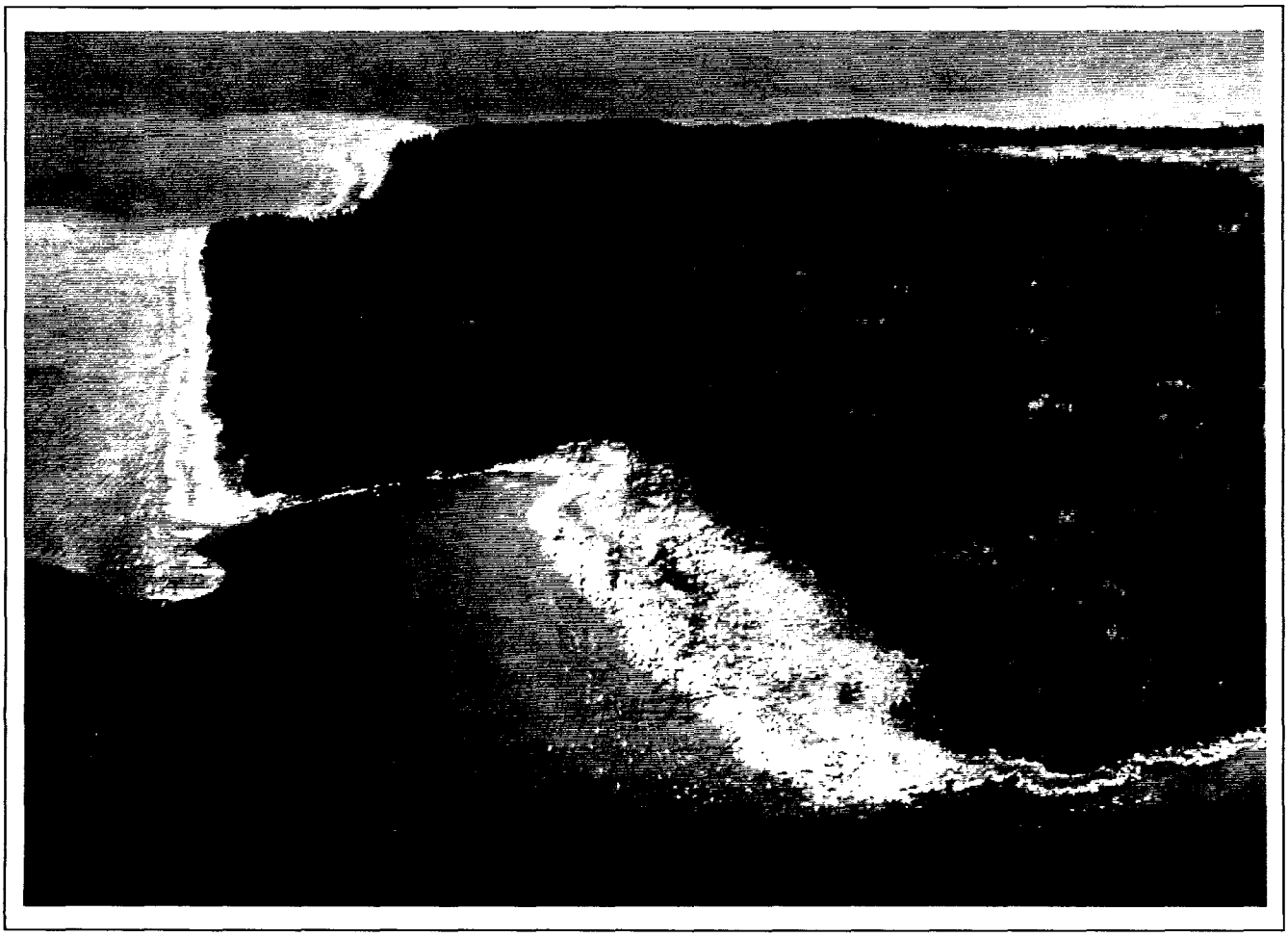
Bedrock Shoreline Survey of the Niagaran Escarpment in Michigan's Upper Peninsula: Mackinac County to Delta County



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ABSTRACT

Bedrock is exposed along large portions of the shoreline of the Great Lakes, especially in the Upper Peninsula, providing scenic views of the Great Lakes. Increasingly the large portions of the Great Lakes shoreline are becoming inaccessible to the public as a result of residential development. In this study we inventoried portions of the coastal bedrock, both in response to extreme development pressure and because of the significant biological diversity that characterizes much of the coastal bedrock. This report summarizes the results of 1995 plant community, rare plant, and insect inventories along the Lake Michigan shoreline in Delta and Schoolcraft counties and continued insect inventories along the Lake Superior shoreline of the Keweenaw Peninsula and the Lake Huron shoreline of Drummond Island.

Differences in bedrock result in strikingly different shorelines with equally distinctive floras and faunas. In this survey, we have concentrated on the Silurian-aged dolomite and limestone along the northern shore of Lake Michigan and on several islands in northern Lake Michigan. Basic characteristics of the dolomite and limestone bedrock are described within the report.

While most of our sampling was conducted in one natural community, **bedrock beach**, sampling was also conducted on **bedrock glade**, **cobble beach**, and **bedrock cliffs**. The greatest diversity of rare plants occurs on bedrock beach, but bedrock glade also contains many rare plant species. Diversity was much lower on cobble beach and bedrock cliffs. It is expected that faunal diversity will be highest on bedrock beach and glade.

The entire shoreline of northern Lake Michigan, from St. Ignace, in Mackinac County, to Menominee in Menominee County, was photo interpreted in preparation for the field surveys. Aerial reconnaissance was conducted to further evaluate sites and to photograph portions of the shoreline. Sampling of the vegetation of bedrock beach sites followed to collect data for the improvement of MNFI's community classification. Surveys of rare plant and animal species were conducted, as were general surveys for insects.

The 1995 surveys have resulted in the discovery of many new sites for both rare plants and high quality bedrock beach. Several new bedrock glades were discovered, which added to our understanding of this under-studied plant community. While no state-listed insect species have been found to date, several new county records and disjuncts have been identified. Identification of insect specimens from the surveys is ongoing.

Management recommendations will be made for the three high-quality bedrock beach sites, Poverty Island, Summer Island, and Pt. Detour, that are largely state-owned. We recommend that acquisition or conservation easements be sought for Goudreau's Harbor, which is recognized as having both the largest stretch of dolomite bedrock shoreline in the state, and populations of both state-listed plants and animals. Stony Point and nearby open dunes should also be considered for acquisition. Although the bedrock beach supports no rare species, several rare plant species occupy the surrounding dunes and there are high quality interdunal swales and bedrock on the point.

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Several entomologists provided identifications, including G.M. Fauske (North Dakota State University, for the Lepidoptera and Orthoptera); K.G.A. Hamilton (Agriculture Canada, for the Cicadellidae in part); D.A. Rider (North Dakota State University, for the Pentatomidae); E.G. Riley (Texas A&M University, for the Chrysomelidae); M.D. Schwartz (Agriculture Canada, for the Miridae); and D.F. Schweitzer (Eastern Regional office of The Nature Conservancy, for the *Papaipema*.

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INTRODUCTION

Varying from vast sandy beaches at the base of towering sand dunes to stern cliffs and rugged coast lands, the shorelines of the Great Lakes offer a striking diversity of specialized habitat, that also provides scenic beauty and recreational opportunity. Sections of this shoreline, especially along the southern coast of Michigan's Upper Peninsula, are characterized by outcrops of resistant limestone and dolomite bedrock. As well as contributing to incomparable vistas of the Great Lakes, this bedrock shoreline creates a unique environment significant to protecting biological diversity.

Almost ten years ago, Asworth (1987) reported that 50 percent of the Great lakes shoreline had been developed for residential, industrial, or commercial purposes. Furthermore, 83 percent of the shoreline was in private ownership and thus could be developed at any time. Rapid development has occurred over significant portions of the Great Lakes shoreline during the last decade. Some of the finest examples of bedrock beach surveyed in 1994 are now slated for development, both on the Keweenaw Peninsula and Drummond Island. Unfortunately, development often locks the shoreline from public access and represents a significant loss of habitat for plants and animals adapted to this unique environment.

In response to extreme development pressure, this study was initiated to provide a more thorough understanding of the significant biological diversity associated with bedrock shoreline communities and to identify locations for conservation. This report summarizes the results of 1995 coastal bedrock inventories along the southern coasts of Delta and Schoolcraft Counties in Michigan's Upper Peninsula.

Plates 1, 2, and 3 illustrate the bedrock of the study area and also the vegetation zones characteristic of the bedrock shoreline. **Plate 4** shows several of the special plants associated with limestone and dolomite bedrock within the study area. Photos of the survey sites are also included in the site summary section of the report.

BEDROCK OF THE NIAGARAN ESCARPMENT

The surface bedrock of Michigan is exposed in a series of concentric bands, increasing in age outward from their approximate center near the Lower Peninsula town of Barryton (Ashworth 1987). One such band, the Niagaran Escarpment, extends from approximately Milwaukee, Wisconsin, across the Upper Peninsula of Michigan and Ontario to Rochester, New York, arching roughly along the outer margins of Lakes Michigan and Huron (Dorr and Eschman 1977). The Niagaran Escarpment can be seen on modern maps as it extends in a northeasterly direction, forming both the Door Peninsula of Wisconsin and the Garden Peninsula of Michigan. The escarpment continues along the southern coast of the Upper Peninsula, where it is locally exposed, to approximately the Straits of Mackinac, where it gradually curves southeast along the northern Lake Huron shoreline, forming Drummond Island in Michigan, and Cockburn and Manitoulan Islands in Ontario. It continues in Ontario as the Cape Hurd and Bruce Peninsulas, and then to the Niagara region between Lakes Erie and Ontario. The Niagara River plunges over the Niagaran Escarpment at Niagara Falls.

At the landscape scale, the major structural feature of this expansive escarpment is a monocline (Ehlers 1973). The structure is loosely analogous to a very shallow bowl, with its interior containing Lakes Michigan and Huron and its rim forming a cliff of varying height. Thus, the rocks of the escarpment dip very gently towards the Great Lakes. The inclination averages about 50 ft. per mile with a minimum and maximum dip of around 40 and 60 ft. per mile (Ehlers 1973).

Plate 1. Dolomite and limestone shoreline of Schoolcraft and Delta Counties.

Plate 1a. The bedrock shoreline at Kregg Bay NE is an argillaceous dolomite, containing impurities such as sand, silt, or clay minerals. Argillaceous dolomite is characterized by a lack of broad solution cracks. Pure limestone and dolomite, in contrast, are more soluble than argillaceous dolomite.

Plate 1b. The dolomite at Goudreau's Harbor illustrates the broad solution cracks that typify relatively pure limestone and dolomite bedrock. Note the perpendicular pattern of the solution cracks. Vegetation can establish in these cracks, where there is greater protection from both wave action and ice scour.

Plate 1c. On the Garden Peninsula and nearby islands in Lake Michigan, the bedrock tilts downward 40 to 60 feet per mile toward the east. As a result of this tilt, bedrock cliffs are exposed along the western edge of the peninsula and islands, as seen in this photograph of Poverty Island, and bedrock beach occurs to the east, as seen in Plates 1a and 1b, above.

Plate 1

a

b

c

Plate 2. Dolomite and limestone shoreline of Schoolcraft and Delta Counties.

Plate 2a. This photograph of Seul Choix Point (Goudreau's Harbor) demonstrates the type of information that can be interpreted from oblique aerial photographs. The extent of the offshore dolomite ledges is evident on the photo, as are the major zones of the bedrock beach, including the wave slash zone, vegetated beach, and conifer-dominated (boreal) forest, as well as a cobble beach between the vegetated beach and the forest. Opening in the forest are also easily seen.

Plate 2b. The wave-splash zone on this portion of Goudreau's Harbor is quite broad. In the background, scattered shrubs can be seen occupying cracks further from the shoreline.

Plate 2c. Broad cracks in the dolomite pavement of Poverty Island support a dense mat of herbaceous plants. Ice scour probably eliminates both soil and plant accumulation on the pavement between the cracks.

Plate 2

a

b

c

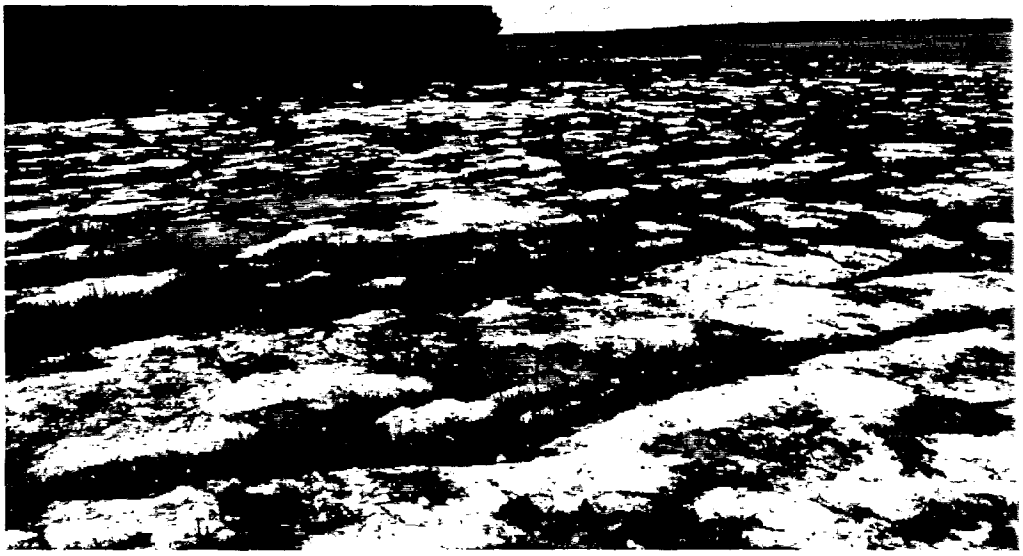


Plate 3. Dolomite and limestone shoreline of Schoolcraft and Delta Counties.

Plate 3a. The dolomite pavement at the eastern edge of Summer Island has almost perpendicular fractures, which support a turf of federally-threatened dwarf lake iris (*Iris lacustris*). Conifer-dominated forest, characteristic of much of the bedrock along the shoreline, can be seen in the background.

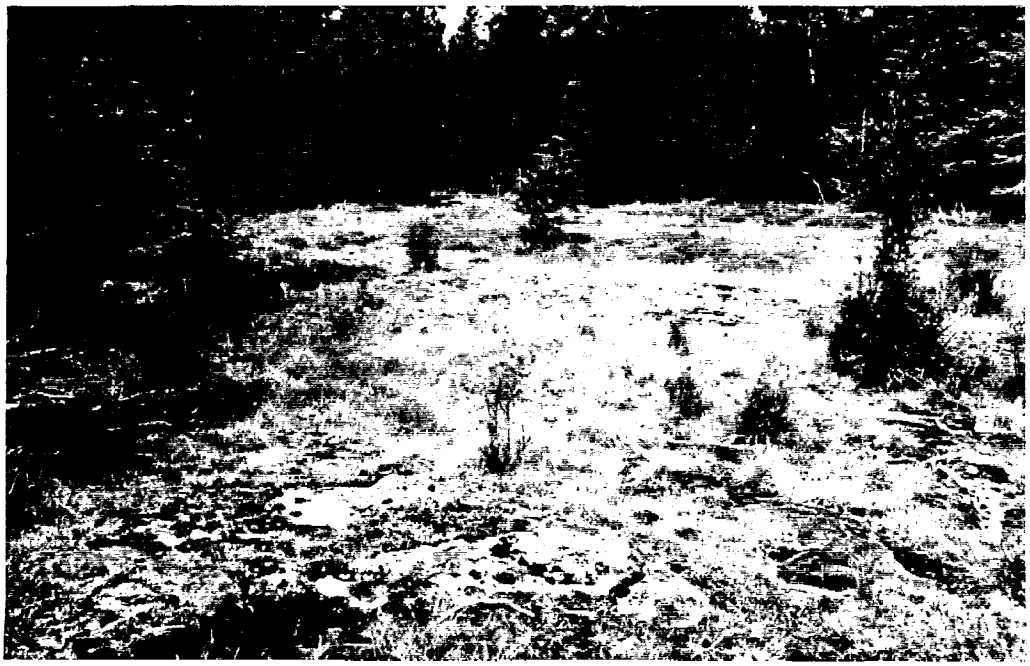
Plate 3b. On many of the bedrock shorelines, such as at Point Detour shown here, herbs and shrubs carpet the bedrock near the forest margin. In the background, closer to the Lake Michigan shoreline, vegetation occupies only cracks in the bedrock.

Plate 3c. On Summer Island, openings, called glades, occur within the boreal forest. The soils in these opening are absent or thin, only an inch or two thick, and range from sands to organic soils in depressions. Some glades are probably the result of human land use, while others result from blow-downs during wind storms. Dominant trees in the forest include northern white-cedar, balsam fir, tamarack, and white spruce. Paper birch and trembling aspen are also present.

Plate 3

a

b



c

Plate 4. Rare plant species characteristic of the Niagaran Escarpment in the Upper Peninsula.

Plate 4a. A portion of an extensive, high quality alvar glade on the Garden Peninsula in Delta County. Dwarf lake iris (*Iris lacustris*, federal and state threatened) is frequently a dominant groundcover species in this region, forming large clones on thin soils over limestone bedrock. The photo displays a glade opening with a nearly continuous groundcover of iris. This is somewhat unusual for the species, as it most often occurs on the margins of shoreline conifer-hardwood forests along Lakes Huron and Michigan, especially on sandy to cobbly beach ridges.

Plate 4b. Close-up of dwarf lake iris and a frequent associate, the pinkish-flowered gaywings (*Polygala paucifolia*). Although dwarf lake iris blooms from approximately mid-May to early June, it can be readily recognized throughout the season by the diminutive stature of the leaves and the nearly surficial, yellowish, narrow rhizomes.

Plate 4c. A close-up photo of Calypso orchid (*Calypso bulbosa*, state threatened), growing in needle duff and thin soil over bedrock under a largely coniferous canopy. This rare orchid species occurs in cedar swamps as well as dry mesic forests along the northern shores of Lakes Michigan and Huron.

Plate 4d. Close-up photo of Richardson's sedge (*Carex richardsonii*, state special concern) during its peak blooming period in late May. This early season sedge occurs along bedrock shorelines, occupying relatively dry microhabitats in alvar glades and along forest edges. This species may be commonly associated with dwarf lake iris and other rarities, such as beauty sedge (*Carex concinna*, state special concern).

Plate 4

a

b

c

d

The Niagaran Escarpment, consisting almost entirely of limestone and dolomite, was formed from resistant carbonate rocks (Ehlers 1973). Dolomite is similar to limestone, except it has a threshold concentration of magnesium in its chemical composition and is generally more resistant to erosion (recent geological terminology uses the term **dolostone** to describe the rock, reserving the term dolomite for the mineral). The rocks were formed in the Silurian Period, during which time marine waters covered the Michigan Basin. The waters over much of the Basin were deep and most rocks of marine sediment origin were formed from precipitates of $CaCO_3$. However, extensive reefs formed at the shallower margins of the basin. While similar in chemical composition to rocks formed from precipitates, rocks from these reefs were constructed of skeletons and excretions of organisms and are comparatively resistant to erosion. Accordingly, rocks of the Niagaran Escarpment, which were formed from reefs, resist erosive forces effectively.

The Niagaran Series, the group of rocks forming the Niagaran Escarpment, consists of four formations: Mayville Dolomite; Burnt Bluff Limestone and Dolomite; Manistique Limestone and Dolomite; and Engadine Dolomite (Ehlers 1973). Figure 1 shows the major bedrock formations of the study area and also indicates the general location of the six bedrock beach survey sites of the study. Note that the bedrock shoreline pertinent to this study was characterized primarily by Manistique Dolomite and, to a lesser extent, Burnt Bluff Limestone and Dolomite and Engadine Dolomite.

NATURAL COMMUNITIES OF THE COASTAL NIAGARAN ESCARPMENT

Bedrock Beach

Bedrock beaches of dolomite were characterized by a zonal gradation of herbaceous vegetation communities, changing in response to distance from the lake and each having a distinct physiognomy (Figures 2A-F). Wave action and ice scrape had their greatest impact in the zones closest to the lake. This wave splash or ice scour zone, which ranged from 4 to 24 m in width, was characteristically devoid of vegetation (Plates 1a and 2b). Adjacent to the inland side of the splash/scrape zone, a vegetated zone was characterized by patchy establishment of vegetation interspersed by areas of exposed bedrock (Plates 1b, 2c, and 3a-b), Often, vegetation establishment was restricted to cracks in the bedrock pavement, resulting in a distinct checkerboard appearance (Plates 1b, 2c, and 3a). Further inland, lack of ice scour allows for the establishment of woody plants and denser assemblages of herbaceous plants. Localized accumulations of sand and gravel or organic materials on the bedrock surface further assist in the establishment of shrubs and trees.

Bedrock Glade

Bedrock glades were sometimes found to occur between the open bedrock beaches and the forests further inland (Plates 3c and 4a). The glades consisted of open, thin-soiled plant communities dominated by scattered, open-grown trees, scattered shrubs or shrub thickets, and a partial turf of grasses and sedges. Bedrock exposures were frequently encountered within the glades. Because bedrock glades were first identified as a characteristic zone along bedrock shorelines of the Great Lakes in 1994 (Albert et al. 1994), there are currently minimal data available to compare or adequately describe the community. However, the bedrock glade community is currently being evaluated.

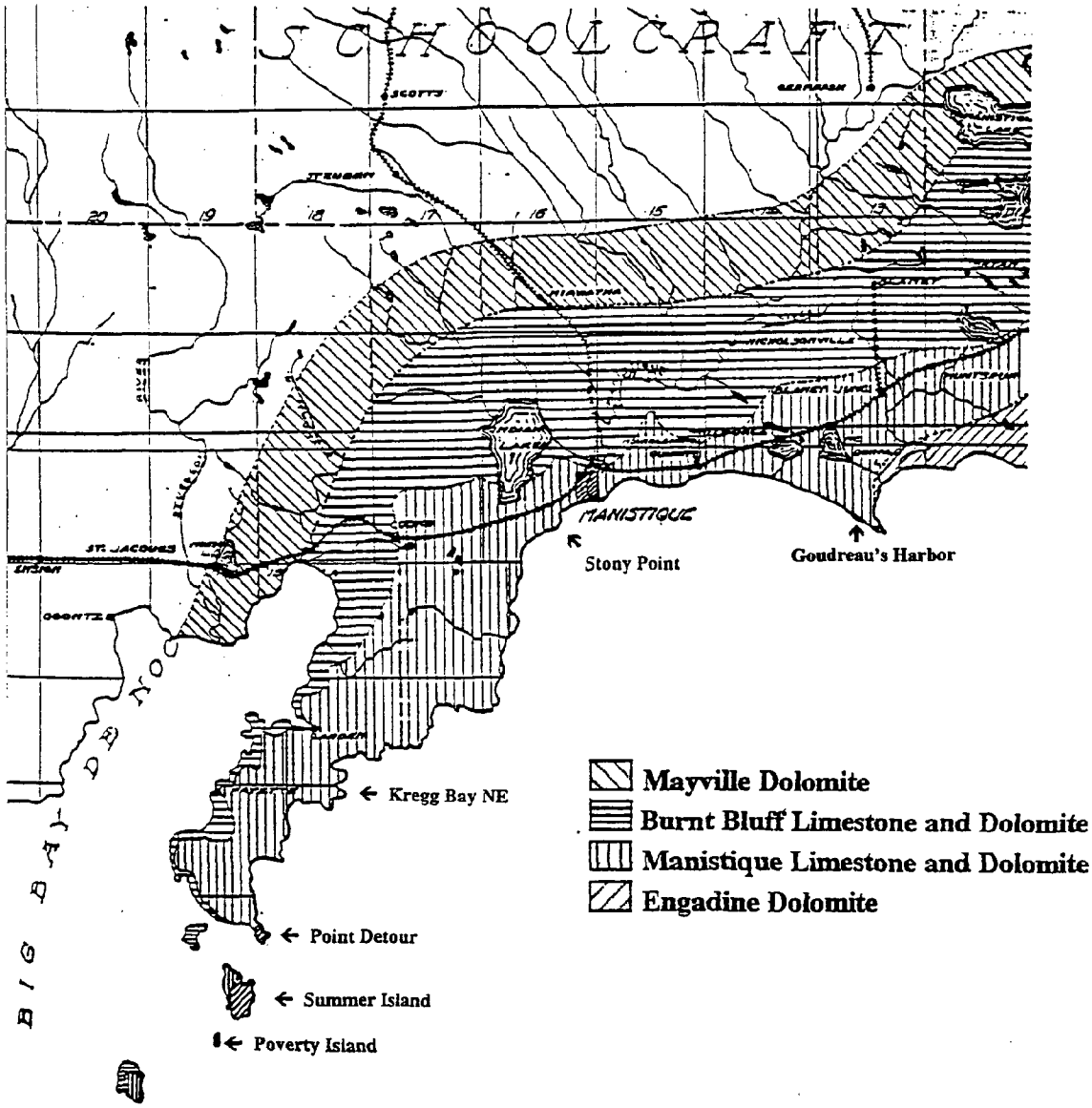


Figure 1. Map of the study area showing major bedrock formations and general location of the six bedrock beach survey sites. (Map from Ehlers 1973, p.10).

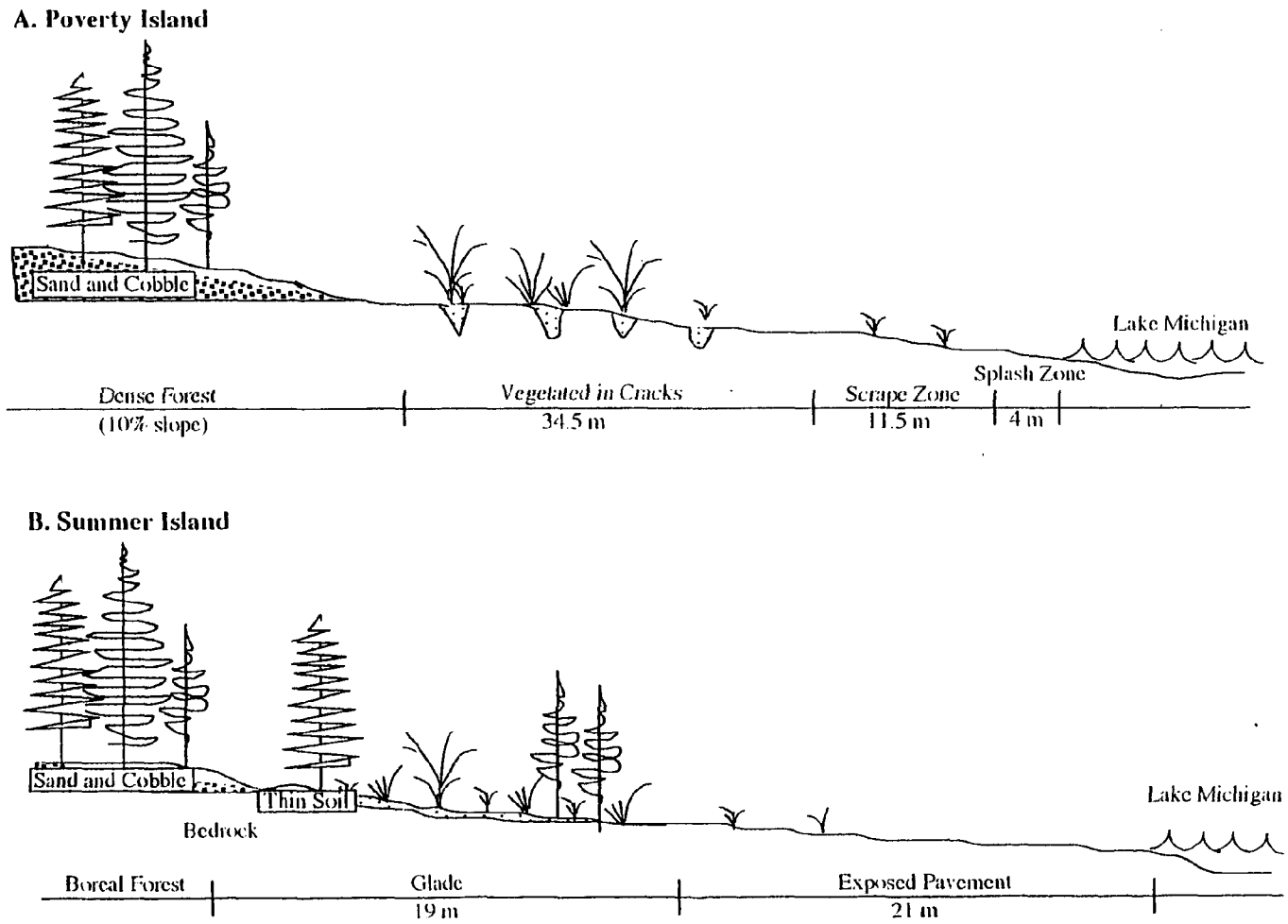


Figure 2A and B. Schematic diagrams of vegetative zones representative of those encountered on Poverty Island (A) and Summer Island (B).

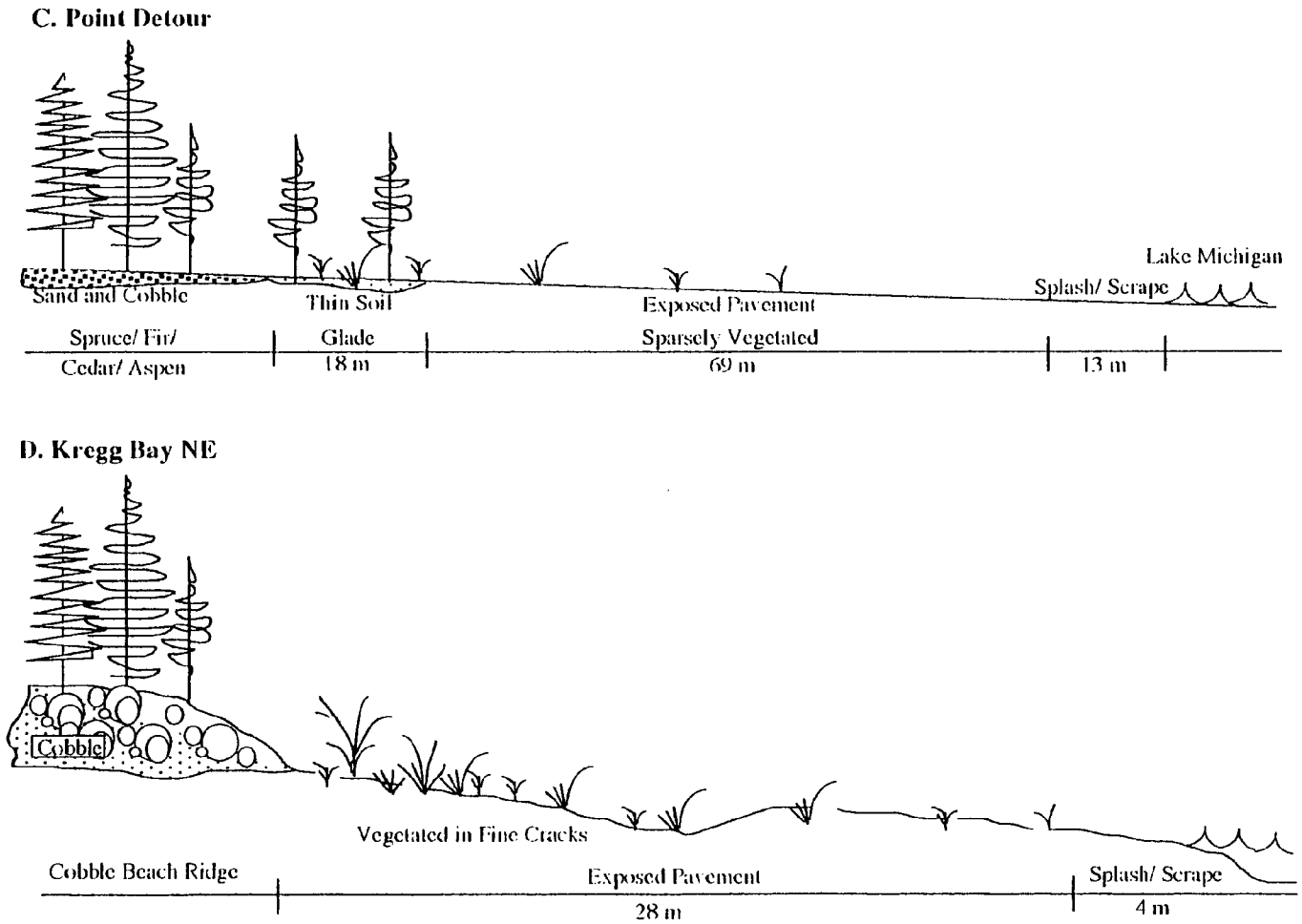


Figure 2C and D. Schematic diagrams of vegetative zones representative of those encountered on Point Detour (C) and Kregg Bay NE (D).

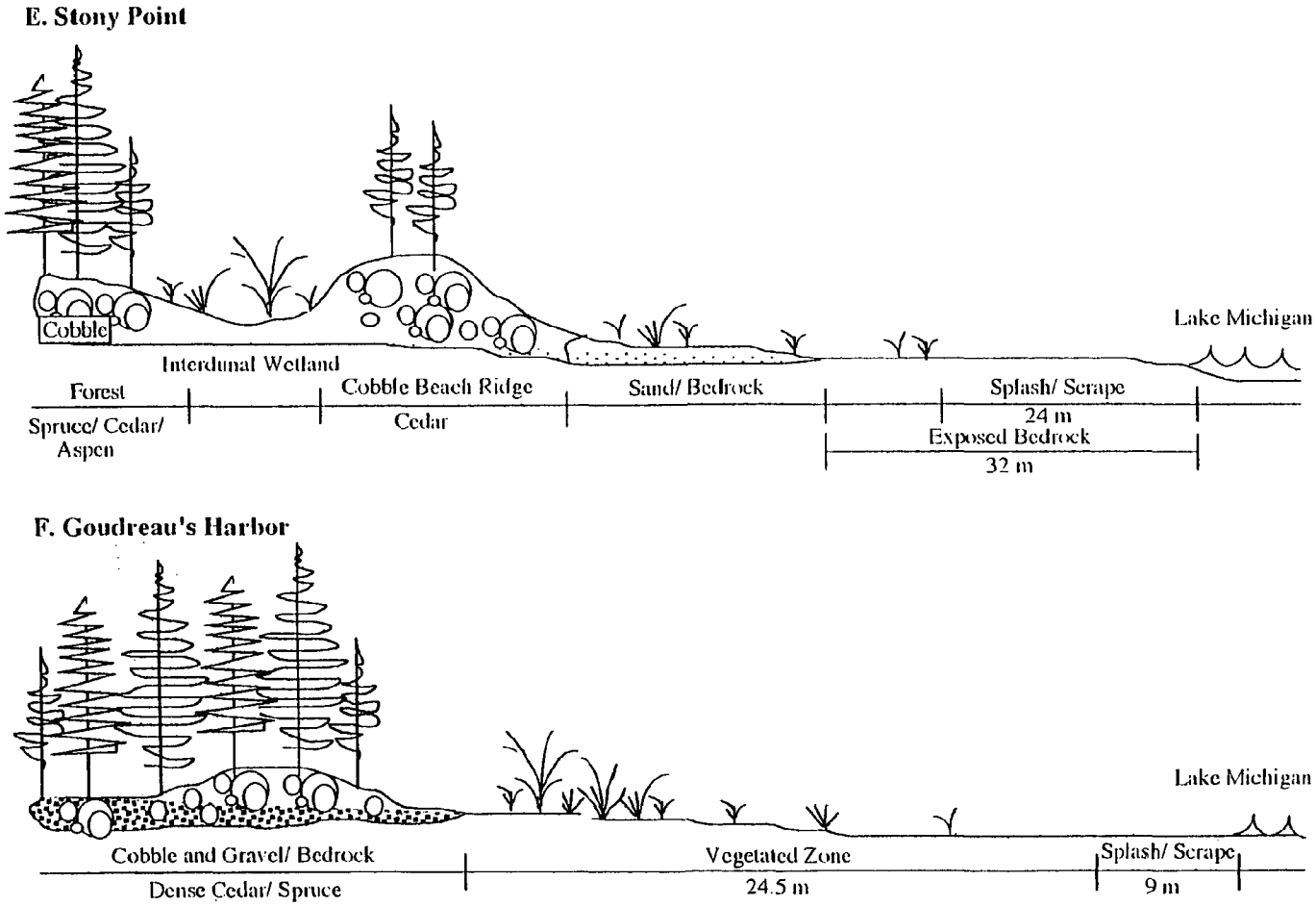


Figure 2E and F. Schematic diagrams of vegetative zones representative of those encountered on Stony Point (E) and Goudreau's Harbor (F).

Alvar

Dolomite or limestone pavement dominated by a plant community of herbs and grasses has been called alvar. Both the bedrock beach and the bedrock glade are treated as types of alvar.

Dry Alkaline Cliff

Where Dry Alkaline Cliffs were encountered, they were sampled and the results included in this report. Although the cliffs are generally low in botanical diversity, they are among the most visually appealing features of the bedrock shorelines (Plate 1c).

Boreal Forest

The boreal forest is an extensive habitat of the northern latitudes and, on the North American Continent, extends from Alaska to Newfoundland (Anonymous 1995). Most of the land on which this forest type occurs was under large sheets of continental ice as recently as 10,000 years ago. Due to the cool northern temperatures and the fact that the region was recently scraped to bedrock during the ice age, minimal soil development has occurred and the region is characterized by very shallow soils. The forest is dominated by coniferous vegetation, primarily spruce (*Picea*) and fir (*Abies*) species. Precipitation greatly exceeds evapotranspiration over the habitat and swamps, bogs, and marshes are abundant in the boreal forest.

There is some debate as to whether Michigan's upland forests dominated by balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), tamarack (*Larix laricina*), and northern white-cedar (*Thuja occidentalis*), along with white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*), should be considered part of the true boreal forest, since Michigan's upland conifer forest supports a greater number of tree species than boreal forests further north, and it also occurs in a mosaic of northern hardwood forests. For this report we will use the term boreal forest to include our conifer-dominated forests along the Great Lakes shoreline, and more specifically, on dolomitic bedrock.

SPECIAL PLANTS

Michigan's bedrock shorelines and their related natural communities, particularly in the Niagaran Escarpment region, support a rich and diverse assemblage of rare vascular plant species. Some of these species are known to be endemic to the Great Lakes, including such notable plants as dwarf lake iris (*Iris lacustris*) and Houghton's goldenrod (*Solidago houghtonii*), both of which are listed as federal and state threatened. The majority of the globally known populations of these two species are documented in Michigan, with major occurrences found in some bedrock shoreline areas. A host of other rare plants can be found in a variety of shoreline and near-shore bedrock habitats, ranging from cliff ferns, such as slender cliff-brake (*Cryptogramma stelleri*) and green spleenwort (*Asplenium viride*), to several rare sedges (*Carex scirpoidea, C. richardsonii, C. concinna*), grasses (*Danthonia intermedia, Poa alpina)*, and plants such as Lake Huron tansy

(*Tanacetum huronense*), a species that can be found on sand dunes and cobble shores in addition to bedrock sites.

INSECT SURVEYS

Bedrock and cobble shorelines of the Great Lakes contain many characteristic and endemic plant species, which have the potential to support unique assemblages of invertebrates, especially habitat restricted specialists. It is assumed that there some of the species found on the dolomite pavement (alvar) of Drummond Island and along the Escanaba River will also be shared with the dolomite pavement along the Great Lakes shoreline.

Little is known about the insect fauna of alvar regions and even less is known about alvar insects in Michigan. In addition to our study, there are two ongoing research projects in Michigan dealing with insects of alvar regions (S. Stephenson, pers. comm.; K. Hamilton, pers. comm.). So far, leafhoppers (Cicadellidae) have received the most study in these habitats including leafhopper species that feed on little bluestem (*Schizachyrium scoparium*), prairie dropseed (*Sporobolus heterolepis*), slender wheatgrass (*Agropyron trachycaulum*), small spikerush (*Eleocharis eliptica*), and creeping juniper (*Juniperus horizontalis*). Leafhoppers are excellent environmental indicators because only the smallest and lightest are regularly carried by wind, and these (subfamily Typhlocybinae) are generally tree-feeding species. Most members of other leafhopper subfamilies do not disperse rapidly or for a great distance (Hamilton and Langor 1987). In addition, many are monophagous (feed on one species of plant) and females of many prairie species are entirely flightless (Hamilton 1994). It has been determined that alvars and sandy areas of northern Michigan have leafhoppers mostly characteristic of Canadian prairies. Sixteen western leafhopper species are associated with such grasslands (Hamilton 1994). A primary goal of this study is to qualitatively describe the insect community for distinct vegetative associations on a variety of bedrock types, including the dolomite and limestone bedrock of the Niagaran Escarpment.

METHODS

BEDROCK CLASSIFICATION AND MAPPING

The bedrock classification used in this study was based on existing geological maps by Reed and Daniels (1987) and Ehlers (1973). Ehlers did detailed mapping and classification of the Paleozoic limestones and dolomites of the Niagaran Escarpment, including those of the shoreline in Schoolcraft and Delta Counties.

SURVEY SITE IDENTIFICATION

Air Photo Interpretation

Photo interpretation of black-and-white and color aerial photography, maintained by the Land and Water Division of the Michigan Department of Natural Resources, was used to identify potential bedrock beach sites within the study area. The Lake Michigan shoreline of Michigan's Upper Peninsula was evaluated from central Mackinac County to Menominee County. Photos of the area were available at the scale of 1 inch equals 500 feet, 1 inch equals 780 feet, and 1 inch equals 2000 feet, and proved excellent for mapping coastal bedrock. Although bedrock shoreline could be easily identified using air photographs, cliffs were less evident and were verified with a reconnaissance flight.

Aerial Reconnaissance

In addition to existing vertical imagery, reconnaissance flights were performed to provide oblique air photographs of the area (see the cover and Plate 2a). The oblique photographs were found to produce a more ecologically interpretable view of shoreline landscapes and were used to further document the extent and quality of the sites identified from vertical imagery.

Bedrock Shoreline Survey Sites

Following air photo interpretation, sites were selected for field survey. Sites found to have high quality areas of exposed bedrock shoreline and associated biota were field sampled. The six sites where vegetation sampling was conducted were **Poverty Island, Summer Island, Point Detour, Kregg Bay NE, Stony Point,** and **Goudreau's Harbor**. The general locations of these survey sites are presented in Figure 1 and detailed maps for each survey site are presented in Appendix 1A - 1F.

VEGETATION SAMPLING

Following site selection, intensive vegetation sampling was performed between June 21 and July 21, 1995. Sampling was conducted along transects that were oriented perpendicular to the shoreline and established along a meter tape extended from the shoreline to the forest zone. The exact bearing and percent slope was measured and recorded for each transect. Schematic diagrams showing slope, bedrock surface, moisture conditions, and approximate width of each vegetative zone were produced for each transect. Vegetation was sampled by placing each species into one of four relative abundance categories. Percent coverage values were estimated for each species as well, by sampling each vegetation zone with a 5 x 5 m plot. Point sampling was conducted for overstory species (>4 inches in diameter) using a BAF 10 prism in the glade and or forest zones, and the presence of each shrub and herbaceous species was also recorded.

SPECIAL PLANTS SURVEY METHODS

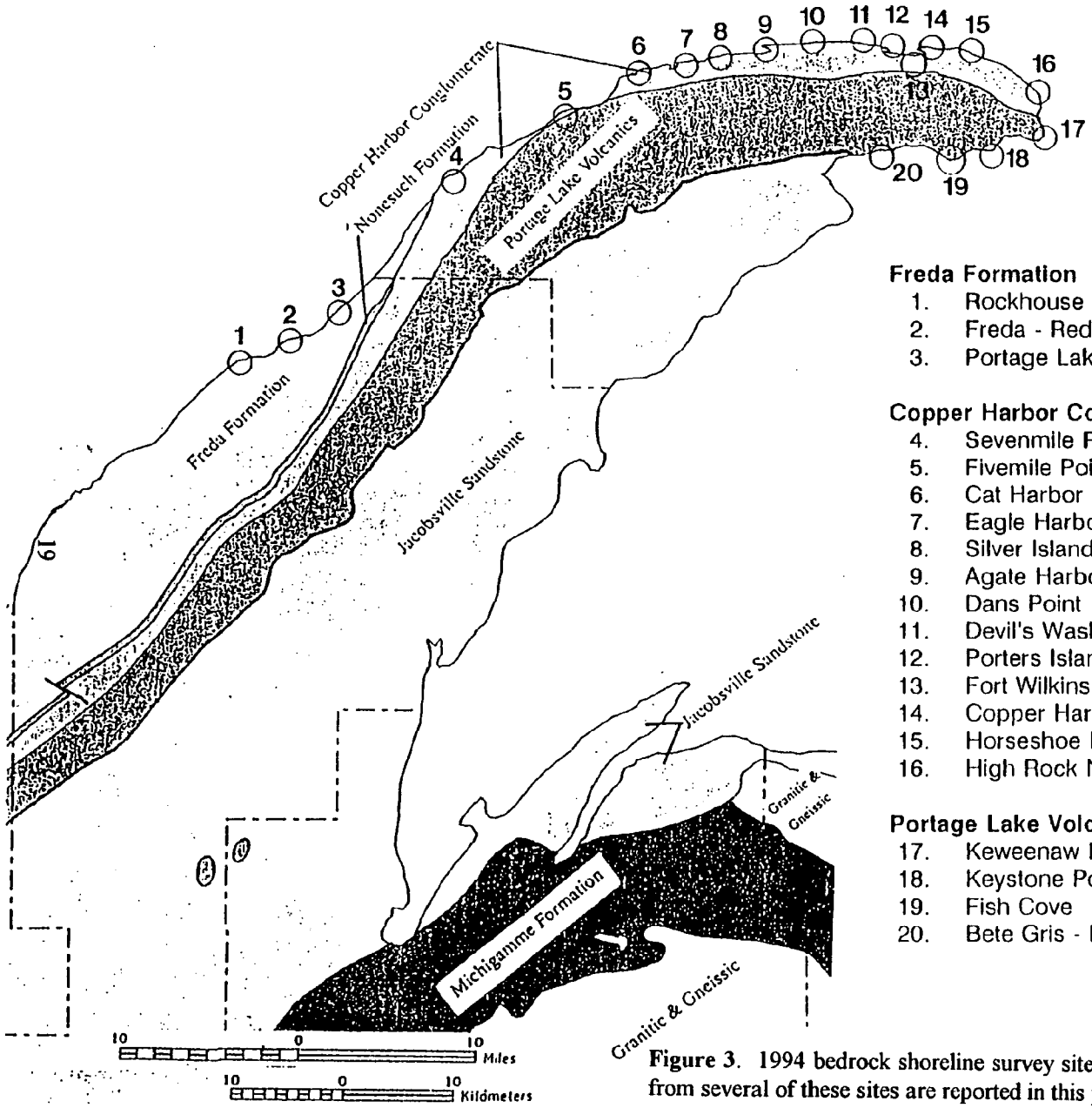
Prior to field inventories, the Michigan Biological and Conservation Database (BCD) was consulted to determine the number and extent of previously documented special plant occurrences likely to be encountered during surveys. These species formed the basis of a priority list to carry into the field, with particular attention given to the rarest taxa, i.e. those with global and/or state ranks of G1-G3 and S1-S3 (see Appendix 3 for criteria used to assign ranks). Special priority was also given to occurrences with historical to relatively old last observation dates, such that these populations could be sought during surveys to determine their present status, extent, and condition. Compiling a list of priority species also provided the opportunity to review phenologies and thus anticipate the best period(s) in which to conduct bedrock surveys.

Special plants were inventoried primarily during natural community surveys as sites were traversed and more or less systematically meander-searched to determine the general community quality. Edges of communities and other ecotonal habitats were concentrated upon, as these microsites were known to frequently support colonies of the target species. Richardson's sedge (*Carex richardsonii*), for example, was sought at the periphery of wet bedrock sites where habitat transitioned into drier glades, whereas more exposed bedrock areas were searched for bulrush sedge (*Carex scirpoidea*). When identified, special plant locations were noted on topographic maps, and special plant forms were initiated for eventual occurrence updating or transcription of new records. Where appropriate, voucher specimens were pressed and prepared for hebarium accessioning. Lastly, reference photographs of selected rare species were taken in representative areas (see Plate 4a-4d).

INSECT SURVEY METHODS

Field work was conducted at 16 sites throughout the summer of 1995 in Chippewa, Delta, and Keweenaw Counties, Michigan (Figures 1, 3, and 4). Three types of insect surveys were conducted in 1995. The first type of inventory, consisting of preliminary surveys, was conducted on some of the high quality sites that were identified by MNFI ecologists and botanists along the mainland shoreline of Schoolcraft and Delta Counties, including Point Detour and Kregg Bay; other sites on the mainland did not receive a preliminary survey due to a severe mid-season illness of the staff zoologist. A second type of survey was an intermediate level survey of Poverty, Little Summer, and Summer Islands, where aerial and sweep netting, as well as light trapping was conducted during three days of field visits in early June of 1995. A third type of insect survey was the revisit of several high quality bedrock sites identified by ecologists and botanists during the 1994 surveys. These 1994-survey sites were visited two or three times during the spring, summer, and early fall. Most of the results reported here are for Drummond Island sites identified in 1994, with some insect sampling in 1995. See Albert et al. (1994) for detailed descriptions of these study areas. Results from this study and further survey work by staff ecologists will be used to focus additional work in 1996.

Several methods were used for surveying insects. Insects were collected with aerial and sweep nets. Light trapping, a method used to document the occurrence of nocturnal insects, was utilized at four sites. Approximately half of the time at each site was spent making a general collection of species present, while the remainder of the time was spent focusing on state or federally listed



Freda Formation

1. Rockhouse Point - Graveraet River
2. Freda - Redridge
3. Portage Lake - Ship Canal West

Copper Harbor Conglomerate

4. Sevenmile Point
5. Fivemile Point - Eagle River
6. Cat Harbor - Eagle Harbor
7. Eagle Harbor - Grand Marais Harbor
8. Silver Island: Grand Marais Harbor - Bailey Creek
9. Agate Harbor: Esrey Park - Lake Glazon
10. Dans Point
11. Devil's Washtub
12. Porters Island
13. Fort Wilkins State Park
14. Copper Harbor Lighthouse - Norland Trust
15. Horseshoe Harbor
16. High Rock North

Portage Lake Volcanics

17. Keweenaw Point: High Rock Bay - Keystone Bay
18. Keystone Point
19. Fish Cove
20. Bete Gris - Bear Bluff

Figure 3. 1994 bedrock shoreline survey sites on the Keweenaw Peninsula. Insect survey results from several of these sites are reported in this paper.

Queenston Shale

1. Maxton Plains West
2. Chippewa Point
3. Grand Marais Lake
4. Poe Point
5. Maxton Plains Middle
6. Raynolds Point
7. Maxton Plains East

Manistique Group (Dolomite)

8. Marble Head

Engadine Group (Dolomite)

9. Bass Cove - Little Shelter Bay
10. Big Shoal Cove
11. Seamans Point
12. Warners Cove
13. Huron Bay

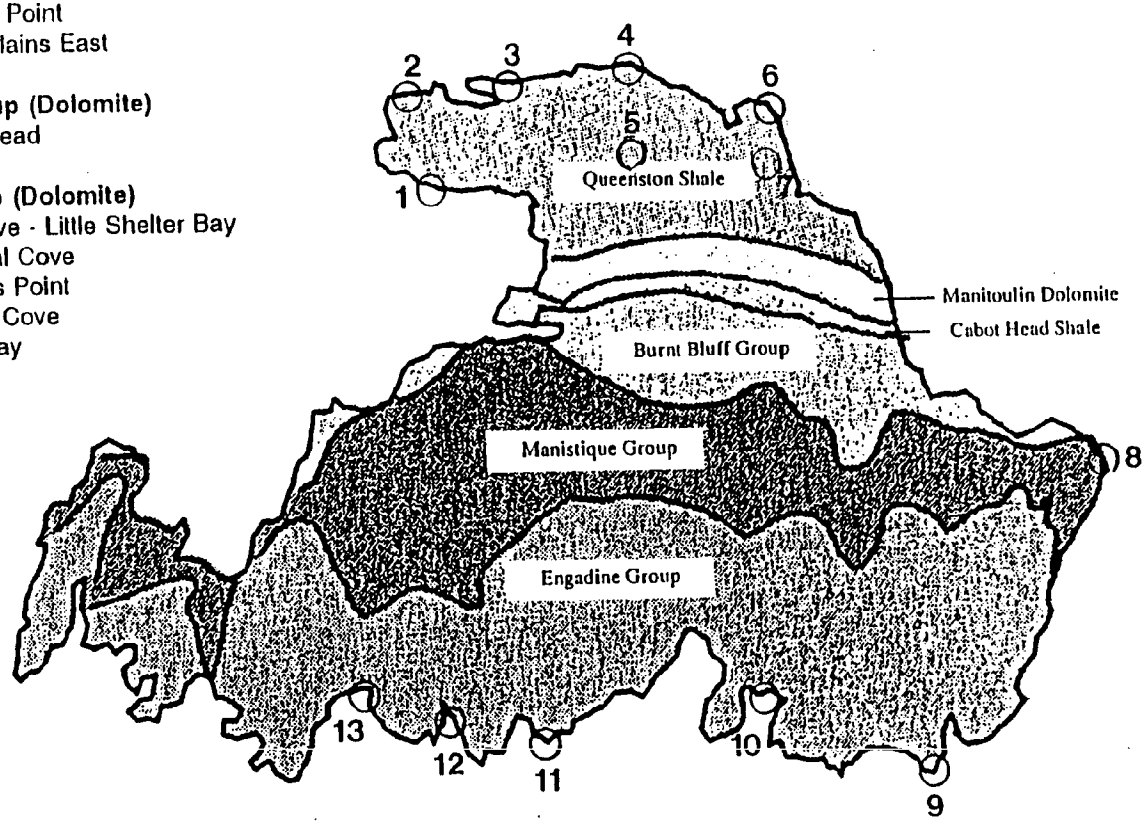


Figure 4. 1994 bedrock shoreline survey sites on Drummond Island. Insect survey results from several of these sites are reported in this paper.

species including the state special concern red-legged spittlebug, (*Prosapia ignipectus)*; the state special concern and federal candidate (C2) Aweme borer moth (*Papaipema aweme)*; the state threatened northern blue butterfly (*Lycaeides idas nabokovi*); the federally endangered Ohio emerald dragonfly (*Somatochlora hineana*); the state special concern warpaint emerald dragonfly (*Somatochlora incurvata*); and the state special concern and federal candidate (C2) tawny crescent butterfly (*Phyciodes batesii*).

Within the general collection category only certain target groups were given priority in collecting, sorting, and identification, because these groups contain many habitat restricted species. The groups included certain families within the Odonata (dragonflies and damselflies), Orthoptera (grasshoppers and katydids), Hemiptera (true bugs), and Homoptera (leafhoppers, spittlebugs, planthoppers, and treehoppers). Species that could be identified in the field were recorded and released. For species that required further study for accurate identification, individuals were collected and prepared following standard insect collection techniques. Insects were keyed to the genus or species level using published references, or were sent to experts.

RESULTS OF 1995 FIELD SEASON

SUMMARY OF NIAGARAN ESCARPMENT BEDROCK SURVEY SITES

The bedrock portions of Schoolcraft and Delta Counties have been divided into six major sites shown on Figure 1 (page 11). More detailed maps of each site are shown in Appendix 1. Information is provided for each of these sites in a summary table (Table 1), which includes site name, location (Township and Range), bedrock type, bedrock classification according to Ehlers (1973), length of bedrock beach, average bedrock beach width, cliff length, ownership (state or private), and level of development. Table 2 is a summary table of plant communities and rare plant occurrences for each survey site. Rare plants are discussed within the bedrock survey sites below.

Poverty Island

Poverty Island, approximately 150 acres in size, is located just southwest of Summer Island. The island is nearly all bedrock sloping gently to the east. As a result, the island contains low cliff all along the west shore (Plate 1c), bedrock beach along the east shore, and dense boreal forest throughout the island's interior. The bedrock beach, averaging 50 m wide, extends for approximately 0.6 mile along the eastern shoreline. It contains a distinctive splash/scrape zone up to 15 m wide that is sparsely vegetated with silverweed (*Potentilla anserina*), low calamint (*Satureja arkansana*), and harebell (*Campanula rotundifolia*). The vegetated zone (Plate 2c) has about 20 percent cover, with shrubby cinquefoil (*Potentilla fruticosa*), rush (*Juncus balticus*), willow (*Salix eriocephala*), grass-leaved goldenrod (*Euthamia graminifolia*), and Ohio goldenrod *(Solidago ohioensis)* among the dominant plant species. Rare plant species associated with this bedrock beach are dwarf lake iris (*Iris lacustris*), beauty sedge (*Carex concinna*), and

Table 1. Summary data for 1995 bedrock beach survey sites.

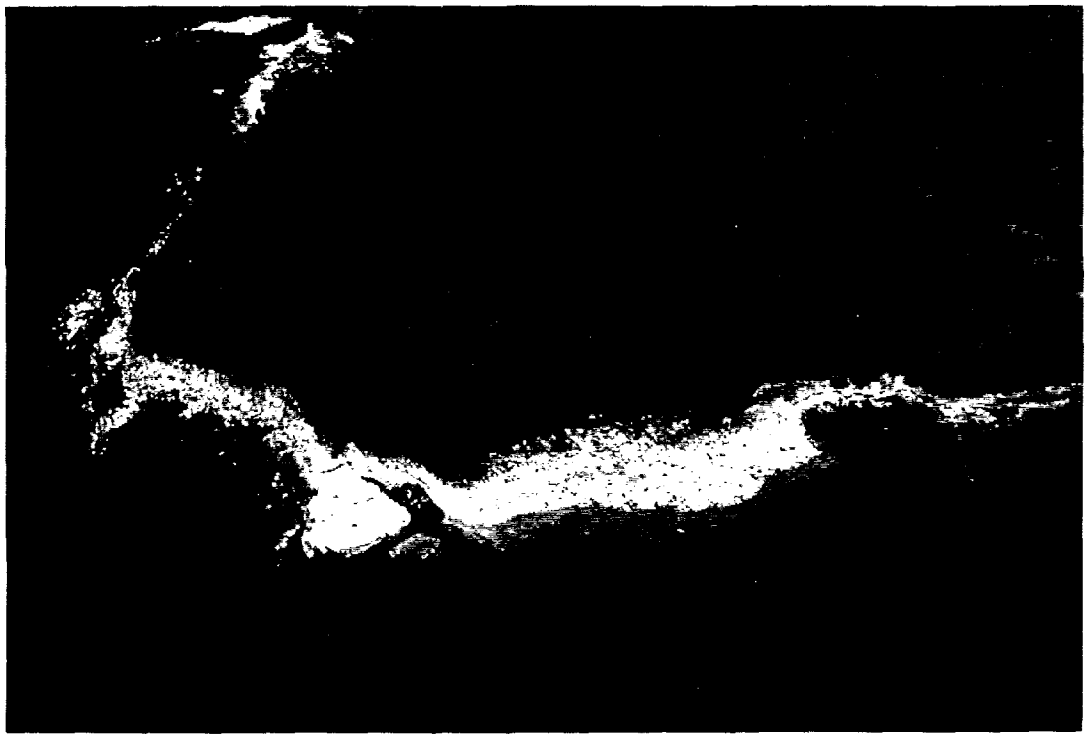
Site	Township/ Range	Bedrock Type	Bedrock Classification	Bedrock Beach: Length (mi)	Average Bedrock Beach Width (ft)	Cliff Length (mi)	Ownership[1]	Level of Development[2]
Poverty Island	T36N R19W	Dolostone	Engadine Dolomite	0.6	164	1.4	MI	U
Summer Island	T36-37N R19W	Dolostone		1.8	98	0.7	MI/P	M
Point Detour	T37N R19W	Dolostone		1.2	190	1.7	MI/P	U
Kregg Bay NE	T38N R18W	Limestone	Manistique Limestone and Dolomite	1.5	100	--	MI/P	H
Stony Point	T41N R16W	Dolostone		0.5	138	--	P	M
Goudreau's Harbor	T41N R13W	Dolostone		2.0	110	--	P	H

1. **MI** = State of Michigan, **P** = private, **MI/P** = mixed State and private.
2. **U** = undeveloped, **M** = moderate development, **H** = heavily impacted by development.

Table 2. Summary of plant communities and rare plant occurrences for the 1995 bedrock beach survey sites. A ● indicates that this is the first reported occurrence of a particular plant or community at the survey site, whereas a ■ indicates that it was previously known from the site. An o indicates that the plant was known to exist at the location, although it was not found or searched for in 1995.

Plant Community or Rare Plant	Bedrock Beach Survey Site					
	Poverty Island	Summer Island	Point Detour	Kregg Bay NE	Stony Point	Goudreau's Harbor
Communities						
Bedrock Beach (G2G3,S2)[1]	●	●	●	●	●	●
Dry Alkaline Cliff (G4,S3)	●	●				
Boreal Forest (GU,S3?)	●					
Bedrock Glade (GU,S3)		●	●			
Plants						
Asplenium viride (G5,S2S3)						o
Carex concinna (G4G5,S3)	●	●	●			o
Carex richardsonii (G4,S3S4)	■	●	●			o
Cryptogramma stelleri (G5,S3S4)		■[2]				o
Danthonia intermedia (G5,S1S2)						o
Iris lacustris (G3,S3)	■	●	■			■
Solidago houghtonii (G3,S2S3)						■
Tanacetum huronense (G3Q,S3)						■
Thalictrum venulosum (G5,S2)						o

[1](GX,SX) = (Global Rank, State Rank). Refer to Appendix 3 for further information.
[2] Found on interior limestone cliff, not on alvar.



Poverty Island: Dolomite pavement along southeast shoreline

Richardson's sedge (*C. richardsonii*). The boreal forest that dominates the entire interior portion of the island is a very high quality example of it's type for Michigan. Although the forests of this island are continually blown down by gusts off Lake Michigan, there are a number of groves of mature northern white-cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), and paper birch (*Betula papyrifera*). The lack of deer on the island has allowed for extensive thickets of Canada yew (*Taxus canadensis*) to develop throughout the island interior. The alkaline cliff, varying from 2-8 m high, is among the more picturesque of the low cliffs in this part of Lake Michigan (Plate 1c). It is sparsely vegetated throughout its face, but has a dense thicket of northern white-cedar and balsam fir along the top. Poverty Island is wholly state owned. There is an abandoned lighthouse located at the southern extreme of the island.

Summer Island

Totaling nearly 2,200 acres in size, Summer Island contains a diversity of forests and Great Lakes shoreline. As with Poverty Island to the southwest, Summer Island is underlain by limestone-dolomite bedrock that dips gently to the east. However, there is much deeper soil throughout Summer Island, and as a result, it supports both boreal forests and northern hardwoods throughout the island interior. A west-facing dry alkaline cliff is located in the islands interior. Survey of the cliff re-confirmed a previously known population of slender rock-brake (*Cryptogramma stelleri*).

The bedrock beach extends for 1.6 miles along the easte shoreline. The width of the beach ranges from 20-30 m. The splash/scrape zone varies from 8-16 m wide and is sparsely vegetated.

The vegetated zone (Plate 3a) contains less than 15% cover, with shrubby cinquefoil (*Potentilla fruticosa*), Ohio goldenrod (*Solidago ohioensis*), Indian paintbrush (*Castilleja coccinea*), rush (*Juncus balticus*), spike-rush (*Eleocharis pauciflora*), and false asphodel (*Tofieldia glutinosa*) among the common plant species. Rare plant species found along the inland edge of the bedrock beach were dwarf lake iris (*Iris lacustris*) (Plate 3a), beauty sedge (*Carex concinna*), and Richardson's sedge (*Carex richardsonii*). Near the south end of the island, a small area of bedrock glade (Plate 3c) extends another five meters inland from the shoreline. The glade is dominated mostly by herbaceous plants, with patches of exposed bedrock at the surface. Hair grass (*Deschampsia cespitosa*), low calamint (*Satureja arkansana*), bastard-toadflax (*Comandra umbellata*), Kalm's St. John's wort (*Hypericum kalmianum*), and sedge (*Carex eburnea*) are among the dominant vascular plant species. Several unidentified moss species were also common throughout the glade. There is an active hunt camp and several access roads located adjacent to the glade, so it is possible that the glade may be, at least in part, the result of past land use. Portions of Summer Island fall on state forest land. Although there are several homes located on the north end of the island, there are currently no permanent island residents.

Summer Island: Bedrock beach and boreal forest along eastern shoreline.

Point Detour

Point Detour extends southeast from the southern tip of the Garden Peninsula (see cover photo). Bedrock beach is found in four distinct segments totaling 1.2 miles in length along the eastern side of the point. Between the segments of bedrock beach there are low cliffs and cobble beaches. The width of the bedrock beach varies from 16 to 100 m, with the widest portion found at the south end. The splash/scrape zone varies from 3 to 10 m wide and is sparsely vegetated.

The vegetated zone (Plate 3b) is best developed along the wide southern-most segment, where vegetative cover reaches 70 percent and common plant species include beak-rush (*Rhynchospora capillacea*), golden-seeded spike-rush (*Eleocharis elliptica*), rush (*Juncus balticus*), Ohio goldenrod (*Solidago ohioensis*), dwarf Canadian primrose (*Primula mistassinica*), spike-rush

Point Detour: Low cliffs of broken dolomite.

(*Eleocharis pauciflora*), and low calamint (*Satureja arkansana*). A small portion of bedrock glade (Plate 4a) is found along the inland margin of the southern-most segment of bedrock beach. This area is dominated by northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), shrubby cinquefoil (*Potentilla fruticosa*), hair grass (*Deschampsia cespitosa*), Ohio goldenrod (*Solidago ohioensis*), and blue-joint (*Calamagrostis canadensis*). Along most of this shoreline there is a low cobble ridge on the inland margin of the beach that supports a dense boreal forest of white spruce, northern white-cedar, balsam fir (*Abies balsamea*), and quaking aspen (*Populus tremuloides*). No rare plant species were encountered along this stretch of shoreline.

All but the southern tip of Point Detour falls on State Forest land. However, there is easy access to this stretch of shoreline, so there is potential for habitat destruction from illegal use of off road vehicles.

Kregg Bay NE

This is a one mile-long stretch of bedrock beach along two small points and a bay that extends southeast into Lake Michigan. It is located just south of Charbaneou Lake and the Portage Bay State Campground. The width of the bedrock beach varies from 17 to 28 m and is quite irregular in rock structure and composition. The southern-most portions are similar in structure to the

bedrock beach at Point Detour, with bleached dolostone containing cracks several inches wide. There are also several large broken rocks and extensive inter-rock pools in this area. The splash zone is generally about four meters wide and very sparsely vegetated. The vegetated zone measures about five meters wide, and has a vegetative coverage of about 5 percent. Common plant species in this area are hair grass (*Deschampsia cespitosa*), harebell (*Campanula rotundifolia*), smooth aster (*Aster laevis*), and low calamint (*Satureja arkansana*).

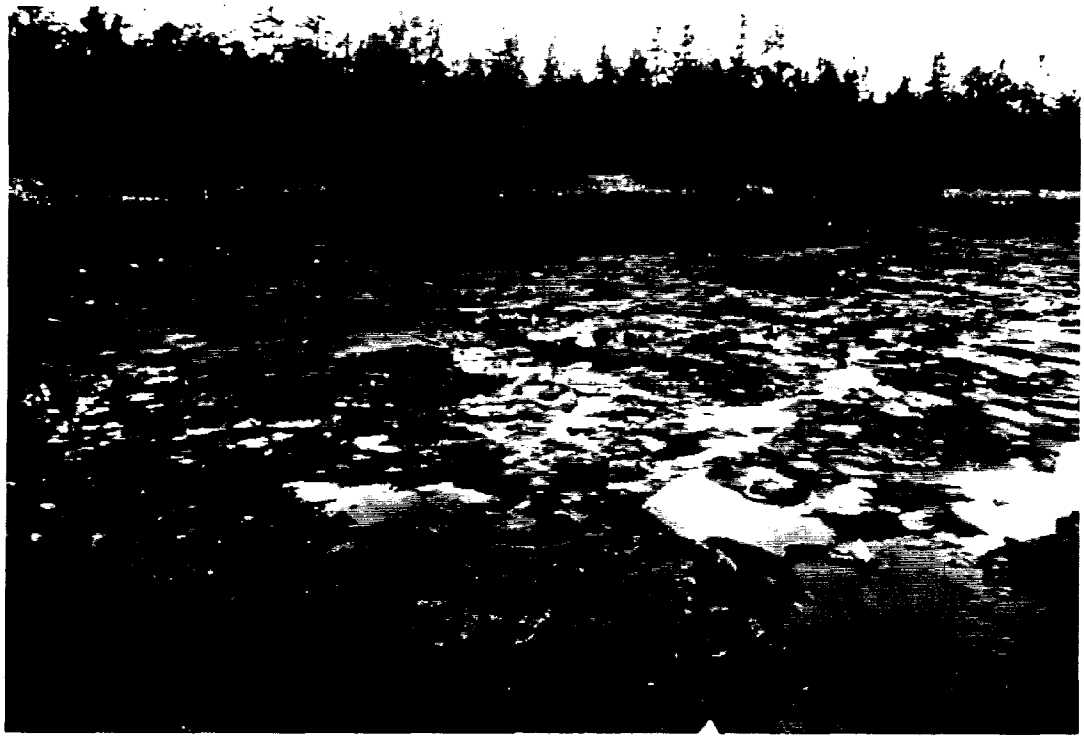
Kregg Bay NE: Fine cracks in argillaceous dolomite at Charbaneau Point.

Along the south side of Charbaneau Point, the dolostone is not bleached and contains very fine cracks (Plate 1a). Much of this exposed bedrock beach is probably inundated during high Great Lakes water levels. Sand has washed down from the inland margins over the surface of portions of this bedrock, providing habitat for many plant species. The splash/scrape zone in this area is about 11 m wide, and is completely unvegetated. The vegetated zone is covered with sand on five percent of it's surface, with total vegetative cover reaching about 3 percent. Common plant species along this stretch of shoreline are grass-leaved goldenrod (*Euthamia graminifolia*), sedge (*Carex viridula*, *C. hystericina*), rush (*Juncus dudleyi*), silverweed (*Potentilla anserina*), and hair grass (*Deschampsia cespitosa*). The inland margin of the entire shoreline is a 1.5 to 5 m high cobble ridge. Nearly all of the ridge supports dense boreal forest of white spruce (*Picea glauca*), northern white-cedar (*Thuja ocidentalis*), quaking aspen (*Populus tremuloides*), and white pine (*Pinus strobus*). No rare plant species were encountered along this shoreline.

The central portion of this shoreline is included within state forest land. Private tracts containing vacation homes are found on both Charbaneau Point and Kregg Bay. Recent tree removal and trail development have taken place inland along the west end of the this bedrock beach. There is much potential for habitat destruction along this stretch of shoreline.

Stony Point

This 0.75 mile-long stretch of shoreline contains exposed bedrock similar in structure and composition to that mentioned along Charbaneau Point. It contains fine cracks in mostly unbleached dolomite. This portion of bedrock beach is clearly inundated during high Lake Michigan water levels. There is a considerable amount of sand washed down onto this bedrock, most of which is saturated with surface seepages. There is also a low cobble ridge located just inland of the bedrock beach; this low ridge is backed by a narrow interdunal wetland (see photo below). Farther inland is boreal forest of white spruce (*Picea glauca*), tamarack (*Larix laricina*), balsam fir (*Abies balsamea*), and northern white-cedar (*Thuja occidentalis*).



Stony Point: Fine argillaceous dolomite beach with interdunal swale in background.

The splash/scrape zone of this shoreline is about 24 m wide, and is almost entirely unvegetated. The eight meter-wide vegetated zone contains roughly 30 percent vegetative cover, 20 percent open pools, and 50 percent exposed bedrock. Common plant species in the vegetated zone are spike-rush (*Eleocharis acicularis*), grass-leaved goldenrod (*Euthamia graminifolia*), three-square bulrush (*Scirpus americanus*), sedge (*Carex crinita*), and Canadian rush (*Juncus canadensis*). Most vegetation occurs where 1-2 inches of sand have accumulated on the bedrock surface. No rare plants were located along this stretch of shoreline.

Stony Point is privately owned. It was offered to the State and rejected as a Natural Resources Trust Fund nomination in 1995. There is easy access to the site from US-2, which passes nearby along the Lake Michigan shoreline.

Goudreau's Harbor

This is among the most extensive and scenic stretches of bedrock beach in the state (Plates 1b and 2a-b). The bedrock beach of Goudreau's Harbor extends for over two miles along the west side of Seul Choix Point. It is broken into a number of distinct segments that are probably connected when Lake Michigan water levels are low. Past rare plant surveys have been conducted along the entire length of this shoreline. Site visits for plant community characterization were conducted at the east end near Seul Choix Point.

Although the width of bedrock beach at this site is quite variable, it averages 33 m wide at the east end. The splash/scrape zone (Plate 2b) is nine meters wide and is sparsely vegetated. The vegetated zone (Plate 1c) is also quite sparsely vegetated, with common plant species including rush (*Juncus balticus*), low calamint (*Satureja arkansana*), sedge (*Carex viridula*), northern bog violet (*Viola nephrophylla*), silverweed (*Potentilla anserina*), Canadian rush (*Juncus canadensis*), and shrubby cinquefoil (*Potentilla fruticosa*). Inland of the bedrock beach, there is dense boreal forest mostly dominated by northern white-cedar (*Thuja occidentalis*). A number of rare plant species occur along this portion of shoreline, including dwarf lake iris (*Iris lacustris*), Lake Huron tansy (*Tanacetum huronense*), oat grass (*Danthonia intermedia*), veiny meadowrue (*Thalictrum venulosum*), Houghton's goldenrod (*Solidago houghtonii*), and green spleenwort (*Asplenium viride*). Piping plovers (*Charadrius melodus*) are known to nest along this stretch of shoreline.

The Goudreau family owns nearly all of this shoreline. There are several homes built along the edge of the bedrock beach. The lighthouse at Seul Choix Point is located just inland of the bedrock beach, and lawns extend to the bedrock beach in several places.

SUMMARY OF SPECIAL PLANTS

Table 2 summarizes special plant occurrences for the six sites surveyed in 1995. Three new occurrences were documented for beauty sedge (*Carex concinna*, state special concern), two new occurrences for Richardson's sedge (*C. richardsonii*, state special concern), and one new occurrence for dwarf lake iris (*Iris lacustris,* federal and state threatened). One known occurrence of Richardson's sedge, one known occurrence of slender cliff-brake (*Cryptogramma stelleri*, state special concern), and two known occurrences of dwarf lake iris were observed, and updated occurrence information for these populations was compiled. Completed forms for these occurrences will be processed and entered into the statewide biological and conservation database. The most significant occurrences are those of Point Detour, an extensive alvar glade community that supports populations of Richardson's sedge, beauty sedge, and especially dwarf lake iris, which dominates several large, high quality glade openings.

PRELIMINARY RESULTS FROM 1994 AND 1995 INSECT SURVEYS

SUMMARIES OF KEWEENAW PENINSULA SITES

Five sites in the Keweenaw Peninsula (Figure 2) were surveyed for insects during 1995. Most of the survey work focused on the open bedrock glades. While no state-listed insects were collected here, we are gaining a better understanding of the insect communities that occur in bedrock glades. In addition, several new state and county records and disjuncts were recorded as part of this study. A total of 39 species of insects from the target groups have been recorded from the Keweenaw Peninsula sites. A complete list of insects recorded by site is summarized in Appendix 2.

Agate Harbor

The large open bedrock glade dominated by white pine (*Pinus strobus*), red pine (*Pinus resinosa*), balsam fir (*Abies balsamea*), red oak (*Quercus rubra*), and several species of shrubs was sweep-netted on two occasions during the 1995 season. The site contains typical insect species one would associate with these plant communities.

Dan's Point

Insect sampling was conducted within the bedrock glades north of M-26 and along the bedrock shoreline north of the highway. Three species of dragonflies were recorded at the site including *Enallagma boreale*, *Leucorrhinia hudsonica*, and *Sympetrum obtrusum*. Most of the insects from this site, including many leafhoppers, are still being identified by experts. This site contains a high quality alvar glade and further invertebrate survey work is recommended including black lighting for nocturnal insects and land snail surveys.

Devil's Washtub

The broad glade that parallels the shoreline was sweep netted on two occasions in 1995. The site is dominated by red pine (*Pinus resinosa*), white pine (*Pinus strobus*), and several shrub species. There are also small openings that are dominated by grasses. Black lighting is recommended for the glade so that we can continue to identify the insect communities that are associated with these unique habitats.

Horseshoe Harbor

Sweep net samples and black lighting occurred at the eastern edge of the preserve in the narrow bedrock glades which are dominated by conifers and various shrubs. Three species of dragonflies were recorded from the preserve including *Enallagma cyathigerum*, *Epitheca canis*, and *Cordulia shurtleffi*. Four species of noctuid moths in the Genus *Catacol*, a known commonly as underwings, were recorded during the August black lighting. This included *Catocala concumbens*, *C. relicta*, *C. semirelicta*, and *C. unijuga*. Many other insects collected here in 1995 are still being identified and the final species list for this site will greatly increase.

Fish Cove

The bedrock glade west of the Montreal River was sampled. In addition, specific survey for the Northern blue (*Lycaeides idas nabokovi*) was conducted here because the host plant (*Vaccinium cespitosum*) is known from the area. Neither the plant nor the butterfly were located at this site but further survey is recommended due to the diminutive nature of the plant and the short flight period of the butterfly.

SUMMARIES OF DRUMMOND ISLAND SITES

Insect survey work was conducted at five sites on Drummond Island during September 1994 and during the summer of 1995. The sampling on Drummond Island focused on open grassland areas, pavements, and a few small bedrock glades. In addition to black lighting and sweep netting, we also included Malaise trapping and pitfall trapping as insect survey techniques during 1995. These samples, however, are still being processed and will be included in the final report. No state-listed insects were recorded from Drummond Island during this survey yet several new county records and disjuncts were recorded. A total of 118 species from the target groups was recorded from Drummond Island. A complete list of insects listed by survey site is included in Appendix 2.

Maxton Plains West

Several sweep net samples were taken throughout the alvar grassland areas and one night of blacklighting was conducted in 1994. Sixty-seven species of insects from the target groups have been recorded from Maxton Plains West (Appendix 2) including 23 species of leafhoppers (Cicadellidae). Some of the typical prairie species found here include *Aceratagallia* n. sp. (being described by K.G.A. Hamilton), *Flexamia delongi*, and *Chlorotettix unicolor*.

Grand Marais Lake (Maxton Plains North)

This site was surveyed one time during the summer of 1995. Sweep net samples were taken within three separate glades near Grand Marais Lake. All of the leafhoppers have not yet been identified from this site, but a species of *Flexamia* (probably *F. delongi*) has been recorded from one of the glades.

Maxton Plains Middle

Sweep net samples were taken both in 1994 and 1995 at this site. A total of 30 species were recorded from the target groups. Thirteen species of leafhoppers were recorded from this site including *Chlorotettix unicolor*.

Maxton Plains East

Maxton Plains East contains one of the most disturbed alvar areas that were sampled for insects. Sweep net samples were taken here in 1995 to be used in comparison with more pristine alvar sites such as Maxton Plains Middle or Maxton Plains West. Only 9 species of leafhoppers were taken at Maxton Plains East but this did include a *Flexamia* species.

Seamans Point

A single sweep net sample was taken here in 1994. The site contains both open pavement and bedrock glade and further survey work is recommended.

Warners Cove

Two sweep samples and one night of black lighting was conducted at Warners Cove in August of 1995. The pavement shoreline here is confined to less than a quarter mile and contained no special insects. In addition to the shoreline, some very small glades further inland were sampled for insects.

Huron Bay

Insect sampling at Huron Bay occurred along the shoreline in section 13 north of Helen's Lake and in the small glade farther inland in section 12. Black lighting at this site occurred on one occasion in 1994 and once in 1995. A total of 48 species from the target orders have been recorded from the inland glade. This site also contains the leafhopper (*Flexamia delongi*), a species associated with prairie.

Big Shoal Cove

The largest dolomite pavements in section 18 were sweep netted for insects. Although this site is one of the richest sites on Drummond Island, containing nine special plants, no special insects were recorded here during these surveys.

Bass Cove Road

This site is not a true alvar area but several dragonflies were observed feeding along the road openings and basking on the gravel road margins. Eight species of dragonflies were recorded from the site, none of which are state-listed or of conservation concern.

SUMMARIES OF GARDEN PENINSULA SITES

Insect survey work within the Garden Peninsula in 1995 was very preliminary in scope. The two sites surveyed included **Garden Southeast and Kregg Bay**. Few insect sweep samples were taken at these two sites and most of the insects collected are still being sorted or identified by qualified personnel. Because new alvar areas were discovered in the Garden Peninsula in 1995 by staff ecologists and botanists, further animal survey work here is warranted. Included should be more sweep samples, black lighting, pitfall trapping, and possibly Malaise trapping.

RECOMMENDATIONS

Poverty Island

This 150-acre island, with the exception of an abandoned lighthouse on the southern end, is undeveloped and within state ownership. The island supports high quality examples of boreal forest and bedrock beach, with three listed plant species. Human use of the island is minimal and is restricted to occasional camping on the more accessible west side of the island. A lack of deer has allowed for good northern white-cedar regeneration. Furthermore, Canada yew (*Taxus canadensis*) is a dominant understory plant. In contrast, this preferred food species has been severely overbrowsed in areas where deer are abundant. Owing to the high quality nature of the mature forest community, and to the extent of bedrock beach and low cliffs, it is recommended that Poverty Island be maintained as a low-use site, with no further development for recreation. If camping or docking areas are needed, it is recommended that they be placed in the formerly occupied lighthouse area, where such structures would have no impacts. Owing to the high quality status of its natural areas, Poverty Island should be considered for Natural Area dedication, a status which would protect the island's sensitive resources but still provide recreational opportunities.

Summer Island

This large island contains extensive second growth mesic northern forest as well as a margin of boreal forest, and an interior limestone escarpment. Along the shoreline are extensive low cliffs and a well-developed, approximately mile and a half long stretch of bedrock beach with associated rare plant species. Although there is some development on this island, which contains significant private lands, there is only seasonal use. The recommendations for this site are that the state owned lands with high quality bedrock beach and rare plant species be maintained with no development,

and that private lands with significant natural features be considered for acquisition. Lastly, landowner contact is suggested to educate private landowners about sensitive natural features and the uniqueness of the bedrock beach resource.

Point Detour

Most of the significant areas within this site fall on state land. The site includes a collective 1.2 mile stretch of good quality bedrock beach; the coastal zone includes a portion of an extensive bedrock glade at the tip of the Garden Peninsula. An extensive, exemplary bedrock glade community covers much of the interior of the tip of the Garden Peninsula; most of this area remaining intact. The bedrock beach and associated glade should both be protected. Our recommendation is to pursue Natural Area dedication for this ecologically significant area, and to apprise Forest Management Division of the sites' importance. The area supports a large population of dwarf lake iris (*Iris lacustris*) and several other rare plants, which may be impacted by current timber management activities.

Kregg Bay NE

State land in this shoreline area is confined to the central portion of the shoreline, whereas private tracts with vacation homes can be found on both Charbaneau Point and Kregg Bay. Because of the potential for habitat destruction, it is recommended that Forest Management Division be apprised of the sensitive nature of the shoreline and its periphery of dense boreal forest. Land owner contact and registry should be conducted for the privately owned tracts.

Stony Point

While there were no rare species found on the Stony Point bedrock beach, there were high quality interdunal swales, and also nearby occurrences of several listed Great Lakes endemic plant species on surrounding coastal dunes, including Pitcher's thistle, dwarf lake iris, and Lake Huron tansy. The combination of dunes and bedrock beach justify reconsideration of Land Trust acquisition of this large tract in 1996.

Goudreau's Harbor

This site constitutes one of the most scenic and extensive stretches of bedrock beach in the state, and is currently encompassed within private ownership. Several homes are built on the periphery of bedrock exposures. Several rare plant species, including federally-listed Great Lakes endemics, and at least one rare animal species, the federal- and state-endangered piping plover, are known along these shores. Currently, the best approach for conservation would be to initiate and maintain landowner contact regarding rare species and their sensitive, unique habitats. Landowner contact may be the best approach to help determine if acquisition of this high quality area may ultimately be feasible.

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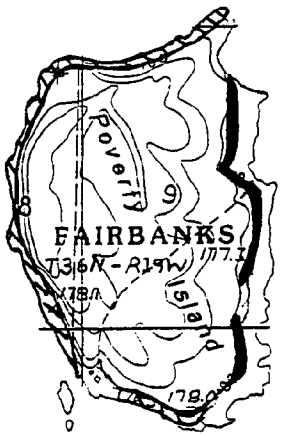
APPENDICES:

APPENDIX I:

Detailed Maps of 1995 bedrock Shoreline Survey Sites

FAIR PORT, MICH.
QUADRANGLE

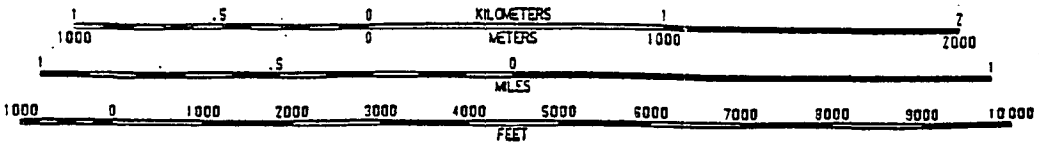


Bedrock Beach

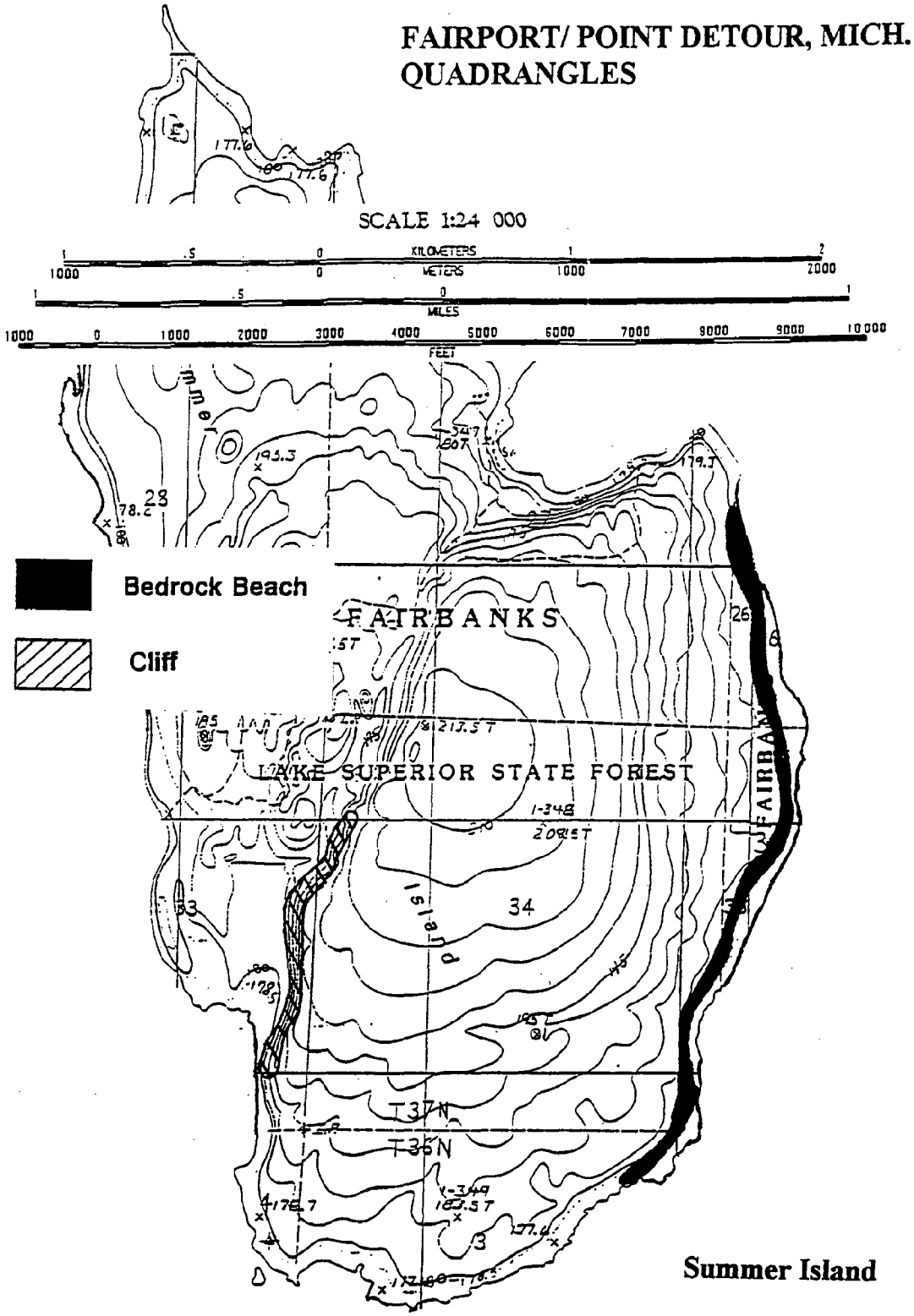
Cliff

Poverty Island

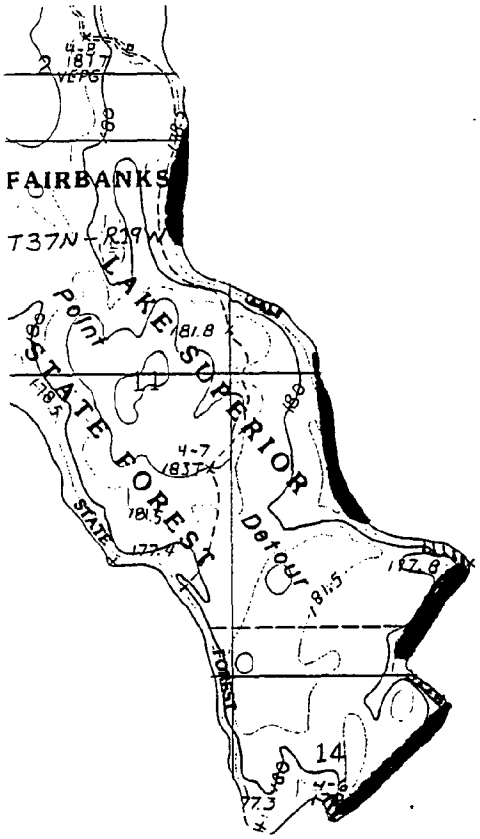
SCALE 1:24 000



Appendix 1A. Extent of Bedrock Beach/ Alvar and Dry Non-Acid Cliff plant communities surveyed on Poverty Island. For convenience, this general survey area is referred to as **Poverty Island** in the text.



Appendix 1B. Extent of Bedrock Beach/ Alvar and Dry Non-Acid Cliff plant communities surveyed on Summer Island. For convenience, this general survey area is referred to as **Summer Island** in the text.



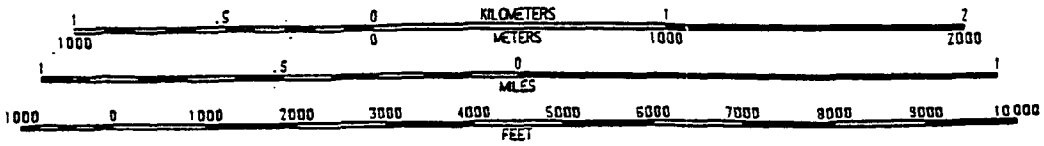
POINT DETOUR, MICH.
QUADRANGLE

Point Detour

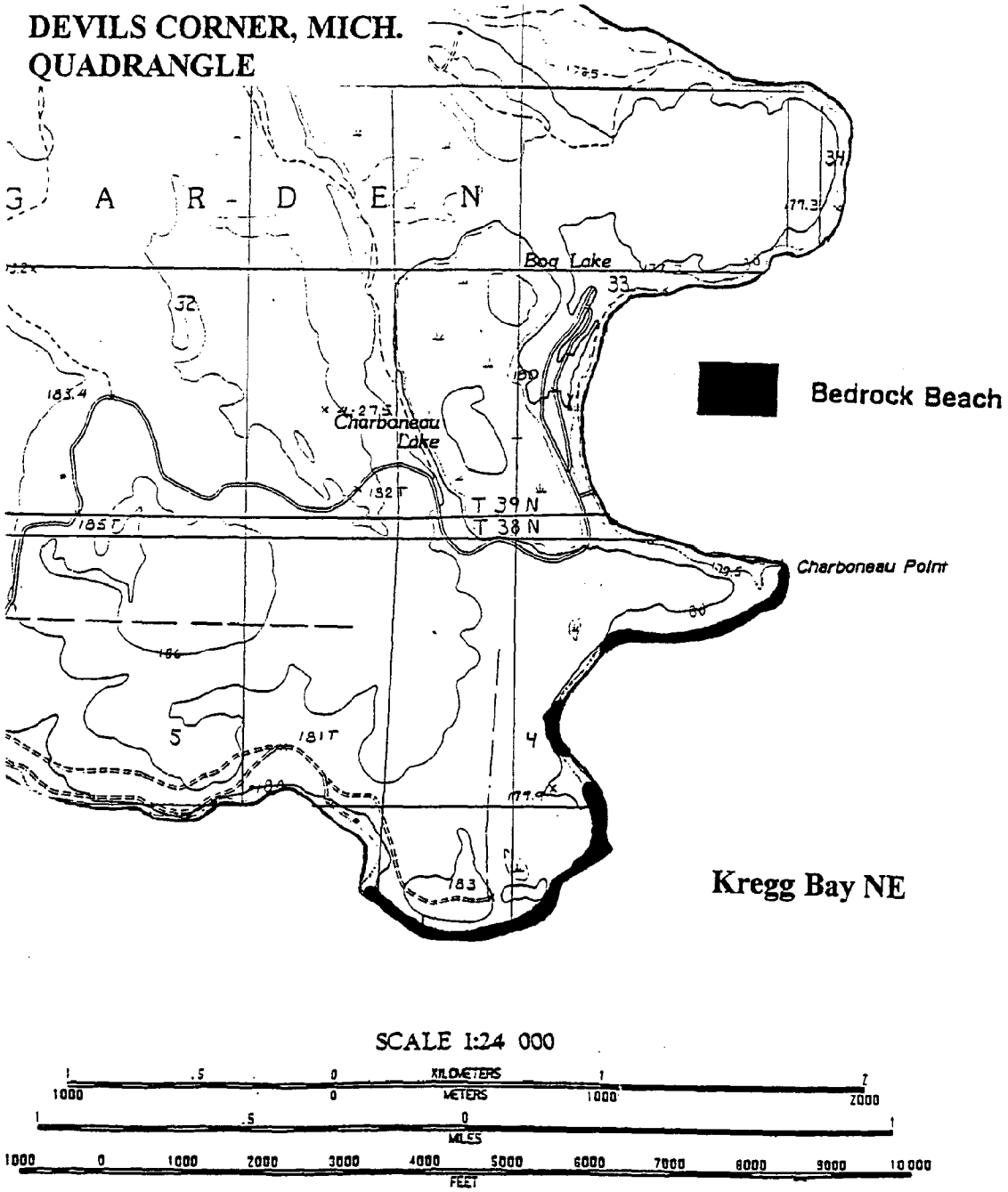
Bedrock Beach

Cliff

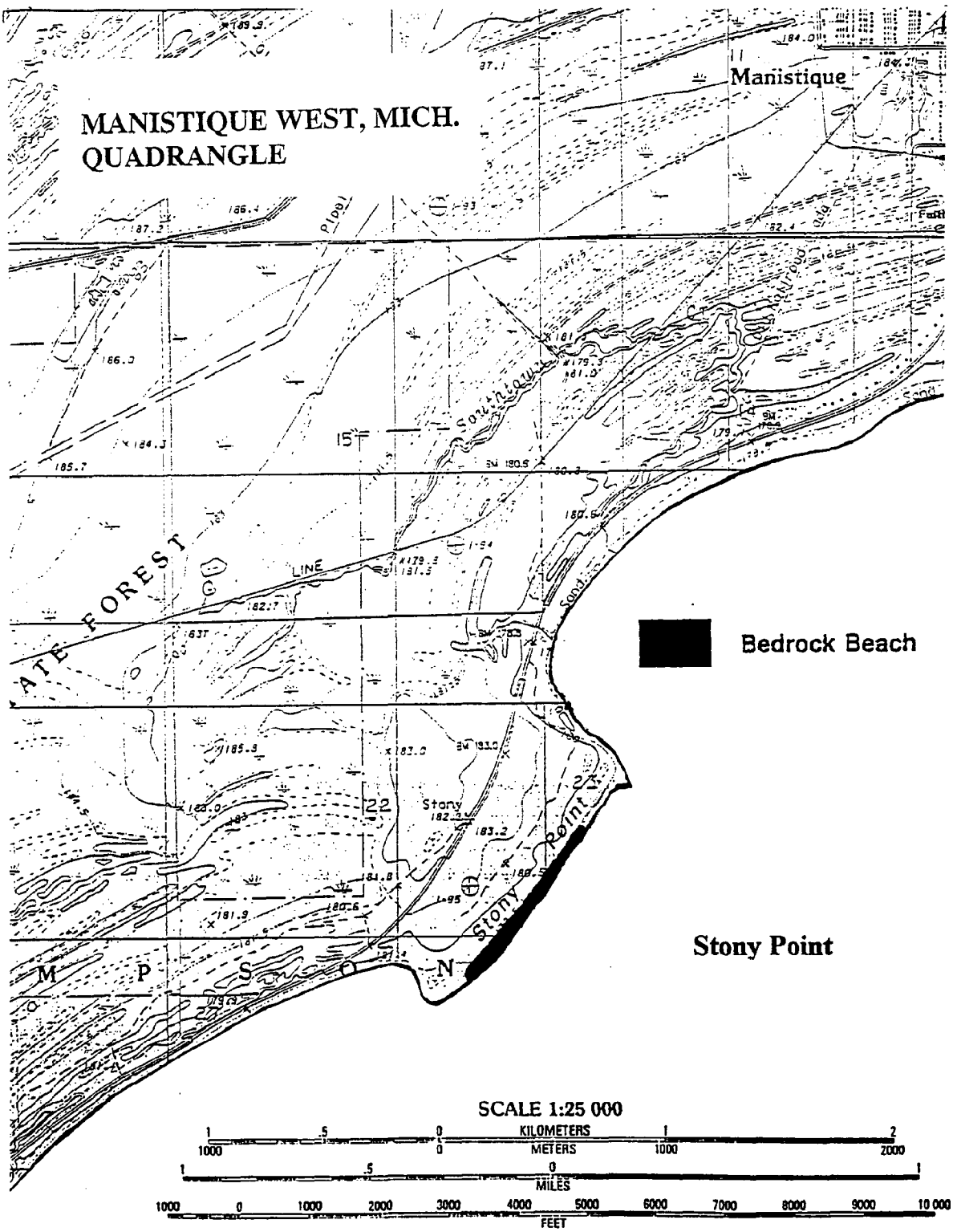
SCALE 1:24 000



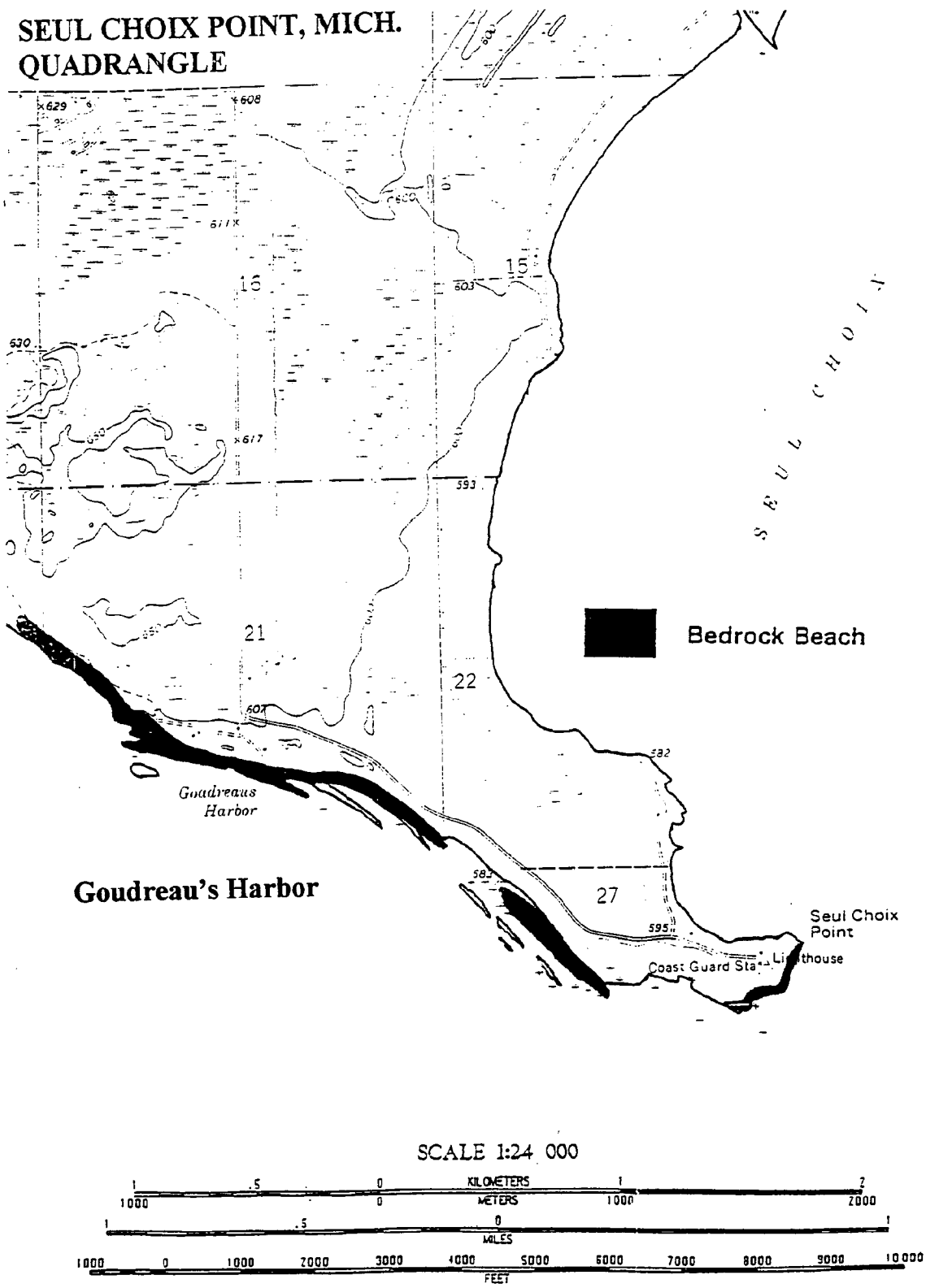
Appendix 1C. Extent of Bedrock Beach/ Alvar and Dry Non-Acid Cliff plant communities surveyed on Point Detour. For convenience, this general survey area is referred to as **Point Detour** in the text.



Appendix 1D. Extent of the Bedrock Beach/ Alvar plant community surveyed in the vicinity of Kregg Bay. For convenience, this general survey area is referred to as **Kregg Bay NE** in the text.



Appendix 1E. Extent of the Bedrock Beach/ Alvar plant community surveyed on Stony Point. For convenience, this general survey area is referred to as **Stony Point** in the text.



Appendix 1F. Extent of the Bedrock Beach/ Alvar plant community surveyed in the vicinity of Goadreaus Harbor. For convenience, this general survey area is referred to as **Goudreau's Harbor** in the text.

Appendix 2. Insect Species Occurrences in 1994-95 for Michigan Bedrock Sites.

AH=Agate Harbor, DP=Dan's Point, DW=Devil's Washtub, HH=Horseshoe Harbor, FC=Fish Cove, MPW=Maxton Plains West, GML=Grand Marais Lake, MPM=Maxton Plains Middle, MPE=Maxton Plains East, SP=Seamans Point, WC=Warners Cove, HB=Huron Bay, BSC=Big Shoal Cove, BCR=Bass Cove Road, GS=Garden Southeast, KB=Kregg Bay NE

HEMIPTERA	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Family Alydidae																
Protenor belfragei						●		●				●				
Family Miridae																
Adelphocoris linolatus						●		●					●			
Lygus lineolaris						●		●				●	●			
Family Nabidae																
Lasiomerus annulatus						●		●				●				
Nabicula subcoleoptrata													●			
Family Pentatomidae																
Banasa dimidiata												●				
Chlorochroa persimilis								●	●							
Cosmopepla lintneriana					●											
Euschistus tristigmus			●	●												
Erygaster alternata						●		●					●			
Homaemus aenifrons				●	●	●										
Mormidea lugens						●										
Neottiglossa undata								●								
Family Reduviidae																
Sinea diadema						●		●								
HOMOPTERA																
Family Cercopidae																
Aphrophora cribrata					●											
Clastoptera obtusa										●						
Clastoptera saintcyri						●										

Appendix 2. Continued.

Family Cicadellidae (cont.)	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Lepyronia coleoptrata		●			●											
Neophilaenus lineatus						●	●	●			●				●	●
Philaenarchys bilineata						●							●			
Philaenus spumarius		●			●	●	●		●		●	●	●		●	●
Family Cicadellidae	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
**Acertagallia* n.sp.		●	●	●	●	●	●		●		●	●			●	●
Amplichephalus inimicus												●				
Athysanus argentatus					●				●							
Balanocerus provancheri						●		●								
Balclutha sp.						●		●								
**Chlorotettix* sp.						●										
**Chlorotettix unicolor*						●		●		●		●	●			
Cicadula subcupraea							●	●								
Cicadula smithi						●		●								
Colladonus eburatus												●				
Cuerna striata		●														
Diplocolenus configuratus						●										
Doratura stylata		●	●	●	●	●										
Empoa latifasciata						●										
Erythroneura sp.				●												
Fitchana vitellina						●						●				
**Flexamia* sp.						●	●		●		●	●				
**Flexamia delongi*						●						●				

Appendix 2. Continued

Family Cicadellidae (cont.)	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
**Graminella fitchii*						●		●			●					
Helochara communis											●	●				●
Idiodonus morsei						●						●				
Kyboasca sp.									●			●				●
Latalus sp.		●	●	●	●		●		●		●	●				
Laevicephalus acus		●		●		●	●	●	●		●	●			●	●
Limotettix spp.						●	●		●							
Limotettix balli										●			●			
Limotettix pseudosphagneticus						●										
Limotettix urmura						●		●								
Macropsis quadrimatulata								●								
Macrosteles sp.				●	●	●		●	●			●			●	●
Neokolla hieroglyphica						●		●							●	●
Paraphelpsius sp.										●	●	●				
Polyamia apicata						●										
Psammotettix lividellus						●										
Scaphytopius sp.		●	●	●	●	●	●	●	●		●	●				
Verdanus evansi						●		●								
Family Dictyopharidae																
Scolopes sulcipes						●		●								
Family Issidae																
Bruchomorpha occulata						●		●								
Family Membracidae																
Campylenchia latipes		●			●	●		●				●				

Appendix 2. Continued

ORTHOPTERA	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Family Acrididae																
Chorthippus curtipennis						●		●				●	●			
Melanoplus islandicus						●							●			
Stethophyma gracila						●										
Trimerotropis verriculata												●				
Family Gryllidae																
Allonemobius griseus						●		●								
Family Tetrigidae																
Nomotettix cristatus						●										
Family Tettigoniidae																
Conocephalus brevipennis						●		●								
Conocephalus fasciatus						●		●				●	●			
Conocephalus saltans						●		●	●							
Neoconocephalus ensiger						●										
Orchilium gladiator						●										
ODONATA	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Family Aeschnidae																
Aeschna constricta													●			
Aeschna interrupta					●								●			
Basiaeschna janata														●		
Family Coenagrionidae																
Enallagma boreale		●														
Enallagma carunculatum														●		
Enallagma cyathigerum				●												

Appendix 2. Continued

	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Family Corduliidae																
Epitheca canis				●	●											
Family Gomphidae																
Gomphus spicatus												●		●		
Family Libellulidae																
Cordulia shurtleffi				●	●									●		
Leucorrhinia frigida					●											
Leucorrhinia hudsonica		●			●									●		
Leucorrhinia intacta														●		
Libellula julia														●		
Libellula quadrimaculata					●									●		
Sympetrum obtrusum		●														
LEPIDOPTERA	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Family Lassiocampidae																
Tolype velleda												●				
Tolype laricis												●				
Family Notodontidae																
Clostera albosigma						●										
Gluphisia tentriognis						●										
Family Arctiidae																
Grammia virguncula						●										
Family Noctuidae																
Amphipoea interoceana (?)						●										
Anagrapha falcifera						●										
Catocala antinympha				●							●					
Catocala briseis				●								●				

Appendix 2. Continued

Family Notodontidae (cont.)	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Catocala concumbens				●		●										
Catocala meski				●							●					
Catocala relicta				●		●					●	●				
Catocala semirelicta				●		●										
Catocala sordida				●												
Catocala unijuga				●		●						●				
Enargia decolor											●	●				
Enargia infumata				●		●					●					
Euxoa perpolita												●				
Faronta diffusa						●										
Feltia jaculifera												●				
Helotropha reniformis												●				
Leucania multillinea				●		●										
Litholomia napaea												●				
Magusa orbifera				●												
Nedra ramosula						●										
Nephelodes minians												●				
Ochropleura plecta						●										
Oligia bridghami												●				
Oligia illocata				●							●					
Papaipema harrisii												●				
Papaipema ptersii												●				
Phlogophora periculosa				●												
Plusia contexta						●										
Protolampra brunneicollis											●					

Appendix 2. Continued

Family Notodontidae (cont.)	AH	DP	DW	HH	FC	MPW	GML	MPM	MPE	SP	WC	HB	BSC	BCR	GS	KB
Pseudoplusia includens												●				
Spodoptera frugiperda												●				
Sunira bicolorago												●				
Syngrapha epidaea						●										
Syngrapha rectangula						●										
Trichosilia geniculata												●				
Xestia adela Franclemont												●				
Xestia collaris												●				
Xestia smithii						●					●					
Family Geometridae																
Ennomos magnaria												●				
Cingilia catenaria												●				
Lambdina fiscellaria												●				

* = special mention in text
shadding = light trap site

APPENDIX III

GLOBAL AND STATE ELEMENT RANKING CRITERIA

Michigan Natural Features Inventory, 1995

GLOBAL RANKS

G1 = critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.

G5 = demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH = of historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).

GU = possibly in peril range-wide, but status uncertain; need more information.

GX = believed to be extinct throughout its range (e.g. Passenger Pigeon) with virtually no likelihood that it will be rediscovered.

STATE RANKS

S1 = critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.

S2 = imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 = rare or uncommon in state (on the order of 21 to 100 occurrences).

S4 = apparently secure in state, with many occurrences.

S5 = demonstrably secure in state and essentially ineradicable under present conditions.

SA = accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.

SE = an exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).

SH = of historical occurrence in state and suspected to be still extant.

SN = regularly occurring, usually migratory and typically nonbreeding species.

SR = reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.

SRF = reported falsely (in error) from state but this error persisting in the literature.

SU = possibly in peril in state, but status uncertain; need more information.

SX = apparently extirpated from state.

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