under the above Good Hart site, and a small population of Pitcher's thistle (*Cirsium pitcheri*) was found in the more extensive beach and dune area occurring immediately behind the Middle Village cemetery. Few exotic plants were recorded, none of which were observed as being invasive.

6. Fisherman's Island State Park (Charlevoix Co.). The survey site consisted of the shoreline within the park from the mouth of Whisky Creek to the southern border, and also the area from Norwood north

to the park boundary. Between Norwood and the park boundary, the shoreline was found to be fairly disturbed, with a narrow sandy cobbly beach backed by a low series of dunes which were in turn backed by an abrupt forest boundary. Several significant exotics were noted south of the park boundary, including bouncing bet (*Saponaria officinalis*), spotted knapweed (*Centaurea maculosa*), and Canada bluegrass (*Poa compressa*). In addition, stranded party balloons with ribbon streamers were found to be common along the beach, a problematic type of refuse noted during the 1992 CZM shoreline inventory for endemic plants (Penskar et al.). Entering the park from the south, the shoreline was noted as being less disturbed and the dunes more extensive in scope. The dunes were dominated by marram grass (*Ammophila breviligulata*), with lesser amount of dune grass (*Calamovilfa longifolia*), Canada rye grass (*Elymus canadensis*), and wheatgrass (*Agropyron repens*). In more vegetated areas, common species included horizontal juniper (*Juniperus horizontalis*), bearberry (*Arctostaphylos uva-ursi*), little bluestem (*Andropogon scoparius*), wormwood (*Artemisia campestris*), poison ivy (*Toxicodendron radicans*), common juniper (*Juniperus communis*), and dune willow (*Salix myricoides*).

More than 100 plants of Pitcher's thistle (*Cirsium pitcheri*) were tallied within the park, part of a previously documented occurrence not observed since 1964. Data gathered during the inventory resulted in an extension of this occurrence, and also provided significant status and ecological data. In addition, a few small colonies of Lake Huron tansy (*Tanacetum huronense*) were discovered, constituting a new occurrence. Observations were made of what appeared to be frequent sightings of Lake Huron locust (*Trimerotropis huroniana*), a Great Lakes endemic locust, with MNFI data indicating a general record for this region last observed in 1923. Overall, several exotic plants were observed during this site survey, the most problematic being -- in addition to those noted above -- quackgrass (*Agropyron repens*), smooth brome (*Bromus inermis*), and basket willow (*Salix purpurea*), all rated as moderately invasive.

7. Banks Township Park (Antrim Co.). Shoreline in this survey site was inventoried from the park south to the mouth of Antrim Creek, approximately one mile in distance. The shoreline consisted of a wide, low-sloping beach area, grading to small expanses of foredunes backed abruptly by forest. The area demonstrated moderate to heavy recreational use and locally heavy use of ORVs. The dune areas were dominated by marram grass (*Ammophila breviligulata*) and common associates such as wheatgrass (*Agropyron dasystachyum*), Canada rye grass (*Elymus canadensis*), wormwood (*Artemisia campestris*), bearberry (*Arctostaphylos uva-ursi*), little bluestem (*Andropogon scoparius*), sand cherry (*Prunus pumila*), common juniper (*Juniperus communis*), and dune willow (*Salix cordata*). A new population of Pitcher's thistle (*Cirsium pitcheri*) was found, with about 100 plants tallied throughout the site. In

addition, several colonies of a previously identified occurrence of Lake Huron tansy (*Tanacetum huronense*) not observed since 1981 were identified and recorded.

8. Peterson Park North. (Leelanau Co.) This survey site consisted of the shoreline from Peterson Park running northeast approximately one and a half miles to Christmas Cove. The shoreline in this region is comprised of a high, steep, eroding moraine bluff with a narrow strand of beach along the base. The sandy end moraine face is vegetated in many portions, interspersed with areas of slumping and active erosion. Relatively little habitat is available for rare plants, owing to the extremely narrow beach zone at the base of the bluff, which throughout most of the shoreline consists almost entirely of cobble beach. This active storm beach is prized by Petoskey stone gatherers, who were encountered frequently near the public access sites at Peterson Park and Christmas Cove. Despite the apparent paucity of habitat found when the site was first observed in the field, a reasonable length of shoreline was searched to characterize this area.

In a very limited expanse of sandy-cobbly foredune no more than approximately 50 m in extent, a small colony of three adult plants of Pitcher's thistle (*Cirsium pitcheri*) were found. Common associates in this site, and sparsely elsewhere in this general survey area, were such species marram grass (*Ammophila breviligulata*), Canada rye grass (*Elymus canadensis*), common juniper (*Juniperus communis*), sea rocket (*Cakile edentula*), wheatgrass (*Agropyron dasystachyum*), sand cherry (*Prunus pumila*), and wormwood (*Artemisia campestris*). Although heavily vegetated over much of its face, the eroding moraine bluff is potential habitat for the rare dunewort (*Botrychium campestre*), a state threatened grape-fern species with a high fidelity to perched dune and eroding moraine habitats in this region of the state, to which it is primarily restricted. Several common exotic plants were noted, with the ubiquitous spotted knapweed (*Centaurea maculosa*) being noted as borderline moderately invasive.

9. Peterson Park (Leelanau Co.). Approximately one and one-half miles of additional shoreline southwest of Peterson Park was inventoried, concentrating again on the narrow strand of beach at the base of the steep, high, eroding moraine bluff. The restricted beach area was found to consist almost entirely of a cobble shore backed abruptly by the wooded bluff dominated by Northern white cedar (*Thuja occidentalis*). The bluff was noted as being somewhat weedy where actively eroding, with such exotic species as spotted knapweed (*Centaurea maculosa*), white sweet clover (*Melilotus alba*), Canada bluegrass (*Poa compressa*), and bladder campion (*Silene vulgaris*). These exotics were classified as moderately invasive throughout the site, with the exception of spotted knapweed, which was found to be extremely invasive. Several typical shoreline and dune plants were observed, such as hair grass

(*Deschampsia cespitosa*), wormwood (*Artemisia campestris*), beach pea (*Lathyrus japonicus*), Canada rye grass (*Elymus canadensis*), sea rocket (*Cakile edentula*), milkweed (*Asclepias syriaca*), and marram grass (*Ammophila breviligulata*), among several others. Calcareous seeps and springs were found occasionally at the base of the slope; these microhabitats supported such plants as grass-of-Parnassus (*Parnassia glauca*) and Kalm's lobelia (*Lobelia kalmii*), indicating the alkaline nature of the groundwater. The federal and state endangered Michigan monkey-flower (*Mimulus glabratus* var. *michiganensis*), known to inhabit cold streams, seeps, and springs in this region of state, was sought but not found. It is likely that these spring areas are too small and limited to support monkey-flower colonies, though there may still be potential elsewhere both north and south of this survey site.

10. Gills Pier (Leelanau Co.). An extensive, heterogeneous portion of shoreline approximately 4.5 miles in length was inventoried, beginning from Onomonee Road and extending to the shoreline region near the north edge of Lake Leelanau. In the vicinity of the end of Onomonee Road and immediately south, a small new population of Pitcher's thistle (*Cirsium pitcheri*) was discovered, occurring on low, cobble-strewn dunes of minimal extent. Despite the restricted amount of dune habitat available between the beach and numerous, densely placed seasonal cottages, several adult as well as juvenile plants were tallied, indicating successful reproduction and moderate viability. The discovery was fortuitous, as the habitat delineated for study had been identified as from Gills Pier southward; with the Onomonee Road vicinity being used only as a shoreline access site. Approximately one-half mile south of the access site, the shoreline was reduced to a narrow, sandy beach strand backed by an abrupt, wooded slope. In this area, numerous homes have been placed at the top of bluff and along the slope toward the base where possible. Numerous springs and seeps emanate from the base of the slope, forming small pools and rivulets of relatively cold, alkaline water. On the north side of the mouth of Gills Creek bubbling springs were observed, and it was within this microsite that sterile plants were found of what might possibly be Michigan monkey-flower (*Mimulus glabratus* var. *michiganensis*). More extensive mats of plants were found at the mouth of Gills Creek, which appeared to provide the cold groundwater necessary for Michigan monkey-flower (Penskar 1997). The specific site location was noted such that this possible rare plant location can be surveyed in 1997 during the blooming period, when a positive identification can be made.

Southwest of the mouth of Gills Creek, the shoreline is comprised largely of a wide beach and well developed foredune areas, backed by wooded areas heavily developed with cottages and seasonal homes. Pitcher's thistle was encountered again below Gills Pier, and nearly 200 plants were tallied until a wider dune expanse with an estimated several hundred individuals was found in the shoreline area

north of Lake Leelanau in section 26. Within this larger dune field, however, were several new private residences built within the dunes proper, primarily at its periphery. Currently there does not appear to be heavy recreational use of the site, but such increased activities may eventually threaten the Pitcher's thistle population. Overall, survey of this site resulted in the extension of the Pitcher's thistle occurrence last observed in 1954, and thus provided significant status information. Common dune associates included such species as marram grass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), wheatgrass (*Agropyron dasystachyum*), starry false Solomon's-seal (*Smilacina stellata*), riverbank grape (*Vitis riparia*), sand cherry (*Prunus pumila*), Eastern cottonwood (*Populus deltoides*), poison ivy (*Toxicodendron radicans*), horizontal juniper (*Juniperus horizontalis*), beach pea (*Lathyrus japonicus*), sea rocket (*Cakile edentula*), and dune grass (*Calamovilfa longifolia*). Relatively few exotic plants were noted, the most invasive being spotted knapweed (*Centaurea maculosa*) and Canada bluegrass (*Poa compressa*); other common exotics included smooth brome (*Bromus inermis*), bladder campion (*Silene vulgaris*), bouncing bet (*Saponaria officinalis*), and wild carrot (*Daucus carota*). One plant of the state special concern swamp rose-mallow (*Hibiscus palustris*) was noted along the beach, but this widely planted species was likely a waif and a garden escape, since all known native occurrences are within southern tier counties of Lower Michigan.

11. Glen Arbor (Leelanau Co.). Prior to the survey of this site, correspondence and pictures of a large Pitcher's thistle (*Cirsium pitcheri*) colony were received from a private landowner, Ms. Kay Barnell, (K. Barnell pers. comm. 1996) confirming an expected new occurrence for this area. Expectations of the occurrence were based on the proximity of a known population to the immediate west at Glen Haven, as well as the presence of apparently good habitat identified from aerial photos. No data had been obtained previously to document Pitcher's thistle here, and the area had been identified as having high potential. The shoreline on the north edge of the city of Glen Arbor was found to consist of a relatively wide foredune and several backdune fields, although because the area is virtually entirely developed with residences, the backdune areas literally comprise the yards of these homes behind the beach and foredune. The foredune was found to be low and broad, dominated by marram grass (*Ammophila breviligulata*) and to a lesser extent dune grass (*Calamovilfa longifolia*), the latter species typically occurring behind the pioneering and dune-stabilizing marram grass. Pitcher's thistle, as demonstrated in the Barnell photos, was found to be locally abundant on the foredune and in the backdune areas immediately behind the foredune, even where somewhat disturbed and where competing exotic plants were present.

Typical open dune associates were noted, such as wormwood (*Artemisia campestris*), milkweed (*Asclepias syriaca*), beach pea (*Lathyrus japonicus*), sand cherry (*Prunus pumila*), seaside spurge (*Euphorbia polygonifolia*), poison ivy (*Toxicodendron radicans*), buffaloberry (*Shepherdia canadensis*), horizontal juniper (*Juniperus horizontalis*), and Canada rye grass (*Elymus canadensis*). Jack pine (*Pinus banksiana*) was common in the backdunes, forming small groves. Hairy puccoon (*Lithospermum caroliniense*) was encountered locally, the first time this species was encountered from the north to south range of sites covered along Lake Michigan. From the Glen Arbor public access area to the west, the foredune dominates along the broad, strongly curving shoreline. The sensitive and careful placement of paths to the beach areas indicated that many landowners are minimizing their impacts to the dune areas. Locally, though, there are pernicious weeds, the most problematic being spotted knapweed (*Centaurea maculosa*), which was found to be highly invasive throughout most of this survey site. A few other exotics were noted, with Lombardy poplar (*Populus nigra* var. *italica*) considered moderately invasive. The shoreline was explored up to about one mile to the west of Glen Arbor, where dune habitat and presumably additional Pitcher's thistle colonies continue. It was then inventoried to the northeast all the way to the mouth of the Crystal River near the Leelanau School. East and northeast of the Glen Arbor public access, the beach and dunes were relatively disturbed and weedy, with Pitcher's thistle becoming patchy and sparse. Approximately one-half mile south of the mouth of the Crystal River, the dune habitat encountered was of better quality, with larger colonies of thistle. The limited dunes near Leelanau School near the river mouth were found to be carefully maintained and managed, as demonstrated by the placement of trails and appropriate signage noting the sensitivity of the habitat. Additional exotic species recorded, though not considered invasive, were white sweet clover (*Melilotus alba*) and bouncing bet (*Saponaria officinalis*).

12. Herring Lake Embayment (Benzie Co.). The focus of this survey was a delineated region of what appeared to be high quality dunes, including a distinct parabolic blowout area, along a region of shoreline not previously inventoried according to MNFI records. This private land was accessed and surveyed through the permission of the owner, Dr. Sivert H. Glarum, a seasonal resident whose extended family owned the majority of the land inventoried. Dr. Glarum provided a personal tour of the property during the survey and provided several observations of particular features of the site, noting that he had spent more than 30 summers at this family cabin. Open dunes along the immediate shore consisted primarily of a well developed foredune dominated by marram grass (*Ammophila breviligulata*), with dune grass (*Calamovilfa longifolia*) occurring behind the foredune and in the blowout. A narrow depressional area occurred behind the foredune, and this zone was backed by an abrupt mesic northern forest edge. Typical

open dune associates included wormwood (*Artemisia campestris*), sea rocket (*Cakile edentula*), hairy puccoon (*Lithospermum carolinense*), bugseed (*Corispermum hyssopifolium*), seaside spurge (*Euphorbia polygonifolia*), little bluestem (*Andropogon scoparius*), bearberry (*Arctostaphylos uva-ursi*), milkweed (*Asclepias syriaca*), and common juniper (*Juniperus communis*). Though limited in aerial extent, the dunes were observed to be of good quality, with only one exotic species noted for the site, spotted knapweed (*Centaurea maculosa*), which occurred locally near the cabin. Pitcher's thistle (*Cirsium pitcheri*) was found to be frequent throughout the open dunes, with several hundred plants estimated. Many particularly robust individuals were observed, with the survey resulting in extensions to the previously documented occurrence for this locality.

A narrow, high, parabolic blowout extending about 0.25 miles inland was traversed to its peak. Active erosion and sand movement were evident across the entire blowout, and numerous plants of Pitcher's thistle were found. At the peak of the blowout, sand deposition was resulting in aggressive encroachment at the forest boundary, where northern red oak (*Quercus rubra*), white pine (*Pinus strobus*), and basswood (*Tilia americana*) were undergoing active burial. Dr. Glarum noted that although active sand movement was occurring in some areas of the shoreline, others had not changed in his memory in more than three decades, such as the foredune area in front of his cabin. In a site about 50 meters south of his cabin, Glarum pointed out a large deposition of sand occurring inside the mature forest boundary. He noted that a short fence set a few years ago to contain this breach was now buried under several feet of sand; the erosion had apparently been caused originally by the establishment of a simple human footpath.

13. Watervale South (Benzie Co.). This site consisted of a well developed eroding moraine bluff comprising approximately two miles of the shoreline south of Lower Herring Lake. The steep bluff face was traversed over about one and one-half miles of its length, where primarily the lower slope areas were examined for potential rare plant species. The bluff was sufficiently stable over portions to support scattered trees, shrubs, and often an unstable turf of grasses and forbs. In many areas, however, the bluff face had actively eroding and slumping soil, frequently displaying bands of clay in the exposed glacial drift profile. Along upper edges of the bluff, holes excavated by cliff swallows were common. Pitcher's thistle (*Cirsium pitcheri*) was documented, comprising a new state occurrence. Plants were found principally along the lower one-third of the bluff, where deeper sand occurred. An estimated 100-200 plants were observed, many of which were large, robust juveniles and adults thriving best in the areas of the most active sand movement. Common associates included dune grass (*Calamovilfa longifolia*), marram grass (*Ammophila breviligulata*), Gillman's goldenrod (*Solidago simplex*), bugseed

(*Corispermum hyssopifolium*), wheatgrass (*Agropyron dasystachyum*), white camas (*Zigadenus glaucus*), evening primrose (*Oenothera* sp.), and willows (*Salix cordata*, *S. exigua*). A few exotic species were recorded, including Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea maculosa*), and bladder campion (*Silene vulgaris*), none of which were found to be invasive. A species of baby's-breath found to be pernicious elsewhere in this region, *Gypsophila paniculata*, was found but was not observed to be invasive at this time; it is possible that the very active erosion on the bluff prevents this species from becoming more competitive. The shoreline was explored to the northern extent of the bluff and then beyond to inventory the beach nearly to Watervale. No additional plants of Pitcher's thistle were observed beyond the bluff. The eroding moraine is likely to support an occurrence of dunewort (*Botrychium campestre*), which has a high fidelity to this habitat, but must be surveyed for in early June. The state threatened fascicled broom-rape (*Orobanche fasciculata*) is also of potential in this site, but is best sought in early to mid-July.

14. Bishop Road (Manistee Co.). A portion of a high, steep, eroding moraine bluff not previously inventoried was surveyed from approximately the end of Bishop Road to an area about 0.75 miles south of where the bluff tailed out. Previous MNFI inventories had covered the area north of Bishop Road to Arcadia Lake. The bluff was accessed via a steep ravine oriented perpendicular to the shoreline bluff. The moraine face was actively slumping and eroding, exposing the sandy-clayey drift in many areas. Dune vegetation was present across much of bluff face, including such species as wormwood (*Artemisia campestris*), marram grass (*Ammophila breviligulata*), dune grass (*Calamovilfa longifolia*), Gillman's goldenrod (*Solidago simplex*), Canada rye grass (*Elymus canadensis*), dune willow (*Salix myricoides*), milkweed (*Asclepias syriaca*), bugseed (*Corispermum hyssopifolium*), and sea rocket (*Cakile edentula*). Additional woody plants included Northern white cedar (*Thuja occidentalis*), which formed small patches across portions of the bluff, paper birch (*Betula papyrifera*), and white ash (*Fraxinus americana*). This habitat is of excellent potential for dunewort (*Botrychium campestre*), which could not be sought during this late season inventory. Exploration of the base of the bluff revealed that an extremely narrow beach strand was present, with little suitable habitat for Pitcher's thistle (*Cirsium pitcheri*), and none was found during the survey of both the beach and bluff face. Overall, the site provided little habitat for Pitcher's thistle or fascicled broom-rape (*Orobanche fasciculata*), both species of which are known less than two miles to the north in dunes adjacent to Arcadia Lake. Several common exotic plants were recorded, such as bouncing bet (*Saponaria officinalis*), spotted knapweed (*Centaurea maculosa*), redtop (*Agrostis gigantea*), and Canada bluegrass (*Poa compressa*), with Lombardy poplar (*Populus nigra* var. *italica*) and bladder campion (*Silene vulgaris*) considered to be moderately invasive.

15. Pierport West (Manistee Co.). The shoreline in this survey site was accessed via the public beach in Pierport to inventory a short stretch of beach and narrow foredune as well as an approximate 0.75 mile expanse of an eroding moraine bluff face. South of the Pierport public beach, the shoreline consists of a moderately wide beach strand and small areas of foredune. The foredune was dominated by marram grass (*Ammophila breviligulata*); common associates included dune grass (*Calamovilfa longifolia*), wormwood (*Artemisia campestris*), dune willow (*Salix myricoides*), Canada rye grass (*Elymus canadensis*), horsetails (*Equisetum hyemale* and *E. arvense*), Gillman's goldenrod (*Solidago simplex*), beach pea (*Lathyrus japonicus*), bugseed (*Corispermum hyssopifolium*), and Eastern cottonwood (*Populus deltoides*). Just over 0.5 miles south of the access point, the foredune gives way to a high, steep, eroding moraine face. The bluff face was actively slumping and eroding, with thick deposits of sand deposited at the base. Lenses of clay within the moraine were occasionally visible along the lower slope. Most of the site appeared to provide potential habitat for Pitcher's thistle (*Cirsium pitcheri*), which was sought along the preceding foredunes and along the sandy lower slope of the moraine face, but no plants were observed. However, because of the difficulty of thoroughly surveying the steep face, it is possible that this species occurs at this site. In the northern portion of the eroding moraine area, a new occurrence of the state threatened broom-rape (*Orobanche fasciculata*) was discovered. The occurrence consisted of two very withered but recognizable stems at the base of the moraine face, found in close association with the obligate host plant, wormwood. Additional plants were not found during this late October inventory, yet is very likely that other plants occur here.

Several common exotic species were noted, such as spotted knapweed (*Centaurea maculosa*), bouncing bet (*Saponaria officinalis*), Canada bluegrass (*Poa compressa*), and white sweet clover (*Melilotus alba*), with two species, bladder campion (*Silene vulgaris*) and Lombardy poplar (*Populus nigra* var. *italica*) being noted as moderately invasive. Lombardy poplar, though unable to reproduce via seed in Michigan due to the lack of female trees, is able to aggressively propagate from rhizomes, and in this site and elsewhere trees were observed to be spreading vigorously in this manner. One large individual Lombardy poplar tree was found at the beach periphery, where it was about to be washed out from the lower slope. Trees being excavated in this way may thus possibly disperse to other shoreline areas via the fragmentation of rhizomes and/or branches.

16. Merkey Road (Manistee Co.). One to two miles south of the Manistee River mouth, a low eroding moraine bluff and associated beach were evaluated for their potential to support Pitcher's thistle (*Cirsium pitcheri*). This site was difficult to access because it was initially thought to be contained entirely within private lands. The site was also difficult to access physically because the eroding moraine bluff was

creviced at the top, and it was evident from the large, vertical monoliths formed that the bluff top was highly unstable and dangerous to traverse. The eroding moraine was thus viewed from several points along a hiking path at the top, where it could be observed that the very clayey moraine drift provided little suitable habitat for Pitcher's thistle, as did the narrow cobbly beach strand. Several exotic plants were recorded, most of which were ranked as moderately to highly invasive, such as spotted knapweed (*Centaurea maculosa*), autumn olive (*Elaeagnus umbellata*), smooth brome (*Bromus inermis*) and wild carrot (*Daucus carota*). The delineated survey habitat continued more than two miles to the southwest, where access was limited again by private land and housing developments. Access from an open parcel 0.5 miles south of Merkey Road where a property was for sale demonstrated the presence of similar bluff habitat, although here the bluff face could be traversed to the bottom for a better view. It was concluded that no suitable habitat was present in this area for Pitcher's thistle or other rare plants, until a fortuitous discovery enabled the inventory at Magoon Creek (below).

17. Magoon Creek North (Manistee Co.). As noted above, the area delineated below the Manistee River mouth was initially thought to be of poor potential, based on two limited reconnaissance areas. While attempting to access the general shoreline region, most of which is held in private ownership, a local dedicated natural area was found near the mouth of Magoon Creek, identified in signage as the Magoon Creek Natural Area. This site is apparently owned and managed by local government, and thus provided public access to a shoreline area that appeared to be of substantially higher quality than that observed in the vicinity of Merkey Road. According to the signage at this site, the natural area was purchased with a Natural Resource Trust Fund grant. The shoreline was then inventoried from the mouth of Magoon Creek to approximately 1.5 miles north, where suitable rare plant habitat tailed out at the edge of the eroding moraine site described above. Within the natural area and beyond, the shoreline consisted of a wide beach strand backed by a low, well developed foredune dominated by marram grass (*Ammophila breviligulata*) and dune grass (*Calamovilfa longifolia*), with associated typical open dune species, including wormwood (*Artemisia campestris*), Canada rye grass (*Elymus canadensis*), beach pea (*Lathyrus japonicus*), Gillman's goldenrod (*Solidago simplex*), little bluestem (*Andropogon scoparius*), common juniper (*Juniperus communis*), bearberry (*Arctostaphylos uva-ursi*), dune willow (*Salix cordata*), and milkweed (*Asclepias syriaca*). Relatively few exotics were noted, with Canada bluegrass (*Poa compressa*) and bouncing bet (*Saponaria officinalis*) noted as moderately invasive and the aggressive spotted knapweed (*Centaurea maculosa*) ranked as highly invasive. Just over 0.5 miles northeast of the Magoon Creek mouth, a new occurrence of Pitcher's thistle (*Cirsium pitcheri*) was discovered, and

ultimately nearly 200 plants were tallied over the inventory, constituting a reasonably good find in this rapidly developing region of the state.

18. Meinert Park (Muskegon Co.). This section of shoreline was accessed via the county park and public beach. Survey was conducted from the park to approximately 1.75 miles south along the shore, primarily to determine the status of a known Pitcher's thistle (*Cirsium pitcheri*) occurrence last observed in 1986 and evaluate possible extensions to this population in additional dune habitat identified to the south. The thistle was observed within the park, occurring on the foredune and backdunes behind the wide, low-sloping beach. South of the mouth of Little Flower Creek, Pitcher's thistle was found on low backdunes, where the dominant vegetation was marram grass (*Ammophila breviligulata*) and dune grass (*Calamovilfa longifolia*). Typical associates were present, including wormwood (*Artemisia campestris*), red osier dogwood (*Cornus stolonifera*), Eastern cottonwood (*Populus deltoides*), and Gillman's goldenrod (*Solidago simplex*). Most of the shoreline south of the park was heavily developed, with large homes lining the shore, including many built virtually within the open dune areas and blowouts. Just over one mile south of Meinert Park, new colonies of Pitcher's thistle were found in section 15, extending the known occurrence. These individuals were observed primarily from the lake edge, to avoid traversing private property. Large numbers of plants are likely to occur well within the several parabolic blowout portions extending up to approximately 0.25 miles inland in markedly higher dune areas. Marram grass was the dominant dune plant encountered throughout the inventory, with relatively few exotics noted, including the rarely encountered winged pigweed (*Cycloloma atriplicifolium*). The most problematical exotic species was Lombardy poplar (*Populus nigra* var. *italica*), a frequently planted ornamental along much of the Lake Michigan coast, but especially occurring in southern Lower Michigan. As observed elsewhere, this species was found to be propagating vegetatively wherever planted. Along the beach, stranded helium party balloons with ribbon streamers were observed to be particularly frequent.

With regard to the status of Pitcher's thistle, it appears that there are lower numbers of plants than characterized during the 1986 survey. Although this inventory resulted in an expected extension of the locality for the known occurrence, the population may be declining, owing to the degree of development that has occurred. Many large homes have now been built along the shore, including several constructed directly within the open dune habitats, including the foredunes, the dune fields, and even within the blowout areas.

19. Sadony Bayou (Muskegon Co.). This site was inventoried in part during the 1992 CZM survey of Lake Michigan drowned river mouths, which identified additional potential rare plant habitat to the north. One mile of shoreline was thus surveyed, beginning at the north edge of the dunes adjacent to Sadony Bayou. The survey was targeted almost exclusively for discovering a possible new Pitcher's thistle (*Cirsium pitcheri*) occurrence. The shoreline was found to consist primarily of a narrow beach backed by a moderately high, steep, sandy bluff of eroding moraine. Near the dunes at the north edge of the Bayou, the only potential habitat for Pitcher's thistle was the eroding moraine slope. The slope was actively eroding, supporting many plant species typical of open dune habitats, including marram grass (*Ammophila breviligulata*), dune grass (*Calamovilfa longifolia*), Canada rye grass (*Elymus canadensis*), wormwood (*Artemisia campestris*), sea rocket (*Cakile edentula*), bugseed (*Corispermum hyssopifolium*), Gillman's goldenrod (*Solidago simplex*), dune willow (*Salix myricoides*), Eastern cottonwood (*Populus deltoides*), evening primrose (*Oenothera* sp.), beach pea (*Lathyrus japonicus*), milkweed (*Asclepias syriaca*), sandbar willow (*Salix exigua*), and red osier dogwood (*Cornus stolonifera*). The eroding moraine slope also had many weeds present, with such exotics as bittersweet nightshade (*Solanum dulcamara*), winged pigweed (*Cycloloma atriplicifolium*), bladder campion (*Silene vulgaris*), yarrow (*Achillea millefolium*), mullein (*Verbascum thapsus*), wild carrot (*Daucus carota*), and white sweet clover (*Melilotus alba*). The most invasive species recorded were quackgrass (*Agropyron repens*), Canada blugrass (*Poa compressa*), the widespread spotted knapweed (*Centaurea maculosa*), and especially bouncing bet (*Saponaria officinalis*). The latter species, often known under the colloquial name of "soapwort", was widespread and highly invasive throughout much of this site. At the northern portion of this survey areas, along the north edge of section 35, the bluff was found to be more stabilized with a turf of vegetation. At the base of the moraine slope, the beach widened, and a low, broad foredune occurred. The foredune, which was heavily dominated with a dense colony of marram grass, was surveyed carefully but unsuccessfully for Pitcher's thistle. It was concluded that the mat of marram grass was so dense and vigorous that no habitat (i.e. the open sand microhabitat required by Pitcher's thistle) was presently available on this foredune for colonization. Overall, with the relative proximity of Pitcher's thistle documented a few miles to the north, this site provides marginal but potential colonization habitat should seeds disperse here.

20. Lake Macatawa South (Allegan Co.). A brief inventory of this site was conducted to determine the possible presence of Pitcher's thistle (*Cirsium pitcheri*) colonies. Site access, which could not be gained on the south side of the Lake Macatawa channel during the 1992 drowned river mouth survey (Penskar et al.), was again attempted via private landowners. Access was given by a resident, Ms. Sandy Clayce,

who gave permission and subsequent directions to the subdivision's communal walkway to the beach areas. Because of this unique opportunity, a survey was conducted up to the Lake Macatawa channel to explore the area not covered in 1992, as well as the delineated shoreline to the south. The shoreline was found to be heavily developed with residences, which have been built densely along the shoreline though mostly at the forest edge. The wide, low-sloping beach graded slowly to a low series of foredune vegetated with extremely dense patches of marram grass (*Ammophila breviligulata*), which formed a virtual monoculture throughout much of the site. The shoreline vegetation here was characterized by its low diversity of plants; among the few associated species were dune grass (*Calamovilfa longifolia*), wormwood (*Artemisia campestris*), riverbank grape (*Vitis riparia*), and staghorn sumac (*Rhus typhina*). There was a commensurate low diversity in exotic species, all of which were classed as non-invasive at this time, including black locust (*Robinia pseudoacacia*), bouncing bet (*Saponaria officinalis*), Japanese knotweed (*Polygonum cuspidatum*), and white sweet clover (*Melilotus alba*). There appears to be a moderate to heavy seasonal use of the shoreline by recreationists, although recreation is perhaps somewhat limited by the lack of public access. Pitcher's thistle was not found during the inventory, although habitat was concluded to be present albeit marginal.

21. Miami Park (Allegan Co.). This site was not fully accessed, but reconnaissance along the bluff edge indicated that the site provided little habitat of interest for detailed survey. The shoreline was found to be comprised of an eroding moraine bluff edge with a narrow, cobbly beach strand. Direct access was difficult, owing to the fact that this survey site was virtually all within private lands. Access was also difficult due to the structure of the moraine bluff. Similar to the Merkey Road site encountered in Manistee County, the eroding moraine was characterized by numerous crevices along the top of bluff, where large monoliths of the unstable, exposed clay drift were forming and breaking away. Much of the bluff edge near the roadside was posted with signs warning of the unstable slope. The site was thus viewed briefly from several aspects along the edge, sufficient to determine that little, if any habitat for Pitcher's thistle (*Cirsium pitcheri*) or other possible rare species appeared to be present, and inventory was thus best directed elsewhere. As expected, the eroding moraine slope was somewhat weedy, as these habitats are intrinsically suited to more ruderal, disturbance-based plants. The exotic species included the very ubiquitous bouncing bet (*Saponaria officinalis*), Canada bluegrass (*Poa compressa*), white sweet clover (*Melilotus alba*), and the ornamental guelder rose or highbush cranberry (*Viburnum opulus*). The most invasive species, based on this very cursory reconnaissance, appeared to be bouncing bet and white sweet clover.

22. Ruggles road (Van Buren Co.). This site was surveyed to determine if a known occurrence of Pitcher's thistle (*Cirsium pitcheri*) in Van Buren State Park could be extended to potential habitat on the northern border of the park. The dune habitat appeared to be essentially contiguous with that contained in the park. The site was accessed via Dyckman Swamp, a local nature preserve on the eastern margin of the shoreline dunes. Of principal interest was the exposed, high dune slope as well as a large blowout area just to the north of the Dyckman swamp area. At the top of the dunes at the forest edge, active sand movement was resulting in the encroachment of dunes at the forest bluff edge. Deep sands were beginning to accumulate, resulting in the active burial of woody vegetation. The dune slope was found to be high and steep. Large portions of the dune slope were vegetated with dense patches of marram grass (*Ammophila breviligulata*), the dominant species throughout. Some portions of the exposed dune slope, particularly in the region of several private homes at the top of the dune bluff, were obviously stabilized with dense, vigorously growing colonies of marram grass, down to the rip-rapped base of the slope and beach zone. In one instance, a landowner provided signage for his planting, encouraging pedestrians to avoid destabilizing the dune slope by hiking across it. Marram grass is available in quantity through various nurseries, although this may often be derived from out-of-state seed sources, and many landowners along Lake Michigan have obtained and planted erosional areas for natural stabilization in this manner. In this site, impressive expanses of the dune slopes were hand planted with this species, often in dense patches.

Approximately one mile of shoreline was surveyed, up to a large blowout-like area in section 29. The open expanse encountered was a large, hilly dune area that was virtually denuded of vegetation by excessive ORV use. Where not heavily damaged, marram grass provided the majority of the vegetative cover. This site was clearly the most degraded area observed during the Lake Michigan inventory. The degree and recency of recreational vehicle use indicated that this site will continue to be utilized in this fashion, and thus recovery cannot be presumed for the near future. Expansion of the non-vegetated areas is likely following this excessive artificial disturbance. Associated dune species were few, but included Eastern cottonwood (*Populus deltoides*), dune grass (*Calamovilfa longifolia*), bugseed (*Corispermum hyssopifolium*), wormwood (*Artemisia campestris*), wild bergamot (*Monarda fistulosa*), and red osier dogwood (*Cornus stolonifera*). Several exotics were noted, including black locust (*Robinia pseudoacacia*), bouncing bet (*Saponaria officinalis*), and Lombardy poplar (*Populus nigra* var. *italica*), all of which were found to be moderately invasive at the site. On the way out of the site, plants of sea rocket (*Cakile edentula*) were found at the top of the bluff, established within the forest boundary, indicating the ability of the prevailing western winds to disperse a typical beach strand species across a high dune slope and significantly inland.

23. Linden Hills South (Van Buren Co.). This site was accessed via a small township park adjacent to Linden Hills, and an approximately 1.5 miles of shoreline was briefly inventoried to attempt to find colonies of Pitcher's thistle (*Cirsium pitcheri*) in what appeared to be somewhat limited but potential dune habitat. The shoreline was densely developed with what were apparently seasonal homes and cottages, many of which were built extremely close to the immediate shore and had extensive rip-rapping to reduce erosion. The shoreline had more limited and marginal habitat than indicated by the topographic quadrangle and recent aerial photo imagery. A moderately wide expanse of dunes occurred near the township park, consisting of low foredunes dominated by marram grass (*Ammophila breviligulata*) with some dune grass (*Calamovilfa longifolia*). This habitat quickly tailed out as the zone narrowed and a densely developed area occurred about 0.5 miles southeast of the park. The cottages in some areas were perched above a vertical "wash-out" zone about 1-2 meters in height; it was along this zone that most residences had rip-rapping, metal seawalls, and large sandbag-like retaining walls. Only a narrow zone of dune habitat was left between the homes and the beach proper. The vegetation consisted primarily of marram grass and dune grass, with common associates such as Eastern cottonwood (*Populus deltoides*), bugseed (*Corispermum hyssopifolium*), scarce wormwood (*Artemisia campestris*), little bluestem (*Andropogon scoparius*), and sea rocket (*Cakile edentula*). A few exotics were noted, including Lombardy poplar (*Populus nigra* var. *italica*), Scotch pine (*Pinus sylvestris*) bouncing bet (*Saponaria officinalis*), and a restricted occurrence of Lyme grass (*Elymus arenarius*), the latter a "rare" though likely somewhat overlooked exotic species known only from about three counties in the state and here constituting an apparent county record (a voucher specimen was taken to confirm this). Several homes were found to be surrounded with frequent plantings of Scotch pine, as well the native white and red pines (*Pinus strobus* and *P. resinosa*, respectively). Pitcher's thistle was carefully sought but could not be found. A large parabolic blowout area which was on private land and could not be accessed in section 18, approximately 0.5 miles south of Linden Hills, remains potential habitat for Pitcher's thistle. Prior to large-scale development along the shoreline, it is likely that Pitcher's thistle was once present, as there are populations known to both the south and north.

24. Mizpah Park (Berrien Co.). This site comprised the last and southernmost survey site, where there was little expectation for rare species. Because the shoreline could not be definitively determined from map and aerial photo interpretation, the site had been delineated as a potential survey site. Similar to other eroding moraine shoreline areas, this shore, with its open slope, could not be reliably distinguished from sandy slopes that in many areas along the Lake Michigan shore are known to support populations of Pitcher's thistle (*Cirsium pitcheri*). This site was very similar to Miami Park (described above), in that

the shoreline was found to consist of an abrupt bluff top characterized by crevices and large-scale erosion and landsliding. Reconnaissance of a representative portion of the shore from the top of the bluff strongly indicated that little habitat was present for Pitcher's thistle or other rare species. The slope and bluff were also quite weedy, but a complete plant list was not made as this site was not formally inventoried. White sweet clover (*Melilotus alba*) was noted as a prominent weed along the bluff and slope. The bluff, which was about 20-30 meters or more above the lake level, was fronted by a narrow cobbly-sandy beach that clearly was not potential habitat for Pitcher's thistle.

Critical Dunes Element Occurrence List

The list of plant and animal element occurrences within designated Critical Dunes (CD) was organized by the Township, Range, and Section(s) of element occurrences (EOs) to allow for easy project screening, and consists of a Microsoft Excel file that can be sorted into regional lists. Table 8 shows a sample output page from the file. In the left column, all Sections within the CD areas are listed. In the cells to the right, all EOs in each section are listed by scientific name. Each element is followed by the BCD record number in parentheses, allowing easy reference to more detailed information in BCD, and by a letter code (S, M, G) that indicates the extent of the occurrence. A code of "S" indicates a very local occurrence, whereas "M" indicates an occurrence extending up to 1.5 miles from the mapped location; "G" indicates an occurrence extending up to 5 miles. It is possible to add the common name of each species to the list, or to use standard MNFI cross reference lists to obtain common names.

Quality checking the complete list against mapped occurrences revealed that the database information did not always reflect the complete extent of occurrences. Since this project did not include adequate funding to completely correct this problem, we are continuing the process under other funding, including a current CZM project that involves examining and analyzing shoreline cumulative impacts. The methodology developed here will be crucial for the completion of the cumulative impact project. A hard copy and electronic EXCEL file of the complete CD list will be made available to CD permitting staff when completed.

While completion of the quality checking of the list may reveal a few more EOs or extensions of the range of some EOs, the following statistics from the data compiled to date provide a good picture of significance of coastal habitats for natural features. Altogether, the list includes 290 EOs in the state's CD, which represents about 13% of the total coastal plant and animal EOs in the MNFI database. This is approximately proportional to the portion of the coast that is designated as CD (about 12% of coastal Sections). Since many of the shoreline plants occur in sparse populations scattered over extensive

Table 8: Plant and Animal Element Occurrences in Coastal Sections - Sample Output
From Michigan Natural Features Inventory Database, December 1996.

Town Range Section	Scientific Name (EO#) Extent*	Scientific Name (EO#) Extent	Scientific Name (EO#) Extent	Scientific Name (EO#) Extent	Scientific Name (EO#) Extent
T05N R16W S4					
T05N R16W S9					
T05S R19W S17					
T05S R19W S20					
T05S R19W S29					
T05S R19W S30					
T05S R19W S31					
T05S R19W S32					
T06N R16W S16					
OT6N R16W S21					
T06N R16W S28					
T06N R16W S33					
T06N R16W S4					
T06N R16W S9					
T06S R19W S18	<i>Hieracium paniculatum</i> (1) S	<i>Pycnanthemum verticillatum</i> (9) S	<i>Sabatia angularis</i> (23) S	<i>Spiranthes ochroleuca</i> (1) S	<i>Triplasis purpurea</i> (2) M
T06S R19W S6	<i>Adlumia fungosa</i> (27) G	<i>Fundulus notti</i> (8) M	<i>Microtus pinetorum</i> (2) S	<i>Triplasis purpurea</i> (8) S	
T06S R19W S7					
T06S R20W S12					
T06S R20W S13					
T06S R20W S24	<i>Adlumia fungosa</i> (3) S	<i>Cirsium pitcheri</i> (16) M	<i>Panax quinquefolius</i> (45) S	<i>Terrapene carolina carolina</i> (38) M	<i>Wolffia papulifera</i> (2) M
T06S R20W S25	<i>Oecanthus pini</i> (3) M				
T06S R20W S26	<i>Cirsium pitcheri</i> (16) M	<i>Terrapene carolina carolina</i> (37) M	<i>Utricularia subulata</i> (1) M	<i>Vitis vulpina</i> (1) M	
T06S R20W S34					
T06S R20W S35					

*For the extent value, **S** indicates very local occurrence, **M** indicates extent up to 1.5 mile radius, and **G** indicates extent up to 5 mile radius

habitat, these EO_s frequently occur in more than one Section. In addition, many Sections have EO_s of several different species. The total number of CD Sections with plant or animal EO_s is about 220, or about 48% of all the CD Sections.

Discussion

Endemic Plants Inventory

Lake Huron

Numerous survey gaps within the coastal zone were investigated during the inventory, resulting in significant new rare plant occurrences and many extensions of previously documented populations. The status of many known occurrences that did not result in extensions was also established, and the general condition and quality of much of the shoreline was assessed. Based upon the considerable survey work that has been conducted along the shoreline through this and previous studies, the northern and southern range boundaries of the four primary target species (dwarf lake iris, Houghton's goldenrod, Lake Huron tansy, and Pitcher's thistle) has now been well established.

Dwarf lake iris occurs from just south of Edgewater Beach in Cheboygan county to just south of Partridge Point in Alpena County. Populations near the north end of its range, at Cadottes Point, Stoney Point, and Point Nipigon, are smaller and considerably more fragmented than those further south. This species is abundant in and around Cheboygan State Park where known populations were extended over one mile to Grass Bay. It reaches its peak of abundance along a 45+ mile stretch from Adams Point just south of Rogers City to North Point south of Alpena. Along this stretch Garlitz (1989) documented significant populations from Adams Point to False Presque Isle Peninsula, and from Monaghan Point to North Point, while populations at Thompson's Harbor, Besser Natural Area, Rockport, and Northport were all extended significantly during the current study. The southernmost known occurrence of dwarf lake iris along Lake Huron was documented just south of Partridge Point in 1987.

Houghton's goldenrod shows the most limited range of distribution of the four target species, occurring from Nipigon Point in Cheboygan County to Evergreen Beach in Presque Isle County. Similar to dwarf lake iris, the northernmost occurrences of this species are small compared to those further south.

The most notable presence of Houghton's goldenrod is in the region from Bernard E. Jarvis State Roadside Park in Presque Isle County south and east to Hammond Bay, where it occurs by the thousands in several long stretches. Several occurrences were reconfirmed south of this region at Hammond Bay East and Evergreen Beach. The southernmost known occurrence, observed in 1982 at Ferron Point in Presque Isle County was not reconfirmed; however the potential for it to persist there remains. Additional survey during the optimal flowering time is warranted at this site.

The northernmost known occurrence of Lake Huron tansy is a small population at Stoney Point, while the southernmost known occurrence is a large population beginning just north of Rogers City and extending north approximately 2.5 miles to Hoeft State Park. Due to the numerous extensions of known

occurrences resulting from this study, the tansy is now known to be distributed in high numbers from Cheboygan State Park to its southern range boundary near Rogers City. This is particularly so along a six mile, more or less contiguous stretch from two miles west of Evergreen Beach in Presque Isle County to the north boundary of Hoeft State Park. Other long stretches of Lake Huron tansy occur at Cheboygan State Park and eastward, Grass Bay and eastward, Huron Beach, and Hammond Bay East.

Pitcher's thistle covers the greatest range of the four priority species, occurring from its northernmost location at Point Nipigon in Cheboygan County to its southernmost occurrence in Huron County at Port Crescent State Park. It is found almost in tandem with Lake Huron tansy, particularly in the six mile contiguous stretch described above. The thistle, however, continues on, more or less, for another three miles to the north side of Rogers City. It is also found, unlike the tansy, in considerable numbers at Thompson's Harbor, Besser Natural Area, and North Point. Those occurrences north of Huron Beach in Presque Isle county are small and isolated, as are the two confirmed occurrences south of North Point (Au Sable Point and Port Crescent State Park), both of which have declined dramatically since previous observations. One additional southern occurrence, at the Oscoda North site, was found to be extirpated, while two other known occurrences at Negwegen State Park and just south of Oscoda were not visited during this study. Regardless of whether these latter two occurrences are considered extant or not, any occurrences south of North Point are only remnants of apparently once more abundant and widespread populations. This is particularly true for the Thumb region, where numerous herbarium collections solidly establish the historical presence and abundance of this species there.

Because of their declining status, the two confirmed southern occurrences at Au Sable Point and Port Crescent State Park provide incentive for the consideration of experimental management for the thistle. It appears that one of the reasons for decline in these two areas is the density of vegetation which limits the availability of colonization sites. Pitcher's thistle is known to require 70% bare sand substrate for successful germination and establishment (Bowles et al. 1993). Experimental clearing and/or planting could be attempted at these sites. In addition, several southern areas warrant further survey effort including the two known occurrences mentioned above that were not visited during this study. Survey at Negwegen State Park, where one of these occurrences is located, should include the area from Black River to Lookout Point in order to evaluate all potential habitat there. In addition, permission should be sought to survey the coastal zone at Pointe Aux Barques in the Thumb region, where potential habitat occurs.

With the exception of those places where it has already been documented, and those places where further survey is recommended, the chances are minimal that additional populations of Pitcher's thistle or most other coastal zone rarities will be documented south of Partridge Point in Alpena County.

This is due to the highly developed nature of the shoreline in this region. South of the Thumb region, for the most part, agricultural activities extend almost to the shoreline, with typically only a narrow band of non-agricultural land lying between the fields and the heavily used, residential lots lining the water's edge. Although agricultural land directly adjacent to the shoreline lessens further north, the heavy concentration of lakeside residences does not, once again precluding the likely persistence of rare plant species.

A review of the overlapping concentrations of the four target species reveals that there are several highly significant regions which harbor at least two if not three or four of the priority species in either high concentration or over long distances. These include the following:

- Cheboygan State Park through Grass Bay to Cordwood Point: (*Solidago houghtonii*, *Cirsium pitcheri*, *Iris lacustris*, and *Tanacetum huronense*)
- Huron Beach south past Bernard E. Jarvis State Roadside Park to Hammond Bay: (*Solidago houghtonii*, *Cirsium pitcheri*, *Tanacetum huronense*)
- Evergreen Beach to 40 Mile Point: (*Cirsium pitcheri*, *Tanacetum huronense*)

A fourth area is identified where only one of the high priority species, dwarf lake iris, is found in abundance, although several other coastal rarities are known to occur in fairly high numbers. These include populations of Richardson's sedge (*Carex richardsonis*) and bulrush sedge (*Carex scirpoidea*) previously documented by Garlitz, as well as beauty sedge (*Carex concinna*) documented by Garlitz and during the current study.

- Adams Point to North Point: (*Iris lacustris*, *C. richardsonis*, *C. scirpoidea*, *C. concinna*)

The four areas noted above should be given high priority for conservation action. Notably, a considerable portion of all of these regions is comprised of privately owned lands. Although numbers of rare species were not typically found to be as abundant on private lands compared to public lands, their presence was notable, encouraging, and worthy of attention. It is in these areas where the fragmentation of populations is most actively occurring, and it is here where fragmentation impacts can be studied and possibly minimized by creative conservation activities (e.g. easements) that would limit the extent of direct disturbance and help prevent further fragmentation of known occurrences. As development pressures continue, as they undoubtedly will, having previously defined conservation actions will help greatly in the conservation of rare plant populations. Private holdings should be identified in detail and aggressive landowner contact and education should be implemented.

Several additional areas of private landholdings, not noted above as high priority because of their small size and isolation, deserve some mention. These include:

- the northernmost occurrence of dwarf lake iris just north of Cadottes Point in Cheboygan County
- Stoney Point in Cheboygan County
- Nipigon Point

Landowner contact and education in these areas is recommended as well.

Much of the publicly owned coastal lands in the four high priority areas are naturally protected, due to the difficulty in gaining access to these shores. But even the public lands are under increasing pressure from visitors, and thought should be given towards setting up long-term monitoring strategies. This would provide a gauge of the status of populations such that early detection of potential problems would be more likely.

Additionally, as evidenced by the exotic species observed at each site (Table 5), the continual invasion of such species is a serious problem in coastal zone natural communities. Highways and access roads often occur in close proximity to shoreline areas, and the large majority of sites experience regular disturbance activities, thus providing dispersal routes for the spread of invasive species. The abundance of exotic species was largely correlated to the accessibility and amount of disturbance at each site, though their presence was evident even in the most remote shores. Relatively few exotic species were found to be moderately to highly invasive over a large number of sites. Of the 38 exotic species observed during the survey, yarrow, spotted knapweed, and Canada bluegrass, all of which are well known for their extreme invasiveness, were by far the most problematic. The other species listed were present at fewer sites, although in some cases in high numbers, and thus these may represent an incipient threat.

Many rare plant occurrences were documented in sites where exotic species were present in significant numbers, though generally the weedier the site, the less vigorous the rare species appeared to be. This may reflect the continual fragmentation of shoreline habitat through coastal zone development, which has enhanced the invasion of exotic species. However, not all rare plant populations appeared to be adversely affected by the presence of exotics. Houghton's goldenrod, for example, was observed in high numbers in some sites where exotics were abundant, such as along a several mile stretch at Mast Point, and thus this species may be more resilient than others.

Lake Michigan

Following the 1992 inventory of drowned river mouth sites (Penskar et al. 1993), numerous sites within the Lower Peninsula coastal zone were delineated as having merit for future inventory, consisting largely of shoreline dunes, interdunal wetlands, and cobble and sand beaches. In this study, we concentrated on investigating the mainland and two near-shore islands as a logical study area, thus

leaving the Beaver Island archipelago for subsequent surveys. Despite the intensive and systematic scrutiny of the Lake Michigan coastline in previous MNFI studies (Albert et al. 1988, 1989; Chapman et al. 1985; Comer & Albert 1993), a moderate number of sites were identified, some of which were extensive. The vast majority of survey sites, as one might expect, occurred in northern Lower Michigan, where there is a markedly higher concentration of coastal dunes and considerably less development. Although many of these survey sites did not constitute large sand dune systems, they were found to provide apparently sustainable habitat for coastal endemics, particularly Pitcher's thistle. Survey sites often consisted of narrow, linear coastal dunes, comprised of no more than a beach strand, a well developed foredune, and limited back dunes or dune fields, if any. In many cases these confined coastal habitats were backed abruptly by forest and/or steep slopes and bluffs of exposed glacial moraine. The sites were often variable, ranging from long, uniform stretches of continuous beach and foredune to more discontinuous areas interspersed with rock and cobble beaches. Despite the restricted depth of these coastal communities, the collective available habitat along large stretches of the shore (i.e. up to one or more miles) was found to support moderately large rare plant populations.

Among the most significant areas identified during the inventory were Waugoshance and Temperance Islands in Wilderness State Park. No rare plant populations were found on Waugoshance Island, but a significant, high quality boreal forest occurrence was identified. In addition, observations were made of a pair of immature bald eagles that may have fledged from a heretofore unknown nest site. Similarly, an observation was made of a possible Northern harrier occurrence. Temperance Island was the richest site found during the Lake Michigan inventory with regard to new natural feature occurrences; inventory there resulted in the discovery of locally abundant numbers of Pitcher's thistle and a moderately large population of Houghton's goldenrod. In addition, a significant occurrence of Great Lakes marsh was found. Both islands show little artificial disturbance and human use, and are protected and managed within Wilderness State Park. Discovery of the above natural features will thus only enhance the management, protection, and appreciation of these sites.

South of the Straits area, the target species were principally Pitcher's thistle, Michigan monkey-flower, and Lake Huron tansy (except in perched dune areas), although the latter species is known to be restricted in Lake Michigan to the northern portion of the basin and thus was not expected below the Grand Traverse Bay region based on the known distribution (Voss 1996). In perched dune areas, fascicled broom-rape (*Orobanche fasciculata*) was sought, as this species occurs in close association with this type of dune system. Because of the timing of the survey, we were unable to conduct inventory for dunewort (*Botrychium campestre*), an ephemeral, early flushing grape-fern that withers by mid- to

late-June, although potential habitat for this species (perched dune systems and eroding moraine bluffs) was noted on field forms when encountered.

Sites in the southern portion of Emmet County (M-119 to Pike Road, Good Hart, Middle Village South) and in Charlevoix County (Fisherman's Island State Park, Banks Township Park) exemplify the restricted type of coastal dunes. Here, long stretches of narrow foredunes and cobble and sand beaches extend for several miles. Several small new occurrences of both Pitcher's thistle and Lake Huron tansy were collectively catalogued, and significant status updates were obtained for known occurrences of these species as well. In Fisherman's Island State Park, a population of the Lake Huron locust (*Timeroptropis huroniana*), a Great Lakes endemic insect, was apparently observed and subsequently reported to MNFI zoologists. The locust was last observed in this site in 1923.

For the vast remainder of sites, from Leelanau County to the southernmost locality in Berrien County, the inventory was almost exclusively targeted for populations of Pitcher's thistle. Within these areas, several of the sites that were inventoried included portions of larger coastal dune systems, such as perched dunes with blowouts (Herring Lake Embayment, Watervale South, Bishop Road, and Pierport West). At Pierport West, a one-mile length of perched dune was surveyed, resulting in the discovery of a new population of fascicled broom-rape.

Perhaps the most significant plant discovery of the survey was the identification of a potential colony of Michigan monkey-flower (*Mimulus glabratus* var. *michiganensis*) at Gills Pier in Leelanau County. Here and in other sites where cold springs, streams, and seeps were present along exposed glacial moraine bluffs, Michigan monkey-flower was sought. At the mouth of a small stream near Gills Pier and within adjacent springs, sterile plants of what may be Michigan monkey-flower were collected. Because only sterile plants were found, this rare federal and state endangered plant could not be positively identified, but the habitat appeared suitable. This locality will be subsequently accessed and surveyed during the peak bloom period in July, hopefully resulting in a confirmation. Currently there are only 14 known extant occurrences for this global rarity that is found only within Michigan (Penskar 1997).

The southernmost new occurrence of Pitcher's thistle found during the inventory was a moderately large population found within and near the Magoon Creek Natural Area, just south of the City of Manistee. This new occurrence is particularly noteworthy, as a population of Pitcher's thistle discovered in the condominium-marina complex in the city has declined severely and is likely no longer viable. Knowledge of the Magoon Creek occurrence thus comprises an important remnant population for the area. Elsewhere to the south, little additional habitat was found ranging down to Berrien County, although it was known *a priori* that increasingly marginal sites were being assessed. At Meinert Park in

Muskegon County, an occurrence of Pitcher's thistle was relocated but appeared to be declining. In this site, numerous homes and cottages were being constructed, many within the dunes proper. This type of development will likely accelerate the loss of dune function, with the ultimate loss of the viability of this population. At Ruggles Road in Van Buren County, extensive steep dunes were surveyed in an unsuccessful attempt to extend the known occurrence of Pitcher's thistle in Van Buren State Park. Outside the park to the north, however, the dune habitat was found to be severely damaged and denuded by ORV's, with virtually no vegetation left in areas accessible to these vehicles. In steep slope areas, landowners are engaged in the active control of the natural mass wasting of the dune slope, as evidenced by numerous revetments, pilings, and extensive plantings of marram grass (*Ammophila breviligulata*).

With regard to exotic species, relatively few of the 51 species recorded were found to be moderately to highly invasive at a large number of sites (Table 7). The most notable invasives are well-known for their ability to invade coastal areas, both with and without artificial disturbance, such as spotted knapweed (*Centaurea maculosa*), Canada bluegrass (*Poa compressa*), Lombardy poplar (*Populus nigra* var. *italica*), and bouncing bet (*Saponaria officinalis*). Perhaps the largest potential problems are spotted knapweed and Lombardy poplar. The former species has been observed to be aggressively colonizing sand dunes throughout Lower Michigan, and many land managers are beginning to implement control measures for this species. Migration along Michigan's roadsides has likely provided a rapid route for dispersal, and although artificial disturbance assists in introducing this species, spotted knapweed is also actively invading undisturbed dunes, owing to the dynamic sand dune environment that is inherently suited for some weed species. Lombardy poplar, planted extensively as an ornamental species, apparently consists only of male plants, and is thus not able to produce seed. However, this species readily propagates itself via long rhizomes well-suited to dune sands, and clones readily wherever planted. Fragmentation of the rhizomes and possibly limbs and twigs may be a form of dispersal for this species along the shoreline. Observations during this survey indicate that artificial disturbance, such as excessive ORV use, can stimulate the growth of this species.

Lastly, as observed during the previous coastal zone inventory for endemic plants (Penskar et al. 1993), refuse that represents a potentially serious problem for wildlife as well as humans is the ubiquitous presence of helium party balloons and ribbon streamers. Released from locations as far away as Wisconsin, these accumulate along beaches in large numbers, and were found in nearly every site surveyed. This problem may be peculiar to the Lake Michigan shore, as opposed to other shorelines in Michigan, due to the westerly wind fetch. Clearly this appears to represent a continuing problem, with the potential to ensnare wildlife and cause other damage, yet at this time we are unaware of the extent of reports of this within the literature and elsewhere.

Critical Dunes Element Occurrence List

The high percentage (48%) of Critical Dunes (CD) Sections which contain plant or animal Element Occurrences (EOs) and the large number of EOs (about 290) indicates that the CD are highly significant habitat for the state's rare species. While the current list provides a quite complete picture of the rare plants occurring in CD areas, the list is less complete at present for animals. Many segments of the shoreline have had little if any systematic animal inventory. Eventually, when animal surveys are as complete as the plant surveys, and natural community occurrences are also incorporated, this list can be used to delineate sections with *no natural features concerns*, which will provide highly efficient screening for permitting staff. In the meantime, the present list will be helpful for the CD program, because most concerns within the CD are plants. The methodology developed will also be useful for production of other lists of coastal features, such as one recently requested by the Army Corps of Engineers.

Production of this list demonstrated some limits of the EO database for extracting information on coastal occurrences which often extend for more than a mile along the shore. Quality testing of the list against manual files indicated that EO extent was not always accurately reflected in the data extracted from the database. To insure that future shoreline data extractions reflect the full extent of all occurrences, MNFI will need to quality check location information in shoreline plant EOs.

A second limit demonstrated by this project was that these data would be easier to extract in a GIS environment than in a database search. The list of coastal Sections is so long (about 4,000 Sections) that the database search procedure is complex and time-consuming, and keeping the shoreline EO list up-to-date when records are updated will not be simple. This is one reason why this type of product should not be attempted until the inventory work is considered largely complete. However, the CD list will be easier to update than the complete shoreline list since EO records falling in CDs include a CD designation field.

This project provided us the opportunity to take the first step toward a more efficient system for screening permitted activities in the coastal zone for impacts on natural features. In the next year we will be refining this screening tool, and extending this step to a study of cumulative impacts of permitted activities in the coastal zone. The methodology developed here will be modified to account for the difficulties encountered, and then used for the cumulative impact evaluation which will include other segments of the coast.

Summary and Recommendations

Summary

To complete a comprehensive inventory of the Lower Michigan coastal zone for endemic plant species, systematic surveys were conducted from May to October, 1996 by MNFI. The purpose of this investigation was to assist in the compilation of thorough natural features database for the state's coastal zone, largely to facilitate environmental review and enhance conservation planning decisions. A total of 52 discrete survey sites -- 28 on Lake Huron and 24 on Lake Michigan -- was delineated and inventoried. Survey sites for Lake Michigan were based on those selected following a shoreline investigation and analysis in 1992 (Penskar et al. 1993). For Lake Huron, shoreline analyses involving aerial photo and database review were conducted in early 1996, followed by site assessments and field inventories within the same year. A total of 24 new rare plant occurrences was identified, in addition to a potentially new occurrence for the endemic Michigan monkey-flower, which could not be verified in sterile condition. Two new high quality occurrences of natural communities were documented. Status information was obtained for 54 occurrences of previously documented rare plant populations, many of which were updated with significant range extensions, especially for several historically documented colonies. More than 114 miles of Lower Michigan shoreline were covered in field inventories. A total of 66 exotic plant species was tallied, with several rated as being moderately to highly invasive in shoreline natural communities.

A component of this project, following field surveys and data transcription, was an effort to compile a comprehensive database of element occurrences (i.e. natural features) within designated Critical Dunes (CD) for use as a permit and project screening tool by Coastal Program staff. A manual check with MNFI maps indicated the files did not always reflect the entire extent of occurrences, and some occurrences were not included. A reconciliation and quality control procedure was initiated under a new, related CZM project (cumulative impacts assessment) to address the discrepancies and ultimately build a fully reliable list. Despite the present discrepancies, the current version of the list includes nearly 300 element occurrences in Michigan's critical dune areas, representing about 13% of the total coastal element occurrences in the MNFI statewide database. This is proportional to the percentage of designated critical dune areas, which comprise about 12% of coastal Sections.

Recommendations

Recommendations based upon the result of this study can be broken down into several categories of action, consisting of: 1) further survey work, 2) landowner contact and education, 3) control of exotic species, and 4) potential research. Specific recommendations are detailed below.

Further Survey Work

During the course of this study, every attempt was made to cover as much potential habitat as possible, in order to investigate shoreline gaps where survey information was lacking, incomplete, or dated. However, since it is impossible to be in all places at the optimal time for each coastal zone rarity, some areas were identified that merit further survey work. In some cases these are sites of previously known occurrences that time did not permit visiting, while elsewhere potentially high quality sites were identified that were not noted during the original delineation of survey sites. For the Lake Huron shoreline, the following areas are recommended for further survey:

- the southernmost occurrence of Houghton's goldenrod at Ferron Point
- the previously known occurrence of Pitcher's thistle at Negwegen State Park
- the previously known occurrence of Pitcher's thistle just south of Oscoda
- the coastal zone at Pointe aux Barques in Huron County where potential Pitcher's thistle habitat occurs

For Lake Michigan, inventory coverage of the mainland coastal zone for endemic plant species is felt to be complete, with the exception of one area, the Leelanau Peninsula. Based on 1996 surveys in adjacent areas, portions of the shoreline northeast of Northport may provide sufficient dune habitat for Pitcher's thistle and Lake Huron tansy. Several miles of shoreline there, though within an area with many cottages and homes, may still provide sufficient habitat for rare plants. Currently no records are known, and thus at least reconnaissance and possibly inventory are warranted. In addition to this area at the tip of the peninsula, it will be necessary to return to the Gills Pier locality to try and verify the possible new occurrence of Michigan monkey-flower. This colony was tentatively identified from sterile plants discovered during the 1996 shoreline inventory. Only 14 localities globally are known for this federal and state endangered monkey-flower, and thus a new occurrence would be highly significant.

The remaining islands delineated as requiring inventory in the Lower Peninsula region of Lake Michigan, namely Beaver Island, Hog Island, Gull Island and High Island, should be surveyed in the near future. This may require extensive effort, as all of the area of Great Lakes islands lies within the state coastal zone. Survey may thus be needed to address potential high quality natural communities in the interior portions of some islands, in addition to the immediate coastal habitats.

In addition to the inventories detailed above, it is also recommended that similar work be considered for the Upper Peninsula, following analysis of data from previous and ongoing shoreline studies (e.g. CZM bedrock community surveys).

Landowner Contact and Education

Four regions of Lake Huron coastal zone were identified where there are overlapping occurrences of two or more rare plant species, and where significant portions are under private land ownership. Aggressive landowner contact and education is recommended in these areas. They include the following:

- Cheboygan State Park through Grass Bay to Cordwood Point: (*Solidago houghtonii*, *Cirsium pitcheri*, *Iris lacustris*, and *Tanacetum huronense*)
- Huron Beach south past Bernard E. Jarvis State Roadside Park to Hammond Bay: (*Solidago houghtonii*, *Cirsium pitcheri*, *Tanacetum huronense*)
- Evergreen Beach to 40 Mile Point: (*Cirsium pitcheri*, *Tanacetum huronense*)
- Adams Point to North Point: (*Iris lacustris*, *C. richardsonis*, *C. scirpoidea*, *C. concinna*)

Several smaller regions of private land-holdings were also identified where landowner contact and education could be valuable. These include:

- the northernmost occurrence of dwarf lake iris just north of Cadottes Point in Cheboygan County
- Stoney Point in Cheboygan County
- Nipigon Point in Cheboygan County

Lake Michigan, in comparison to portions of the Lake Huron shore, is markedly different with regard to the pattern of plant occurrences. It clearly lacks the dense clustering and sheer diversity of rare plant species such as those found along northern Lake Huron shores. However, the state's best coastal dune systems are found in the Lake Michigan coastal zone, most of which are found on public lands, such as Sleeping Bear Dunes National Lakeshore, Ludington Dunes, and others. Accordingly, many of the state's best populations of species such as Pitcher's thistle, and Western disjuncts such as fascicled broom-rape and dunewort, occur in this region. Landowner contact is thus of somewhat less urgency, owing in part to this patterning of rare plant occurrences. Nonetheless, development is occurring at a rapid pace on the Lake Michigan shore. Currently, MNFI is engaged in an active landowner contact program that has conducted work in the Emmet County area. Because of the fragility and vulnerability of populations in the southern region of the Lake Michigan, a general recommendation is made here to initiate landowner contact at all desirable sites in southern Lower Michigan, where development recreational pressures are high.

Exotic Species

Exotic species have long been known to be troublesome in coastal zone communities. This study has resulted in the elucidation of those species that are currently most problematic, as well as some general baseline data. Although, the presence of exotic species does not preclude the presence of rare species, it certainly will erode the viabilities of rare populations over time, as well as those of other indigenous plants that form the greater portion of native plant communities. Measures must be taken to document and stem their invasion on public lands. Such measures should also be a component of landowner contact and education efforts on private lands, which will require information materials to assist in the identification of and control target exotic species.

Research

Ultimately, many sites may require intensive management to maintain natural communities and rare plant populations. In addition, restoration is likely to be attempted in many areas where landholders, both in public and private sectors, are committed to sustaining natural diversity. To this end, research will be needed to determine the most appropriate management techniques. Without detailing an extensive potential list of research areas and specific topics, we would merely like to highlight this subject and suggest that consideration be given in future funding to projects that may help ascertain the specific actions needed to maintain, restore, and perpetuate the biodiversity of coastal ecosystems.

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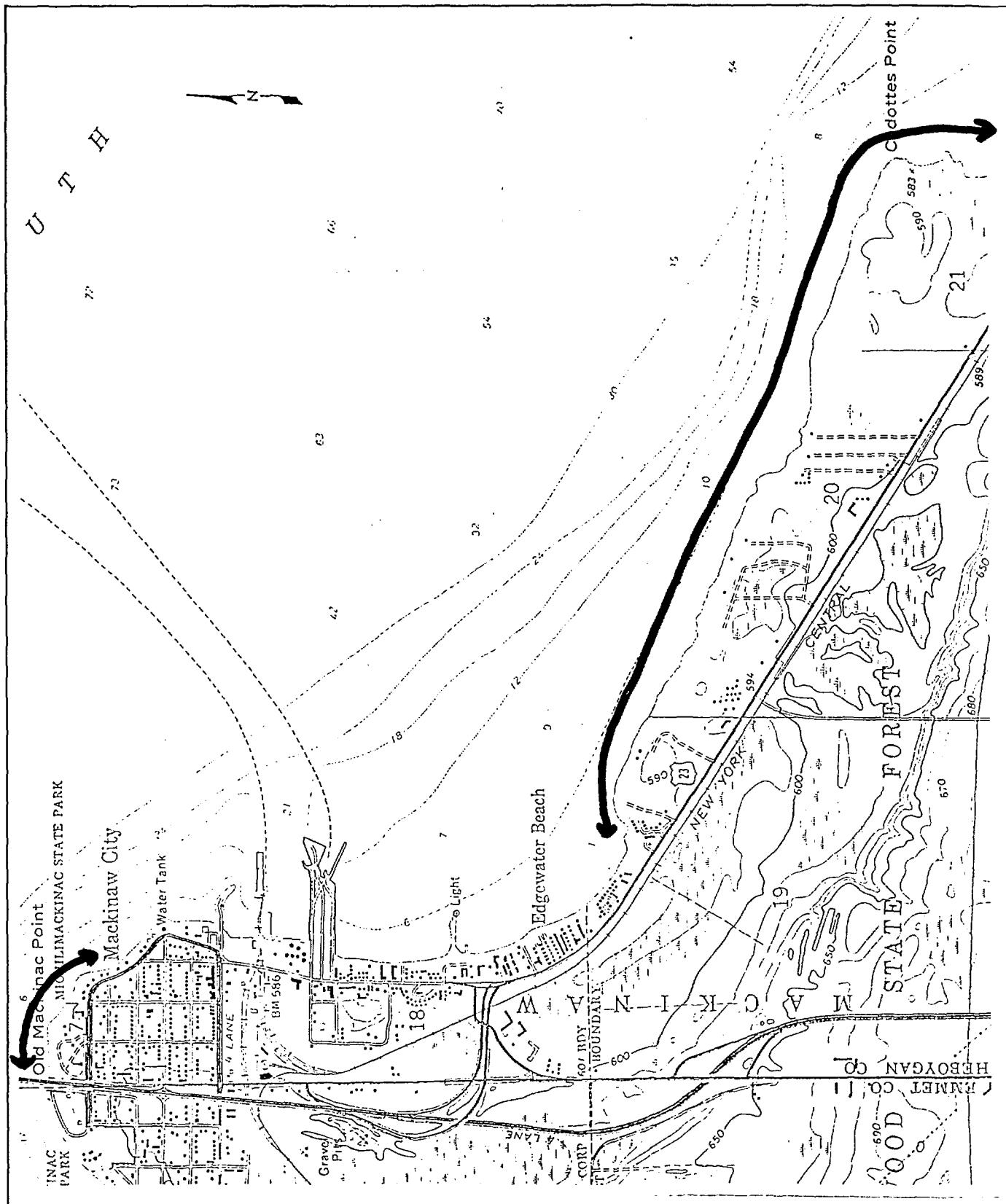
Penskar, M. R. & J. P. Ludwig. 1981. A Summer Survey of 35 BLM Islands in the St. Mary's River and Lake Huron for Rare, Threatened, and Endangered Plants and Animals. Ecological Research Services, Iron River, Michigan. 88 pp.

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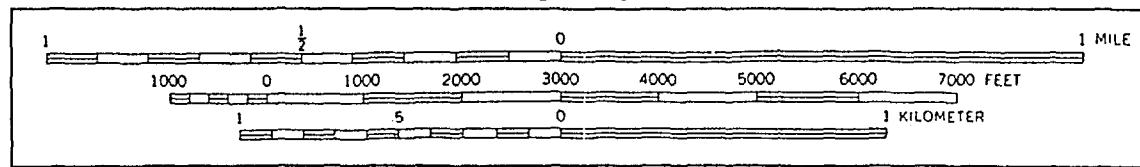
APPENDIX A

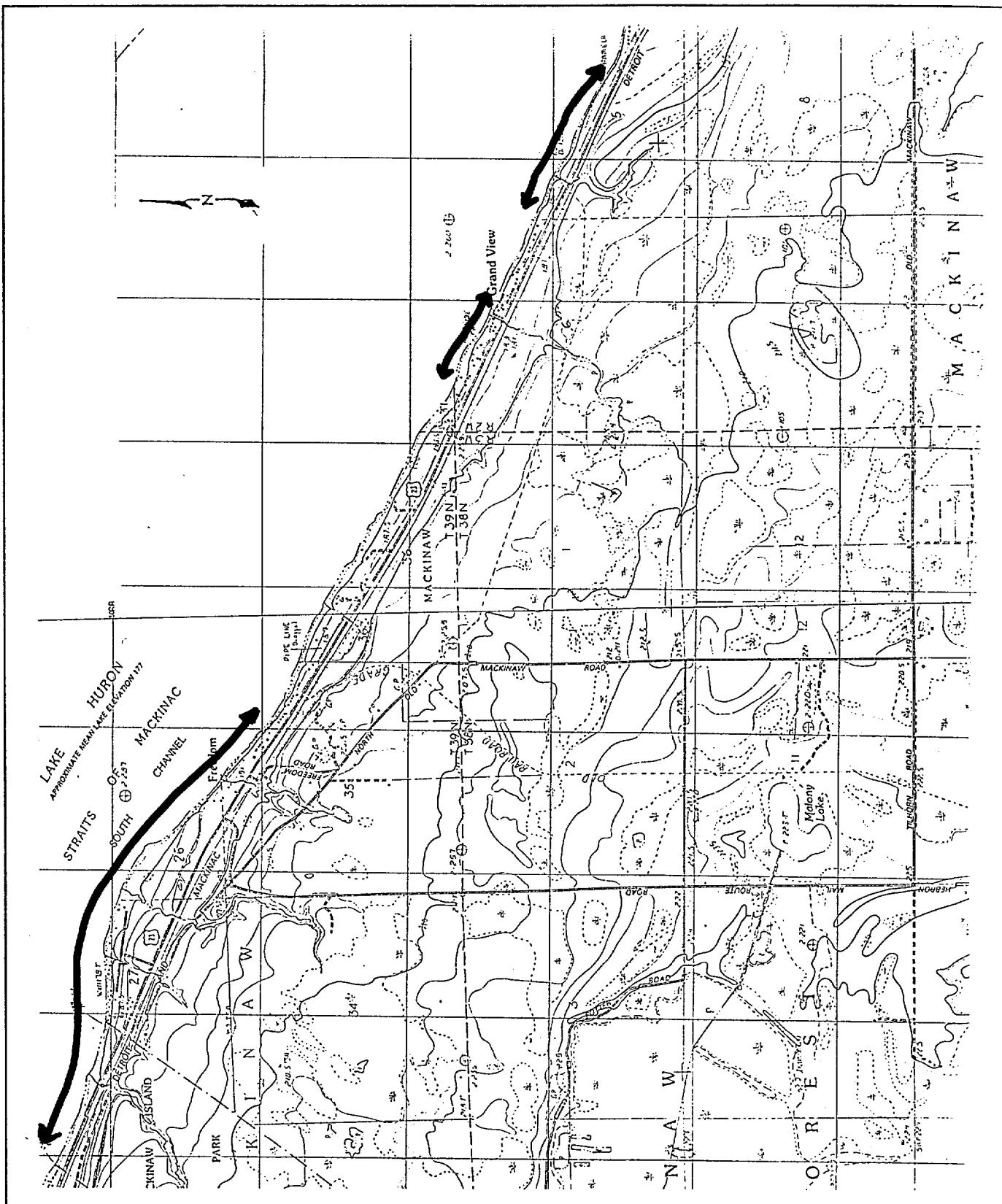
Maps of survey sites for Lake Huron and specific shoreline areas inventoried

1. Mackinac City to Cadottes Point

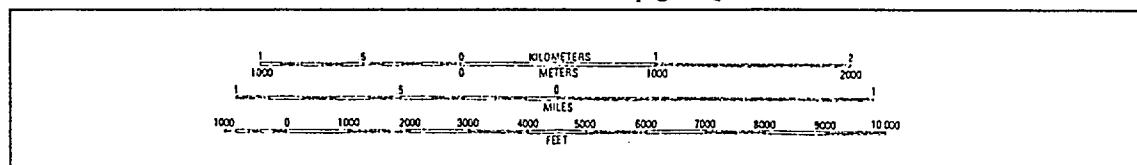


United States Geological Survey 7.5 minute topographic map
St. Ignace Quad

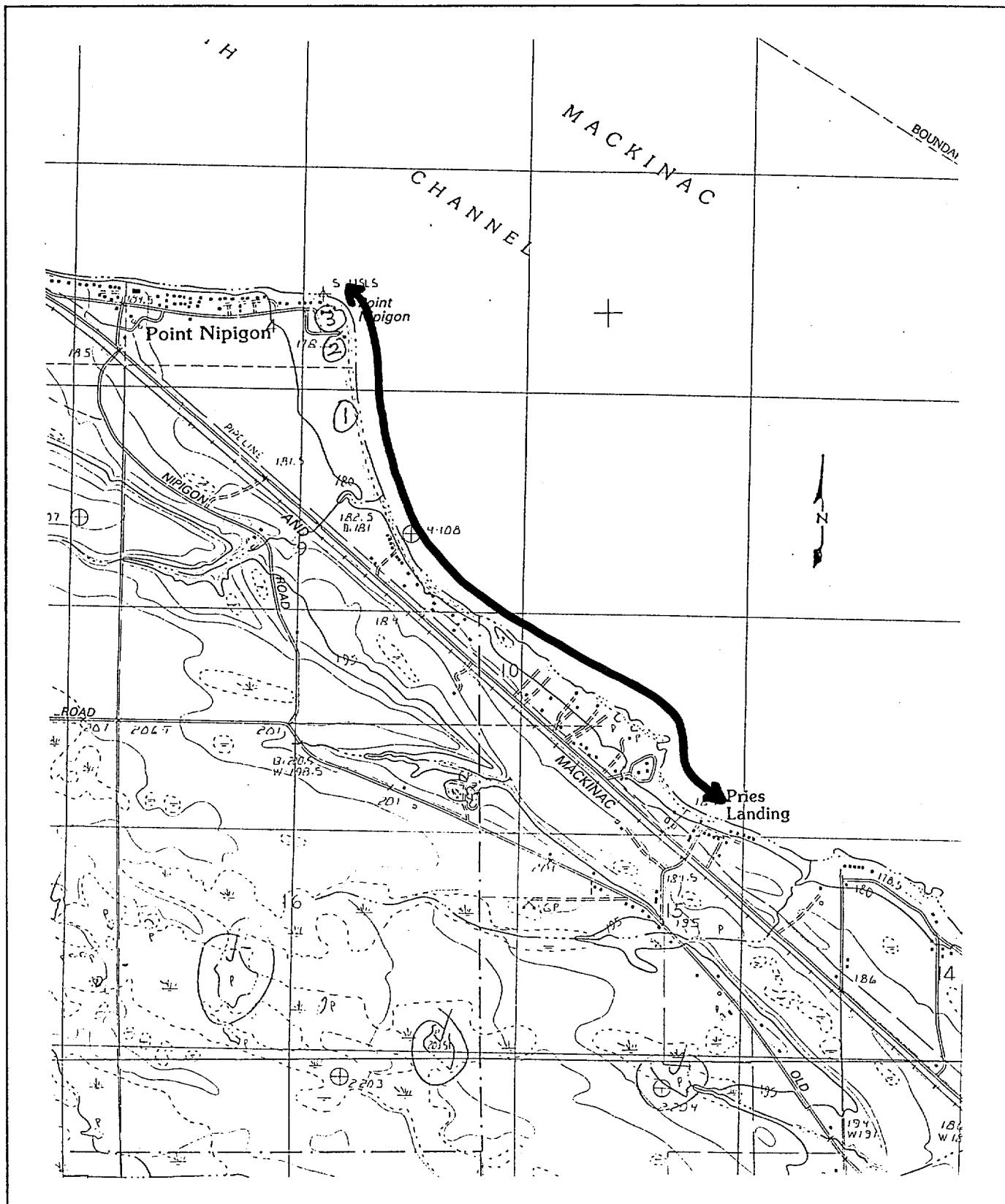




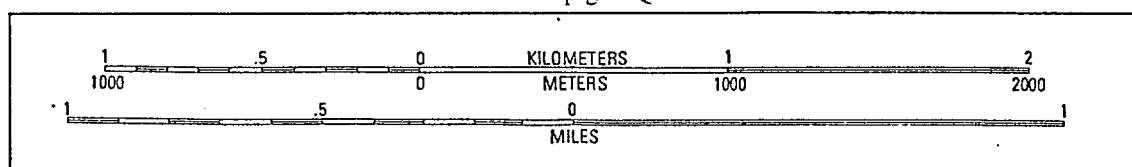
United States Geological Survey 7.5 minute topographic map
Freedom and Point Nipigon Quads



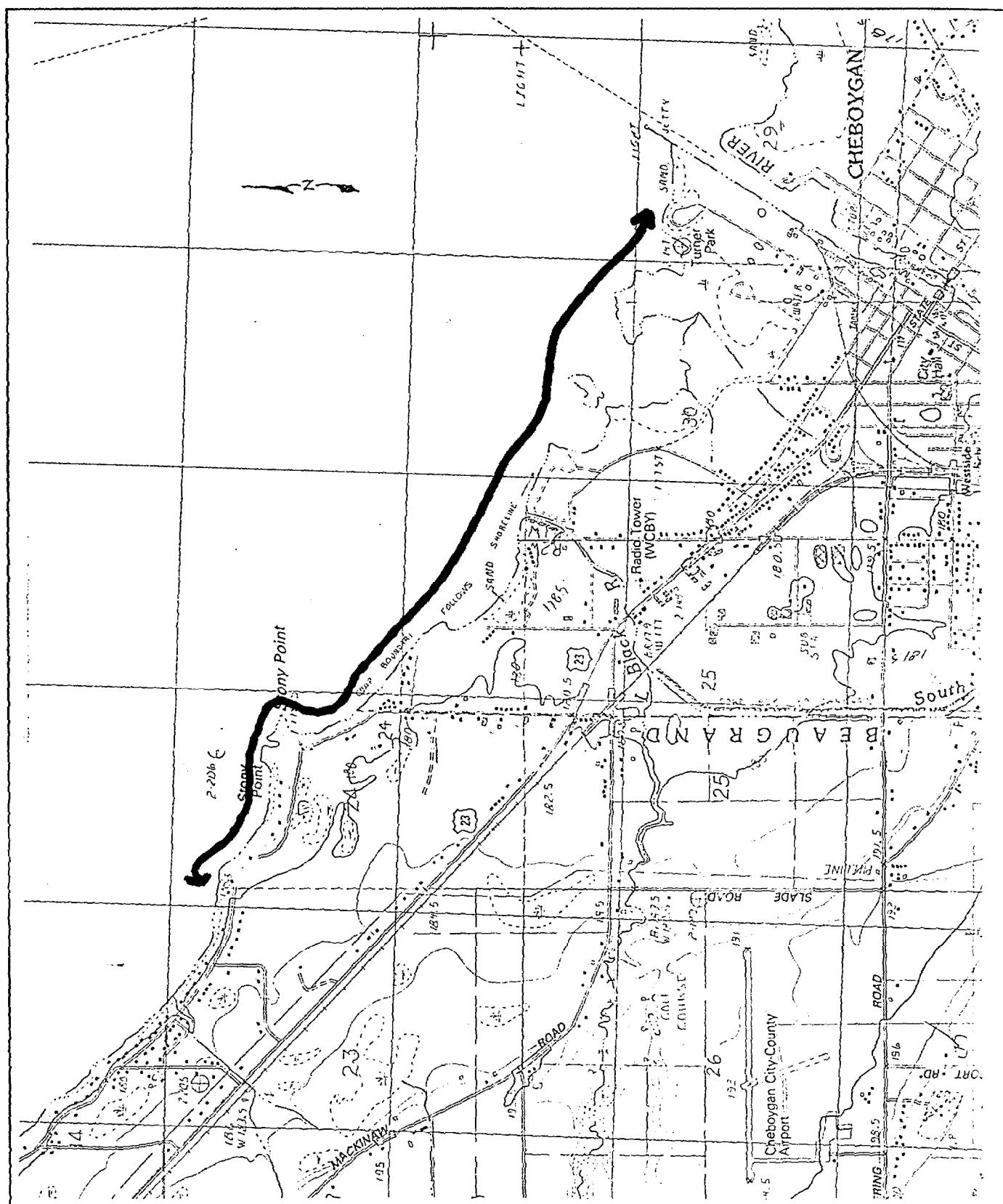
3. Point Nipigon to Pries Landing



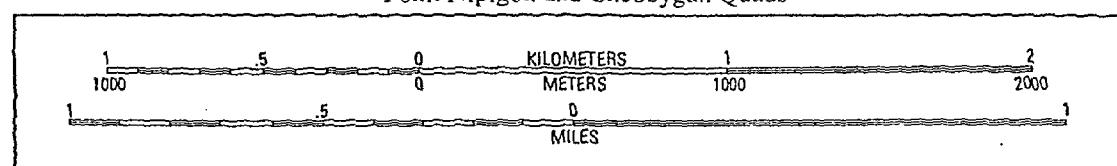
United States Geological Survey 7.5 minute topographic map
Point Nipigon Quad

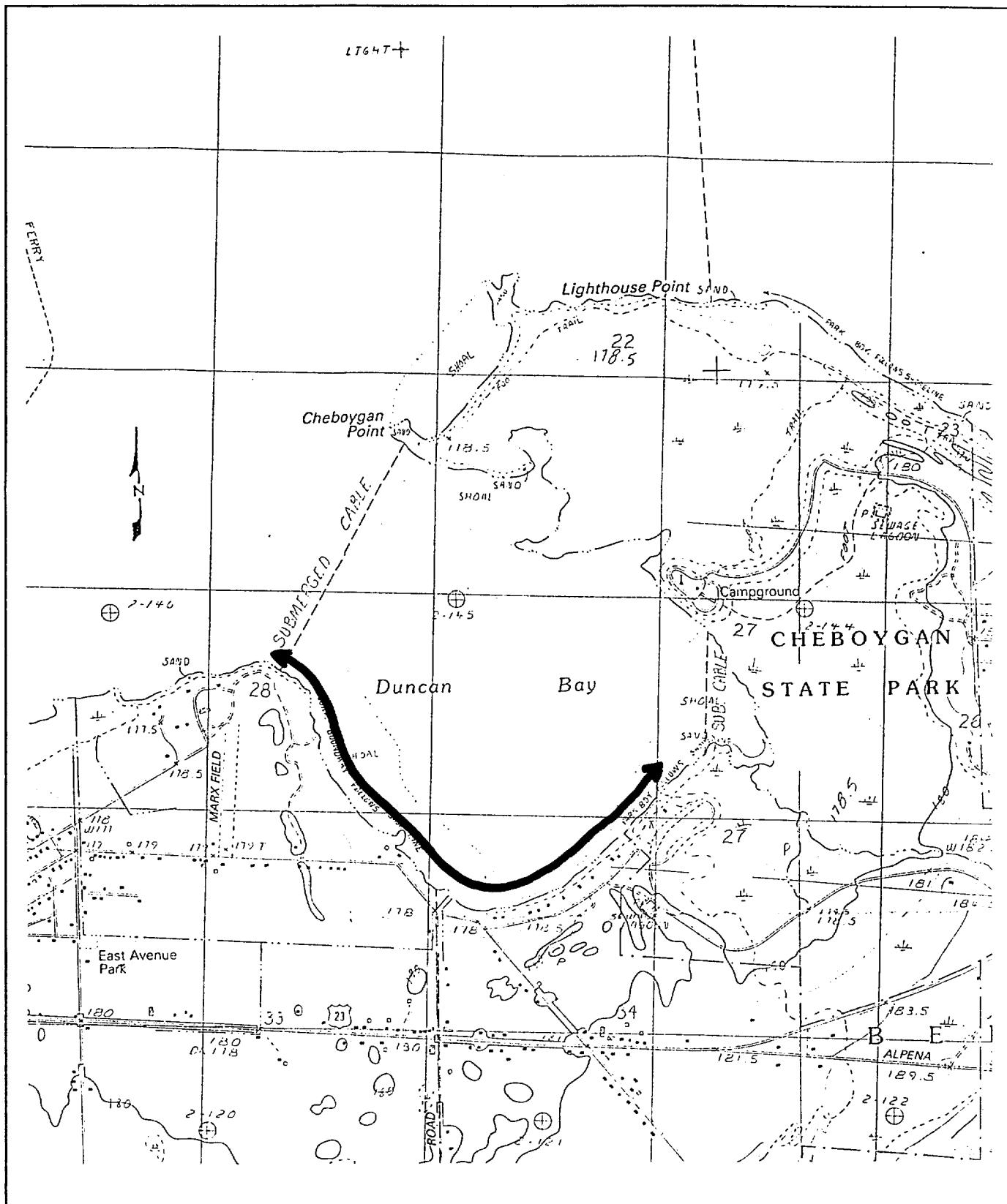


4. Stoney Point

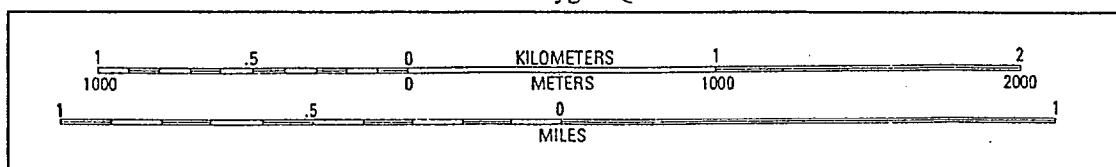


United States Geological Survey 7.5 minute topographic map
Point Nipigon and Cheboygan Quads

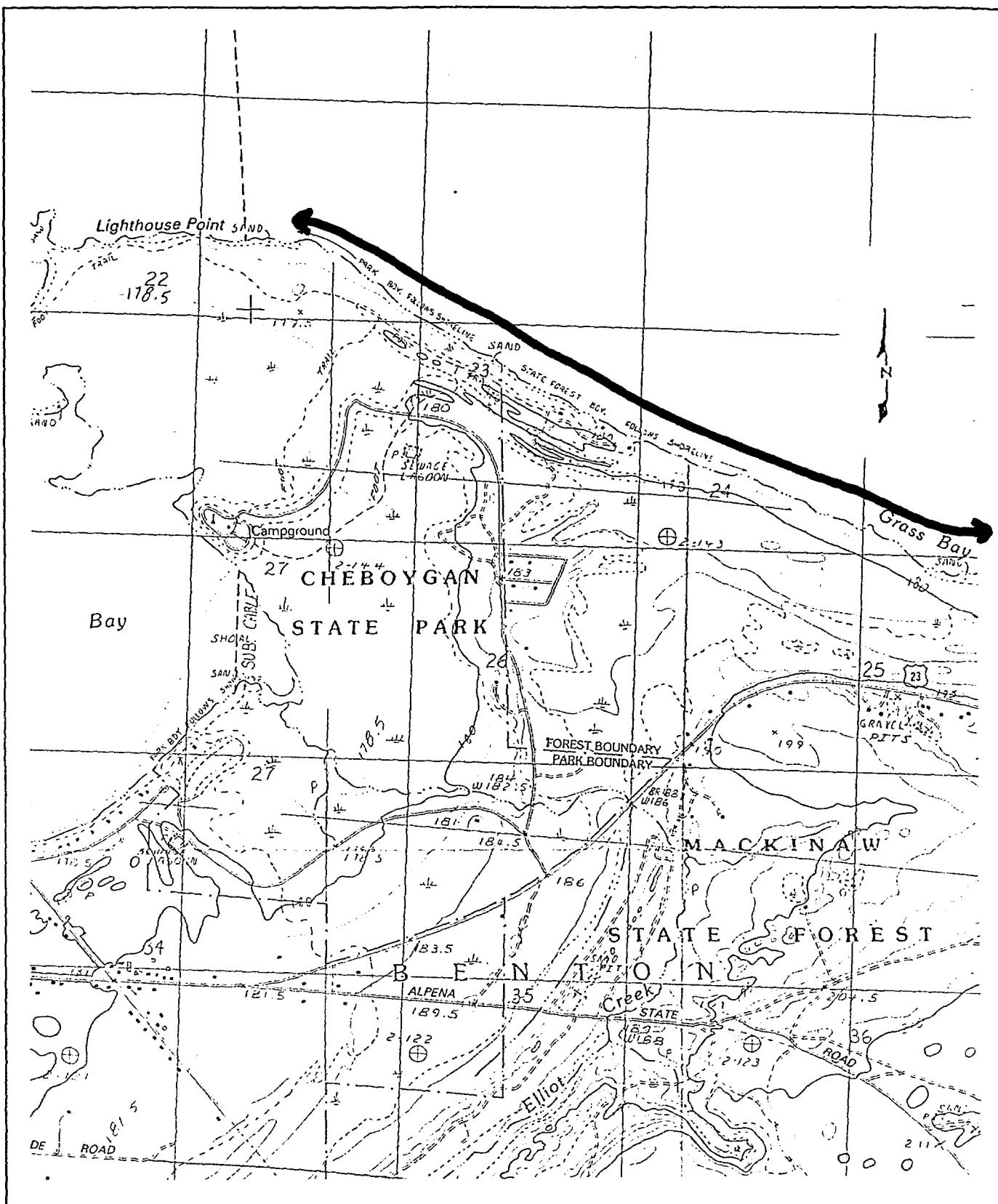




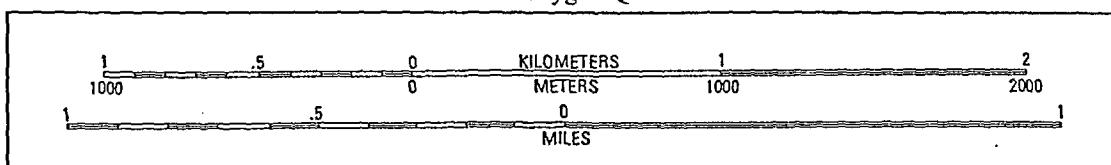
United States Geological Survey 7.5 minute topographic map
Cheboygan Quad



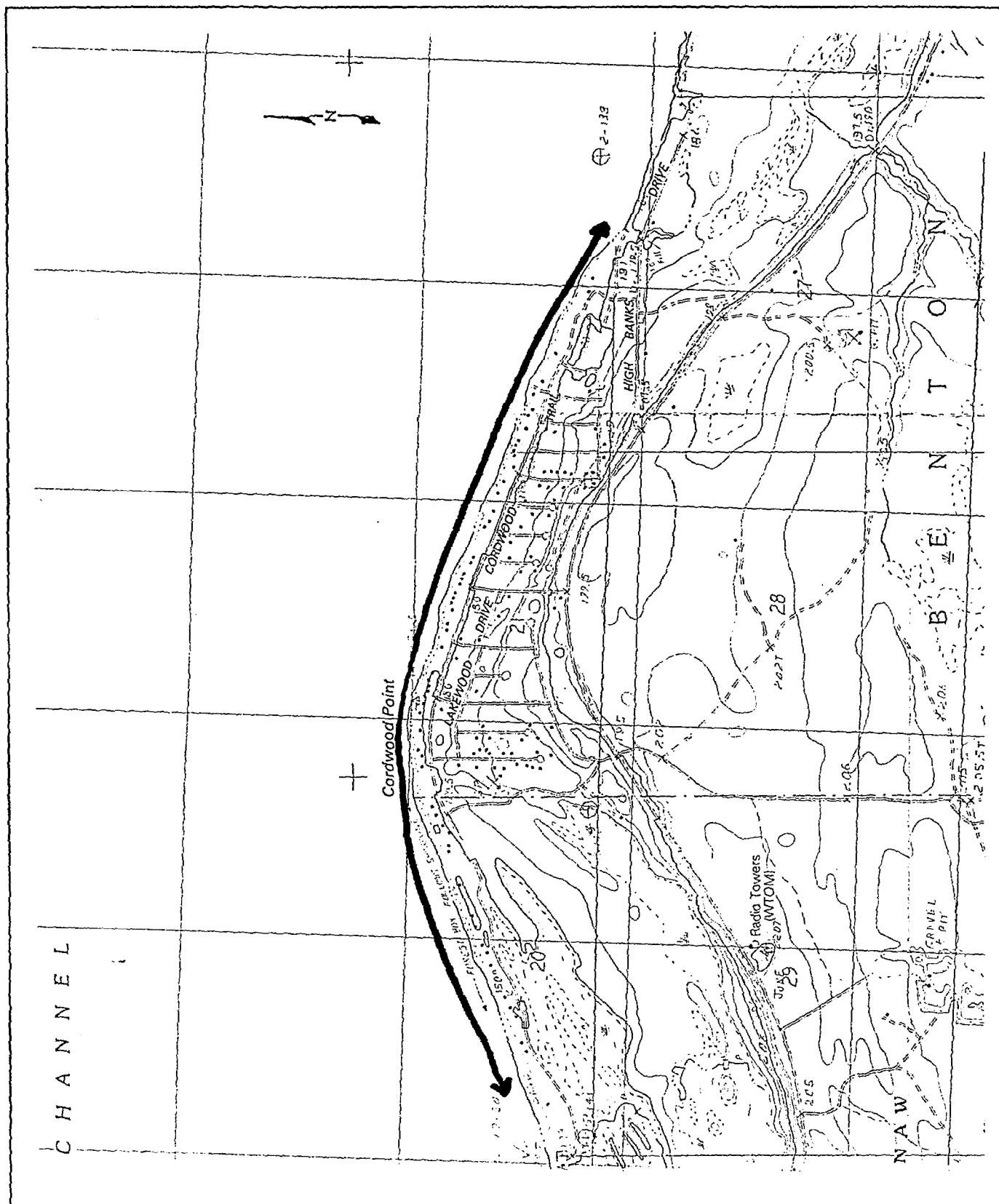
6. Cheboygan State Park East



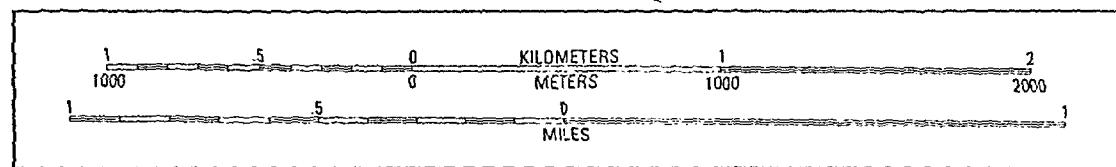
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Cheboygan Quad



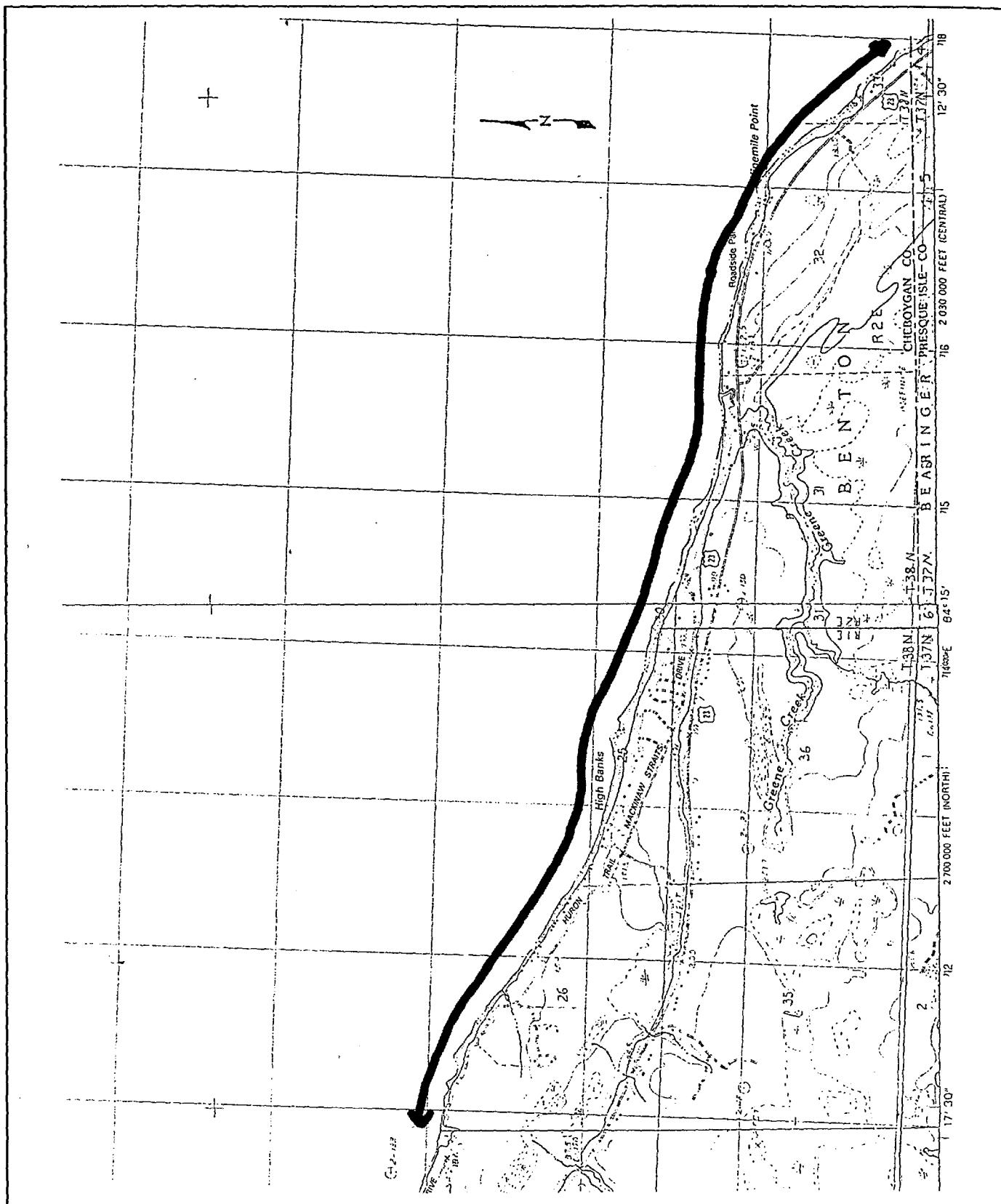
7. Cordwood Point



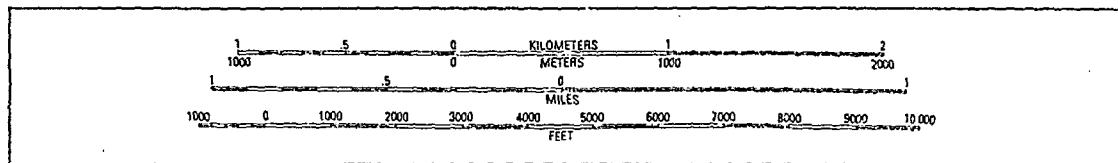
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Cordwood Point Quad



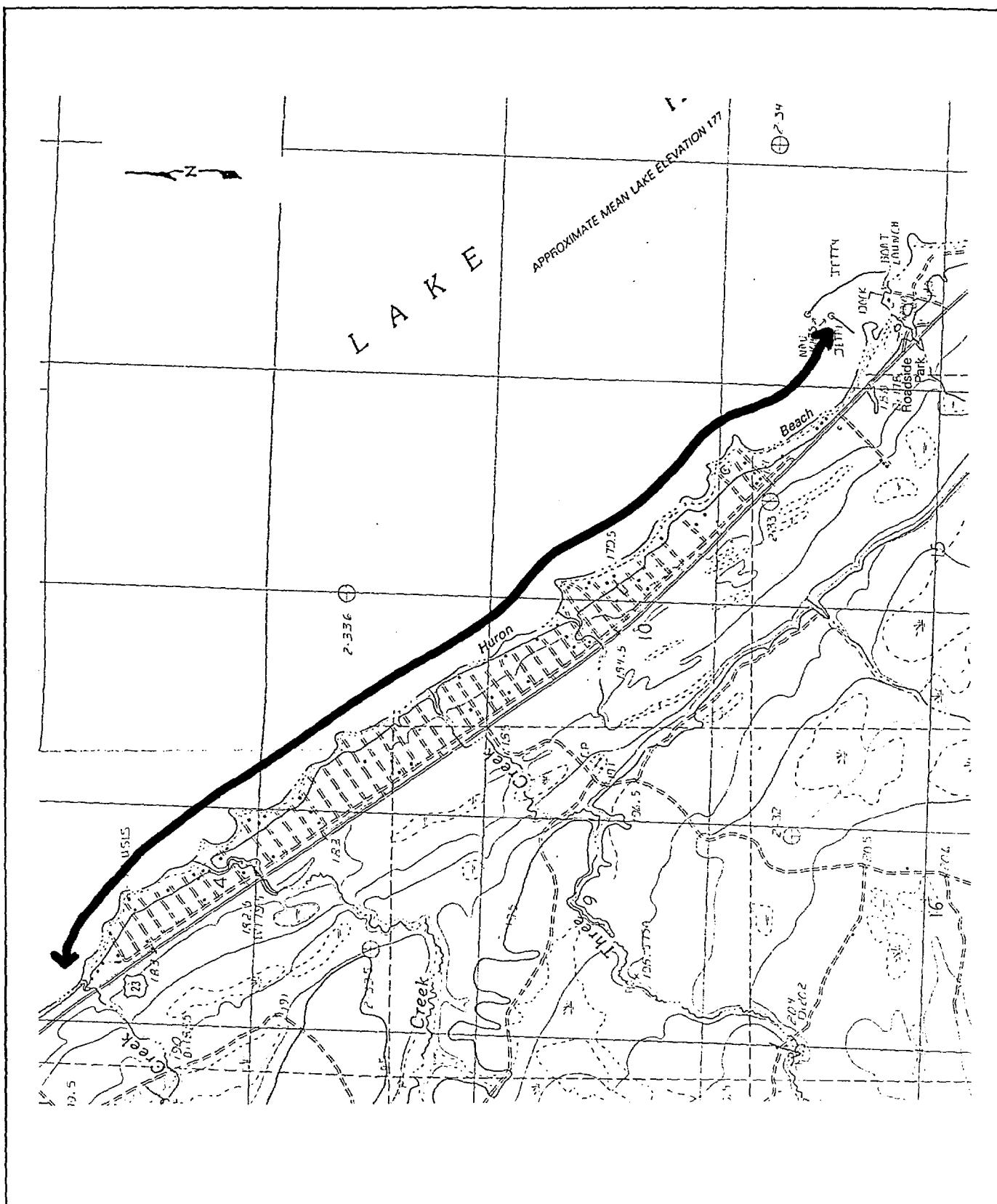
8. High Banks



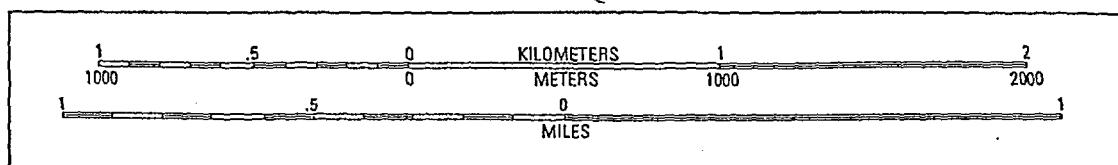
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Cordwood Point and Nine Mile Point Quads

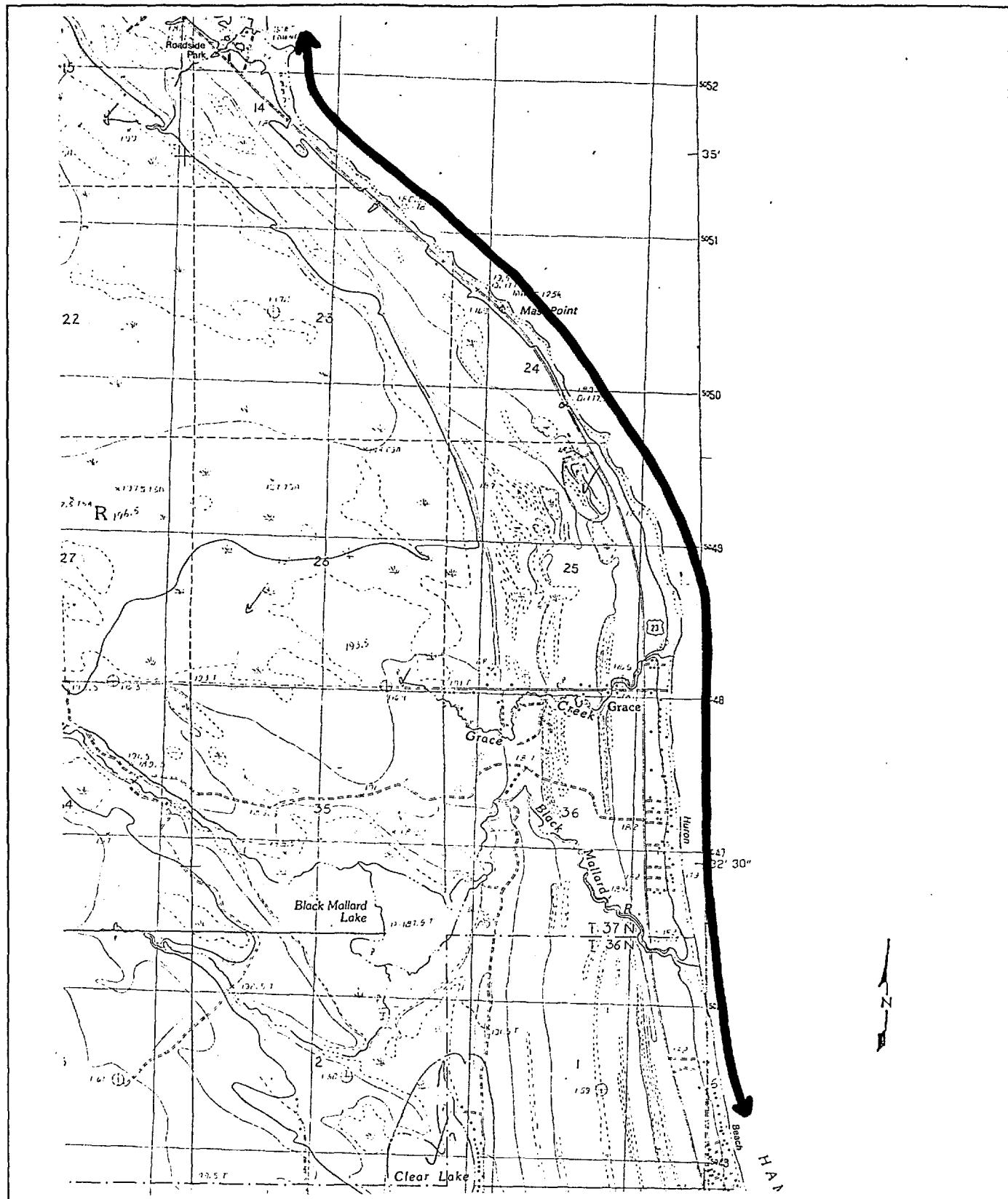


9. Huron Beach

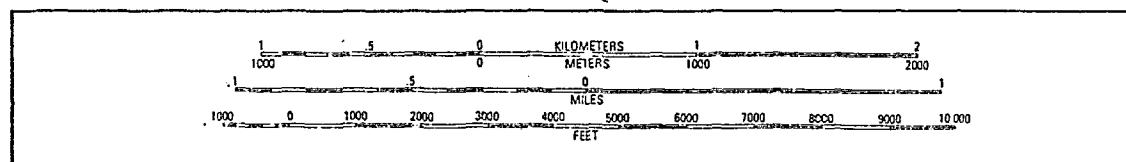


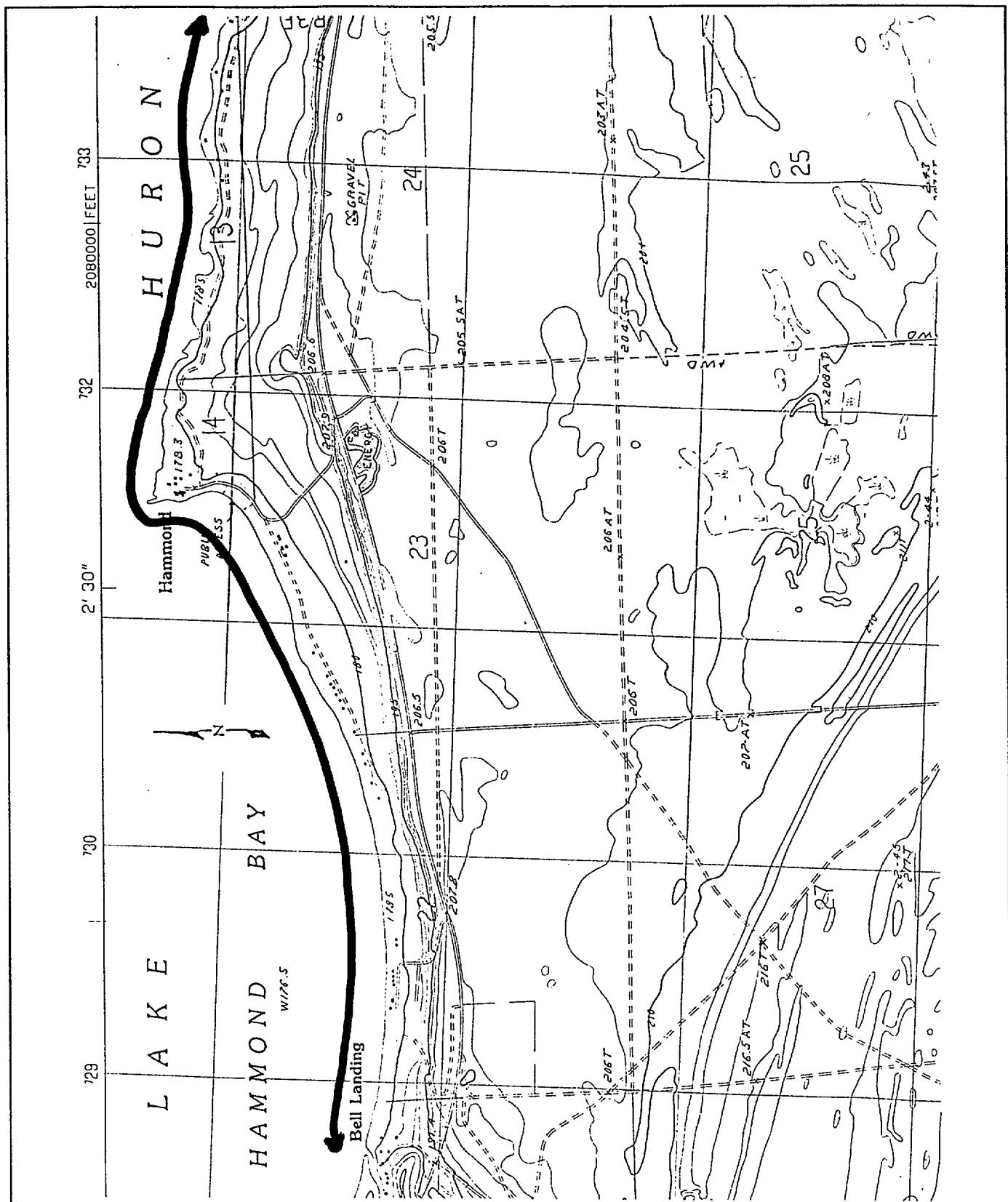
United States Geological Survey 7.5 minute topographic map
Grace Quad



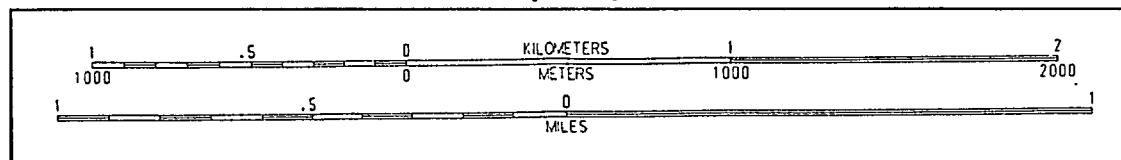


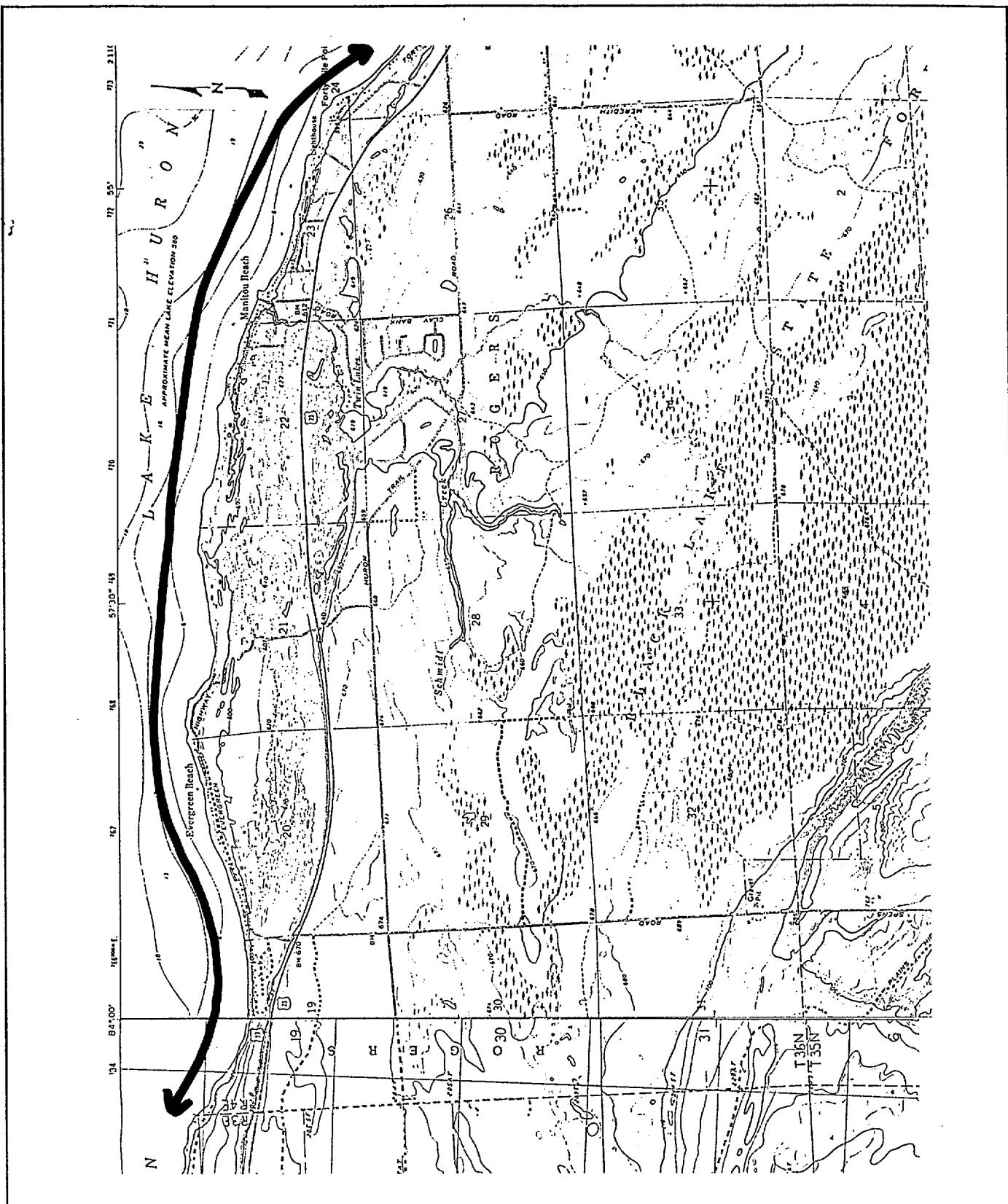
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Grace Quad



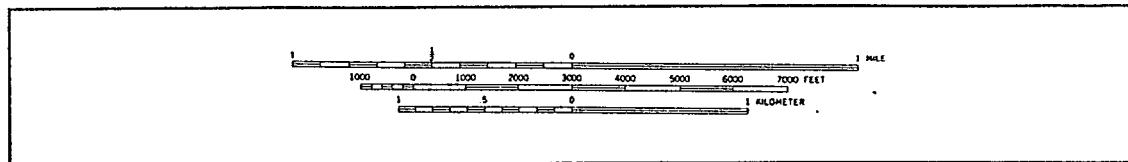


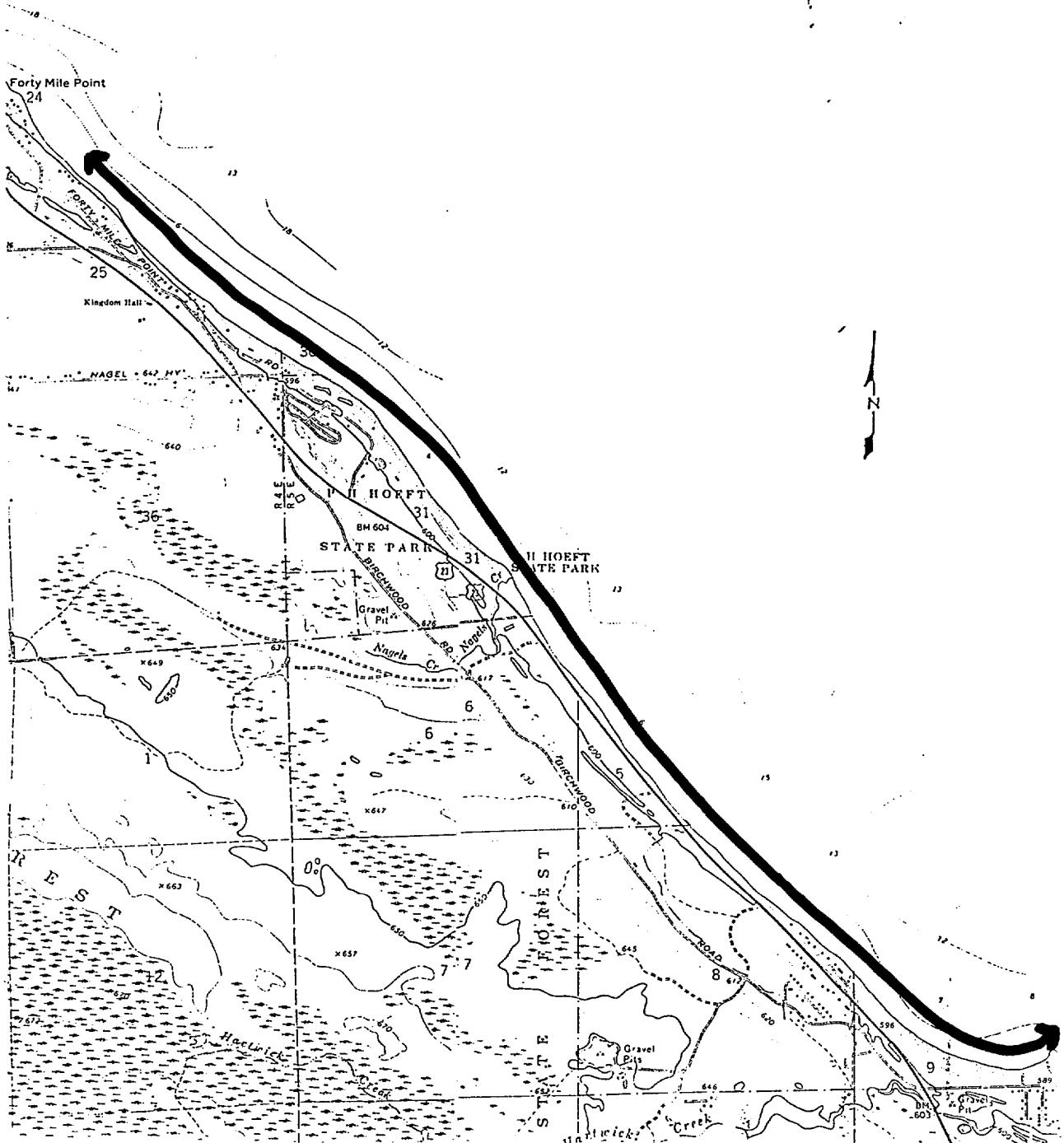
United States Geological Survey 7.5 minute topographic map
Ocqueoc Quad



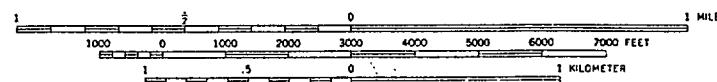


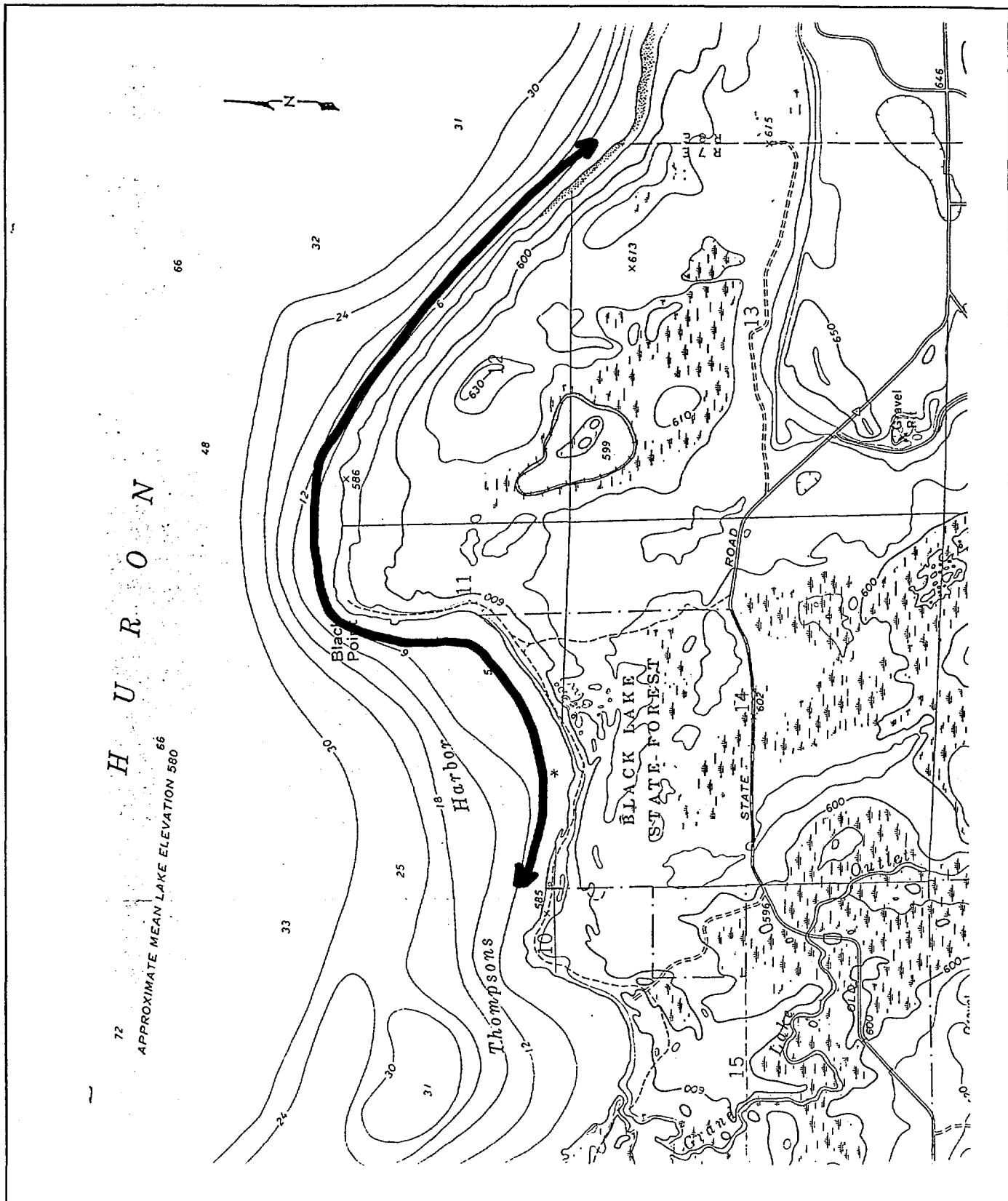
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Ocqueoc and Moltke Quad



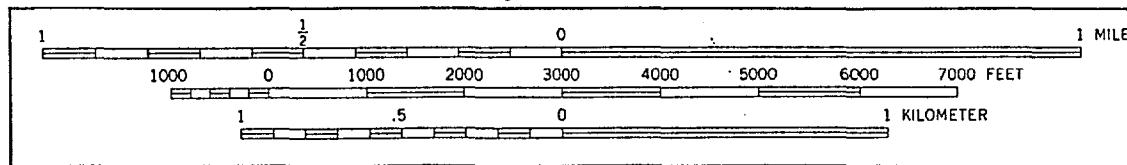


United States Geological Survey 7.5 minute topographic map
Moltke and Rogers City Quads

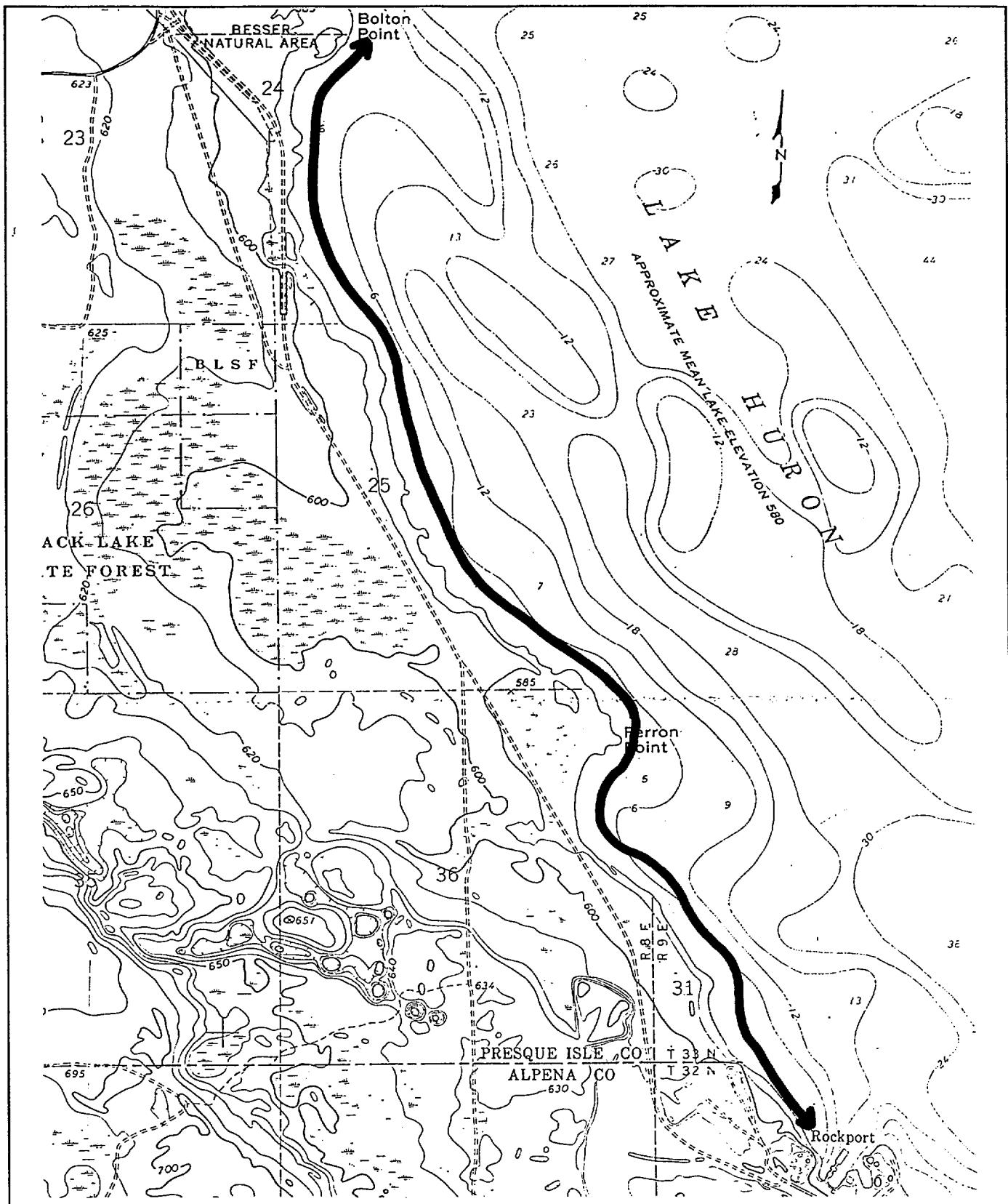




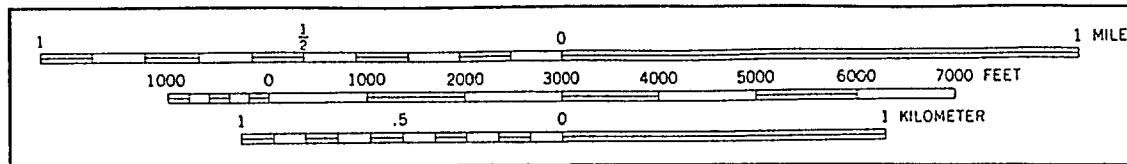
United States Geological Survey 7.5 minute topographic map
Thompson's Harbor Quad

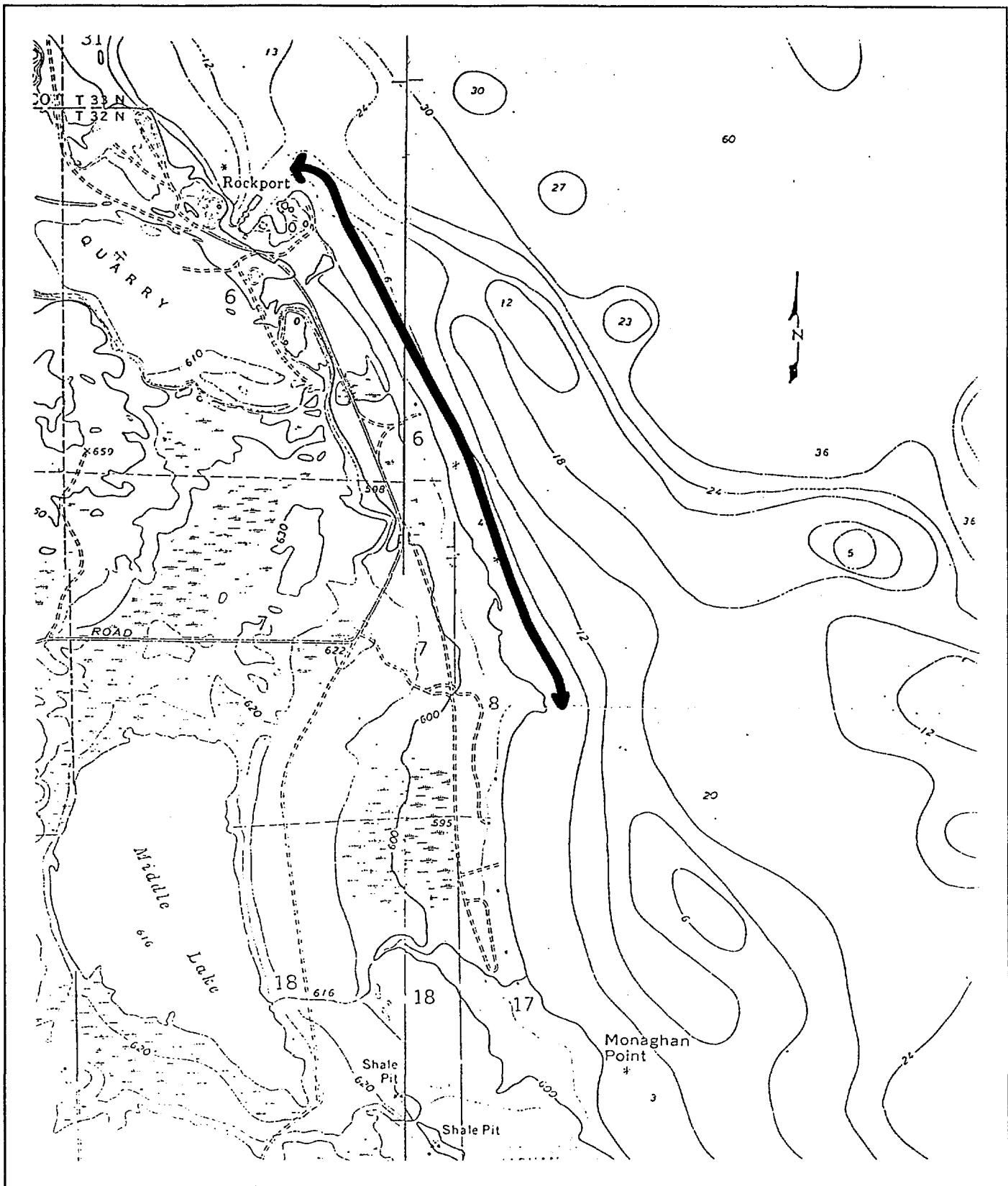


15. Bolton Point to Rockport

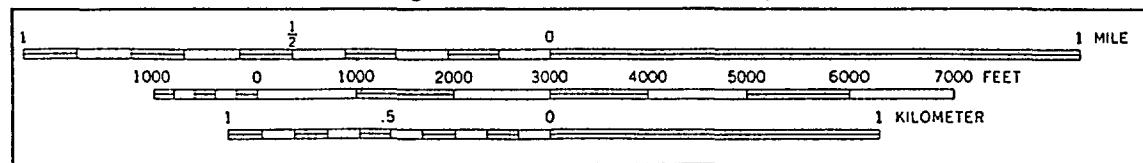


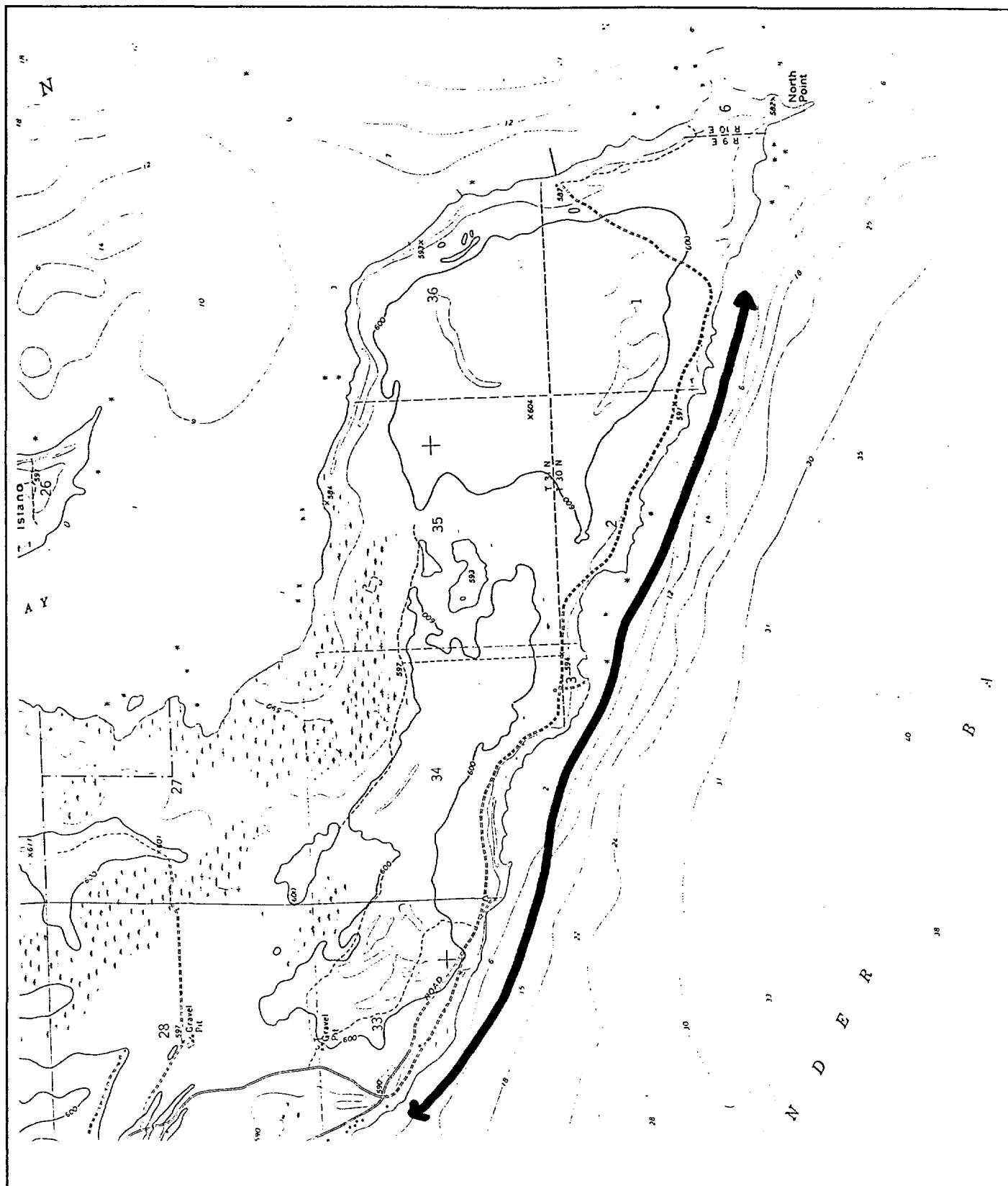
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Long Lake East Quad



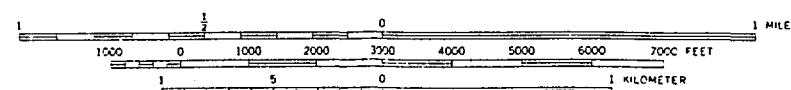


United States Geological Survey 7.5 minute topographic map
Long Lake East and Middle Island Quads

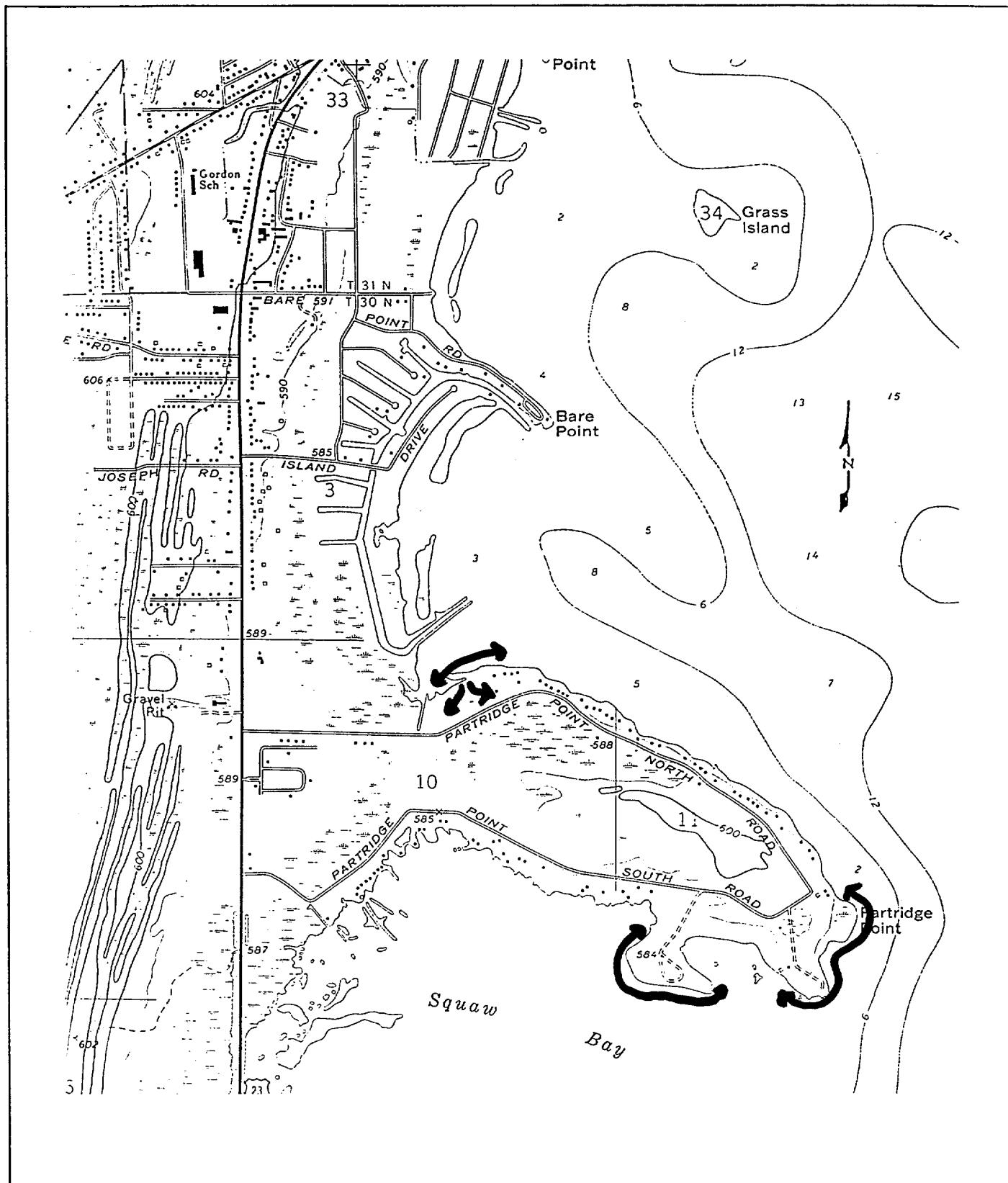




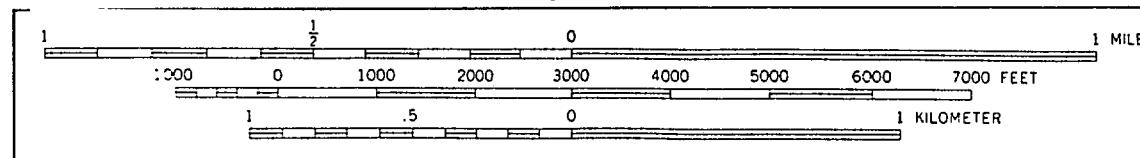
United States Geological Survey 7.5 minute topographic map
North Point Quad



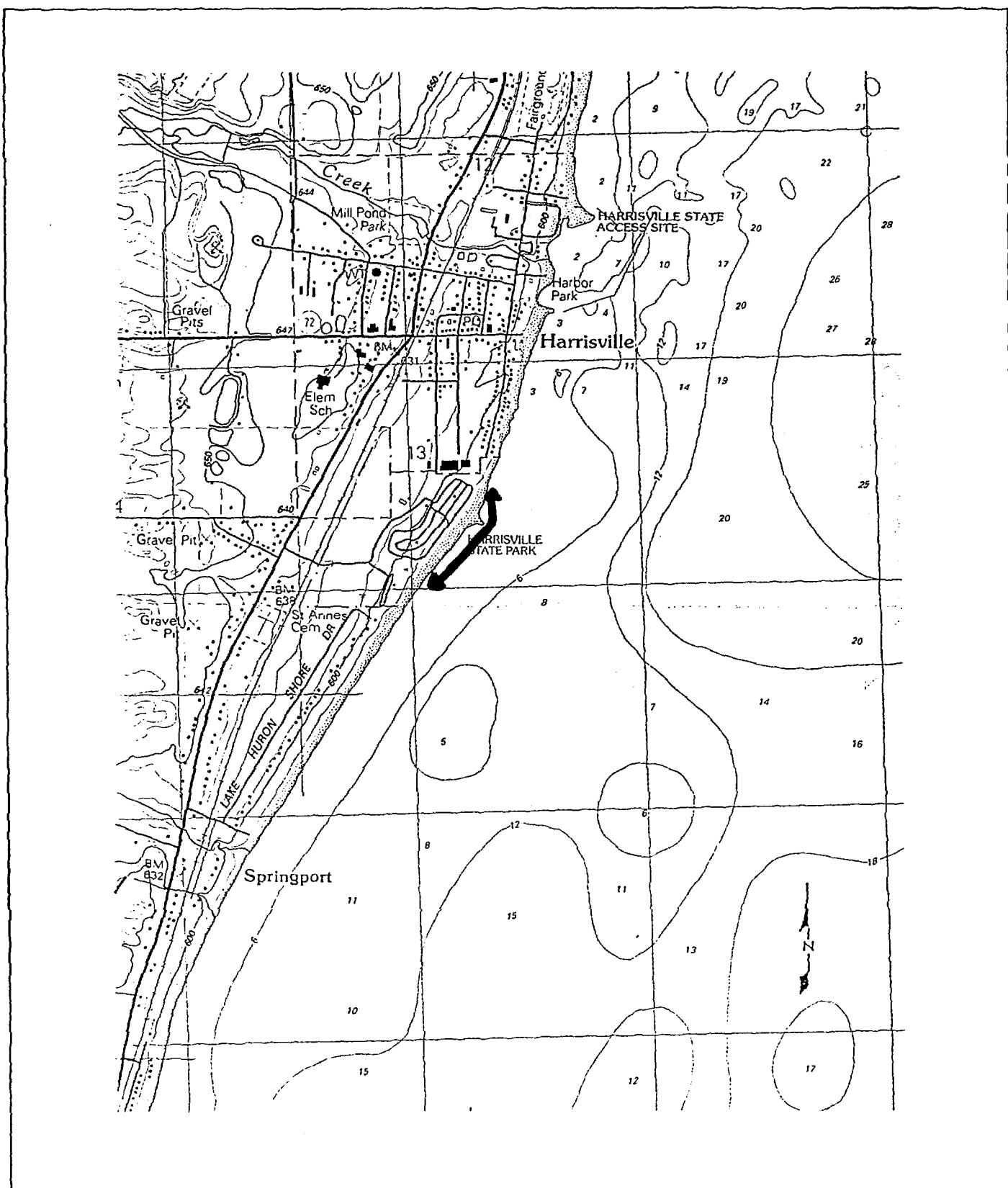
18. Partridge Point



United States Geological Survey 7.5 minute topographic map
Alpena Quad



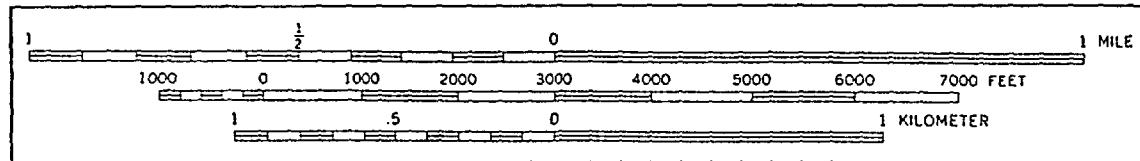
19. Harrisville State Park

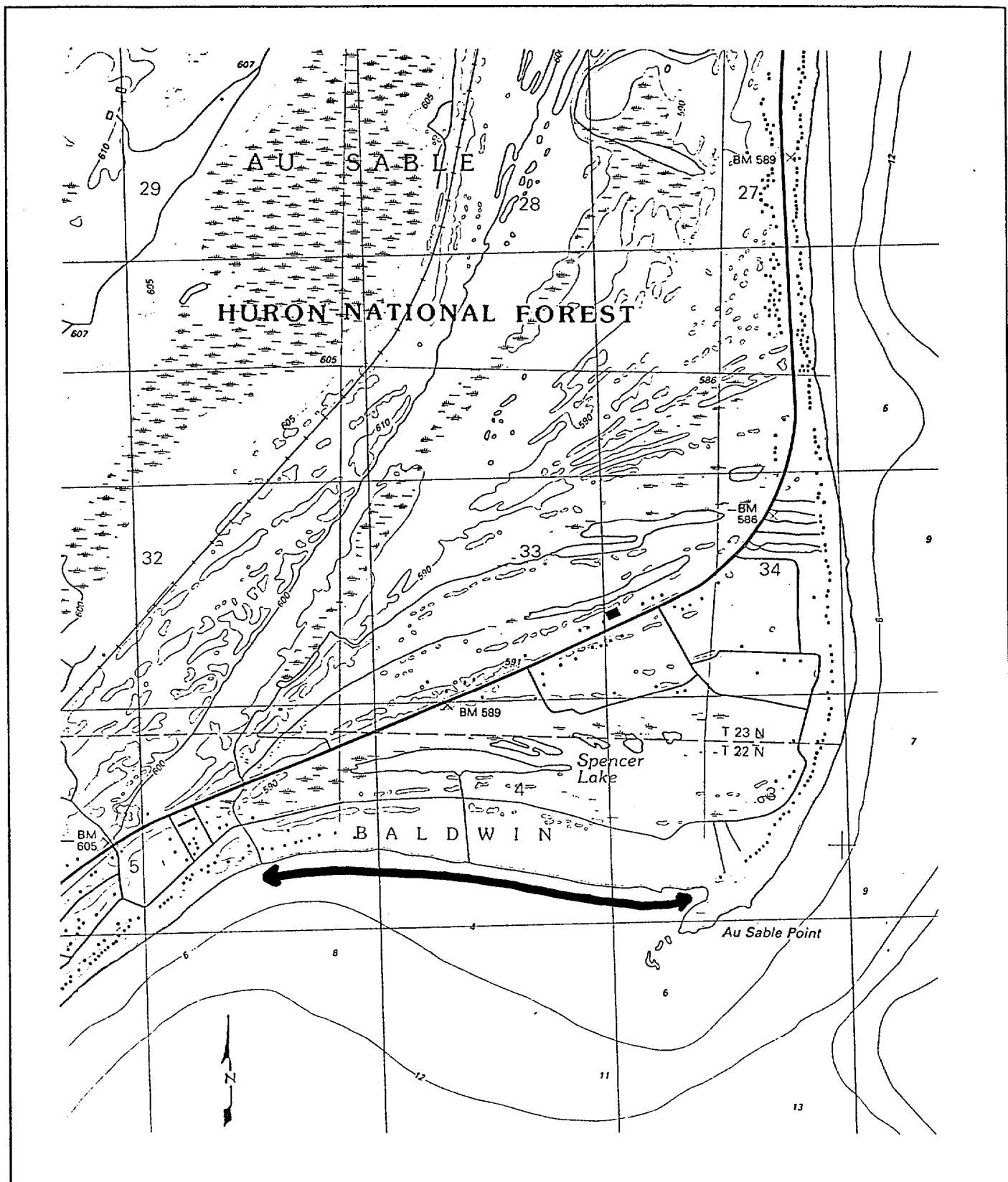


20. Oscoda North

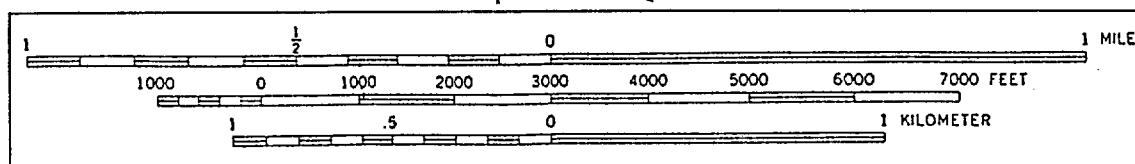


United States Geological Survey 7.5 minute topographic map
Oscoda Quad

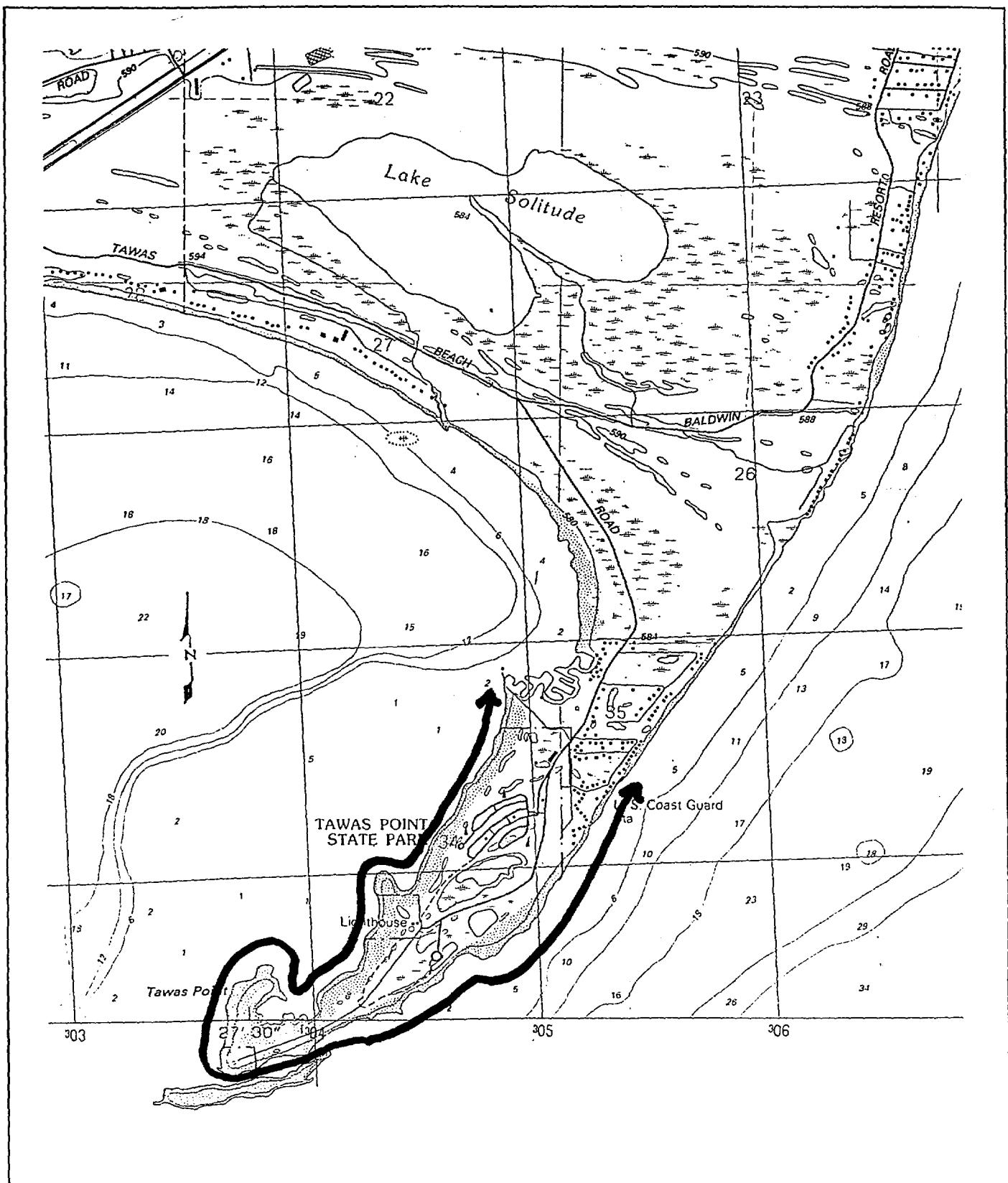




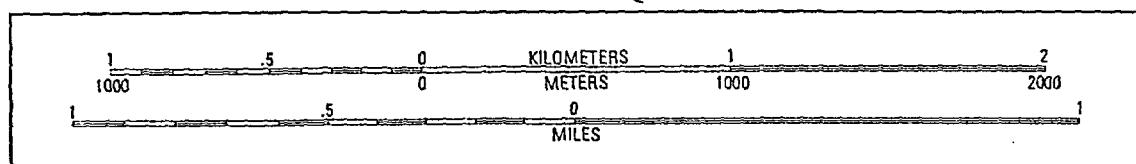
United States Geological Survey 7.5 minute topographic map
Spencer Lake Quad

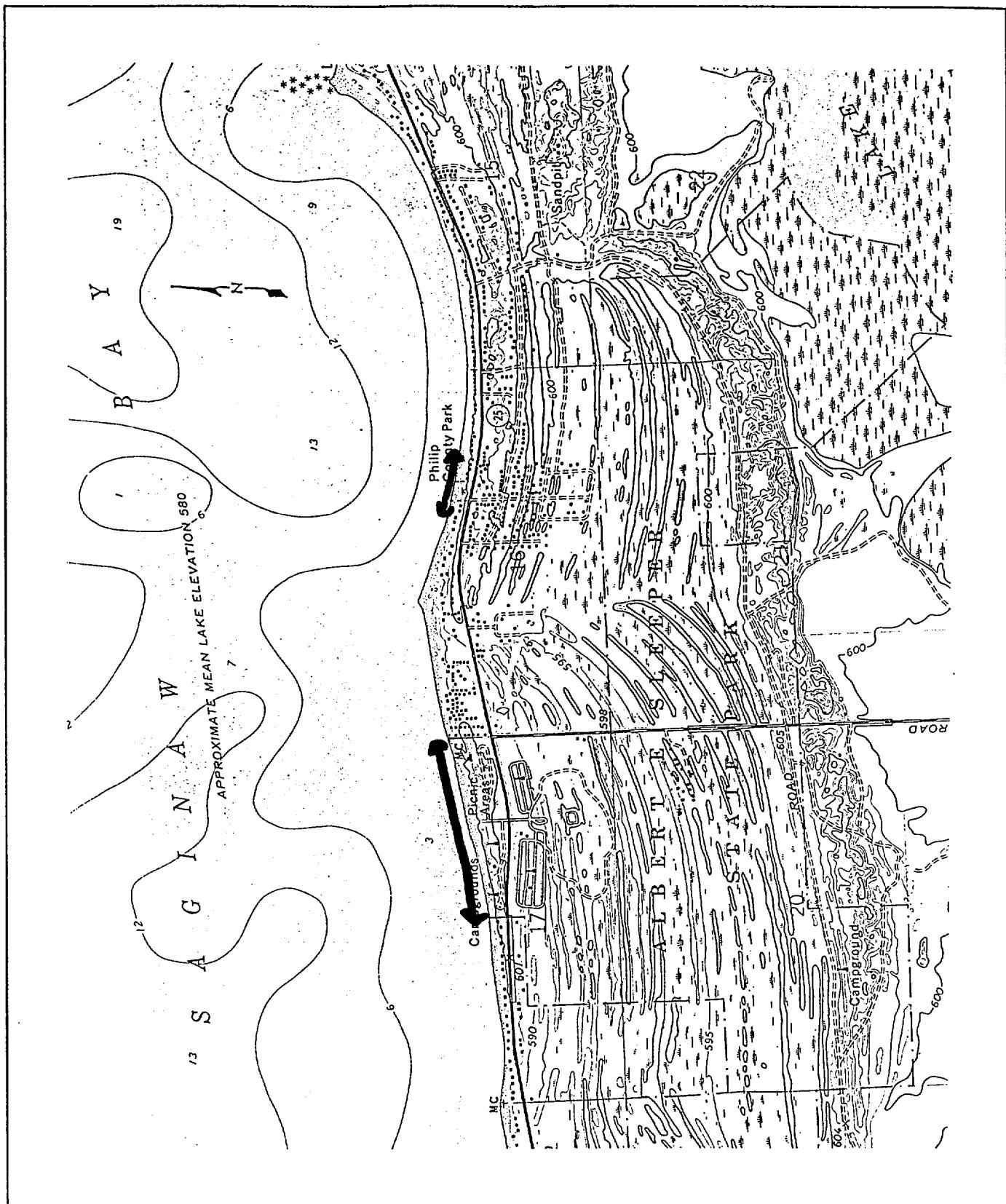


22. Tawas Point

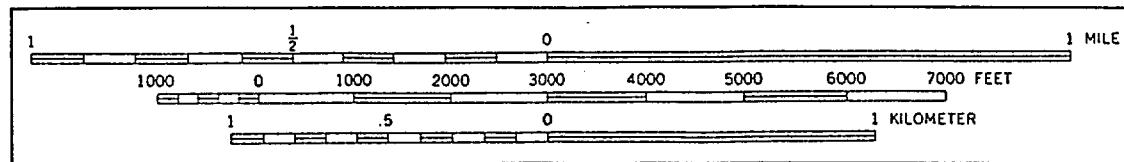


United States Geological Survey 7.5 minute topographic map
East Tawas Quad

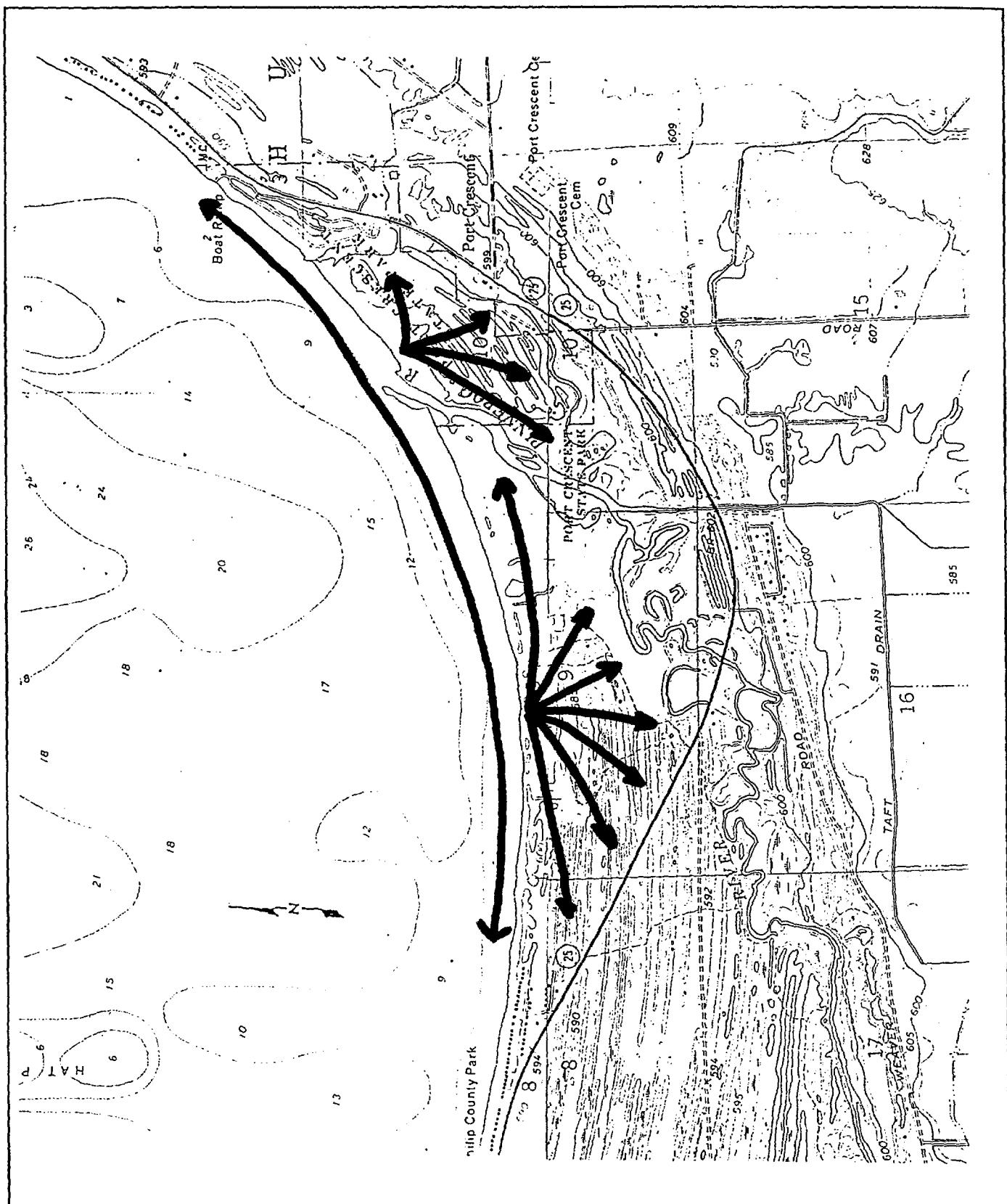




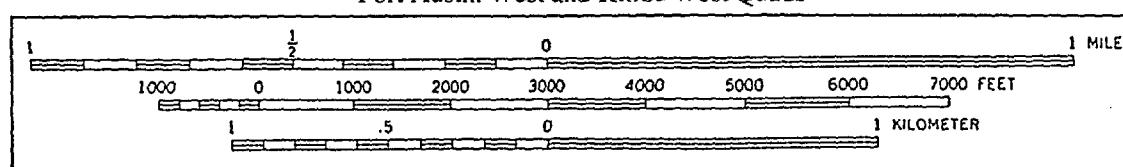
United States Geological Survey 7.5 minute topographic map
Rush Lake Quad



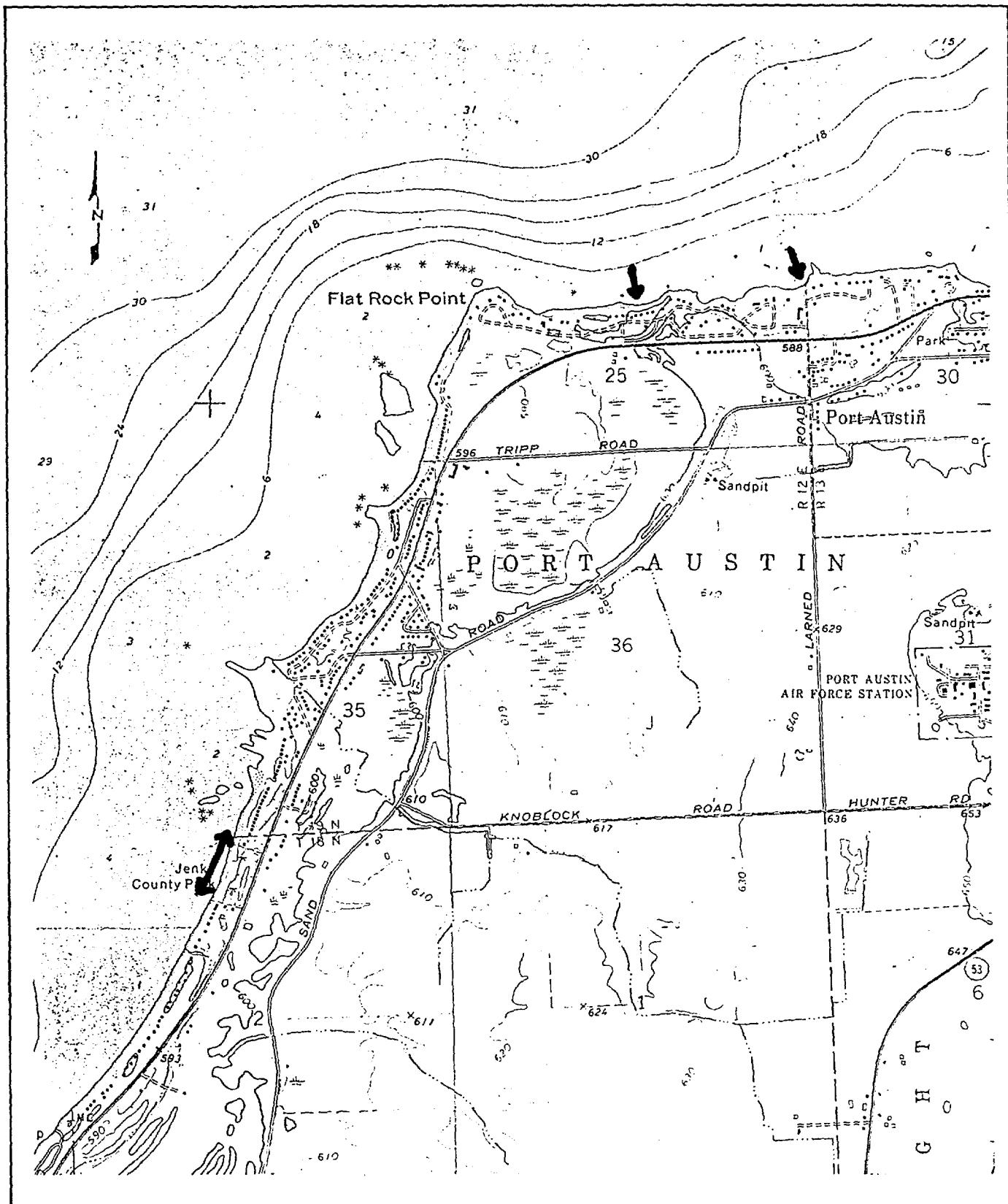
24. Port Crescent State Park



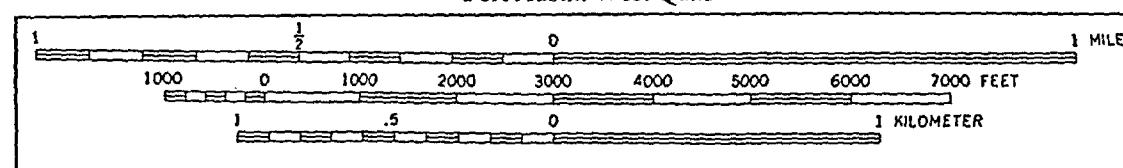
United States Geological Survey 7.5 minute topographic map
Port Austin West and Kinde West Quads



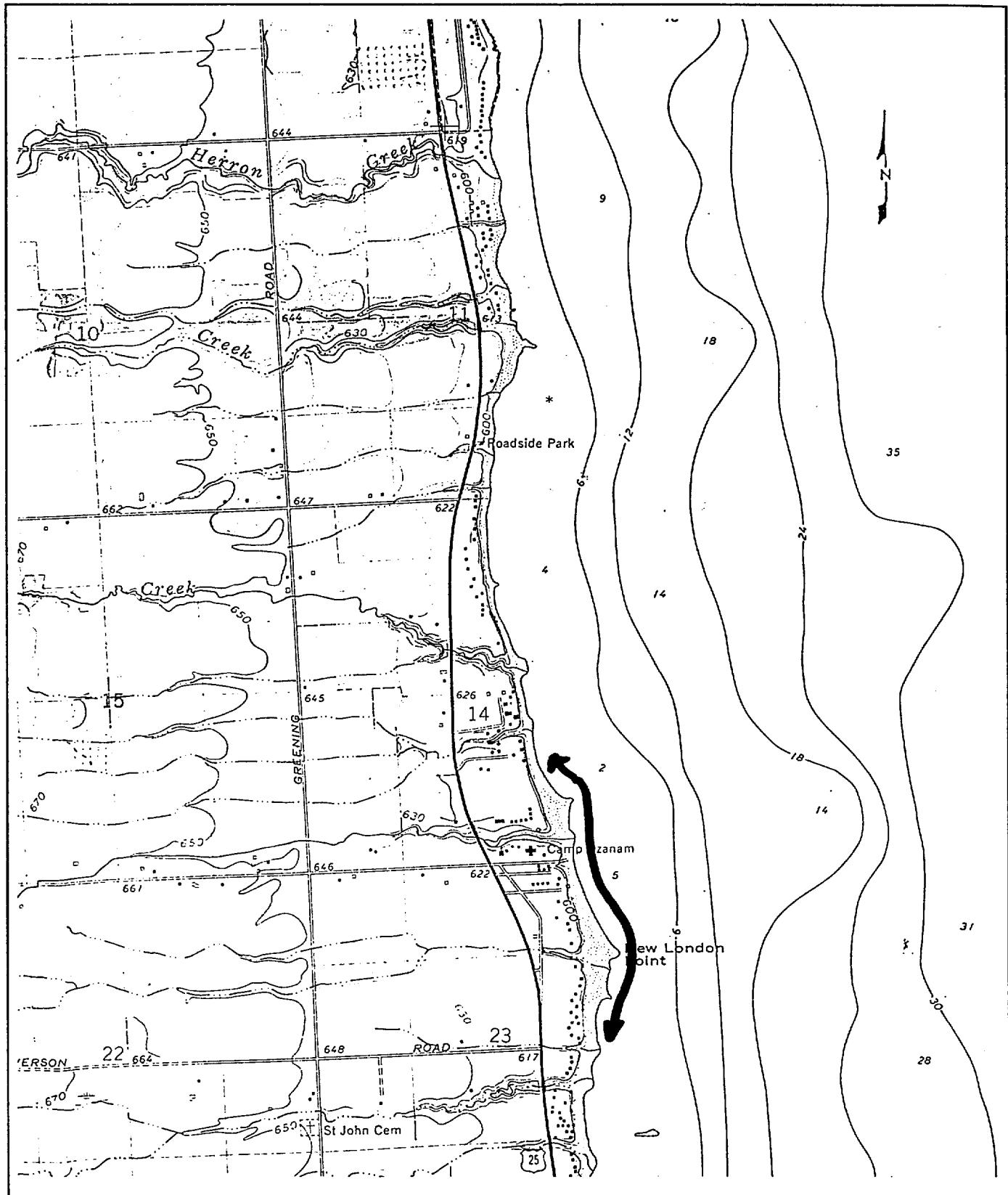
25. Port Austin



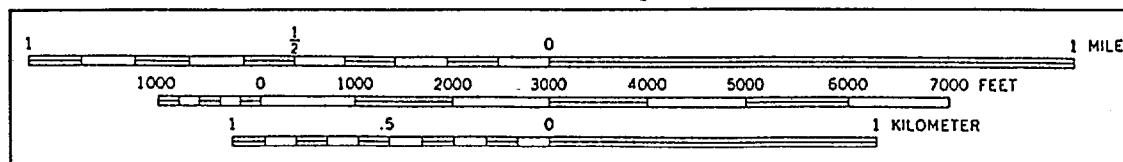
United States Geological Survey 7.5 minute topographic map
Port Austin West Quad

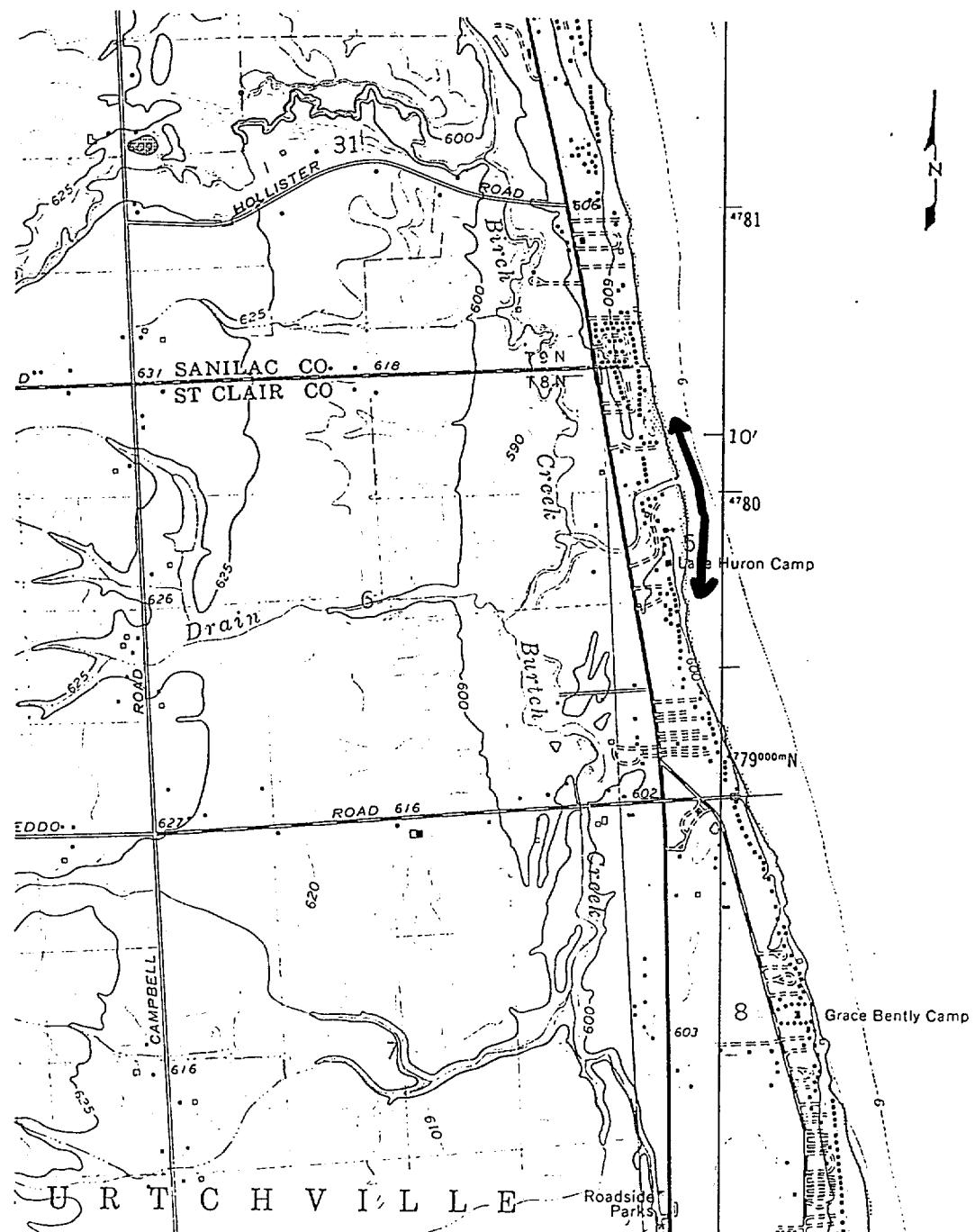


26. New London Point

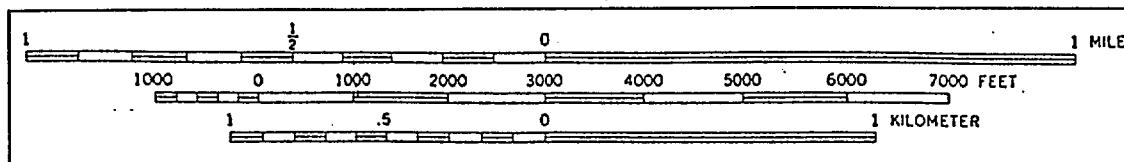


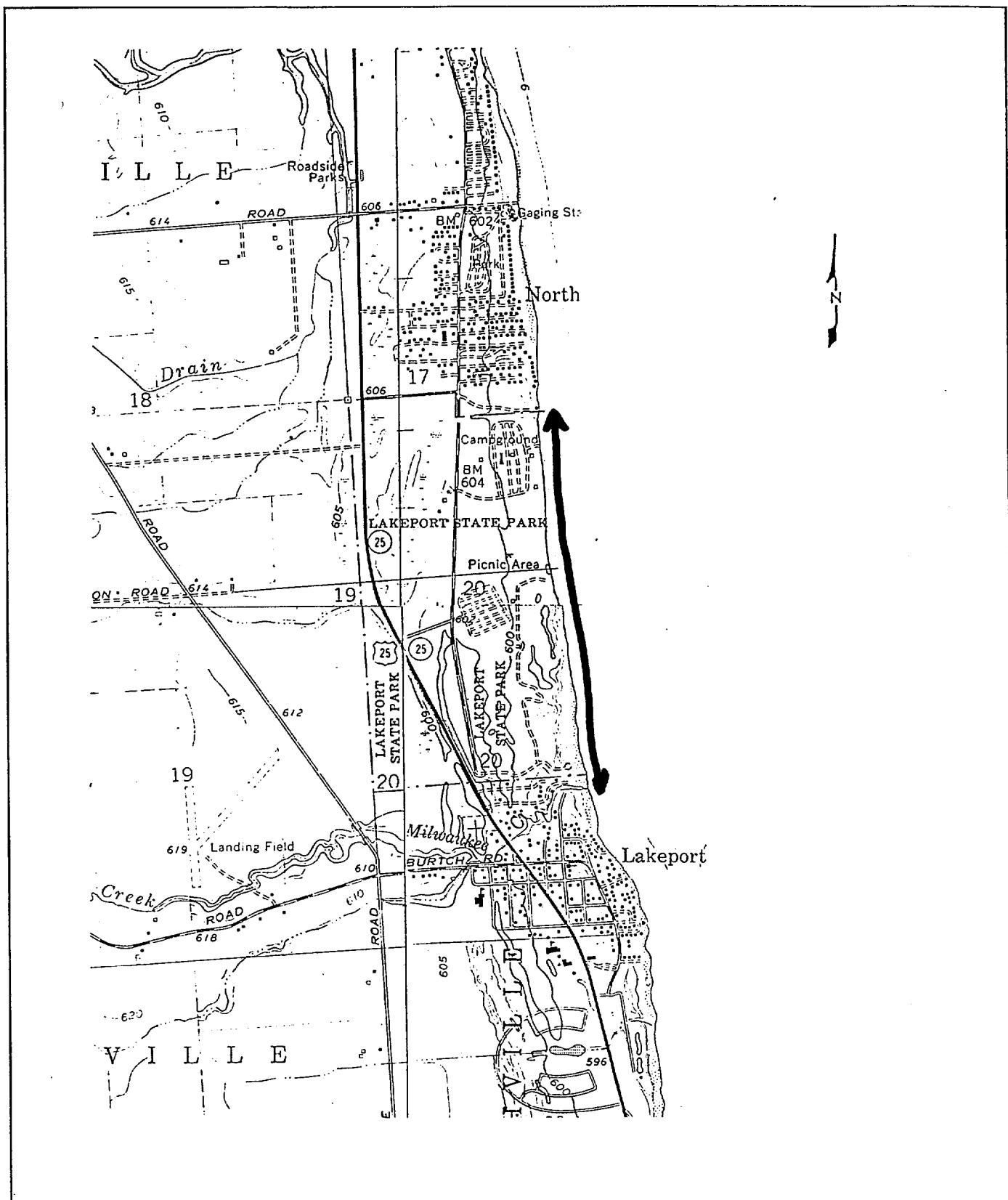
United States Geological Survey 7.5 minute topographic map
Port Sanilac Quad



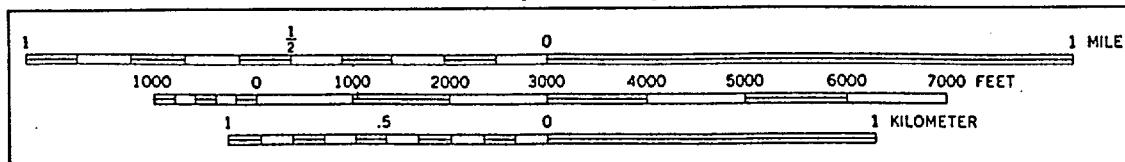


United States Geological Survey 7.5 minute topographic map
Jeddo Quad



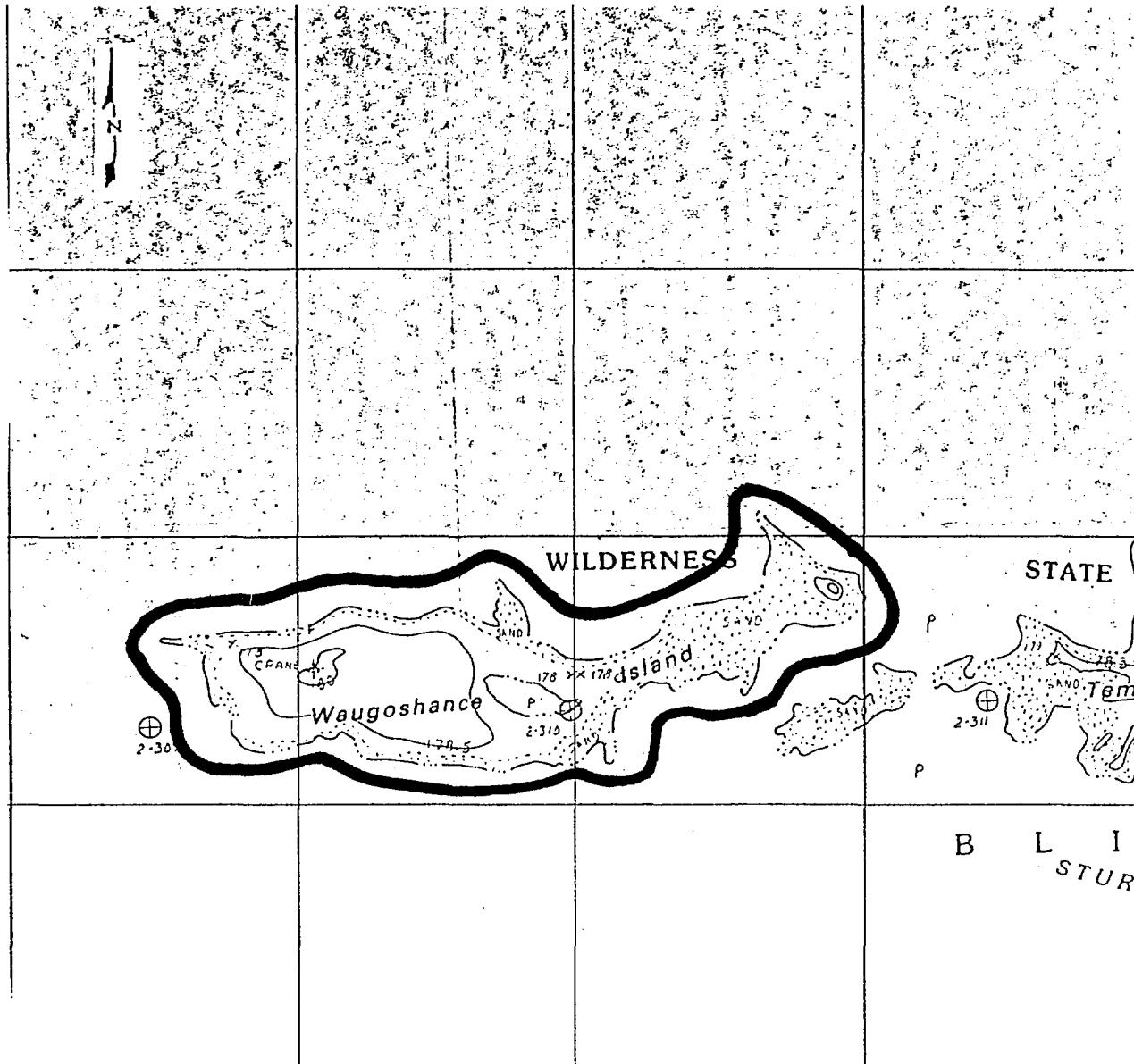


United States Geological Survey 7.5 minute topographic map
Jeddo, Ruby, and Lakeport Quads

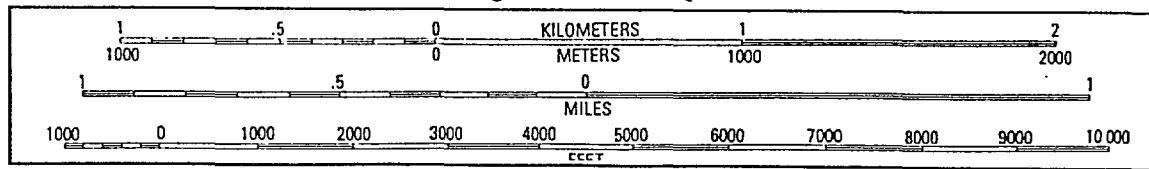


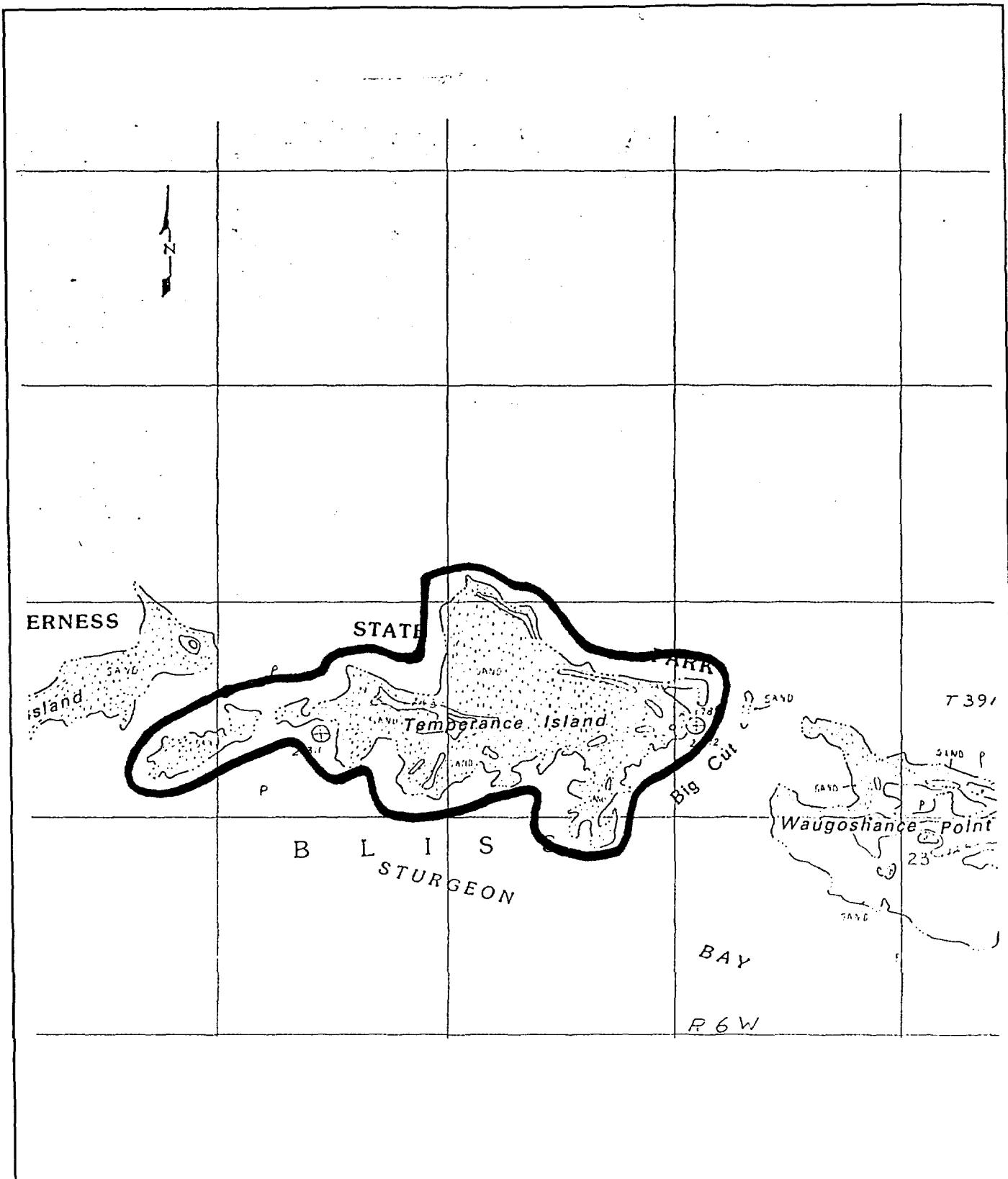
APPENDIX B

Maps of survey sites for Lake Michigan and specific shoreline areas inventoried

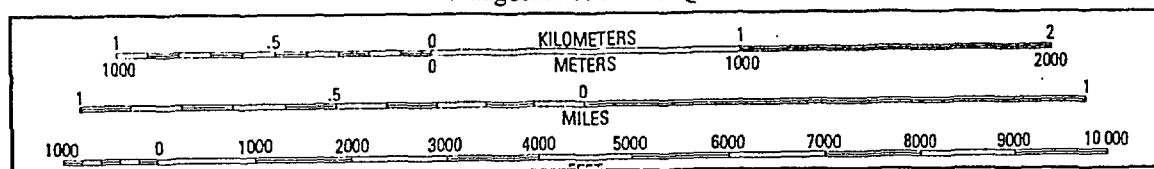


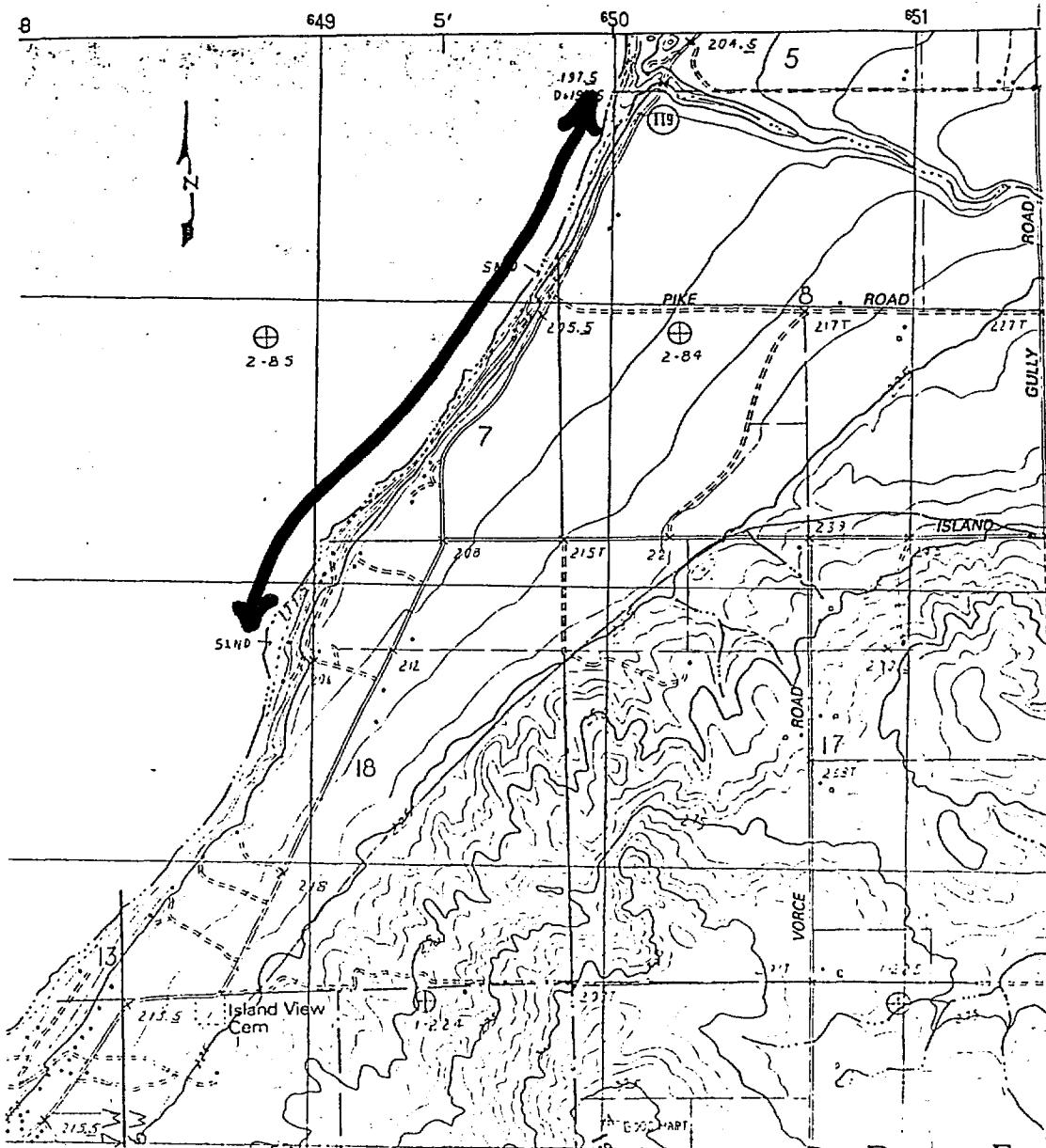
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Waugoshance Island Quad

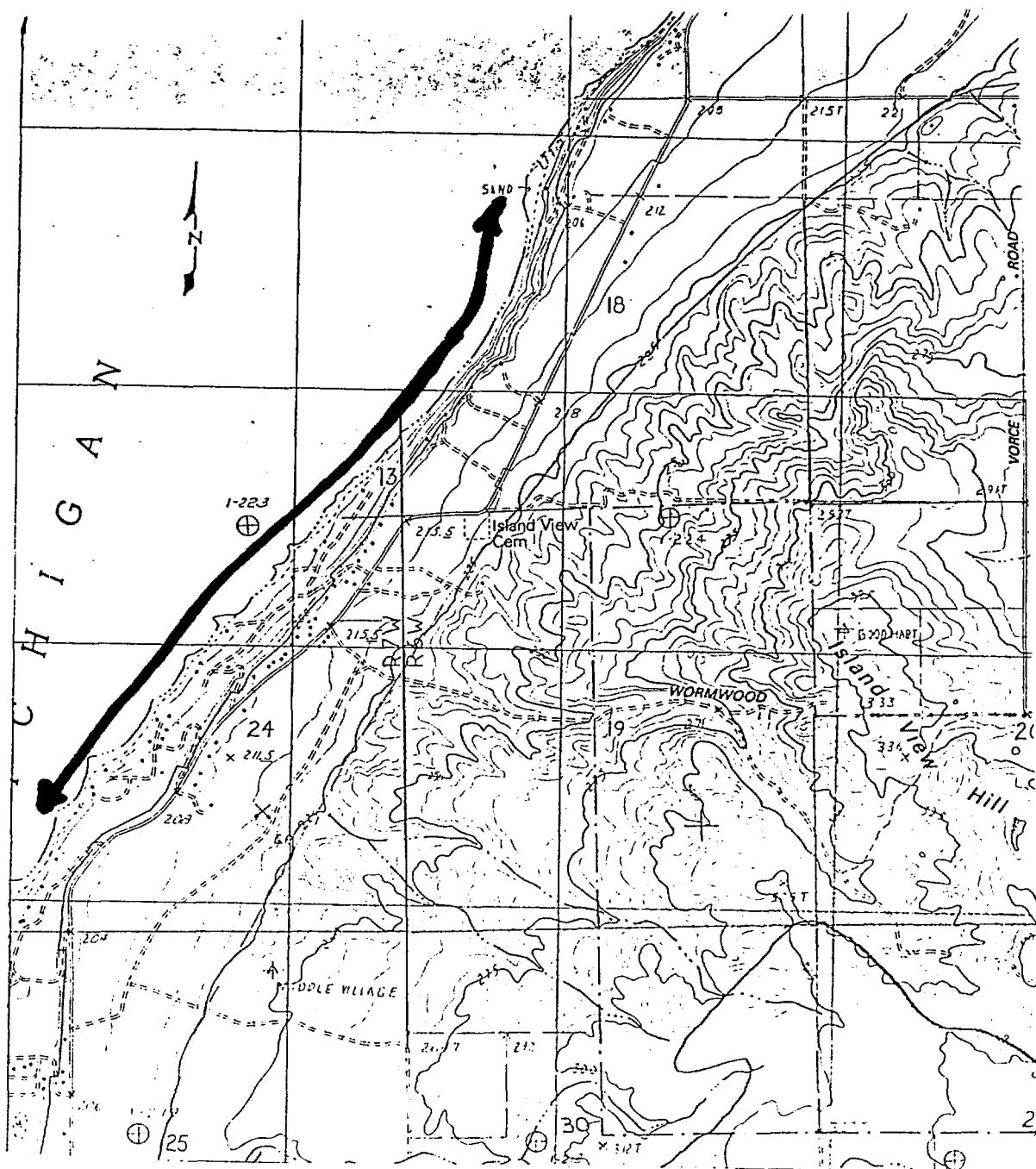




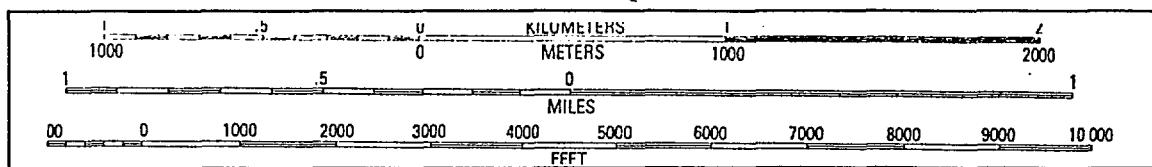
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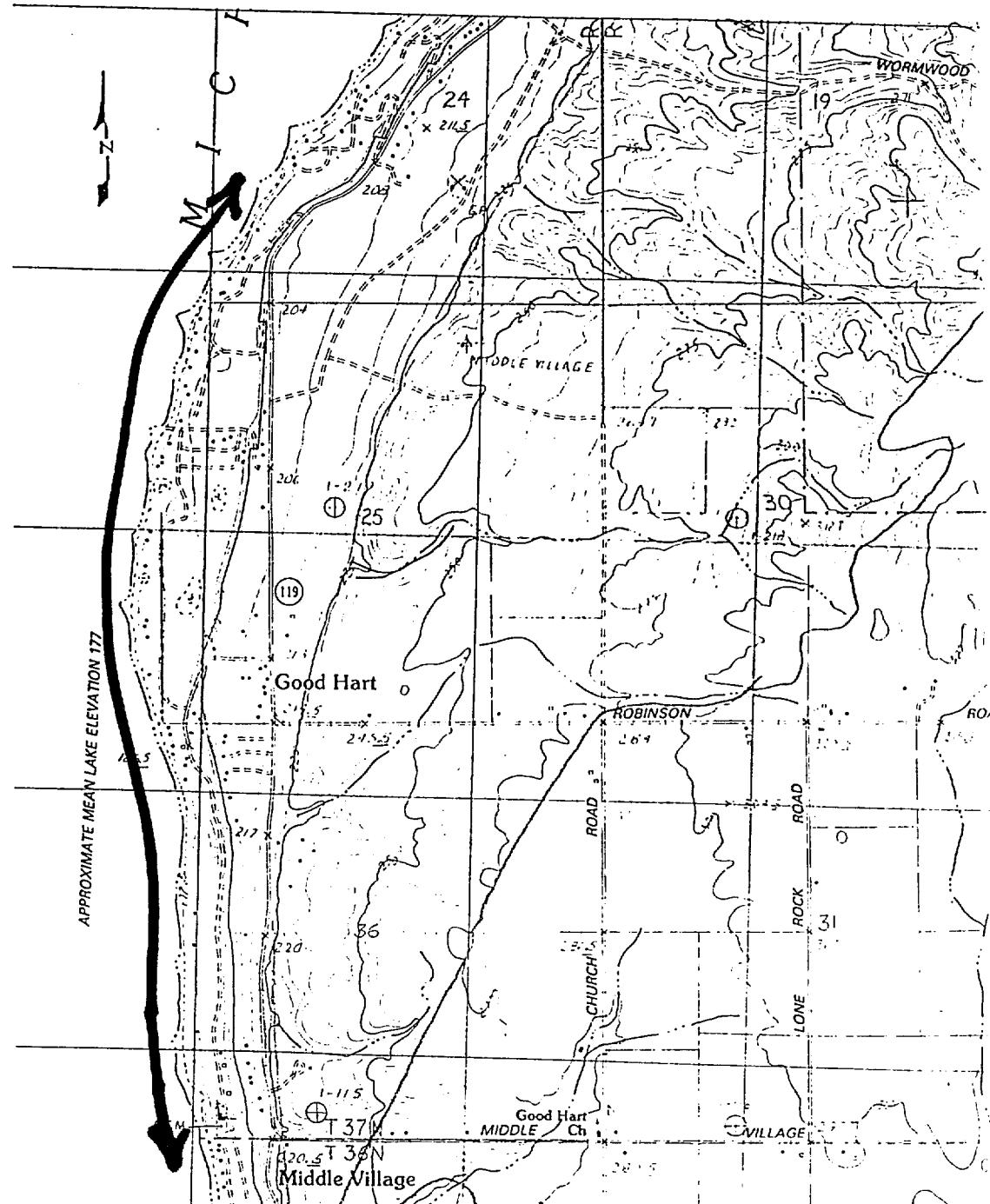


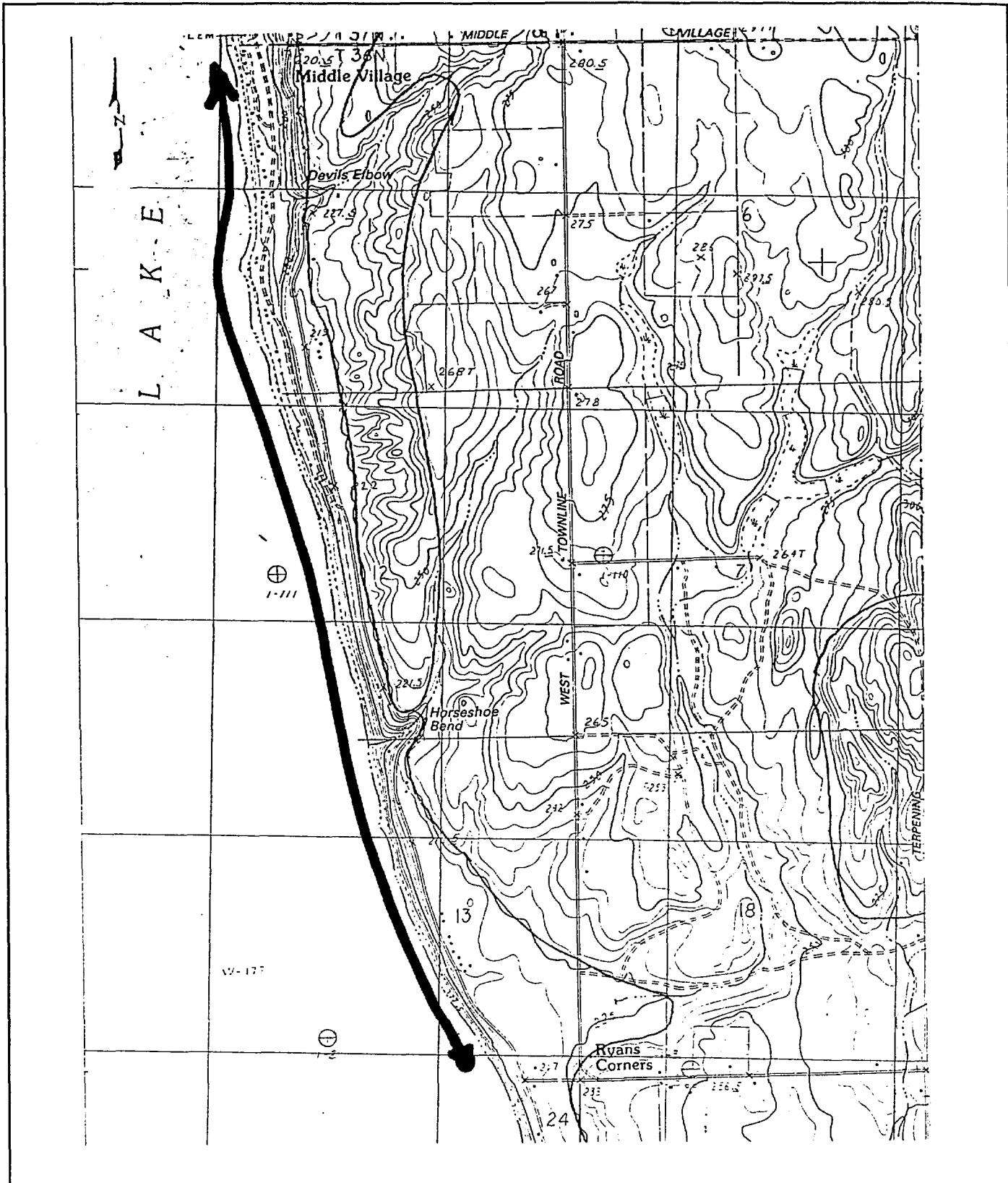




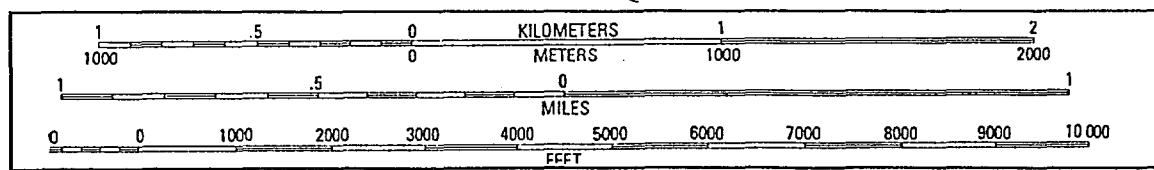
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Good Hart Quad

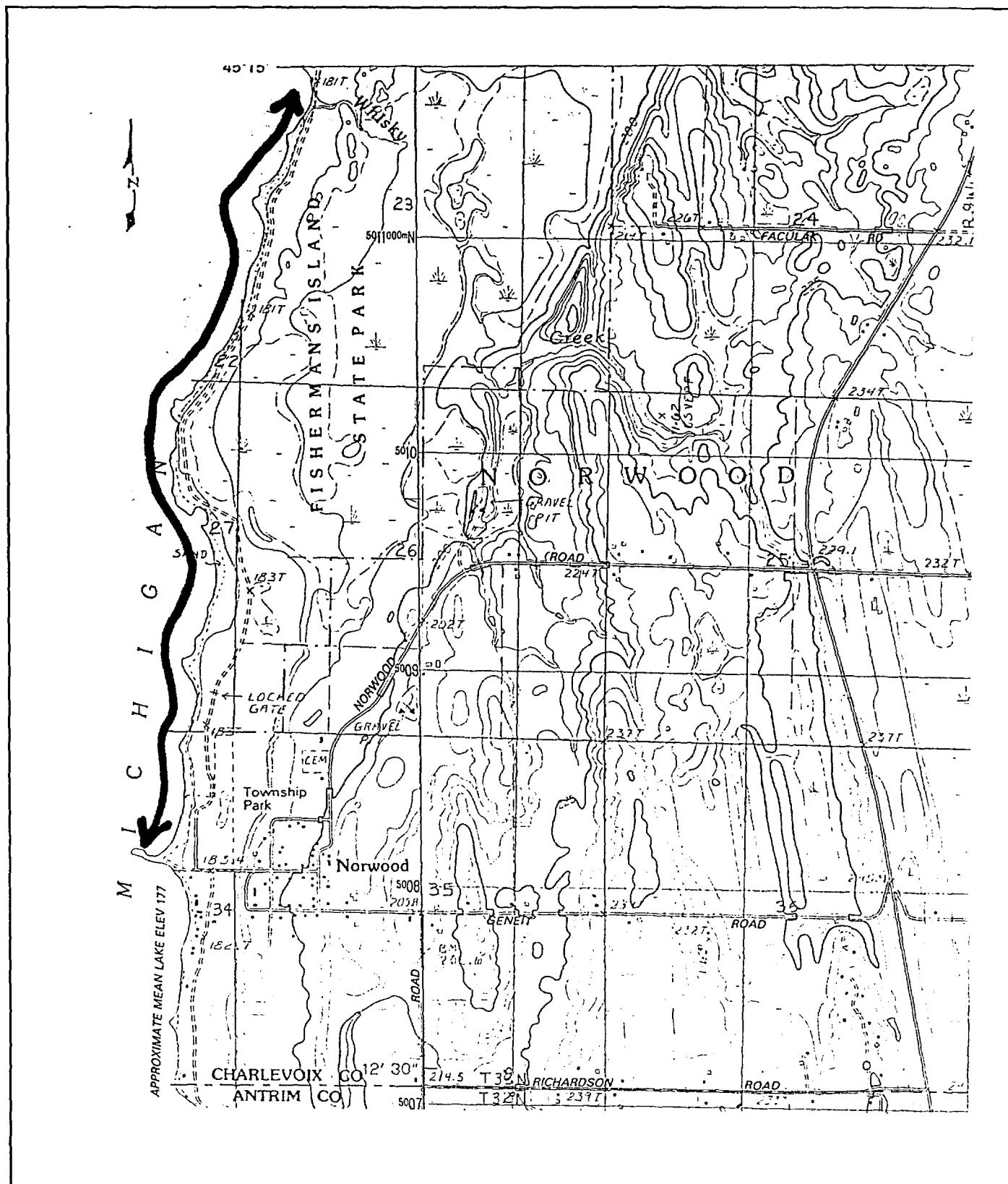




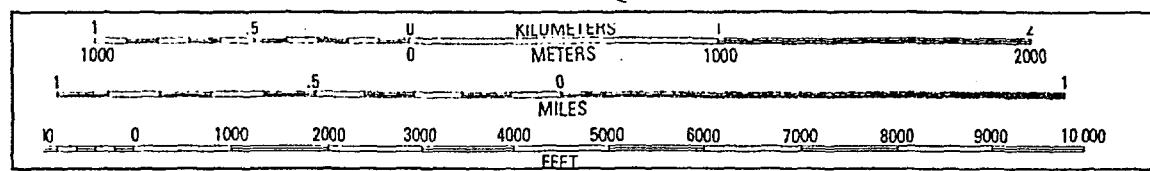


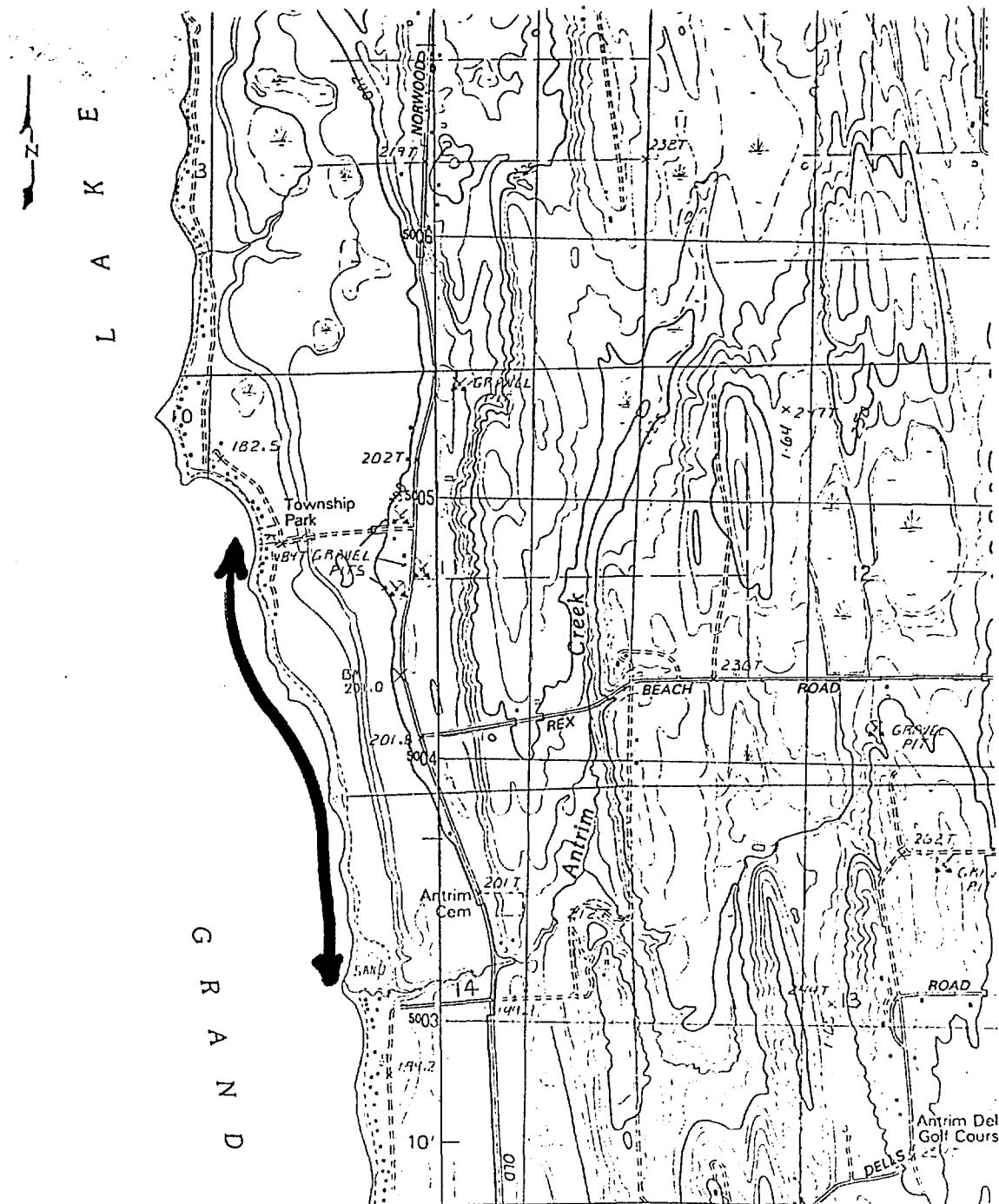
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Good Hart Quad



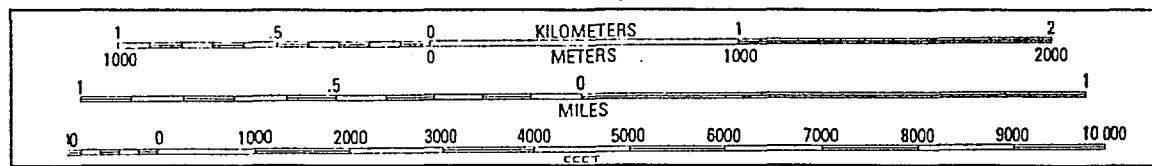


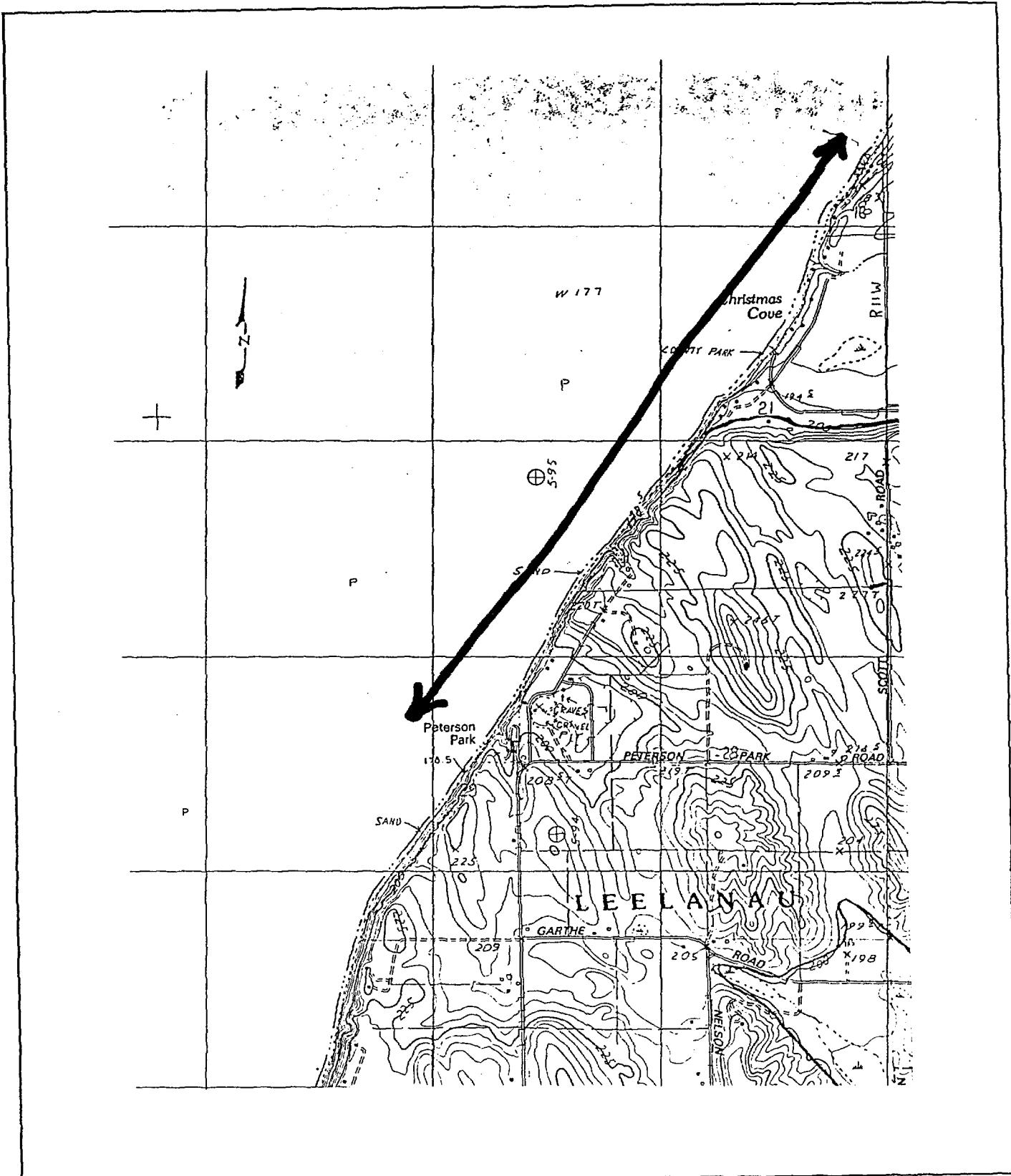
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Atwood Quad



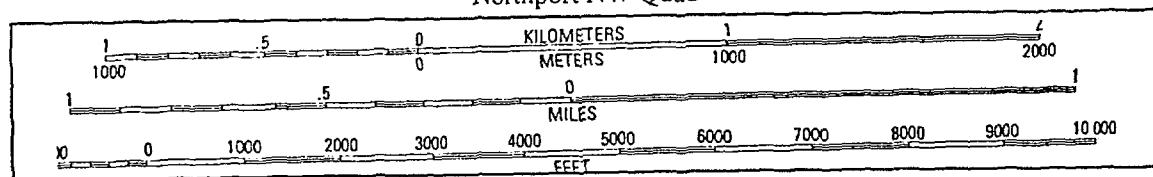


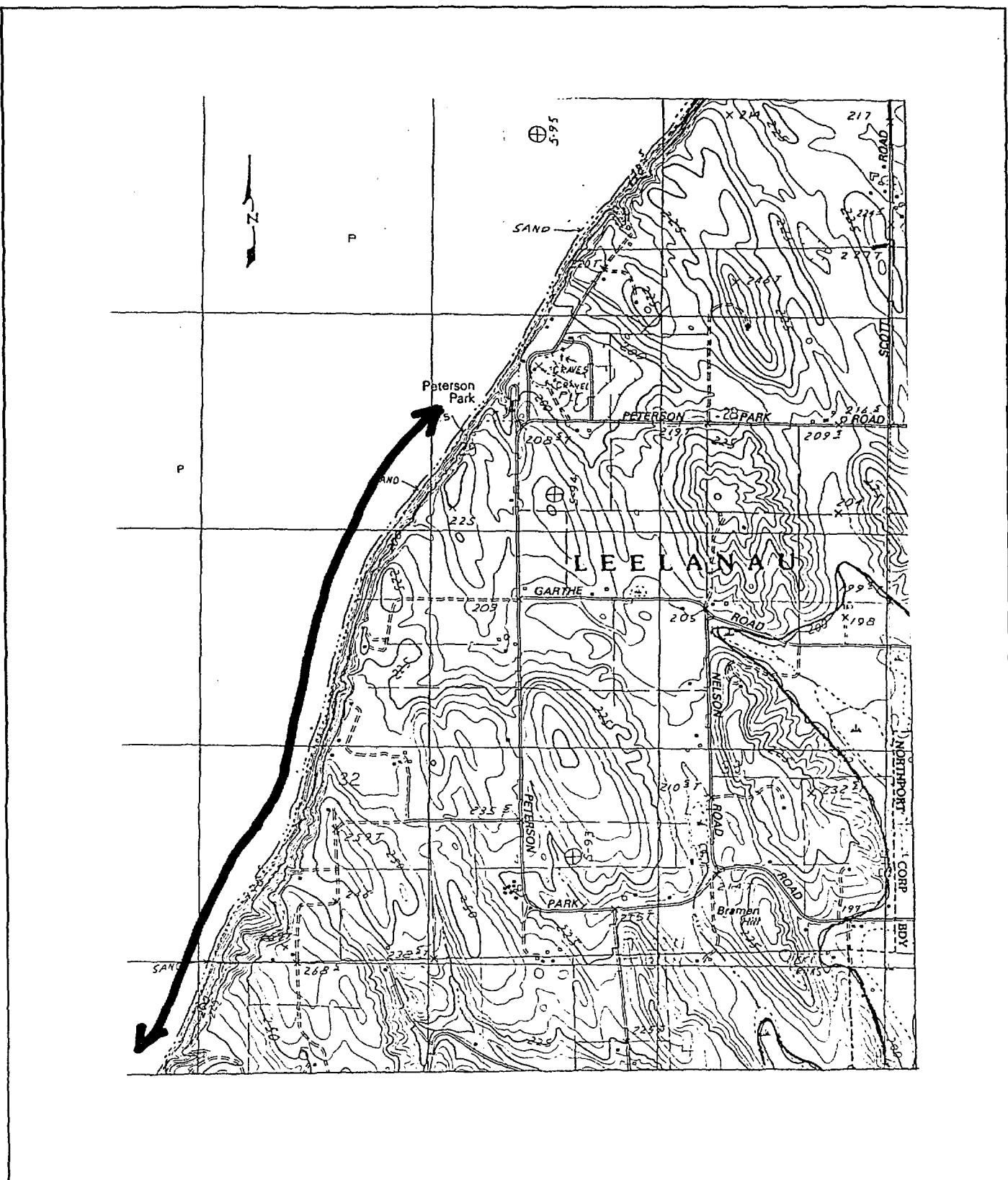
United States Geological Survey 7.5 minute topographic map
Atwood Quad



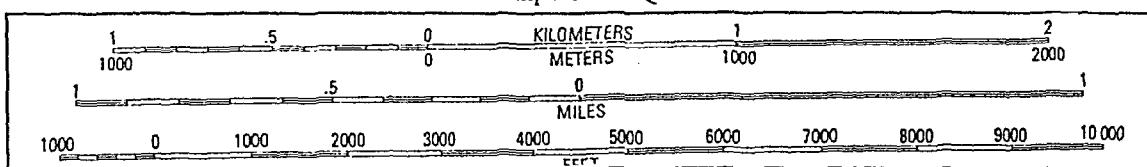


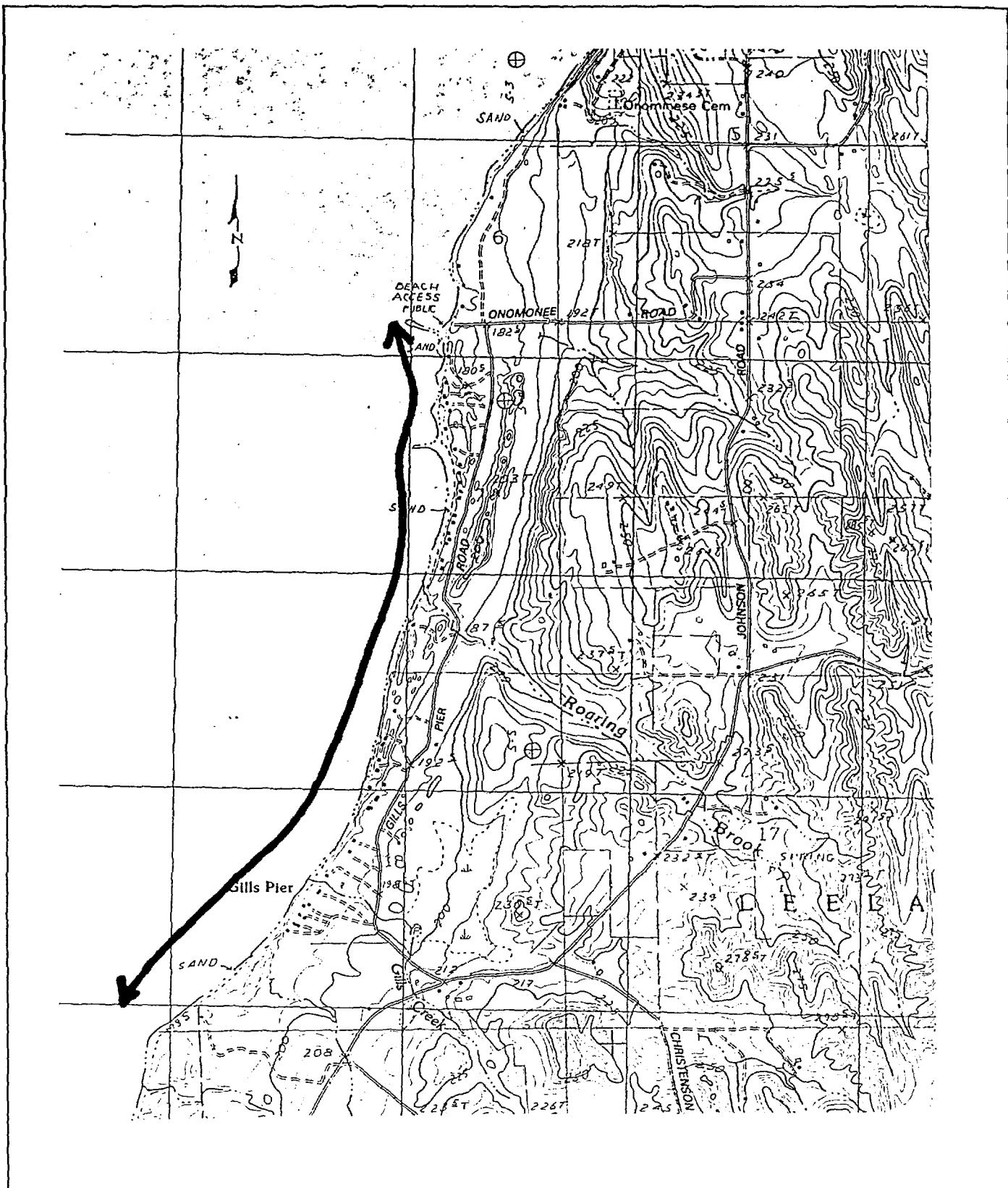
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Northport NW Quad



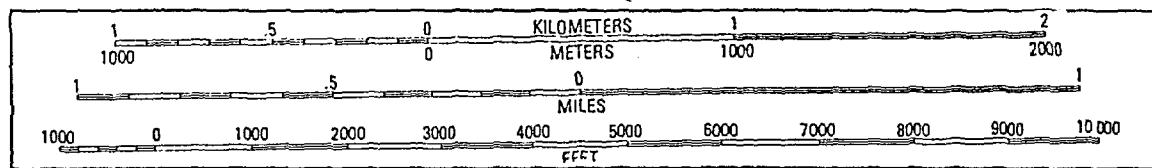


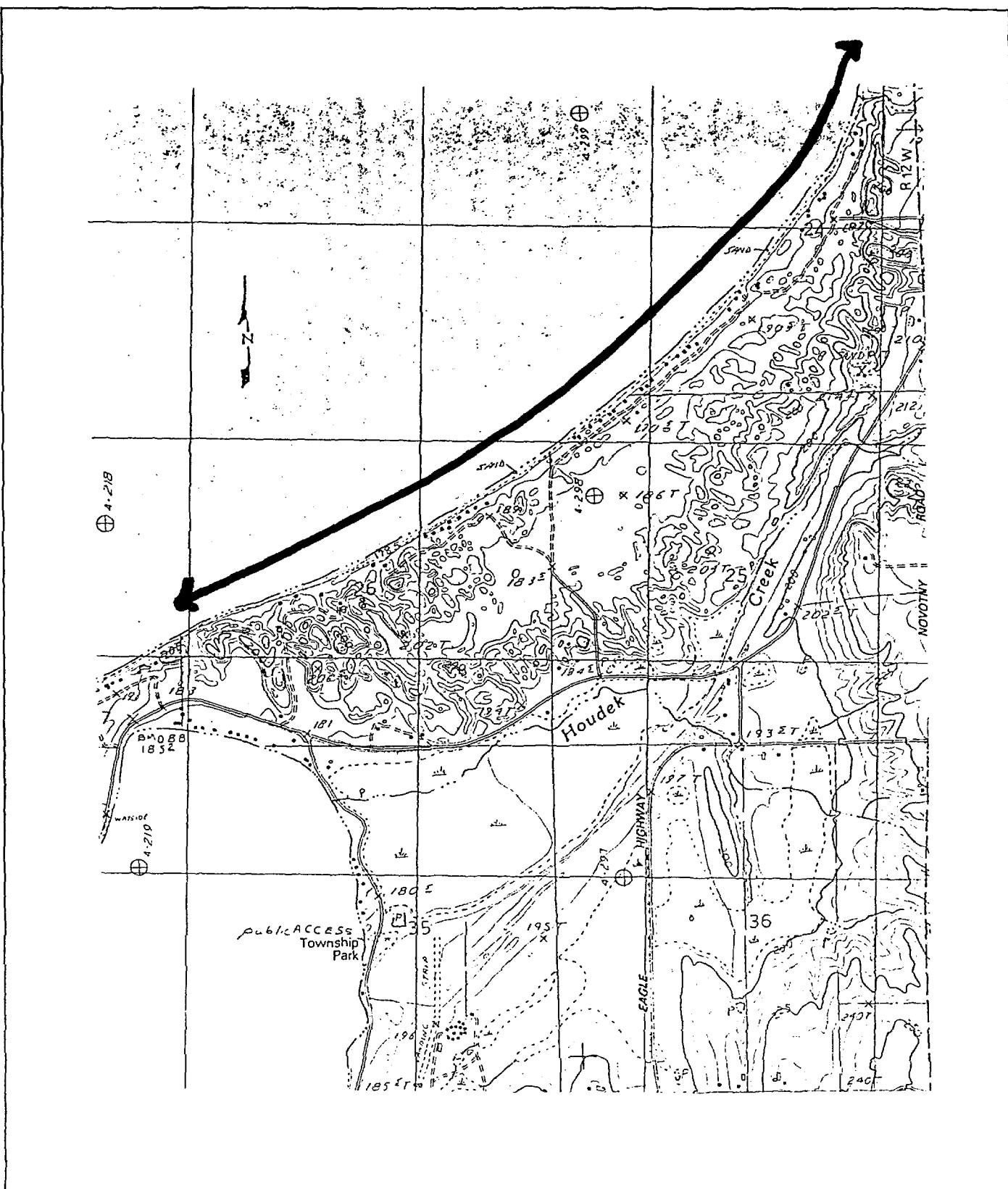
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Northport NW Quad



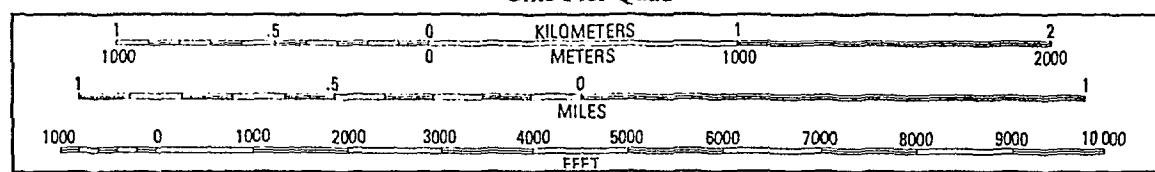


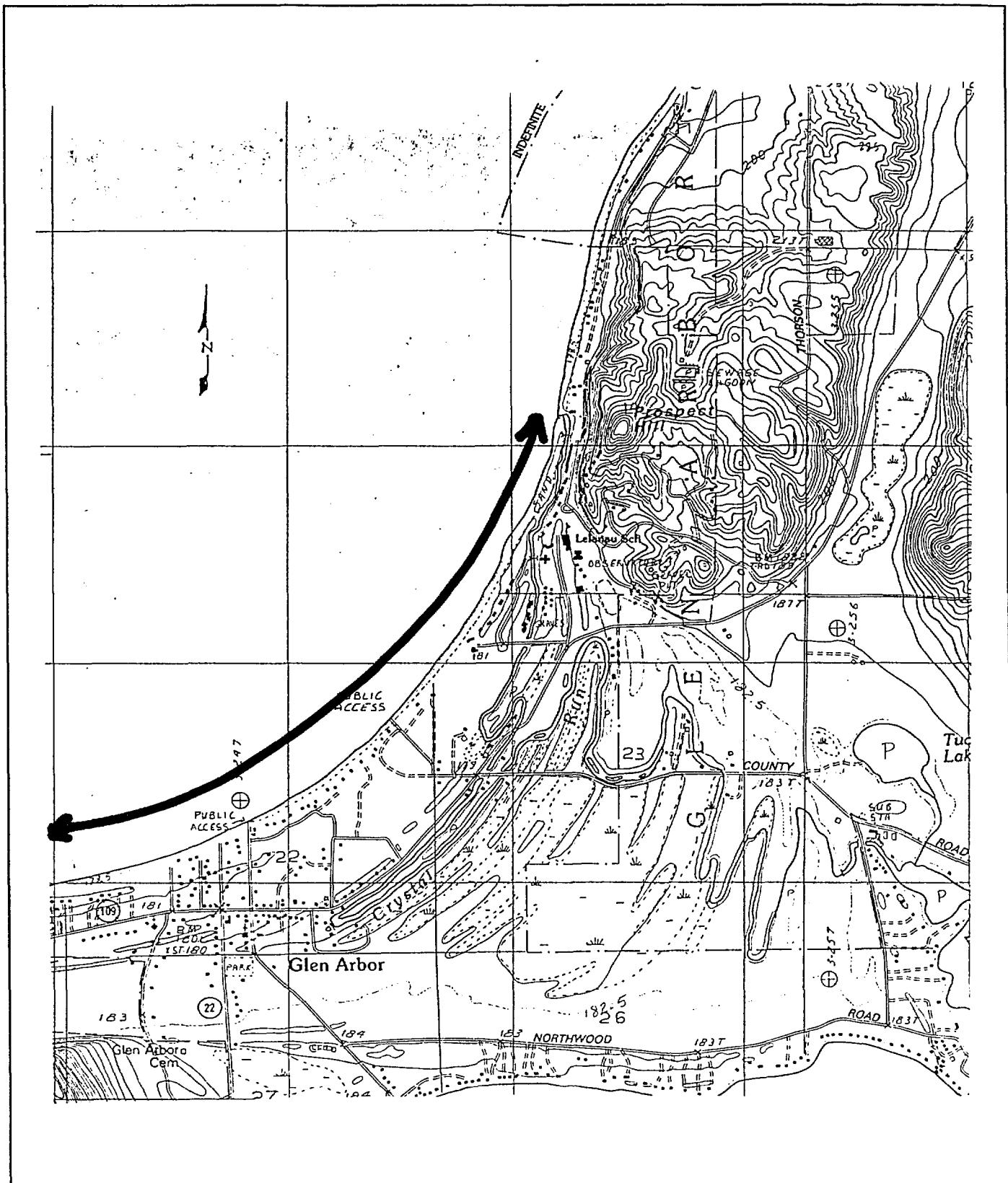
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Gills Pier Quad



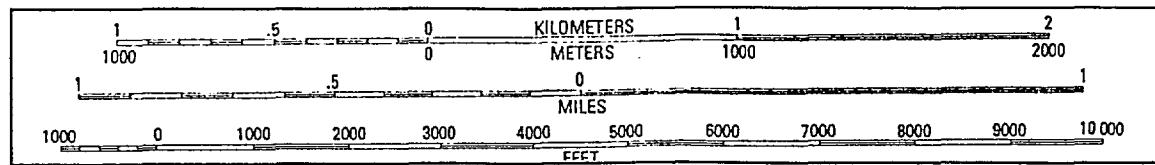


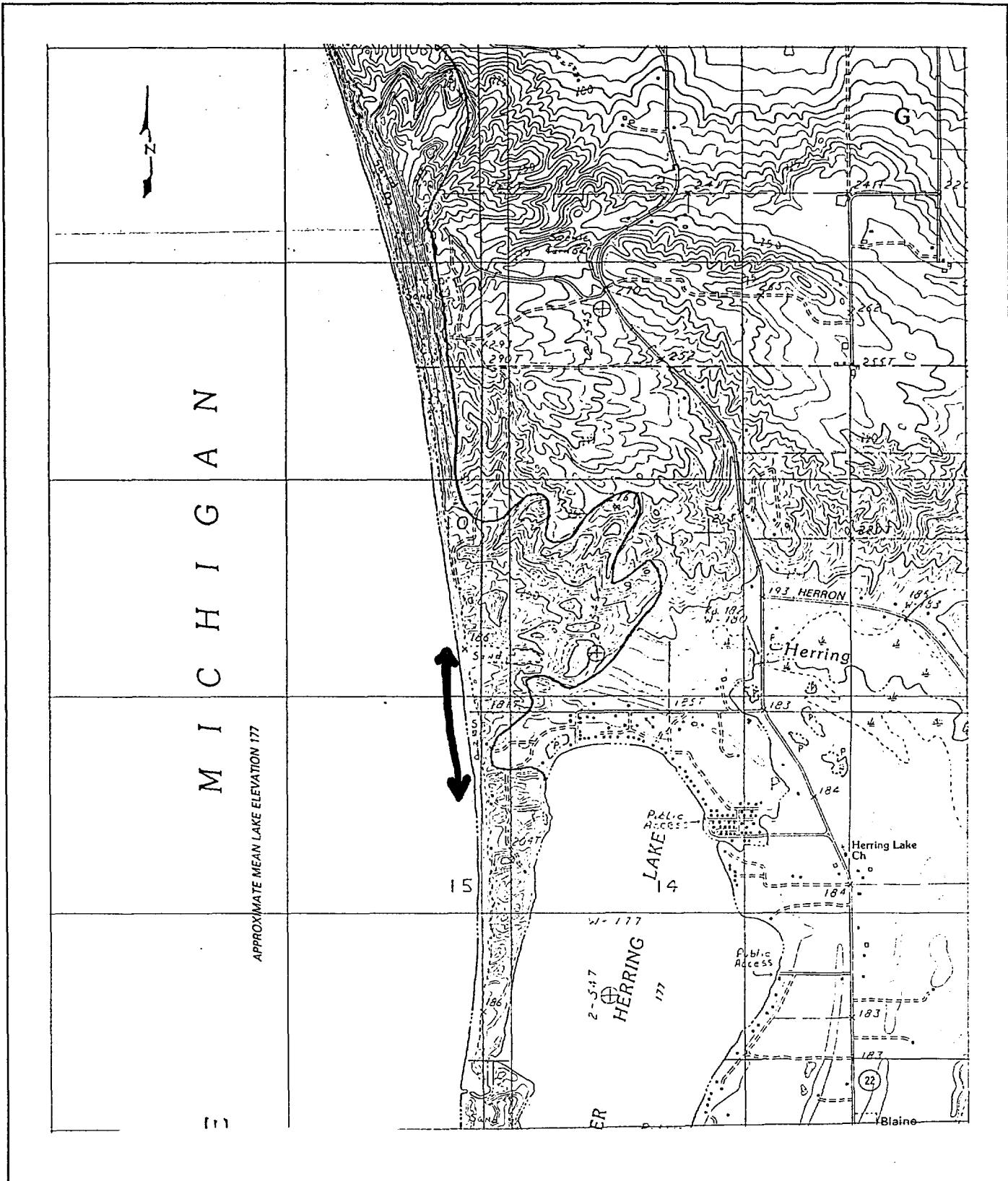
United States Geological Survey 7.5 minute topographic map
Gills Pier Quad



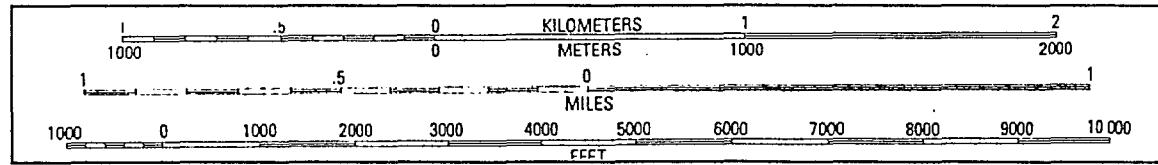


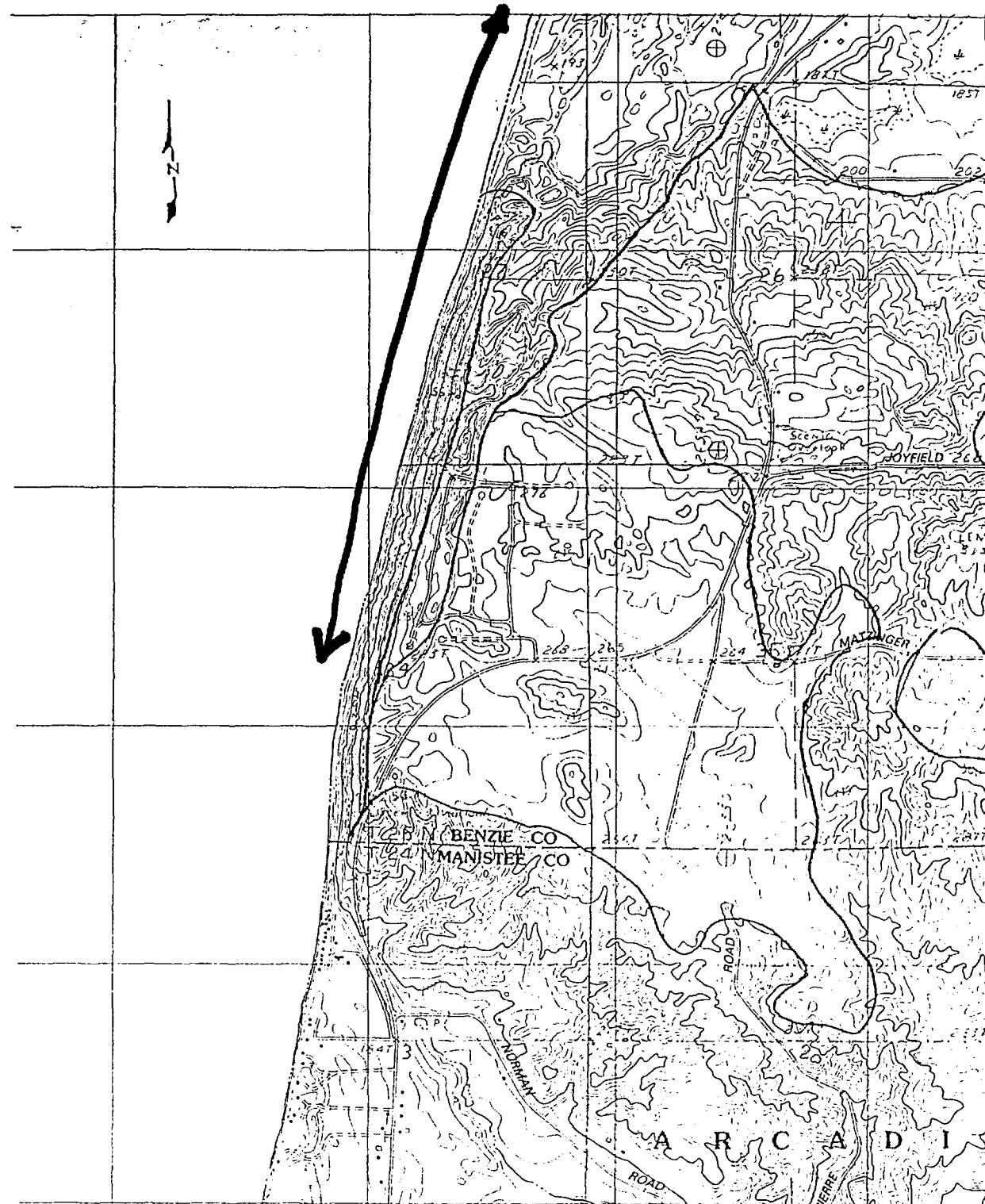
United States Geological Survey 7.5 minute topographic map
Glen Arbor Quad



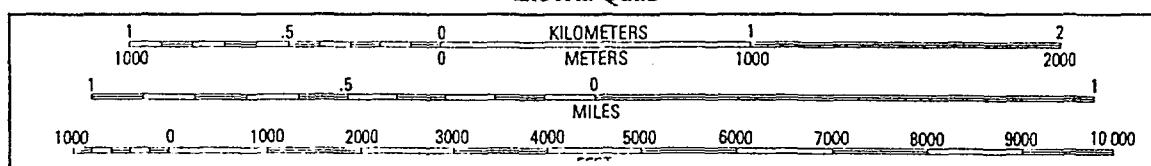


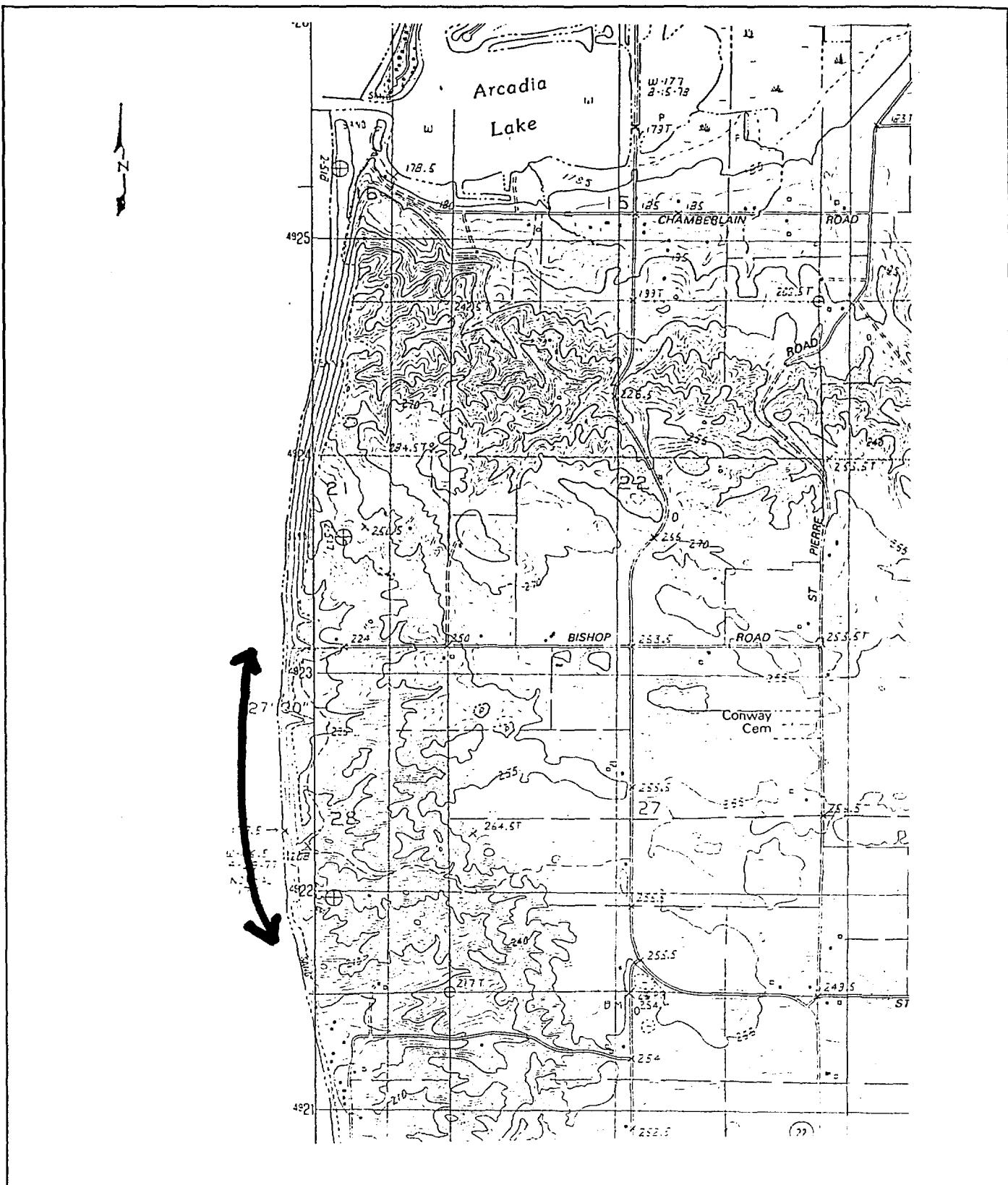
United States Geological Survey 7.5 minute topographic map
Elberta Quad



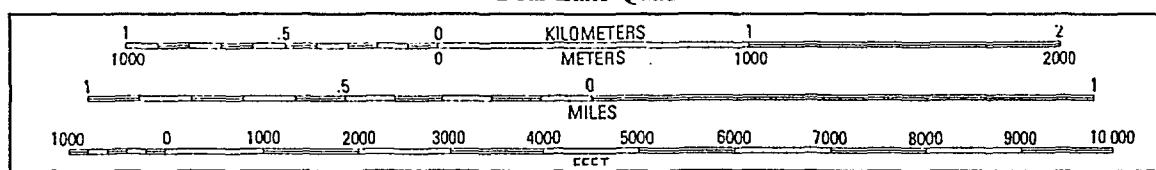


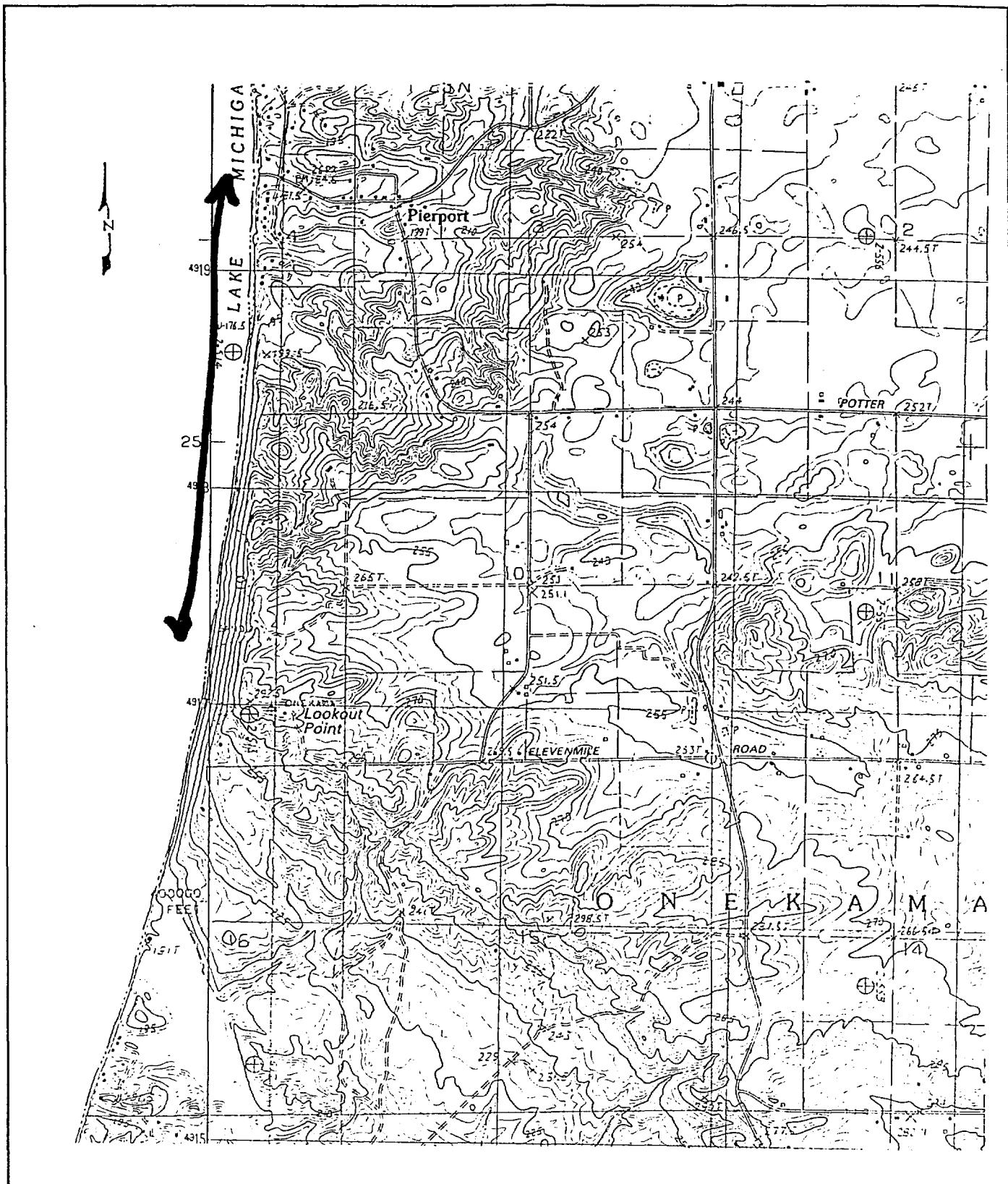
United States Geological Survey 7.5 minute topographic map
Elberta Quad



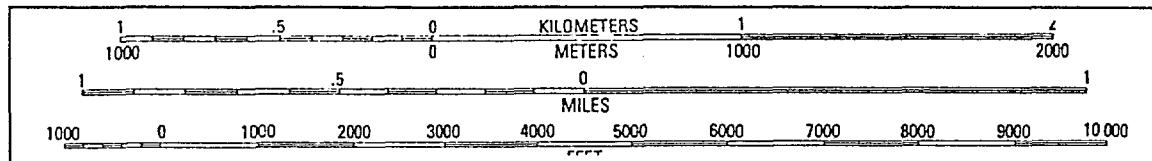


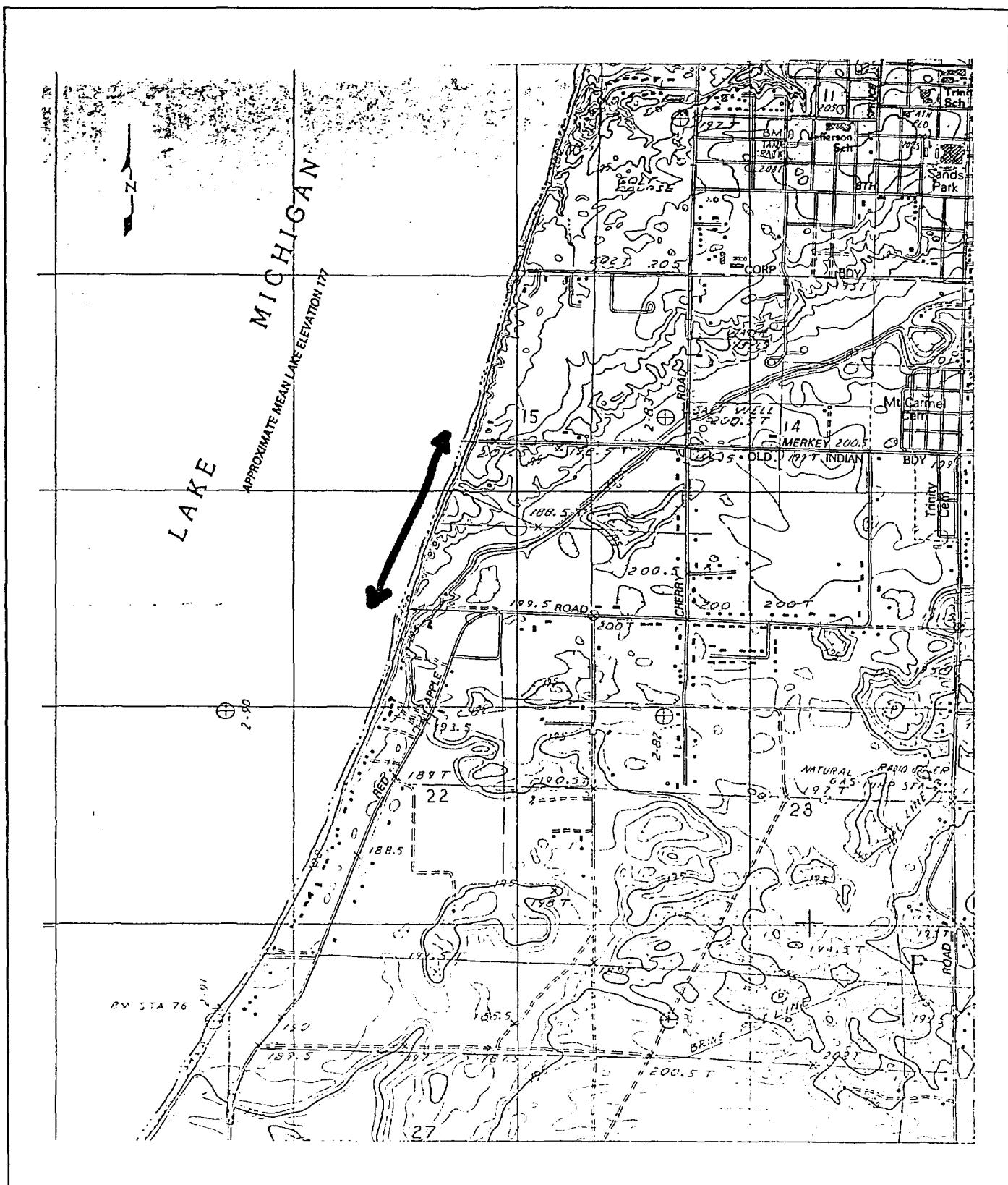
United States Geological Survey 7.5 minute topographic map
Bear Lake Quad



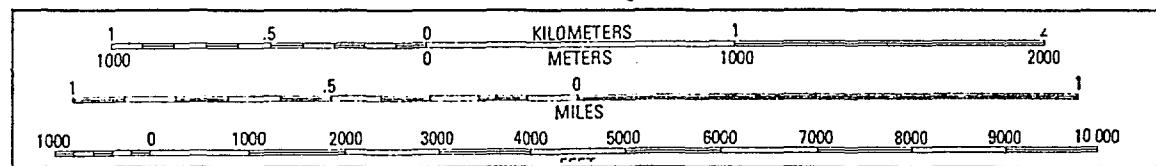


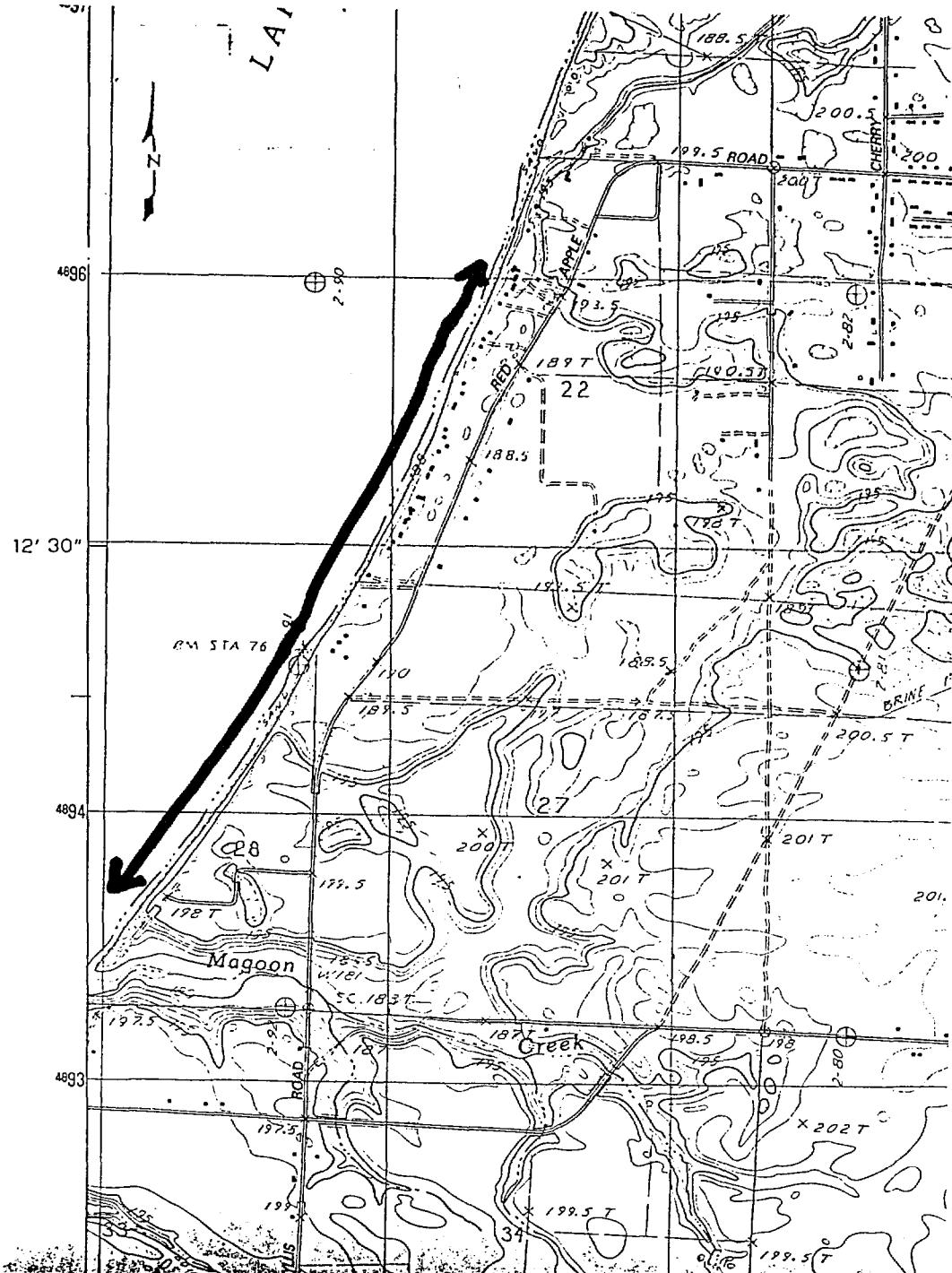
United States Geological Survey 7.5 minute topographic map
Bear Lake Quad



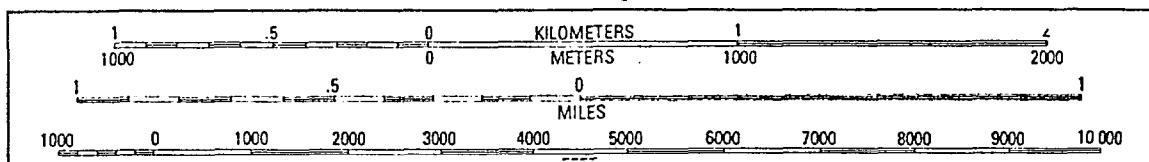


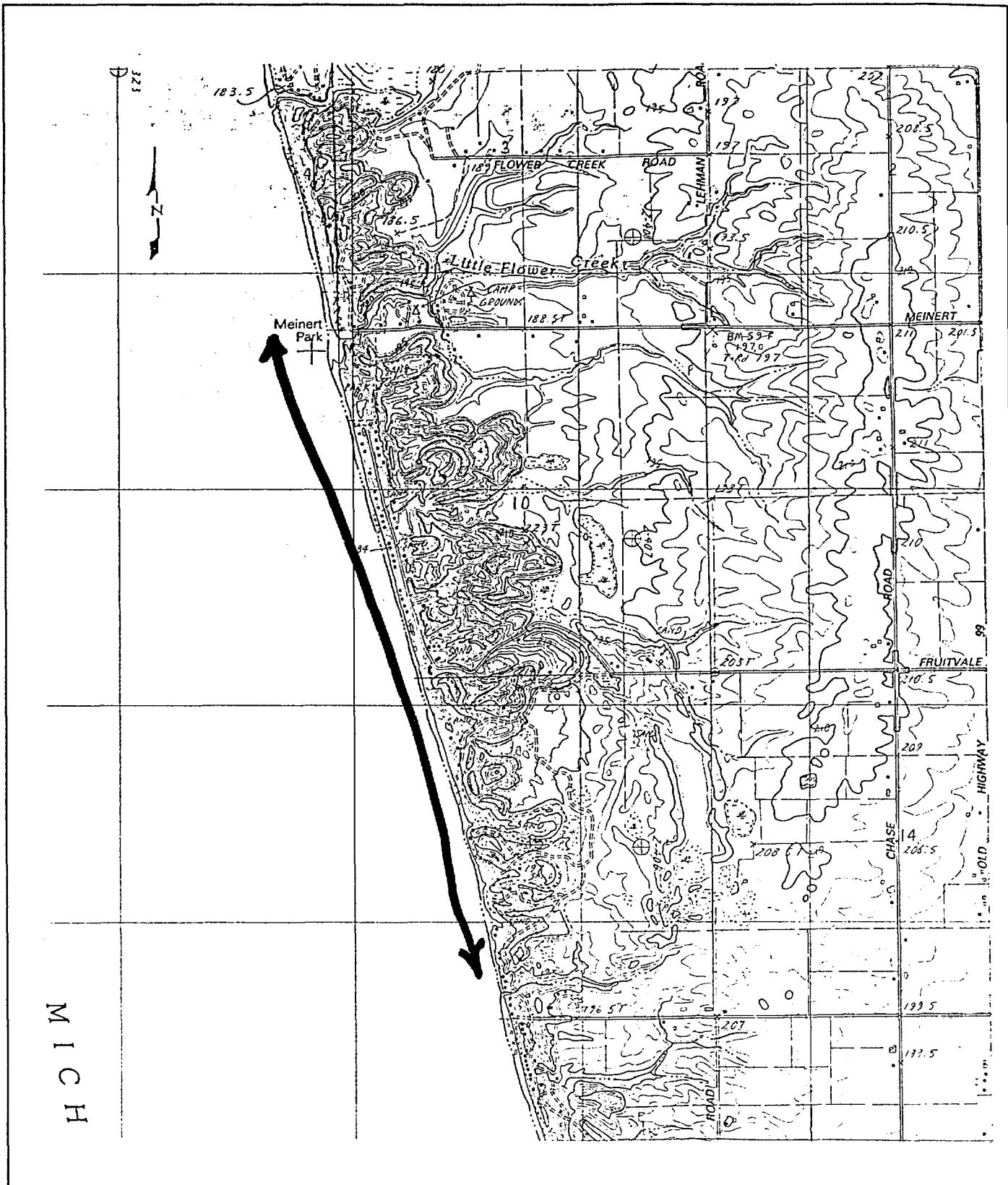
United States Geological Survey 7.5 minute topographic map
Manistee Quad



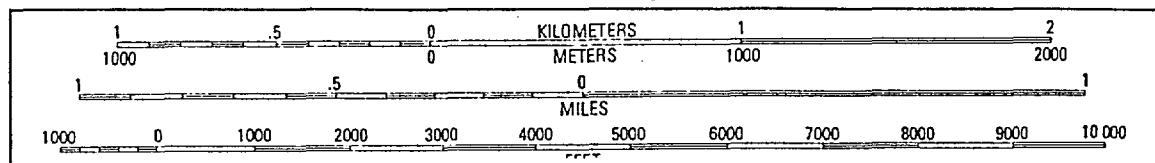


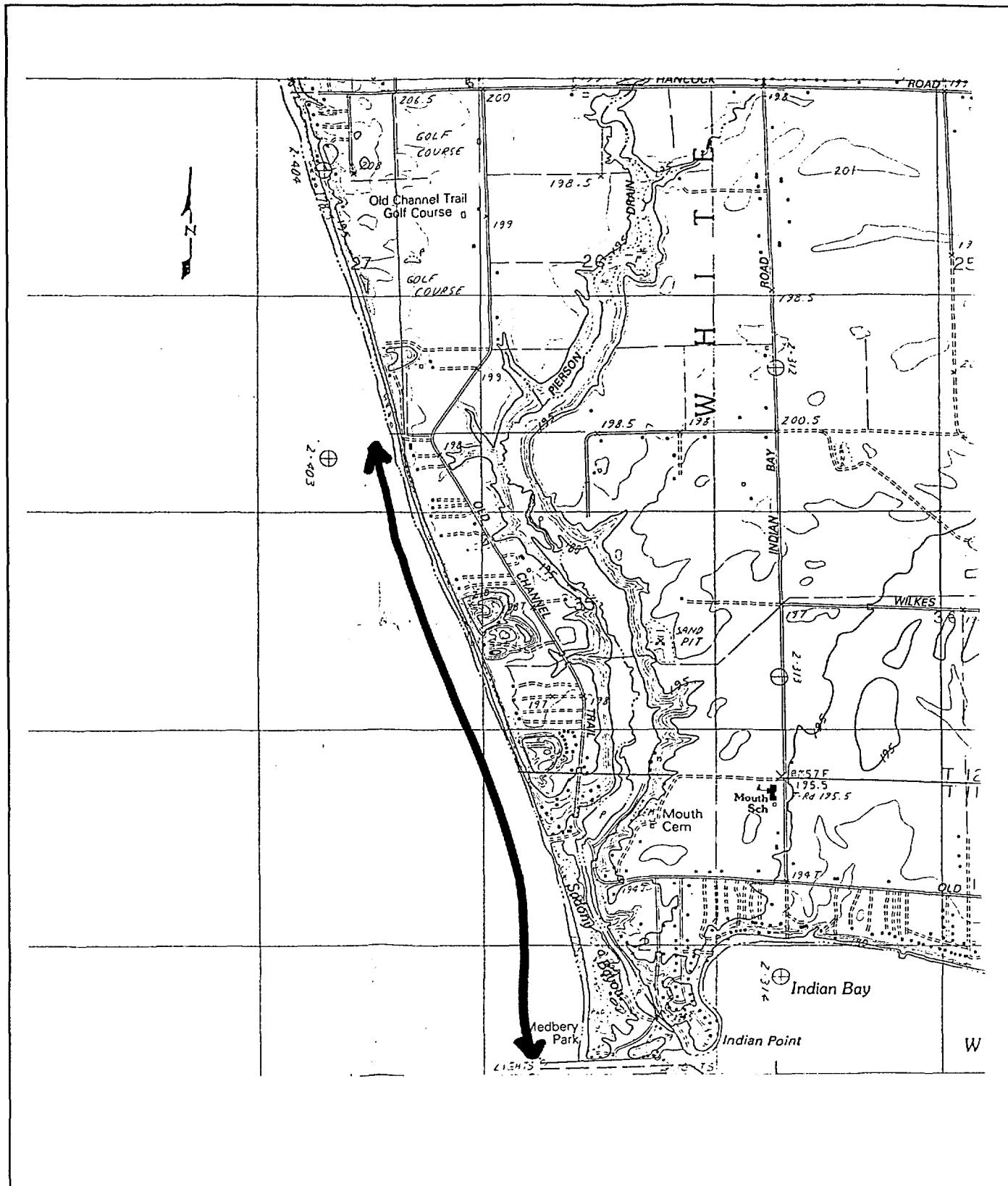
United States Geological Survey 7.5 minute topographic map
Manistee Quad



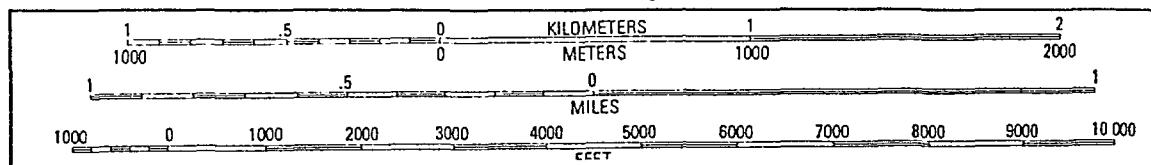


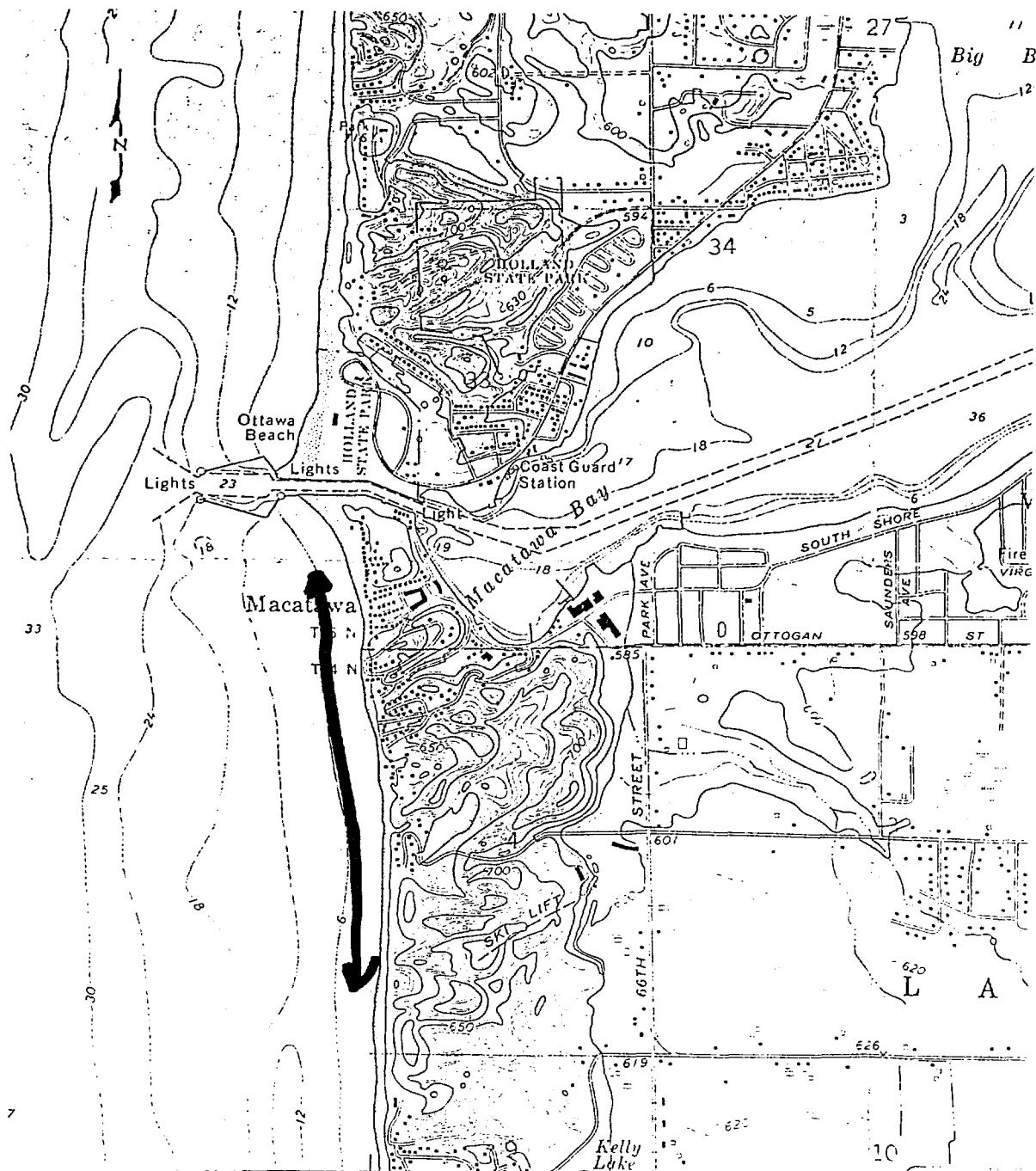
United States Geological Survey 7.5 minute topographic map
Flower Creek Quad



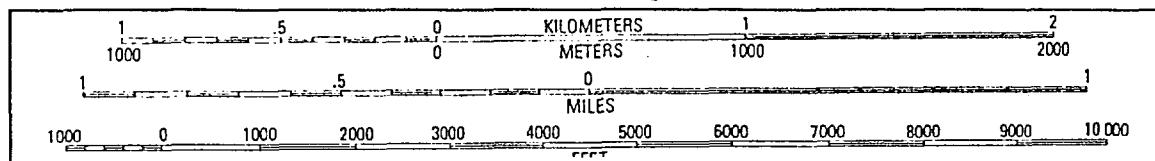


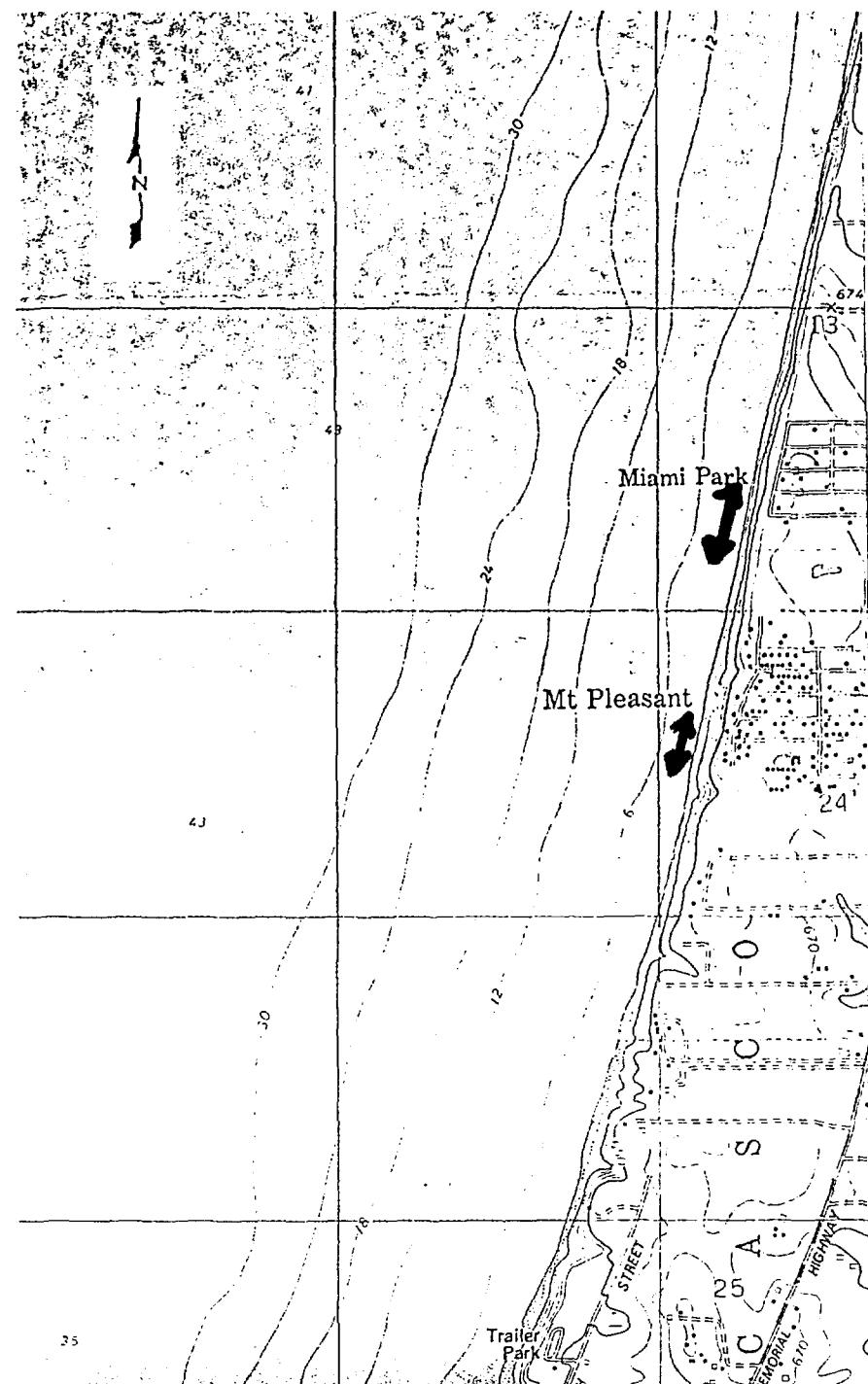
United States Geological Survey 7.5 minute topographic map
Flower Creek Quad



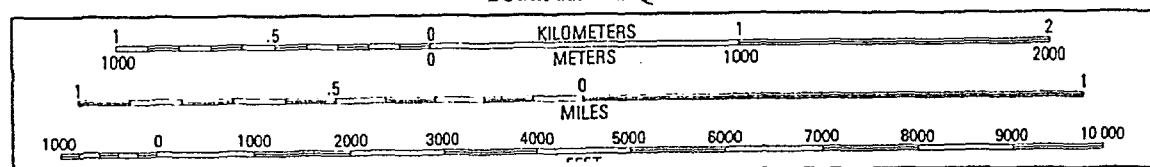


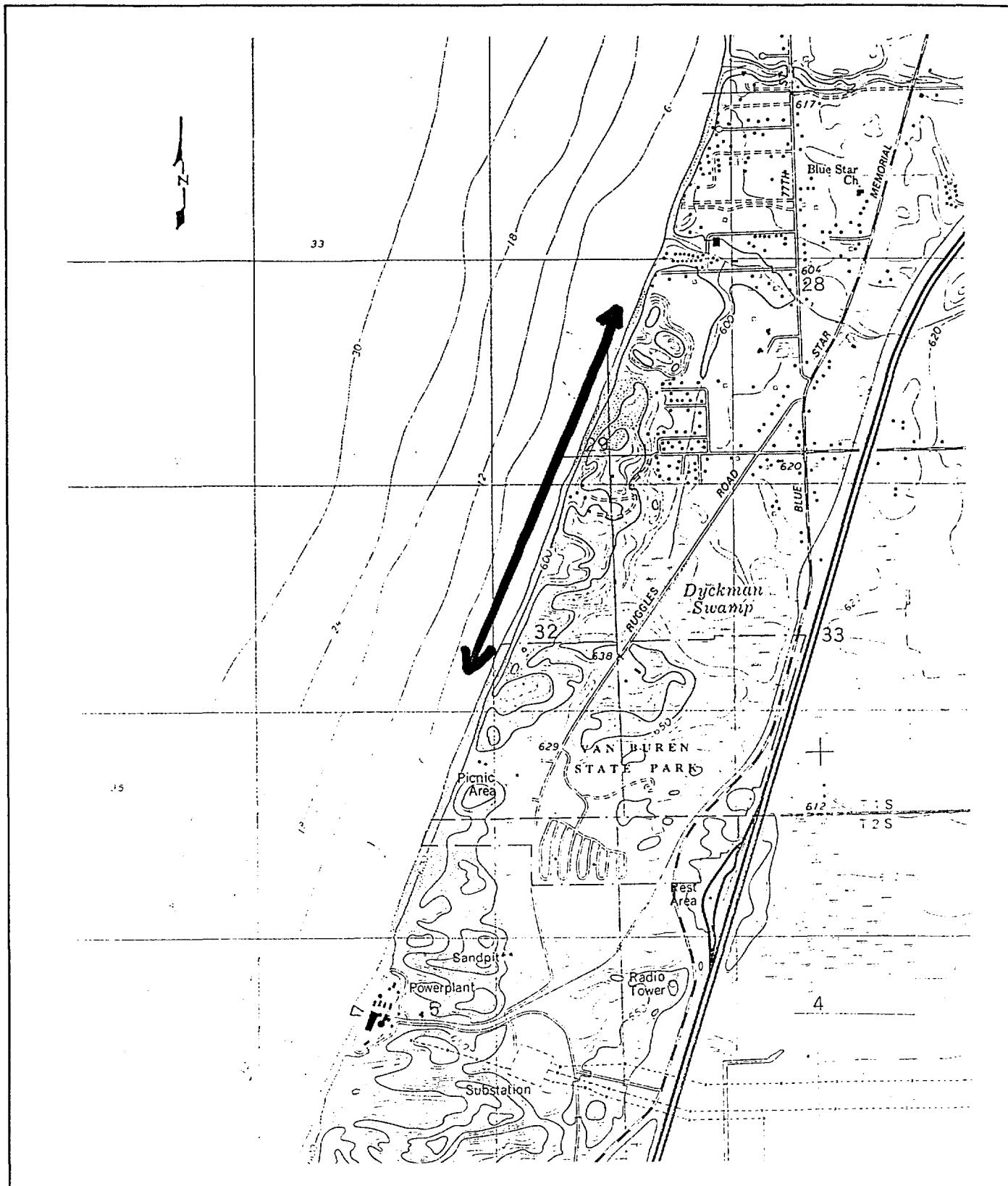
United States Geological Survey 7.5 minute topographic map
Holland West Quad



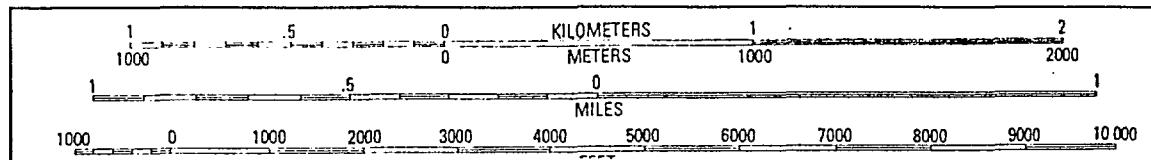


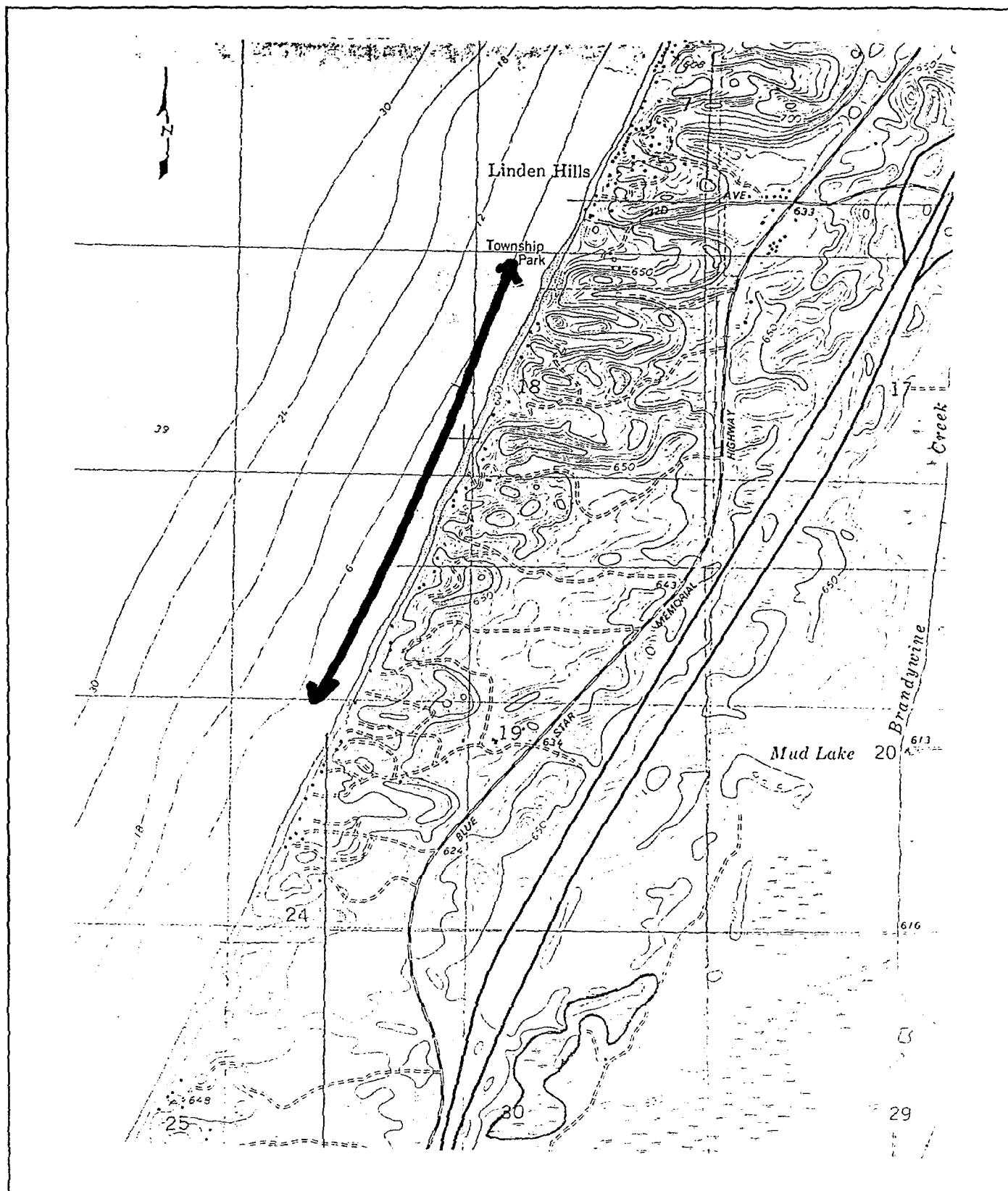
United States Geological Survey 7.5 minute topographic map
South Haven Quad



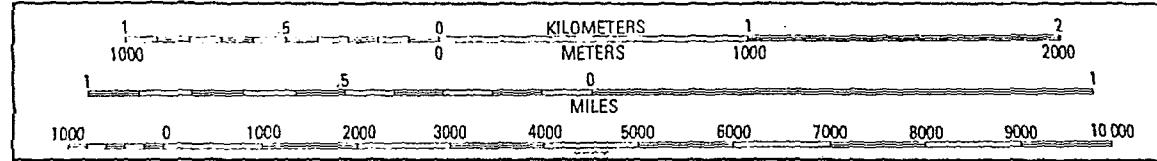


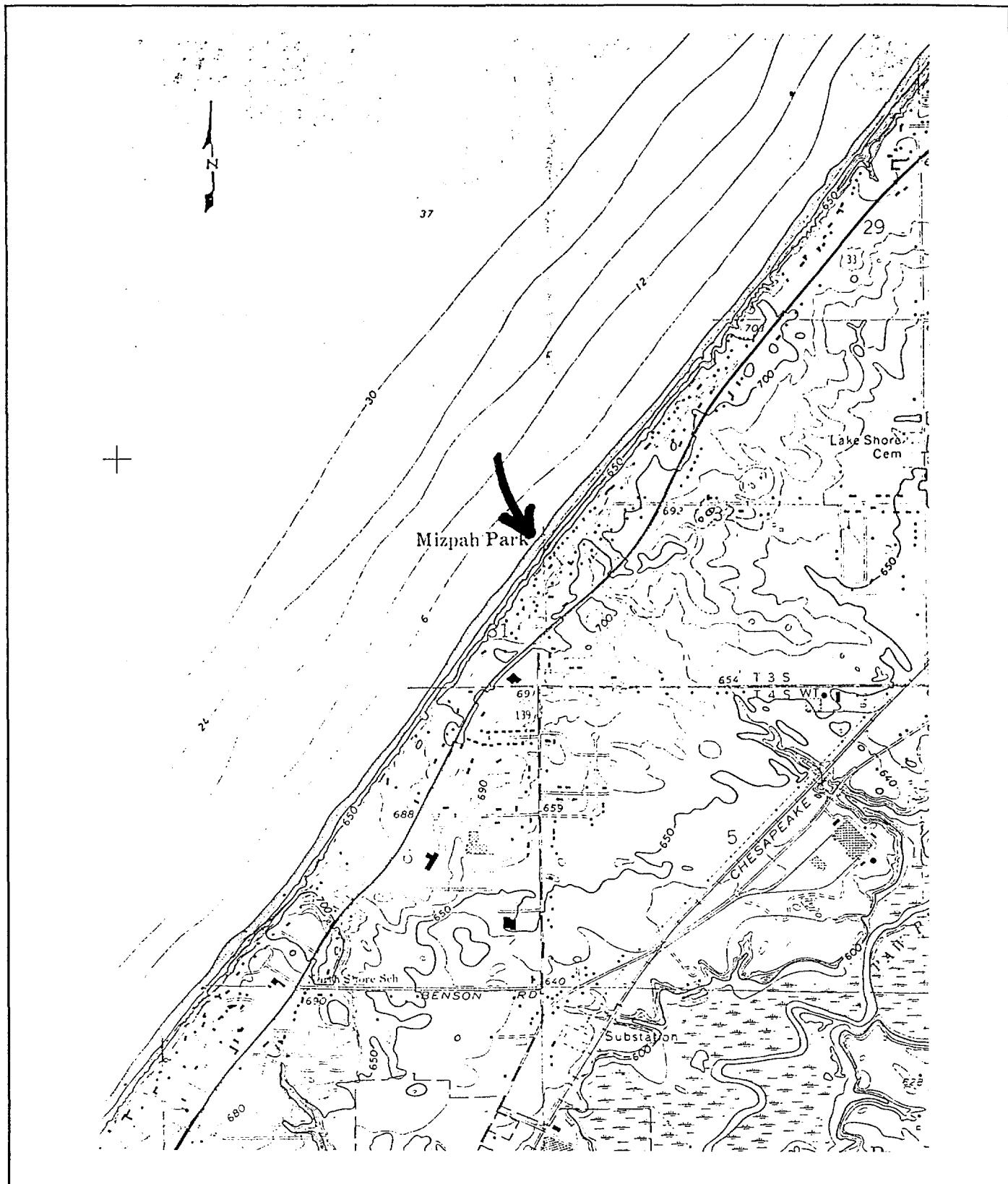
United States Geological Survey 7.5 minute topographic map
Covert Quad





United States Geological Survey 7.5 minute topographic map
Covert Quad





United States Geological Survey 7.5 minute topographic map
Benton Heights Quad

