

Natural Areas Report for 1999-2000



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Table of Contents

Introduction.....	1
Methods	1
Field Survey Preparation	1
Natural Community Mapping and Inventory Methods.....	1
Rare Plant Inventory Methods	2
Aquatic Inventory Methods	2
Rare Wildlife Inventory Methods	3
Avian Species	3
Reptiles	3
Invertebrates.....	3
Results By Site.....	4
Bald Mountain	4
Bois Blanc Island.....	5
Cathead Bay.....	8
Garden Island.....	13
Grand Mere.....	18
Haven Hill.....	21
Hoffmaster Wild Area	24
Hog Island Sites	25
Maple River Salt Marshes	28
Muskegon Dunes and Swales	29
Porcupine Mountains	30
Rocking Chair Lakes.....	35
Thompson’s Harbor	41
Turner Creek Wetlands and Bowerman-Barry Prairie	41
Warren Dunes	41
Discussion and Summaries	51
Ecology	51
Rare Plant Inventory Results	51
Zoology Inventory Results.....	51
Discussion of Aquatic surveys.....	51
Acknowledgements.....	52
Literature Cited.....	52

List of Figures

Figure 1. Northshore Research Natural Area	6
Figure 2. Location of <i>Calypso bulbosa</i> within Northshore Research Natural Area	7
Figure 3. Cathead Bay Communities	9
Figure 4. Cathead Bay Community Quality Designation	11
Figure 5. Cathead Bay Boundaries	12
Figure 6. Natural Community Element Occurrences on Garden Island	14
Figure 7. Rare Plant Occurrences on Garden Island.....	15
Figure 8. Grand Mere Communities	20
Figure 9. Grand Mere Communities Quality Designation.....	22
Figure 10. Grand Mere Boundaries	23
Figure 11. Natural Community Element Occurrences on Hog Island	26
Figure 12. Rare Plant and Animal Occurrences on Hog Island.....	27
Figure 13. Locations of streams surveyed in the Porcupine Mountains Natural Area.....	31

List of Figures, Continued

Figure 14. Locations of lakes surveyed in the vicinity of the Rocking Chair Lakes Natural Area 37
Figure 15. Ecological/bathymetric zonation of Rocking Chair Lake 38
Figure 16. Ecological/bathymetric zonation of Island Lake 39
Figure 17. Proposed Rocking Chair Lakes Natural Area: Original and Proposed Boundaries 42
Figure 18. Proposed Rocking Chair Lakes Natural Area: Ownership..... 43
Figure 19. Location of *Somatochlora hineana* and *Cacalia plantaginea* at Thompson’s Harbor SP..... 44
Figure 20. Location of *Lepyronia angulifera* and *Terrapene c. carolina* at Turner Creek Wetland 45
Figure 21. Warren Dunes Communities 47
Figure 22. Warren Dunes Communities Quality Designation 49
Figure 23. Warren Dunes Boundaries 50

List of Tables

Table 1. Zoology Inventory Results..... 24
Table 2. Fish species collected at the Porcupine Mountains sample sites. 32
Table 3. Aquatic invertebrate characteristics collected at the 5 Porcupine Mountain sites sampled..... 33
Table 4. Aquatic macroinvertebrate species collected in lakes in Rocking Chair Lakes Natural Area 40

INTRODUCTION

Inventory of Natural Areas was initiated during the 1999 field season. This report will summarize the results of inventories in both 1999 and 2000. The inventories conducted in 1999 were limited in scope, including surveys at Bois Blanc, Hog, and Garden Islands, as well as Rocking Chair Lakes. The Rocking Chair Lake inventory demonstrated the need for a more expansive inventory, which also explored the aquatic resources and further outside the proposed boundaries. Photos were taken at two additional sites in 1999, Pointe aux Chenes and Big Knob.

During 2000, inventories were conducted at several sites, including Thompson's Harbor, Haven Hill, Bowerman-Barry Prairie, Turner Creek, Porcupine Mountains, Rocking Chair Lakes, Bald Mountain, Maple River Salt Marshes, Warren Dunes, Grand Mere Dunes, Muskegon State Park, and Cathed Bay. These sites were visited by different programs of MNFI, depending on inventory needs.

Inventory priorities were identified by each MNFI program based on summary tables created during the winter and spring of 2000. Ecology focused on sites where there were questions concerning plant community boundaries and conditions, as well as evaluating the ecological boundary of the natural area as a whole. Botany inventories were focused on sites with potential new rare plant occurrences, or where there was inadequate information on the distribution of a known element occurrence at a site. Zoology inventories were similarly focused on potential rare animal occurrences or updating of old occurrence records. Aquatic Ecology was conducting inventories to evaluate aquatic communities or to assist in the development of either lake or stream classifications, with the purpose of populating the lake and stream database. Aquatic Ecology was also doing inventory for rare fish and invertebrates.

METHODS

Field Survey Preparation: Prioritization of sites to be surveyed was guided by the generation of a table of the natural areas which summarized existing ecological information (Appendix I). Included in the table was a compilation of the element occurrences within the natural areas and within five miles of the natural area, and information on ecological and jurisdictional boundaries, natural communities, aquatic features and legal status.

Natural Community Mapping and Inventory Methods: Aerial photography interpretation was completed for natural areas selected for field survey via the above prioritization process. Photographic interpretation will serve the following purposes: generation of maps of the natural communities, allow for the comparison of existing natural area boundaries and ecological boundaries, help guide rare plant and wildlife surveys, and provide a benchmark for the analysis of change over time. Aerial photographic interpretation can be completed using photographs from 1978, 1988-1990, and/or 1998-2000. The 1978 photos are color infrared at the scale of 1:24,000, 1988-1990 photos are black and white at a scale of 1:24,000, while the 1998-2000 photos are black and white and at the scale of 1:15,840. Which set of aerial photographs are selected will depend on the scale and composition of the prevalent communities of the natural area and the rate of landscape change within that natural area. For many sites we utilized more than one type of aerial photography for analysis. For 1999, aerial photographic interpretation was completed for Hog Island, Garden Island, and parts of Bois Blanc Island. For 2000, photo interpretation

was completed for Cathead Bay, Grand Mere, Warren Dunes, Rocking Chair Lakes, Maple River Salt Marshes, Muskegon State Park, and Dead Stream Swamp.

Delineation of community boundaries and community identity was verified by ground truthing. In addition, field visits allowed for the assessment of the proposed or existing natural-area boundaries in comparison to ecological boundaries, the quality of the natural communities, the level of threat and location of exotic species and subsequent need for stewardship, and the necessity for restoration management. For some sites, evaluation of prevalent natural communities was facilitated by establishment of qualitative plots. Within these plots, species lists were compiled for the overstory, the shrub layer and the ground cover. For some sites, maps of natural communities were completed on mylar overlays, based on a combination of photo interpretation and field surveys. Overlays were produced in a format to facilitate GIS mapping of these natural areas.

Comparisons will be made for natural areas which represent the same ecosystem. In this year's inventory this approach was explored for Warren Dunes, Grand Mere, and Cathead Bay, all sites with open and forested sand dunes.

Rare Plant Inventory Methods: Rare plant species were identified for surveys based upon historical distribution and currently known occurrences within the region. Natural community information, as determined by previous air photo interpretation and on-the-ground assessments by ecologists and botanists, was utilized to delineate survey sites.

Aquatic Inventory Methods: Aquatic features of most Michigan Natural Areas are largely unknown, and no standardized methods have previously been developed to evaluate aquatic ecosystems within Natural Areas. A large component of these initial site visits was an evaluation of survey needs at representative natural areas and development of appropriate protocols for conducting future surveys. The Porcupine Mountains and Rocking Chair Lakes Natural Areas encompass aquatic resources representing both stream and lake ecosystems and were deemed appropriate as a basis for beginning the development of aquatic survey methods for Michigan Natural Areas.

Stream sites were visually evaluated to assess the variety of aquatic habitats present, and a 100-m stream reach encompassing these habitats was surveyed. Within the study reach, temperature, pH and conductivity were measured using a digital Oakton hand-held meter. Fish were collected using a Coffelt gas-powered backpack electroshocker. A single, thorough electroshocking pass was conducted through all available stream habitats within the study reach. Larger streams were sampled along both shorelines of the study reach. Fish were identified to species, enumerated, examined for overall condition and age, and then released. Benthic invertebrate samples were collected from all substrates (i.e. riffles, undercut banks, log-jams and macrophytes) with a 500 micron mesh dip net and preserved in 70% ethanol (EtOH). Macroinvertebrates in the samples were identified to the lowest possible taxonomic level using a stereo microscope. Tolerance values (TV's ranked 0-10, Barbour et al. 1999) based on sensitivity to disturbance were applied to individual taxa collected at a site. A zero rank (0) represents intolerant taxa grading to a 10 rank which represents taxa with the greatest tolerance to degraded environmental conditions. The taxa biotic index (TBI) is derived by multiplying the number of individuals of taxon (i) found in a sample (n^i) by that taxon's tolerance value (TV^i) and summing all ($n^i TV^i$) in the sample. Finally, the $\sum n^i TV^i$ is divided by the total number of individuals in the sample (TN) to derive the TBI for the site. Total taxa richness and EPT taxa parameters (EPT Index is the total number of Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies) species in the sample) were also determined for each site.

The purpose of the lake visits was primarily to evaluate survey needs and to provide initial descriptive evaluations of these systems. Water physicochemical properties, including conductivity, pH, dissolved oxygen concentration (DO) and temperature were measured at sampling stations throughout each lake at 1-m depth increments using an Oakton® multimeter and a YSI® 55 temperature-DO meter. Depth was measured at each station using a Hondex™ digital depth sounder. Substrate composition and depth was determined by probing lake bottoms with a canoe paddle. Plant communities were visually assessed and component species identified on-site. Several benthic samples were collected along lake margins and preserved in 70% EtOH. Benthic macroinvertebrates were later identified to the lowest taxonomic level possible to determine macroinvertebrate community composition. Fish communities were described based on visual surveys.

Rare Wildlife Inventory Methods: Rare animal species were identified for surveys based upon historical distribution and currently known occurrences within the region. Natural community information, as determined by previous air photo interpretation and on-the-ground assessments by ecologists, was utilized to delineate survey sites. Surveys for rare animal species were then conducted during the time periods when the species of interest were most conspicuous. Surveys emphasized both the identification of new occurrences and reconfirmation of historical occurrences. Every effort was made to optimize surveys, however, for a variety of reasons, rare wildlife species, particularly invertebrates and herps are often quite difficult to document. Some of the difficulties in surveying for rare animals include: a very limited time period when a species may be conspicuous, species are often cryptic, and rare animals often occur in very low numbers, which increases the difficulty in their documentation.

Avian Species. Rare songbird species were surveyed during April-June 2000. Surveys were conducted by walking through appropriate habitat during the breeding season between the hours of sunrise and 11:00 am and listening and looking for rare species. Cerulean warblers, red-shouldered hawk, and Cooper's hawks were searched for in deciduous forest habitats. For the hawks, in addition to looking and listening, taped con-specific calls were broadcast every 1/4 mile throughout the forested habitat. A taped red-shouldered hawk call was broadcast at 60 degrees for ten seconds, 160 degrees for ten seconds, and 300 degrees for ten seconds. This was followed by 30 seconds of listening. This calling sequence was repeated three times at each calling station (Cooper et al. 1999). The same methods but with a taped Cooper's hawk call were used during June 2000 to survey for this species.

Reptiles. Blanding's turtles and eastern massasauga rattlesnakes were surveyed during the Mitchell's satyr research project. As biologists walked throughout the prairie fen and surrounding habitats all reptiles that were observed were recorded. Surveys took place during July and August and mostly during the middle portion of the day.

Invertebrates. Prairie fen invertebrate species (angular spittlebug) were surveyed by using a sweep net. Fen vegetation was swept a minimum of 50 times per site. The contents collected were placed in a "kill jar" charged with ethyl acetate. Invertebrate and vegetative matter were then transferred into plastic storage bags and later sorted and identified. Mitchell's satyr surveys were conducted in prairie fens by walking through suitable habitat. A pair of close-focusing binoculars was used to verify the satyr. Hine's emerald dragonfly surveys were conducted in northern fens by walking through suitable habitat and capturing emerald dragonflies with an aerial net. Specimens were then carefully removed from the net, inspected in the field and released. Select sites that contained tamarack were surveyed for the tamarack tree cricket. Observers swept the branches of tamarack trees with sweep nets during August 2000. A typical sweep net was utilized but the handle was extended to ten feet by fastening a piece of 3/4 inch conduit onto the handle. Tree crickets were collected, processed, and keyed to species. Black-

light surveys were conducted for *Papaipema* moth species in prairie fen habitats. A tubular 15 watt DC black-light, powered by a portable gas generator (in some cases both the black-light and 250 watt mercury vapor bulb) was suspended from a rectangular aluminum frame approximately 1.5 m above the ground. A white bed sheet was suspended on the aluminum frame that supported the black-light. Lights were turned on around dusk and ended near 1 am. The ultraviolet light illuminated the white bedsheet and insects attracted to the black-light landed on the sheet. Individual insects were then collected with an ethyl acetate charged jar. Moths were pinned, spread, and identified in the laboratory.

RESULTS BY SITE

Bald Mountain

Inventory of the Bald Mountain Recreation Area was concentrated in the northern block, often called the north unit, an area containing Chamberlain, Tamarack, Heart (or Hart), and Shoe Lakes. This area has been proposed as the Chamberlain Lakes Nature Study Area. Our inventory included Chamberlain Lakes and several associated wetlands, as well as the upland oak forest concentrated along the eastern edge of these extensive wetlands.

The wetlands and lake margins can be characterized as relict conifer swamp, dominated by tamarack, prairie fen, and southern swamp forest. Black spruce is also locally present along the lake margins. The wetlands contained the typical flora associated with prairie fens, but no hillside seepages were encountered as part of these wetlands.

While tamarack are present along the edges of all of the ponds and lakes within this complex, largest tamaracks were encountered along Bunny Run, about a quarter mile south of Miller Road. While the tamaracks were impressive and the ground cover contained a broad diversity of fen and swamp species, there were major concentrations of two exotics as well, glossy buckthorn (*Rhamnus frangula*), and barberry (*Berberis thumbergii*).

The presence of several exotic plant species, including purple loosestrife, glossy buckthorn, barberry), and reed canary grass, was a major concern for these wetlands. Purple loosestrife was most common in the wetland in the southwestern, while glossy buckthorn was more widespread and concentrated in the northern part of the wetland complex. Barberry was concentrated in the swamps and drier portions of the fen in the northern part of the wetland complex. Without some management, glossy buckthorn will probably continue to expand throughout the wetland complex.

The upland oak forest (dry-mesic southern forest) was already recognized as an element occurrence in the MNFI database. This community consists of a mixed oak and hickory forest, with oaks as large as two feet in diameter (60 cm). The flora, like that of most dry-mesic southern forests, is not particularly diverse. Based on the historic surveyors notes, parts of this forest were probably originally oak barrens, with a much more open structure and a ground cover of prairie grasses and forbs. This interpretation is supported by isolated pockets of prairie grasses in more open old fields and successional forests at the southern edge of the tract.

Recommendations: Exotic shrubs and purple loosestrife control will be needed to return the wetlands back to natural-area quality. Without exotic control, much of the natural area value of this tract will eventually be lost. For the upland forests, the mature forest value as habitat for songbirds and other wetland fauna probably outweighs the effort required to return the forest to oak barrens or savanna. One possible advantage of utilizing fire management to restore the uplands is the benefit to the fens, which has a flora that would also likely improve with fire.

Bois Blanc Island

Bois Blanc Island has several areas of proposed natural area, including the already dedicated *Northshore* and *Snake Island-Mud Lake* natural areas. The other proposed areas for dedication include 1) the *Mixed Forest* natural area immediately south of the *Northshore* natural area, 2) *Beach Ridge*, and 3) *Central Woodland*.

Northshore and the northern part of *Mixed Forest* were surveyed together (Figure 1). *Northshore* is dominated largely by conifers in the northern portion, where the preserve is a narrow peninsula jutting out into Lake Huron. The shoreline is a relatively narrow gravel beach, which transitions rapidly into a narrow zone of northern white-cedar forest, and then into a forest of mixed upland hardwoods and conifers. Dominants include white pine, red pine, northern white-cedar, balsam fir, and hemlock. Large white pine and red pine formed a super-canopy above the other conifers and hardwoods. Windthrown trees were extremely common. Sugar maple, American beech, yellow birch, and hemlock dominated other portions of the RNA, especially inland from the shoreline. Just north of Deer Lake large sugar maple and beech cover the low, gravelly ridges. Old growth northern white-cedar surround Deer Lake, but the northern hardwood forest south of Deer Lake has been high-graded; only large American beech remain.

Calypso orchids (*Calypso bulbosa*) were observed in several areas that were dominated by northern white-cedar, but patches of this species were small (Figure 2). Dr. Edward Voss identified several populations of Calypso in cedar swamp at the northern end of the island and another recent record of Calypso was noted during MNFI surveys. Other rare species known from the site include, *Iris lacustris* (dwarf lake iris), *Adlumia fungosa* (climbing fumatory), and nesting bald eagles. Neither climbing fumatory nor bald eagles were seen during summer or fall inventories. There are also signs of Native American occupation within the tract, probably indicating some agricultural use of some of the uplands in the distant past. *Northshore* provides an excellent example of northern hardwood forest with a super-canopy of white pine, and demonstrating the windthrow dynamics so typical of forests near the Great Lakes shoreline.

Mixed Forest is primarily second growth forest. It was originally identified as providing buffer to the *Northshore* tract, and this is a function that is very important. Old-growth forests adjacent to clear cuts or heavily cut forests are known to be more susceptible to large-scale windthrow. Eventually its structure and diversity will likely return to a condition similar to the adjacent old-growth forest. The site also supports a population of *Crataegus douglasii* (Douglas' hawthorn) along the shoreline.

Central Woodland, immediately south of *Mixed Forest*, is also an area that was proposed for dedication, but which is no longer being considered for dedication, because of its wide use by snowmobilers. This area was not visited as part of the inventory, but aerial photo interpretation and descriptions in other documents indicate that the area is largely second growth forest with large amounts of early successional forest.

Beach Ridge was also proposed for dedication, but then removed from consideration because of possible need for power cables along the north shore. Residents strongly opposed this dedication. During our 1999 visits to the island, we surveyed this area, beginning at the north shore. Ecologically, it is probably not an area worthy of dedication, regardless of the potential for future power lines. The site appears to have originally supported some upland conifers and red oak, as well as American beech and sugar maple. The forest is now dominated by early successional forests of aspen, ash, and red oak.

Figure

1

Figure 2

Snake Island Natural Area consists of both Great Lakes shoreline and several small ponds and portions of inland lakes. Survey work has been extensive within the area by Nature Conservancy, Heritage, and Department of Natural Resource staff. Rare species, the focus of the natural area, include *Cacalia plantaginea* (prairie Indian plantain), *Iris lacustris* (dwarf lake iris) and *Solidago houghtonii* (Houghton's goldenrod), *Sistrurus c. catenatus* (eastern massasauga), and *Somatochlora hineana* (Hine's emerald). Hine's emerald was only recently discovered; it is present both north and south of Snake Island along the road. Prairie Indian plantain and Houghton's goldenrod occupy the interdunal wetlands within the natural area, and Hine's emerald similarly occupies marly ponds. Dwarf lake iris occupies the cobble beach, open cedar forest, and parts of the limestone cobble beach. Both the interdunal wetlands and the cobble beach are element occurrence records. Most of the forests within the natural area have been logged in the past and the forests are by no means the focus of this natural area. These forests are probably best described as boreal forest. Similarly, much of the rich conifer swamp within the preserve have either been cut in the past, or are of small stature because of the very wet conditions and beaver flooding. Even the shoreline communities, the interdunal wetlands and cobble beaches show signs of human disturbance, but they are highly significant in terms of providing important habitat for the several rare species that they support. Detailed mapping was not done for this natural area, as it was mapped in some detail in the past by Nature Conservancy staff. The Nature Conservancy report is in MNFI's general map files. Also, because of its location along the shoreline and also because of the considerable impact by beaver, the features of this natural area are continually changing, making detailed mapping a futile effort.

Recommendations: Based on surveys, we would modify the boundaries of the Northshore Natural Area to recommend significant areas of mature and old-growth rich conifer swamp, dominated by northern white-cedar. This additional cedar swamp is located in section 4, east of the present natural area boundaries, and includes the entire swamp surrounding Lost Lake (See figure 1).

Cathead Bay

Landscape Context and Historical Context: Cathead Bay Natural Area is located in subsection VII.5.2 (Traverse City). The dune sands are derived from glacial sediments, including lacustrine and outwash sands and sandy tills (Dorr and Eschman 1970). The dune complexes from this natural area are associated with the Lake Nipissing stage of the Great Lakes, when water levels were 25 to 30 feet higher than present day lake levels. These higher lake levels resulted in greater amounts of coastal erosion and dune formation. The dune formation of the Cathead Bay Natural Area is the parabolic dune. Parabolic dunes, which are U-shaped, with the bottom of the U inland, typically form when stable, forested dunes are destabilized, and they often occur as series of overlapping dune ridges. As inferred from the original land-surveyors notes (GLO), presettlement forests of these dunes were dominated by beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and hemlock (*Tsuga canadensis*). Additional components of the canopy include white pine (*Pinus strobus*), red oak (*Quercus rubra*), paper birch (*Betula papyrifera*), black cherry (*Prunus serotina*) and red maple (*Acer rubrum*). The shoreline along Cathead Bay was described in the GLO as "sand bluffs". While wind is the prevalent form of natural disturbance within the dune fields, fires resulting from lightning strikes and Native American ignition also occurred, but were less common. Where oaks, hickories and pines were common on the dunes, fire was probably a significant natural disturbance factor.

Ecological Site Summary: Figure 3 delineates natural communities found within and surrounding the Cathead Bay Natural Area. Field survey efforts, conducted on October 19th and 20th, 2000, were concentrated in open dunes, Great Lakes barrens, northern dune forest, and the hardwood-conifer swamp associated with Leg Lake. A hypothetical transect from the Lake Michigan lakeshore inland would

encounter the following general natural communities: sand beach, open dune, Great Lakes barrens, and northern dune forest. The open dunes at Cathead Bay are comprised of sand/gravel beach, foredune, and blowouts. The sand and gravel beach is narrow and backed by the low foredune ridges, behind which are several interdunal wetlands and sand-gravel flats where piping plover (*Charadrius melodus*) nest and feed. With the exception of Mt. Baldy, which has been degraded by foot traffic, the narrow blowouts are predominantly dominated by herbaceous vegetation. Throughout the open dunes and the Great Lakes barrens, pitcher's thistle is thriving; hundreds of plants were observed. The Great Lakes barrens is composed principally of scattered and stunted white pine and northern white-cedar (*Thuja occidentalis*). Creeping cedar (*Juniperus horizontalis*), common juniper (*Juniper communis*), balsam poplar (*Populus balsamifera*), sand cherry (*Prunus pumila*), and bearberry (*Arctostaphylos uva-ursi*) are common in the shrub layer.

The most extensive community at Cathead Bay is second-growth northern dune forest, which can be classified as two distinct types. Immediately behind the Great Lakes barrens and the blowouts, the dune forest is completely dominated by conifers for a width of 2-4 chains. A diversity of tree species make up this distinct strip, including jack pine (*Pinus banksiana*), red pine (*Pinus resinosa*), white pine, northern white-cedar (often locally dominant), balsam fir (*Abies balsamea*, especially dominant in the understory), hemlock (scattered), basswood (*Tilia americana*), and paper birch. A 39-cm diameter red pine was estimated to be 109 years old, based on an increment core. Behind the boreal/conifer belt of dune forest is a mesic northern forest that contains both patches of deciduous trees and mixed deciduous and coniferous trees. The canopy in this community is dominated by beech, sugar maple, hemlock, and red oak. Other important canopy species include white pine, white ash (*Fraxinus americana*), red maple, and bigtooth aspen (*Populus grandidentata*), with bigtooth aspen especially common on the easternmost dune slopes. A hemlock with a diameter at breast height of 37 cm was estimated to be 134 years old. This forest is characterized by numerous windthrow and snags of diverse species but of similar diameter and decomposition classes. Where the dune forest does not abruptly transition into agricultural or abandoned agricultural lands, the mesic northern forest of the dunes grades into a younger mesic northern forest dominated by successional species, and then into conifer swamp and hardwood-conifer swamp. To the southwest of the natural area, adjacent to Leg Lake, is a high quality old-growth hardwood-conifer swamp, which has been designated by the Leelanau Conservancy as the Kehl Lake Natural Area. This 100-acre tract is characterized by supercanopy white pines, which overtop hemlock, paper birch, red maple, and green ash. This community contains a wealth of downed woody debris and snags of diverse species, diameter, and decomposition classes and numerous tip up mounds. Invasive exotic species were not observed dominating the strata in any of the surveyed communities.

Recommendations: Figure 4 displays the boundaries of Leelanau State Park and the Cathead Bay Natural Area, with a quality designation of the mapped communities. Three categories were used to describe the quality of the communities, degraded (i.e. degraded natural community, agriculture, recreation, and residential), potential buffer, and natural-area quality. The above categories were used to help guide the creation of a recommended natural-area boundary. Figures 4 and 5 show the jurisdictional boundaries as well as the recommended natural-area boundary. The recommended boundary contains the full extent of the open dunes, sand/gravel beach, Great Lakes barrens, non-degraded northern dune forest, Leg Lake, Mud Lake and the associated inland emergent marsh, the hardwood-conifer swamps, and portions of the "buffer quality" mesic northern forest and lowland conifer swamp. The areas of northern dune forest deemed unsuitable for natural areas quality are located at the western and northern extremes of the state park and have been degraded by residences and associated roads. The degraded open dunes were included within the recommended boundary because control of foot traffic in the blowout should aid the recovery of herbaceous cover on the most degraded portions of Mt. Baldy. Both Leg and Mud lakes should be considered for future aquatic inventory work.

Figure 4

Garden Island

Surveys of Garden Island sites were conducted in 1999; there was an attempt to coordinate Island and Natural Area surveys to more effectively use travel and staff time. Maps of the areas visited are included in the 2000 Islands Report (Penskar et al. 2000). This report includes two maps, the first showing natural communities (Figure 6) and the second showing the localities of rare species (Figure 7). Garden Island is particularly interesting and provides difficulties in interpretation of natural communities because of its complex disturbance history. The surveyors' notes from the mid-1800s reference windthrown forests, burned forests, and "Indian fields". This combination of natural disturbance with Native American land management may explain

some of the incongruities on the island. For example, the boreal forest contains 40 to 50 cm diameter northern white-cedars, with no signs of logging, but with few fallen trees lying on the ground. These trees are only 90 to 120 years old. In such a relatively young stand one would expect to find large amounts of dead trees on the ground if it were indeed old-growth forest. Perhaps Native American use of fire for either agricultural land use or for clearing the land for easier travel, or even extensive collection of firewood, could help account for the open character of the forest stands on the island.

Garden Island Harbor

A northern wet meadow occurs inland from Garden Island Harbor in an old, abandoned embayment of Lake Michigan. This bay is now separated from the lake by a dune ridge. The edges of the bay support cedar swamp, while the center of the bay contains a small lake with a thick organic bottom. Between the lake and the cedar swamp there is a broad band of wet meadow, which supports many plants characteristic of northern fens.

Garden Island West Boreal Forest

An extensive, approximately 600-acre tract of boreal forest was located along the western shore of Garden Island on shallow organic soil over limestone cobble. This stand was mapped as an element occurrence during the Island project. The natural community was characterized by well developed pit-and-mound microtopography and single and group tree windthrow; characteristics indicative of mature forest with the natural disturbance regime intact. Overstory species were predominantly northern white-cedar (*Thuja occidentalis*) and white spruce (*Picea glauca*) with lesser but significant amounts of balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), and balsam poplar (*Populus balsamifera*). The forest sub-canopy, generally sparse but dense locally, was dominated by balsam fir with lesser amounts of white cedar and white ash (*Fraxinus americana*). Shrub layer species included mountain maple (*Acer spicatum*), beaked hazelnut (*Corylus cornuta*), round-leaved dogwood (*Cornus rugosa*), and American fly honeysuckle (*Lonicera canadensis*). The understory, sparse with extensive areas of exposed soil and duff, included creeping rattlesnake plantain (*Goodyera repens*), Menzies' rattlesnake plantain (*G. oblongifolia*), twin flower (*Linnaea borealis*), goldthread (*Coptis trifolia*), large round-leaved orchid (*Platanthera orbiculata*), blue-bead lily (*Clintonia borealis*), and various species of Violets (*Viola* sp.) and sedges (*Carex* sp.). There is some chance that several rare orchids, including ram's head lady's slipper (*Cypripedium arietinum*) and calypso orchid (*Calypso bulbosa*), may occur within this natural community, but no early survey was conducted for T & E plants.

No human disturbance, *e.g.* timber harvests, stumps, trails, or other clearings, was noted within the forest. This site is among the largest and highest quality tracts of boreal forest described in Michigan to date. The largest trees in this stand are 90 to 120 years old, meaning that the stand actually originated about 1880. This date of origin is similar to that found in the red oak forests at the eastern edge of the island. Detailed charcoal analysis of the soils (Albert and Minc 1987) might provide insights to

Figure 6

understanding the dynamics of disturbance and Native American land management in the forests of the island.

Indian Harbor

A large Great Lakes marsh occurs in the narrow bay at Indian Harbor. This marsh is considered an A-ranked element occurrence in our database. Typical of many of the marshes along Beaver, Garden, and Hog Islands, and of the Mackinac Straits area in general, there are typical emergent marsh plants like threesquare (*Scirpus americanus*) in the deeper portions of the marsh, but along the shallower edges, northern fen species are dominant. The northern fen gradually becomes drier and changes to open cedar swamp along its inland margin. While no plants of Houghton's goldenrod (*Solidago houghtonii*) were encountered, the habitat seemed appropriate for this Great Lakes endemic, and thus the site may merit inventories in the future to seek this rare species.

Jensen Harbor

A large population of butterwort (*Pinguicula vulgaris*) was found growing in the northern fen at Jensen Harbor. While butterwort often occupies moist, marly habitat, it was growing on the moist sand of the low beach ridges, along with dried up *Nostoc*, an algae. It appears that the seeds of butterwort were deposited on the moist sand when the water levels were high, in 1997 and 1998. None of these plants were flowering; all appeared to be juvenile plants. Houghton's goldenrod (*Solidago houghtonii*) was found locally growing within the northern fen, occupying the moist swales. Butterwort was also growing nearby. A large northern fen occurred along the margin of the bay, with open marsh extending into the shallow waters of the bay. The fen extends up to cedar forest at the inland margin of the open wetland. Cedar also grew both on low beach ridges along the shoreline and in shallow swales. There was no sign of past logging of the cedar. The cedar were relatively small diameter, probably due to periodic wind storms along the shoreline.

Jensen Harbor West

The entire shoreline was traversed southeast from sweat lodge swale to Jensen's Harbor to assess the status of previously documented occurrences of Pitcher's thistle and Lake Huron tansy, and to determine if other listed shoreline species may be present. The shoreline is mostly rocky with a shallow, steep bluff topped with boreal forest. For the most part it lacks the sandy dune features typical of thistle and tansy habitat. Just west of the harbor, however, lies a narrow strip of sandy beach, the presumed location of earlier records for these species. Several hundred clumps of tansy were found scattered throughout, but no Pitcher's thistle plants were observed. No additional rarities were discovered along this sandy strip, however beauty sedge was discovered in several pockets northwestward, growing sparsely in crevices of the rocky substrate forming the top lakeward edge of the bluff.

Manitou Bay to Sturgeon Bay

Surveys were conducted along the shoreline from the east edge of Northcutt bay to Sturgeon Bay. Due to the extreme low water year, significant areas of marly, rocky, sand lake bottom with little vegetation was exposed along each of the bays. Occasional islands of vegetation are scattered throughout these flats. At the edge of the normal waterline, Great Lakes Marsh vegetation with a northern fen component dominates, similar to that described in the Northcutt Bay site description below. Occasional swales occur, often with a marly crust, dominated by calciphiles such as twig-rush (*Cladium mariscoides*), spike-rush (*Eleocharis rostellata*), and Buxbaum's sedge (*Carex buxbaumii*). Marly pockets with species such as grass-of-Parnassus (*Parnassia glauca*), pitcher-plant (*Sarracenia purpurea*), false asphodel (*Tofieldia glutinosa*), bird's-eye primrose (*Primula mistassinica*), Indian paint brush (*Castilleja coccinea*), and (*Carex flava*) can also be found here.

Northcutt Bay

Surveys were conducted along the shoreline from Indian Harbor to Northcutt Bay, targeting a previously documented Pitcher's thistle record and any additional shoreline rarities. The shoreline is characterized by a band of Great Lakes Marsh and northern fen species including blue joint (*Calamagrostis canadensis*), tickle grass (*Agrostis hyemalis*), hardstem bulrush (*Scirpus acutis*), spike-rush (*Eleocharis elliptica*), arrow-grass (*Triglochin maritimum*), rushes (*Juncus balticus*, *J. brevicaudatus*), Calamint (*Calamintha arkansana*), silvery cinquefoil (*Potentilla anserina*), Kalm's lobelia (*Lobelia kalmii*), and fringed gentian (*Gentianopsis procera*). Further inland, it typically grades into a shrub-graminoid zone with the addition of shrubby cinquefoil (*Potentilla fruticosa*), red-osier dogwood (*Cornus stolonifera*), ninebark (*Physocarpus opulifolius*), and sweet gale (*Myrica gale*). This, in turn, is backed by white cedar, white birch, spruce dominated boreal forest. Most of the immediate shoreline along this stretch contains a fair number of exotic species including bouncing bet (*Sapponaria officinalis*), ox-eye daisy (*Chrysanthemum leucanthemum*), spotted knapweed (*Centaurea maculosa*), and yarrow (*Achillea millefolia*).

Northcutt Bay was the only region of the island with any significant sandy shoreline, consisting of a narrow strip along the inner northwest corner of the Bay. A population of Pitcher's thistle persists here, consisting of 50-100 clumps scattered sparsely in only a small region of the inner Bay. The sandy shore backs up immediately to boreal forest where sparse amounts of beauty sedge (*Carex concinna*) were found along the forest-dune ecotone. The site was quite weedy and there was evidence of human activity such as boat launching, picnic sites, and hiking.

A northern fen, an element occurrence in our database, occurs a little further eastward of the sandy portion of the Bay. White cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*) are scattered throughout a marly, hummocky, matrix of shrubby cinquefoil (*Potentilla fruticosa*), twig-rush (*Cladium mariscoides*), bulrush (*Scirpus cespitosus*), and little bluestem (*Andropogon scoparius*). Additional species include grass-of-parnassus (*Parnassia glauca*), false asphodel (*Tofieldia glutinosa*), Kalm's lobelia (*Lobelia kalmii*), Indian paintbrush (*Castilleja coccinea*), sundew (*Drosera linearis*), and Pitcher plant (*Sarracenia purpurea*). The fen extends inland, forming a "bouncy" peat-mat surrounding a large pool of open water. A large, A-ranked wet meadow extends inland from the fen.

Merlin (state threatened) was seen flying at Northcutt Bay and osprey (state threatened) was observed at Indian Harbor. No nests were observed, although it is likely that they nest on the island.

Red Oak Garden

A forested track of mature red oak (*Quercus rubra*) occurs within southern portions of the islands interior forest. The site is included here because of its significance as a possible artifact of presettlement Native American land use. The General Land Office surveyors of the mid-1800's noted this area as having been "cleared by fire" and "burned". Today the site is completely dominated by large red oaks with few sugar maples (*Acer saccharum*) and white ash (*Fraxinus americana*) reaching the canopy. It is likely that the native people inhabiting Garden Island in presettlement times regularly burned this area to keep it open for agriculture. When fires were common, red oak rapidly established and then assumed dominance when the field was abandoned. Fields were only maintained for five to ten years, at which point raspberries and blackberries made management difficult and nutrient levels had probably also dropped considerably, reducing output of corn or other crops. Sugar maple, the dominant species throughout the islands' mesic forests will soon regain its place in this site's canopy as it currently dominates the forest's understory. Litter samples taken in the oak stand during the 1999 field season contained small amounts of charcoal in three out of five samples. As expected, most of the charcoal was sugar maple, another indication that, without fire, the stand will return to sugar maple and other northern hardwoods. Other common understory species include ironwood (*Ostrya virginiana*), and hazelnut

(*Corylus americana*), a fire-adapted shrub. Common groundlayer species include wild sarsaparilla (*Aralia nudicaulis*), sedges (*Carex pensylvanica* and *C. pedunculata*), and sugar maple. In 1999, this site was surveyed again. No white pine (*Pinus strobus*) was found; many other Native American former agricultural sites also contain groves of white pine that established at the same time as the red oak. Based on trees cut near the trail, individuals of red oak were found to be at least 120-125 years old, meaning that the forests established sometime around 1875 or earlier.

Sweat Lodge Swale

A small, high quality northern fen occurs approximately 30 meters inland from the island's northwest shore. This fen is mapped as an element occurrence record in the MNFI database. The swale is bordered by an extensive boreal forest to the south and a thin band of cedar glade separating the northern fen from Lake Michigan. The long, narrow fen is distinctly different at each end. The marly, eastern portion of the fen contains a diverse array of calcium loving species including English sundew (*Drosera anglica*) and butterwort (*Pinguicula vulgaris*), both species of special concern, Ohio goldenrod (*Solidago ohioensis*) Kalm's lobelia (*Lobelia kalmii*), grass-of-Parnassus (*Parnassia glauca*), sedges (*Carex viridula* & *C. flava*) and false asphodel (*Tofieldia glutinosa*). In contrast the western portion of the fen was dominated by sedge (principally *Carex lasiocarpa*) and contained little plant species diversity. Within the limestone rich cedar glade to the north of the swale several Native American, traditional sweat lodges have been erected and although empty, were in good repair. The sandy and limestone cobble shoreline bordering the cedar glade contained several dozen, scattered Pitcher's thistle (*Cirsium pitcheri*), constituting a small new occurrence for the island.

A return trip was made to sweat lodge swale in 1999 to survey for beauty sedge (*Carex concinna*) and ram's head orchid (*Cypripedium arietinum*) during their prime. Beauty sedge was found flourishing in the rich cedar glade bordering Lake Michigan. The species was growing in abundance, widely scattered in crevices in the flat bedrock substrate at the edge of the cobble beach terraces and boreal forest further inland. It's most common associates included bearberry (*Arctostaphylos uva-ursi*), sedges (*Carex pedunculata*, *Carex eburnea*), gay wings (*Polygala pauciflora*), twinflower (*Linnaea borealis*), and various mosses and lichens. Ram's head orchid was not observed, however, a dozen or so yellow lady's-slipper orchids were found there.

Recommendations: The decision concerning natural-area dedication of the island is not an easy one. While there are areas of high quality, undegraded habitat that could clearly be considered for dedication, there are other areas that are more disturbed or that have cultural significance to the Native Americans of northern Michigan. A decision concerning final dedication boundaries will have to take both ecological and political conditions into account.

Grand Mere

Landscape and Historical Context: Grand Mere Lakes Natural Area is located in the Southern Lake Michigan Lake Plain in subsection VI 3.2 (Albert 1995). The dune sands are derived from glacial sediments, including lacustrine and outwash sands and sandy tills (Dorr and Eschman 1970). The dune complexes from this natural area are associated with the Lake Nipissing stage of the Great Lakes, when water levels were 25 to 30 feet higher than present day lake levels (Dorr and Eschman 1970). These higher lake levels resulted in greater amounts of coastal erosion and dune formation. The natural area contains parabolic dunes, which are U-shaped, with the bottom of the U inland typically formed when stable, forested dunes are destabilized, and they often occur as series of overlapping dune ridges. As inferred from the original land surveyors notes, the presettlement forests of the dunes were dominated by black oak (*Quercus velutina*), white oak (*Quercus alba*), red oak, pignut hickory (*Carya glabra*) and mockernut hickory (*Carya ovata*). Additional components of the canopy include: white pine, sugar maple, red maple, black cherry, and white ash. Several large areas of open, blowing sand (blowouts)

were also noted in the GLO surveys. While wind is the prevalent form of natural disturbance within the dune fields, fire resulting from lightning strikes and Native American ignition also occurred, but was less common. Where oaks, hickories, and pines were common on the dunes, fire was a significant natural disturbance factor.

The high parabolic dunes at the site are formed on a sand spit, behind which three shallow lakes and associated wetlands are located. The oldest lake is to the south, about four feet above the present lake level, while the youngest lake to the north is only about a foot about Lake Michigan. Herbaceous and shrub vegetation extend across the entire lakes. Plants of the Atlantic coastal plain characterize many of these lakes and ponds in the southern half of the Lower Peninsula, but the coastal plain flora does not appear to be well developed at Grand Mere. Surveys were conducted on the northern-most lake at the site during the fall of 2000, but no rare coastal plain disjuncts were encountered. The other two lakes will be surveyed in 2001.

Ecological Site Summary: Figure 8 depicts the delineated natural communities found within and surrounding the Grand Mere Natural Area. The prevalent communities are sand beach, open dune, southern dune forest, inundated shrub swamp, inland emergent marsh, southern swamp, and conifer swamp. The open dunes at Grand Mere include foredunes and blowouts. Locally, the open dunes in the blowouts of Grand Mere have been degraded by foot traffic and are lacking in areas of abundant herbaceous cover. The northern third of the dunes directly west of Middle Lake where previously mined for sand. In addition, the northern most open dunes have been invaded by numerous exotic species, such as bouncing bet (*Saponaria officinalis*), Lombardy poplar (*Populus nigra*), and sweet white clover (*Melilotus alba*). Field survey efforts were concentrated in the southern dune forest and in the swamp forests. The southern dune forest in Grand Mere can be classified as dry-mesic southern forest. The canopy in this community is dominated by black oak, with significant amounts of black cherry, white oak, red oak, chinquapin oak (*Quercus muehlenbergii*), and sassafras (*Sassafras albidum*). Chinquapin oak appears to occur commonly in many of the dunes south of Muskegon, but it is absent in the northern dunes. Numerous floristic indicators of oak savanna are found throughout this dune forest including: bracken fern (*Pteridium aquilinum*, locally dominant), common oak sedge (*Carex pennsylvanica*, locally dominant), early low blueberry (*Vaccinium angustifolium*, locally dominant), pasture rose (*Rosa carolina*), wild columbine (*Aquilegia canadensis*), arrow-leaved aster (*Aster sagitifolia*), and woodland sunflower (*Helianthus divaricatus*). In addition to the prevalence of oak savanna species, the wide spacing and open-grown structure of the canopy dominants suggests that this forest has been fire suppressed and would benefit from restorative fire management.

The southern swamp forest, which is the prevalent community east of Grand Mere Lakes, contains the following canopy dominants: silver maple (*Acer saccharinum*), red maple, and green ash. American elm (*Ulmus americana*) and tulip poplar (*Lireodendron tulipifera*) are also present, but of less importance. The forest has moderate amount of downed woody debris and snags of similar species, diameter, and decomposition classes. Interspersed within the southern swamp forest are several pockets of conifer swamp. Qualitative sampling in the southernmost conifer swamp indicated that this portion should be classified more specifically as a relict conifer swamp since the canopy was composed of tamarack (*Larix laricina*), northern white-cedar, red maple, black ash (*Fraxinus nigra*), and green ash. The status of red maple in the canopy of this community should be monitored and if red maple appears to thrive at the expense of the conifers, girdling of red maples should be considered. An unusual ecotone exists where the southernmost portion of the relict conifer swamp grades into the southern dune forest. This ecotone is a thin band dominated by hemlocks and white pines of large stature and diameter. Further quality assessment of the remaining "islands" of conifer swamp in the southern swamp will require an early to mid-summer field visit. Invasive exotic species were not observed dominating the strata in any of the surveyed communities.

The lakes have suffered some degradation by present and existing management practices. There has been cranberry operations on South Lake. Runoff from I-94 has also been directed into Grand Mere through culverts and Thorton Drain.

Recommendations: Figure 9 displays the boundaries of Grand Mere State Park and the Grand Mere Lakes Natural Area, with a quality-designation of the mapped communities. Three categories were used to describe the quality of the communities, degraded (i.e. degraded natural community, residential, recreation, Agriculture, and sand mining), potential buffer, and potential natural-area quality or natural-area quality. The category of potential natural area quality captures two community conditions. One condition is for those areas that were visited and judged to be capable of attaining natural-areas quality with time or stewardship (i.e. the southern dune forest). The other condition that falls into the “potential natural area” category is that which was not visited but does not show signs of degradation on the aerial photographs. The above categories were used to help guide the creation of a recommended natural areas boundary. Figure 10 shows the jurisdictional boundaries as well as the recommended natural-areas boundary, which is very similar to the actual natural-areas boundary. The natural area is limited by four very distinct boundaries. To the west is Lake Michigan and to the east, Thorton Drive and I-94. Residences and sand mining create a barrier to the south and residences create a barrier to the north. The recommended boundary contains the full extent of non-degraded southern dune forest and non-degraded southern swamp forest, the islands of conifer swamp, the relict conifer swamp, all lakes and their associated communities (inland emergent marsh and inundated shrub swamp), the sand beach, and the open dunes (including degraded). Designation as potential buffer or degraded does not rule an area out as capable of achieving natural-areas quality, nor does designation of natural-areas quality guarantee such status for perpetuity. A concerted stewardship effort is required to promote and maintain natural areas quality. Control of foot traffic in the blowout should aid the recovery of vegetation on the degraded open dune. Girdling of red maple may prove to be a necessary means of preserving the conifer component of the relict conifer swamp. The use of prescribed fire in the southern dune forest will enhance native species diversity. Control of exotic species should be considered for the open dunes.

Inventory of the ponds and wetlands was not completed in 2000. It is recommended that further inventories for submergent and emergent aquatic plants be conducted in the early fall of 2001.

Haven Hill

Rare animal inventories resulted in a new record for Blanding’s turtle (See Table 1). The mosaic of upland oak forests and extensive wetlands provides good habitat for Blanding’s turtle. Surveys were also conducted for nesting red-shouldered hawk and Cooper’s hawk, but no occurrences were found for either species. Unsuccessful inventories were also conducted for Blanchard’s cricket frog and two rare moths, the blazing star borer moth and regal fern borer moth. No natural community or rare plant surveys were conducted at the natural area.

Recommendations: Surveys for natural communities and rare plants are planned for this site, as there has been extensive survey done for both in the past.

Figure 9

Table 1. Zoology Inventory Results.

Natural Area Surveyed	Species	Species Scientific Name	Year last observed	Previous known EO	New EOs
Haven Hill	Cerulean warbler	<i>Dendroica cerulea</i>	1999	0	1
	Red-shouldered hawk	<i>Buteo lineatus</i>		(0)	0
	Cooper's hawk	<i>Accipiter cooperii</i>		(0)	0
	Blanding's turtle	<i>Emydoidea blandingii</i>		0	1*
	Blanchard's cricket frog	<i>Acris crepitans blanchardi</i>		(0)	0
	Blazing star borer moth	<i>Papaipema beeriana</i>		(0)	0
	Regal fern borer moth	<i>Papaipema speciosissima</i>		(0)	0
Thompson's Harbor	Hine's emerald dragonfly	<i>Somatochlora hineana</i>	1999	1	0
	Eastern massasauga	<i>Sistrurus c. catenatus</i>		(0)	0
	Prairie Indian plantain	<i>Cacalia plataginea</i>		0	1
Turner Creek Wetlands	Mitchell's satyr	<i>Neonympha m. Mitchellii</i>	1999	1	0
	Angular spittlebug	<i>Lepyronia angulifera</i>		0	1
	Tamarack tree cricket	<i>Oecanthus laricis</i>	1999	1	0
	Blazing star borer moth	<i>Papaipema beeriana</i>		(0)	0
	Regal fern borer moth	<i>Papaipema speciosissima</i>		(0)	0
	Eastern box turtle	<i>Terrapene c. carolina</i>		0	1
	Prairie Indian plantain	<i>Cacalia plataginea</i>	1999	1	0

Key: 1 = year 1999 survey record
0 = year 2000 survey record
(0) = year 2000 unsuccessful survey

Hoffmaster Wild Area

Based on recommendations from Hoffmaster State Park staff, surveys at Hoffmaster State Park were conducted in natural communities of Black Lake, a shallow lake with extensive southern swamp forest and inland emergent marsh along its margins. Extensive submergent marsh occupies almost the entire basin of the shallow lake. While the marsh is extensive, it probably does not justify inclusion in the natural area, although it may warrant acquisition of additional shoreline for inclusion within the park. The state park already owns sections of shoreline along the lake, but a blacktop road crosses this property.

Local residents claim to regularly sight spotted turtles in the spring, when the turtles leave the wetlands along the lake to lay eggs in the nearby dunes. No photographs or other documentation is available for the spotted turtles.

No specific inventory was conducted within the designated natural area at Hoffmaster. The site was visited during the writing of MNFI's dune booklet, Borne of the Wind, and the severity of the windthrow within the natural area was observed. The severe windthrow was the result of a storm that occurred during the spring of 1998. All of the coastal parks near Muskegon were affected by this storm.

An enclosure was placed within the windthrown trees to document the effect of deer browse on groundcover flora and forest regeneration. MNFI staff placed funnels and short lengths of plastic tubing within the dune forest at measured distances from the open dunes to document aeolian sand movement within the forest. The study documented some movement of fine sand at considerable distance from the open dunes, but vandalism of many of the sand trap greatly limited the usefulness of the study.

Photo interpretation of the dune forests showed that, as at Warren Dunes State Park, most aerial photos were not adequate for accurately identifying areas of hemlock and white pine within the forests at Hoffmaster State Park. However, the most recent leaf-off photography from 1996 showed that these conifers were concentrated in narrow bands along the steep northeast slopes of the blowouts, where the topography probably resulted in reduced transpiration for these northern conifers.

Recommendations: One area to investigate is the impact or ORV entrance to the park from private lands to both the north and the south. During field visits, it was obvious that there were ORV incursions into the park from the south. No specific incursions were noted from the north. No signs of ORVs were noted on the blowouts, but there was sign of ORV use on the beach. A better perception of the severity of this problem could probably be gotten from park staff.

Hog Island Sites

Surveys of Hog Island were jointly conducted for both the Islands project and the Natural Areas project for increased resource use. Maps summarize the plant community occurrences (Figure 11) and rare species (Figure 12) of the island. The majority of the text is modified from the Islands Report (Penskar et al. 2000). Earlier inventories were conducted on Hog Island as part of the dunes inventory in 1986. It was interesting to note the differences in the coastal ecosystems; the 1986 survey was conducted in high-water conditions, while the 1999 inventory was conducted during low-water conditions. Photos were taken of several natural communities on the island, including Great Lakes marsh, northern fen, and northern hardwood swamp.

Baltimore Bay EA

This state environmental area consists of a couple of very narrow embayments that support Great Lakes marsh, northern fen, and at their inland edge, interdunal wetlands. During 1999, due to the low water levels in the Great Lakes, these bays were almost completely dry. Emergent marsh vegetation dominates the outer portion of the wetland, while northern fen vegetation occurs near the swamp forest border that is dominated by northern white cedar (*Thuja occidentalis*). The marsh is dominated by hardstem bulrush (*Scirpus acutus*), and includes such species as rush (*Juncus balticus*). Common and dominant plants of the northern fen include Kalm's lobelia (*Lobelia kalmii*), Arkanasa mint (*Calamintha arkansana*), sedge (*Carex viridula*), twig-rush (*Cladium mariscoides*), and rush (*Juncus balticus*).

In addition to the natural community occurrences, common terns (*Sterna hirundo*) were encountered along the narrow embayments of Baltimore Bay. Four adult terns were observed, and were quite aggressive, appearing to be defending nests. This was the only place where common terns were encountered, but the previously known nesting site on the point near Grape Island was not visited.

Hog Island East Shoreline

The eastern shoreline of Hog Island consists of several small dune and swale complexes, areas of open dune, cobble beach, and coastal wetland. There is very little sign of human disturbance along this entire shoreline. Along the southeastern shoreline there is a relatively large stretch of Great Lakes marsh, mapped as an A-ranked element occurrence in 1999. The substrate is generally cobbly, with marl and northern fen plants near the upland edge of the wetland complex. This section of shoreline has a record

Figure 11

for Pitcher's thistle (*Cirsium pitcheri*), but there was very little sand substrate, so it is likely that the collections were made from further north along the eastern shoreline. Populations were ultimately found in the northern portion of this site. The populations of Pitcher's thistle are relatively small, located west and north of Tim's Island. The smaller area of habitat supported approximately 60 plants, while the larger northern area had only four plants. The cobbly nature of much of the shoreline does not provide optimal habitat for this plant, although this species has been observed to form moderately large colonies on cobbly-sandy beaches (Penskar et al. 1997).

The dune and swale complex, although not large, was mapped an AB-ranked element occurrence. The complex has one large swale and two well developed dune ridges. The foredune provided habitat for both Pitcher's thistle and Lake Huron locust (*Trimerotropis huroniana*). Lake Huron locust is found along the narrow foredune of the eastern shoreline in several places. Most of these populations are small, a result of the small area of habitat, but one large stretch of beach is over a half mile long and contains the largest population of the locust, with 38 locusts counted. A dwarf lake iris (*Iris lacustris*) population occurs on the southern edge of this site. This population of dwarf lake iris is the first occurrence documented from the island. The population occupies a small open beach ridge, with many ant mounds interspersed throughout. Portions of the beach ridge and adjacent swale support small northern white-cedars (*Thuja occidentalis*), under which scattered clumps of sterile dwarf lake iris are also found. The northern white cedars within this complex were not large, but there were no stumps. Storms may cause blowdowns to occur commonly in these shoreline cedars.

Hog Island North

Both of the natural community occurrences in the northern part of the island are inland sites. Most of the upland forest has been cut in the past, probably around the turn of the century for fueling steam ships. The upland old-growth forest is almost certainly the result of Native American agricultural activities. An old-growth black ash (*Fraxinus nigra*) swamp was found east of Fisherman Bay; it is mapped as an A-ranked element occurrence of northern hardwood swamp. The black ash trees, which ranged from 26 to 40 cm in diameter, were highly buttressed, indicating that the water levels were typically high. In 1999 the swamps were completely dry; these areas were probably considered to be of poor productivity and thus were not harvested during the cutting of adjacent upland sites. West of the swamp there was almost impassible shrub swamp, with a large beaver pond, also completely dry in 1999.

An area that is a remnant of Native American occupation occurs on a small ridge. The top of this low sand ridge, probably a beach ridge created several thousand years ago, supports a forest of white pine (*Pinus strobus*) and red oak (*Quercus rubra*). This site was referenced as an Indian field in the presettlement surveys. Former MNIF ecologist Gary Reese cored trees in 1986, and identified trees that dated from 1830s to 1840s, which provides potential evidence that the area was farmed by Native Americans using fire as a tool for agriculture. Plot data were compiled during 1999 surveys of the site.

Recommendations: The island is characterized by low levels of human land use and definitely qualifies for Natural Area status. The red oak stand probably warrants more detailed archeological investigation. Storage pits were searched for during the 1999 inventory, but none were found. It would also be useful to do charcoal analysis of the substrate to assist in determining the forest vegetation prior to Native American management for agriculture.

Maple River Salt Marshes

The Maple River salt marshes were visited during mid-summer and again in October. Visits were conducted by both MNFI botanist and ecologist, who were accompanied by Dr. Tom Burton and Cindy Koppen-Hodges, a graduate student interested in restoration of Dow Chemical's salt drying ponds using native salt-tolerant plants. Searches were conducted for the rare plants known from these marshes,

both (*Scirpus olneyi*) and (*Eleocharis parvula*). *Scirpus olneyi* was found in the salt marshes on both the north and south sides of the river, but *Eleocharis parvula* could not be found in its known site along the north side of the river. The habitat along the north side of the river seems to have changed dramatically since its earlier study (Chapman et al. 1985). In the 1980s, there were open, salt seeps referenced within the wetland. During the summer and autumn 2000 visits, as well as during earlier visits by MNFI ecologists in the late 1980s and in the 1990s, no open seepages were seen on the northern side of the river. In contrast, brackish seepages are common on the south side of the river, where the population of *Scirpus olneyi* is much larger. As in most wetlands, there is considerable change in the amount of water within the wetland from year to year. During a wet summer in the mid-1990s, the southern wetland had standing water covering its entire surface. In contrast, during the summer of 2000, only a small area immediate to the salt seeps was flooded. It was obvious that seeps were regularly visited by deer; almost the entire seepage was dug up by deer hooves.

Comparison of the 1978 and the 1998 aerial photos of the salt marshes demonstrates the shrinkage of open marsh habitat with time. In the 1978 photos, open seepage areas were evident, whereas in the later 1988 and 1998 photos, no areas of seepage were visible.

Recommendations: Exotic plants are also common on the north side of the river. These include a large population of *Phalaris arundinacea* near to the previously noted areas of salt seepage. It is recommended that controlled burns be introduced to the salt seeps of the natural area in an attempt to reduce exotics and reduce cover of native graminoids within the salt marsh. This may provide enough open habitat to allow the diminutive *Eleocharis parvula* to re-establish from the seed bank. It is likely that there is a long history of fire at this site, as Native Americans probably utilized the salt either for direct consumption or as a predictable place to hunt deer and other large game. Stump-sprouted white and black oaks immediately upland of the marsh are a strong indication of such fire management.

Muskegon Dunes and Swales

Inventory at this site was concentrated along Lost Lake to search for additional coastal plain marsh species during this low-water year. This lake had been recommended for inclusion within the natural area. All of the element occurrence records for coastal plain disjuncts were verified, but no new species were identified. *Psilocarya scirpoides* (bald-rush) was particularly abundant along the eastern edge of the lake. A new population of *Zizania aquatica* var. *aquatica* (wild rice) was found in Snug Harbor, a small bay of Muskegon Lake.

Probably the most impressive change observed in the natural area were the effects of the spring 1998 windstorm, which resulted in extensive windthrows in the forests here and at nearby Hoffmaster State Park. These blowdowns provide opportunity to observe successional changes within the dune forests. These storms are a normal process in all Great Lakes coastal forest systems. Observations of the open dunes indicates relatively high levels of human use and resulting degradation to the open dunes. However, comparison of aerial photographs from 1978, 1988, and 1999 does not appear to indicate increased levels of degradation within the open coastal dunes. In fact, there may be increased herbaceous cover on portions of the dunes. The only place where this pattern does not seem to hold is at the extreme southern end of the park, where easy road access seems to have resulted in much more intensive recreational destruction of the dunes.

Recommendations: It is recommended that Lost Lake be considered for inclusion within the natural area. Part of this recommendation would include acquiring the remaining private portions of the lake. The land-use history of the lake should be investigated, as the aerial photos appear to indicate that there was some sand mining along the east and north sides of the lake, where many of the coastal plain plants are concentrated.

Monitoring of the long term changes within the blowdowns could also provide insights into the dynamics of the forests of the dunes. Such a study would have to be initiated immediately, with the recognition that some of the first changes, such as herbaceous response might not be documentable at this point. The effect of a large deer population upon the herbaceous vegetation is not readily apparent, but results of studies within exclosures at Hoffmaster State Park should probably be evaluated for applicability at Muskegon State Park as well.

While the dune portion of the natural area has been partially degraded by human recreational use, the natural area remains significant. Long-term photo points within the natural area could provide an effective way to monitor the effects and levels of recreational use. On a dynamic, open system like the dunes, periodic inventory without specific reference points is probably ineffective for site evaluation.

In terms of ongoing inventory needs, post-field-season interpretation of the most recent aerial photography available from the DNR Parks Division resulted in the identification of an additional small wetland along the shore of Muskegon Lake, just west of Snug Harbor, for conducting surveys for coastal plain marsh plants in 2001. This wetland was not visible in earlier aerial photography and may be the result of the extreme low water conditions.

Porcupine Mountains

The five stream reaches sampled (Figure 13) yielded a total of 11 fish species representing 6 species associations (Table 2) and 121 invertebrate taxa (Table 3). Streams visited varied in terms of channel size, substrate composition, hydrology and position within drainage networks. Accordingly, biological community composition and physical habitat properties observed varied from site to site. No listed aquatic taxa were observed during the stream surveys.

The Big Carp River (PM1, Figure 13) survey reach was located just below the outflow of Lake of the Clouds in the Porcupine Mountains Wilderness Park. The survey reach was approximately 2m wide and was characterized by a very low gradient, meandering channel within a moderately constrained floodplain. Water depth was approximately 0.75m throughout much of this reach and water current velocity was very low.

Conductivity (63 $\mu\text{S}/\text{cm}$) and pH (7.2) measures were the lowest of all sites visited. The water in this reach was lightly stained (brown), and large amounts of decaying organic materials were present, suggesting production of humic acids that lower pH and influence concentrations of ions in the water column that contribute to specific conductance. Substrates were dominated by mud, fine and coarse organic materials, and silt with occasional patches of fine gravel. Streambanks were steep (~0.5m high) with some overhanging brushy vegetation, extensive root mats and undercuts. No riparian canopy was present to shade the stream, providing high incident sunlight levels to support numerous macrophyte beds and filamentous algal mats. The comparatively warmer temperature in this stream (12.4°C) was probably due to higher levels of incident light and lower flushing rates compared to the other streams surveyed.

The fish community of the surveyed reach was comprised of only two species, smallmouth bass (*Micropterus dolomieu*) and central mudminnows (*Umbria limi*). Both species are commonly associated with low-current, coolwater streams. We expected to collect stickleback species at this site, but thorough survey efforts yielded no additional species. It is assumed that smallmouth bass are not native in this system, as they were introduced into Lake of the Clouds in the 1930s, along with bluegills, and they are managed as a fishery (DNR Fisheries, personal communications). Historical introduction of smallmouth bass has likely lowered biological integrity of the aquatic ecosystem due to alterations in the community that may have occurred as a result of this introduction. The Big Carp River had the highest benthic

macroinvertebrate taxa richness of all stream sites visited and had a particularly diverse dragonfly assemblage that included 13 species, the highest of any site visited (Table 3). Not surprisingly, the Carp River site had fewer EPT taxa (12) than the other sites, and the highest biotic index, indicating a more tolerant community. Most EPT taxa are more characteristic of higher current velocity, rocky substrate habitats and many species that are considered tolerant are characteristic of slackwater conditions with sandy, silty and/or organic substrates. In this case, the higher tolerance of the community is not indicative of low ecological integrity. Rather, the taxonomic composition of the macroinvertebrate community and habitat conditions of the site reflect rather high levels of ecological integrity for a low-gradient, broadly meandering stream with low water velocity regime. Aerial photos indicate that the nature of the Big Carp River changes significantly downstream from the reach surveyed during our field visit. Additionally, the upper part of the watershed is isolated from the lower river segments of the Big Carp River by a subterranean river reach that likely represents a large gravel deposit over bedrock. Surveys of additional reaches within the Big Carp River drainage below this underground reach are needed to provide a more extensive ecological inventory and classification of this river system.

Table 2. Fish species collected at the Porcupine Mountain sample sites. Species associations are based on Zorn and Seelbach (unpubl. notes).

Fish Species	Species Code	Survey Stream				
		Presque Isle River	Lost Creek	Pinkerton Creek	Big Carp River	Scott Creek
Brook trout (<i>Salvelinus fontinalis</i>)	BRTR	X	X			
Mottled Sculpin (<i>Cottus bairdi</i>)	MOSC	X		X		
Longnose Dace (<i>Rhinichthys cataractae</i>)	LODA	X	X	X		
Blacknose Dace (<i>Rhinichthys atralatus</i>)	BLDA	X	X	X		
Northern Redbelly Dace (<i>Phoxinus eos</i>)	NORE			X		
River Chub (<i>Nocomis micropogon</i>)	RICH	X				
White Sucker (<i>Catostomus commersoni</i>)	WHSU	X				
Creek Chub (<i>Semotilus atromaculatus</i>)	CRCH		X	X		X
Brook Stickleback (<i>Culaea inconstans</i>)	BRST					X
Smallmouth Bass (<i>Micropterus dolomieu</i>)	SMBA				X	
Central Mudminnow (<i>Umbra limi</i>)	CEMU				X	
Species Group Associations		1,3,5,7,15	1,5,7	1,3,7	4,15	1,3

Scott Creek (PM2, Figure 13) is a small, low-gradient headwater stream that drains into the lower Big Carp River. The reach sampled was approximately 0.5m wide, and water depth ranged from 4-10 cm with a few deeper pools. Conductivity (162 μ S/cm) and pH (7.9) values were higher than those observed in the Big Carp River, but were comparable to measures observed at other stream sites surveyed. Substrates were primarily sand with moderate organic content and occasional gravel beds. The surrounding riparian area was comprised of trees, shrubs and some grasses, providing a range of incident sunlight levels from fully shaded to almost completely unshaded. Sections of the stream were dominated by dense growths of *Sparganium spp.* that served as cover for the very abundant brook sticklebacks (*Culaea inconstans*). Creek chub aggregations (*Semotilus atromaculatus*) were also present in small pools. The macroinvertebrate community was similar in species richness (41 species) but characterized by lower EPT taxa richness and a higher community tolerance compared to the other headwater streams visited. Plecoptera (stoneflies) were absent and there were comparatively fewer Ephemeroptera (mayfly) taxa in Scott Creek. This was not surprising given the moderately slow water current and predominance of sandy substrates in the stream. The presence of coarse woody debris in the floodplain of Scott Creek indicated that there is at least some degree of flashiness in this system and that surface runoff plays a significant role in shaping the hydrology of the stream. Habitat diversity was low in Scott Creek, but was consistent with the habitat that is generally available in streams flowing across lake plain deposits.

Lost Creek (PM3, Figure 13) is a small second-order tributary stream of the Little Iron River watershed that flows through a constrained floodplain. It is very characteristic of stream systems considered by fisheries biologists to be brook trout streams/fisheries. The reach surveyed was a cold-water (9°C), shallow (i.e., generally <10cm deep) stream dominated by cobble substrates and riffle habitats. Occasional sand and gravel bars occurred in pools and on inside bends of the moderately

Table 3. Aquatic invertebrate characteristics collected at the 5 Porcupine Mountain sites sampled.

Macroinvertebrate metrics	Presque Isle River	Lost Creek	Pinkerton Creek	Big Carp River	Scott Creek
Total Taxa	41	36	44	46	41
EPT Index	21	22	23	12	15
Taxa Biotic Index	3.74	2.69	3.45	4.08	3.89
# (%) of Mayfly Taxa	10 (32)	8 (29)	9 (19)	6 (23)	5 (20)
# (%) of Stonefly Taxa	2 (16)	3 (15)	3 (12)	0 (0)	0 (0)
# (%) of Trichoptera Taxa	9 (15)	11 (24)	11 (21)	6 (15)	10 (23)
# (%) of Dragonfly Taxa	1 (2)	3 (8)	6 (13)	13 (28)	3 (7)

meandering stream channel. Conductivity (188 $\mu\text{S}/\text{cm}$) and pH (7.9) measures suggested moderate-high stream water ion concentrations characteristic of carbonate/bicarbonate buffered streams in post-glacial landscapes. Mean stream width was $\sim 1.5\text{m}$, and the channel was characterized by a moderate gradient that created fast-moving water currents through multiple pool-riffle-run habitat sequences. Floodplain characteristics suggested that overbank flow events were uncommon. Streamflow is therefore likely to be largely stable and dominated by groundwater inputs in Lost Creek.

Lost Creek's fish community was comprised of four species: brook trout (*Salvelinus fontinalis*), creek chubs (*S. atromaculatus*), blacknose dace (*Rhinichthys atralutus*) and longnose dace (*Rhinichthys cataractae*). All four species are common and characteristic members of cold-water stream fish assemblages. Brook trout dominated the Lost Creek fish assemblage and included large numbers of young-of-the-year and two-year-old fish. Several adult *S. fontinalis* exhibiting spawning coloration were also collected during the survey. Brook trout are often considered to be indicators of high stream ecological integrity given that this species is intolerant of degraded environmental conditions. We expected to find mottled sculpins (*Cottus bairdi*) in Lost Creek given the temperature regime and habitat available, although no *C. bairdi* were observed during the surveys (although they were observed in adjacent streams). The macroinvertebrate community in Lost Creek was characterized by the lowest taxa richness (36 taxa) of all stream reaches visited in the Porcupine Mountains Wilderness Park, although this is not uncommon for small cold water stream systems. The number of EPT taxa present in Lost Creek was among the highest observed (22). The TBI score was also the lowest observed, indicating that the Lost Creek invertebrate community was the most intolerant of degraded environmental conditions and thus represented high biological integrity. The majority of the most intolerant macroinvertebrate taxa observed during the Porcupine Mountains surveys occurred in Lost Creek, including the heptageniid mayfly *Epeorus vitreus*; the chloroperlid stoneflies *Clioperla clio* and *Utaperla gaspersi*; and glossosomatid caddisflies, *Glossosoma sp.* Stream ecological and biological community properties observed during the site visit indicated that Lost Creek is a very high quality example of a small, shallow, moderate gradient, cold water stream dominated by large rocky substrates and riffle habitats.

Pinkerton Creek (PM4, Figure 13) is similar in size to Lost Creek, although it is functionally very different. It is a tributary of Lake Superior that flows directly to the lake with no intermediate connecting rivers. The estimated mean channel width of the stream reach surveyed was 1.5m, although beaver damming of reaches below the study area had drastically broadened the stream channel in those areas, creating deeper, stillwater habitats. Multiple large woody debris accumulations (LWDA) within the floodplain and the height of within-channel LWDA (i.e., 1-1.5m) suggest that Pinkerton Creek is a flashy, runoff-dominated stream system with commonly occurring bank overflow events. This flashiness may indicate some upstream basin disturbance such as forest clear-cutting that has altered watershed hydrology and the stability of Pinkerton Creek. Alternatively, it may be related to surface geology properties that promote rapid percolation of water during rainfall events. This would be consistent with the lake plain deposits upon which this stream flows. Channel meander and gradient were both low-moderate, and stream flow/current velocity were moderate during the survey (mean depth $\sim 5\text{-}10\text{cm}$). Substrates consisted of sand, gravel, occasional cobbles, and abundant coarse and large woody debris. Pool-riffle-run habitats were not as well defined in Pinkerton Creek, and the flashy nature of this stream likely changes the morphology and distribution of these habitats within the stream channel on a regular basis.

Pinkerton Creek exhibited comparatively high species richness with respect to both the fish and benthic macroinvertebrate communities. Five fish species comprised the fish assemblage in Pinkerton Creek, including creek chubs (*S. atromaculatus*), blacknose dace (*R. atralutus*), longnose dace (*R. cataractae*), northern redbelly dace (*Phoxinus eos*) and mottled sculpins (*C. bairdi*). There was no clearly dominant species as was the case in Lost Creek, Scott Creek and the Big Carp River upper main

stem. Pinkerton Creek had both high macroinvertebrate species richness and high EPT taxa richness. The comparatively low TBI value (high biological integrity) reflects a community comprised of multiple taxa that are very intolerant (e.g., *Ephemerella dorothea*, *E. needhami*, *E. invaria*, *E. subvaria*, *Acronuria arida*, *Glossosoma sp.*) and moderately intolerant (e.g., *Ameletus lineatus*, *Stenonema vicarium*, *Nigronia serricornis*, *Helicopsyche borealis*) of degraded environmental conditions or slackwater habitats. The greater species richness of Pinkerton Creek may be due, in part, to the comparably greater variability in flow regime in Pinkerton Creek that routinely reshuffles habitat availability and provides greater habitat diversity. The direct connection of Pinkerton Creek to Lake Superior and existence of lowland areas susceptible to damming by beavers may also contribute to the biological community characteristics in Pinkerton Creek, enabling direct species exchange with Superior and increasing the diversity of available habitats.

The survey reach in the main stem of the Presque Isle River (PM5, Figure 13) was the largest stream site visited in the Porcupine Mountains Natural Area. The survey reach was a large cool water (10°C during site visit) stream with a forested riparian area characterized by steep streambanks. Mean stream width was estimated to be 10m, and mean water depth was ~0.3m. Shading in this reach is limited to the nearshore areas of each side of the river, and the water is likely to have a more variable temperature regime in warmer months and higher instream primary productivity compared to smaller streams that are completely shaded. Conductivity (166 µS/cm) and pH (8.3) measures indicated moderate-high ionic concentrations in the Presque Isle River. Channel gradient was moderate-high, with local habitats and substrates that varied greatly from swift mid-channel currents over bedrock/boulder/cobble substrates to sandy backwaters along the channel margin. Most substrates were comprised of sand and gravel patches, cobbles, and boulders over bedrock. Large exposed bedrock shelves were common. Channel meander was very broad, and riffle/run habitats dominated the area, with slackwater eddies forming small pools locally. Streambanks were high on both sides of the reach, and high flow events appeared to be infrequent based on observations of the floodplain area.

The biological community characteristics of the Presque Isle River survey reach were consistent with large, cool water stream systems with swiftly flowing, shallow waters. Mottled sculpins (*C. bairdi*) and longnose dace (*R. cataractae*) were the most abundant fish species present. Brook trout (*S. fontinalis*), blacknose dace (*R. atralutis*), river chubs (*Nocomis micropogon*) and white suckers (*Catostomus commersoni*) were also present in small numbers. Macroinvertebrate TBI measures (3.74) indicated a moderately intolerant benthic community. The TBI score was tempered by the presence of taxa that are associated with streams having higher levels of primary productivity (e.g., algal growth). Many of these taxa are often considered to be more tolerant of degraded environmental conditions because they persist in areas that have been disturbed. However, the presence of several highly intolerant species, including the heptageniid mayfly *Rhithrogena pellucida*, and the perlid stoneflies *Acronuria arida* and *A. ruralis*, indicated high quality stream conditions.

Rocking Chair Lakes

The survey of this site could be broken into two distinct parts, survey of the lakes and survey of the upland forests. Previous work had been restricted to surveys of the terrestrial part of the natural area, concentrating primarily on the rare plants of the cliffs. These cliff survey already identified significant rare plants. The upland forests were dominated with northern hardwood forests, with concentrations of mature red oak, white pine, red pine, and hemlock where the soils were thin, i.e., on parts of the cliff faces and on the exposed or thin-soiled bedrock knobs. The forests could generally be characterized as old-growth northern hardwood forests, with many small stands of mature and old-growth white pine and hemlock. Red oak were less concentrated, occurring as individuals or groups within the conifer or hardwood dominated stands.

Site visits to several lakes in the vicinity of the Rocking Chair Lakes Natural Area (RCLNA, Figure 14) provided an excellent opportunity for evaluating survey needs and methods development for small inland lakes. Although no listed species were identified as a result of these visits, it allowed MNFI staff to begin conceptualizing a classification framework that would enable us to recognize and track lakes as significant elements of biodiversity in the future. The lake descriptions developed from these visits provide a foundation for further survey and classification of these lakes during the 2001 field season.

Rocking Chair Lake is a relatively small (~4 hectares), shallow (maximum depth 6m) Pleistocene ice scour lake with substrates dominated by an organic layer >1m thick (Figure 15). Other substrates noted during the site visit were a few sandy areas along the lake margin, and boulder and cobble substrates along the southeastern lakeshore where a large granite outcrop supplies these materials locally. Water conductivity (166 $\mu\text{S}/\text{cm}$) and pH (8.8) measures indicated moderate to high ion concentrations characteristic of a carbonate/bicarbonate buffering system. The lake was not thermally stratified, and the shallow water depth and exceptional water clarity suggested a continuous littoral zone throughout the lake. Aquatic macrophytes were abundant throughout most of the lake. *Myriophyllum farwellii* was especially dense in the shallow northern portion of the lake, although it was common throughout. Macroalgae (*Chara sp.*) covered most of the lake bottom at all water depths. Other macrophytes were comparatively less abundant (e.g., *Potamogeton natans*, *P. amplifolia*, *P. richardsonii* and *Nuphar variegata*), but were common throughout much of the lake. The emergent *Eriocaulon septangulare* was very common in the shallow area along the eastern and southern lakeshores. Benthic macroinvertebrates identified from samples taken along the lake margin included odonate (dragonfly) larvae, chironomid larvae (midges), amphipods (*Gammarus sp.*) and two species of aquatic gastropods (snails) (Table 4). Fish community descriptions were based solely on visual surveys along the shoreline. Creek chubs (*Semotilus atromaculatus*) were extremely abundant, and although there was evidence of recreational fishing efforts, no other fish species were observed during the site visit.

Island Lake is a larger (~14 hectares), deeper (maximum depth 15m) Pleistocene ice-scour lake adjacent to the RCLNA (Figure 16). Some ecological features noted during the site visit were similar to Rocking Chair Lake, especially in shallow areas that were dominated by *Chara sp.* and *Eriocaulon septangulare*. However, lower conductivity (20.9 $\mu\text{S}/\text{cm}$) and pH (7.2) measures indicate much lower ion concentrations in Island Lake. Island Lake also exhibited thermal stratification (thermocline depth = 7.0m), and is characterized by both littoral and profundal habitats. The plant community differed from that observed in Rocking Chair Lake. Two species of *Myriophyllum* were present in low densities, including *M. farewellii* and *M. tenellum*. Other aquatic plants observed in Island Lake included *Nuphar variegata*, *P. epihydrus*, and isolated patches of *Vallisneria americana*. The only fish species observed was the brook stickleback, *Culaea inconstans*. Isolated colonies of freshwater Porifera (freshwater sponges) were observed in shallow areas of the lake. Few macroinvertebrates were identified from benthic samples collected along the shoreline of Island Lake, although those that were present were consistent with the taxa observed in Rocking Chair Lake. The wide variety of habitats within Island Lake likely support far greater biological diversity than that identified during this initial survey. A return visit using more fully developed survey methods should provide a better characterization of this lake.

The third “lake” visited was a small beaver pond just north of Lake 8 (see Figure 14). The small pond created by the beaver dam showed evidence of relative stability based on the plant community present. Exposed flats along the edge of the basin suggested that the water level was lower than normal or that the site is subject to regular flooding. Submergent plant species included *Chara sp.*, *M. farwellii*, *P. epihydrus*, *Sparganium sp.*, *Utricularia resupinata*, and *N. variegata*. These plant populations would

Figure 14

Figure 15

Table 4. Aquatic macroinvertebrate species collected in lakes surveyed in the vicinity of the Rocking Chair Lakes Natural Area near Ishpeming (Marquette Co., MI). The occurrence of macroinvertebrate species in the study lakes is indicated by an "X."

Macroinvertebrate Taxon	Water Body		
	Rocking Chair Lake	Island Lake	Beaver Pond
Aquatic Insects			
Chironomidae (Midge Larvae)		X	X
Ceratopogonidae <i>Antocha sp.</i> (Tipulid Crane-fly Larvae)	X		X
<i>Sympetrum sp.</i> (Libellulid Dragonfly Larvae)	X		X
<i>Cordulia spp.</i> (Corduliid Dragonfly Larvae)			X
<i>Chromagrion sp.</i> (Coenagrionid Damselfly Larvae)			X
<i>Lype sp.</i> (Psychomyiid Caddisfly Larvae)			X
<i>Banksiola crotchi</i> (Phryganiid Caddisfly Larvae)			X
<i>Limnephilus sp.</i> (Limnephilid Caddisfly Larvae)			X
Mollusks			
Spaeridae (Fingernail Clams)	X	X	X
<i>Laevapex fuscus</i> (Limpet)	X		
<i>Gyalus hirsutus</i> (Snail)	X	X	
<i>Heliosoma anceps</i> (Snail)	X	X	
Other			
Leeches	X	X	
Amphipods (<i>Gammarus sp.</i>)	X	X	X

probably not persist if the basin dried out frequently. The presence of freshwater sponges also suggested the long-lived and persistent nature of the beaver pond. Conductivity (61 μ S/cm) and pH (7.4) measures were slightly higher than those observed in Island Lake, although they were still much lower than Rocking Chair Lake. Benthic invertebrates were more abundant in samples collected from the beaver pond compared to Island and Rocking Chair Lakes. The small size of the basin and proximity to flowing water presumably contributed to the presence of multiple invertebrate taxa that were not observed in the other lake samples (e.g., the caddisflies *Banksiola crotchi*, *Lype spp.* and *Linnophilus sp.*). No fish were observed at this site.

Recommendations: We recommend that the boundaries of the proposed natural area be revised to include several additional lakes to the north and south, including Island Lake and Lakes 2, 3, and 8 (Figures 17 and 18). These lakes could all be characterized by extremely low levels of human activity, with sediments and vegetation characteristic of these softwater lakes intact. The boundaries that we recommend are based on our surveys, aerial photographs, and ownership. One of the primary owners of this area recommended that his lands be considered for Land Trust acquisition in 1992. The lands that he offered are very similar to our acquisition recommendations.

Thompson's Harbor

Surveys were conducted for two species, Hine's emerald dragonfly and eastern massasauga. Hine's emerald was not verified for 2000; it was first seen at the site in 1999 at a site approximately one mile to the west of the natural area, but still within the park boundary (Figure 19). The survey for eastern massasauga was also not successful, however, a population of prairie Indian plantain was discovered by zoology staff during their faunal inventories.

Recommendations: It is recommended that the Hine's emerald site be included within the natural area boundary, possibly by proposing a second natural area surrounding the wetland where the dragonfly occurs.

Turner Creek Wetlands and Bowerman-Barry Prairie

Zoology surveys resulted in new occurrences of angular spittlebug and eastern box turtle (See table 1 and Figure 20). Earlier occurrences for Mitchell's satyr and tamarack tree cricket were re-confirmed, as was a rare plant occurrence of prairie Indian plantain. Surveys were also conducted for blazing star borer moth and regal fern borer moth, but these surveys were unsuccessful.

Warren Dunes

Landscape and Historical Context: Warren Dunes Natural Area is located in the Southern Lake Michigan Lake Plain in subsection VI 3.2 (Albert 1995). The dune sands are derived from glacial sediments, including lacustrine and outwash sands and sandy tills (Dorr and Eschman 1970). The dune complexes from this natural area are associated with the Lake Nipissing stage of the Great Lakes, when water levels were 25 to 30 feet higher than present day lake levels, which resulted in greater amounts of coastal erosion and dune formation. The dunes of the natural area are parabolic dunes, formed when stable, forested dunes were destabilized. The dunes occur as a series of overlapping dune ridges. As inferred from the original land surveyors notes, the presettlement forests of the dunes were dominated by eastern hemlock and beech. Additional components of the canopy include: white pine, red oak, white oak, and sugar maple. Several large areas of open, blowing sand (blowouts) were also noted in the GLO surveys. While wind is the prevalent form of natural disturbance within the dune fields, fire resulting from lightning strikes and Native American ignition also occurred, but was less common. Oaks,

Figure 17

hickories and pines were common on the dunes, indicating fire was a significant natural disturbance factor.

Site Summary: Figure 21 depicts the delineated natural communities found within and surrounding the Warren Dunes Natural Area. A hypothetical transect from the Lake Michigan lakeshore east would encounter the following general natural community classes: sand beach, open dune and southern dune forest. The open dunes at Warren Dunes include foredunes and blowouts which were mapped as herbaceous and non-herbaceous. The southernmost blowout (Figure 21), which has been subject to abundant foot traffic, is highly degraded. Moving north from this parking lot, the blowouts increase in degree of herbaceous cover with the northernmost blowouts being predominantly herbaceous. The aerial photograph interpretation from the 1998 black and white photos at the scale of 1:15,840 allowed for the differentiation of herbaceous versus non-herbaceous open dune while the 1988 color infrareds at the scale of 1:24,000 did not allow for such a distinction. In addition, interdunal wetlands could be distinguished using the black and white aerial photographs, as could small stands of upland conifer on steep northeast facing slopes.

The most extensive community at Warren Dunes is the southern dune forest, which can be classified on the ground as mesic southern forest, mesic northern forest and dry-mesic southern forest. Because these three types could not be differentiated on the aerial photographs, they were lumped into the category of southern dune forest. The northwestern portion of the dune forest from Figure 16 is dry-mesic southern forest. The canopy in this community is dominated by black oak, (*Quercus velutina*) and the following species are significant canopy components: white oak (*Quercus alba*), red oak (*Quercus rubra*) and sassafras (*Sassafras albidum*). The wide spacing and wolfy structure of the canopy dominants and the local dominance of *Carex pennsylvanica* and *Vaccinium angustifolium* suggest that this portion of forest would benefit from fire management.

The remainder of the southern dune forest is composed of predominantly Mesic Southern Forest and to a lesser degree mesic northern forest, forest types in these dunes that often grade in to each other. The mesic northern forest portions of the dune forest are found in narrow ravines and north facing slopes close to the lakeshore and in protected bowl-like depressions between dune ridges. In these localities hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are frequently significant components of the canopy or dominants. Deciduous species prevalent in the overstory are sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), red oak (*Quercus rubra*) and basswood (*Tilia americana*). Throughout the area regeneration of hemlock was scant if not absent and frequently overstory hemlock were suppressed beneath a deciduous canopy, perhaps accounting for the difficulty in differentiating between mesic northern forest and mesic southern forest on the aerial photographs. Only in one locality was canada yew (*Taxus canadensis*) found and that was in a narrow ravine that was littered with woody debris. This observation suggests that white-tailed deer browse is likely effecting understory composition throughout the natural area since canada yew was historically abundant in the understory of dune forests and is heavily browsed when exposed. The predominance of the high quality examples of mesic northern forest (southern dune forest with a conifer component) is found north of the proposed Warren Dune Natural Area boundary. The mesic southern forest is consistently of high quality throughout the area mapped. The majority of the southern dune forest can be classified as mesic southern forest. A diversity of deciduous species dominate the canopy in this type, including: sugar maple (*Acer saccharum*), bitternut hickory (*Carya cordiformis*), beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), chinquapin oak (*Quercus muhlenbergii*), red oak (*Quercus rubra*) and basswood (*Tilia americana*). Ridgetops and slopes of southeastern exposure are typically dominated by red oak, chinquapin oak, beech and sugar maple, while bowls and ravines support stands of tulip poplar, basswood, sugar maple, and beech. Abundant shrub species are paw paw (*Asimina triloba*) and spice bush (*Lindera benzoin*). In a report to the Wilderness and Natural Areas Advisory Board, Paul

Thompson of the Michigan Natural Areas Council recommended the protection of a “virgin hardwood forest” located just north of Mt. Edwards in a deep dune valley. Upon visiting this site it was confirmed that this tract of Mesic Southern Forest contains characteristics of old-growth forest including trees of large diameter and stature and standing snags and dead and down woody material in various diameter classes and in various stages of decomposition. It should be noted that this stand is located north of the Warren Dunes Natural Area boundary.

Though varying in canopy composition throughout the natural area, the southern dune forest in Warren Dunes is of exceptional quality throughout. This forest is characterized by a wealth of downed woody debris and snags of diverse species, diameter and decomposition classes. Impacts from exotic species are minimal in the southern dune forest. Garlic mustard does occur sporadically along deer trails on ridge tops and where southern dune forest is adjacent to southern swamp forest. In contrast the non-dune southern mesic forest associated with the Painterville Creek (located just southwest of the Warren Dunes Natural Area proposed boundary near the campground) has abundant populations of the following exotic species: garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), common privet (*Ligustrum vulgare*), and multiflora rose (*Rosa multiflora*). Despite the prevalence of exotic species along Painterville Creek, several areas just to the west of the creek are characterized by diverse spring flora. The southern swamp and non-dune mesic northern forest adjacent to the northern portion of the Yellow Birch Trail Loop are heavily utilized by migratory birds.

Recommendations: Figure 22 displays the boundaries of Warren Dunes State Park and the Warren Dunes Natural Area, overlying a quality designation of the mapped communities. Three categories were used to describe the quality of the communities, degraded (i.e. degraded natural community, recreation, agriculture, residential and sand mining), potential buffer and natural-areas quality. These categories were used to help guide the creation of a recommended natural-areas boundary. Figure 23 shows the jurisdictional boundaries as well as the recommended natural-areas boundary. This recommended boundary contains the full extent of the non-degraded southern dune forest and all of the mapped blowouts with the exception of the southernmost and most anthropogenically disturbed blowout. Also included within the recommended natural areas boundary is the southern swamp forest and the non-dune mesic southern forest to the north of the swamp. These communities were not deemed exceptional in terms of their structure and vegetation but were included because of their importance for migratory birds. The designation as natural-area quality does not guarantee such status for perpetuity. Control of foot traffic, especially in the southernmost blowout, should aid the recovery of vegetation on the degraded dunes. Removal of invasive exotics along Painterville Creek will not only enhance the quality of the surrounding forest, but could check the advance of exotics into the adjacent high quality southern dune forest. In areas where fire suppression has resulted in shrub and *Carex pennsylvanica* encroachment, such as the northwest corner of the southern dune forest, the use of prescribed fire could enhance native species diversity.

Comparison of forests with those further north indicates significant differences in dune forests geographically. Southern dune forests have greater diversity of oaks, including chinquapin, as well as sassafras. White pine and eastern hemlock are restricted to steep northeastern slopes, narrow ravines and protected bowls. In contrast, northern dunes, such as those at Cathead Bay, have much less oak diversity, no sassafras, and a much greater predominance of upland conifers throughout the dunes.

Figure 22

DISCUSSION AND SUMMARIES

Ecology:

Ecological surveys resulted in addition of a mesic northern forest EO at Rocking Chair Lakes. Forest surveys of dune forests provide us with insights into regional differences between the dune forests of the south and north. A new coastal plain marsh occurrence was recorded for Lost Lake at Muskegon S. Park and hardwood swamp, northern fen, and Great Lakes marsh occurrences were added for Hog Island and Garden Island. Existing plant community EOs were re-evaluated at Bald Mountain and Maple River.

Rare Plant Inventory Results:

Additional rare plant occurrences were added for Garden Island, Hog Island, Thompson's Harbor, Turner Creek, Muskegon State Park, and Rocking Chair Lakes. Existing EOs were evaluated at Maple River salt marsh and Lost Lake (Muskegon State Park). There were no new plant EOs for Bald Mountain.

Zoology Inventory Results:

During the summer of 2000, zoology surveyed three separate natural areas including Haven Hill, Thompson's Harbor, and Turner Creek Wetlands. Several animal species were searched for during appropriate survey times. A total of five new element occurrences were documented from these three sites (Table 1). In addition, five occurrences for listed species were updated, including two federal and state endangered insect species.

Discussion of aquatic surveys:

Survey methods used to evaluate the stream sites visited in the Porcupine Mountains were adequate for allowing the survey team to effectively evaluate the ecological and biological community characteristics of several stream reaches. Additional site visits at other reaches within the study streams and additional streams within the Porcupine Mountains Natural Area are needed to more fully evaluate and describe the stream ecosystems present. The five streams visited during the initial surveys varied widely in terms of ecological function and biological community composition. Additional surveys will help to determine how representative these streams are within a regional context as well as identifying appropriate rankings of each stream ecological type. Observations from these initial surveys suggest that nearly all of the streams visited are excellent examples of several stream ecological types, although further verification needs to be conducted.

Survey methods used to assess lakes in the vicinity of the Rocking Chair Lakes Natural Area provided an overall scope of the lake characteristics, but provided little detailed information on the biological/ecological properties of the lakes. Standardized methods for evaluating lake ecological condition are not nearly as well developed for lakes compared to streams. The remoteness of these particular lakes made them difficult to survey using conventional methods (e.g., motor boats, canoes, electroshocking equipment, dredges, etc.). Yet, by the very nature of their remoteness, such lakes are likely to represent high levels of ecological integrity that are unique within most North American landscapes. These initial surveys have contributed to the development of future survey protocols, and revisits using these methods will be conducted during 2001. Elements of lake ecosystems considered to be important for characterizing the ecological properties of lakes include water chemistry, biological community composition (e.g., fish, macroinvertebrates and macrophytes), bathymetry (i.e., depth contours) and substrate composition. Combinations of these properties effectively define ecological zones within lakes that reflect the diversity of habitats and biota present. Future surveys will incorporate detailed mapping of the lakes using a GPS unit to geospatially define distinct zones within the lakes.

Biological samples will be collected within each zone to more quantitatively define the community characteristics of these zones including gill net sets and collapsible fish traps, multiple benthic invertebrate and planktonic community samples, and quantitative (quadrat) sampling of macrophyte communities.

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