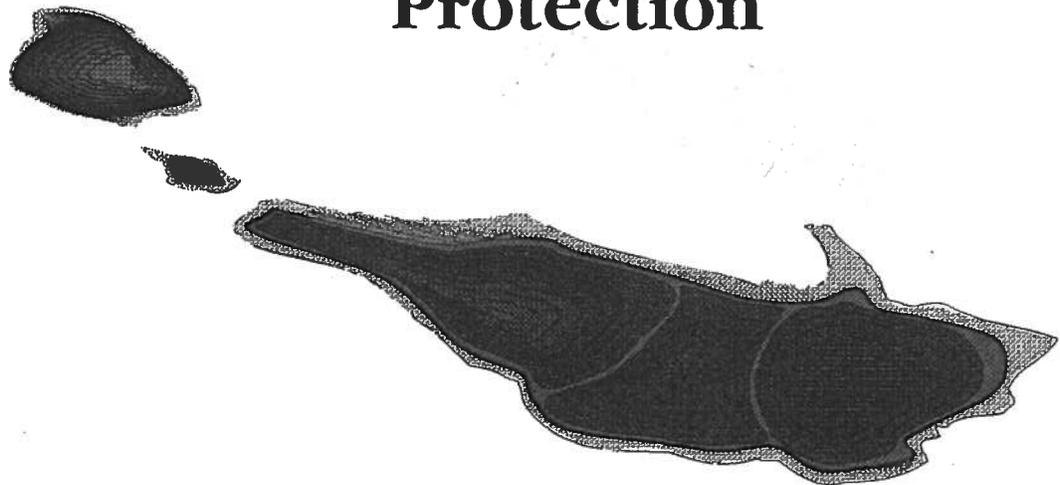


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Biodiversity of Michigan's Great Lakes Islands

Knowledge, Threats and Protection



Judith D. Soule
Conservation Research Biologist

April 5, 1993

Report for:
Land and Water Management Division
(CZM Contract 14C-309-3)



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BIODIVERSITY OF MICHIGAN'S GREAT LAKES ISLANDS

Knowledge, threats, protection

EXECUTIVE SUMMARY

VALUES OF THE ISLANDS

Sprinkled across all five of the Great Lakes, thousands of islands form a landscape unique in the world. Nowhere else does the combination of vast, interconnected, mid-continental bodies of freshwater and such a number and variety of islands occur. Uniqueness, beauty, value to wildlife, and scientific significance - these qualities qualify the Great Lakes islands for a status similar to precious gems. They should be treasured and protected.

Although the islands rival the mainland's habitat variety, the geography of islands, their varying degrees of isolation, varying sizes, and their very "island-ness," create conditions that are quite different than those *naturally* occurring on the mainland. For the past century, human activity has been fragmenting mainland habitats, creating a landscape of "islands" to the native biota. The Great Lakes islands have much to teach us about the consequences of these activities on the mainland.

Michigan's share of this global treasure, including the islands in the state's waters of all four bordering Lakes and their connecting channels, totals nearly 600 islands, including approximately 20 in Lake Erie, 32 in the Detroit River, 6 in Lake St. Clair, 200 in Lake Huron, 76 in Lake Michigan, 86 in the St. Marys River, and 175 in Lake Superior, including Isle Royale National Park. Michigan's Great Lakes islands are especially rich in variety of geography, geology, history and biodiversity. Although other territories have more islands in sheer numbers, Michigan's variety of islands rivals all. Thus, to a great degree, the policies of the state of Michigan are key to the destiny of this global legacy. This is a critical time to consider what it would take to maintain or enhance the natural values of these islands.

In considering this challenge, it is important to realize that the value of a whole collection of islands is much greater than the sum of the individual islands' resources.

Management policy based on an island by island, case by case approach can potentially result in degradation of the entire array of islands by diminishing potential sources of colonizing populations, or disrupting suitable habitat for migrating birds that use the islands as stepping stones. The islands must be considered as a single, irreplaceable resource, and protected as a whole, if the high value of this natural heritage is to be maintained.

History, physical description, and biodiversity of the islands

Virtually all of the unique natural features associated with the Great Lakes shoreline can be found on Michigan's Great Lakes islands, including some of the best examples. Some features are nearly confined to islands: predator-free habitat for sensitive colony-nesting waterbirds, alvar (grasslands on thin soil over limestone bedrock). Unique conditions also exist: deer-free forests, absence of natural predators or competitors, unusually high populations of certain organisms (*e.g.*, snakes on Hog Island, Beaver Archipelago). Variation in geology, post-glacial history, size, isolation and human use history are factors that makes these islands biologically varied and valuable for research.

Birds, fish and plants: The islands along the north shore of Lake Huron, in the St. Marys River and in the St. Clair Delta have extensive marshes that serve as valuable stopover points for many migrating waterfowl. Other islands serve as nesting sites for certain waterfowl. A high proportion of Great Lakes populations of colonial waterbirds breed in Michigan's waters of the Great Lakes. Of the colonial waterbirds nesting on the U.S. Upper Great Lakes in 1989, Michigan claimed 75 percent of the double-crested cormorant and ring-billed gulls, 89 percent of Caspian terns, and 83 percent of common terns. Many of the islands are considered important migratory stopover sites for neotropical migrant songbirds and for raptors, and harbor fish spawning areas. Several species of plants are found only along the Great Lakes shores, and nowhere else in the world. Scientists call such species "endemic." All these endemic plants (Pitcher's thistle, Lake Huron tansy, dwarf lake iris, and Houghton's goldenrod) occur on Michigan's islands.

Shoreline ecosystems: The entire array of mainland Michigan shoreline features and associated ecosystems are also found on the islands: from sand/gravel beaches backed by open sand dunes (*e.g.*, Beaver, High, North and South Fox), perched dunes (South Manitou, High), wooded dunes and swales (Grand), northern fen (St. Martin - Mackinac

County, Marquette), interdunal wetlands (Beaver, Hog), and marshy shores (Sugar, Harbor, Dickinson, Grand), to cobble (High), bedrock (Thunder Bay, Isle Royale, Drummond), and cliffs (Grand, Drummond). The dunes, like the plants described above, are "endemic:" nowhere else on earth are there dunes of this size and extent along the shore of a body of fresh water.

Threatened, endangered, and exemplary natural features: Michigan's Great Lakes islands have a disproportionate number of occurrences of endangered, threatened or rare species, exemplary natural communities (characteristic plant associations that provide the vegetative structure of ecosystems) and other special natural features (collectively called "elements" in this report) when compared to the rest of the state. Some *933 element occurrences* have been found on these islands. This is about one-eleventh of the state's total known element occurrences, whereas the islands represent only about one-hundredth of the state's land area (total island area is about 420,800 acres). Even after excluding the 361 element occurrences on Isle Royale and surrounding islands, the remaining islands have about seven times more element occurrences than would be expected. The unusual number of rare or exemplary natural features on islands can be attributed to protection from human disturbance by virtue of isolation, moderated climate, location at the extreme edge of the state's boundaries, and the fact that colonial nesting waterbirds nest almost exclusively on islands.

Examples of biological research on islands

A fruitful resource for biological research, Michigan's Great Lakes islands have served as laboratory for a number of long-term and comprehensive studies. Isle Royale has hosted long-running studies of moose and wolves. Long-term studies on the effects of deer browsing on vegetation have been performed on North Manitou Island. Both moose and deer studies have shown dramatic vegetation changes caused by heavy browsing when deer and moose populations were high. The Great Lakes islands offer the rare chance to study the ecology of native ecosystems where deer populations are not maintained at artificially high levels. Other research topics included island biogeography, predator-prey relations, and competition studies.

STATUS OF KNOWLEDGE OF ISLAND BIODIVERSITY

While there have been many biological inventories of the Great Lakes islands, no one island has been thoroughly studied for all groups of organisms, and large gaps in knowledge of island biodiversity still exist. The colonial nesting waterbirds are the only group of organisms that has been consistently and repeatedly inventoried throughout the islands over the last three decades.

The Beaver Island group, one of the better known groups, still lack vertebrate inventory for Hog Island, and invertebrates for all except a few groups on Beaver Island. Drummond also has an obvious gap in information on native invertebrates. Adequate inventory of natural communities is largely lacking among the islands. Since communities are a key to ecosystem health, they are a good starting point for inventory of biodiversity. Most of the larger islands need community inventory. The recent plant inventory on Grand Island showed a surprising number of species, but the list is still incomplete, as much of island was not covered. North and South Manitou have had thorough botanical surveys, but Beaver Island has not. The islands are clearly rich in outstanding natural values, and completion of inventory work will certainly reveal an even greater wealth of natural heritage.

PROTECTION AND THREATS TO ISLAND BIODIVERSITY

The status of biodiversity on the islands cannot be assessed solely by compiling lists of the biota present, but requires evaluation of the likelihood of their persistence.

Ongoing and anticipated threats and opportunities for protection

Many of the islands are currently experiencing pressures and threats similar to those experienced on the mainland Great Lakes shoreline, and this can be expected to increase. These include habitat destruction and degradation by developments or homes, alterations of shorelines with revetments and seawalls, manipulations of marshy shorelines that benefit certain species, but in the process, eliminate habitat for other species, and ORV use. Clearly, there is a need for island management plans that provide for human needs in ways compatible with maintenance of ecosystem integrity.

Islands provide a unique opportunity for conservation. Discrete boundaries of islands can ensure limited access and facilitate management of visitor use. Islands are naturally ecologically buffered, contain complete ecosystems and offer the opportunity to allow

Great Lakes ecosystem processes, such as dune building and shoreline erosion, to proceed unchecked. They provide a laboratory for study of the dynamic ecology of Great Lakes shorelines.

Current status of protection of the islands

Current protection status of the islands range from mandated permanent protection provided to dedicated wilderness areas, to a lack of any formal protection. Isle Royale and North and South Manitou Islands are examples of islands provided a high degree of protection by ownership and dedication. Beaver and Drummond Island, are examples of islands with many significant natural features that are only partially protected. North Fox Island, a small island with ten known element occurrences, is an example of an ecologically significant island that has been proposed for major development.

ISLAND INVENTORY AND CONSERVATION NEEDS

As a first step in insuring maintenance of the aesthetic and biological values of the islands, the gaps in inventory of the islands should be filled, before the islands are further altered in any way. For efficiency, these inventories should focus on high quality natural communities, migratory bird visits, waterfowl resources, and rare, threatened, and endangered species. The results will help to better define island conservation needs and priorities.

High priority inventory needs

Islands that lack protection but are known to have significant natural features or have a high potential for such features but lack adequate inventory are of highest priority for inventory. These islands follow:

Grand Island (Alger County)
Drummond, Sugar, Neebish, and Lime, islands in Potagannissing Bay
and Detour Passage, Harbor Island (Chippewa County)
Les Cheneaux Islands, Marquette, LaSalle, Little LaSalle, Albany, St. Martin and
Big St. Martin (Mackinac County)
Crooked, Middle, Thunder Bay Island (Alpena County)
Wildfowl Bay islands (Bay County)
Beaver, Garden, Whiskey, Hog and High Islands (Charlevoix County)
North Fox (Leelanau County)
Summer, Little Summer, Poverty, and St. Martin (Delta County)
Dickinson and Harsens (St. Clair County)

Needs for protective designations

Ideally, the islands, as an integral part of the fabric of the Great Lakes ecosystem, would be systematically moved into protective ownership and managed for maintenance of their natural values. This would be a significant step toward providing for the maintenance of intact examples of many of Michigan's native ecosystems, as well as insuring the integrity of this globally unique resource.

Realistically, it is crucial that the protection needs be prioritized. Systematic prioritization of protection needs could be accomplished with a mechanism known as a "scorecard," procedure which uses number of elements, quality rank of each occurrence, endangerment status, and degree of protection at each site to rank protection priorities. The following islands are considered of highest priority for further protection, based on lack of protection and known or potential significant natural features:

Grand, Drummond, Bois Blanc, Marquette,
Little LaSalle, LaSalle,
Harsens, Dickinson,
Beaver, North and South Fox

Protection for certain of these islands should be considered in an inter-state or international context. Long-term conservation of the biota of the Michigan islands in the St. Clair River Delta may well be tied to long-term conservation of the seed sources for prairie species on Walpole Island. Similarly, Drummond Island is very close to Cockburn and Manitoulin Islands, Ontario, and ecological processes on the three islands are undoubtedly linked. In western Lake Michigan, the chain of islands between Wisconsin's Door Peninsula and Michigan's Garden Peninsula are clearly linked biologically. Conservation management organized cooperatively across the state and national boundaries would greatly enhance effectiveness of management and protection actions.

Inventory and conservation recommendations

The following actions are recommended in order to conserve the unique values of Michigan's Great Lakes islands:

- 1) Proceed immediately with completion of natural features inventories on the islands listed in Table 5.
- 2) Require that islands be inventoried and that environmental evaluation be performed prior to any further alterations.

- 3) Move toward development of a complete scorecard for all the islands.
- 4) Develop a policy that treats islands as a whole as a state resource, sets maintenance and restoration of the islands' native biodiversity as an overriding goal, and restricts further alteration of islands to actions that are compatible with maintenance of the natural values of the islands.
- 5) Support acquisition of islands by the state or conservation organizations, and provide protective designations for publicly owned islands, concentrating first on those islands indicated above (1) and 3)) as high priorities for protection.
- 6) Develop management plans that integrate human uses with maintenance of island ecosystem integrity and all the natural values of the islands.
- 7) Hold fast on further development of island shorelines, and consider declaring island shores a public resource, such that private ownership would revert to the state at the end of current owners' lifetimes.
- 8) Prevent introduction of invasive exotic species to islands.
- 9) Initiate and participate in interstate, regional, and international planning for island conservation.

A serious commitment to the endurance of this globally unique heritage would be evidenced by a policy that treated all the islands as a group, as a whole, invaluable landscape. Because many of the islands are relatively undisturbed at present, and because of their discrete and unique nature, islands offer possibilities to *anticipate and prevent* loss of biodiversity and ecosystem integrity. In this way, the need for future restoration can be short-circuited by protecting intact functioning systems before they are degraded.

References to published literature and unpublished reports on various aspects of the biology of Michigan's Great Lakes Islands are compiled in the annotated bibliography appending this report (Appendix C).



BIODIVERSITY OF MICHIGAN'S GREAT LAKES ISLANDS

Knowledge, Threats and Protection

INTRODUCTION

Sprinkled across all five of the Great Lakes, thousands of islands form a landscape unique in the world. Nowhere else does the combination of vast, interconnected, mid-continental bodies of freshwater and such a number and variety of islands occur. From bedrock to sand and gravel shoal, from ancient to recent, from basalt to limestone, the Great Lakes islands offer a variety of habitats that rivals the variety found on the mainland. These islands serve as stepping stones for migrating waterfowl, raptors, and songbirds. They hold some of the region's best remaining examples of intact ecosystems, especially along their shorelines. They provide isolated, safe nesting sites for colonial nesting waterbirds, and harbor numerous threatened and endangered species. Their beauty and isolation provide a refuge for the human spirit, as well. Michigan's share of this global treasure, including the islands in the state's waters of all four bordering Lakes and their connecting channels, totals nearly 600 islands.

While the islands rival the mainland's habitat variety, the geography of islands, their varying degrees of isolation, varying sizes, and their very "island-ness," create conditions that are quite different than those *naturally* occurring on the mainland. For the most part, mainland habitat is part of a broad landscape of intergrading, interconnected habitats, whereas islands are isolated habitats with abrupt boundaries in a matrix of conditions hostile to terrestrial organisms. On islands, the processes of immigration and emigration are greatly restricted. When a local population goes extinct on an island, a ready source of colonists is not available a short distance away, as is often the case on the mainland.

Island biogeography studies have repeatedly shown that the number of species on an island is related to island size and is always lower than comparable natural habitat on the mainland. Such studies have great relevance to management of mainland habitat now and

in the future. While natural approximations of island conditions occur occasionally on the mainland on isolated mountaintops and in isolated lakes, for the past century, human activity has been creating *inland islands* of habitat. As forests have been fragmented, wetlands removed, inter-habitat corridors chopped up, rivers dammed, as highways criss-crossed the land, and human habitations crept away from cities, the mainland has become a landscape of "islands" to the native biota. Thus, the Great Lakes islands have much to teach us about the consequences of these activities on the mainland.

In addition to the values conveyed by uniqueness, these islands are storehouses of biological information. They have long been the subject of biologists' studies, attracted by the special opportunities for designing research on islands. Several continuing, long-term research projects undertaken on the islands have produced significant results. Comparative studies of biota on different islands have added to knowledge of the species and history of the Great Lakes, biogeography, ecology and evolution. The volume of studies on these islands illustrate the richness of the islands, both as reservoirs of the state's biodiversity, and as biological laboratories. Clearly, the islands offer unique opportunities for conservation and research.

Michigan's Great Lakes islands are especially rich in variety of geography, geology, history and biodiversity. Although other territories have more islands in sheer numbers, Michigan's variety of islands rivals all. Thus, to a great degree, the policies of the state of Michigan are key to the destiny of this global legacy.

Policy and management of islands have captured public interest in the state recently. The Department of Natural Resources (DNR) is in the process of identifying and reviewing information on the islands in order to develop a Departmental Island Management Strategy. Citizens groups, including Michigan Natural Areas Council (MNAC) and Clean Water Action, have called for evaluation and protection of the Great Lakes islands (MNAC New & Views, Third Quarter, Aug. 5, 1991; Dave Dempsey, "Islands of the Lakes," July 12, 1991 research report of Clean Water Fund; MNAC, "Natural Values of Michigan's Island Ecosystems," a grant proposal to C.S. Mott Foundation, April 1992). Public interest can also be seen in the proposed Island Explorer Trail for personal-powered crafts, a recreation opportunity designed with sensitivity to the biological and archaeological significance of the islands. Support for this trail has been expressed in the DNR, by the Great Lakes Lighthouse Association, in the State House and Senate, by Superior-Baikal

Connect and by the grass-root conservation organization, the Inland Sea Association (Dean Sandell, Michigan DNR, Forest Management Division, personal communication).

A dramatic demonstration of concern about island conservation has been the controversy surrounding proposed private development of North Fox Island. The proposal for condominiums, golf course, marina and other structures, as well as some undeveloped areas, has resulted in heated debate in the media and in Leelanau Township hearings on zoning issues.

Uniqueness, beauty, value to wildlife, and scientific significance - these qualities qualify the Great Lakes islands for a status similar to precious gems. They should be treasured and protected. Yet today, the islands are not treated uniformly as a valuable natural legacy. Although many individual islands are protected by ownership, many are not. No formalized state policy stipulates conservation or management for Great Lakes islands in Michigan. What we do or do not do with these islands will have profound influence on their future values. This is a critical time to consider what it would take to maintain or enhance the natural values of these islands.

For effective management and conservation the islands must be considered as a whole group. The Great Lakes' islands are an integral link in the Great Lakes system, separate, yet interacting with both the mainland and Lakes ecosystems. Islands' functions as storehouses of biological information and as wildlife refugia, and often as an aesthetic landscape as well, are diminished beyond proportion of land area when some individual islands are degraded and altered. The value of a whole collection of islands is much greater than the sum of the individual islands' resources. For example, consider migrating birds that hopscotch from island to island, or rest on islands when caught over water at daybreak. Encountering deforested, developed, degraded islands in the middle of a chain could lower the success rate of migrants crossing the lakes. Similarly, waterfowl that seek the quiet marshy shorelines of islands for nesting, could be greatly disrupted by boat traffic from a neighboring developed island.

Further, within an isolated archipelago, islands can be the most important source of colonizing populations for other islands. Small populations lead to repeated extinction and immigration events on islands, making source populations especially important for maintenance of biodiversity. When one island in a chain is developed and degraded to the point of jeopardizing the native biota, neighboring islands are also affected and

diminished by the consequent reduction in source populations. Similarly, if the nearest mainland shores are developed to the point of losing the native biotic communities, off-shore islands will suffer from loss of source colonizing populations. Management policy based on an island by island, case by case approach can potentially result in degradation of the entire array of islands. Island management that ignores mainland shoreline protection will likely eventually result in degradation of island resources. The islands must be considered as a single, irreplaceable resource, and protected as a whole, if we are to retain the high value of this natural heritage.

This report reviews published and unpublished literature on the biota and ecology of the Great Lakes Islands within Michigan's boundaries. The first section of the report describes the ecological resources of the islands. Next, a brief overview of a number of research projects on the islands is given. The status of knowledge of the biota and of protection of the islands are each reviewed. The report ends with a summary of inventory and conservation needs and priorities.

HISTORY AND PHYSICAL RESOURCES

Michigan's Great Lakes Islands are numerous and diverse both in terms of geology and biology. While the exact number of islands is not entirely clear, and in fact varies with fluctuations in lake levels, the Michigan DNR recently identified a total of 595 islands in all of Michigan's Great Lakes and their connecting channels. By Lake, the totals in Michigan waters are approximately 20 in Lake Erie, 32 in the Detroit River, 6 in Lake St. Clair, 200 in Lake Huron, 76 in Lake Michigan, 86 in the St. Marys River, and 175 in Lake Superior, including Isle Royale National Park.

Geology and post-glacial history

Geological substrates range from exposed igneous, and sedimentary bedrock to glacial deposits, including lacustrine soils and clays, deltaic deposits, till, sand dunes, and lake-deposited sand and gravel bars. For example, glacial till overlying limestone bedrock forms the bulk of the Beaver Island group (e.g., Beaver, High). Deltaic deposits compose Dickinson and Harsens Islands at the mouth of the St. Clair River. Pismire (Beaver group)

is an example of a sand and gravel bar island, while South Fox and others in the Beaver group are partly formed of wind-blown sand dunes. In addition, there are a few man-made islands formed of dredged material in Saginaw Bay, Lake St. Clair, and the St. Marys River. Several unusual geological features are found on the islands. A fine example of a tombolo occurs on Grand Island. Outstanding ancient lake shorelines can be seen on Mackinac Island. Drummond Island has places to view Silurian earth history. Early Precambrian earth history, extrusive igneous features and tilted bedrock occur on Isle Royale.

Most islands in Lake Superior are formed of igneous and metamorphic bedrock with the exception of Grand Island, Alger County, which is sandstone of the Jacobsville and Munising formations. Igneous bedrock is represented in the precambrian amygdaloidal basalts of Isle Royale, and the granite upthrust that formed the Huron Islands, Marquette County. Conglomerates are represented in the small islands near Copper Harbor, Keweenaw County. The islands along the northern rim of Lake Huron (*e.g.*, Les Cheneaux, Drummond) and in western Lake Michigan at the mouth of Green Bay (*e.g.*, Summer, Little Gull) are formed of outcroppings of dolomite, part of the Niagaran Escarpment that continues east - southeast across northern Lake Huron to Niagara Falls. South of the Mackinac Straits, the islands of Lake Michigan and Lake Huron are formed of younger limestone.

Post-glacial history varies also. Among the islands of Eastern Lake Michigan, South Fox is thought to date back to the earliest stages of Lake Algonquin. Beaver, the Manitous and possibly High also emerged as islands in early stages of Lake Algonquin. The smaller islands of the Beaver Group emerged during later, lower Algonquin levels. These islands probably went through several phases of being awash, then emerging, then once again awash. At its lowest stage, some 200 feet below present lake level, all of the Beaver Islands, the Manitous and probably North Fox were connected to the mainland via land bridges. South Fox, however, may have remained an island. During the extreme high water of Lake Nipissing, the last great rise of the lake, all the small islands, and a large portion of the area of the large islands were covered by water (Hatt 1948).

This variation in history is one factor that makes these islands biologically varied and valuable for research, for it means that the islands are of different ages and their biota have had varying amounts of time to colonize, interact, and evolve. It also means that some islands have been connected to the mainland in the past, while others have not.

Size, isolation, and climate

The Great Lakes islands range in size from well under one acre to the 139,000 acres of Isle Royale. The 10 largest Michigan islands are listed in Table 1. Size is not a static measurement for Great Lakes Islands, however, as it fluctuates considerably on the smaller, lower islands with variations in lake levels. Some of the low islands regularly disappear when lake levels are high. During high water years in the 1980s many islands formerly used as nest sites for colonial nesting waterbirds were inundated, and nest sites became seriously limited for these birds. This recurrent cycle of inundation suggests that management plans need to take a long time-scale perspective in order to adequately maintain the natural resource values of the islands. For instance, some of the larger permanent islands might be acceptable alternative nest sites during high-water periods if they were left relatively undeveloped and predator populations were not encouraged.

Table 1. Sizes of the ten largest islands in Michigan's waters of the Great Lakes

<u>ISLAND</u>	<u>COUNTY</u>	<u>SIZE (acres)</u>
Isle Royale	Keweenaw	139,021
Drummond	Chippewa	83,087
Beaver	Charlevoix	36,791
Sugar	Chippewa	31,625
Bois Blanc	Mackinac	23,659
North Manitou	Leelanau	14,414
Grand	Alger	13,564
Neebish	Chippewa	13,765
Dickinson	St. Clair	6,751
South Manitou	Leelanau	5,344

Degree of isolation also varies greatly. South Fox is the most isolated island in Lake Michigan, lying 17 miles from the mainland of the Lower Peninsula, and 4 miles from North Fox. Gull Island, in northeastern Lake Michigan is the most isolated of the Beaver Group, lying 6.5 miles from its nearest island neighbor (High Island), and 15 miles from the nearest mainland shore (Seul Choix Point in Schoolcraft County). The Beaver group

as a whole, the Fox and Manitou Islands, and Isle Royale are more isolated from the mainland than any of Michigan's other Great Lakes islands.

Both size and degree of isolation are of special biogeographical significance because they affect flora and fauna, degree of human disturbance, and value as migration stopovers and secure breeding colony sites for waterbirds. For example, the isolation of Gull Island (northeastern Lake Michigan) is reflected in the unusual mice population. The mice (*Peromyscus maniculatus gracilis*) are noticeably (and statistically significantly) larger in body size on Gull Island than on other islands in the Beaver Group (Lederle *et al.* 1985). In addition, the climate of the islands tends to be modified by the Lakes, and thus some species are seen farther north on the islands than on the mainland (*e.g.*, the massasauga rattlesnake on Bois Blanc Island).

Human history

Variation in human history provides another dimension responsible for creating diversity of habitats. While most, if not all, of the islands were logged at one time, some for fuel for passing steamers, some for cedar for staves and boxes, some for timber for local construction, or transport to the mainland, for the most part they were logged only once and then left to regenerate. In contrast to the usual pattern in other parts of the state, most of the islands have not been cleared and then converted to agriculture. Some agriculture has occurred (and in some cases still does occur) on some of the larger islands. Beaver, High, and the Manitou Islands were farmed. Harsens Island (St. Clair River Delta), was already being farmed by white settlers prior to 1800 (Lawler 1938). Most of the islands of northern Lake Huron and Lake Superior were apparently unsuitable for farming. Indications of Native American farming have been found on Hog, Garden, St. Martin, and Drummond Islands (MNFI surveys and GLO notes). Some of the islands have forests that now approximate pre-logging conditions. For example, forests on North Fox Island were apparently logged in the mid-1800s and now show little evidence of this past disturbance (Albert and Reese 1990).

BIODIVERSITY OF THE ISLANDS

Virtually all of the unique natural features associated with the Great Lakes shoreline can be found on Michigan's Great Lakes islands. Some of Michigan's islands, being less accessible than the mainland shore, have received less development pressure and disturbance, and as a result, some of the best or only examples of Michigan's special natural heritage remain on the islands. Some features are nearly confined to islands: predator-free habitat for sensitive colony-nesting waterbirds, alvar (grasslands on thin soil over limestone bedrock). Unique conditions also exist: deer-free forests, absence of natural predators or competitors, unusually high populations of certain organisms (*e.g.*, snakes on Hog Island, Beaver Archipelago).

Rare animals

The unique animal habitats offered along the shore also occur on the islands, and for some species of colonial nesting waterbirds virtually all reproduction takes place on islands which lack predators. Some of the rarest or most fragile special animals inhabiting islands are piping plovers, peregrines (hacked on Grand Island in 1992), bald eagles (especially islands in Lake Superior, Lake Huron, and the St Marys River), common terns and other colonial waterbirds (hundreds of the smaller islands in all the lakes and connecting channels), and mussels (one of the state's richest mussel beds is on Belle Isle in the Detroit River).

Waterfowl values

The islands along the north shore of Lake Huron, in the St. Marys River and in the St. Clair Delta have extensive marshes that serve as stopover points for many migrating diving ducks. Marshes of St. Marys River, northern Lake Huron shoreline, Saginaw Bay, Green Bay to Bay de Noc in western Lake Michigan, Lake St. Clair, Detroit River and western Lake Erie are important for migrating and nesting ducks of many species (North American Waterfowl Management Plan, USFWS and Environment Canada 1986; Jerry Martz, Michigan DNR - Wildlife Division, personal communication). All these areas include numerous islands, many with marshy shorelines.

The North American Waterfowl Management Plan (1986) indicates that Michigan wetlands in Saginaw Bay, Green Bay-Big Bay De Noc, and Lake St. Clair south to Lake Erie, all areas with many islands used by waterfowl, are areas that need special attention because of an alarming degree of wetland destruction. The wetlands of the southeastern shoreline of Michigan are part of the Lower Great Lakes-St. Lawrence Priority Habitat area. Two-thirds of the waterfowl habitat has already been lost in this priority area. The Plan placed high priority on conservation of black duck habitat in this Priority Area, targeting an increase of 10,000 protected acres in the United States, and 60,000 in Canada. The islands in this area provide special potential for habitat protection.

Since the publication of this plan in 1986, the island-dotted north shores of Lakes Huron and Michigan, Saginaw Bay, and St. Marys River have been added as focus areas for the Upper Mississippi River/Great Lakes and Lower Great Lakes/St. Lawrence Basin Joint Ventures of the North American Waterfowl Management Plan (Martz, personal communication). The integrity of the marshy shorelines of the islands in these areas are vital to the quality of habitat for waterfowl.

Species of waterfowl with **major migration corridors** crossing Michigan's island areas include: whistling swan, lesser snow geese, Canada geese, black ducks, canvasback, redhead, greater scaup, lesser scaup, bufflehead, and ruddy ducks. Oldsquaw, red-breasted mergansers, and common merganser winter throughout the Great Lakes, while common goldeneyes winter in Saginaw Bay and southeastern Lower Michigan island areas. Species with **breeding centers** among the islands include hooded merganser (north of Lake St. Clair), common merganser, and ruddy duck (minor breeding area in western Lake Erie) (Bellrose 1976). Many other species use these areas for migration or breeding in considerable numbers, although they may represent a small proportion of their continental populations.

Other birds and fish

Many of the islands are considered important migratory stopover sites for neotropical migrants and raptors, and harbor spawning areas for fish. The waters surrounding Dickinson and Harsens Islands have important fish spawning and nursery grounds (Edsall *et al.* 1988). Raptors and shorebirds migrate north through the Traverse Islands from the Door Peninsula, Wisconsin to the Garden Peninsula, Michigan (Scharf *et al.* 1979). Raptors

also migrate through the Beaver group en route north through the Straits of Mackinac (Sheldon 1965). An important flyway for songbirds extends from South and North Manitou Islands through South and North Fox Islands (Scharf *et al.* 1979; Scharf and Jorae 1980).

Unique plants

A number of species of plants are found only along the Great Lakes shores, and nowhere else in the world. Scientists call such species "endemic." All these endemic shoreline species occur on Michigan's islands. Pitcher's thistle (*Cirsium pitcheri*), Lake Huron tansy (*Tanacetum huronense*), dwarf lake iris (*Iris lacustris*), and Houghton's goldenrod (*Solidago houghtonii*) occur throughout the Manitou, Fox, and Beaver Islands, and sporadically through the Mackinac Straits, Les Cheneaux Islands, islands in the St. Marys River, as far south as the Charity Islands in Lake Huron, and west to the Grand Traverse Islands that lie across the mouth of Green Bay in western Lake Michigan.

Shoreline ecosystems

The entire array of mainland Michigan shoreline features and associated ecosystems are also found on the islands: from sand/gravel beaches backed by open sand dunes (*e.g.*, Beaver, High, North and South Fox), perched dunes (dunes on top of high moraine - South Manitou, High), a complex of wooded dunes and swales (Grand), northern fen (St. Martin, Marquette Islands), interdunal wetlands (Beaver, Hog), and marshy shores (Sugar, Harbor, Dickinson, Grand), to cobble (High), bedrock (Thunder Bay, Isle Royale, Drummond), and cliffs (Grand, Drummond). The dunes are an especially notable Great Lakes shoreline feature because, like the plants described above, they are "endemic:" nowhere else on earth are there dunes of this size and extent along the shore of a body of fresh water.

Threatened, endangered, and exemplary natural features

Michigan's Great Lakes islands have a disproportionate number of occurrences of endangered, threatened or rare species, exemplary natural communities (characteristic plant associations that provide the vegetative structure of ecosystems) and other special natural features when compared to the rest of the state. These species and communities

are collectively called "elements" in this report, and an "element occurrence" refers to a discrete site where the species or community occurs. Some 933 *element occurrences* have been found on these islands. This is about one-eleventh of the state's total known element occurrences, whereas the islands represent only about one-hundredth of the state's land area (total island area is about 420,800 acres). This high number of element occurrences is partly explained by the fact that Isle Royale, the northernmost point in Michigan, harbors many species at the southern end of their range that are not found elsewhere in the state. Even after excluding the 361 element occurrences on Isle Royale and surrounding islands, however, 572 records (about five percent of the entire state occurrence records) fall on the remaining islands. This number is about seven times higher than would be expected by the proportion of land area represented by these remaining islands (281,824 acres, about seven-tenths of a percent of the state's land area). Islands with the greatest number of element occurrences are listed in Table 2 (all those with more than 10 occurrences). Lists of elements occurring on each island appear in Appendix A.

The disproportionate number of occurrences of rare or exemplary natural features on islands can be attributed to a combination of the following (order is arbitrary, not a reflection of relative importance):

- 1) Islands provide a certain degree of protection from human disturbance by virtue of isolation or harsh conditions, which has allowed some rarities to survive.
- 2) Island climate is often moderated compared to inland sites, allowing some species to exist beyond the mainland edge of their range.
- 3) Some of the islands are positioned at the extreme edge of the state's boundaries, and may thus be closer to source populations of species which reach the edge of their range near Michigan.
- 4) Most of the colonial nesting waterbirds nest almost exclusively on islands and several are considered rare or threatened in the state.
- 5) Islands are particularly well-suited for research and thus some islands have perhaps received disproportionate scientific attention (though rarely has this attention provided complete biological inventories).

Table 2. Islands with more than 10 element occurrences (EOs)

<u>ISLAND</u>	<u>COUNTY</u>	<u>NUMBER EOs</u>
Isle Royale	Keweenaw	220
Other islands in IRNP	Keweenaw	156
Drummond	Chippewa	85
Beaver	Charlevoix	67
Bois Blanc	Mackinac	29
South Manitou	Leelanau	19
Belle	Wayne	19
Sugar	Chippewa	17
Harsens	St Clair	17
South Fox	Leelanau	15
High	Charlevoix	14
Grosse Ile	Wayne	11
Thunder Bay	Alpena	11
Manitou	Keweenaw	11

OVERVIEW OF ISLAND RESEARCH ON MICHIGAN'S GREAT LAKES ISLANDS

Island research values

Some of the factors that make islands valuable sites for biological research are as follows:

1) Islands have discrete boundaries and immigration and emigration are limited for many groups of organisms. This is an aid in population studies. As Allen (1971, "The Worth of Wilderness," p. 180) put it, discussing the value of Isle Royale National Park as an outdoor research laboratory:

"The striking limitations of its biota represent a measure of simplification over what is commonly found elsewhere. As an island, it offers relatively 'confined' populations of animals, which can be inventoried somewhat more easily than is possible on study plots in more extensive habitats."

2) Island biogeography and the study of evolutionary processes among island populations have provided intriguing questions for investigation since the time of Darwin. The variation in age, size, isolation, degree of natural disturbance, and history of connections with the mainland among Michigan Great Lakes islands provides excellent conditions for these lines of investigation.

3) The flora and fauna of many islands are impoverished, which can provide an ideal setting for comparing interactions among coexisting species.

4) Michigan has biological research stations connected with state universities on two islands (Beaver Island - Central Michigan University, and Sugar Island - University of Michigan).

Examples of biological research on islands

A fruitful resource for biological research, Michigan's Great Lakes islands have served as laboratory for a number of long-term and comprehensive studies.

Moose: Isle Royale has provided an ideal laboratory for study of moose biology. Population dynamics, consequences of overpopulation, impacts of grazing on vegetation, nutritional controls of population levels, and of course, the predator-prey relationship

with wolves have been studied in depth. Several researchers have figured prominently in this research. Murie (1934) focused attention on overgrazing problems 20 years after moose last invaded the island. Hickie (1937) summarized past and present (as of 1937) status of the moose population. Krefting (1951) reported on moose population cycles of increase, overbrowsing, and decline. Janke (1979) researched the relationship between, moose, fire and forest ecology on Isle Royale. Peterson's long-term wolf studies included the moose-wolf interactions (1958-1992). Aho (1978) and Belovsky (1981a-d) researched dietary limitations on moose populations.

Wolves: Isle Royale wolf studies have been ongoing since wolves colonized the island mid-century. Prominent researchers on the biology, social behavior, interactions with moose populations have been Peterson (1958-1992), Mech (1966), Jordan (1967, with others), Allen (1979), Wolfe (1973, with Allen).

Deer: Michigan's Conservation Department biologists performed long-term studies on the effects of deer on vegetation by comparing deer exclusion areas with the rest of the island on North Manitou (Bartlett 1939-1967). Hazlett and VandeKopple (1983) compared vegetation in relation to deer browsing on North Manitou Island (with deer) and South Manitou Island (no deer). King (1970) also compared vegetation under light (Garden) and heavy (South Fox) grazing pressure. State biologists reported on deer populations on Beaver Island, Bois Blanc Island (Bartlett 1938 & 1945), and Drummond Island (Cooley 1946, McBeath 1941, Reynolds 1942 & 1944, Schemenauer 1950 & 1951). Whitcomb and Currie (1975) produced an annotated bibliography of all Wildlife Division reports concerned with deer to date of publication.

These island studies have shown dramatic vegetation changes caused by deer browsing, as have moose browse studies on Isle Royale. The Great Lakes islands offer the rare chance to evaluate impacts of deer population density on vegetation in an objective manner, and to study the ecology of native ecosystems where deer populations are not maintained at artificially high levels.

Colonial nesting waterbirds: A high proportion of Great Lakes populations of colonial waterbirds breed in Michigan's waters of the Great Lakes. Of the colonial waterbirds nesting on the U.S. Upper Great Lakes in 1989, the following percentages of nest sites were in Michigan waters: double-crested cormorant - 75 percent, ring-billed gulls - 75 percent, herring gulls - 67 percent, Caspian terns - 89 percent, and common terns -

83 percent (Scharf and Shugart 1991b). Inventories and studies of this group have been ongoing for over 30 years, beginning with Ludwig's first comprehensive inventory published in 1962 (Ludwig 1962 & 1984, Ludwig *et al.* 1989, Scharf 1971, 1978, 1981 & 1989, Scharf and Shugart 1981, 1984 & 1991a&b, Scharf and Trapp 1991, Shugart and Scharf 1983a&b, and Shugart, Scharf, Cuthbert 1978). In recent years Ludwig and associates have studied the impacts of toxins in the lakes and substrate of man-made islands on the reproductive success of these birds (Kurita and Ludwig 1988, Ludwig *et al.* 1988, Ludwig and Ludwig 1986, Tillitt *et al.* 1992). In conjunction with this work deformities in chicks, toxin levels in eggs, birds, and food sources have been documented and correlated with reproductive success. Scharf, Shugart and associates have performed extensive surveys of nesting colonies on the Great Lakes, discussed population trends, and threats and analyzed the significance of man-made sites for nesting colonies of certain species.

Island biogeography studies: Islands are especially intriguing to ecologists because of the fruitful source of insight they proved for Charles Darwin. They present a set of basic scientific puzzles: origin of the biota, relationship of island size and isolation to the number of species present, species responses to lack of traditional competitors or predators, the process of speciation. The islands of eastern Lake Michigan, and to a lesser extent, those of western Lake Michigan have inspired a number of studies of these subjects. Phillips *et al.* (1965), and Ozoga and Phillips (1964) discussed origins of vertebrate fauna in the Beaver Islands. Scharf (1973) studied the vertebrates and discussed faunal affinities on South Manitou Island. Corin (1976) discussed effects of island size on vertebrate fauna of the Huron Islands, Lake Superior. Long (1978) discussed vertebrates on the Grand Traverse chain (western Lake Michigan at the mouth of Green Bay), and included discussion of Apostle Islands in Wisconsin. Invertebrate faunas have largely been neglected for biogeographic studies on Michigan islands, but Scharf (1991) used the flea fauna of certain mammals to decipher routes of mammal colonization of the eastern Lake Michigan Islands. There is room for a great deal more research on invertebrate biogeography on Michigan's Great Lakes islands.

Long (1978) found smaller *Peromyscus* on islands of Green Bay compared to mainland Wisconsin, but Lederle *et al.* (1985) found larger *Peromyscus* on Gull Island (Beaver Group) compared to mainland Michigan populations.

Predator-prey relations: Examples of studies that focused on predator-prey relations are Peterson's Isle Royale wolf/moose studies (Peterson 1959-1992), and studies of red-fox predation on gulls on South Manitou Island (Shugart 1977, Shugart and Scharf 1977, Southern *et al.* 1983).

Competition studies: Examples of studies on competition include research on coyotes and wolves on Isle Royale (described in Krefting 1969), and a study of voles and mice on the Grand Traverse Islands (Long 1978). Some studies have found situations on the islands where a species' usual competitors are missing and consequently that species occupied different habitats compared to mainland populations. Ozoga and Phillips (1964) noted that chipmunk and deer mice use different habitats on Beaver Island than on the mainland.

STATUS OF KNOWLEDGE OF ISLAND BIODIVERSITY

While there have been many biological inventories of the Great Lakes islands, no one island has been thoroughly studied for all groups of organisms. The colonial nesting waterbirds are the only group of organisms that has been consistently and repeatedly inventoried throughout the islands over the last three decades. A summary of inventory work to date follows. A compilation of inventory information for Michigan's Great Lakes islands can be found in Appendix B. Inventories were recorded in this Appendix when a particular group was carefully surveyed, even if inventories did not cover all groups. For example, animal inventories will be indicated for an island if a good bird inventory, or a good reptile and amphibian survey has been made, even if this is the only animal group that has been surveyed. The table does not indicate whether or not an island has had *comprehensive* inventories of all groups.

Animals

A number of the islands have had careful land vertebrate and bird inventories, but few have had any invertebrate inventories, and none have been *adequately* surveyed for invertebrates or aquatic organisms. One exception is a small portion of Beaver Island, Gull Harbor, where aquatic invertebrates, terrestrial invertebrates, and fish have been

inventoried, as well as plants, birds and terrestrial vertebrates, natural communities, fish spawning sites and other features of ecological significance (Central Michigan University 1991).

Vertebrates: In eastern Lake Michigan Hatt (1948) provided fairly extensive vertebrate lists for Beaver and the Manitou Islands, the Fox Islands, Gull, Squaw, Trout and Whiskey Islands. Notable gaps in his lists were Garden, High, and Hog Islands. Since this publication, additional vertebrate surveys have been produced for High Island (Basil 1975, Berg 1975 - both birds), Beaver and Garden Islands (Belote 1978 - vertebrates), Beaver Island (Drew and Phillips 1964 - birds; Gillingham 1988 - amphibians and reptiles; Ozoga and Phillips 1964 - mammals), Garden Island (Phillips *et al.* 1965) South Manitou and North Manitou Islands (Scharf 1973 - birds; Scharf and Jorae 1980 - land vertebrates).

Long (1978) reported on the mammals of the islands of Green Bay, western Lake Michigan. Long *et al.* (1987) and Long and Long (1976) listed amphibians and reptiles of these same islands (Rock, Poverty, Big Summer, Little Summer and Washington Islands). In Lake Superior, Corin (1976) studied land vertebrates of the Huron Islands. Manville (1951) studied all aspects of fauna and flora on one small island in Potagannissing Bay (Little Rogg Island), on the northwest side of Drummond Island, Lake Huron. Pruitt (1951) provided a list of mammals of the Osborn Preserve on Sugar Island, St. Marys River, and Butsch (1957) listed the winter birds of Sugar Island.

Little inventory work has been done on Lake Superior islands with the exception of Isle Royale. University of Michigan Museum expeditions to Isle Royale in 1904 and 1905 produced lists of many different groups of animals and plants. These are compiled in Adams (1909). Vertebrate groups covered include: birds (Peet), cold-blooded vertebrates (Ruthven), and notes on mammals (Adams). Later Isle Royale vertebrate species lists are reported in Hubbs and Lagler (1949 - fish), Johnsson and Shelton (1960 - vertebrates), Janke and Janke (1964 - birds), and Krefting *et al.* (1966 - birds).

One exception to lack of thorough inventory are those islands which are solely occupied by colonial waterbirds. The vertebrate fauna of these one-species islands can be considered complete.

Invertebrates: The most thorough island invertebrate inventory, in terms of groups surveyed, was undertaken during the 1904-1905 University of Michigan Museum expeditions (Adams 1909). These groups were covered: Coleoptera (Adams), invertebrates

(Gleason), Diptera (Hine), Orthoptera (Morse), Neuropteroid insects (Needham), Hymenoptera (Titus), molluscs (Walker), and ants (Wheeler). Subsequent additions include an incomplete list of Lepidoptera (Nielsen 1983), and ectoparasites (Wilson and Johnson 1971).

Invertebrate inventories of the islands of **eastern Lake Michigan** should be a *high priority*. Species with western affinities, some reaching the eastern extent of their range are to be expected on these islands. Recently, some studies have begun to appear on this subject. Bland (1989) published a list of the Orthoptera of Beaver Island, and Profant (1991) listed Lepidoptera from the entire Beaver archipelago. Bowman (1974) studied tiger beetles on South Manitou. Another high-priority area for insect inventories is Drummond Island, where disjunct populations of species from western grasslands are expected in the alvar communities.

A list of Coleoptera from the Charity Islands, **Lake Huron**, was compiled during the Mershon expedition of the Michigan Biological Survey (Andrews 1916).

Natural communities

Surveys of natural communities help identify high quality intact ecosystems that often provide rare species' habitat. Protection of high quality ecosystems provides a central core for biodiversity maintenance in the state. Therefore, natural community surveys are an important step in evaluating conservation needs. One community type, Great Lakes marsh, has been rather thoroughly covered among the islands. The entire coastline of Michigan, including islands, has been inventoried for high quality examples of these marshes by Michigan Natural Features Inventory (Albert *et al.* 1987, 1988 & 1989). Beyond this survey, few of the islands have had any degree of inventory for natural communities, and even fewer have been thoroughly surveyed, yet those islands that have been well-explored are largely those that have the most promise of retaining intact functioning ecosystems. One gap in natural community inventory is Isle Royale and associated islands, although the floristic studies of Janke and Slavick included vegetational analysis. Because of the high level of protection to islands in Isle Royale National Park, this inventory is not of highest priority, however. It would mainly serve to satisfy scientific interest, rather than add to conservation of the natural diversity of the islands.

Among the islands of **Lake Michigan**, in the Beaver Group, **Beaver, High and Hog Islands** have had natural community surveys, but Beaver Island inventories are incomplete. Some work on the hardwood forests of **Garden** has been done by Burr (1974). **North Fox** has had adequate community survey (Albert and Reese 1990). **South Fox** has also been subject to community inventory work but it has not been as thorough as that on North Fox. In **northern Lake Huron**, many islands have been surveyed for high quality Great Lakes marshes, but few have been comprehensively inventoried. Shorelines of **Sugar Island, St. Marys River**, have been surveyed for Great Lakes marshes, but systematic searches in upland and inland wet areas have apparently not been made. **Marquette Island**, in the Les Cheneaux Island group, has had shoreline marsh surveys, and some plant and animal inventory, but could use more interior coverage. **Drummond Island** has had limited community work, primarily focused on the globally rare alvar community, a grassland type on shallow-soil over dolomite. There are large areas of this island that have had no natural community inventories. **Bois Blanc Island** has had some plant and community surveys, but has not been comprehensively inventoried. **Harbor Island, Potagannissing Bay**, was surveyed for communities, plants and animals by Scharf and Chamberlin in 1978, and again by Penskar in 1981, but these surveys were only cursory.

Downstate, the islands of **Wildfowl Bay** in Saginaw Bay, **Lake Huron**, have been partially explored for marsh, prairie and lakeplain oak openings. **Dickinson and Harsens Islands** in the **St. Clair River Delta** have been partially surveyed for communities and plants.

Plants

Several of the islands of **eastern Lake Michigan** have had relatively thorough botanical surveys. **Beaver Island**, being largest, has not surprisingly received the most attention (Henry and Hampton 1974 - macrolichens; Hohn 1977 - bog flora; Griffith 1978 - desmids of Green Lake; Jaworski 1979 - grasses; Morgan 1977 - Potamogetonaceae; Veldman and Wujek 1971 - Pteridophytes). However, these studies all focused on specific groups, and no comprehensive botanical inventories have been completed. Voice *et al.* (1982) surveyed some of the smaller islands (**Tims, Inner Grape and Outer Grape** and some small unnamed islets) for rare plants (and animals as well). Wujek (1972, *etc.*). Hazlett

and VandeKopple (1983) and Hazlett (1981) provide extensive floras and vegetational analyses of **North and South Manitou Islands**.

Forzley and Grudzien (no date) provide lists of some of the plants on the **Grand Traverse Islands** between the Garden and Door Peninsulas in **western Lake Michigan**, and Miller and Halbert (1971) collected bryophytes from one of these, **Summer Island**.

In **Lake Huron**, the **Charity Islands** were surveyed for vegetation and flora in the early 1900s (Dodge 1911 & 1914) as part of the Michigan Geological and Biological Surveys, and **Big Charity** was again surveyed for certain species in 1992 (Higman and Goff 1992). In Potagannissing Bay of **northern Lake Huron**, **Harbor Island** (Penskar 1981) and **Little Rogg Island** (Manville 1951) have both had partial plant surveys. Many other, mostly small islands in Lake Huron and the **St. Marys River** were surveyed for rare plants by Penskar and Ludwig (1981) and Voice *et al.* (1982). Voss (1950) provided a flora of **Green Island**, a tiny island in the Straits of Mackinac, and has also studied (but not published) the flora of **St. Helena Island**, in the same region. Dodge (1914) catalogued the flora of **Mackinac Island**.

Rogers and Premo (1991) surveyed plants on **Grand Island, Lake Superior**. Although they documented nearly 700 species, a significant portion of the island remained unsurveyed, and the authors did not consider their list complete. Contributions to the flora of **Isle Royale** are provided in Brown (1937), Crispin *et al.* (1985 - rare, threatened, and endangered plants of Passage Island), Hendrick and Lowe (1936 - lichens), Povah (1935 - fungi), Slavic and Janke (1987 - most complete vascular flora to date), Thorpe and Pova (1935 - bryophytes) and Wetmore (1985 - lichens).

Physical Features

In the 1940s C. H. Wonser of the Michigan Department of Conservation recorded geology, geography, soils, cover types, wildlife, and economic development for a number of the Beaver Islands. Bartlett (1945) did a similar DNR survey of South Fox. Hatt (1948) recounts geological history of the Beaver Islands in some detail. Kapp (1969) contributed new information on the geology and forest history of Beaver Island. Geological and soil survey work was performed on many BLM islands in the eastern UP prior to transfer to the state of Michigan (Ludwig 1980).

Although the number of element occurrences known from the islands would suggest a great deal of knowledge of their biodiversity, large gaps in knowledge of island biodiversity still exist. The Beaver Island group, one of the better known groups, still lack vertebrate inventory for Hog Island, and invertebrates for all except a few groups on Beaver Island. Drummond also has an obvious gap in information on native invertebrates. Adequate inventory of natural communities is largely lacking among the islands. Since communities are a key to ecosystem health, they are a good starting point for inventory of biodiversity. Most of the larger islands need community inventory. The recent plant inventory on Grand Island (Rogers and Premo 1992) showed a surprising number of species, but the list is still incomplete, as all of the island was not covered. North and South Manitou have good floras, but Beaver Islands' flora is still quite incomplete.

This review of the known natural features of the islands has shown them to be rich in outstanding natural values, despite the fact that inventory work is incomplete in nearly all cases. This suggests that with further inventory, even greater wealth of natural heritage would be discovered.

PROTECTION AND THREATS TO ISLAND BIODIVERSITY

The status of biodiversity on the islands cannot be assessed solely by compiling lists of the biota present, but requires evaluation of the likelihood of their persistence. To what extent is this rich natural heritage threatened, and to what extent protected?

Ongoing and anticipated threats

Many of Michigan's Great Lakes islands are currently experiencing pressures and threats similar to those experienced on the mainland Great Lakes shoreline. Population growth, one measure of development pressure, is high in Michigan's coastal zones. In a 1991 report by Clean Water Fund/Clean Water Action, "The Endangered Zone," Leelanau County, which includes the Fox and Manitou Islands, ranked third in percentage population increase between 1980 and 1990. Chippewa County, with numerous near shore islands in Lake Huron and the St. Marys River, ranked second. These counties also ranked within the top 6 in a combined "stress index" developed in "The Endangered Zone"

report. As prime mainland scenic land fills up in these growth areas, pressure for island development can be expected to increase, as has already occurred with North Fox Island, Leelanau County.

Development can affect coastal resources by destroying or degrading natural habitat, or more subtly, by altering it with revetments, seawalls, or other structures that stop the deposition-erosion processes intrinsic in a dynamic coastal zone ecosystem. Such shoreline structures fundamentally change the aquatic-terrestrial interface. Although one can argue that one more seawall will not make a significant change, the effects are cumulative. Piece by piece these structures are altering and damaging the near-shore portion of the coastal ecosystem. Islands affected by shoreline alterations include Harsens and all the small islands in the St. Clair Delta.

Marshy shorelines are also subject to alterations that have profound ecological consequences. Some have been manipulated for wildlife management purposes (St. Clair Delta, Wildfowl Bay). These manipulations benefit certain species, but in the process, habitat for other species is eliminated. Others in sheltered bays yield to docks or marinas (*e.g.*, Grand Island 1992 Draft Environmental Impact Statement, "Orange," "Yellow," and "Teal" proposed alternative plans). Where natural harbors are lacking, development may include creation of harbors (*e.g.*, proposed plans for creating a harbor on Big Charity Island by removing bedrock, or creation of a harbor for a marina on North Fox Island).

Although the extent of the problem on islands is unknown, ORVs are another major source of damage to shorelines. Shoreline ecosystems are fragile. They occupy a dynamic environment subject to repeated disturbance. ORV traffic increases the degree and frequency of disturbance and is a different type of disturbance than wave action, ice scouring, and changes in lake levels, a type the native vegetation has not evolved to endure. ORVs compact the soil in wetlands, create blowouts in dunes, crush and destroy vegetation, and can breach a foredune and drain an interdunal wetland. Plants unique to the Great Lakes shoreline, several listed as threatened under the Federal Endangered Species Act, grow in these fragile habitats.

The issue of ORV use on islands where automobile use is prohibited or severely limited is especially sensitive. For example, this is a central controversy in developing plans for the Grand Island recreation area. Clearly, there is a need for island management plans that provide for human needs in ways compatible with maintenance of ecosystem

integrity. Such plans will at minimum need to include prescribed routes for ORV use that avoid sensitive habitats. However, use of personal ORVs may not be practical at all in many cases because enforcement of restrictions may be unmanageable on remote islands. For example, in 1991 extensive ORV damage was reported South Fox Island in association with a construction project (John Bellow, *Traverse City Record-Eagle*, Friday, June 21, 1991, p 3A).

The aesthetic appeal of islands and the human fascination with isolation, along with the decreasing availability of mainland Michigan shoreline for development, suggests that we can expect more pressure for development on these islands in the near future. Because of the ecological significance of the islands, conflicts between development plans and environmental protection can be expected. Already, controversies have arisen over commercial development plans for North Fox and Big Charity Islands. Development pressure continues to grow in the Les Cheneaux Islands, a group that has been inadequately surveyed, but has known high value for waterfowl (Jerry Martz, Michigan DNR Wildlife, personal communication), and a number of occurrences of threatened plants, birds, and exemplary natural communities (MNFI database).

Opportunities for biodiversity conservation

Islands provide a unique opportunity for conservation. In some cases, the discrete boundaries of islands can ensure limited access and facilitate management of visitor use. Islands are also ecologically buffered: an island that is protected as a whole, will not be subject to disturbances and activities on adjacent or upstream lands, although oil spills or toxic contaminants in the Great Lakes can have major impacts. This offers opportunity for conservation of complete ecosystems, a task that is much more difficult to accomplish on the mainland. Ideally, state policy would recognize the Great Lakes Islands as the globally unique ecological system that they are, and would strive to maintain and restore intact ecosystems on all the islands, both publicly and privately owned.

On some islands, human uses have not been well established, and therefore, conflicts between conservation goals and human uses may remain minimal. On these islands Great Lakes ecosystem processes (*e.g.*, dune building, stabilization and blow-outs, sand and gravel shoreline erosion and deposition, burying of forests by blowouts, natural succession on sand, forest successions, cedar windthrows, fir regeneration and insect destruction,

cedar regeneration) can be allowed to proceed unchecked, whereas on more developed mainland shorelines they have often been halted to prevent conflict with human uses. Some of these processes can only be observed where unique conditions (such as lack of deer) occur, as on some of the islands. Thus, the Great Lakes islands provide a laboratory for study of the dynamic ecology of Great Lakes shorelines, as well as other ecological phenomenon. Conservation of the natural features of many of the islands is practical, possible and an investment that will reap benefits in future knowledge.

Further, some of the State's natural features can best be protected on islands, for they occur nearly exclusively there. Many species of colonial waterbirds are nearly completely confined to islands for nesting sites. Alvar, a globally rare natural grassland community, occurs extensively on Drummond Island, but at only a few other sites in the state. Its occurrence on the Garden Peninsula suggests that this community may also exist on the Grand Traverse Islands, strung between the Garden and Door Peninsulas in western Lake Michigan.

Current status of protection of the islands

While at present the potential for conservation of island ecosystems remains high, the potential for future conflicts over island use as mainland Michigan shorelines become more and more developed is also high. It is useful to consider current levels of protection for the islands and examine gaps in protection. Protected status of the islands range from mandated permanent protection provided to dedicated wilderness areas, to a lack of any formal protection beyond standard state permitting requirements under most private ownership. This is not to say that most private owners do not protect the biodiversity of their land, but rather that the ability to protect is subject to the plans of each owner, and is therefore not guaranteed over the long run. Isle Royale and surrounding islands are provided a high degree of protection by their status as a National Park, and the Park Service's protective policies. Sleeping Bear Dunes National Lakeshore provides protection for North and South Manitou islands. The potential for conservation of the natural features of these islands over the long term is high. Beaver Island, Charlevoix County, and Drummond Island, Chippewa County, are examples of islands with many significant natural features that are only partially protected. Both are partly private, partly state owned, but neither portions are fully dedicated to conservation of overall biodiversity.

At the other end of the scale is North Fox Island, a small island with 10 known element occurrences, which is under private ownership by an owner who wishes to develop the island for residential and recreational use, albeit in a manner that retains some natural areas on the island.

Protected islands: Islands that are wholly owned by conservation organizations, or are managed by public agencies for wilderness or preservation of natural conditions are listed in Table 3. These islands are considered "protected". Several of these islands are important nesting sites for colonial nesting waterbirds (Gull, Grass, Bird, and Scarecrow in Alpena County, Shoe, Pismire, Hat, and Gull in Charlevoix County, "Two Islands" in Delta County). Harbor Island, Potagannissing Bay, Chippewa County has an extensive marshy harbor that is important habitat for waterfowl, and also has rare plant habitat. Waugoshance and Temperance Islands include habitat for threatened shoreline plants and birds. Round Island (Mackinac County) has habitat for threatened plants, and the Huron Islands have historic peregrine falcon habitat. Isle Royale and Passage Island have extensive habitat for rare plants and a host of animals and ecosystems.

Partially protected islands: Islands that are partially in protective ownership, or are publicly owned, but managed with a primary purpose other than conservation of the native biota (*e.g.*, for recreation, forest products or production of particular wildlife species) are considered "partially protected" and are listed in Table 4. While these resource uses in some cases may not be in conflict with conservation of biodiversity, there is no guarantee that they will not be in conflict, and thus, the "partially protected" designation is used. In addition to the incomplete protection afforded Drummond and Beaver Islands that was discussed above, Sugar Island is another notable partially-protected island, with 17 known element occurrences, despite incomplete inventory work. Bois Blanc Island is also only partially protected, being partly private and partly state forest land. The list of 29 known element occurrences for this partially surveyed island suggests that a more comprehensive ecosystem conservation plan, based on complete inventories and probably including protective designations for more of the island, is needed. Several of the Delta County islands, the site of significant vertebrate studies, are state-owned, and thus potentially well-protected, but not officially dedicated to biodiversity conservation.

Table 3. Protected Michigan Great Lakes Islands

Alpena County	
Gull Island	Michigan Nature Association preserve
Grass Island	Michigan Nature Association preserve
Bird Island	Michigan Nature Association preserve
Scarecrow Island	Michigan Islands Wilderness Area, USFWS, administered by Shiawassee NWR
Charlevoix County	
Shoe, Pismire, Gull Islands	Michigan Islands Wilderness Area, USFWS, administered by Shiawassee NWR
Hat	The Nature Conservancy preserve
Chippewa County	
Harbor Island	The Nature Conservancy preserve
Delta County	
Two Islands	Michigan Nature Association preserve
Emmet County	
Waugoshance, Temperance Islands	State of Michigan dedicated Natural Area, administered by Wilderness State Park
Grand Traverse County	
Power Island (= Marion I.)	Grand Traverse County park with deed restriction to maintain wilderness nature ("good forestry and wildlife management" are allowed)
Keweenaw County	
Isle Royale	U.S. Wilderness Area, administered by National Park Service
Passage Island	U.S. Research Natural Area (all but 1 acre), administered by National Park Service
Mackinac County	
Government Island	U.S. Wilderness Area (RARE II), administered by Hiawatha National Forest
Round Island	U.S. Wilderness Area (RARE II), administered by Hiawatha National Forest
Marquette County	
Huron Islands	U.S. Wilderness Area (formerly NWR), administered by Seney National Wildlife Refuge.

Protection initiatives with private landowners: In addition to protective ownership or management designations, conservation can be accomplished by the desire of private owners to protect their land. Voluntary protection can be formalized by deed restrictions or a variety of other tools if owners wish to insure protection for perpetuity. Some programs in the state have targeted voluntary protection by private owners. The Nature Conservancy is working along the northern shoreline of Lake Huron, including the numerous coastal islands, on projects integrating conservation of biodiversity with existing land uses. This organization works with landowners using a variety of protection mechanisms (Dave Ewert, The Nature Conservancy, Michigan Field Office, personal communication). The goal is to assist in integrating human activities with the landscape in ways that allow for maintenance of both the integrity of the complex coastal ecosystems and the quality of life for the human residents. This project may provide a model for integrated ecosystem management which could be applied to the Great Lakes islands as a group. Michigan Natural Features Inventory is piloting a program in the Straits of Mackinac region to solicit voluntary protection of natural features by landowners along Great Lakes shorelines, including island shores.

Table 4. Partially protected Michigan Great Lakes Islands

Alger County Grand Island	National Forest Recreation Area, small Research Natural Area, administered by Hiawatha NF
Alpena County Middle Island	State of Michigan, Forest Management
Thunder Bay	U.S. Coast Guard, managed by Shiawassee NWR
Charlevoix County Fisherman Island	Fisherman Island State Park, undeveloped
Garden, High, Hog, Horseshoe, Tims, Little, parts of Beaver and South Fox Islands	State of Michigan, Beaver Islands Wildlife Research Area
Chippewa County Drummond Island	State Forest land, private, and Maxton Plains Nature Conservancy preserve
Sugar Island	Chase S. Osborn Preserve, Univ. of Mich. in one large and several small parcels, administered by Univ. Mich. Biological Station
Lime, Mare parts of Burnt Island plus many other small islands in vicinity	State of Michigan, administered by Forest Management (Lake Superior SF) and Wildlife Divisions
Delta County Round, Poverty, most of Summer, and parts of Little Summer Islands	State of Michigan, administered by Forest Management (Lake Superior SF)
Huron County Wildfowl Bay Islands: Heisterman (= Stony), Lone Tree, N. Mineshas (= Defoe), Katechay (= Middle Grounds)	State of Michigan, administered by Wildlife Division (Wildfowl Bay State Wildlife Area)
Keweenaw County Porter's Island	State of Michigan, proposed Wilderness Natural Area, administered by Parks Division
Manitou Island	U.S. National Forest Service

Table 4. Partially protected islands, continued

Leelanau County

South Fox Island Part State of Michigan, Beaver Islands Wildlife Research Area.

Mackinac County

Bois Blanc Island More than half owned by State of Michigan, Mackinaw SF, includes Mixed Forest Natural Study Area, Snake Island/Mud Lake Natural Area, Northshore Research Natural Area; also The Nature Conservancy has a preserve, and there are many private owners.

Little LaSalle The Nature Conservancy owns part, rest private

Marquette Is. The Nature Conservancy has two preserves at Voight and Peck Bay. Les Cheneaux Foundation also owns some land intended to remain undeveloped.

Mackinac State Park (development is limited)

Crow State of Michigan, administered by Wildlife Division

Marquette County

Picnic, Little Presque Isle, State of Michigan, administered by Wildlife Division
Larus, and Garlic Islands

St. Clair County

Dickinson, Harsens, State of Michigan, administered by Wildlife Division
Strawberry, and other St. Clair Flats Wildlife Area
small islands

Wayne County

Celeron State of Michigan, administered by Wildlife Division

INVENTORY AND CONSERVATION NEEDS

The Great Lakes islands have many unique values. They are an aesthetic resource unique in the world. They perform vital ecological functions in the Great Lakes ecosystem that are quite different from those of mainland habitats. They function as migration stepping stones for raptors, songbirds and waterfowl, and as nesting sites for colonial waterbirds. They have a remarkable wealth of rare, threatened and endangered species, and intact functioning ecosystems compared to what is currently known for mainland Michigan. They are isolated microcosms, ideal natural research laboratories, in which ecosystems are buffered from the types of adjacent land-use impacts common on the mainland. *As a first step in insuring maintenance of these natural values, the gaps in inventory of the islands should be filled before the islands are further altered in any way.* For efficiency, these inventories should focus on high quality natural communities, migratory bird visits, waterfowl resources, and rare, threatened, and endangered species. The results will help to better define island conservation needs and priorities.

High priority inventory needs

Islands that lack protection but are known to have significant natural features or have a high potential for such features but lack adequate inventory are of highest priority for inventory (Table 5). Potential was based on known features, known physical features, or known natural features on neighboring islands and the adjacent mainland. The islands in this table represent the most significant inventory and protection gaps among the islands.

Based on gaps in present knowledge, potential for intact ecosystems and rare species, and degree of threat, the following inventories should be considered high priority:

Grand Island, Lake Superior has been partially surveyed botanically and found to have a very diverse flora. Given the potential threat of increased use as the island is developed into a Recreation Area, the botanical inventory should be completed. Inventory of the entire biota of the island would provide a good baseline for assessing future conditions and impacts.

Given the large number of rarities already found on **Drummond Island**, and the presence of globally rare alvar communities, more rare plant work is merited. Unusual

insects, with affinities to western grasslands, can also be expected here. Homoptera and microlepidoptera are groups especially likely to include an unusual set of species in alvar communities. The inland cliffs on the east side of the island have been explored as a possible peregrine release site, and may also have unusual plants. Drummond Island occasionally receives wolves moving across the ice from Canada in winter, and is thus a potential center for reestablishment of this endangered species in Michigan. This island has a fairly large area of state owned land, so protection of the native biodiversity could be fairly easily achieved.

Table 5. High priority inventory needs on Michigan's Great Lakes Islands

<u>County Island</u>	<u>Inventories needed</u>
<u>Alger</u> Grand Island	plant, animal
<u>Chippewa</u> Drummond Island Sugar Neebish Lime Harbor Potagannissing Bay & Detour Passage islands	community, plant, animal community, plant, animal community, plant, animal community, plant, animal community, plant, animal rare plant, animal
<u>Mackinac</u> Bois Blanc Marquette Albany Little LaSalle LaSalle Big St. Martin St. Martin	community, plant, animal community, plant, animal plant, animal plant, animal community, plant, animal community, plant, animal community, plant, animal
<u>Charlevoix</u> Beaver Garden Hog High Whiskey	community, plant community plant, invertebrates plant, invertebrates community, plant

Table 5. High priority island inventory needs, *continued*

<u>County Island</u>	<u>Inventories needed</u>
<u>Delta</u>	
Summer	community, plant
Little Summer	community, plant
Poverty	community, plant
St. Martin	community, plant
<u>Bay</u>	
Wildfowl Bay Islands	community, plant, animal
<u>Alpena</u>	
Thunder Bay Island	plant
Crooked Island	community, plant
Middle Island	community, plant
<u>St. Clair</u>	
Harsens	community, plant
Dickinson	community, plant
<u>Leelanau</u>	
South Fox	community, plant, animal
North Fox	plant, animal

Sugar Island, St. Marys River, Chippewa County has osprey and common tern nesting areas, both threatened species in Michigan, and some high quality Great Lakes marsh habitat, used by many waterfowl. This island needs inventory of natural communities, plants and animals. Some of the larger islands in the St. Marys River, especially **Neebish and Lime** have had little to no inventory and may have significant natural features. All types of inventory would be valuable. Inventory of state-owned **islands in Potagannissing Bay and Detour Passage**, and of **Harbor Island**, the largest of these, would be useful for illuminating the biological importance of this large group of islands.

In **Northern Lake Huron, Les Cheneaux Islands** also merit more community and plant inventory work. Based on the high value of the marshes around these islands for waterfowl habitat, the scanty inventory work to date, knowledge of substrates and topography and the natural communities of the adjacent mainland **Marquette, LaSalle and Little LaSalle, and Albany Island** deserve investigation, particularly rare plant

surveys. The value of the smaller islands for wildlife should also be assessed through inventory work. Further west, the same criteria suggest that **St. Martin and Big St. Martin, Mackinac County**, are very likely to have high quality northern fen communities with associated rare plants, and perhaps massasaugas (a C2 candidate for federal listing). Massasaugas are found on Bois Blanc Island to the south, in habitat similar to that expected on the St. Martin Islands, but this is at present the northernmost record for the species in the state. The St. Martin Islands are privately owned and have not been surveyed. **Bois Blanc Island**, though better known, has similar potential, and deserves thorough inventory.

Crooked Island and Middle Island, both in **Alpena County**, have high potential for rare plant habitat, and perhaps high quality natural communities. Again, this is based on knowledge of substrates, topography and adjacent island and mainland habitats. **Thunder Bay Island** rare plant surveys should be completed, as the island is already known to have several rare and threatened species.

In the **Wildfowl Bay Islands**, the presence of natural prairie and savanna communities suggests inventories of the plants and insects will likely yield occurrences of rare species. Nongame bird and vertebrate use of these islands would also be valuable in planning future management strategies.

The **Beaver Islands**, along with **North and South Fox and North and South Manitou Islands** in **northeastern Lake Michigan**, are arguably the biologically richest islands in the Great Lakes. Their isolation, the variety of shoreline features, the presence of all the Great Lakes endemic plant species, colonial waterbirds, migratory stopovers for a variety of birds, as well as their varying histories of inundation and connection, produces an ideal setting for a myriad of research questions. The value of the group as a whole is dependent on the presence of natural habitat on all of the islands. Protection and inventory needs among these islands follow below.

Beaver Island, the largest, and perhaps most significant of the islands, has not been systematically surveyed specifically for all outstanding examples of natural communities, or for rare plants. The island has been the site of a great deal of biological research because of the presence of the Central Michigan University Biological Station, but basic biological inventory work is still incomplete. This inventory should be considered very high priority. Not only is the discovery of more rare and exemplary natural-features likely, but the island has permanent residents, private land and is likely to experience increased

development in the near future. The information obtained from inventories could aid in planning to minimize impacts on the natural biodiversity.

Garden Island (Charlevoix County) has several rare plant occurrences, and is surrounded by other islands with significant natural features. This suggests that community surveys would be important here. Most of the smaller islands in the Beaver group are dominated by nesting colonies of waterbirds, and are consequently nearly devoid of vegetation, and not a high priority for natural community inventory. **Whiskey Island**, lacking colonial nesting birds, may have some potential for intact plant communities, and merits community and plant survey work. **Hog and High Islands** are worthy of rare plant and insect inventories, at a minimum. High Island has excellent examples of open dune vegetation, perhaps in better condition than any mainland Michigan dunes (Francesca Cuthbert, University of Minnesota, Dept. Fish and Wildlife, personal communication).

North Fox could use more rare plant work, and certainly invertebrate surveys, and **South Fox** could use more work in all areas. Both **North** and **South Manitou** are well-known and protected, and further inventory work is lower priority there, except for invertebrates.

In western Lake Michigan, **Summer, Little Summer, Poverty, and St. Martin Islands, Delta County**, all show potential for intact natural communities and possibly for rare species and deserve further inventory.

Dickinson and Harsens - Vertebrate and invertebrate surveys would compliment the good store of present knowledge for these ecologically significant islands.

Belle Isle and Grosse Ile, while both have many records of rare plants, the records are old, and the present potential is low. Rare plant surveys are *not* high priority on these islands. **Belle Isle** has also had important mussel beds along the north shore, harboring some of the rarest species in the state. These have suffered with the invasion of the exotic zebra mussel. The damage should be assessed via a thorough survey.

Adequate inventories will allow responsible planning for the future long-term conservation of these islands. Inventory priorities can be initially directed by threats, but should aim toward complete inventory well before development plans have been drawn up. This will help avoid volatile confrontations, and allow for orderly institution of management plans.

Needs for protective designations

Ideally, the islands, as an integral part of the fabric of the Great Lakes system, would be systematically moved into protective ownership and managed for maintenance of their natural values. This would be a significant step toward providing for the maintenance of intact examples of many of Michigan's native ecosystems, as well as insuring the integrity of this globally unique resource.

Realistically, this goal cannot be met immediately, nor can a complete inventory of island resources be completed in the next year or two. Therefore, it is crucial that protection needs be prioritized. As a first step in this prioritization, the same bases as were used to identify inventory needs above (lack of protection, known significant natural features, or high potential for such features based on physical features or known natural features on neighboring islands and the adjacent mainland) point to several islands that clearly deserve increased or complete protective status.

Islands with known significant natural features, but incomplete or no protection for some or all these features need more protection:

Grand Island (Alger County)
Drummond Island (Chippewa County)
Bois Blanc Island (Mackinac County)
Marquette Island (Mackinac County)
Little LaSalle Island (Mackinac County)
LaSalle Island (Mackinac County)
Beaver Island (Charlevoix County)
Harsens and Dickinson Islands (St. Clair County)
North and South Fox Islands (Leelanau County)

These islands (in part or in entirety) should be top priority for acquisition by the state or private conservation organizations, or for protective designations by present owners.

Other islands may have excellent natural values, but their protection needs are more difficult to prioritize because of inadequate inventory. Other than Harbor Island (Chippewa County), which is entirely in protective ownership, all of the islands identified as top priority for inventory in Table 5 fall in this category.

Systematic prioritization of protection needs could be accomplished with a mechanism known as a "scorecard." Michigan Natural Features Inventory and The Nature Conservancy

developed this method several years ago for ranking protection priorities across the state. The scorecard procedure uses the following information to prioritize protection needs:

- 1) the number of different elements (for example rare species, exemplary natural communities, or colonial bird nesting sites) at a site
- 2) a rank of the quality of each element occurrence relative to all the other occurrences of that element in the state
- 3) the endangerment status of the element across its entire range
- 4) the endangerment status of the element in the state
- 5) the degree of protection afforded the element in the state, and at the site

High quality occurrences of elements that are highly endangered globally and have few protected occurrences are given highest priority for protection action. The priorities for island protection given above are based on an informal scorecard method. The number and endangerment status of the elements, and the protection status of the sites were considered to derive priorities. The quality of occurrences was inferred from the natural community element occurrences: only the higher quality occurrences of natural communities are recorded in MNFI's database. Therefore, the presence of several natural community element occurrences on an island indicates that good habitat exists on the island. A more rigorous prioritization would require a closer examination of occurrence quality ranks. In many cases this would require more inventory (site revisits, *de novo* searches) in order to assess current quality of occurrences. Completion of the inventories indicated as high priority above would allow a more accurate prioritization of protection needs. In the meantime, the islands that clearly need more protection based on current knowledge should be top priority.

Protection for certain of these islands should be considered in an inter-state or international context. Harsens and Dickinson Islands are part of the St. Clair River Delta, which includes islands in Canada's portion of the delta. Walpole Island has extensive areas of the native wet prairies that once occurred more extensively in the region. Long-term conservation of the biota of the Michigan islands may well be tied to long-term conservation of the seed sources for prairie species on Walpole Island. The entire delta island complex needs to be considered and managed compatibly, requiring international efforts. Similarly, Drummond Island is very close to Cockburn and Manitoulin Islands,

Ontario, and ecological processes on the three islands are undoubtedly linked, such that coordinated protection for the two islands would greatly enhance the effectiveness of the actions. In western Lake Michigan, the chain of islands between Wisconsin's Door Peninsula and Michigan's Garden Peninsula are clearly linked biologically, and conservation management should be organized cooperatively across the state boundary.

Management needs

To maintain the special values of these islands for wildlife, research, and recreation, management policies must be based on the primary goal to maintain and restore the islands' native biodiversity. Human uses should be planned within the context of this overriding goal. This may mean that some uses will be constrained or even halted if their impacts compromise the goal. While this policy could be unpopular initially, a campaign to educate the public about the islands' values and to celebrate the global uniqueness of this state treasure would likely diminish public protests.

One management policy that supports the primary goal is to prevent invasions or introductions of exotic species on the islands. Because of the low probability of natural colonization, some islands are still largely free of exotic species that dominate much of the disturbed landscape of the mainland. This offers the chance to observe native communities as they once functioned. As efforts to restore native ecosystems on the mainland proceed, these intact island ecosystems can be valuable standards.

Management policy will also have to address development, recreational use, ORV use, shoreline alterations, boat traffic, and private versus public ownership of Great Lakes shoreline. While the mainland shores of the Great Lakes are subject to more and more pressure for development, the islands offer an opportunity to hold fast on protection of remaining intact shoreline communities, as well as other inland examples of intact functioning ecosystems. Consideration should be given to declaring island shorelines a public resource, such that current privately owned shoreline tracts would eventually revert to the state at the end of lifetime tenure.

If management policies maintain a focus on the overriding goal of maintenance of islands' natural values, waterbirds and waterfowl will be provided vital habitat, migrating raptors and songbirds will continue to find safe resting spots, and many threatened and endangered species will be protected.

INVENTORY AND CONSERVATION RECOMMENDATIONS

In summary, the following actions are recommended in order to conserve the unique values of Michigan's Great Lakes islands:

- 1) Proceed immediately with completion of natural features inventories on the islands listed in Table 5.
- 2) Require that islands be inventoried and that environmental evaluation be performed prior to any further alterations.
- 3) Move toward development of a complete scorecard for all the islands.
- 4) Develop a policy that treats islands as a whole as a state resource, sets maintenance and restoration of the islands' native biodiversity as an overriding goal, and restricts further alteration of islands to actions that are compatible with maintenance of the natural values of the islands.
- 5) Support acquisition of islands by the state or conservation organizations, and provide protective designations for publicly owned islands, concentrating first on those islands indicated above (1) and 3)) as high priorities for protection.
- 6) Develop management plans that integrate human uses with maintenance of island ecosystem integrity and all the natural values of the islands.
- 7) Hold fast on further development of island shorelines, and consider declaring island shores a public resource, such that private ownership would revert to the state at the end of current owners' lifetimes.
- 8) Prevent introduction of invasive exotic species to islands.
- 9) Initiate and participate in interstate, regional, and international planning for island conservation.

A serious commitment to the endurance of this globally unique heritage would be evidenced by a policy that treated all the islands as a group within an invaluable land- and water-scape. Because many of the islands are relatively undisturbed at present, and because of their discrete and unique nature, islands offer possibilities to *anticipate and prevent* loss of biodiversity and ecosystem integrity. In this way, the need for future restoration can be short-circuited by protecting intact functioning systems before they are degraded.

INTRODUCTION TO THE BIBLIOGRAPHY

References to published literature and unpublished reports on various aspects of the biology of Michigan's Great Lakes Islands are compiled in the annotated bibliography appending this report (Appendix C). The bibliography was composed in a computerized database to facilitate additions as more references are produced or gathered, and to facilitate easy retrieval of references by subjects. Thus, this document is expected to remain a dynamic, updated bibliography.

While gathering references for this bibliography, it quickly became apparent that the literature on Isle Royale would swamp all other references if all were included. It was also learned that Isle Royale National Park maintains updated bibliographies of all research completed in the park, also on computer files. Thus, the decision was made to include only selected references on Isle Royale. Three bibliographies with extensive references on Isle Royale are referenced in this bibliography (Keough, *et al.* 1981, National Park Service 1985, U. S. Man and Biosphere Program 1985). Most recently, references on Isle Royale were compiled for a U.S. Man and the Biosphere Program report (1985). This two volume set of reports is particularly useful because the first volume gives a thorough history of scientific studies on Isle Royale. The second volume is an annotated bibliography. The Isle Royale references included here were selected by these criteria:

- a) comprehensive inventories of some group of organisms, or a particular section of the island or park.
- b) representative or summary papers in a series of research papers by a particular author, or from a particular long-term research project.

- c) results of research projects on subjects peculiar to island biology (*e.g.*, invasions, island biogeography, *etc.*)

The references provided here will provide good leads to similar literature through their bibliographies. In a few cases, sources with especially good reference lists are so noted in the abstract.

Appendix C contains the complete annotated bibliography. References are arranged alphabetically by author, with sequential record numbers. Appendix D comprises lists of references by subject. References are given only as record numbers, which correspond to those in the complete bibliography (Appendix C).

ACKNOWLEDGEMENT'S

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APPENDIX A

**Element Occurrences on Michigan Great Lakes Islands:
Species of endangered, threatened and rare plants and animals,
types of exemplary natural communities,
an other notable natural features**

...the first of these is the fact that the ...

...the second is the fact that the ...

...the third is the fact that the ...

...the fourth is the fact that the ...

...the fifth is the fact that the ...

...the sixth is the fact that the ...

...the seventh is the fact that the ...

...the eighth is the fact that the ...

...the ninth is the fact that the ...

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...the eleventh is the fact that the ...

...the twelfth is the fact that the ...

...the thirteenth is the fact that the ...

...the fourteenth is the fact that the ...

...the fifteenth is the fact that the ...

...the sixteenth is the fact that the ...

...the seventeenth is the fact that the ...

...the eighteenth is the fact that the ...

...the nineteenth is the fact that the ...

...the twentieth is the fact that the ...

APPENDIX A Element occurrences on Michigan Great Lakes Islands: species of endangered, threatened and rare plants and animals, types of exemplary natural communities, and other notable natural features.

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
ALCONA				
BLACK RIVER ISLAND	PHALACROCORAX AURITUS STERNA CASPIA			
ALGER				
AU TRAIN ISLAND	HALIAETUS LEUCOCEPHALUS		EMPETRUM NIGRUM PINGUICULA VULGARIS	
GRAND ISLAND	HALIAETUS LEUCOCEPHALUS FALCO PEREGRINUS	GREAT LAKES MARSH MESIC NORTHERN FOREST	CRATAEGUS DOUGLASII CRYPTOGRAMMA STELLERI	GREAT BLUE HERON ROOKERY
WILLIAMS ISLAND				
WOOD ISLAND	HALIAETUS LEUCOCEPHALUS			
ALPENA				
BIRD ISLAND				GREAT BLUE HERON ROOKERY
GULL ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX			GREAT BLUE HERON ROOKERY
GRASS ISLAND	NYCTICORAX NYCTICORAX			
MIDDLE ISLAND			CAREX CONCINNA	
SCARECROW ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX STERNA HIRUNDO			GREAT BLUE HERON ROOKERY
SULPHUR ISLAND	HALIAETUS LEUCOCEPHALUS			
THUNDER BAY ISLAND	STERNA CASPIA STERNA HIRUNDO	BOREAL FOREST BEDROCK BEACH	TRICHOSTEMA BRACHIATUM PINGUICULA VULGARIS CRATAEGUS DOUGLASII CAREX SCIRPOIDEA IRIS LACUSTRIS CALYPSO BULBOSA CYPRIPEDIUM ARIETINUM	

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
AREMAC				
BIG CHARITY ISLAND	SISTRURUS CATENATUS CATENATUS MICROPHORUS AMERICANUS		CIRSIIUM PITCHERI	
LITTLE CHARITY ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX			GREAT BLUE HERON ROOKERY
RAY				
CHANNEL-SHELTER DIKE	NYCTICORAX NYCTICORAX STERNA CASPIA STERNA HIRUNDO STERNA FORSTERI			
CHARLEVOIX				
BEAVER ISLAND	GAVIA IMMER CHARADRIUS MELODUS PAPAIPENA AWEWE TRIMERTROPIS HURONIANA STAGNICOLA CONTRACTUS	BOG INTERDUNAL WETLAND BOREAL FOREST	CIRSIIUM PITCHERI TANACEETUM PITCHERI DROSER A ANGLICA PINGUICULA VULGARIS EPILOBIUM PALUSTRE OROBANCHE FASCICULATA LITTORELLA AMERICANA RANUNCULUS CYMBALARIA MIMULUS GLABRATUS VAR MICHIGANENSIS CAREX CONCINNA SCIRPUS TORREYI IRIS LACUSTRIS CALYPSO BULBOSA CYPRIPEDIUM ARIETINUM BROMUS POMPELLIANUS	
GARDEN ISLAND	STERNA HIRUNDO		CIRSIIUM PITCHERI SOLIDAGO HOUGHTONII TANACEETUM HURONENSE PINGUICULA VULGARIS ADLUMILA FUNGOSA CALYPSO BULBOSA	GREAT BLUE HERON ROOKERY
GRAPE ISLAND	STERNA HIRUNDO PHALACROCORAX AURITUS			
GULL ISLAND	PHALACROCORAX AURITUS			GREAT BLUE HERON ROOKERY

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
CHARLEVOIX continued HAT ISLAND	PHALACROCORAX AURITUS STERNA CASPIA			GREAT BLUE HERON ROOKERY
HIGH ISLAND	CHARADRIUS MELODUS STERNA CASPIA STERNA HIRUNDA	BOREAL FOREST OPEN DUNES COBBLE BEACH SAND/GRAVEL BEACH	CIRSIIUM PITCHERI TANACETUM HURONENSE STELLARIA LONGIPES OROBANCHE FASCICULATA	
HOG ISLAND	TRIMOTROPIS HURONIANA	RICH CONIFER SWAMP INTERDUNAL WETLAND DRY-MESIC NORTHERN FOREST	CIRSIIUM PITCHERI SOLIDAGO HOUGHTONII TANACETUM HURONENSE	
HORSESHOE ISLAND	STERNA HIRUNDO		CIRSIIUM PITCHERI	
PISMIRE ISLAND	PHALACROCORAX AURITUS			
SHOE ISLAND	STERNA CASPIA			
SNAKE ISLAND	STERNA HIRUNDO			
SQUAW ISLAND				
TIMS ISLAND				
WHISKEY ISLAND	CHARADRIUS MELODUS		TANACETUM HURONENSE	GREAT BLUE HERON ROOKERY
CHIPPEWA				
BASS REEF	STERNA HIRUNDO			
BELLEVUE ISLAND		BOREAL FOREST		
BLM ISLANDS #16-17	STERNA HIRUNDO			
BLM ISLAND #59 (Albany Bay)			PINGUICULA VULGARIS	
BLM ISLAND #91	STERNA HIRUNDO			
BLM ISLAND #108			CAREX SCIRPOIDEA	
BLM ISLAND #109		BEDROCK BEACH GREAT LAKES MARSH		

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
CHIPPENAW continued				
BOUNDARY ISLAND	STERNA HIRUNDO			
BURNT ISLAND	PANDION HALIAETUS			
BURNT ISLAND REEF	STERNA HIRUNDO			
BUTTERFIELD ISLAND	HALIAETUS LEUCOCEPHALUS			
CEDAR ISLAND	PANDION HALIAETUS			GREAT BLUE HERON ROOKERY
CROW ISLAND			TANACETUM HURONENSE	
DRUMMOND ISLAND	PANDION HALIAETUS	GREAT LAKES MARSH	CIRSIUM HILLII	SILURIAN EARTH HISTORY
	HALIAETUS LEUCOCEPHALUS	BOREAL FOREST	SOLIDAGO HOUGHTONII	GREAT BLUE HERON ROOKERY
	STERNA HIRUNDO	BEDROCK BEACH	PTEROSPORA ANDROMEDEA	
	CANIS LUPUS	ALVAR	ASTRAGALUS NEGLECTUS	
			SCUTELLARIA PARVULA	
			TRICHOSTEMA BRACHYLATUM	
			ADLUMIA FUNGOSA	
			GEUM TRIFLORUM	
			CAREX CONGINNA	
			CAREX PALLESCENS	
			CAREX RICHARDSONII	
			CAREX SCIRPOIDEA	
			ELEOCHARIS COMPRESSA	
			IRIS LACUSTRIS	
			CALYPSO BULBOSA	
			CYPRIPEDIUM ARIETINUM	
			PIPERIA UNALASCENSIS	
			POA ALPINA	
			SPOROBOLUS HETEROLEPIS	
			TRISTEMUM SPICATUM	
			PELLAEA ATROPURPUREA	
			ASPLENIUM VIRIDE	
			GYMNOCARPIMUM ROBERTIANUM	
DUCK ISLAND	STERNA HIRUNDO			
ESPANORE ISLAND	HALIAETUS LEUCOCEPHALUS			
FRYING PAN ISLAND	STERNA HIRUNDO			
GARDEN ISLAND		BOREAL FOREST		
GEM ISLAND				GREAT BLUE HERON ROOKERY

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
CHIPPENAW continued				
GLUE ISLAND (? E. shore Sugar Isl.)				GREAT BLUE HERON ROOKERY
GRAVEL ISLAND				GREAT BLUE HERON ROOKERY
HARBOR ISLAND	HALIAETUS LEUCOCEPHALUS		TANACETUM HURONENSE	
HARBOR ISLAND REEF	STERNA HIRUNDO			
HOG ISLAND	TRIMETROPIS HURONIANA	DRY MESIC NORTHERN FOREST INTERDUNAL WETLAND RICH CONIFER SWAMP	CIRSIUM PITCHERI SOLIDAGO HOUGHTONII TANACETUM HURONENSE	
IROQUOIS ISLAND				GREAT BLUE HERON ROOKERY
LIME ISLAND	PANDION HALIAETUS			
LITTLE CASS ISLAND	STERNA HIRUNDO			
LOVE ISLAND	HALIAETUS LEUCOCEPHALUS			GREAT BLUE HERON ROOKERY
MIDDLE NEEBISH CHANNEL DIKE	STERNA HIRUNDO			
MOON ISLAND (1 of 4)				
MUNUSCONG ISLAND				GREAT BLUE HERON ROOKERY
NAOMIKONG ISLAND	STERNA HIRUNDO			GREAT BLUE HERON ROOKERY
NEEBISH ISLAND	STERNA HIRUNDO ALGES ALGES			
PECK ISLAND	HALIAETUS LEUCOCEPHALUS			
PILOT ISLAND	PANDION HALIAETUS			
ROCK ISLAND				GREAT BLUE HERON ROOKERY
ROUND ISLAND (St. Marys River)				GREAT BLUE HERON ROOKERY
SADDLEBAG ISLAND				GREAT BLUE HERON ROOKERY
SAND ISLAND	PANDION HALIAETUS			
SIX MILE POINT ISLAND	STERNA HIRUNDO			
		GREAT LAKES MARSH		
			CALYPSO BULBOSA	
				GREAT BLUE HERON ROOKERY
				GREAT BLUE HERON ROOKERY
				GREAT BLUE HERON ROOKERY

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
CHIPPWA continued				
STEAMBOAT ISLAND	STERNA HIRUNDO			
STRAWBERRY ISLAND (BLM #75)			CAREX CONGINNA CIRSIIUM FITCHERI SOLIDAGO HOUGHTONII	
SUGAR ISLAND	PANDION HALIAETUS STERNA HIRUNDO SOREX FUMEUS HALIAETUS LEUCOCEPHALUS	BOG GREAT LAKES MARSH	TANACETUM HURONENSE JUNCUS VASEYI ELYMUS GLAUCUS	
SWEETS ISLAND (W.)	STERNA HIRUNDO			
WATSON REEF RUINS	STERNA HIRUNDO			
DELTA				
FORD RIVER ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX			
GRAVELLY ISLAND	PHALACROCORAX AURITUS STERNA CASPIA			
LITTLE GULL ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX			
LITTLE SUMMER ISLAND	HALIAETUS LEUCOCEPHALUS			
POVERTY ISLAND			CAREX RICHARDSONII IRIS LACUSTRIS	
ROCKY ISLAND	PHALACROCORAX AURITUS			
ROUND ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX			GREAT BLUE HERON ROOKERY
SNAKE ISLAND	PHALACROCORAX AURITUS			
ST. MARTIN ISLAND			ADLUMIA FUNGOSA CALYPSO BULBOSA	
ST. VITAL ISLAND	NYCTICORAX NYCTICORAX STERNA HIRUNDO			GREAT BLUE HERON ROOKERY

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
DELTA continued				
SUMMER ISLAND			TANACETUM HURONENSE ADLUMIA FUNGOSA CAREX CONCINNA CRYPTOGRAMMA STELLERI IRIS LACUSTRIS	
EMMETT				
TEMPERANCE ISLAND (E.)	CHARADRIUS MELODUS			
TEMPERANCE ISLAND (W.)	STERNO HIRUNDO			
MAUGOSEANCE ISLAND				GREAT BLUE HERON ROOKERY
GRAND TRAVERSE				
MARION ISLAND (=Power)	HALIAEETUS LEUCOCEPHALUS	MESIC NORTHERN FOREST		
HOUGHTON				
TRAVERSE ISLAND	PHALACROCORAX AURITUS HALIAEETUS LEUCOCEPHALUS			GREAT BLUE HERON ROOKERY
HURON				
DEFOE ISLAND (=N. Mineshas)	STERNA HIRUNDO			
HEISTERMAN ISLAND (=Stony)	HALIAEETUS LEUCOCEPHALUS SISTRURUS CATENATUS CATENATUS	LAKEPLAIN OAK OPENINGS		GREAT BLUE HERON ROOKERY
LONE TREE ISLAND	STERNA HIRUNDO			
MANISOU ISLAND	STERNA FORSTERI	GREAT LAKES MARSH LAKEPLAIN OAK OPENINGS		
MIDDLE GROUNDS (=Katechay)		GREAT LAKES MARSH		
NORTH ISLAND	SISTRURUS CATENATUS CATENATUS			

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KENNEBEC				
AMYGDALOID ISLAND	GAVIA IMMER		RIBES OXYACANTHOIDES POTENTILLA PENNSYLVANICA CRYPTOGRAMMA ACROSTICHOIDES	
BAILEY ISLAND			CRYPTOGRAMMA ACROSTICHOIDES	
BAT ISLAND			DRABA ARABISANS SAGINA NODOSA POTENTILLA PENNSYLVANICA SAXIFRAGA TRICUSPIDATA	
BELLE ISLE			DRABA ARABISANS CLEMATIS OCCIDENTALIS	
BIRCH ISLAND			CASTILLEJA SEPTENTRIONALIS BECKMANNIA SYZIGACHNE	
BLM ISLAND #008			DANTHONIA INTERMEDIA	
BLM ISLAND #018			DRABA ARABISANS	
BLM ISLAND #019			DANTHONIA INTERMEDIA	
BOTTLE ISLAND				GREAT BLUE HERON ROOKERY
BURNT ISLAND				GREAT BLUE HERON ROOKERY
CAPTAIN KIDD ISLAND			PHACELIA FRANKLINII SALIX PLANIFOLIA	
CORK ISLAND			RIBES OXYACANTHOIDES	
DAVIDSON ISLAND	GAVIA IMMER		VIBURNUM EDULE POA ALPINA TRisetum SPICATUM	
DEAD HORSE ROCKS			SALIX PLANIFOLIA	
EAST CARIBOU ISLAND			LONICERA INVOLUCRATA	

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KEMERMAN continued EDWARDS ISLAND			<p>OPLOPANAX HORRIDUS EMPETRUM NIGRUM VACCINIUM ULIGINOSUM PINGUICULA VULGARIS SAXIFRAGA TRICUSPIDATA CASTILLEJA SEPTENTRIONALIS EUPHRASIA ARCTICA CAREX ATRATIFORMIS TOFIELDIA PUSILLA POA ALPINA</p> <p>RIBES OXYACANTHOIDES</p> <p>SALIX PELLITA</p> <p>DRABA ARABISANS RIBES OXYACANTHOIDES</p> <p>DRABA INCANA SALIX PLANIFOLIA</p> <p>SAXIFRAGA TRICUSPIDATA</p> <p>OSMORHIZA DEPAUPERATA OPLOPANAX HORRIDUS ASTER MODESTUS LACTUCA PULCHELLA SENECIO INDECORUS DRABA ARABISANS SUBULARIA AQUATICA ARENARIA MACROPHYLLA SAGINA NODOSA CALLITRICHHE HERMAPHRODITICA LONICERA INVOLUCRATA VIBURNUM EDULE DROSERIA ANGLICA EMPETRUM NIGRUM VACCINIUM CESPITOSUM VACCINIUM ULIGINOSUM</p>	<p>GREAT BLUE HERON ROOKERY</p> <p>EARLY PRECAMBRIAN EARTH HISTORY EXTRUSIVE IGNEOUS FEATURE GREAT BLUE HERON ROOKERY TILTED BEDROCK</p>
FLAG ISLAND				
GALE ISLAND	GAVIA IMMER			
GREEN ISLAND				
GREENSTONE ISLAND				
GULL ISLANDS				
HAT ISLAND	HALIAETUS LEUCOCEPHALUS			
HAWK ISLAND				
HERON ISLAND				
ISLE ROYALE	<p>PSEUDACRIS TRISERIATA MACULATA GAVIA IMMER PANDION HALIAETUS HALIAETUS LEUCOCEPHALUS COREGONUS BARTLETTII CANIS LUPUS FELIS LYNX ALCES ALCES LYCAEIDES IDAS NABOKOVI</p>			

COUNTRY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KENEKAW continued				
ISLE ROYALE continued			RIBES OXYACANTHOIDES MYRIOPHYLLUM ALTERNIFLORUM PHACELIA FRANKLINII PINGUICULA VULGARIS NYMPHEA TETRAGONA EPILOBIUM PALUSTRE POLYGONUM VIVIPARUM CLEMATIS OCCIDENTALIS RANUNCULUS MACOUNII RANUNCULUS RHOMBOIDEUS CRATAEGUS DOUGLASII POTENTILLA PENNSYLVANICA SALIX PLANIFOLIA PARNASSIA PALUSTRIS SAXIFRAGA PANICULATA SAXIFRAGA TRICUSPIDATA CASTILLEJA SEPTENTRIONALIS COLLINSIA PARVIFLORA EUPHRASIA ARCTICA CAREX ATRATIFORMIS CAREX MEDIA LUZULA PARVIFLORA ALLIUM SCHOENOPRASUM TOFIELDIA PUSILLA AMERORCHIS ROTUNDIFOLIA CALYPSO BULBOSA CYPRIPEDIUM ARIETINUM LISTERA AURICULATA CALAMAGROSTIS LACUSTRIS POA ALPINA POA CANBYI TRisetum SPICATUM CRYPTOGRAMMA ACROSTICHOIDES LYCOPodium SELAGO	
JOHNSON ISLAND				
LITTLE SISKIWIIT ISLAND				
				RIBES OXYACANTHOIDES VIBURNUM EDULE

COUNTRY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KIRIBATI continued				
MANITOU ISLAND	HALIAETUS LEUCOCEPHALUS		OSMORHIZA DEPAUPERATA ARNICA CORDIFOLIA DRABA ARABISANS ARENARIA MACROPHYLLA SAGINA NODOSA LITTORELIA AMERICANA CASTILLEJA SEPTENTRIONALIS VIOLA EPIPSILA DRYOPTERIS FILIX-MAS	
MIRONG ISLAND			SALIX PLANIFOLIA SAXIFRAGA TRICUSPIDATA	
MOTT ISLAND			OSMORHIZA DEPAUPERATA SENECIO INDECORUS BRAYA HUMILIS LONICERA INVOLUCRATA VIBURNUM EDULE DROSERA ANGLICA EMPETRUM NIGRUM VACCINIUM ULIGINOSUM RIBES OXYACANTHOIDES PINGUICULA VULGARIS CLEMATIS OCCIDENTALIS POTENTILLA PENNSYLVANICA PARNASSIA PALUSTRIS SAXIFRAGA PANICULATA CASTILLEJA SEPTENTRIONALIS CAREX ATRATIFORMIS CAREX MEDIA CALYPSO BULBOSA LISTERA AURICULATA CRYPTOGRAMMA ACROSTICHOIDES	
NET ISLAND			RIBES OXYACANTHOIDES POTENTILLA PENNSYLVANICA	GREAT BLUE HERON ROOKERY
NORTH GOVERNMENT ISLAND			OPIOPANAX HORRIDUS DRABA ARABISANS SAGINA NODOSA EMPETRUM NIGRUM VACCINIUM ULIGINOSUM PINGUICULA VULGARIS	

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KENNEBEC continued				
NORTH GOVERNMENT ISLAND continued			SAXIFRAGA TRICUSPIDATA TOFIELDIA PUSILLA POA ALPINA	
OUTER HILL ISLAND			CAREX ATRATIFORMIS SAGINA NODOSA SAXIFRAGA TRICUSPIDATA	
PASSAGE ISLAND			OPLOPANAX HORRIDUS SENECIO INDECORUS DRABA ARABISANS DRABA GLABELLA DRABA INCANA SAGINA NODOSA VIBURNUM EDULE DROSER A NGLICA EMPETRUM NIGRUM VACCINIUM ULIGINOSUM PINGUICULA VULGARIS POLYGONUM VIVIPARUM RANUNCULUS MACOUNII SAXIFRAGA PANICULATA SAXIFRAGA TRICUSPIDATA CAREX MEDIA CASTILLEJA SEPTENTRIONALIS CAREX ATRATIFORMIS LUZULA PARVIFLORA ALLIUM SCHOENOPRASUM TOFIELDIA PUSILLA BECKMANNIA SYZIGACHNE POA ALPINA TRisetum SPICATUM CRYPTOGRAMMA STELLERI DRYOPTERIS EXPANSA LYCOPodium SELAGO	
PORTER ISLAND			OPLOPANAX HORRIDUS	
PORTERS ISLAND			DANTHONIA INTERMEDIA	
RABBIT ISLAND	GAVIA IMMER			

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
KAWAHAU continued RASPBERRY ISLAND			SENECCIO INDECORUS SAGINA NODOSA PINGICULA VULGARIS POTENTILLA PENNSYLVANICA CAREX MEDIA POA ALPINA DRYOPTERIS EXPANSA	
ROCK HARBOR LIGHTHOUSE			PHACELIA FRANKLINII VACCINIUM ULIGINOSUM	
ROCKY ISLET				
SILVER ISLE		BEDROCK BEACH	CAREX ROSSII TRISETUM SPICATUM	
SMITHWICK ISLAND			OPLOPANAX HORRIDUS SAGINA NODOSA LONICERA INVOLUCRATA VIBURNUM EDULE VACCINIUM VITIS-IDAEA RIBES OXYACANTHOIDES POLYGONUM VIVIPARUM CASTILLEJA SEPTENTRIONALIS CALYPSO BULBOSA DRYOPTERIS EXPANSA	
SOUTH GOVERNMENT ISLAND			OPLOPANAX HORRIDUS DRABA ARABISANS	GREAT BLUE HERON ROOKERY
WASHINGTON ISLAND			POLYGONUM VIVIPARUM RANUNCULUS MACOUNII DRYOPTERIS EXPANSA	
WEST CARIBOU ISLAND			ANTENNARIA ROSEA PHACELIA FRANKLINII CALYPSO BULBOSA LYCOPODIUM SELAGO	GREAT BLUE HERON ROOKERY

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
LEKLAWAU				
NORTH FOX ISLAND	TRIMERTROPIS HURONIANA	LANDSCAPE COMPLEX NORTHERN SWAMP MESIC NORTHERN FOREST BOREAL FOREST	CIRSIIUM PITCHERI TANACETUM HURONENSE ADLUMIA FUNGOSA CALYPSO BULBOSA BROMUS PUMPELLIANUS	
NORTH MANITOU ISLAND	GAVIA IMMER CHARADRIUS MELODUS		CIRSIIUM PITCHERI BROMUS PUMPELLIANUS BOTRYCHIUM CAMPESTRE	
SOUTH FOX ISLAND	HALIAEETUS LEUCOCEPHALUS FALCO PEREGRINUS CHARADRIUS MELODUS	MESIC NORTHERN FOREST BOREAL FOREST OPEN DUNES SAND/GRAVEL BEACH	PANAX QUINQUEFOLIUS CIRSIIUM PITCHERI TANACETUM HURONENSE OROBANCHE FASCICULATA BROMUS PUMPELLIANUS ASPLENIUM VIRIDE BOTRYCHIUM CAMPESTRE	
SOUTH MANITOU ISLAND		MESIC NORTHERN FOREST BOREAL FOREST OPEN DUNES PERCHED DUNES	PANAX QUINQUEFOLIUS CIRSIIUM PITCHERI OROBANCHE FASCICULATA OROBANCHE FASCICULATA CALYPSO BULBOSA CYPRIPEDIUM ARIETINUM BROMUS PUMPELLIANUS CAMPTOSORUS RHIZOPHYLLUS ASPLENIUM VIRIDE BOTRYCHIUM CAMPESTRE	CHAMPION TREE
MACKINAC				
BIG ST. MARTIN ISLAND				GREAT BLUE HERON ROOKERY
BOIS BLANC ISLAND	GAVIA IMMER PANDION HALIAETUS HALIAEETUS LEUCOCEPHALUS STERNA FORSTERI SISTRURUS CATENATUS CATENATUS	MESIC NORTHERN FOREST	CACALIA PLANTAGINEA CIRSIIUM PITCHERI SOLIDAGO HOUGHTONII TANACETUM HURONENSE PINGUICULA VULGARIS ADLUMIA FUNGOSA CRATAEGUS DOUGLASII CAREX CONCINNA IRIS LACUSTRIS CALYPSO BULBOSA CYPRIPEDIUM ARIETINUM	

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
MACKINAC continued				
CROW ISLAND				
EPOUFETTE ISLAND	STERNA HIRUNDO			GREAT BLUE HERON ROOKERY
GOOSE ISLAND	PHALACROCORAX AURITUS NYCTICORAX NYCTICORAX STERNA CASPIA STERNA HIRUNDO			GREAT BLUE HERON ROOKERY GREAT BLUE HERON ROOKERY
GREEN ISLAND	NYCTICORAX NYCTICORAX			
LASALLE ISLAND			CALLITRICHE HERMAPHERODITICA ADLUMIA FUNGOSA	
LITTLE HOG ISLAND				GREAT BLUE HERON ROOKERY
LITTLE LASALLE ISLAND			IRIS LACUSTRIS CALYPSO BULBOSA	
LITTLE ST. MARTIN (=St. Martin Shoal)	PHALACROCORAX AURITUS		TANACETUM HURONENSE	
MACKINAC ISLAND			DRABA ARABISANS PTEROSPORA ANDROMEDEA PINGUICULA VULGARIS ADLUMIA FUNGOSA CALYPSO BULBOSA	DEVONIAN EARTH HISTORY ABANDONED SHORELINE MISCELLANEOUS ANCIENT COASTAL FEATURE
MARQUETTE ISLAND	PANDION HALIAETUS HALIAETUS LEUCOCEPHALUS	GREAT LAKES MARSH	SOLIDAGO HOUGHTONII IRIS LACUSTRIS	
NAUBINWAY ISLAND	PHALACROCORAX AURITUS			
ROUND ISLAND			IRIS LACUSTRIS CALYPSO BULBOSA	
ROVER ISLAND			DRABA ARABISANS CALYPSO BULBOSA	
SNAKE ISLAND		INTERDUNAL WETLAND COBBLE BEACH	CACALIA PLANTAGINEA SOLIDAGO HOUGHTONII IRIS LACUSTRIS	

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
MACINTAC continued				
ST. HELENA ISLAND	HALIAEETUS LEUCOCEPHALUS		TANACETUM HURONENSE MIMULUS GLABRATUS VAR JAMESII	GREAT BLUE HERON ROOKERY
ST. MARTIN ISLAND	HALIAEETUS LEUCOCEPHALUS STERNA HIRUNDO			
MARQUETTE				
MACINTYRE ISLAND (=E. Huron)	HALIAEETUS LEUCOCEPHALUS			GREAT BLUE HERON ROOKERY
HURON ISLAND (=Lighthouse)	FALCO PEREGRINUS		DRYOPTERIS FILIX-MAS	
PARTRIDGE ISLAND	HALIAEETUS LEUCOCEPHALUS		TRISETUM SPICATUM	
PICNIC ROCKS (BLM #6-8)				
MONROE				
UNNAMED ISLAND	STERNA HIRUNDO			
WATERMAN ISLAND			PLATANATHERA LEUCOPHAEA	
ST CLAIR				
DICKINSON ISLAND	HALIAEETUS LEUCOCEPHALUS RALLUS ELEGANS STERNA HIRUNDO	GREAT LAKES MARSH LAKEPLAIN WET PRAIRIE LAKEPLAIN OAK OPENINGS	PLATANATHERA LEUCOPHAEA	GREAT BLUE HERON ROOKERY
GREEN ISLAND	STERNA FORSTERI			
HARSENS ISLAND	CLEMMYS GUTTATA ELAPHE VULPINA GLOYDI STERNA FORSTERI STERNA HIRUNDO RALLUS ELEGANS	LAKEPLAIN WET PRAIRIE LAKEPLAIN WET-MESIC PRAIRIE	ASCLEPIAS SULLIVANTII CIRSIMUM HILLII FIMBRISTYLIS PUBERULA PANICUM LEIBERGII PLATANATHERA LEUCOPHAEA POLYGALA INCARNATA SCLERIA TRIGLOMERATA TRIPLASIS PURPUREA	
MIDDLE ISLAND	STERNA FORSTERI			

COUNTY & ISLAND	ANIMAL	COMMUNITY	PLANT	OTHER
ST. CLAIR continued				
ST. CLAIR RIVER DELTA	STERNA FORSTERI			
WAYNE				
BELLE ISLE	STERNA HIRUNDO STERNA FORSTERI CYCLONAIAS TUBERCULATA DYSNOMIA SULCATA DELICATA DYSNOMIA TORULOSA RANGLANA DYSNOMIA TRIQUETRA OBOVARIA SUBROTUNDA SIMPSONICORCHA AMBIGUA VILLOSA FABALIS		ARISTOLOCHIA SERPENTARIA EUPHORBIA COMMUTATA STROPHOSTYLES HELVULA ROSA SETIGERA CAREX FRANKII CAREX HYALINOLEPIS SISYRINGHIUM HASTILE ZIZANIA AQUATICA VAR AQUATICA SMILAX HERBACEA	
GRASSY ISLAND	STERNA HIRUNDO			
GROSSE ISLE	ELAPHE VULPINA GLOYDI			CHAMPION TREE CHAMPION TREE CHAMPION TREE
POWDER HOUSE ISLAND	STERNA HIRUNDO			
ROUND ISLAND		MESIC SOUTHERN FOREST		
STONY ISLAND	DYSNOMIA TORULOSA RANGLANA ELAPHE VULPINA GLOYDI CYCLONAIAS TUBERCULATA DYSNOMIA TRIQUETRA LAMPISILIS FASCIOLA OBOVARIA SUBROTUNDA			
SUGAR ISLAND	PERCINA COPELANDI			



APPENDIX B

**Status of Inventory of Natural Features
on Michigan's Great Lakes Islands**

APPENDIX

Appendix 1: Interview Schedule

Appendix 1.1: Interview Schedule

APPENDIX B: Status of inventory of natural features on Michigan's Great Lakes islands.

COUNTY	GREAT LAKE ²	ISLAND NUMBER ³	ISLAND NAME	EOs? ⁴	SURVEYS? ¹				COL ⁵
					A	P	C	G	
Alcona	HU	010001	Black River	Y	Y	Y			Y
Alger	SU	020005	Au Train	Y					Y
Alger	SU	020002	Grand Island	Y	Y	Y	Y	Y	Y
Alger	SU	020003	Williams	Y					Y
Alger	SU	020004	Wood	Y					Y
Alpena	HU	040001	Bird	Y	Y	Y		Y	Y
Alpena	HU	040004	Grass	Y			Y	Y	Y
Alpena	HU	040010	Gull	Y	Y		Y	Y	Y
Alpena	HU	040011	Middle	Y					
Alpena	HU	040002	Scarecrow	Y					Y
Alpena	HU	040008	Sugar						Y
Alpena	HU	040003	Sulphur	Y					Y
Alpena	HU	040009	Thunder Bay	Y	Y	Y			Y
Arenac	HU	060002	Big Charity	Y	Y	Y			Y
Arenac	HU		Gravelly Shoal						Y
Arenac	HU	060001	Little Charity	Y					Y
Bay	HU	090001	Gull						Y
Charlevoix	MI	150006	Beaver	Y	Y	Y	Y		
Charlevoix	MI	150005	Fisherman						Y
Charlevoix	MI	150013	Garden	Y	Y				
Charlevoix	MI		Grape	Y	Y	Y			Y
Charlevoix	MI	150008	Gull	Y	Y				Y
Charlevoix	MI	150003	Hat	Y	Y				Y
Charlevoix	MI	150009	High	Y	Y				Y
Charlevoix	MI	150004	Hog	Y	Y		Y		
Charlevoix	MI	150001	Horseshoe	Y					Y
Charlevoix	MI	150018	Pismire	Y					Y
Charlevoix	MI		Shoe	Y	Y				Y

¹SURVEYS? - "Y" indicates there have been surveys of animals (A), plants (P), natural communities (C) or geophysical features (G).

²Great Lakes: DE=Detroit River, ER=Erie, HU=Huron, MI=Michigan, SM=St Marys River, SC=Lake St Clair, SU=Superior.

³ISLAND NUMBER - number assigned by MI DNR island inventory.

⁴EOs? - "Y" indicates there are known occurrences of endangered, threatened or rare species, exemplary natural communities, or other significant natural features.

⁵COL - "Y" indicates occurrence of colonial bird nesting site.

APPENDIX B - continued

COUNTY	GREAT LAKE	ISLAND NUMBER	ISLAND NAME	EOs?	SURVEYS?				COL
					A	P	C	G	
Charlevoix	MI		Snake (Grass)	Y					Y
Charlevoix	MI	150014	Squaw	Y					Y
Charlevoix	MI	150002	Tims	Y	Y	Y			Y
Charlevoix	MI	150010	Trout						Y
Charlevoix	MI	150011	Whiskey	Y					Y
Chippewa	SM	170099	Advance		Y	Y			
Chippewa	SM	170046	Arrow						Y
Chippewa	HU		BLM#108	Y	Y	Y	Y		
Chippewa	HU		BLM#109	Y	Y	Y	Y		
Chippewa	SM		BLM#16-17	Y					Y
Chippewa	HU		BLM#59	Y	Y	Y	Y		
Chippewa	HU		BLM#75	Y	Y	Y	Y		
Chippewa	HU		BLM#91	Y					Y
Chippewa	HU		BLM#92		Y	Y	Y		
Chippewa	HU	170050	Bacon						Y
Chippewa	HU		Bass						Y
Chippewa	SM	170035	Bass Reef	Y					Y
Chippewa	HU	170007	Bellevue	Y					
Chippewa	HU	170021	Bootjack			Y			
Chippewa			Boundary	Y					Y
Chippewa	HU	170048	Bow						Y
Chippewa	HU	170076	Burnt	Y					Y
Chippewa	HU		Burnt Island Reef	Y					
Chippewa	SM	170054	Butterfield	Y					
Chippewa	SM	170070	Cedar	Y					Y
Chippewa	HU	170004	Crow	Y					Y
Chippewa	HU	170019	Drummond	Y	Y	Y	Y		Y
Chippewa	SM		Duck (Sugar)		Y	Y			
Chippewa	HU		Duck (Drummond)	Y					Y
Chippewa	HU	170020	Espanore	Y	Y	Y	Y		
Chippewa	HU	170010	Frying Pan	Y					Y
Chippewa	HU	170022	Garden	Y	Y	Y	Y		
Chippewa	SM	170101	Gem	Y	Y	Y			Y
Chippewa	HU	170029	Gravel	Y					Y
Chippewa	HU	170067	Harbor	Y	Y	Y	Y	Y	Y
Chippewa	HU		Harbor Island Reef	Y					Y
Chippewa	SM		Hog	Y		Y			
Chippewa	SU	170111	Iroquois	Y					Y
Chippewa	HU	170083	Jim		Y	Y			
Chippewa	SM	170032	Lime	Y					
Chippewa	HU	170016	Little Cass	Y	Y	Y	Y		Y
Chippewa	HU	170066	Little Rogg		Y	Y	Y	Y	
Chippewa	SM	170034	Love	Y					Y
Chippewa	HU	170053	Macomb						Y
Chippewa	SM		Mid Six-Mile Point	Y					Y
Chippewa	SM	170089	Moon (1 of 4)	Y	Y	Y			Y
Chippewa	SM	170086	Munuscong	Y	Y	Y			Y
Chippewa	SU	170112	Naomikong	Y					Y
Chippewa	SM	170094	Neebish	Y	Y				Y

APPENDIX B - continued

COUNTY	GREAT LAKE	ISLAND NUMBER	ISLAND NAME	EOs?	SURVEYS?				COL
					A	P	C	G	
Chippewa	HU		Peck	Y					
Chippewa	HU	170002	Peters				Y		Y
Chippewa	SM		Pilot	Y					
Chippewa	HU	170012	Pipe Is Twins			Y	Y		Y
Chippewa	HU		Propeller						Y
Chippewa	SM	170100	Rock	Y	Y	Y			Y
Chippewa	SM	170036	Round (Lime)	Y					Y
Chippewa	SU	170110	Round						Y
Chippewa	HU	170001	Saddlebag	Y	Y	Y		Y	Y
Chippewa	SM		Sand	Y					Y
Chippewa	SM	170087	Sand				Y		
Chippewa	SM		South Six-Mile Point	Y					Y
Chippewa	HU	170074	Spence			Y	Y		
Chippewa	HU	170013	Squaw			Y	Y		Y
Chippewa	SM		Steamboat	Y		Y			Y
Chippewa	HU		Strawberry	Y					Y
Chippewa	SM	170097	Sugar	Y	Y	Y	Y		Y
Chippewa	HU	170014	Sweets Islands	Y					Y
Chippewa	SU	170113	Tahquamenon						Y
Chippewa	SM	170039	Twin						Y
Chippewa	HU		Watson Reef Ruins	Y					Y
Chippewa	HU	170062	Wreck			Y	Y		
Delta	MI		Ford River	Y					Y
Delta	MI		Gravelly	Y		Y			Y
Delta	MI	210008	Little Gull	Y		Y			Y
Delta	MI	210005	Little Summer	Y	Y				
Delta	MI	210010	North Gull (=Big Gull)			Y			Y
Delta	MI	210007	Poverty	Y	Y	Y			Y
Delta	MI		Rocky	Y					Y
Delta	MI		Round	Y					Y
Delta	MI	210003	Snake	Y					Y
Delta	MI	210011	St Martin	Y		Y			
Delta	MI	210002	St Vital's	Y					Y
Delta	MI	210006	Summer	Y	Y	Y			
Emmet	MI		Ile aux Galets			Y	Y		Y
Emmet	MI	240004	Temperance (east)	Y					
Emmet	MI	240003	Temperance (west)	Y					Y
Emmet	MI	240001	Waugoshance	Y	Y	Y	Y	Y	Y
Grand Traverse	MI	280002	Marion	Y	Y	Y			
Houghton	SU	310001	Traverse	Y					Y
Huron	HU	320004	Katechay (Middle Grounds)	Y		Y			Y
Huron	HU	320006	Lone Tree	Y		Y			Y
Huron	HU	320017	Manisou	Y		Y			
Huron	HU	320005	N Mineshas (Defoe)	Y		Y			Y
Huron	HU	320002	North	Y					

APPENDIX B - continued

COUNTY	GREAT LAKE	ISLAND NUMBER	ISLAND NAME	EOs?	SURVEYS?				COL
					A	P	C	G	
Huron	HU	320003	Stony (Heisterman)	Y					Y
Keweenaw	SU		Amygdaloid	Y					Y
Keweenaw	SU		BLM#18	Y		Y			
Keweenaw	SU		BLM#19	Y		Y			
Keweenaw	SU		BLM#8	Y		Y			
Keweenaw	SU		Bailey	Y					
Keweenaw	SU		Bat	Y					Y
Keweenaw	SU		Belle	Y					
Keweenaw	SU		Birch	Y		Y			
Keweenaw	SU		Bottle	Y					Y
Keweenaw	SU		Burnt	Y					Y
Keweenaw	SU		Burnt						Y
Keweenaw	SU		Captain Kidd	Y					
Keweenaw	SU		Cork	Y					
Keweenaw	SU		Davidson	Y		Y			
Keweenaw	SU		Deadhorse Rocks	Y					
Keweenaw	SU		E Caribou		Y				
Keweenaw	SU		Edwards	Y		Y			
Keweenaw	SU		Flag	Y					
Keweenaw	SU		Gale	Y					
Keweenaw	SU		Green	Y					
Keweenaw	SU		Greenstone	Y					
Keweenaw	SU	420009	Gull	Y					Y
Keweenaw	SU		Gull Rock	Y					Y
Keweenaw	SU		Hat	Y					
Keweenaw	SU		Hawk	Y		Y			Y
Keweenaw	SU		Heron	Y		Y			
Keweenaw	SU	420006	Isle Royale	Y		Y	Y	Y	Y
Keweenaw	SU		Johnson	Y					
Keweenaw	SU	420014	Little Siskiwit	Y					
Keweenaw	SU		Long						Y
Keweenaw	SU		Mad	Y					
Keweenaw	SU	420005	Manitou	Y		Y	Y		Y
Keweenaw	SU	420012	Menagerie				Y		
Keweenaw	SU		Minong	Y					
Keweenaw	SU		Mott	Y		Y			Y
Keweenaw	SU		N Government	Y					
Keweenaw	SU		Net	Y		Y			Y
Keweenaw	SU		Outer Hill	Y					Y
Keweenaw	SU	420008	Passage	Y		Y			Y
Keweenaw	SU		Paul						Y
Keweenaw	SU		Porter	Y					
Keweenaw	SU	420007	Porters	Y		Y	Y		Y
Keweenaw	SU		Rabbit	Y					
Keweenaw	SU		Raspberry	Y		Y			
Keweenaw	SU	420010	Rock of Ages						Y
Keweenaw	SU		S Government	Y		Y			Y
Keweenaw	SU		Schooner						Y
Keweenaw	SU		Silver	Y		Y	Y		Y

APPENDIX B - continued

COUNTY	GREAT LAKE	ISLAND NUMBER	ISLAND NAME	EOs?	SURVEYS?				COL
					A	P	C	G	
Keweenaw	SU		Smithwick	Y					
Keweenaw	SU		W Caribou	Y	Y				Y
Keweenaw	SU		Washington	Y					
Leelanau	MI	450002	North Fox	Y	Y	Y	Y	Y	
Leelanau	MI	450005	North Manitou	Y	Y	Y	Y	Y	
Leelanau	MI	450003	South Fox	Y	Y		Y		
Leelanau	MI	450004	South Manitou	Y	Y	Y	Y	Y	Y
Mackinaw	HU	490010	Bear						Y
Mackinaw	HU	490029	Big St Martin	Y					
Mackinaw	HU	490001	Bois Blanc	Y	Y	Y	Y		Y
Mackinaw	HU	490009	Crow	Y					Y
Mackinaw	MI	490030	Epoufette	Y			Y		Y
Mackinaw	HU	490018	Goose	Y					Y
Mackinaw	MI	490047	Green	Y	Y				Y
Mackinaw	HU	490003	LaSalle	Y					
Mackinaw	MI	490032	Little Hog	Y					Y
Mackinaw	HU	490002	Little LaSalle	Y	Y	Y	Y	Y	
Mackinaw	HU		Little St Martin Shoal	Y		Y			Y
Mackinaw	HU	490026	Mackinac	Y			Y		
Mackinaw	HU	490058	Marquette	Y					
Mackinaw	MI	490033	Naubinway	Y					Y
Mackinaw	HU	490027	Round	Y		Y	Y		
Mackinaw	HU	490012	Rover	Y					
Mackinaw	HU		Snake	Y		Y	Y		
Mackinaw	MI	490025	St Helena	Y	Y	Y			Y
Mackinaw	HU	490028	St Martin	Y					Y
Marquette	SU		Garlic			Y	Y		
Marquette	SU		Huron	Y	Y		Y	Y	Y
Marquette	SU	520006	Larus		Y	Y			Y
Marquette	SU		McIntyre (East Huron)	Y	Y		Y	Y	Y
Marquette	SU	520001	Middle		Y	Y			Y
Marquette	SU	520007	Partridge	Y					
Marquette	SU	520004	Picnic Rocks (BLM#6-8)	Y	Y	Y			
Monroe	ER	580021	Unnamed island	Y			Y		Y
Monroe	ER		Waterman	Y			Y		
St Clair	SC	740002	Dickinson	Y	Y	Y	Y	Y	Y
St Clair	SC		Green	Y					Y
St Clair	SC	740001	Harsens	Y	Y	Y	Y	Y	Y
St Clair	SC		Middle	Y					Y
St Clair	SC		Strawberry						Y
Wayne	DE	820016	Belle Isle	Y	Y				Y
Wayne	DE	820013	Grassy	Y					Y
Wayne	DE	820012	Grosse Ile	Y		Y			
Wayne	DE	820014	Mud						Y

APPENDIX B - continued

COUNTY	GREAT LAKE	ISLAND NUMBER	ISLAND NAME	EOs?	SURVEYS?	
					A P C G	COL
Wayne	DE	820011	Powder House	Y		Y
Wayne	DE	820022	Round	Y		
Wayne	DE	820010	Stony	Y		Y
Wayne	DE	820006	Sugar	Y		

APPENDIX C

**Bibliography of Research on the Natural Features
of Michigan's Great Lakes Islands**

The first part of the report discusses the current state of the world economy and the impact of the global financial crisis. It highlights the challenges faced by many countries, particularly in the emerging markets, and the need for coordinated international action to address these issues.

The second part of the report focuses on the role of the International Monetary Fund (IMF) in providing financial assistance and technical support to member countries. It details the various programs and facilities available, as well as the conditions attached to these programs.

The third part of the report discusses the importance of strengthening macroeconomic and financial systems to ensure long-term growth and stability. It provides recommendations for policy reforms and capacity building in key areas such as fiscal management, monetary policy, and financial supervision.

The fourth part of the report addresses the need for improved data collection and reporting to support evidence-based decision-making. It outlines the requirements for high-quality data and the role of the IMF in providing technical assistance to improve data systems.

The final part of the report concludes with a summary of the key findings and recommendations, and a call for continued international cooperation and support for the global economic recovery.

APPENDIX C

Bibliography of Research on the Natural Features of Michigan's Great Lakes Islands

1. Adams, Charles C. 1909. Annotated list of certain Isle Royale invertebrates. pp 249-280 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections were made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905.
2. Adams, Charles C. 1909. The Coleoptera of Isle Royale, Lake Superior, and their relations to the North American centers of dispersal. pp 157-216 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: This is chapter 6 in the report on the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905. Topics covered were habitat relations of beetles, succession of beetle associations along the lake shore, in rock openings, in lakes and ponds, and in forests. The fauna was interpreted in relation to the geographic distribution of the North American beetle fauna and centers of dispersal. A list of beetles collected in 1905 with supplements from A. B. Wolcott was included.
3. Adams, Charles C. 1909. An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: The ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported. Descriptions of ecological settings and lists of plants and animals in their habitats were provided. This reference included many lists and studies by many researchers, which are often referred to by individual authors.
4. Adams, Charles C. 1909. The ecological succession of birds. pp 121-156 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: This was chapter 5 in the report on the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905. Topics included an overview of succession, avian environments, avian succession in various habitats, and a summary on principles of succession.
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Lake Superior. Lansing, MI: Michigan State Biological Survey.
(Mich. Biol. Surv. Report for 1908) 468 pp.

ABSTRACT: Observations made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.

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7. Albert, Dennis A., S. R. Crispin, G. Reese, L. A. Wilsmann and S. J. Ouwinga. 1987. A survey of Great Lakes marshes in Michigan's Upper Peninsula. Lansing, MI: Michigan Natural Features Inventory. Unpub. rept. for Land and Water Mgmt. Div., Mich. DNR. 73 pp.

ABSTRACT: Results of first year (1987) of Great Lakes marsh survey conducted by Michigan Natural Features Inventory and funded by a Michigan Coastal Zone Management grant. Includes aerial photo interpretation and field results for marshes from Upper Peninsula shoreline. Information gathered includes description of natural communities, abiotic factors, flora, observed fauna, and disturbances, both human and natural. Areas covered were in Lake Superior, northern Lake Huron, and St. Mary's River. Community and plant surveys generally adequate; animals surveys incidental. Islands visited were Hog, Sugar, and Sand Islands (St. Marys River, Chippewa Co.), Drummond Island and two Munuscong Lake Islands (Chippewa Co.), and islands at Rapid River - Whitefish River Delta (Delta Co.).
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ABSTRACT: This report summarizes the presettlement vegetation of the island and gives a description of the major vegetational zones, plant communities, and dominant species. The significance of the island as a Natural Area is presented: forests were virgin or essentially recovered, in a mature to overmature state, and considered top quality under MNFI ranking criteria; three exemplary natural community occurrences are noted. Research possibilities are indicated.
9. Albert, Dennis A., G. Reese, S. R. Crispin, M. R. Penskar, L. A. Wilsmann and S. J. Ouwinga. 1988. A survey of Great Lakes marshes in the southern half of Michigan's Lower Peninsula. Lansing, MI: Michigan Natural Features Inventory. Unpub. rept. for Land and Water Mgmt. Div., Mich. DNR. 116 pp.

ABSTRACT: This report covers results of 1988 field surveys and aerial photograph interpretation of Great Lakes marshes along the shores of the southern half of Michigan's Lower Peninsula. Information is presented on natural communities, fauna, flora, abiotic factors, and disturbances, both human and natural, along the shorelines and estuaries of Saginaw Bay, Lake St. Clair, Lake Erie and Lake Michigan. Community and flora descriptions are

generally adequate, but animal observations are incidental. Islands included are in Erie Marsh and Swan Creek Mouth (Monroe Co.), Dickinson and Harsen's Isl. (St. Clair Co.), Heisterman, Middle Channel, Manisou, Rose, and unnamed islands in Wildfowl Bay (Huron Co.).

10. Albert, Dennis A., G. Reese, M. R. Penskar, L. A. Wilsmann and S. J. Ouwinga. 1989. A survey of Great Lakes marshes in the northern half of Michigan's Lower Peninsula and throughout Michigan's Upper Peninsula. Lansing, MI: Michigan Natural Features Inventory. Unpub. rept. for Land and Water Mgmt. Div., Mich. DNR. 124 pp.
ABSTRACT: Results of the third year (1989) of Great Lakes marsh surveys conducted by Michigan Natural Features Inventory and funded by a Michigan Coastal Zone Management grant are presented. Report includes aerial photo interpretation and field results for estuarine marshes throughout the state. Information gathered includes description of natural communities, abiotic factors, flora, observed fauna, and disturbances, both human and natural. Areas covered were estuaries of Saginaw Bay, Lake Erie, Lake Huron, Lake Michigan, and Lake Superior. Islands visited were Marquette (Mack. Co.), Grand Island (Alger Co.); islands with vegetation zones delineated from air-photos include Crooked, Round and 3 other islands in Misery Bay (Alp. Co.), Goose Island (Mack. Co.), Epoufette Island (Mackinac Co.). Community and flora surveys were generally adequate for marshes. Faunal surveys were incomplete.
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ABSTRACT: Brief introduction and a list of plants "collected in flower or fruit during July and August, 1920" in the vicinity (mainland and islands) of Cedarville, Mackinac Co. [abstract from Voss 1963]
12. Allen, Durward L. 1979. *Wolves of Minong*. New York: Houghton Mifflin. 499 pp.
ABSTRACT: This volume summarized wolf ecology studies on Isle Royale from 1958 through 1975. It included descriptions of the principle researchers and their contributions.
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ABSTRACT: This philosophical discussion of the value of wilderness uses the author's many years of research on Isle Royale wolves and moose to illustrate some of these values.
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ABSTRACT: Hunting statistics and population survey results were reported.

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ABSTRACT: Hunting statistics and population survey results, as well as the history of these two species' populations on the island are reported.
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ABSTRACT: Manitoulin Isl., Ontario is compared to Drummond Isl. L. Schemenauer summarizes this comparison, including geology, geography, size, population, industries, snow depths, food conditions (for deer, winter browse), deer, hunting. The Canadian Island had better browse and healthier deer.
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ABSTRACT: A history of grouse on Michigan Islands is given. Grouse were introduced successfully on Beaver, Bois Blanc, and Drummond Island.
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ABSTRACT: A careful study of the beetle fauna of the Charity islands during 9 days in 1910 turned up 623 species. Habitat data was also noted. The list of species was given, but was thought to be incomplete due to the brief period of the study. Big Charity, at about 650 acres had the most varied habitats and consequently the richer beetle fauna.
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ABSTRACT: This report provides physical description of Gull Island, brief plant, mammal and bird lists.
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ABSTRACT: This draft design package provides detailed description of this island within a lake on Bois Blanc Island,

northern Lake Huron, MI. It includes lists and descriptions of natural communities, special plants and special animals. It also includes discussion of geology and pre-settlement ecology, as well as the present conditions, threats, and preserve boundary justifications. Maps include ownership, natural communities, and special features.

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ABSTRACT: In addition to information about deer on the island, this report gave some background on human use, lumbering, etc.
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ABSTRACT: This report described human use history, vegetation cover types, recreation and deer hunting history and potential.
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ABSTRACT: The author described the history of the deer herd between 1925 and 1948. The original forest understory vegetation and logging history were described briefly.
26. Bartlett, I. H. 1941. Manitou Island deer yards. Lansing, MI: Mich. Dept. Cons. (Game Division Report No. 600) 6 pp.
ABSTRACT: Condition of deer yards on North Manitou Island were described. Other wildlife were noted, and vegetation was described.
27. Bartlett, I. H. 1939-1967. North Manitou Island deer. Lansing, MI: Mich. Dept. Cons. (Game Division Reports Nos. 430, 658, 995, 2011, 2010, 2069, 2096, 2145, 2146, 2177, 2343, 2342, 2420, 2434, 2507, 2508) various pp.
ABSTRACT: This series of annual reports described the hunting take, health, reproduction and effects on vegetation of the North Manitou Island deer herd. The earliest report, 1939 notes that the deer herd began in 1925 with 9 planted deer, and by the report date was estimated at more than 700. The author stressed the need to prevent further increases in the herd because the vegetation was being browsed too heavily. A deer enclosure on the island showed that the deer had a major impact on the vegetation, including altering the forest tree composition to mostly beech.
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ABSTRACT: This description focused on the physical characteristics of the island, the history of human use and status of land. Forest types and lumbering history were described.

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ABSTRACT: Research was done out of the CMU Biological Station on Beaver Island
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ABSTRACT: A list of plants found from mid-July through mid-August at this site.
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ABSTRACT: This comprehensive book on waterfowl biology includes maps and discussions of important migration paths and breeding habitat of individual species. While Great Lakes islands are not explicitly discussed in most cases, some pathways and breeding areas clearly center on areas with islands known to have waterfowl breeding habitat.
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ABSTRACT: Research was completed out of CMU Biological Station on Beaver Island.
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36. Belovsky, Gary E. 1981. A possible population response of moose to sodium availability. *J. Mammal* 62: 631-3.
ABSTRACT: Aquatic plants supply sodium to moose. A population dynamics model based on sodium as the limiting factor was developed. The author suggested that overpopulation resulting in greatly reduced aquatic vegetation availability (and consequent sodium shortage) may have been the primary factor in moose population die-offs.
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ABSTRACT: A balance sheet for sodium losses and intakes was developed for moose at Isle Royale National Park, MI. This technique emphasized potential times of year and avenues of sodium loss that might be limiting. A mechanism for sodium storage was proposed that involves replacement of sodium in salivary-rumen fluids with potassium during periods of sodium deficiency (Sept.-May).

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ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

39. Bland, R. G. 1989. An annotated list of the Orthoptera of Beaver Island, Lake Michigan. *Great Lakes Entomologist* 22: 39-43.

ABSTRACT: Thirty-six species of Orthoptera were collected from Beaver Island in northern Lake Michigan. Species distribution was Tetrigidae, 4; Acrididae, 16; Tettigoniidae, 8; Gryllacrididae, 1; and Gryllidae, 7. There are about 62 species listed from nearby counties of the Upper and Lower Peninsula of Michigan. This list was the result of a fairly comprehensive field study during 1987 and 1988.

40. Blokpoel, Hans. 1977. Gulls and terns nesting in northern Lake Ontario and the Upper St. Lawrence River. (*Can. Wildl. Serv. Prog. Notes* 75) 12 pp.

ABSTRACT: Information on the Canadian Great Lakes waterbirds complimented the numerous studies in Michigan waters.

41. Blokpoel, Hans. 1983. The status of tern populations in northeastern United States and adjacent Canada: the Canadian Great Lakes. *Colonial Waterbirds* 6: 86-106.

ABSTRACT: A brief overview of the status of Common, Caspian, and Black Terns in the Canadian Great Lakes in 1982. Rangewide data is summarized, and no significant references to specific islands are made.

42. Blokpoel, Hans and P. M. Fetterolf. 1983. Reproductive performance of Caspian Terns at a new colony on Lake Ontario, 1979-1981. *J. Field Ornith.* 54: 170-186.

43. Blokpoel, Hans; Ryder, J. P.; Seddon, I.; Carswell, W. R. 1980. Colonial waterbirds nesting in Canadian Lake Superior in 1978. (*Can. Wildl. Serv. Prog. Notes* 118) 13 pp.

ABSTRACT: This study complimented similar studies in U.S. waters.

44. Blokpoel, Hans; Scharf, William C. 1991. Status and conservation of seabirds nesting in the Great Lakes of North America. International Council for Bird Preservation. (Technical Publication No. 11) 24 pp.

ABSTRACT: The breeding distribution and nesting habitats, past and present population size, threats, and conservation, management and research were given for the 8 species of seabirds that nest on the Great Lakes. Maps, and tables included.

45. Bowman, Jerry. 1974. Some observations and ecological considerations concerning the tiger beetles (Cicindelidae: Cicindela spp.) of South Manitou Island. Kalamazoo, MI: Kalamazoo College. BA thesis. 58 pp + references.

ABSTRACT: Eight species of tiger beetles were studied on S. Manitou Is., Lake Michigan. Distribution, interspecific activity and habitat preferences were described. This was considered a high number of species for such a small land area. Only six counties had more species of tiger beetles. All species could be found in a single square mile in the southwest corner of the island.

46. Brown, Clair A. 1937. Ferns and flowering plants of Isle Royale, Michigan. Washington, D.C.: U.S. Dept. of Interior Natl. Park Service. 90 pp.

ABSTRACT: A general ecological description and comments on vegetation changes was given. Flowering plant and fern lists were complete as of the time of publication, and were based on reported records and field work during the summer of 1930 by a party from the University Museum of the University of Michigan, Ann Arbor.

47. Bureau of Land Management. 1989. Public lands list for the State of Michigan, Michigan Public lands Improvement Act of 1988. Milwaukee, WI: U.S. Department of the Interior, Bureau of Land Mgmt., Eastern States Office. 333 pp.

ABSTRACT: Maps, township-range, county, USGS topo quad name are given for all BLM lands in MI as of 1988.

48. Burr, Ronald D. 1974. Structure of hardwood forest stands on Garden and High Islands adjunct to Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.

ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

49. Burwell, R. W., Regional Director, U.S. Fish and Wildl. Serv., March 7, 1968. letter to: John W. Humke. 2 pp.

ABSTRACT: This letter described the physical, geological, and biological features of Gull Island, Lake Huron, Alpena County, MI. The island had a large colony of gulls and a great blue heron rookery at the time of the letter. The author promoted the idea that the island should be acquired by The Nature Conservancy for its ecological study and wildlife values.

50. Butsch, Robert S. 1957. Notes on the winter birds of Sugar Island, Michigan. Jack-Pine Warbler 35: 14-19.

ABSTRACT: A total of 32 observation days over a 5 year period produced this list of 27 species. Several observers were involved in each survey, and all habitat types on the island were visited. Numbers of individuals seen are also included.

51. Case, D. J. and D. R. McCullough. 1987. The white-tailed deer of North Manitou Island. *Hilgardia* 55 (9): 57 pp.
ABSTRACT: Data on the North Manitou Island white-tail deer population from June 1980 to May 1982 are presented. The population increased 66% and 59% in 1980 and 1981 prior to winter up to a total population of over 2000 deer. However, 75% died during the winter of 1981-82 due to lack of woody browse and adequate thermal cover. This cycle is expected to continue unless numbers of deer are controlled and woody vegetation is regenerated. Hunting is proposed as a control mechanism.
52. Case, D. J. and D. R. McCullough. 1987. White-tailed deer forage on alewives. *J. Mammal.* 68: 195-197.
ABSTRACT: The authors discovered in 1980 that white-tailed deer consumed large quantities of dead alewives along the beaches of N. Manitou Island. This type of novel food consumption was considered to be only occasional until this report.
53. Case, David J. and W. C. Scharf. 1985. Additions to the birds and land vertebrates of North Manitou Island. *Jack-Pine Warbler* 63: 17-23.
ABSTRACT: Twenty-seven species were added to the known vertebrate fauna of North Manitou Island, and others were confirmed as residents or nesters during studies conducted between June 1980 and May 1982.
54. Catling, P. M. On the occurrence of *Oarisma garita* (Reakirt) (Lepidoptera: Hesperidae) in Mantoulin District, Ontario. *Great Lakes Lepidopterist* 10: 59-63.
55. Catling, P. M., J. E. Cruise, K. L. McIntosh and S. M. McKay. 1975. Alvar vegetation in southern Ontario. *Ont. Field Biol.* 29: 1-25.
ABSTRACT: Alvar vegetation in Ontario was defined and the distribution described. Species presence was recorded on 7 widely separated alvars, and the phytogeography of this community was discussed. The mosaic pattern of vegetation was described and discussed also. Ontario's alvar vegetation was thought to be of natural origin, and relict. The prospect for the community type was not good, as it was increasingly being used for livestock and dumping.
56. Cent. Mich. Univ. Biol. Sta. 1991. St. James Township Gull Harbor project biological profile and ecological significance. Unpub. rept. produced at CMU Beaver Island Biol. Sta. 18 pp.
ABSTRACT: Includes a partial (summer) flora, summer aquatic invertebrate fauna of Gull Harbor, Beaver Island (includes some indigenous species as well as some common to Lake Michigan proper), very preliminary terrestrial invertebrate list, summer fish fauna of Gull Harbor, a late summer list of amphibians and reptiles, a good list of birds (from 8 years of research by Hamas), and a list of mammals from a brief summer survey. Ecological significance is summarized and includes migratory bird stopovers, feeding areas for colonial nesting birds, and

fish-spawning sites, as well as high quality natural communities, natural diversity, and aesthetic value.

57. Chadwick, Robert P. 1982. Visitor usage on the trails and campgrounds at Isle Royale National Park. Houghton, MI: Mich. Tech. Univ. Master's thesis. 81 pp.
58. Christopher, Kent L. 1980. A survey of peregrine falcon habitat in Upper Michigan with emphasis on reintroduction potential. Houghton, MI: Mich. Tech. Univ. 145 pp.
ABSTRACT: This complete reivew of peregrine falcon nesting habitat in Upper Michigan described current conditions of 13 historic eyrie sites and 10 additional potential sites. Reintroduction potential of the areas was evaluated in terms of contamination levels in potential prey and status of Great Horned Owls. Four sites were recommended: Bear Bluff on Keweenaw Peninsula, Ives Mountain and Conway Point in the Huron Mountain Club, and Grand Island. Number of birds to be hacked is also evaluated.
59. Cleland, Charles E. 1968. Analysis of the fauna of the Indian Point site on Isle Royale in Lake Superior. Mich. Archaeol. 14: 143-146.
60. Conklin, C. H. 1914. A list of Hepaticae collected upon Isle Royale, Lake Superior. Bryologist 17: 46-48, 52-55.
61. Cooley, Marvin. 1946. Drummond Island deer hunting investigations, 1945. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 902) 9 pp.
ABSTRACT: The number and estimated ages of deer harvested from the island in 1938 were reported. Observations of coyote, bear, snowshoe hare, snowy owls, barred owls and great-horned owls were also included.
62. Cooper, W. S. 1912. A catalogue of the flora of Isle Royale, Lake Superior. Mich. Acad. 16: 109-131.
63. Cooper, W. S. 1913. The climax forest of Isle Royale, Lake Superior, and its development. Bot. Gaz. 55: 1-44, 115-40, 189-235.
64. Cooper, William S. 1913. A list of mosses collected upon Isle Royale, Lake Superior. Bryologist 16: 3-8.
ABSTRACT: The author presents an annotated list of 106 species of moss from Isle Royale. Their habitat is described, and whether they are part of the bog, or bare rock successional sere is noted. The list was the most complete published to date for the island, but was not expected to be complete. Field work occurred in one season, and the author describes himself as a "beginner in the study of mosses." Besides the main island, Raspberry, Smithwick, Gull and unnamed islands near Park Place and in the upper end of Rock Harbor are mentioned as collecting sites.

65. Cooper, William S. 1928. Seventeen years of successional change upon Isle Royale, Lake Superior. *Ecology* 9: 1-5.
ABSTRACT: Secondary succession following fire, primary rock shore succession, and bog succession are described. The author notes that moose have turned the sedge mat zone in many bogs to mud wallows.
66. Core, E. C. 1948. The flora of the Erie islands, an annotated list of vascular plants. Ohio State University. (Franz Theodore Stone Lab. Contrib. 9) 106 pp.
67. Corin, Carla W. 1975. The ecology of the terrestrial vertebrate fauna of the Huron Islands, Lake Superior. Marquette, MI: North. Mich. Univ. 105 pp.
ABSTRACT: The terrestrial vertebrate species were surveyed by observation and live-trapping on the two main islands, Huron Island and East Huron Island. The fauna was compared between islands and between islands and mainland. Population densities of three mice species were higher on islands than on the mainland. Double-crested cormorants, peregrine falcons, and bald eagles, though once present, were not found during this study.
68. Corin, Carla W. 1976. The land vertebrates of the Huron Islands, Lake Superior. *Jack-Pine Warbler* 54: 138-147.
ABSTRACT: The author's observations increased the recorded numbers of species on the Huron Islands to 4 amphibians, 2 reptiles, 75 birds, and 8 mammals. The list may not be complete for birds because visits were only in summer months. However, the author believed that the amphibian and reptile lists were likely complete. Although the Huron Islands lack predators, and gulls nest on East Huron, Gull Rock, and Cattle Island, there are no gulls on Huron Island, probably because of human activity.
69. Courtney, P. A. and H. Blokpoel. 1979. The Common Tern on the lower Great Lakes: an overview. Ottawa, Ontario: Can. Wildl. Serv. 60 pp.
70. Craker, Kathy Nickerson. 1983. They came to South Fox Island. Chelsea, MI: Book Crafters, Inc. 154 pp.
ABSTRACT: Craker presented the human history of S. Fox Island in this volume. It included a section on "the naturalists," and a bird list.
71. Crispin, Susan R. 1980. Nature preserves in Michigan, 1920-1979. *Mich. Botanist* 19: 99-242.
ABSTRACT: This monographic work provides a comprehensive description of all Michigan nature preserves, along with coverage of preservation organizations and ongoing and prospective programs. Descriptions include size and location, ownership and type of protection, management and general character of each preserve. The information is summarized by county, ownership, and plant communities represented.

72. Crispin, Susan R., K. Chapman and J. K. Marr. 1985. A comprehensive survey of the rare, threatened, and endangered plants on Passage Island, Isle Royale National Park, MI. Lansing, MI: Michigan Natural Features Inventory. 72 pp.
ABSTRACT: This report is the result of extensive field inventory work. Nearly all shoreline was surveyed on foot, and selected inland areas were also surveyed. A total of 29 special plant species were located and mapped on Passage Island during this study. All species previously documented or reported from the Island were found, and one species new to the state were found during the inventory. The plant list is annotated with location, abundance and habitat information. All special plant species (threatened, endangered, or special concern) are mapped.
73. Crispin, Susan R., V. L. Dunevitz and J. K. Marr. 1984. A survey for endangered, threatened, and special concern plant species in Isle Royale National Park, Michigan. Lansing, MI: Michigan Natural Features Inventory. 15 + app.
ABSTRACT: Field surveys to ascertain the status of plant species listed or proposed as endangered, threatened, or special concern at the state and federal level were conducted in certain areas of the park in 1982. Records of previously known localities were used to direct the ground searches. Data was collected on 31 special plant species. Surveys concentrated on three areas that receive relatively intense use by park personnel and visitors.
74. Cuthbert, Francesca J. 1979. Caspian and common tern colony sites: northeastern Lake Michigan (1976-1979). Unpublished data.
ABSTRACT: This is a collection of maps and tables that describe the breeding colony sites of these two species on High Island, High Island Shoal, Pismire, Grape, Shoe, and Hat Islands, Ile aux Galets, Waughoshance Point islands, and Pt. aux Chenes Bay Island. Estimated number of breeding pairs is given for each site.
75. Cuthbert, Francesca J. 1980. An evaluation of the effectiveness of fence enclosures in reducing predation of common tern nests by snakes. Final Report to MI DNR. 9pp.
ABSTRACT: Studies indicated that nesting success was reduced by snake, fox and owl predation. Limits on visitors and researchers, and predator control are recommended to increase the productivity of the High Island colony, which is one of the few common tern breeding sites in the state that is not periodically submerged or washed over by waves during summer storms.
76. Cuthbert, Francesca J. 1985. Intraseasonal movement between colony sites by Caspian terns in the Great Lakes. *Wilson Bull.* 97: 502-510.
ABSTRACT: Colony-site use patterns were studied in Caspian terns (*Sterna caspia*) nesting on five islands in northeastern Lake Michigan. It was common for birds to switch between colonies during the breeding season. Birds without mates, nest site, or those with failed nesting attempts frequently moved to different

colonies. Colonies were on High, Hat, and Shoe Islands, High Island Shoal and Ile aux Galets.

77. Cuthbert, Francesca J. 1985. Mate retention in Caspian terns. *Condor* 87: 74-78.

ABSTRACT: Mate retention was studied in Caspian terns on High, Hat, and Shoe Islands, and Ile aux Galets, northeastern Lake Michigan. Only 25% of original pairs bred together for consecutive seasons. Mate retention did not appear to be related to previous reproductive success.

78. Cuthbert, Francesca J. 1988. Reproductive success and colony-site tenacity in Caspian terns. *Auk* 105: 339-344.

ABSTRACT: Colony-site use by individual Caspian terns (*Sterna caspia*) was studied at four colonies in northeastern Lake Michigan from 1976-1979. The terns usually returned to the same nesting site if they successfully reproduced there the previous year. They generally switched sites the following year if they were unsuccessful in reproducing. Colony sites were on High, Hat, Shoe Islands, and Ile aux Galets.

79. Davis, Thomas E. and M. R. Erwin. 1982. Potential impacts of extended winter navigation upon migratory birds of the Upper U.S. Great Lakes. Laurel, MD: Migratory Nongame Bird Section, Patuxent Wildl. Res. Center, USFWS. Rept. for U.S. Fish and Wildl. Serv. (FWS/OBS-82/51) and U.S. Army Corps of Eng. (Tech. Rept.). 372 pp.

ABSTRACT: This report describes the results of a number of surveys and studies conducted in many localities in the Upper U.S. Great Lakes, from northwestern Lake Erie/Detroit River to the Duluth-Superior Harbor complex in western Lake Superior. The projects were aimed at determining: (1) both the historical and present winter abundances and distributions of selected species of migratory birds from Lake Superior to the Detroit River, (2) the potential for perturbing riverine/harbor wetlands and benthos communities (and consequences for migratory birds), (3) the extent of bird mortality along selected lakeshore segments, and (4) major migratory pathways of birds in both spring and fall. Literature, aerial, and ground surveys were performed between 1979 and 1981. Results showed a great deal of fluctuation in numbers and locations of birds. Report recommends minimal icebreaking near shallow feeding areas and erosive islands.

80. Dennis, D. G.; Chandler, R. E. 1974. Waterfowl use of the Ontario shoreline of the southern Great Lakes during migration. in: H. Boyd (ed.). *Canadian Wildlife Service Waterfowl Studies in Eastern Canada*. Ottawa, Ontario: (Can. Wildl. Serv. Rep. Ser. 29).

ABSTRACT: This Canadian study compliments similar studies in Michigan.

81. Dennis, D. G.; North, N. R. 1981. Waterfowl use of the Lake St. Clair marshes during migration in 1976-77 versus 1968-69. (Can. Wildl. Serv. Rep. Ser., unpublished report).

ABSTRACT: This Canadian study compliments studies of waterfowl use of U.S. portions of Lake St. Clair wetlands.

82. Dice, L. R. 1925. The mammals of Marion Island, Grand Traverse County, Michigan. Occas. Papers Mus. Zool., Univ, Michigan No. 160: 1-8.
83. Dickinson, J. 1979. The effects of artificial cover availability on the ecology and movements of a population of the garter snake, *Thamnophis s. sirtalis*. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island
84. Dickinson, John A. 1979. Long-eared owl on Beaver Island, Charlevoix County, Michigan. Jack-Pine Warbler 57: 28.
ABSTRACT: The first report of long-eared owl on Beaver Island was on 8 August 1978. The species is uncommon in the state and only rarely breeds north of the Saginaw-Grand Valleys.
85. Dodge, C. K. 1908. A botanical trip to Thunder Bay Island. Mich. Acad. Sci. Ann. Rept. 10: 40-41.
ABSTRACT: Dodge was in search of *Crategus borealis* Ashe. He found *Crataegus* species on nearby Sugar Island, but none on Thunder Bay Island. He describes the principle species, the general vegetation, and a number of interesting species, including several state threatened plants.
86. Dodge, C. K. 1921. Observations on the flowering plants, ferns, and fern allies on and near the shore of Lake Huron from Linwood Park near Bay City, Bay County, to Mackinaw City, Cheboygan County, including the vicinity of St. Ignace, Mackinac and Bois Blanc Islands, Mackinac County, Michigan. Misc. Pap. on the Bot. of Mich., Mich. Geol. & Biol. Surv. Publ. 31 (Biol. Ser. 6): 15-74.
ABSTRACT: An annotated list, often with specific county records but also often without specific records is presented. It should be noted that, like most of Dodge's published lists, a great number of the records are not backed up with specimens in his herbarium, which was left to the University of Michigan. [Abstract from Voss 1963].
87. Dodge, C. K. 1911. Results of the Mershon Expedition to the Charity Islands, Lake Huron. pp 173-190: (Mich. Geol. and Biol. Survey Publication 13) Biol. Series.
ABSTRACT: An account of the vegetation and flora of the Charity Islands was presented. The annotated flora contained 372 plants, which the author considered depauperate compared to some 900 species on the adjacent mainland.
88. Dodge, Charles K. 1914. The flowering plants, ferns and their allies of Mackinac Island. Rep. Mich. Acad. 15: 218-237 + 2 addenda.
ABSTRACT: This is an annotated list of over 400 plant species from Mackinac Island, Lake Huron, Mackinac Co. A list of

additions is given by J.E. Potzger in *Am. Midl. Nat.* 25: 303 (1941). [Abstract from Voss 1963; article was reprinted in Edwin O. Wood, *Historic Mackinac*, Vol. 2: 641-678.]

89. Doolittle, E. A. 1906. The summer birds of Grand Island. No. 7067 in Marquette Co. Histor. Soc. manuscript file. 13 pp.
90. Drew, Leslie C. and C. J. Phillips. 1964. Observations concerning the birds of Beaver Island, Charlevoix County, Michigan. *Jack-Pine Warbler* 42: 234-238.
ABSTRACT: This report covers new bird species observed on the island from 1944 to 1964.
91. Duffy, Walter G.; Batterson, Ted R.; McNabb, Clarence D. 1987. The St. Marys River, Michigan: an ecological profile. (U.S. Fish Wildl. Serv. Biol. Rep. 85(7.10) 138 pp.
ABSTRACT: This monograph reviewed the published and unpublished ecological information available for the St. Marys River. The review covered the geologic history, human exploration, and settlement of the region, as well as physical, chemical, biological and ecological characteristics of the river. The final chapter discussed anthropogenic influences on the river ecosystem and suggested various natural resource management strategies.
92. Dustin, Fred. 1957. An archaeological reconnaissance of Isle Royale. *Mich. Hist.* 41: 1-34.
93. Dustin, Fred. 1932. The gems of Isle Royale, Michigan. *Papers of the Mich. Acad. of Sci., Arts, Letters* 16 (1931): 383-398.
ABSTRACT: While Isle Royale is unlikely to be a source of wealth through its gems, chlorastrolites, thomsonites, and carnelians are fairly plentiful. Amethysts of gem quality may occasionally be found. Other minerals of interest on Isle Royale are zeolite, datolite, apophyllite and epidote.
94. Edsall, T. A., T. P. Poe, R. T. Nester and C. L. Brown. 1989. Side-scan sonar mapping of lake trout spawning habitat in northern Lake Michigan. *N. Am. J. Fish. Manag.* 9: 269-279.
ABSTRACT: Side-scan sonar is demonstrated to improve ability to locate substrates where stocked lake trout eggs, fry, or juveniles' survival would be maximized. The substates and bathymetry of large areas of historical lake trout spawning grounds in the Fox Island Lake Trout Sanctuary in northern Lake Michigan are described. This area could support a contemporary self-sustaining lake trout population within the sanctuary, and perhaps in surrounding waters.
95. Edsall, Thomas A.; Manny, Bruce A.; Raphael, C. Nicholas. 1988. The St. Clair River and Lake St. Clair, Michigan: an ecological profile. (U.S. Fish Wildl. Serv. Biol. Rep. 85(7.3) 130 pp.
ABSTRACT: This report synthesized existing information on the ecological structure and function of the St. Clair River and Lake St. Clair ecosystem. It included descriptions of biological

characteristics, ecological relationships, commercial and recreational uses, and discussions of management considerations and issues. The ecosystem was determined to provide valuable habitat for migrating waterfowl, fish spawning and nursery areas, and to contain some of the most extensive emergent wetlands in the region.

96. Ehlers, G. M. 1924. An Ordovician reef on Sulphur Island, Lake Huron. Pap. Mich. Acad. 4: 425-430.
ABSTRACT: This short paper describes an interesting geological feature on Sulphur Island, which lies in the North Passage of Lake Huron a few miles north of Drummond Island.
97. Farwell, O. A. 1942. A botanical trip through Keweenaw Co., Michigan. Bull. Gray Mem. Bot. Assoc. 9: 10-11.
98. Firestone, Kathleen Craker. 1992. An island in Grand Traverse Bay. Northport, MI: Michigan Islands Research. 107 pp.
ABSTRACT: This volume primarily catalogued the human history of the island, and descriptive material on the habitat. Lists of birds and vascular plants were also included.
99. Fitzgerald, Sue and R. E. Bailey. 1975. Vegetational characteristics of a circum-neutral bog, Barney's Lake, Beaver Island, Michigan. Mich. Acad. VII: 477-488.
ABSTRACT: Barney's Lake Bog, with a pH range of 6.4-7.5, is characterized by nine vegetational communities. Dominant plant species and frequency class distribution of the species as well as community occurrence of each species were recorded. Phenological data for the major species were tabulated. The possible transition between acid and alkaline bog habitats is discussed.
100. Foran, Jeffery A. and R. H. King. 1982. A regression analysis of the summer population dynamics of *Polyarthra vulgaris* in a northern Michigan bog lake. Hydrobiologia 94: 237-246.
ABSTRACT: The population dynamics of a planktonic rotifer (*Polyarthra vulgaris*) were examined in a brown water, acid bog lake (Greens Lake, Beaver Island). Predation and low food concentrations were the main limiting factors for the rotifer population. The authors state that their data support a hypothesis for zooplankton limitation by an invertebrate predator.
101. Foran, Jeffery A. and R. H. King. 1981. Summer production estimates for the rotifer *Polyarthra vulgaris* in a northern Michigan bog lake. J. Freshwater Ecol. 1: 3-11.
ABSTRACT: Summer production estimates were made for the rotifer *Polyarthra vulgaris* in Greens Lake bog, Beaver Island, Lake Michigan. Egg development times, and dry weight were measured. Production ranged from 0.0 ug/L/day to 26.9 ug/L/day during the summer of 1977. Two different methods for calculating production were compared and discussed.

102. Forzley, Kathleen C., T. A. Grudzien and J. R. Wells. No date. Comparative floristics of seven islands in northwestern Lake Michigan. Bloomfield Hills, MI: Oakland Univ. and Cranbrook Inst. of Sci. 28 pp.
ABSTRACT: Floristic comparisons of islands between Garden and Door Peninsulas were made, and consistency with Island Biogeography theory and known land-use history was discussed. Two threatened and two special concern plant occurrences were noted. In all, 367 plant species were found on the 7 islands (Gravelly, Little Gull, Gull, Poverty, St. Martin, Summer, Washington) investigated. Data are a combination of field work literature searches.
103. Freitag, T. M. 1984. Recent naiad mollusks of the Detroit River. *Am. Malacol. Bull.* 3: 105.
104. Gibson, William L. 1980. Succession in upland boreal forest understory vegetation in Isle Royale National Park. Mich. Tech. Univ. Master's thesis.
105. Gillingham, James C. 1988. The amphibians and reptiles of Beaver Island. *J. Beaver Isl. Hist.* 3: 87-115.
ABSTRACT: This account is written for a general audience. Brief descriptions of distinguishing characteristics and drawings by the author are provided, along with ecological and life history information for each species. The origin of the herpetofauna is briefly discussed.
106. Gillingham, James C., J. Rowe and M. A. Weins. 1990. Chemosensory orientation and earthworm location by foraging eastern garter snakes, *Thamnophis s. sirtalis*. In: D. W. Macdonald, E. Muller-Schwarze, S. E. Natynczuk (eds.). *Chemical signals in vertebrates 5*. Oxford: Oxford University Press.
ABSTRACT: Foraging garter snakes were intercepted and stomach contents examined. The snakes had an average of 19 worms in their stomachs, and it was calculated that they located between 5.1 and 13.6 worms per hour. Laboratory tests showed that the snakes were attracted to fresh earthworm castings. Further experiments showed that earthworms were frequently present directly below fresh castings.
107. Gleason, H. A. 1909. The ecological relations of the invertebrate fauna of Isle Royale, Michigan. pp 57-80 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: This is Chapter 2 in the report on ecological investigations by the University Museum of the University of Michigan in 1904 and 1905. Contents address the invertebrate fauna of the lake, the inland lakes, tamarack and arbor vitae swamps, gravel and sand beaches, rock beach, Cladonia clearings and jack pine ridges, balsam-spruce forest, and artificial clearings.

108. Goodrich, C. and H. Van der Schalie. 1939. Aquatic mollusks of the Upper Peninsula of Michigan. Univ. Mich. Mus. Zool. Misc. Publ. (No. 43): 45 pp.
ABSTRACT: This reference includes two island collections: *Planorbella crassilabris* (Walker) from Bois Blanc Island, and *Valvata sincera nylanderi* Dall on Isle Royale.
109. Goodyear, C. D.; Edsall, T. A.; Dempsey, D. M. O.; Moss, G. D.; Polanski, P. E. 1982. Atlas of the spawning and nursery areas of Great Lakes fishes. Vol. VI-St. Clair River, Vol. VII-Lake St. Clair, Vol. VIII-Detroit River. (U.S. Fish and Wildlife Service FWS/OBS-82/52) 86 pp.
110. Graham, Loren. 1984. Features of Grand Island justifying its preservation in a natural state. Unpub. account. 3pp + 7 p list.
ABSTRACT: The author presents a series of 9 reasons why the island has special value biologically and culturally, and should be kept in its natural state. He also includes a 7 page plant list produced in 1951.
111. Great Lakes Shoreline Recreation Area Survey. 1959. Remaining shoreline opportunities. Natl. Park Serv. Rept. for U. S. Dept. of Int. 191 pp.
ABSTRACT: This shoreline survey covered the entire U.S. Great Lakes shoreline, and took place during 1957-58. The objective was to determine what natural lakeshore areas still remained which were worthy of preservation for their scenic, natural or other recreational values. This is a supplement to the report "Our Fourth Shore," which describes the overall situation along the Great Lakes shoreline. This report describes the individual areas suitable for preservation, physical aspects of sites, scenic, recreation, and in some cases, wildlife values of each site.
112. Griffith, Steven P. 1978. Desmid flora of Green's Lake, Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.
113. Grosnick, M. 1976. The leeches (Hirudinea) of Isle Royale National Park, Michigan. Marquette, MI: N. Mich. Univ. Master's thesis.
114. Grudzien, Thaddeus A. and P. J. Owens. 1991. Genic similarity in the gray and brown color morphs of the snake *Storeria occipitomaculata*. J. Herpetol. 25: 90-92.
ABSTRACT: The genetics of two color morphs in the red-bellied snakes are examined. No adaptive value of the colors is known. Allozyme evidence from this study indicates the morphs are members of a common gene pool. Three alternative hypotheses about how the morphs are maintained are presented.

115. Guire, Kenneth E. and E. G. Voss. 1963. Distributions of distinctive shoreline plants in the Great Lakes Region. Mich. Botanist 2: 99-114.
ABSTRACT: Type localities, habitat, biogeography and general distribution are described for 27 species of shoreline plants. Distribution maps are included for eleven species. There are occurrences of some of these species on all of the major island groups.
116. Hamas, Michael J. 1987. Final report: piping plover survey of the Beaver Islands. 5 pp.
ABSTRACT: Ten islands in the Beaver Archipelago (including High, South Fox, Beaver, Garden, Hat, Hog, Pismire, Squaw, Trout, and Whiskey Islands were surveyed for piping plovers in 1987. High island plovers nested successfully. No plovers nested on the other islands, but Beaver and South Fox had suitable habitat for plovers.
117. Hamas, Michael J. and J. C. Gillingham. 1984. Northern cardinals breeding on Beaver Island. Jack-Pine Warbler 62: 75.
ABSTRACT: The first report of northern cardinals reported breeding on Beaver Island is made. The species is rather sedentary and they are absent on most islands in the Great Lakes. No evidence of an established resident population on the island was found.
118. Hampton, Raymond E. and J. C. Gillingham. 1989. Habituation of the alarm reaction in neonatal eastern garter snakes, *Thamnophis sirtalis*. J. Herpetol. 23: 433-435.
ABSTRACT: Baby garter snakes were found to respond much more to overhead objects than to the same objects presented at eye-level. They found short term and possibly long term habituation to the stimulus. The habituation to such a moving objects was to some degree specific to the object.
119. Hansen, H. L.; Krefting, L. W.; Kurmis, V. 1973. The forest of Isle Royale in relation to fire history and wildlife. (Minnesota Agr. Exp. Sta. Tech. Bull. 294) 44 pp.
120. Harris, Stanley E., J. S. Fralish and G. T. Weaver. cir. 1973. A survey of potential National Natural Landmarks of the Eastern Central Lowlands Physiographic Province of the United States, Vol. 1. Univ. S. Ill., Carbondale. Unpublished report to U.S. Dept. Int., Nat. Park Serv. 523 pp.
ABSTRACT: This comprehensive report includes one Michigan island reference. Site 16, Mackinac Island, is recommended as a landmark based primarily on geological features and themes. The island clearly shows the shorelines of modern Lake Huron, and ancient Lakes Nipissing, and Algonquin.
121. Hatt, R. T., J. VanTyne, L. C. Stuart, C. H. Poper and A. B. Grobman. 1948. Island life: a study of the land vertebrates of the

islands of eastern Lake Michigan. Cranbrook Inst. of Sci. Bull. 27: 1-179.

ABSTRACT: This extensive study covers the following islands in the Beaver Group to varying levels of detail: Beaver, Gull, Hat, High, Hog, North Fox, North Manitou, Pismire, Shoe, South Fox, South Manitou, Squaw, Trout, and Whiskey. The topics covered are geological history, cultural history, descriptions of islands, amphibians and reptiles, birds, mammals, modification of habits, factors of distribution. It concludes with lists of the vertebrate faunas of each islands.

122. Havel, John E., J. Link and J. Niedzwiecki. 1993. Selective predation by *Lestes* (Odonata, Lestidae) on littoral microcrustacea. Freshwater Biol. In press.

ABSTRACT: Predation experiments showed that the damselfly, *Lestes* sp. preferred small cladocera over larger cladocera or ostracods. Large damselflys could capture and consume the small ostracod, but smaller ones could not.

123. Hayes, B. N. 1964. An ecological study of a wet prairie on Harsens Island, Michigan. Mich. Botanist 3: 71-83.

ABSTRACT: This paper reports the discovery of a wet prairie on Harsens Island. Species density and dominance were calculated. A plant species list is included along with abundance indices. The community apparently persisted because of biannual burning and spring inundation. Plants are a mixture of prairie and marsh species.

124. Hazlett, Brian T. 1991. The flora of Sleeping Bear Dunes National Lakeshore, Benzie and Leelanau Counties, Michigan. Mich. Botanist 30: 139-202.

ABSTRACT: Vegetation of the Platte River Unit, Sleeping Bear Dune Unit, Good Harbor Bay Unit, Bow Lakes Unit and Manitou Islands is discussed. A catalog of the vascular plants of the park is presented. This is a very thorough flora, based on literature and field work.

125. Hazlett, Brian T. 1980. Untitled. Pellston, MI: Univ. Mich. Biol. Sta. Unpublished study. 13 pp.

ABSTRACT: This is a revision of an independent study of Round Island, T40N, R3W, located in the Straits of Mackinac approximately 0.5 miles south of Mackinac Island, 0.25 miles north of Bois Blanc Island. The study was part of continuing botanical surveys of Michigan's RARE II wilderness areas. The vegetation zones were described and species listed both according to vegetation and taxonomic relations. The study concluded that the island does not have an abundant number of threatened plant species, but is significant because of its primitive nature. The author found the island to be largely undisturbed and undeveloped.

126. Hazlett, Brian T., S. P. Hendricks, G. P. Fons, P. W. Thompson and J. R. Wells. 1986. A botanical foray to the Fox Islands, northern Lake Michigan. Mich. Botanist 25: 3-10.

ABSTRACT: This article mainly describes the adventure of the foray to the Fox Islands. It is noted that 125 plant species new to the islands were found, and a better knowledge of the individual floras of each island was obtained. Some of the new species are listed.

127. Hazlett, Brian T.; VandeKopple, Robert J. 1983. The terrestrial vegetation and flora of North and South Manitou Islands, Sleeping Bear

Dunes National Lakeshore. Pellston, MI: Univ. Mich. Biol. Station. (U.M.B.S. Technical Report No. 11) 143 pp.

ABSTRACT: Results of 1982-1983 field study of vegetation and flora of North and South Manitou Islands in northern Lake Michigan were described. Contents included maps of vegetation associations and a list of 490 vascular plants found on the islands. Topics discussed included contrasts between forest structure and flora on the two islands, influence of deer on North Manitou (no deer on S. Manitou). A DNR deer exclusion area on N. Manitou confirmed the effects of deer on vegetation. The authors set up 20 permanent plots for future study. Distribution of 8 endangered, threatened or special concern plant species were noted and recommendations for resource management were proposed.

128. Hendrick, J. and J. L. Lowe. 1936. Lichens of Isle Royale, Lake Superior. *Bryologist* 39: 73-91.

ABSTRACT: A Univ. of Mich. botany survey party collected lichens in the northeastern conifer forest zone on Isle Royale in 1930. All 296 species and subspecies are from the main island. Of these, 138 were previously unknown in Michigan. This list was the most complete list at time of publication. The list is annotated with habitat and collection site.

129. Hendrickson, J., W. L. Robinson and L. D. Mech. 1975. Status of the wolf in Michigan, 1973. *Am. Midl. Naturalist* 94: 226-232.

ABSTRACT: Wolf in the Upper Peninsula declined from 45 - 50 animals in the mid-1950s to near extinction in 1973. This was attributed to overharvest under the bounty system. In 1973 there were thought to be about 6 wolves left, mostly immigrants from Ontario and Minnesota, but possibly still breeding occasionally in the state.

130. Henry, Mary Lou and R. E. Hampton. 1974. Macrolichens of Beaver Island, Charlevoix County, Michigan. *Mich. Botanist* 13: 65-67.

ABSTRACT: Collections of lichens on Beaver Island were made in 1970-1973, and were considered to represent a fairly complete record of the lichen flora. In all, 67 species in 20 genera and 12 families were recorded. Affinities with the major vegetation types on the island are given. The open sandy areas and the coniferous forests showed the greatest species diversity of lichens.

131. Herdendorf, C. E.; Harley, S. M.; Barnes, M. D. 1981. Fish and wildlife resources of the Great Lakes coastal wetlands within the United States. Washington, D.C.: U.S. Fish and Wildl. Serv. (FWS/OBS-81/02-v1,3,4) Vol 1: Overview, 469 pp; vol 3: Overview, 505 pp; vol. 4: Lake Huron, 792 pp.
132. Herdendorf, Charles E.; Raphael, C. Nicholas; Jaworski, Eugene. 1986. The ecology of Lake St. Clair Wetlands: a community profile. (U.S. Fish and Wildl. Serv. Biol. Rep. 85(7.7) 187 pp.
ABSTRACT: This publication reviewed the ecological data and information on the wetlands of Lake St. Clair. These wetlands were considered among the most productive areas in the Great Lakes ecosystem. Topics covered included the geologic history of the region leading to development of wetlands and the present environment, biological production and community organization, and many species lists.
133. Herendeen, Patrick S. 1984. Untitled [Summary description of Maxton Plains, Drummond Island, MI]. Lansing, MI: The Nature Conservancy, Mich. Chpt. Unpub. rept. 8 pp.
ABSTRACT: This report summarizes the natural and historical significance of the Maxton Plains on Drummond Island. Plant species present that are of special concern, threatened or endangered status in the state are listed. Ecological information includes geology and soils, flora, and fauna (incomplete). Management, inventory and monitoring needs are outlined.
134. Hiawatha National Forest, Munising Ranger District. 1992. Grand Island National Recreation Area Draft Environmental Impact Statement. Munising, MI: U.S. Dept. Agriculture, Forest Service. 220 pp + appendices A-H.
ABSTRACT: The DEIS described and evaluated eight alternatives for managing the Grand Island National Recreation Area of the Hiawatha National Forest. Effects of alternatives on the physical and biological environment, social and economic conditions, and resource management were presented. It included lists of endangered, threatened and special concern plants and animals present or potential on the island, but did not include flora or fauna lists.
135. Hickie, Paul. 1937. A preliminary report on the past and present status of the moose, *Alces americana* (Clinton), in Michigan. Pap. Mich. Acad. Sci. Arts and Letters 22: 629-639.
ABSTRACT: Studies on the browse preferences of Isle Royale moose showed that moose preferred a mixture of coniferous and deciduous browse. Hunting is suggested as means of controlling the population in the absence of significant predators, but not until the population had become established. Food shortages were discussed.
136. Higman, Phyllis J. and F. G. Goff. 1992. Threatened/endangered/special concern species assessment, Big

Charity Island, Arenac County, Michigan, Lake Huron. West Branch, MI: Vital Resources Consulting. Unpub. rept. 20 pp + appendices.

ABSTRACT: Report consists of three subreports describing searches for Pitcher's thistle, American burying beetle, and Massasauga rattlesnake. Only Pitcher's thistle was found. Thirteen colonies were found, and 7 of these fell on lots proposed for development.

137. Hiltunen, Jarl K. 1962. Notes on the flora of Chippewa County, Michigan. Mich. Botanist 1: 23-26.

ABSTRACT: The author's findings from collecting plants on Sugar Island and Drummond Island are described. Marsh species are emphasized for Sugar Isl., while limestone pavement and cliff species are discussed for Drummond Isl. A list of conspicuous species for Drummond limestone pavement is given. This is by no means a complete list. The focus is on interesting, unusual, rare species.

138. Hinds, Donn S. 1978. Snowshoe hare population and ecotoparasites, Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.

ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

139. Hine, James S. 1909. Diptera of the 1905 University Museum Expedition to Isle Royale. pp 308-316 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.

ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.

140. Hohn, Matthew H. 1977. Guide to the flora of Beaver Island, Michigan, Part I - the bogs. Beaver Island, MI: Central Michigan University Biological Station. 69 pp.

ABSTRACT: This booklet described the bogs of Beaver Island, discussed how they were formed and where they occur. Then it provided an illustrated key to the plants of the bogs.

141. Holt, W. P. 1909. Notes on the vegetation of Isle Royale, Michigan. pp 217-248 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.

ABSTRACT: Bog societies, shore vegetation, forests and burnings were described, and an annotated plant list was included.

142. Howell, A. H. 1936. Description of a new red squirrel from Isle Royale, Michigan. Michigan Mus. Zool. Occasional Pap. 13 ((338): 1-2.

ABSTRACT: This short paper gives the scientific description of a purported new form of red squirrel from Isle Royale. The form

is distinct from either the north or south shore of Lake Superior forms, but closer to the Ontario race. No intergradation was found. The squirrel is lighter in color than nearby races.

143. Hubbs, Carl L. and K. F. Lagler. 1949. Fishes of Isle Royale, Lake Superior, Michigan. Pap. Mich. Acad. Sci. Arts Lett. 33: 73-133.
ABSTRACT: The fish fauna of Isle Royale National Park is listed, based on records and field work. Zoogeography, ecology, speciation and conservation of the fauna are discussed. An annotated species list is presented.
144. Huber, N. King. 1973. Glacial and postglacial geologic history of Isle Royale National Park, Michigan. Washington, D.C.: U.S. Government Printing Office. (U.S. Geological Survey Professional Paper No. 754-A) 15 pp.
145. Isaacs, Frank B. 1976. Historical survey of peregrine falcon eyries in National Park Service lands bordering Lake Superior. Houghton, MI: Michigan Technological University. 128 pp.
ABSTRACT: Thesis begins with thorough literature review on life history and population status of the species. A second section gives the results of an evaluation of the history, current status, and reintroduction potential of sites in the Apostle Islands, Isle Royale, and Pictured Rocks National Lakeshore. The study concluded that reintroductions were not yet feasible because DDE and PCB levels in Lake Superior ecosystem were too high.
146. Isaacs, Frank B. 1975. Peregrine falcon reintroduction program 1975 progress report. Unpub. rept. 22 pp + appendix.
ABSTRACT: A survey of past and current peregrine falcon uses was conducted in Isle Royale and Picture Rocks National Parks. Three areas in I.R.N.P and one in P.R.N.L. were identified, described and evaluated.
147. Jackson, H. H. T. 1927. Notes on the summer birds of Door Peninsula, Wisconsin, and adjacent islands. Trans. Wisc. Acad. Sci. Arts Lett. 23: 639-65.
ABSTRACT: Although this reference only includes Wisconsin islands north to Washington Island, the bird fauna of the Michigan islands in the same chain is probably closely related. Physiography and life zones are described. The list of 86 species is very thoroughly annotated, and represents summer 1917 field work, as well as a bit in 1922. Two genera not previously known in WI are included.
148. Janke, R. A. 1975. The ecology of the spruce-fir-birch forest type of Isle Royale National Park. Houghton, MI: Mich. Tech. Univ., Dept. Biol. Sci. 11 pp.
149. Janke, R. A. 1981. The flora and vegetation ecology of Isle Royale National Park. Unpub. rept. to U.S. Natl. Park Serv. 95 pp.
ABSTRACT: This report describes the results of a 5 year study of the vegetation of Isle Royale. This research included

production of an annotated list of the 699 vascular plant species on the island. Primary succession and species composition on exposed rocky shores was studied. Effects of moose browsing on aspen regeneration was also studied. Results discounted browsing and pointed to lack of light as major cause of young aspen mortality. Beavers' effects on vegetation were also studied. Re-vegetation following recent burns was tracked.

150. Janke, Robert A. 1979. Moose-forest-fire ecology in Isle Royale National Park. Proceedings of the First Conference on Scientific Research in the National Parks. USDI, Nat. Park Serv.
ABSTRACT: This study was a phase of a long-term research project on the ecology of the upland boreal forest type on Isle Royale National Park. It focused on relationships between moose, fire, and the forest ecosystem.
151. Janke, Robert A. and N. Janke. 1964. The birds of Isle Royale National Park. Wolf's Eye 6 (3): 1-38.
ABSTRACT: This article contains popular descriptions, illustrations and a checklist of Isle Royale birds.
152. Janke, Robert A. and N. Janke. 1962. The wildflowers of Isle Royale National Park. Wolf's Eye 5 (2&3): 1-85.
ABSTRACT: This article contains popular descriptions and illustrations of about 100 wild plants of Isle Royale.
153. Janke, Robert A., D. McKaig and Raymond R. 1978. A comparison of pre-settlement and modern upland boreal forests on Isle Royale National Park. Forest Science 24: 115-121.
154. Jaworski, Joseph E. 1979. Grasses of Beaver Island, Charlevoix County, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.
155. Jenkins, Benjamin C. 1939. Drummond Island deer hunting investigation, 1938. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 363) 7 pp.
ABSTRACT: This report gave the number and estimated ages of deer harvested from the island in 1938. Notes on rabbits and bear populations were also included.
156. Jensen, William F., W. L. Robinson and N. L. Heitman. 1982. Breeding of the great gray owl on Neebish Island, Michigan. Jack-Pine Warbler 60: 27-28.
ABSTRACT: Evidence that great gray owls nested on Neebish Island in 1981 is provided from field observations. Juveniles were found, but no nest observed. This is the first report of probable nesting in the state.
157. Johnson, D. K. 1980. Ecological relationships of aquatic invertebrates in Siskiwit River, Isle Royale National Park, Michigan. Houghton, MI: Mich. Tech. Univ. Master's thesis.

158. Johnson, Wendel J. 1970. Food habits of the red fox in Isle Royale National Park, Lake Superior. *Am. Midl. Naturalist* 84: 568-572.
ABSTRACT: The food habits of the red fox in Isle Royale Nat. Park over the three year period, 1966 - 1968, were found to be dominated by mammals. Snowshoe hare was highest in percent of total diet, especially during the winter months. Diet is almost exclusively fruits in Aug.- Sept. Prey diversity is considered low, and effects are discussed.
159. Johnsson, R. G. 1963. The orchids of Isle Royale National Park. *Wolf's Eye* 6 (2): 1-29.
160. Johnsson, R. G. and P. C. Shelton. 1960. The vertebrates of Isle Royale National Park. *Wolf's Eye* 4: 1-24.
161. Johnsson, Robert G., P. Shelton and P. Jordan. 1982. *Wildlife of Isle Royale*. Isle Royale Natural History Assoc. 43 pp.
162. Jordan, P. A., P. C. Shelton and D. L. Allen. 1967. Numbers, turnover and social structure of the Isle Royale wolf population. *Amer. Zool.* 7: 233-252.
ABSTRACT: The social structure, recruitment, pack size, and number of packs were reported for 1961-1966. During this time, the main pack numbered between 11 and 22. Only during 1965 did any breeding occur outside the main pack. The alpha male of the large pack apparently was killed in 1966.
163. Kapp, Ron. Wild. Nat. Areas Adv. Board. July 31, 1973. letter to: Wildlife Division Friends. 2 pp.
ABSTRACT: This letter gave the WNAAB opinion on the wilderness value of islands.
164. Kapp, Ronald O., S. Bushouse and B. Foster. 1969. A contribution to the geology and forest history of Beaver Island, Michigan. pp 225-236 in: *Proceedings of the 12th Conference on Great Lakes Research*. Internat. Assoc. Great Lakes Res.
ABSTRACT: Pollen analysis and characterization of the sediments from two basins on Beaver Island, Michigan were used to produce a tentative correlation between water level in the Michigan basin, sedimentation and forest history. The late-glacial forest was dominated by spruce, followed by mixed northern hardwood forest including pine. Beech and hemlock migrated to Beaver Island about 7300 BP.
165. Keough, Janet R., G. R. Guntenspergen, C. P. Dunn and F. W. Stearns. No date, cir. 1981. *Bibliography of the biology of the Superior Upland Province*. Milwaukee, WI: Univ. of Wisc.-Milwaukee, Dept. Botany. 165 pp.
ABSTRACT: In this very thorough bibliography, references are grouped by themes, i.e. Boreal Forest, Prairie, Open Bog, etc. Wildlife are divided into sections for Mammals, Birds, Fish-Amphibians-Reptiles, Invertebrates and a general vertebrate category. Two additional sections, Natural History and Ecology,

and Floras, Monographs and Plant Lists, relate to all themes. References are dated up to 1980.

166. King, Dennis R. 1970. Deer population-range relationships on Garden and South Fox Islands, Michigan. Ann Arbor, MI: Univ. of Mich. 228 pp.

ABSTRACT: The deer population was compared on the two islands in relationship to availability and use of different types of browse materials. Vegetation sampling was used to determine browse availability. Hare browsing was also analyzed. Garden Isl. had a low deer population and the deer were not affecting the vegetation. Deer population on S. Fox Isl. was high, and was projected to eliminate ground hemlock within a few years. This result would lower the island's carrying capacity for both deer and hares considerably.

167. King, Robert H. 1968. Distribution of aquatic midge larvae (Diptera: Tendipedidae), Barney's and Fox Lakes, Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.

ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

168. Koziol, Ann M. 1982. Dynamics of lightly exploited populations of the lake whitefish, Isle Royale vicinity, Lake Superior. Lansing, MI: Mich. Dept. Natur. Resour., Fish. Div. (Fisheries Research Report No. 1911) 36 pp.

169. Krefting, L. W.; Lee, F. B.; Shelton, P. C.; Gilbert, K. T. 1966. Birds of Isle Royale in Lake Superior. U.S.D.I., Fish Wildl. Serv., Bur. Sport Fish. Wildl. (Wildlife Series No. 94) 56 pp.

170. Krefting, Laurits W. 1963. Beaver of Isle Royale. (Minnesota) Naturalist 14 (2): 2-11.

ABSTRACT: A popular account with photos, this article notes that old dams and beaver-cut stumps were observed in 1847 on Isle Royale, but fresh beaver sign was not noted until 1878. By 1930 beaver were fairly common everywhere. By the late 1940s there were 150-200 colonies, followed by a die-off. The cause was thought to be food depletion. Effects of predation by red fox, coyote and wolf were thought to be slight when food supply was adequate.

171. Krefting, Laurits W. 1969. Rise and fall of the coyote on Isle Royale. (Minnesota) Naturalist 20 (4): 24-31.

ABSTRACT: This popular article with photos gives the history of the coyote on Isle Royale. Reasons for the rise and then disappearance of this species on the island, over a period of less than 60 years, are discussed. This is the only documented island situation where the timber wolf replaced the coyote. The habitat was always marginal, and became more so with strict fire suppression policy. Competition and predation by wolves are thought to have caused the coyotes extirpation from the island.

172. Kuhn, William G. 1975. Dynamics of reproduction, growth, and survival of the bluegill population in Barney's Lake, Beaver Island, Charlevoix County MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.

ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

173. Kurita, Hiroko and J. P. Ludwig. 1988. Embryonic teratologies and abnormalities assessed in naturally-incubated eggs of double-crested cormorants (*Phalacrocorax auritus*) and caspian terns (*Hydroprogne caspia*) from Michigan Great Lakes colonies in 1988. Bay City, MI: Ecological Research Services, Inc. Draft 2 in: Report consisting of four manuscripts to the Michigan Audubon Society on the 1986-1988 findings of the Michigan colonial waterbird monitoring project. 41 pp.

ABSTRACT: Frequency and types of deformities in embryos were detailed. Results suggested that environmental contaminants were ubiquitous in the Great Lakes, but worse in some areas than others. In particular, lipid-soluble highly toxic contaminants are apparently present at embryologically lethal levels in Green Bay and Saginaw Bay. Cormorants are suggested as a highly sensitive and accurate biomonitor of toxic chemical effects.

174. LaCore, Ivan A. 1970. The distribution, nesting and behavior of the spotted sandpiper (*Actitis macularia*) on Beaver Island, Charlevoix County, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.

ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

175. Lambert, Anne and B. Ratcliff. 1979. A survey of piping plovers in Michigan: 1979. 37 pp.

ABSTRACT: The entire mainland shore of Michigan on Lakes Michigan, Huron, Erie, St. Clair and Superior, and Big Charity Island, Drummond Island, Beaver, High, Squaw, Whiskey, Trout, South Fox and South Manitou Islands were surveyed. Thirty-one mated pairs and 14 single adults were found at 27 locations. Of the islands, only High and Beaver Islands had plovers.

176. Larson, R. J. 1968. The Mott Island conglomerate, Isle Royale National Park, Michigan. Houghton, MI: Mich. Tech. Univ. Master's thesis. 76 pp.

177. Lavalley, Steven. No date, cir. 1985. Site evaluation for reintroducing peregrine falcons in Michigan's Upper Peninsula. Unpub. rept. 70 pp.

ABSTRACT: This study examined 6 potential peregrine hacking sites. Acres of openings within 10 miles of each site were mapped. Mean prey availability was calculated from field work and breeding bird atlas data. Great horn owls were censused, and contaminants in food base were evaluated. The sites were Bear Bluff (Keweenaw Co.), Burnt Bluff (Delta Co.), Trap Hills (Ontonagon Co.), Ives Mountain (Marquette Co.), Grand Portal (Alger Co.), Grand Island (Alger Co.). Each site was given a habitat suitability index based

on habitat, prey, and disturbance. Trap Hills came out highest, Grand Island second, followed by Portal, Burnt, Bear and Ives sites.

178. Lawler, William P. 1938. Michigan Islands. Mich. Hist. Mag. 23 (3): 281-310.
ABSTRACT: Cultural history of a number of Michigan Islands is given. From Isle Royale to the Detroit River, the major islands in the major island groups are described.
179. Lederle, Patricia E., W. C. Scharf, G. Shugart and M. Fitch. 1985. Size variation in *Peromyscus maniculatus gracilis* from the Beaver Islands. Jack-Pine Warbler 63: 110.
ABSTRACT: Mice from Gull Island, the westernmost and most isolated of the Beaver Group, were found to be larger than those from other islands in the archipelago. This may indicate a different source for founder populations on Gull Island, possibly the Upper Peninsula.
180. Linn, Robert M. 1962. Forests and trees of Isle Royale National Park. Wolf's Eye 6 (1): 1-34.
181. Linn, Robert M. 1957. The spruce-fir, maple-birch transition in Isle Royale National Park, Lake Superior. Durham, NC: Duke Univ. Ph.D. dissertation. n.p.
182. Linton, Mary C. and L. B. Kats. 1987. A survey of the herpetofauna of the Manitou Islands. Unpub. rept. 4 pp.
ABSTRACT: A 1987 field survey for herps of both N. and S. Manitou Islands is reported. Methods employed were looking under objects and wading inland lake shores. Most of the species found in previous studies were found again in this study, but abundances were different for some species.
183. Linton, Mary C., L. B. Kats, R. A. Linton and W. C. Scharf. 1988. Update of the salamanders of the Manitou Islands. Jack-Pine Warbler 66: 121-122.
ABSTRACT: Spotted salamanders were found on both N. and S. Manitou Is. for the first time in 1984 (S.) and 1987 (N.). The authors also note a shift in collections of red and grey color morphs of red-backed salamanders on the Manitous to predominantly red in their 1987 collection.
184. Liston, C. R.; McNabb, C. D.; Duffy, W.; Ashton, D.; Ligman, R.; Koehler F.; Bohr, J.; Fleischer, G.; Schuette, J.; Yanusz, R. 1983. Environmental baseline studies of the St. Marys River near Neebish Island, Michigan, prior to proposed extension of the navigation season. U.S. Fish and Wildl. Serv.
185. Long, C. A. 1978. Mammals of the islands of Green Bay, Lake Michigan. Jack-Pine Warbler 56: 59-82.

ABSTRACT: Long described the mammals in the chain of islands from the Door Peninsula in Wisconsin to the Garden Peninsula in Michigan, and compared and contrasted these with the mammals of Chambers Island, which lies to the south in Green Bay, and is geologically and ecologically distinct from this chain (called the Grand Traverse Islands). In particular, Washington, Rock, St. Martin, Poverty, Big Summer and Little Summer islands were surveyed.

186. Long, Charles A. 1974. Mammals of the Lake Michigan Drainage Basin. Argonne, IL: Argonne National Laboratory. (ANL/ES-40 vol. 15) 108 pp. Environmental status of the Lake Michigan region 15

ABSTRACT: Information on the mammals of the Lake Michigan drainage basin was compiled. Included were descriptions of each species with such topics as aesthetic attributes, value, status, and distribution. A distribution county map accompanied each species. Island occurrences are noted.

187. Long, Charles Alan, J. E. Long and C. A. Long. 1987. A listing of known amphibians and reptiles from Washington Island, Lake Michigan, with new records of the milk-snake and red-bellied snake. Jack-Pine Warbler 65: 39.

ABSTRACT: New records for the milk snake and red-bellied snake on Washington Island, Wisconsin, were reported in this paper. This island was the first record of milk snakes on the islands of the Grand Traverse chain. All other known amphibians and reptiles from the island are listed.

188. Long, Charles Alan and C. A. Long. 1976. Some amphibians and reptiles collected on islands in Green Bay, Lake Michigan. Jack-Pine Warbler 54: 54-58.

ABSTRACT: Amphibians and reptiles collected in the summers of 1974-1975 on the islands lying between the Door Peninsula, WI, and the Garden Peninsula, MI, in northwestern Lake Michigan are reported here. The surveys covered St. Martin, Rock, Poverty, Big Summer, Little Summer, and Washington Islands, in Wisconsin, and Delta County, MI.

189. Long, Charles Alan, J. E. Long and C. A. Long. 1978. Some amphibians and reptiles from Chambers Island, Green Bay, Lake Michigan. Jack-Pine Warbler 56: 46-47.

ABSTRACT: The herps of Chambers Island, Wisconsin were listed with descriptions of habitat. The acid nature of soils on this island are noted and contrasted with the alkaline soils of the nearby Grand Traverse Islands.

190. Ludwig, James P. 1984. Decline, resurgence and population dynamics of Michigan and Great Lakes double-crested cormorants. Jack-Pine Warbler 62: 91-102.

ABSTRACT: After a decline during the 1960s and 1970s, double-crested cormorants were found to be recovering and in the early phase of a classic population explosion in the early 1980s.

191. Ludwig, James P. 1982. Report on spring-early summer, 1982 survey for nesting and individual peregrine falcons in Michigan at historic sites and areas believed to be acceptable peregrine habitat. Iron River, MI: Ecological Research Services, Inc. Unpub. rept. for MI Natural Features Inventory. 43 pp.
ABSTRACT: All historic sites were surveyed for peregrines. None were found, and virtually none were seen anywhere near any of these sites. Sites were evaluated for current potential for the species, and recommendations as to suitable hacking sites were made.
192. Ludwig, James P. 1979. Present status of the Caspian tern population of the Great Lakes. Mich. Acad. XIII: 69-77.
ABSTRACT: Data on banded birds and nest colonies from the U.S. and Canada showed that Caspian terns were reproducing successfully in Canada, but populations were declining in the U.S. Canada populations were serving as the source of about 40% of the U.S. nesting birds. The author suggested that research on U.S. populations should be curtailed, or limited until the population showed a rebound. Specific islands were not mentioned by name.
193. Ludwig, James P. 1962. A survey of the gull and tern populations of Lakes Huron, Michigan, and Superior. Jack-Pine Warbler 40: 104-119.
ABSTRACT: Ludwig inventoried the gull and tern nesting colonies of most of Lake Huron (not Saginaw Bay), northern Georgian Bay, St. Marys River, southern shore of Lake Superior west to Baraga County, the Beaver, Fox and Mackinac Straits islands (but not the Manitous), and the Green Bay (Grand Traverse) islands. Herring and ring-billed gulls, common and Caspian terns were included, and their numbers at each nesting site for 1 or more dates are recorded. Herring gulls were most widely distributed. Ring-billed gulls were expanding rapidly, and competing with common terns for nest areas. Common terns were variable in population size, and Caspian terns were the fewest in number, but perhaps increasing.
194. Ludwig, James P. 1980. A survey of substrates, soils, biota and potential for management of 88 U.S. Bureau of Land Management Island Properties from Sault Ste. Marie and Cedarville eastward to Canada in Michigan. Iron River, MI: Ecological Research Services, Inc. Unpub. rept. 11 pp + tables and appendices.
ABSTRACT: This report presents the results of brief visits to islands in 1980. Information recorded includes physical description, geological substrate, soils, and general vegetation characteristics. Flora, fauna, and natural community information is preliminary. This is a good companion reference for Voice et al, 1982, and Penskar and Ludwig, 1981.
195. Ludwig, James P. and D. D. Bromley. 1988. Observations on the 1965 and 1966 mortalities of alewives and ring-billed gulls in the Saginaw Bay-Lake Huron ecosystem. Jack-Pine Warbler 66: 2-19.

ABSTRACT: Field observations during the 1965-66 alewife and waterbird die-offs confirmed laboratory studies by other authors that the primary cause of death was botulism. Some organochlorine chemical poisoning was also apparent. The birds avoided the putrefied dead fish whenever alternate food was plentiful.

196. Ludwig, James P., C. N. Hull, M. E. Ludwig and H. J. Auman. 1989. Food habits and feeding ecology of nesting double-crested cormorants in the Upper Great Lakes, 1986-1989. *Jack-Pine Warbler* 67: 114-126.

ABSTRACT: Diet of double-crested cormorants was compared across different regions of the Upper Great Lakes and across seasons. From the data it is clear that the species is not a major consumer of commercially important fish species in the Great Lakes. Regional dietary differences were found between N. Green Bay, N. Lake Michigan (Beaver Islands), N. Lake Huron, and N. Channel and Georgian Bay Canadian colonies. Alewives are by far the greatest part of the diet of cormorants in all locations except the N. Channel and Georgian Bay colonies. In these colonies, consumption of yellow perch is nearly as great as the consumption of alewives.

197. Ludwig, James P., H. Kurita, M. E. Ludwig and J. W. Ludwig, Victoria J. Ludwig. 1988. Productivity, egg hatchability and chick survival in four double-crested cormorant and three caspian tern colonies of Michigan 1986-1988: possible relationships of toxic contamination to selection. Bay City, MI: Ecological Research Services, Inc. Review Draft 1 in Report consisting of four manuscripts to the Michigan Audubon Society on the 1986-1988 findings of the Michigan colonial waterbird monitoring project. 49 pp.

ABSTRACT: Presents data on reproductive success and shows decreases in both hatchability and chick survival for Caspian terns, but less so for double-crested cormorants. Differences in diets and behavior are discussed and hypotheses about trends and differences between species are put forth.

198. Ludwig, James P. and M. P. Ludwig. 1986. Productivity and deformities in chicks of the Michigan Great Lakes' colonies of double-crested cormorants (*Phalacrocorax auritus*) and Caspian terns (*Hydroprogne caspia*) in 1986. Ecological Research Services, Inc. 30 pp + appendices.

ABSTRACT: Tissue samples were taken from the Michigan colonies of each species for analysis of toxins. Reproductive parameters and deformities were noted and compared to previous years and among regions.

199. MacMullan, R. A. 1948. Pheasants on Pelee Island. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 990) 4 pp.

ABSTRACT: The pheasant population, along with the physical conditions and predators were described for Pelee Isl., Ontario, an island 50 mi se of Detroit in the Pt. Pelee - Sandusky archipelago, Lake Erie.

200. Manny, Bruce A.; Edsall, Thomas A.; Jaworski, Eugene. 1988. The Detroit River, Michigan: an ecological profile. 86 pp. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.17).
ABSTRACT: This report summarized existing scientific information on the ecological structure and functioning of this ecosystem. Topics included the geological history of the region, climatic influences, river hydrology, lower trophic-level biotic components, native and introduced fishes, waterfowl use, ecological interrelationships, commercial and recreational uses of the river, and management issues. The report concluded that the wetlands associated with the publicly owned river islands were of prime importance in maintaining and enhancing the diverse fish, waterfowl and benthic populations that the river still supported.
201. Manville, R. H. 1951. A small island community in midsummer. *Ecology* 32: 608-617.
ABSTRACT: This paper presents results of a rather thorough study of Little Rogg Island, a small island (9.5 acres) in Potagannissing Bay, North Channel, Lake Huron. The island experienced a severe fire about 40 years prior to this study. Vegetation is described, including a list of herbaceous plants and trees and shrubs. Invertebrates are also listed, but the list is incomplete. Only one frog and one snake were found, and 25 bird species at least visited the island during this month-long study. The author thought that there were only 18 breeding pairs on the islands, and located only 5 nests. Only 8 species of mammals were found.
202. Manville, Richard H. 1948. The Huron Island rookery. *Jack-Pine Warbler* 26: 152-155.
203. Manville, Richard H. 1950. The mammals of Drummond Island, Michigan. *J. Mammal.* 31: 358-359.
ABSTRACT: This list is compiled from the author's own field work and the observations of some residents. The author notes that more thorough collecting could disclose additional species of shrews, bats, and rodents.
204. Master, Lawrence L. 1982. Smoky shrew: a new mammal for Michigan. *Jack-Pine Warbler* 60: 28-29.
ABSTRACT: The first record of the smokey shrew in Michigan on Sugar Island, Chippewa County was reported here. The species was found by pitfall trapping in northern hardwood (hemlock, sugar maple and white birch). The species was possibly new to the state, arriving from Canada, or may have been previously overlooked due to lack of pitfall trapping in suitable habitat.
205. Master, Lawrence L. 1979. Some observations on great gray owls and their prey in Michigan. *Jack-Pine Warbler* 57: 215-217.
ABSTRACT: Great gray owls were present on Neebish Island, Chippewa County, in the winter of 1978-79. The owls were found to feed mainly on voles and short-tailed shrews. They fed during the

daylight and were quite tame, as is usually the case for this species.

206. McBeath, Donald Y. 1941. Report of deer and winter range conditions on Drummond Island February - March, 1941. Lansing, MI: Mich. Dept. Cons. (Game Div. Report #617 or 624 (2 c.) 10 pp.
ABSTRACT: This report described the condition of the vegetation with respect to deer browse in several deeryards on the island, and briefly on Meade Island. Notes about coyotes, hares and mice were included.
207. McCann, Robert. 1975. The terrestrial vertebrates of the Sleeping Bear Region of Michigan. Douglas Lake, Pellston and Ann Arbor, Michigan: Univ. Mich. Biol. Sta. A final report submitted to the Nat. Park Serv. 33 pp.
ABSTRACT: This summarizes previous literature from the mainland and the Manitou Islands, and field survey results obtained during June and July, 1973 on the mainland. The list is annotated, and those taxa found on the islands are noted. The report ends with recommendations to minimize recreational use impacts on vertebrate fauna.
208. McCreary, Otto. 1909. The ecological distribution of the birds of Isle Royale, Lake Superior. pp 81-96 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: This was Chapter 3 of the report on ecological investigations by the University Museum of the University of Michigan in 1904 and 1905. Birds from Light-house Peninsula, McCargoe Cove, the western end of Rock Harbor, and Siskiwit Lake areas were described in relation to habitats.
209. McCullough, G. B. 1982. Wetland losses in Lake St. Clair and Lake Ontario. pp 81-89 in: A. Champagne (ed.). Ontario Wetlands Conference. Sept. 1981, Ryerson Polytech. Inst., Toronto, Ontario.
210. McKaig, D. M. 1978. Past and present forests of Isle Royale National Park. Houghton, MI: Mich. Tech. Univ. Master's thesis. 81 pp.
211. Mech, L. David. 1966. The wolves of Isle Royale National Park. Washington, D.C.: Superintendent of Documents. (U.S. National Park Service Fauna Series No. 7) 210 pp.
ABSTRACT: This reports on the author's extensive research on wolves in Isle Royale.
212. Meeks, R. L. and R. D. Hoffman. 1980. Bird populations common to the Sister Islands--the role of Navarre Marsh. Toledo, OH: Toledo Edison Co. 60 pp.
213. Menapace, Francis J. and D. E. Wujeck. 1987. *Carex bushii* Mack., a sedge new to Michigan. Mich. Botanist 26: 167-168.

ABSTRACT: Extensive collections of sedges during July of 1985 on Beaver Island turned up 5 species new to the island, including one new to Michigan (*Carex bushii* Mack.). Others were *C. buxbaumii*, *C. granularis*, *C. lanuginosa*, and *C. scabrata*.

214. Metzger, Frederick T. 1974. No title. [Grand Island RNA]. St. Paul, MN: North Central Forest Experiment Station, USDA, Forest Service. 7 pp.

ABSTRACT: This report described important features of this undisturbed northern hardwoods tract at the north end of Grand Island in Lake Superior. Beech is a major component of this forest, and this site is near the northwestern limit of the species in North America.

215. Michigan Nature Association. No date. Bird Island in Thunder Bay. MNA. 1 p.

ABSTRACT: A brief description of this small island, home to a very large colony of ring-billed gulls in 1969, is given in this small tract.

216. Michigan Nature Association. No date. Charles E. Zeerip Memorial Plant Preserve. Mount Clemens, MI: MNA. 2 pp.

ABSTRACT: A brief description of a small preserve on Drummond Island, Chippewa County, MI. Fourteen species of orchid are reported to occur on the 6.2 acre preserve. Vegetation is largely stunted spruce woods, but balsam fir and cedars also occur.

217. Michigan Nature Association. No date. Gull Island Nature Sanctuary. MNA. 4 pp.

ABSTRACT: This tract describes MNA-owned Gull Island in Thunder Bay, and the herring gulls, great blue herons and black-crowned night herons that nested there in 1969 when the island was acquired.

218. Michigan Natural Areas Council. 1960. South Manitou Island Site Committee Report. MNAC. Unpub. Rept. # 62. 4 pp + app.

ABSTRACT: This brief report describes the island and its history, the geology, vegetation, notable plants and animals, and human use. It presents recommendations for the preservation of natural features, including a preserve along the western border of the island encompassing the perched dunes and adjoining forest, and a nature study area at Gull Point on the northeastern shores of the island.

219. Michigan Nature Association. No date. Two Wilderness Islands Nature Sanctuary. 2 pp.

ABSTRACT: This tract describes the MNA Two Wilderness Islands Nature Sanctuary. The two islands names have been changed and locations are not provided in the literature for the public, to protect the nesting birds. The islands supported nesting colonies of Caspian tern, double-crested cormorant, and

black-crowned night heron in 1979 when the islands were acquired by MNA.

220. Mikula, E. J. 1968. Importance of Celeron Island to waterfowl. Lansing, MI: Michigan Department of Conservation, Game Division. (Information Circular No. 149) 2 pp.
ABSTRACT: Describes island use by migrating waterfowl in spring and fall. As many as 155,000 ducks had been known to use the area in spring, and as many as 352,000 in fall. In addition, whistling swans frequent the area in spring. The island has an extensive shallow-water area surrounding it (particularly in high-water periods), and this provides good feeding areas.
221. 1979. B. A. Miller 1979. Lansing, MI: Michigan Dept. Nat. Resour., Fish Div. (Tech. Rep. No. 80-1) 24 pp.
222. Miller, H. J. 1945. Report on waterfowl food plantings at Middle Grounds on Saginaw Bay - Spring 1945. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 914) 7 pp.
ABSTRACT: Various aquatic plants were planted using hand labor. Results are noted.
223. Miller, J. S. 1943. Waterfowl survey, Saginaw Bay-Lake St. Clair-Lake Erie. Lansing, MI: Michigan Department of Natural Resources. (MDNR Proj. No. 13-R) 132 pp.
224. Miller, Norton G. and R. L. Halbert. 1971. A collection of bryophytes from Summer Island, Delta County, Michigan. Mich. Botanist 10: 3-13.
ABSTRACT: The authors reported 130 species of bryophytes collected during several days in July, 1968, on Summer Island, in northwestern Lake Michigan. This was the first report of bryophytes from the island, and Delta County had not been well explored for this group. The collection included 35 hepatics and 95 mosses, and two species evidently previously unreported in Michigan.
225. Moran, R. J. 1964. Bobcat found on Lake Michigan island. J. Mammal. 46: 645.
ABSTRACT: A dead bobcat was found on the southeast corner of Garden Island, in the Beaver group, Lake Michigan. The animal was of moderate age, and was the only documented case of bobcat on the Beaver Islands. The author suspects this was a wandering individual, but notes that Garden Island had not been well-surveyed for animals, and it was possible that a population existed on this and other small isolated islands of the group.
226. Morgan, Dennis R. 1977. The Potamogetonaceae of Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.

227. Morris, R. D., R. A. Hunter and J. F. McElman. 1976. Factors affecting the reproductive success of Common Tern (*Sterna hirundo*) colonies on the lower Great Lakes during the summer of 1972. *Can. J. Zool.* 54: 1850-1862.
228. Morse, A. P. 1909. Report on the Isle Royale Orthoptera of the 1905 Expedition to Isle Royale. pp 299-304 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905.
229. Murie, Adolph. 1934. The moose of Isle Royale. Univ. Mich. Mus. Zool. (Misc. Publ. No. 25) pp 1-44.
ABSTRACT: Moose had become numerous since the most recent invasion (winter 1912-13). The population was estimated at greater than 1000 in 1930. Data on weights and size of adults, development and descriptions of young, hearing, smell, and vision are provided. Home range, diurnal activity, sociality, mating behavior, pests, causes of death, and percent of breeding females with calfs are all provided. The authors conclude that the island is being serious overgrazed and that a drastic population reduction is needed.
230. National Park Service. No date, cir. 1980. Bibliography - Lake Superior National Park System Areas (Apostle Islands, Isle Royale, Pictured Rocks). Omaha, Nebraska: Midwest Region, National Park Service. 92 pp.
ABSTRACT: A bibliography of published and unpublished materials on history, human activity, biology, geology of Isle Royale, the Apostle Islands, and Pictured Rocks. The most recent date on a reference is 1979.
231. National Park Service. 1985. Bibliography: Isle Royale National Park. Isle Royale National Park, an International Biosphere Reserve. 53 pp.
ABSTRACT: This is an updated version of the literature, published and unpublished, on the park. It covers biology, geology, and human history, but most references are on biological research. The sources range from scientific journals, to popular books, articles and guides, to unpublished reports.
232. The Nature Conservancy. 1980. Preserve Master Plan for Little LaSalle Island. Michigan Field Office. 26 pp.
ABSTRACT: Summarizes information on topography, flora (incomplete), fauna (incomplete), soils, geology, climatological features, and cultural history of Little LaSalle Island, Clark Township, Mackinac County, Michigan. Also has maps of preserve design, and protection, and scientific use objectives.

233. The Nature Conservancy. 1988. [Proposal for Natural Area Designation for Hog Island]. Michigan Chapter, TNC. 5 pp + figures.
ABSTRACT: Hog Island, in the Beaver Archipelago, was undeveloped, and about 98% state-owned at time of preparation of this report. Natural beauty and significance for research are cited as important values. Has high quality Great Lakes marsh and interdunal wetlands, as well as three state-listed shoreline plant species. Note that Grape and Tim's islands are considered extensions of Hog island beach.
234. The Nature Conservancy. 1988. Untitled [Hog Island]. Lansing, MI: Michigan Chapter, TNC. 5 pp + figures.
ABSTRACT: This Natural Area nomination form for Hog Island describes the significant natural features of the island and justifies its designation as a dedicated natural area.
235. The Nature Conservancy, Michigan Field Office. 1980. Preserve Master Plan for Little LaSalle Island. Lansing, MI: TNC, Mich. Field Off. 15 pp.
ABSTRACT: The topography, flora, fauna, soils, geology, climate, and cultural history of Little LaSalle Island, Mackinac County, Michigan, are described. Incomplete plant, bird, and mammal lists are provided.
236. Needham, James G. 1909. Neuropteroid insects from Isle Royale, Michigan. pp 305-307 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.
237. Nichols, Gary E. and R. C. Stones. 1971. Occurrence of red bats near and on Isle Royale in Michigan. Jack-Pine Warbler 49: 130-131.
ABSTRACT: A first report of this species on Isle Royale. Bats were found mating.
238. Nickell, Walter P. 1966. The nesting of the black-crowned night heron and its associates. Jack-Pine Warbler 44: 130-139.
ABSTRACT: Results of a 6 year breeding season study on Harsens Island, St. Clair County, Michigan, and Walpole Island, Kent County, Ontario. Type of nesting site, nesting dates, chronology, clutch size, behavior and food of young, enemies, migration, longevity and nesting associates are all discussed.
239. Nielsen, Mo. 1983. Collecting lepidoptera on Isle Royale. Michigan Entomological Society Newsletter 28 (No. 1).
ABSTRACT: This brief account of lepidopterans collected by the author and others on Isle Royale, MI, includes a list of 32

butterfly and 13 moth species. Abundance is ranked either numerous or scarce. The list is not comprehensive.

240. Ozoga, John J. and C. J. Phillips. 1964. Mammals of Beaver Island, Michigan. Publications of the Museum - Michigan State University, Biological Series 2 (6): 305-348.
ABSTRACT: This is a thorough treatment of the mammal fauna of Beaver Island, including a species list, a discussion of means of arrival of the different species, and species accounts. It is well researched, including comprehensive literature search and field work.
241. Paterson, Robert L., Jr. 1982. Passerine community structure at the beech-maple coniferous forest interface. *Jack-Pine Warbler* 60: 15-21.
ABSTRACT: Breeding passerines were censused in two forest types on Beaver Island, Michigan during June and July 1976. Fewer species were breeding in the beech-maple than the mixed-coniferous forest. The same pattern did not hold in mainland forests. The author suggested that the greater structural diversity of mixed-conifers could not explain this difference, and hypothesized that differential immigration rates for birds associated with the two community types might be responsible.
242. Peet, Max M. 1909. Annotated list of the birds of Isle Royale. pp 337-388 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Observations made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.
243. Peet, Max M. 1909. The fall migration of birds at Washington Harbor, Isle Royale, Lake Superior. pp 97-120 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: This was chapter 4 in the report of the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905. Topics covered included the environment, weather and migrants, six large bird waves, routes of migration and perils of migration.
244. Penskar, Michael R. 1981. Harbor Island in Potagannissing Bay: a partial inventory. *Mich. Natural Features Inventory*. 3 + figures.
ABSTRACT: This is a partial flora of the island, that was produced in conjunction with the Ludwig-Penskar BLM islands survey. Contains a list of plants, as well as descriptions of the vegetation types searched.
245. Penskar, Michael R. 1981. A summer survey of 35 islands owned by the BLM in Michigan in the St. Mary's River & Lake Huron for rare,

threatened & endangered plants & animals. Iron River, MI: Ecological Research Services, Inc. Unpub. rept. 88 pp.

ABSTRACT: This report of 1981 field work includes qualitative descriptions of islands, plus flora and fauna lists. The survey was directed at rare species, but flora is probably fairly complete, as each island was visited twice. It covers 37 of the "most promising" islands in the eastern Upper Peninsula, including the St. Mary's River. Refer to Ludwig, 1980 for geology, soils, and general community descriptions.

246. Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. Washington, D.C.: U.S. Government Printing Office. (U.S. Natl. Park Serv. Sci. Monogr. Series 11) 210 pp.

247. Peterson, Rolf O. 1991. Ecological Studies of Wolves on Isle Royale. Ecological studies of wolves on Isle Royale. Houghton, MI: Isle Royale Natural History Association. (Annual Report - 1990-1991) 14 pp.

ABSTRACT: This is the thirty-third year of research. Previous annual reports appeared under the same title. Wolf population dropped to 12, the lowest since the annual censuses began in 1959, and reproductive success was poor. The author called the outlook for wolves "bleak" unless trends in reproduction are quickly reversed. The explanation for low reproduction may be inbreeding depression, disease or food problems, but evidence was not conclusive. Wolf predation was too low to control moose population growth.

248. Pettingill, Olin S. Jr. 1958. Notes on the birds of the Straits Region, Michigan. Jack-Pine Warbler 36: 7-11.

ABSTRACT: An annotated list of some records obtained since 1946 from the Straits Region, including Mackinac County just north of the Straits, Green Island, and a few locations south of the straits on the Lower Peninsula, especially Grass Bay (Cheboygan County).

249. Phillips, C. J., J. J. Ozoga and L. C. Drew. 1965. The land vertebrates of Garden Island, Michigan. Jack-Pine Warbler 43: 20-25.

ABSTRACT: This is the first published account of the mammalian fauna of Garden Island, the second largest island in the Beaver Archipelago. The list was prepared from knowledgeable sources, as well as from field work by the authors. Thirteen species were found to have occurred on the island, but one, the caribou, was reported as a "visitor," and another, the bobcat, was known only from one dead specimen. The origin of the fauna was not definitively determined from this study.

250. Phillips, E. A. 1976. Changes in the phytosociology of boreal-conifer-hardwood forests on Mackinac Island, Michigan, 1934-1974. Am. Midl. Naturalist 96: 317-23.

ABSTRACT: Stands studied by Potzger in 1934 were re-studied in 1974. Over this time-period, American beech became second in

basal area and first in importance value in the hardwood stands on the higher center of the island. These stands increased in basal area, while number of trees remained almost the same. The boreal conifer forest on the lower island periphery changed little in composition, except that white pine increased in dominance from 5th to 2nd, while spruce and fir declined. Maple was invading some conifer stands. Basal area increased while number of trees declined in boreal forests.

251. Pike, Edward A. and R. A. Wolinski. 1984. A survey of the piping plover in Michigan: 1984. Unpublished report to MI DNR. 11 pp.
ABSTRACT: Statewide survey discovered only 13 pairs of piping plovers nesting in Michigan in 1984. One pair was on North Manitou Island. No other island breeding plovers were found.
252. Pike, Edward A. and R. A. Wolinski. 1984. A survey of the piping plover in Michigan: 1985. Unpublished report to MI DNR. 11 pp.
ABSTRACT: In 1985, statewide surveys found 19 pairs of piping plovers nesting in Michigan at eight locations. Plovers nested unsuccessfully on North Manitou Island.
253. Poole, Morgan, R. Babcock, P. W. Thompson, G. W. Thomson and E. Voss. No date. Bois Blanc Island Survey. Michigan Natural Areas Council. 5 pp.
ABSTRACT: This report describes the natural vegetation of the island and recommends 3 areas be designated Nature Study Areas (Beach Ridge Hardwood Forest, Snake Island-Mud Lake, north uncut portion of Section 6). Two other areas are recommended for Nature Reservations (Central Woodland Area and the Mixed Forest Area in Sect. 6 & 7). The Northshore Tract was recommended for Natural Beauty Road, classed as a Scenic Site.
254. Potzger, J. E. 1954. Post-Algonquin and post-Nipissing forest history of Isle Royale, Michigan. *Butler Univ. Botanical Stud.* XI: 200-209.
255. Potzger, J. E. 1944. The vegetation of Round Island (Straits of Mackinac), Michigan. *Butler Univ. Bot. Stud.* 6: 116-122.
ABSTRACT: This description of the vegetation of this small island includes a list of 84 plant species collected in two days in August during 1935 and 1936.
256. Povah, A. H. W. 1935. The fungi of Isle Royale, Lake Superior. *Pap. Mich. Acad. Sci. Arts Lett.* 20: 113-156.
ABSTRACT: The collections reported here were primarily made in 1930. A total of 231 genera, 525 species, and 5 forms were recorded. In addition to Isle Royale proper, collections were also made on Birch Island (McCargo Cove), Ryan and Wright Islands (Siskiwit Bay).
257. Powell, Abby N. 1990. Eastern wood-pewee attempts to feed killdeer chicks. *J. Field Ornith.* 61: 214-216.

ABSTRACT: An eastern wood-pewee, apparently attracted by chick calls, attempted to feed to captive killdeer chicks throughout one day. Observations were made on High Island, Lake Michigan.

258. Powell, Abby N. 1991. Great Lakes piping plovers: recovery or extirpation? *Endang. Species Update* 8 (9&10): 1-2, 4.
ABSTRACT: The Great Lakes piping plover population remained relatively stable since listed as endangered under federal Endangered Species Act in 1976. However, the population was so small in 1991 that it was very vulnerable to extirpation. The author argued that the Great Lakes population is an important link between East Coast and Great Plains populations of plovers. A recovery plan was called for which would include habitat protection and perhaps captive rearing and population augmentation.
259. Powell, Abby N. and F. J. Cuthbert. 1993. Augmenting small populations of plovers: an assessment of cross-fostering and captive-rearing. *Conservation Biol.* 7: 1-9.
ABSTRACT: Captive-reared, cross-fostered and parent-reared killdeer were compared. Spotted sandpiper in the wild were used for cross-fostering. Captive rearing produced the highest success rate, and the birds behavior when released appeared normal. Cross-fostering was equally successful and parent-rearing. All killdeer chicks responded to adult killdeer alarm calls. Captive-rearing is suggested to be a viable technique to use for augmenting piping plover populations.
260. Powell, Abby N. and F. J. Cuthbert. 1992. Habitat and reproductive success of Piping Plovers nesting on Great Lakes islands. *Wilson Bull.* 104: 155-161.
ABSTRACT: Piping plovers tended to nest behind the foredune on Beaver and High Islands. Beach width from water to foredune was between 20 and 30 m, and behind foredune was wider. Distance to trees was greater than 400 m. Reproductive success varied from 0.4 to 2.5 chicks fledged per nest.
261. Prescott, Gerald W. 1941. A concluding list of Desmids from Isle Royale, Michigan. *Mich. Acad.* 26: 23-29.
ABSTRACT: This list includes 32 species and varieties, and is the last in a series of four, published in the same journal since 1937.
262. Prescott, Gerald W. 1940. Desmids of Isle Royale, Michigan. The genera *Staurostrum*, *Micrasterias*, *Xanthidium* and *Euastrum*, with a note on *Spinoclosterium*. *Mich. Acad.* 25: 89-100.
ABSTRACT: This list, 3rd in a series of 4 in same journal (1937-1941), contains 58 species and varieties, mostly different from those of previous lists.

263. Prescott, Gerald W. 1938. Further notes on the Desmids of Isle Royale, Michigan. The genus *Cosmarium*. Mich. Acad. 23: 203-213.
ABSTRACT: This paper, 2nd in a series of 4 in the same journal (1937-1941), includes 62 species and varieties of the genus *Cosmarium*. Isle Royale is particularly rich in large species of this genus.
264. Prescott, Gerald W. 1937. Preliminary notes on the Desmids of Isle Royale, Michigan. Mich. Acad. 22: 201-214.
ABSTRACT: This is the first of a series of 4 papers published in the same journal (1937-1941). It includes 75 species. Presumably some of these are repeated in later lists (esp. genus *Cosmarium*).
265. Profant, D. 1991. An annotated checklist of the Lepidoptera of the Beaver island Archipelago, Lake Michigan. Great Lakes Entomologist 24: 85-97.
ABSTRACT: A survey of Lepidoptera was conducted in 1987 and 1988 on Beaver Island, Lake Michigan. When combined with a 1930 survey of the Beaver Island Archipelago, this new data brings the total lepidopteran fauna of the islands to 757 species from 41 families.
266. Pruitt, W. O. 1951. Mammals of the Chase S. Osborn Preserve, Sugar Island, Michigan. J. Mammal. 32: 470-472.
ABSTRACT: This brief list of mammals known from the 3144 acre Chase S. Osborn Preserve (Sugar Island, Chippewa County, MI) reflects field trapping of small mammals by the author and observations of large mammals by the preserve caretaker. The list is annotated with the Chippewa dialect names and with habitat and abundance notes.
267. Rahrer, J. F. Age, growth, maturity, and fecundity of "humper" lake trout, Isle Royale, Lake Superior. Trans. Am. Fisheries Soc. 94: 75-83.
ABSTRACT: A race of lake trout on a reef south of Isle Royale (east end of island) was found to be smaller than "lean lake trout." The slow growth, as well as age of reproductive maturity, fecundity, growth rate, and number of years to legal size are all given.
268. Rakowski, Barbara A. 1978. Qualitative and quantitative algal phytoplankton and chemical analyses, Lake Geneserath, Beaver Island, Charlevoix County, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.
269. Raphael, C. N. and E. Jaworski. 1982. The St. Clair River Delta: a unique lake delta. Geogr. Bull. 21: 7-28.

270. Reynolds, Albert. 1942. Drummond Island Deer Hunting Investigations, 1942. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 710) 6 pp.
ABSTRACT: Reports on the number and estimated ages of deer harvested from the island in 1938. Notes on rabbits, bear, prairie chicken, wolf, ruffed grouse, weasel, spruce hen, coyote, sharptail grouse observed by hunters are also included.
271. Reynolds, Albert. 1944. Drummond Island Deer Hunting Investigations, 1943. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 771) 13 pp.
ABSTRACT: Reports on the number and estimated ages of deer harvested from the island in 1938. Notes on rabbits, bear, wolf, fox, coyote, observed by hunters are also included. Snow depth and weather for Nov 15-30 are tabulated. The report discusses at length the poor condition of the winter deeryards on the island (too many deer), the influence of coyotes, and the problems of too large a deer herd.
272. Richardson, William B. 1990. A comparison of detritus processing between permanent and intermittent headwater streams. J. Freshwater Ecol. 5: 341-351.
ABSTRACT: Leaf pack decomposition, and density and biomass of the invertebrate detritivores were compared in an intermittent and a perennially flowing headwater stream in autumn and spring. High and low nitrogen leaves were also compared. The intermittent stream had a depauperate shredder fauna and was numerically dominated by collectors. Lack of shredders, combined with decreased duration of submersion, resulted in reduced leaf decomposition in the intermittent relative to the permanently flowing stream. The research was performed in the Jordan River (intermittent) and Iron Ore Creek (permanent) on Beaver Island, Lake Michigan.
273. Robinson, W. L. and M. L. Amacher. 1982. Final supplemental report to potential effects of winter navigation on movements of large land mammals in the eastern Lake superior and St. Marys River area. U.S. Fish and Wildl. Serv. (FWS/OBS-80/61.2) 60 pp.
274. Robinson, W. L.; Jensen, R. W. 1980. Effects of winter navigation on waterfowl and raptors in the St. Marys River area. Detroit, MI: U.S. Army Corps Eng. (DACW-35-30-X-0194) 102 pp.
275. Robinson, W. L.; Jensen, W. F.; Amacher, M. L. 1982. Supplemental report to potential effects of winter navigation on movements of large land mammals in the eastern Lake Superior and St. Marys River area, 1980-81. U.S. Fish and Wildl. Serv. (FWS/OBS-80/61.1) 87 pp.
276. Rogers, Elizabeth I. and D. B. Premo. 1991. A botanical survey of Grand Island, Michigan. Amasa, MI: White Water Associates, Inc. Unpub. rept. 37 pp + appendices.

ABSTRACT: This extensive survey lists 699 species, including several state endangered/threatened/special concern species. The report is considered "confidential" and is not for general distribution because specific locations of sensitive species are included. Preliminary management recommendations to protect the islands sensitive species are included.

277. Rupp, Patricia M. 1978. Quantitative analysis of plankton diatoms in the vicinity of Beaver and Garden Islands, Charlevoix County, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.
278. Ruthven, A. G. 1909. The cold blooded vertebrates of Isle Royale. pp 325-328 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.
279. Ruthven, A. G. 1905. Spiders and insects from the Porcupine Mountains and Isle Royale, Michigan. In: C. C. Adams (ed.). An ecological survey in northern Michigan. Lansing, MI: Michigan Geolog. Surv. Annual Report.
280. Rutkowski, Darcy R. 1984. A comparison of the bryophyte component of three boreal forest post-fire successional forest types in Isle Royale National Park, Michigan. Houghton, MI: Mich. Tech. Univ. Master's thesis for Dept. of Biol. Sci.
281. Scharf, William C. 1973. Birds and land vertebrates of South Manitou Island. Jack-Pine Warbler 51: 3-19.
ABSTRACT: Vegetation of South Manitou Island is briefly described, and the origin of the fauna is briefly discussed. An annotated list of birds, mammals, amphibians, and reptiles follows. The list represents a great deal of field work by the author and others. The author expects that the lists may not yet be complete, but they do add substantially to Hatt et al.'s 1948 list.
282. Scharf, William C. 1989. Coastal great blue heron and great egret colonies of the Michigan Great Lakes. Jack-Pine Warbler 67: 53-65.
ABSTRACT: This paper reported the results of a 1987 census of coastal and island great blue heron and great egret colonies in Michigan. The entire 4-lake coast, including connecting channels, was included. This was the first complete census since 1976-77. Colony size, location, vegetation and substrate data were presented. The coastal great blue heron population increased 61.7% between 1976-77 and 1987. See vol. 67:102 for correction to Table 1.

283. Scharf, W. C. 1978. Colonial birds nesting on man-made and natural sites in the U.S. Great Lakes. Vicksburg, MS: U.S. Waterways Experiment Station. (Final Report TR D-78-10 and FWS/OBS-78/15) 136 pp.

ABSTRACT: Habitats and nesting populations of colonial nesting birds of the U.S. Great Lakes were determined by aerial census, ground nest observations, and vegetation analysis during 1976 and 1977. Thirteen species at 267 colonies were found during this 2-year study. An atlas of nesting sites and populations for both years of the study locates and gives the sizes of the colonies. Intensive vegetation and habitat studies were performed on 24 sites: 8 natural, 16 dredged material locations. Critical parameters for colonies include water table, human intrusions, predators, aircraft, plant cover, height of dikes. Site characteristics of gulls and terns are compared and contrasted.

284. Scharf, William C. 1989. Corrigendum: "Coastal great blue heron and great egret colonies of the Michigan Great Lakes". Jack-Pine Warbler 67: 102.

ABSTRACT: This correction provides a new Table 1 (for paper in 1989, vol. 67:53-65) with three corrections in number of great blue heron nests on Williams Island, Round Island and the total for 1987 colonies.

285. Scharf, William C. 1971. Critical nesting and migration areas survey: shoreline appendix of the Great Lakes Basin shoreline survey. Appendix to unpublished report for Great Lakes Basin Comm. 44 pp.

ABSTRACT: This appendix identifies 252 Great Lakes shoreland areas in the U.S.A. that are significant for nesting and migrating wildlife. The sites were gleaned from literature and local experts. The information is presented in a table that includes location by name, source of information, significance of some of the sites, threats at some sites, the species using the site, and whether for nesting or migration. Species included are: herring gull, ring-billed gull, common tern, caspian tern, black tern, great blue heron, waterfowl, eagle, osprey (nesting); waterfowl, shorebird, woodcock, passerine, hawk (migration).

286. Scharf, William C. 1991. Geographic distribution of Siphonaptera collected from small mammals on Lake Michigan islands. Great Lakes Entomologist 24: 39-43.

ABSTRACT: This paper reports the flea species found on small mammals on the islands in northeastern Lake Michigan. Implications for immigration routes of small mammals onto the islands are discussed. It appears from the flea fauna that more than one route was involved. The southernmost islands (Manitous) may have been colonized from Leelanau County, while the northernmost islands may have been colonized from the Upper Peninsula.

287. Scharf, William C. 1970. Gull Point, South Manitou Island - 1966-1969. Inland Bird Banding News 42: 6-9.

ABSTRACT: This brief paper describes and maps the gull colony on S. Manitou Isl., and discusses population trends of the two species of gulls present, Ring-billed and Herring gulls.

288. Scharf, William C. 1984. Meadow voles on Marion Island. Jack-Pine Warbler 62: 77.

ABSTRACT: Meadow voles were re-found in a small opening on the island. They apparently have become very rare because the island has become very forested following the cessation of deer over-browsing. Meadow voles are only known from one other Lake Michigan Island, Summer Island.

289. Scharf, William C. 1983. New Caspian tern colonies in Lake Huron. Jack-Pine Warbler 61: 15-15.

ABSTRACT: Three new Caspian tern colonies were found in Lake Huron in 1982 during common tern surveys. The three were on Goose Island, in the Straits of Mackinac region, Black River Island, Thunder Bay, Alcona County, and on the Channel-Shelter diked disposal site in Saginaw Bay.

290. Scharf, William C. 1981. The significance of deteriorating man-made island habitats to common terns and ring-billed gulls in the St. Mary's River, Michigan. Colonial Waterbirds 4: 155-159.

ABSTRACT: Common terns showed decreased reproductive success and unsuccessful re-nesting due to storms and wave inundation. The author suggested ways to enhance nesting habitat on man-made sites for this species.

291. Scharf, William C. and M. L. Chamberlin. 1978. Ecological inventory of Harbor Island, Chippewa County, Michigan. Unpub. rept. for The Nature Conservancy. 17 pp.

ABSTRACT: Harbor Island's highly protected harbor provides nesting habitat for several species of marsh birds and waterfowl. The upland forests include oak and maple and are used by migrating birds. The protected marsh is unusual among the rocky islands of Potagannissing Bay, and is an important stopover point for migrating waterfowl, hawks, shorebirds, and passerines. Several threatened hawks and Michigan's largest carnivores recur on the island regularly. Includes lists of birds, plants, mammals, reptiles and amphibians.

292. Scharf, William C.; Chamberlin, Michael L.; Shanks, Larry; Landin, Mary. 1979. Nesting and migration areas of birds of the U.S. Great Lakes (30 April to 25 August 1976). Washington, D.C.: U.S. Fish and Wildlife Service, Office of Biological Services. (FWS/OBS-77/2) 113 pp.

ABSTRACT: Results of a 2-yr study to evaluate the current status of migratory and colonial nesting bird species in the Great Lakes region. Population estimates, approximate nesting dates, vegetation associations, and substrates for 207 nesting sites are presented. In addition, 75 migration areas are listed, and their significance to avian populations is discussed. Includes maps of

vegetation and bird colonies on many islands, and lists of former colony sites no longer used.

293. Scharf, William C. and M. L. Jorae. 1980. Birds and land vertebrates of North Manitou Island. *Jack-Pine Warbler* 58: 4-15.
ABSTRACT: This paper describes North Manitou Island's location, glacial history and habitats in relation to the fauna. The results of field work begun in 1973 show 6 amphibians, 5 reptiles, 164 birds and 16 mammals. The additional species not found in Hatt et al. (1948) are 1 amphibian, 1 reptile, 87 birds, and 3 mammals. The island is important as a bird migration stop-over and nesting site for many species. Modes of colonization are discussed.
294. Scharf, William C. and G. Shugart. 1984. Distribution and phenology of nesting Forster's Terns in eastern Lake Huron and Lake St. Clair. *Wilson Bull.* 96: 306-309.
ABSTRACT: A rapid increase in Forster's tern nesting in the Great Lakes was documented between 1976 and 1982. The species has changed from being an uncommon nester, to a common nester in Saginaw Bay and northern Lake St. Clair. Possible reasons for the change are discussed.
295. Scharf, William C. and G. W. Shugart. 1991a. Gulls, terns, and cormorants of the Lower U.S. Great Lakes- 1990. Unpub. interim rept. to U.S. Fish and Wildl. Serv. 29 pp.
ABSTRACT: This report summarizes the U.S. portion of an international inventory of nesting gulls, terns, and cormorants on the lower Great Lakes. The survey was accomplished in 1990, and was part of the first thorough inventory of the U.S. portion of the Great Lakes since 1977. The 1990 study area covered all the shoreline, islands, bays and connecting channels of Lakes St. Clair, Erie, and Ontario and the St. Clair, Detroit, Niagara and St. Lawrence Rivers. Aerial surveys were conducted from float planes. Colonies were photographed from the air, then counted on the ground in all cases where access was possible from the float plane.
296. Scharf, William C. and G. W. Shugart. 1991b. Gulls, terns, and cormorants of the Upper U.S. Great Lakes- 1989. Unpub. interim rept. to U.S. Fish and Wildl. Serv. 14 pp + tables and appendices.
ABSTRACT: Nesting populations of double-crested cormorants, ring-billed gulls, herring gulls, Caspian terns, and common terns were inventoried in the Upper three Great Lakes, Superior, Michigan, and Huron, and their connecting channels in 1989. This report covers the inventory in the U.S. portions of this region. All locations of suspected or known colonies were observed and photographed from a floatplane, and nest counts were also made on the ground in almost all cases.
297. Scharf, William C. and G. Shugart. 1975. Nestling banding: an index of reproductive success in a herring gull colony. *IBBA News* 47: 125-129.

ABSTRACT: Six years of nearly complete banding coverage of the herring gull colony on South Manitou Island was used to determine reproductive success. It was found to be extremely low in this highly disturbed colony (only about 0.57 fledged per pair).

298. Scharf, William C. and G. Shugart. 1981. Recent increases in double-crested cormorants in the United States Great Lakes. *Am. Birds* 35: 910-911.

ABSTRACT: Sites of cormorant nests in 1980 in the U.S. Great Lakes are listed. The population has increased from 157 in 1977 to 714 nests in 1980. The birds used 12 colony sites, all on islands, and most in Michigan waters.

299. Scharf, William C. and K. R. Stewart. 1980. New records of Siphonaptera from northern Michigan. *Great Lakes Entomologist* 13: 165-167.

ABSTRACT: Fleas from birds and mammals in the northern Lower and Upper Peninsulas of Michigan are listed. Noteworthy island range extension records include *Stenoponia americana* from Harbor Island, Lake Huron, and *Hystrichopsylla dippiei* from Hog Island, Lake Michigan.

300. Scharf, William C. and J. L. Trapp. 1992. Heron, egret, and marsh nesting tern colonies of the U.S. Great Lakes- 1991. Unpub. interim rept. to U.S. Fish and Wildl. Serv., Off. of Migratory Bird Management. 54 pp.

ABSTRACT: This report summarizes results of 1991 breeding season field surveys of U.S. portions of the Great Lakes from Minnesota to New York including all connecting waters and adjacent lands. Nest counts were made at all colonies of great blue herons, great egrets, black-crowned night herons, cattle egrets, snowy egrets, little blue heron and the 2 marsh-nesting terns, Forster's tern and black tern. Includes tables and maps.

301. Schemenauer, L. G. 1950, 1951. 1950, 1951 Drummond Island deer hunting seasons. Lansing, MI: Mich. Dept. Cons. (Game Div. Repts. Nos. 1111, 1166) 13 pp, 11 pp.

ABSTRACT: Reports on the 1950 and 1951 deer hunting season on the island. Also includes notes on other animals taken and weather conditions.

302. School of Natural Resources, U. M. 1986. Great Lakes Basin: a study of wildlands. Ann Arbor, MI: Univ. Mich. Unpub. rept. from N.R. 555, Wildland Management, class project. 73 pp.

ABSTRACT: This report is a compilation of information on national "wildlands" of the Great Lakes Basin. Small scale maps are included for each Great Lake, along with brief descriptions of areas. Wildland values, issues and conflicts are discussed.

303. Scott, Michael L. and P. G. Murphy. 1986. Origin and composition of an old-growth cedar-hardwood stand: the role of dune activity. *Mich. Botanist* 25: 57-65.

ABSTRACT: This study provides a detailed description of current composition and stand structure of the undisturbed upland white cedar forest on South Manitou Island, Lake Michigan. Large, old-growth cedar presently dominate the stand. Sugar maple and white ash are important co-dominants. The forest is thought to have originated when dunes advanced toward hardwood stands of the island interior. The persistence of white cedar on the island may be dependent on continued disturbance and dune formation.

304. Sheldon, Francis D. 1959. Geology of Mackinac Island and Lower and Middle Devonian south of the straits of Mackinac. Michigan Basin Geological Society. (Michigan Basin Geological Society Annual Geological Excursion Geological Files) 63 pp.

ABSTRACT: Detailed descriptions, maps and illustrations prepared for the annual field trip of the MBGS. The field trip visited Mackinac Is. and the Rogers City quarry.

305. Sheldon, William. 1965. Hawk migration in Michigan and the Straits of Mackinac. Jack-Pine Warbler 43: 79-83.

ABSTRACT: This is a compilation of observations of people in the Straits area, on Beaver Island, Isle Royale and in the Michigan Dept. of Conservation, as well as the author's own observations at the Straits in April of 1963. Two routes were indicated: from SandPoint - Tawas Point - Cheboygan - Bois Blanc Island group on the east side of the state, and from the Leelanau Peninsula - Beaver and Fox Island group - Waugoshance Point on the west side. Whitefish Point and the tip of the Keweenaw Peninsula are also concentration points.

306. Shelton, Philip C. 1979. Population studies of beavers in Isle Royale National Park, Michigan. In: Proceedings of the first conference on scientific research in the National Parks. (U.S. Dept. Int. National Park Service Trans. and Proc. Series No. 5(1) pp. 353-356.

307. Shugart, Gary W. 1976. Effects of ring-billed gull nesting on vegetation. Jack-Pine Warbler 54: 50-53.

ABSTRACT: Ring-billed gull nesting activity on South Manitou Island, northern Lake Michigan resulted in the death of woody vegetation in the nesting area over at least a 5-year period ending in 1969 or 1970. By the early 1970s the gulls had moved to adjacent areas with normal dune and beach vegetation, which was also dying by 1972-74.

308. Shugart, Gary W. 1977. Resident red fox predation upon an island gull colony. Jack-Pine Warbler 55: 199-205.

ABSTRACT: Fox predation on gull colonies on South Manitou Island was monitored, and found to reduce gull productivity. The author concluded that the gull colony would not persist on this island without fox control by humans.

309. Shugart, Gary W. and W. C. Scharf. 1983. Common terns in the northern Great Lakes: current status and population trends. *J. Field Ornith.* 54: 160-169.
ABSTRACT: Common terns were censused in 1980 in the same area of the northern Great Lakes that was covered by 1962, 1976, and 1977 censuses. This species declined from 1962 through 1977 due to loss of nesting sites for both natural and human-caused reasons, and nest predation. In 1980 the species had rebounded, surpassing the 1962 level. This was attributed to a switch to man-made nesting sites. Still, nest failure was at 30% in 1980 and it appeared that suitable nesting sites were limited in this region. This paper does not give data on specific islands or island groups.
310. Shugart, Gary and W. C. Scharf. 1982. Final Report: Reproductive assessment of Michigan Great Lakes Common Terns (*Sterna hirundo*). Mich. Dep. Nat. Resour.
311. Shugart, Gary W. and W. C. Scharf. 1977. Predation and dispersion of herring gull nests. *Wilson Bull.* 89: 472-473.
ABSTRACT: Fox predation on herring gulls nesting on South Manitou Island resulted in renesting attempts on the same territory. A brief note.
312. Shugart, Gary, W. C. Scharf and F. J. Cuthbert. 1978. Status and reproductive success of the Caspian Tern (*Sterna caspia*) in the U.S. Great Lakes. pp 146-156 in: U.S. Great Lakes. Proc. 1977 Colonial Waterbird Group.
ABSTRACT: From fieldwork in 1976-1978 five Caspian Tern nesting sites, with a total of about 1600 pairs, were known in the U.S. Great Lakes, all in Michigan. Reproductive success was low, due to earlier nesting Herring Gulls, fluctuating water levels, and human disturbance. The authors recommended continued monitoring of this species' Gt. Lakes populations because of the small number of nesting pairs concentrated at a few colonies.
313. Shugart, Gary and W. C. Scharf. 1983. The Status of tern populations in northeastern United States and adjacent Canada: the U.S. Great Lakes. *Colonial Waterbirds* 6: 85-106.
ABSTRACT: A brief overview of the status of Common, Caspian, and Black Terns in the U.S. Great Lakes in 1982. Rangewide data is summarized, and no significant references to specific islands are made.
314. Shugart, Gary W. and W. C. Scharf. No date (@1984). The ecology of Caspian tern (*Sterna caspia*) nesting area at Hat Island Preserve. 11 pp.
ABSTRACT: Methods for studying and monitoring populations of Caspian terns on the Hat Island Preserve were outlined, and management recommendations, including limits on research, signage, and monitoring were made.

315. Slavick, Allison D. 1983. Vascular plants of Isle Royale, National Park, Michigan. Houghton, MI: Mich. Tech. Univ. Master's thesis. 45 pp.

ABSTRACT: A complete flora of Isle Royale was produced over a 5-yr study period. One hundred fifty new species were added since Clair Brown published a flora of the island in 1935. See also works by Janke who was also involved in the 5-yr study. List is annotated with habitat, location and abundance. Plants on adjacent islands are also included, and several pages of discussion about the plant communities and floristic affinities are included.

316. Slavick, Allison D. and Robert A. Janke. 1987. The vascular flora of Isle Royale National Park. Mich. Bot. 26: 91-134.

ABSTRACT: This flora updated the 1937 list published by Clair Brown with the addition of 153 new species. It also included some results of a five year study on the relative abundance and habitat preferences of plants on the island. Sections on the physical environment, botanical history, plant communities, and phytosociology were included, as well as the annotated list. The annotations describe abundance and habitat preferences.

317. Snyder, J. D. and R. A. Janke. 1976. Impact of moose browsing on boreal-type forests of Isle Royale National Park. Am. Midl. Nat. 95: 79-92.

ABSTRACT: Long-range effects of moose browsing on Isle Royale were measured. Overall forest density decreased while average basal area per tree increased. Balsam fir was drastically reduced, especially younger trees. Mountain ash also declined, while unpalatable white spruce increased. Yew had almost disappeared on all browsed sites.

318. Southern, W. E., S. R. Patton, Southern L. K. and Hanners L. A. 1985. Effects of nine years of fox predation on two species of breeding gulls. Auk 102: 827-833.

ABSTRACT: During 9 years of exposure to red fox predation, ring-billed and herring gulls nesting on S. Manitou Island experienced total or nearly total reproductive failure in all but 1 year between 1975 and 1983. The number of active nests declined over the period. The colonies cannot be sustained given continued regular fox predation.

319. Southern, William E., S. R. Patton, F. J. Cuthbert and L. K. Kinkel. 1975. Wood storks in Michigan. Jack-Pine Warbler 53: 158.

ABSTRACT: Two wood storks, one mature, one immature were seen on 29 May 1975 on the shore of South Manitou Island. This was apparently the third published account of the species in the state. Wood storks are considered a casual wanderer to southern Michigan. These birds may have arrived on a strong flow of warm gulf air from Florida.

320. Stauber, E. 1963. The birds of prey of Isle Royale. Department of Forestry and Conservation Special Report. Lafayette, IN: Purdue, Univ. 29 pp. + 6 maps.
321. Stauber, E. 1964. Birds of prey on Isle Royale National Park II. Department of Forestry and Conservation Report. Lafayette, IN: Purdue, Univ. 17 pp + 1 map.
322. Stearns, Forest and J. Keough. 1982. Ecology and geology of the Superior Upland Region: a theme study for the National Park Service. Milwaukee, WI: Univ. of Wisc.--Milwaukee. Unpub. rept. for USDI, Nat. Park Serv. 180 pp.
ABSTRACT: This report describes the major ecological and geological characteristics of the Superior Upland Physiographic Region in Michigan, Minnesota, and Wisconsin, and recommends sites of national significance for inclusion in the National Natural Landmarks Program.
323. Stearns, Forest; Lindsley, Diane. 1977. Environmental status of the Lake Michigan Region Vol. 11. Natural areas of the Lake Michigan drainage basin and endangered or threatened plant and animal species. Argonne,

IL: Argonne National Laboratory. (ANL/ES-40 Vol. 11) 90 pp. Environmental Control Technology and Earth Sciences (UC-11)
ABSTRACT: Report provides brief descriptions of current and potential natural areas, including statement of natural value. Also includes lists of endangered and threatened species in the Lake Michigan Region
324. Stephenson, S. N. 1989. 1989 Research Activities on Maxton Plains Preserve, Drummond Island, Michigan. Unpub. final rept. to The Nature Conservancy. 27 pp.
ABSTRACT: This covers research conducted on Maxton Plains Preserve between April and November, 1989. Intensive studies of alien taxa (*Hypericum perforatum*) and (*Centaurea maculosa*), monitoring of selected listed species (*Geum triflorum*, *Cirsium hillii*, and *Carex scirpoidea*), and monitoring of sprout survivorship in invading aspen (*Populus tremuloides*) are described. Additionally, author describes studies of alien species invasion at a Middle Maxton site.
325. Stephenson, S. N. 1990. Check list of the birds of Drummond Island, Chippewa County, Michigan with special reference to the Maxton Plains Preserve. Mich. State Univ. Unpub. rept.
ABSTRACT: A list produced incidentally during field work from 1981 to 1989, mostly in the spring, summer and fall.
326. Stephenson, Stephen N. 1984. Maxton Plains, prairie refugia of Drummond Island, Chippewa County, Michigan. pp 56-60 in: Proceedings of the Eighth North American Prairie Conference.

ABSTRACT: This paper reported on the results of a study of the composition and structure of the vegetation in 5 of the larger grassy openings known as the Maxton Plains, Drummond Island, MI. Results indicated that this is a natural community that is stable and highly resistant to invasion by adjacent forest or introduced alien species.

327. Stephenson, Stephen N. and P. S. Herendeen. 1986. Short-term drought effects on the alvar communities of Drummond Island, Michigan. *Mich. Botanist* 25: 16-27.
ABSTRACT: Alvar communities on Maxton Plains, Drummond Island were studied before and after the growing season drought of 1983. Some of the rare and threatened plants found on alvars declined while others increased, and others underwent population structure changes. Encroaching woody vegetation was killed, while some new species appeared.
328. Stottlemeyer, J. Robert, et al. 1984. Effects of atmospheric acid deposition on watershed/lake ecosystems of Isle Royale and Michigan's Upper Peninsula. (1983 progress report) 54 pp.
329. Tanton, John H. 1973. Beaver Island Archipelago Reconnaissance Report. Mich. Nat. Areas Council. Unpub. rept. 2 pp.
ABSTRACT: A brief report of a site visit to High, Hog and Garden Islands. Presence of gulls and terns are noted on High Island.
330. Taylor, R. W. 1935. Phytoplankton of Isle Royale. *Am. Microscopical Soc.* 54: 83-97.
331. Thompson, Paul W. 1963. Character of an ancient white cedar forest on South Manitou Island, Michigan. *Pap. Mich. Acad.* 48: 177-186.
ABSTRACT: The "Valley of the Giants" on S. Manitou was described ecologically. Many trees were over 100 ft in height and one was 206 inches in girth. A fallen tree showed 528 rings. Factors allowing this extremely old stand to remain were discussed.
332. Thompson, Paul W. 1974. Ecological survey of South Manitou Island, Michigan. Bloomfield Hills, MI: Cranbrook Inst. of Sci. Unpub. rept. 22 pp.
ABSTRACT: This report covers the physical features, vegetation, animal life, human history, and provides a plant list and maps of geology, topography and soils. It ends with an evaluation of the natural quality of the island and a recommendation that it be designated as a Wilderness Area.
333. Thompson, Paul W. 1972. Espanore and Boot Jack Islands - Chippewa County, MI. 2 pp + 1 p list.
ABSTRACT: Describes forest types, other natural communities and reports on some birds and plants seen on these two heavily wooded islands located in Island Harbor, off the southwest shore of Drummond Island.

334. Thompson, Paul W. 1962. The giant cedars of South Manitou Island. Cranbrook Inst. Sci. Newsletter 32 (3): 16-30.
ABSTRACT: In this paper the author described the habitat. The valley of the giant cedars is protected on three sides by dune ridges from wind, which explains how the cedars have remained so long and become so large. The largest tree was measured at 110 ft tall, 17 ft circumference.
335. Thompson, Paul W. 1955. South Manitou Island. Bloomfield Hills, MI: Cranbrook Inst. Sci. Reconnaissance report for Mich. Natural Areas Council. 3 pp.
ABSTRACT: This brief description primarily makes a case for protection of the natural character of the island.
336. Thompson, Paul W. 1960. South Manitou Island. Bloomfield Hills, MI: Cranbrook Inst. of Sci. Site report for Mich. Natural Areas Council. 6 pp.
ABSTRACT: A brief description of history, geology, vegetation, animal life, present conditions and recommendations for preservation.
337. Thompson, Paul W. 1962. An unusual fern station on South Manitou Island, Michigan. Amer. Fern J. 52 (4): 157-159.
ABSTRACT: Three ferns uncommon in Michigan were found in the Valley of the Giants cedar stand on S. Manitou Island. Northern holly fern (*Polystichum lonchitis*), walking fern (*Camptosorus rhizophyllus*), and green spleenwort (*Asplenium viride*). These were unexpected in this location because they are associated with limestone elsewhere in the state, and are here growing in sandy loam over glacial till. The author theorized that the till contained enough of the limestone bedrock to create favorable conditions.
338. Thompson, Paul W. 1967. Vegetation and common plants of Sleeping Bear. Cranbrook Inst. of Sci. Bull. 52: 1-47.
ABSTRACT: This publication covers the common plants and vegetational communities of the Sleeping Bear Lakeshore area, including the Manitou Islands. The author notes that it is a condensation of a much larger work that was in preparation at the time of publication, that was to include the complete flora and more detailed descriptions of the vegetation of Leelanau County, MI. This version is aimed at the general reader.
339. Thompson, Paul W. and J. R. Wells. 1974. Vegetation of Manitou Island, Keweenaw County, Michigan. Mich. Acad. 6 (3): 307-312.
ABSTRACT: The vegetation was described. Boreal forest, bog and rocky outcrop vegetation were the primary types described. A list of spring and early summer vascular plants was presented.
340. Thorpe, F. J. and A. H. W. Povah. 1935. The bryophytes of Isle Royale, Lake Superior. Bryologist 38: 32-46.
ABSTRACT: This list is from the 1930 U. of Mich. Botanical survey, and includes 24 genera, and 39 species of Hepaticae, and

65 genera, 105 species, 8 varieties of Musci. All other species previously reported are also included (raises total to 281 species and varieties of the two groups combined), so that the list is complete to date, but not thought to be definitive. The list is annotated with habitat and collection sites.

341. Tillitt, Donald E., G. T. Ankley, J. P. Giesy, J. P. Ludwig, H. Kurita-Matsuba, D. V. Weseloh, P. S. Ross, C. A. Bishop, L. Sileo, K. L. Stromborg, J. Larson and T. J. Kubiak. 1992. Polychlorinated biphenyl residues and egg mortality in double-crested cormorants from the Great Lakes. *Envir. Toxicol. and Chem.* 11: 1281-1288.
ABSTRACT: Egg mortality was found to be correlated with the PCB residues in eggs when an invitro bioassay system (H4IIE) rat hepatoma cell bioassay) was used. Egg mortality and PCB residues are given for several Great Lakes Islands. The authors believe that PCB continues to be a problem for fish-eating birds in the Great Lakes.
342. Titus, E. S. 1909. Annotated list of Isle Royale Hymenoptera. pp 317-324 in: C. C. Adams. *An ecological survey of Isle Royale, Lake Superior.* Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.
343. Tuzzolino, Debora A. 1989. Assortative mating of white-throated sparrows, Beaver Island, MI. Mt. Pleasant, MI: Centr. Mich. Univ. Master's thesis.
ABSTRACT: Research completed at CMU Biological Station on Beaver Island.
344. U.S. Army Corps of Engineers Detroit District. 1989. Operation of the Lock Facilities to 31 January + 2 weeks. Supplement II to the Final Environmental Impact Statement: Operations, maintenance, and minor improvements of the federal facilities at Sault Ste. Marie, Michigan (July 1977). U.S. Army Engineer Dist. Detroit, MI. 174 pp + app. A-E.
ABSTRACT: This supplement discusses the potential impacts of extending the shipping season on the St. Marys River. Sections with information about Great Lakes islands include: discussion of possible impacts on Neebish and Sugar Is. deer populations; occurrences of moose, wolves, deer, eagles and peregrines, and potential for impacts; description of fish spawning sites in Detroit River; Diving ducks use of islands; lists studies done on potential wildlife impacts.
345. U.S. Department of the Interior. 1967. Drummond Island Group. Ann Arbor, MI: Lake Centr. Reg. Off. Preliminary report of Bureau of Outdoor Recreation, USDI. 66 pp.
ABSTRACT: This study proposed creating a recreation area on northwest shores of Drummond Island and many of the Potaganissing Bay islands. Includes map of vegetation types, mammalian fauna

list, topography, shoreline, hydrology, climate, lake levels, water quality, ice conditions, general plant community information, and cultural information such as ownership, development and roads for Drummond, and to lesser extent, for other islands. No flora lists.

346. U.S. Department of the Interior. No date. Green Bay Islands. Ann Arbor, MI: Lake Central Regional Office. Preliminary report of Bur. of Outdoor Rec., USDI. 55 pp.
 ABSTRACT: This study proposed creating a wilderness recreation area in the Green Bay Islands of Wisconsin and Michigan. Includes map of vegetation types, mammalian fauna list, topography, shoreline, hydrology, climate, lake levels, water quality, general plant community information, and cultural information such as ownership, development and roads. No flora lists.
347. U.S. Department of the Interior, National Park Service. 1984. Bald eagle/osprey inventory. Isle Royale National Park, Michigan: (Resources Management report No. 4) 9 pp.
348. U.S. Department of the Interior, National Park Service. 1981. Fire Management Plan. Isle Royale National Park, Michigan. 63 pp.
349. U.S. Department of the Interior, National Park Service. 1984. Great Blue Heron inventory. Isle Royale National Park, Michigan: (Resources Management report No. 5) 8 pp.
350. U.S. Department of the Interior, National Park Service. 1984. Peregrine falcon reestablishment plan and environmental assessment. Isle Royale National Park, Michigan: 42 pp.
351. U.S. Department of the Interior, National Park Service. 1984. Resources inventory maps. Isle Royale National Park, Michigan: (Management report No. 1) 6 pp.
352. U.S. Fish and Wildl. Serv. 1985. A detailed report on biological resources impacted by the proposed modifications at Duluth-Superior Harbor and the Upper St. Marys River. Final Fish and Wildlife Coordination Act Report for the Great Lakes Connecting Channels and Harbors Study: East Lansing, MI: U.S. Department of the Interior, Fish and Wildl. Serv. Ecological Services Field Offices, East Lansing, MI and St. Paul, MN. 68 pp.
 ABSTRACT: This report includes summaries and evaluations of the impact of the proposed project on fish and wildlife resources, their habitat, and their utilization by the public. Environmental concerns and data needs are updated and refined. Methods for preserving, compensating and enhancing resources are recommended. Readers are referred to an earlier report, "Final Stage II Report for the GLCCHS" (USFWS, 1981) for extensive ecological descriptions.

353. U.S. Fish and Wildl. Serv. 1967. Michigan Islands Wilderness Study Area. U.S. Dept. Int., Fish Wildl. Serv., Bur. Sport Fish. & Wildl.
ABSTRACT: The Michigan Islands Wilderness Study Area includes several of the Beaver group and Thunder Bay Isl. in Alpena Co.
354. U.S. Fish and Wildl. Serv. and Environment Canada. 1986. North American waterfowl management plan. USDI FWS and Env't. Canada. 19 pp.
ABSTRACT: This document describes critical habitat and areas of concern for ducks, geese and swans in North America, and recommends future action for habitat management, duck harvest, goose and swan management, and research. Coordination between Canada and the U.S. is also described.
355. U.S. Fish and Wildl. Serv. 1986. Revised draft detailed report on biological resources impacted by the proposed navigation season extension to January 31, + or - 2 weeks, on the Upper Great Lakes. D. D. U.S. Army Corps of Engineers Draft Environmental Impact Statement Supplement II to the Final Environmental Impact Statement: Operations, maintenance, and minor improvements of the federal facilities at Sault Ste. Marie, Michigan (July 1977), March 1988. East Lansing, MI: U.S. Department of the Interior, Fish and Wildl. Serv. Ecological Services Field Offices at East Lansing, MI; St. Paul, MN; Bloomington, IN; Rock Island, IL; Columbus, OH; Cortland, NY. pp H156-H425.
ABSTRACT: This document included summaries and evaluations of the impact of the proposed projects on fish and wildlife resources and general environmental conditions. Environmental concerns and data needs were described, and extensive lists of fish and wildlife resources of the various Great Lakes connecting channels were included.
356. U.S. Fish and Wildl. Serv. 1985. White-tailed deer and gray wolf populations and winter movements in the Great Lakes connecting channels. Draft report submitted by E. Lansing field office to the U.S. Army Corps of Engineers, Detroit, MI.
357. U.S. Forest Service. 1975. Grand Island Research Natural Area. Hiawatha Nat. Forest. Environmental Analysis Report. 17 pp.
ABSTRACT: The report concludes that the proposed research natural area would aid researchers in better understanding the northern hardwood forest community throughout its natural range. It is suited for ecological research. Virtually no environmental impacts or short-term economic benefits were identified.
358. U.S. Forest Service. 1978. Lake States supplement to USDA Forest Service Environmental Statement, Roadless Area Review and Evaluation II (RARE II). Milwaukee, WI: USFS Eastern Region (R-9). (USDA-FS-WO 78-04 DES LEG) 169 pp.
ABSTRACT: This supplement provided information on each roadless area in MI, MN, and WI. Physiography, vegetation and

ecosystems, wildlife and fish, ownership, resource uses and social and economic overviews were included. Alternatives were presented and impacts examined. Islands included were Round Island, Straits of Mackinac, and Government Island, one of Les Cheneaux Islands.

359. U.S. Man and the Biosphere Program. 1985. Isle Royale Biosphere Reserve: a bibliography of scientific studies. Prepared by: D. B. Sci. Mich. Tech. Univ. Atlanta, GA: U.S. Dept. Interior, National Park Service. (U.S. MAB Report No. 11, Vol. II) 55 pp.

ABSTRACT: This report contains an annotated bibliography of scientific studies of Isle Royale National Park and Biosphere Reserve. The computer-based bibliographic file is maintained at Isle Royal National Park and the Midwest Regional Office of the National Park Service. For detailed description and synthesis of the history of scientific studies and the current available information base at the park, see "Isle Royale Biosphere Reserve: history of scientific studies" (U.S. MAB Report No. 11, Vol. I).

360. U.S. Man and the Biosphere Program. 1985. Isle Royale Biosphere Reserve: history of scientific studies. Prepared by: D. B. Sci. Mich. Tech. Univ. Atlanta, GA: U.S. Dept. Interior, National Park Service. (U.S. MAB Report No. 11, Vol. I) 115 pp.

ABSTRACT: A detailed description and synthesis of the history of scientific studies and the current available information base at the park is given in this volume. See "Isle Royale Biosphere Reserve: a bibliography of scientific studies" (U.S. MAB Report No. 11, Vol. II) for bibliography.

361. Veal, D. M. 1968. Biological survey of the St. Marys River. Ont. Min. Environ. Water Resour. Comm. and Int. Joint Comm. 23 pp + app.

362. Vegetation type map of Isle Royale National Park. 1970. Krefting, L. W., H. L. Hansen and M. P. Meyer (compilers). Denver, CO: U.S. Bureau of Sport Fisheries and Wildlife. Bur. Sports Fish. and Wildl. Map 1: 31,250.

363. Veldman, Lorraine Calhoun and D. E. Wujeck. 1971. Pteridophytes of Beaver island, Charlevoix County, Michigan. Mich. Botanist 10: 194-196.

ABSTRACT: Field inventory of pteridophytes of Beaver Island during the summers of 1969 and 1970 yielded 44 species and varieties. Only three species known from mainland Charlevoix County were not found. Eleven taxa new for the county were found.

364. Voice, Steven P., S. V. Milan and J. P. Ludwig. 1982. A spring and early summer survey of 62 islands owned by the U. S. Bureau of Land Management in Lake Huron, Lake Michigan, and Lake Superior for rare, threatened and endangered plants and animals. Iron River, MI: Ecological Research Services, Inc. Unpub. rept. 154 pp.

ABSTRACT: This report covers the fourth year of surveys of the U.S. Bureau of Land Management owned islands in the Great Lakes. Flora and fauna were recorded on single visits to 62

islands (39 in Lake Superior, 10 in Lake Huron, and 16 in Lake Michigan). Visits were too brief to obtain complete flora and fauna lists.

365. Voss, Edward G., University of Michigan Herbarium. July 4, 1990. letter to: Moehl, Richard L. 3 pp.
ABSTRACT: This letter included Voss' still incomplete flora of St. Helena Island, Mackinac County, MI. The list was developed during visits in 1968, 1970, 1976, 1989, and 1990. Only one listed species, Lake Huron tansy was recorded.
366. Voss, Edward G. 1963. Michigan plants in print: a guide to literature on the Michigan flora. Mich. Botanist 2: 55-59.
ABSTRACT: This mini-bibliography focuses on publications that do not have keys or descriptions (see Sept. 1962 issue for that). These papers purport to give complete, or reasonably extensive, lists of a particular region of the state, or provide aid in understanding what is already known about the flora of Michigan. Several relate to islands.
367. Voss, Edward G. 1950. Observations on the Michigan flora, III. The flora of Green Island (Mackinac County). Ohio Jour. Sci. 50: 182-190.
ABSTRACT: Introduction and annotated list of 138 species from tiny island in the Straits of Mackinac. [Abstract from Voss 1963.]
368. Walker, Bryant. 1909. Annotated list of the Mollusca of Isle Royale, Michigan. pp 281-298 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections reported here were made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905.
369. Wallis, O. L. 1960. An evaluation of the fishery resources of Isle Royale National Park. (U.S.D.I. National Park Serv. Report) 18 pp.
370. Weatherbee, Ellen Elliott. 1990. Cliff brake on Drummond Island: a gravel roadside locality found by amateur botanists. Mich. Botanist 29: 103-105.
ABSTRACT: A discovery of purple cliff brake, *Pellaea atropurpurea* on Drummond Island was the first for this species outside the Keweenaw Peninsula. The species was found on limestone substrate, the usual substrate for this species in nearby locations in Canada.
371. Webster, A. A. 1932. Minong: the floating island. American Forests 38: 439-441+ pp 462, 479.
ABSTRACT: The native Americans called Isle Royale "Minong" and thought it was a floating island. In prehistoric times it was

mined, and the unique form of copper found here has been found widely on the continent as well as elsewhere in the world.

372. Weise, Thomas F. 1985. Large and small mammal records from Chippewa County and the eastern Upper Peninsula of Michigan. Sault Ste. Marie, MI: Mich. Dep. Nat. Resour. Unpub. rept.
373. Weise, Thomas F. March 20, 1986. Memo: Munuscong Bay area birds species list. Sault Ste. Marie, MI: Michigan Department of Natural Resources. Unpub. rept. 4 pp + map.
ABSTRACT: A list of birds species compiled over the previous 10 years from casual visits to the Munuscong Bay area. No systematic attempt was made for a complete species list. Species with positive nesting records in the area are noted.
374. Weise, Thomas F. 1985. Waterfowl, raptor, and colonial bird records for the St. Marys River. Sault Ste. Marie, MI: Michigan Dept. Nat. Resour. Unpub. rept.
375. Wells, James R. and P. W. Thompson. 1973. Preliminary checklist of vascular plants of Manitou Island, Keweenaw County, Michigan. Unpub. list. 2 pp.
ABSTRACT: A typed list of species with voucher collection numbers and collector indicated.
376. Wells, James R., P. W. Thompson and F. D. Sheldon. 1975. Vegetation and geology of North Fox Island, Lake Michigan. Mich. Botanist 14: 203-214.
ABSTRACT: A thorough treatment covering topography, geology, climate, and descriptions and typical flora of the hardwood forest, lowland conifer forest, swamp forest, mixed forest, dunes and sandy beaches, and meadow and grasslands of North Fox Island, Leelanau County, MI.
377. Wetmore, Clifford M. 1985. Lichens and air quality in Isle Royale National Park. Botany Dept., Univ. Minnesota. Final report for National Park Service. 41 pp + maps.
ABSTRACT: This report summarizes the results of a survey of the lichens of Isle Royale National Park. It includes a lichen flora, results of chemical analyses of lichens, and evaluation with respect to air quality. These data are meant to provide a baseline for future comparative studies.
378. Wheeler, William M. 1909. The ants of Isle Royale, Michigan. pp 325-328 in: C. C. Adams An ecological survey of Isle Royale, Lake Superior. Lansing, MI: Michigan State Biological Survey. (Mich. Biol. Surv. Report for 1908) 468 pp.
ABSTRACT: Collections made during the ecological investigations by the University Museum of the University of Michigan in 1904 and 1905 were reported.

379. Whitcomb, Douglas A. 1974. Characteristics of an insular woodcock population. Lansing, MI: Mich. Dep. Nat. Resour. (Wildl. Div. Rep. No. 2720) 78 pp.
ABSTRACT: A study of a population of woodcock on High Island, Lake Michigan, investigated the population dynamics, effects of hunting, usefulness of singing male counts for monitoring, and behaviors important to population growth or management. The population dynamics suggested that the species could not sustain a high degree of hunting.
380. Whitcomb, Douglas A.; Currie, Bruce A. post-1975. Annotated bibliography of Wildlife Division reports concerned with deer. Lansing, MI: Mich. Dept. Nat. Res. (Wildl. Div. Rept. No. 2757) 40 pp.
ABSTRACT: An annotated bibliography of deer reports that covers dates up to 1975.
381. Williamson, B. B. 1979. The wetlands of Dickinson Island, St. Clair County, Michigan and their responses to water level fluctuations. Ypsilanti, MI: East. Mich. Univ. Master's thesis. 79 pp.
ABSTRACT: no copy
382. Williams, M. Y. 1942. Notes on the fauna of Bruce Peninsula, Manitoulin and adjacent islands - mammals. Can. Field-Naturalist 56: 92-93.
ABSTRACT: An annotated fauna of Manitoulin, Cockburn, Fitzwilliam Islands, and the Bruce Peninsula, Ontario. These are a continuation of the same geological formation that constitutes Drummond Island. The list is annotated as to when and where species were found, and abundance is often noted.
383. Wilsmann, Leni A. 1987. Piping plover survey on the Beaver and Fox Island Groups. Report to Coastal Zone Management Unit, LWMD, MI DNR. 4 pp.
ABSTRACT: This report summarizes the results of Hamas' 1987 island surveys. Plovers were found only on High Island, although suitable habitat existed on Beaver and S. Fox. Six other islands in the Beaver Group did not have suitable habitat.
384. Wilson, N. and W. J. Johnson. 1971. Ectoparasites of Isle Royale, Michigan. Michigan Entomol. 4: 109-115.
ABSTRACT: Twenty species of ectoparasites were collected from Isle Royale, incidental to studies of red fox and prey, snowshoe hare, red squirrel, gray wolf, and deer mouse. The fauna is considered diverse for such a small area. The island appears to be in a critical position in the distribution and speciation of some Siphonaptera.
385. Wolfe, M. L. and D. L. Allen. 1973. Continued studies of the status, socialization, and relationships of Isle Royale wolves, 1967 to 1970. J. Mammal. 54: 611-633.
ABSTRACT: The numbers, pack structures and relationships among the wolves of Isle Royale from 1967-1970 were reported. A

new pack of 7 immigrated in the winter of 1967, and 4 of these were black, which allowed for easy tracking. At least 28 wolves, in packs of 6-7 were present at the end of the study period.

386. Wolfe, Michael L. 1977. Mortality patterns in the Isle Royale moose population. *Am. Midl. Naturalist* 97: 267-279.

ABSTRACT: Sex, age and distribution in time of 439 Isle Royale moose, dying from natural causes were analyzed. Forty-five percent were killed by wolves. Young moose made up a smaller percentage of wolf kills than this group represented in the moose population. Older moose were preferred by wolves. The role of wolf predation in moose population regulation was discussed.

387. Wolff, R. G.; Huber N. K. 1973. The Copper Harbor conglomerate (Middle Keweenawan) on Isle Royale, Michigan, and its regional implications. *U.S. Geol. Surv. (Prof. Pap. 754-B)* 15 pp.

388. Wolinski, Richard A. and E. A. Pike. 1987. First sight record of yellow-crowned night-heron on North Manitou Island. *Jack-Pine Warbler* 65: 16.

ABSTRACT: The first record of this species on N. Manitou island was reported. It was only the second Michigan record of yellow-crowned night-herons north of a line from Bay County to Allegan County.

389. Wonser, C. H. 1946. Beaver Island. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 910) 5 pp.

ABSTRACT: The geology, geography, soils, cover types, and economic development of Beaver Island, Lake Michigan, were described, and recommendations for management were given briefly in this report.

390. Wonser, C. H./Jenkins, B. C. 1946. Bois Blanc Island. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 908) 6 pp.

ABSTRACT: The geology, geography, soils, cover types, wildlife, and economic development of Bois Blanc Island, Straits of Mackinac, were described, and recommendations for management were given briefly.

391. Wonser, C. H./Jenkins, B. C. 1946. The islands of the Beaver Group. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 911) 7 pp (Wonser) + 2 pp (Jenkins).

ABSTRACT: The geology, geography, soils, cover types, wildlife, and economic development of Gull, Trout, Garden, Whiskey, Hog, and Hat Islands were described, and recommendations for management were given briefly.

392. Wonser, C. H. 1945. South Manitou Island. Lansing, MI: Mich. Dept. Cons. (Game Div. Report No. 882) 4 pp.

ABSTRACT: The geology, geography, soils, cover types, and economic development of South Manitou Island, Lake Michigan, were described, and recommendations for management were given briefly.

393. Wujek, Daniel E., M. Gretz and M. G. Wujek. 1977. Studies on Michigan Chrysophyceae. IV. Mich. Botanist 16: 191-194.
ABSTRACT: This was the fourth in a series of papers dealing with species of Chrysophyceae occurring in samples collected from some lakes and ponds in Michigan. Sites included lakes on Beaver Island in northern Lake Michigan. Four taxa new to Michigan and to the continental U.S. were reported. One of these was described as a new species.
394. Wujek, Daniel E. and R. Hamilton. 1972. Studies on Michigan Chrysophyceae. I. Mich. Botanist 11: 51-59.
ABSTRACT: This paper was the first in a series dealing with species of Chrysophyceae occurring in samples collected from some lakes and ponds in Michigan, including lakes on Beaver Island in northern Lake Michigan. It included discussion of *Mallomonas* spp., *Synura* spp., and *Chrysosphaerella* spp., and notes on vegetation, temperature, and chemistry of the sample waters. Of the 12 species observed, 11 were new to Michigan.
395. Wujek, Daniel E. and R. Hamilton. 1973. Studies on Michigan Chrysophyceae. II. Mich. Botanist 12: 118-122.
ABSTRACT: This was the second in a series of papers dealing with species of Chrysophyceae occurring in samples collected from some lakes and ponds in Michigan, including lakes on Beaver Island in northern Lake Michigan. Seven taxa found were new records for the state, and all but three species were new records for the continental U.S.
396. Wujek, Daniel E. and J. L. Wee. 1983. Chrysodidymus in the United States. Trans. Am. Microsc. Soc. 102: 77-80.
ABSTRACT: The first record of the chrysophycean alga genus *Chrysodidymus* for the United States was reported. Two species (*C. gracilis* and *Synura microcrepis* were shown to be synonymous with the type species. Retention of the genera *Chrysodidymus* and *Catenochrysis* was supported.
397. Wylie, Kenneth C. 1983. Michigan's island treasures. Mich. Nat. Res. March/April: 20-27.
ABSTRACT: A popular account including mostly human history of use of the Manitou and Fox islands.

APPENDIX D

Island Bibliographies

Sorted by subject

QUESTION 1

QUESTION 1 (10 MARKS)

QUESTION 1 (10 MARKS)

Inventory References - Natural Communities

8	127	233	315
9	133	266	316
71	149	282	323
125	201	292	338

Inventory References - Natural Communities

8	127	233	315
9	133	266	316
71	149	282	323
125	201	292	338

Inventory References - Animals

7	67	185	247	283	296
9	68	190	249	284	298
10	74	192	251	285	300
18	79	193	252	286	313
39	116	194	258	288	314
41	121	201	260	291	323
44	133	230	265	292	383
45	143	233	266	293	385
50	145	240	281	294	
56	175	245	282	295	

Inventory References - Plants

7	102	224	316
8	115	226	323
9	124	230	330
10	125	233	338
46	127	244	340
56	128	245	363
72	133	256	367
73	149	276	377
87	194	291	
88	201	315	

Biodiversity of Great Lakes Islands

Wolves and Moose References

6	135	344
13	149	385
34	150	386
35	171	
36	211	
37	229	
65	247	
129	317	

Colonial Waterbird References

19	102	234	307
40	173	238	308
41	190	245	309
43	191	282	310
44	193	283	312
49	195	284	313
56	196	285	314
67	197	287	318
68	198	289	329
69	200	290	332
74	202	292	336
75	215	294	341
76	217	295	344
77	218	296	352
78	219	297	353
79	227	298	355
91	233	300	364

Lake Erie References

7	66	175	285	314
9	69	199	292	354
10	79	212	295	
31	80	227	300	
41	111	282	302	
44	115	283	309	

Biodiversity of Great Lakes Islands

Lake Huron References

7	54	136	198	282	314
9	55	137	203	283	324
10	58	155	206	285	325
11	61	165	215	289	326
14	71	173	216	292	327
15	79	175	217	294	333
16	85	178	222	296	341
17	87	190	232	298	344
18	96	191	235	299	345
22	108	192	245	300	353
24	111	193	248	301	354
31	115	194	250	302	358
41	120	195	253	304	364
44	125	196	270	305	365
49	133	197	271	309	370
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Lake Michigan References

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8	39	78	114	163	186
9	44	79	115	164	187
10	45	83	116	165	188
17	48	84	117	166	189
19	51	90	118	167	190
21	52	94	121	172	191
23	53	98	122	173	192
25	56	99	124	174	193
26	58	100	126	175	196
27	70	101	127	177	197
28	71	102	130	178	198
29	74	105	138	179	207
32	75	106	140	182	213
33	76	111	147	183	218
219	260	297	319	363	
224	265	298	323	364	
225	268	299	329	376	
226	272	300	331	379	
233	277	302	332	383	
234	281	303	334	388	
240	282	305	335	389	
241	283	307	336	391	
248	285	308	337	392	
249	286	309	338	393	

Biodiversity of Great Lakes Islands

Lake Michigan References, *continued*

251	287	310	341	394
252	288	312	343	395
257	292	313	346	396
258	293	314	353	397
259	296	318	354	

Lake Superior References

1	65	134	160	194	243
2	67	135	161	196	247
3	68	139	162	197	254
4	71	141	165	198	256
5	72	142	168	202	258
7	73	143	169	208	261
10	79	144	170	211	262
12	92	145	171	214	263
36	93	146	173	228	264
37	97	149	175	229	267
41	107	150	177	230	276
43	108	151	178	231	278
44	110	152	180	236	279
46	115	153	190	237	282
58	119	158	192	239	283
64	128	159	193	242	284
285	317	364	387		
292	322	368			
296	330	369			
298	340	371			
300	341	375			
302	342	377			
309	354	378			
314	357	384			
315	359	385			
316	360	386			

St. Marys River References

30	111	201	284	344
31	115	204	285	352
41	137	205	290	354
44	156	244	291	355
50	178	245	296	373
71	184	266	302	
79	193	274	309	
91	196	282	314	

North and South Manitou Islands References

8	58	158	193	292	319
21	70	166	207	293	323
25	75	167	218	296	331
26	94	170	251	297	332
27	111	175	252	303	334
28	116	178	258	305	335
45	121	182	271	307	336
51	124	183	281	308	337
52	126	186	286	312	338
53	127	192	287	318	376
383					
384					
388					
397					

Western Lake Michigan Island References

44	173	227	325
46	185	245	339
56	187	282	341
68	188	283	346
71	190	288	364
75	192	292	
89	196	296	
100	197	298	
101	198	300	
102	219	313	
147	224	323	

Isle Royale References

12	96	152	230	292	384
13	108	158	237	296	385
37	128	170	239	300	386
64	135	171	245	305	
71	142	178	256	315	
72	143	192	263	317	
73	145	193	267	359	
79	146	194	282	360	
91	149	197	283	371	
93	151	211	290	377	

Biodiversity of Great Lakes Islands

Drummond Island References

7	133	245	326
14	137	270	327
15	155	271	345
16	175	283	352
17	178	292	355
61	193	296	370
71	196	300	
91	203	301	
96	206	324	
111	216	325	

Beaver Islands References

17	100	174	260	364
19	101	175	265	379
23	105	178	268	383
29	106	179	272	389
32	111	186	277	391
33	112	190	282	392
38	114	192	283	393
39	116	193	286	394
44	117	196	292	395
48	118	197	296	396
56	121	198	298	
71	122	213	299	
74	130	225	300	
75	138	226	305	
76	140	233	310	
77	154	234	313	
78	163	240	323	
79	164	241	329	
83	166	249	341	
84	167	257	343	
90	172	258	353	
99	173	259	363	

Les Cheneaux Islands References

10	178	232	289	302
11	193	235	292	358
31	196	282	296	364
71	197	283	300	