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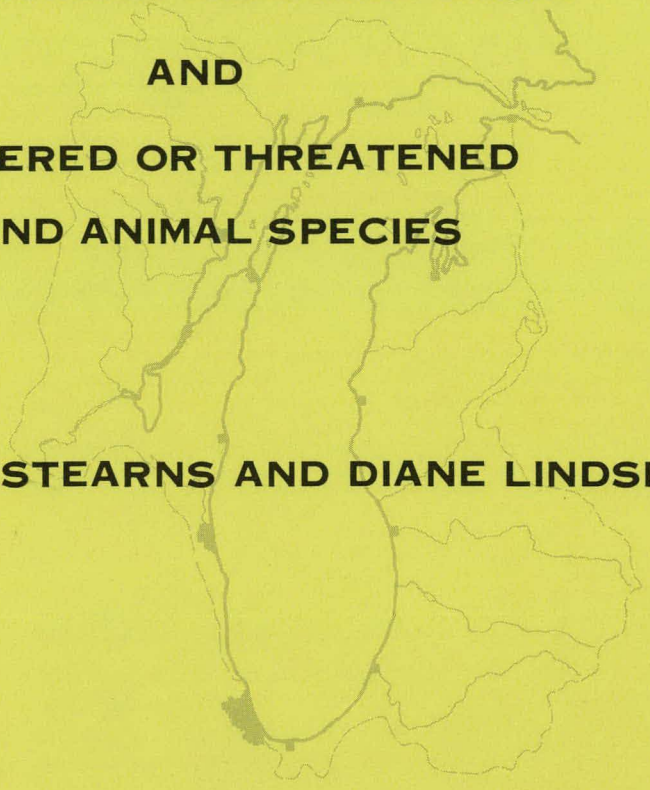
ENVIRONMENTAL STATUS OF THE LAKE MICHIGAN REGION

VOLUME 11. NATURAL AREAS OF THE LAKE MICHIGAN DRAINAGE BASIN AND ENDANGERED OR THREATENED PLANT AND ANIMAL SPECIES



FOREST STEARNS AND DIANE LINDSLEY

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ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

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ENVIRONMENTAL STATUS OF THE LAKE MICHIGAN REGION

Volume 11. Natural Areas of the Lake Michigan Drainage Basin and Endangered or Threatened Plant and Animal Species

by

Forest Stearns* and Diane Lindsley**

Consultants to
Division of Environmental Impact Studies

September 1977

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ENVIRONMENTAL STATUS OF THE LAKE MICHIGAN REGION

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PREFACE

Assessments of the environmental impacts of individual nuclear power plants sited on the shores of Lake Michigan have led to increased recognition of the need for regional considerations of the environmental impacts of various human activities, and a compendium of information on the environmental status of the region for use in assessing such impacts. In response to these needs, a report series describing the status of Lake Michigan and its watershed is in preparation. This series is entitled "Environmental Status of the Lake Michigan Region"; this report is part of that series.

The report series provides a reasonably comprehensive descriptive review and analysis of natural features and characteristics, as well as past, present, and proposed natural processes and human activities that influence the environmental conditions of Lake Michigan, its watershed, and certain adjacent metropolitan areas. This series will constitute a regional reference document useful both to scientific investigators and to other persons involved in environmental protection, resource planning, and management. In these regards, the "Environmental Status of the Lake Michigan Region" will serve in part as an adjunct to reports of broader scope, such as the Great Lakes Basin Commission's Framework Study.

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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

by

Forest Stearns and Diane Lindsley

Abstract

The accelerating encroachment of human activity on the natural landscape has made many citizens appreciate the need to save representative biotic communities before urbanization and technologically induced change eliminate such communities. Active programs in natural-area preservation are now in progress in the four basin states; these programs have strong public support and legislative mandate. Local, state, and federal agencies and private individuals have taken an active interest in protecting select areas as samples of the biotic communities and natural features of the Basin. Most natural areas described in this report have been dedicated or reserved in some fashion. Other areas are being added by the basin states each year.

The maintenance of natural communities is closely linked to the preservation of endangered and threatened species of plants and animals which would cease to survive as isolated populations. Under federal regulations, certain plants and animals are listed as endangered or threatened in the Basin. As individual state lists are prepared and investigations proceed, it is probable that many more threatened species will be found.

INTRODUCTION

At the time of European settlement, the Lake Michigan Drainage Basin supported a mosaic of diverse biotic communities, each adapted to a particular environment. The complex basin morphology, which had been formed by the advance and retreat of the Late Wisconsin ice sheets, provided the soil and moisture conditions to support a continuum of plant communities. Soon after the ice retreated, basin landscapes developed interacting biotic communities which functioned to maintain the entire region as a naturally productive system. Solar energy incorporated into organic matter by green plants served to support intricately related groupings of animals, microorganisms, and non-green plants. Mineral nutrients were cycled into the community and back to the soil with minimum leakage into the bodies of water which supported other

biotic communities. The many environments of the Basin were utilized effectively by plants and animals adapted to the prevailing conditions. These communities were not static--disturbance in the form of fire, wind, and drought was common. However, the communities were diverse and resilient, and following disturbance, species populations and communities usually recovered in numbers and in extent.

With the rapid growth in human population, agricultural and technological support systems inevitably encroached on the natural landscape. The naturally evolved communities, adapted to specific sets of environmental conditions, were modified or replaced by communities giving direct support to human settlement. In many places, communities essential to the continued functioning of the landscape--for example, wetlands which serve as temporary storage for floodwater--were modified or eliminated. Major degradation in the vigor and area of biotic communities results in displacement or eradication of component plant and animal species. These changes often lessen the species diversity of the community, simplify its structure, and diminish its ability to recover from disturbance.

Landscapes are composed of communities interacting with each other and exchanging seeds and spores, exchanging mature or larval forms of animals, receiving and contributing minerals, and retaining water. They may function less efficiently when community units are disrupted or eliminated. In some situations, disturbance is essential to maintain community integrity: the northern xeric forest of jack or red pine will eventually disappear unless it is occasionally swept by fire; in the pine stands, a hot burn kills the more shade-tolerant broadleafed species and provides a seed bed for pine seeds to germinate; for a red squirrel population, fire and regeneration of pine is important, but for an individual animal, it may be fatal.

Neither plant nor animal species survive independently, and most species will not persist in the absence of certain physical and biotic components found in the communities to which they have become adapted. This is especially true of the specialized plants--such as orchids, heaths, and gentians--and of various animals, birds, and insects. The tree-hole mosquito and the pitcher-plant mosquito, whose larvae develop in water ponded in the leaves of pitcher plants, are two examples. Many other plants and animals are less specialized; however, even the versatile white-tailed deer maintains itself within a specific range of available resources. The gradual loss of white-cedar reproduction in the northern part of the Basin, partly as a result of heavy browsing pressure by the deer themselves, has reduced the resilience of the northern deer herds. These herds now suffer high mortality during severe winters and rebound less rapidly after several years of deep snow.

Some ferns, *e.g.* the interrupted fern (*Osmunda claytonii*), tolerate removal of forest cover as long as the soils in which they are rooted remain moist. Other species, such as the maidenhair fern (*Adiantum pedatum*), disappear after logging removes the protective overstory of northern mesic forest. Similarly, there are many birds, small mammals, invertebrates, fungi, and lichens that are restricted to a particular plant community. Other invertebrates, large mammals, and birds require several different communities to meet the food and cover needs of different stages in their life cycles.

Community size may be important in regulating species composition and diversity. Studies of oceanic islands have shown that many species will disappear if an island is below a certain critical size; the island community will lose or never support the many species considered as characteristic of larger units of the same vegetation type. Recent studies have demonstrated a similar response in tree and bird diversity for the forest "islands" which lie in the agricultural matrix of northeastern New Jersey (Forman and Elfstrom, 1975; Forman *et al.*, 1976; Galli *et al.*, 1976). In small islands, similar results for trees are evident from a current Wisconsin study (Levenson, 1976). However, in Wisconsin, tree species richness proved more closely related to disturbance than to island size.

NATURAL AREAS DEFINED

A natural area is generally construed to mean a tract of land which has retained its natural character or has regained it after disturbance, *i.e.* it does not show lasting effects from human manipulation. Many natural areas include successional communities characteristic of the region, which are recovering from damage after some human or natural perturbation. Natural areas may include significant geological, archeological, or scenic features and support a rich (highly diverse) or unique fauna or flora. Natural areas are those places where natural processes, which may include catastrophic disturbance, provide the dominant controls for system function (Franklin *et al.*, 1972). Lindsey *et al.* (1970) suggested a non-rigid definition: *"A natural area is any outdoor site that contains an unusual biological, geological or scenic feature or else illustrates common principles of ecology uncommonly well."*

Although the definitions of the federal agencies and those of the several basin states vary somewhat in detail, the concept involved appears reasonably constant. Some of the states have enumerated categories of natural areas in their enabling acts; others have left definition of areas to the designated operating body.

In selecting sites for the Wisconsin scientific areas designation, Tans (1974) suggested that scenic beauty, public enjoyment, access, *etc.*, should not be considered and that quality should be based on species diversity, extent of human disturbance, and the integrity of community structure. The degree to which the total area of the particular community has been converted to other land uses serves as a measure of commonness. Other factors to be considered are the variety of communities within the tract, its size, and the degree of buffering available.

IMPORTANCE OF NATURAL AREAS

State natural-area programs are based on the expressed desire to preserve samples of natural communities and of significant geological features before they are lost to cultural development. Such areas have biological, cultural, and ethical importance. Lindsey *et al.* (1970) categorized the values of nature preserves in five groups: (*i*) scientific usefulness, (*ii*) education and cultural values, (*iii*) aesthetic benefits, (*iv*) practical benefits, and (*v*) long-range socioeconomic benefits. These themes recur in other discussions of natural areas and are expanded upon below.

Natural-area potentials for biological research rest on the fact that a natural area is comprised of sets of species adapted to living as component units of an ecosystem. In large measure, the complete ecosystem may be studied in the absence of extraneous man-generated factors. Likewise, the behavior and function of individual plant or animal species can be studied in an environment to which they are adapted (*i.e.* in which they are successful survivors). Endangered and threatened species are often limited to specific habitats and may be retained only in natural areas which provide these habitats. The soil scientist may examine undisturbed soils and their development; the geologist will have a special interest in significant geological features, outcrops, dune systems, caves, *etc.*; whereas the anthropologist may find clues to human history.

Natural areas serve an important function in education, where students can see and understand the meaning of biotic community. Formal class activity is only one phase; however, some natural areas can sustain educational programs extending to conservation and land-use planning, bird study, wildlife photography, and similar activities. Natural areas may serve a valuable role in demonstrating the structure of natural communities to future scientists. Laymen, too, need a fuller understanding if they are to appreciate the complexities of maintaining the biosphere.

Natural areas are often of great aesthetic value. In general, they lose most of that value with the addition of human improvements.

Natural areas have direct practical, *i.e.* utilitarian, benefits. As habitat for endangered and threatened species as well as for many relatively uncommon forms of plants and animals, these areas serve to protect plant and animal gene pools for potential future use. Similarly, natural areas support populations of native plants and animals which will be sources for replenishment of the same species lost from unprotected communities. This *refuge* concept has its limitations, but if the natural area is of sufficient size it will, presumably, continue to replenish adjoining populations with mobile individuals or propagules. Many common, but interesting and important, animals (such as birds) may utilize natural areas for all or part of their needs.

Natural areas serve as controls which can be used to compare the effect of various land-management practices. The need for improved techniques to assist in sustaining our renewable resource base will increase; natural areas will hold many clues, and solutions may be found in the functioning of the natural ecosystem.

Long-range benefits of natural areas derive from the fact that the existence of such areas preserves options for future decision. By preventing or delaying a change in land use, the resource is retained--a resource which may have a far higher value in the future than today. The importance of natural areas in benefiting human mental and physical health and in providing intellectual stimulation will become increasingly evident.

Ethical values are important. If man destroys all nature, he not only destroys species, communities, and ecosystems of interest and value to his well-being, but he destroys organisms of equal value to himself. Man in an artificial environment rapidly loses his ethical sense. Leopold (1949) proposed the land ethic as an approach toward establishing land values, *i.e.* he

suggested that the responsibility to maintain, rather than exploit, should be the future basis for land ownership and management. The land ethic extends to biotic communities and to our responsibility to maintain natural complexity, not only for our own benefit but as our contribution to environmental quality for future generations.

The value of natural-area preservation is not yet widely understood. It can be difficult to demonstrate how the removal of a small tract of forest, marsh, or shoreline can seriously influence the operation of a landscape in energy exchange, the water cycle, or other major functions. This is especially true if neither endangered nor threatened species have been found in the area. However, the conversion of natural ecosystems to man-dominated ones continues day-by-day and year-after-year, and the acreage of existing natural systems continues to shrink under the combined pressures of urbanization, agriculture, and related demands for land.

As vegetation types adapted to the regional landscape disappear, the acreage of unsubsidized systems which help to support human settlement and activities is likewise reduced. For example, wetlands function in nutrient retention and in the complex cycling of nitrogen, sulfur, carbon, and oxygen. Forest areas influence water retention and recharge while accumulating biomass and processing airborne materials. These unsubsidized support systems may not be undisturbed, but they function because they retain the diversity of animals and plants needed to provide pathways for material exchange and energy flow essential to system function.

The values of natural areas were listed earlier; preservation is essential to salvage those values for the future. Natural areas represent a relatively minute proportion of the lands within the Basin. Alternative sites in the form of already modified lands are usually available for development. Preservation of natural areas is not *locking up* a natural resource, but rather it is providing the cultural and scientific assets of these areas for the people of the Basin now and in the future.

PROTECTION FOR NATURAL AREAS

Many natural areas have been preserved inadvertantly, or otherwise, as parts of state and national parks and forests, as wildlife refuges, or as holdings of private groups and individuals with foresight and resources.

To protect declining and endangered species of plants and animals and to provide suitable study areas, all of the states in the Lake Michigan Drainage Basin have established natural area programs. The Wisconsin Conservation Department established a Natural Areas Committee in 1945 (Tans, 1974), and the Michigan Natural Areas Council began its activities in 1951 (Thompson, 1976). The Illinois Nature Preserves System and the Illinois Nature Preserves Commission were established by the legislature in 1963, and in 1967, Indiana Legislative Act 176 was enacted "... *creating a division of nature preserves, establishing a state system of nature preserves, providing for their acquisition, control, use, management, and protection, and making an appropriation.*" Since the beginning of the Michigan and Wisconsin programs, there have been changes in authority, funding, and operational patterns, but the objective has remained constant.

In 1951, passage of Wisconsin Statute 23.27 created the Scientific Areas Preservation Council, an advisory board now attached for administrative purposes to the Department of Natural Resources. The Council formulates policy, identifies and evaluates potential scientific areas, and arranges for acquisition and preservation of these areas. Over 140 scientific areas have been designated in Wisconsin which together encompass approximately 19,300 acres. Wisconsin Scientific Areas are "... *permanently protected tracts of land or water in a natural or near natural state, which are managed to serve a threefold purpose: scientific research, teaching of conservation and natural history, and preservation for future generations of rare plants and animals or entire biotic communities, as well as unique geological and archeological features*" (Wisconsin Scientific Areas Preservation Council, 1970).

In Michigan, the Michigan Natural Areas Council dedicated more than 30 areas, chiefly lands in public ownership. The Michigan Wilderness and Natural Areas Act of 1972 established a new Wilderness and Natural Areas Board within the Department of Natural Resources. The board was charged with reviewing former dedications and other proposals both for public and private lands. In addition, the Governor created an Advisory Council for Natural Areas to review and recommend to the department areas to be considered for dedication. Working under the 1972 act, 11 areas have been rededicated in the state of which two are in the Basin. Others are undergoing review for dedication. Natural areas in Michigan are classified as (Mich. Dep. Nat. Resour., 1973):

Wilderness - Large (over 3000 acres) areas of state land and islands affected chiefly by natural phenomena and with opportunities for solitude and ecological, geological or other features of value.

Wild - Areas of state land smaller than 3000 acres with attributes similar to wilderness.

Natural Areas - Tracts of land or water in state ownership which have features of educational or scientific value and have retained their natural character.

The 1967 Indiana Legislative Act 176 established a Division of Nature Preserves within the Department of Natural Resources. Ten tracts have been designated within the Lake Michigan Drainage Basin.

The Illinois Nature Preserves Commission shares responsibility for the system with the Illinois Department of Conservation. An Illinois Nature Preserve "... *is an area of land or water in public or private ownership that is formerly dedicated, pursuant to the terms of the law, to being maintained in its natural condition. It must either retain to some degree its primeval character (though it need not be completely natural and undisturbed at the time of dedication) or have floral, faunal, geological or archaeological features of scientific or educational value*" (Ill. Dep. Conserv. and Ill. Nat. Preserves Comm., 1972). The system now consists of 62 areas containing 15,543 acres (Ill. Nat. Preserves Comm., 1977). Most are publicly owned. Organization of the nature preserves system is based on natural geographic divisions of Illinois--integrating soils, topography, geology, and biotic communities in one classification.

SCIENTIFIC AREAS, NATURAL AREAS, NATURE PRESERVES, AND OTHER SIGNIFICANT AREAS IN THE LAKE MICHIGAN DRAINAGE BASIN

Enumeration of the significant natural areas in the Basin is a complex process. The several states use different criteria for designation (Tans, 1974) and are at different stages in the designation process. In addition to official state classifications, the U. S. Park Service has established a system of national natural landmarks for areas of national significance, and the Bureau of Sport Fisheries and Wildlife maintains a system of refuges. Other groups such as The Nature Conservancy; the Michigan Nature Association; Acres, Inc.; and the Society of American Foresters have their own designations. Areas of significance in Illinois and Indiana tend to be smaller than those designated in Michigan and Wisconsin, in part a result of the duration of settlement and the density of human population.

Criteria for preservation can also be expected to change with time, as urban sprawl and industrialization occupy more land and as agriculture and forestry become more intensive. Areas available for dedication will decrease in size while at the same time the human population will experience an increasing need for such areas for education and recreation.

Significant areas in the Basin are listed below by county within each state, progressing in a clockwise fashion around the Basin. General locations are mapped (Fig. 1), and specific details can be obtained from the sources indicated as landowners. Each listing is prefaced by an indication of the types of areas included for that state, whether all are officially designated (Wisconsin) or whether proposed areas and non-official holdings are included. The number following the name and county of each area in the listing corresponds to the number for that area in Figure 1.

Natural-area designation is a dynamic process, and new areas will be added. The following listing describes many significant areas in the Basin but is not to be construed as a complete inventory. Such an inventory remains to be done for many counties in Wisconsin and Michigan; lists for Illinois and especially Indiana are more complete.

MICHIGAN NATURAL AREAS--ESTABLISHED AND POTENTIAL

Prior to 1970, Michigan had designated a number of areas in state parks and state forests as natural areas or preserves. These areas and others are now in the process of redesignation under the Michigan Wilderness and Natural Areas Act of 1972 (Mich. Dep. Nat. Resour., 1973).

The listing for Michigan that follows includes designated areas, areas proposed for designation, and other significant areas held by public agencies and by quasi-public groups such as The Nature Conservancy and the Michigan Nature Association. Information on these tracts has been provided by the U. S. Forest Service, U. S. Bureau of Sport Fisheries and Wildlife, Michigan Department of Natural Resources, Michigan Nature Association, and The Nature Conservancy.

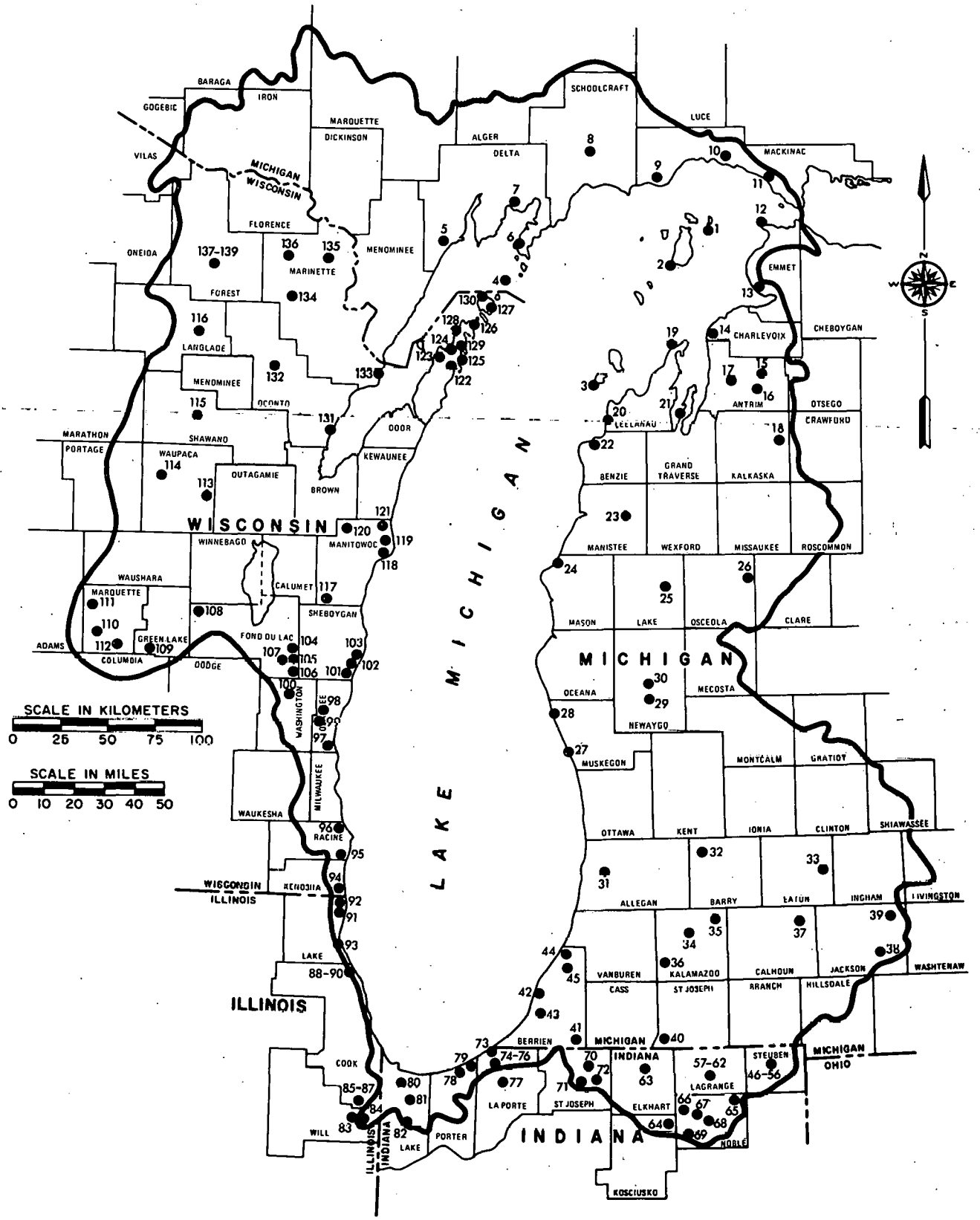

Figure 1. Natural Areas in the Lake Michigan Drainage Basin:

No.	Michigan	County
1	Michigan Island National Wildlife Refuge	Charlevoix
2	Beaver Islands (Island Wilderness)	Charlevoix
3	South Manitou Island	Leelanau
4	Washington-Summer Island	Delta*
5	Hiawatha National Forest	Delta*
6	Garden Peninsula	Delta
7	Sturgeon River	Delta
8	Seney National Wildlife Refuge	Schoolcraft
9	Point Patterson	Mackinac
10	Ryerse Lake	Mackinac
11	Little Brevort Lake	Mackinac
12	Wilderness State Park	Emmet
13	West Wequetonsing Nature Preserve	Emmet
14	Whiskey Creek Tract	Charlevoix
15	Green River	Antrium
16	Cedar River	Antrium
17	Grass River	Antrium
18	Cranberry Lake	Kalkaska
19	Cathead Bay	Leelanau
20	Sleeping Bear Dunes	Leelanau
21	Marion Island	Grand Traverse
22	Platt River Tamarack Bog	Benzie
23	Manistee National Forest	Manistee*
24	Ludington State Park	Mason
25	Luther-Baldwin Swamp	Lake
26	Prairie Chicken Management Area	Osceola
27	Hoffmaster State Forest	Muskegon
28	Duck Lake	Muskegon
29	Newaygo Dry Prairie (U. S. For. Serv.)	Newaygo
30	Newaygo Dry Prairie (Mich. Nat. Assoc.)	Newaygo
31	Allegan Pine Plains	Allegan
32	Bowerman Prairie	Barry
33	Woldumar Nature Center	Eaton
34	Kalamazoo Nature Center	Kalamazoo
35	Fort Custer	Kalamazoo
36	Big Island	Kalamazoo
37	Pennfield Bog	Calhoun
38	Lefglen	Jackson
39	Black Spruce Bog or Waterloo Nature	Jackson
40	White Pigeon	St. Joseph
41	Fernwood Nature Center	Berrien
42	Warren Dunes State Park	Berrien
43	Warren Woods	Berrien
44	Grand Mere	Berrien
45	Robinson Preserve	Berrien

No.	Indiana	County
46	Beaverdam Lake	Steuben
47	Fawn River below Orland	Steuben
48	Potawatomi Nature Preserve	Steuben
49	Marsh Lake Wetlands	Steuben
50	Wing Haven	Steuben
51	Woodland Bog Nature Preserve	Steuben
52	Charles McClue Reserve	Steuben
53	Stayner Dry Prairie	Steuben
54	Gannon (or Stayner) Lake	Steuben
55	Beechwood Nature Preserve	Steuben
56	Ropchan Memorial Nature Preserve	Steuben
57	Lane Lake	Lagrange
58	Olin Lake	Lagrange
59	Quog Lake	Lagrange
60	Tamarack Bog Nature Preserve	Lagrange
61	Nasby Overlook Prairie	Lagrange
62	Wear Woods	Lagrange
63	Parson's Swamp Woods	Elkhart
64	Grider's Woods Nature Preserve	Kosciusko
65	Gene Stratton Porter State Memorial Woods	Noble
66	Edna W. Spurgeon Nature Preserve	Noble
67	Long Swamp Woods and Pond	Noble
68	Lloyd W. Bender Nature Preserve	Noble
69	Merry Lea Nature and Religious Center	Noble
70	Saint Mary's College Nature Area	St. Joseph
71	Bendix Woods Nature Preserve	St. Joseph
72	Spicer Lake	St. Joseph

No.	Indiana (contd.)	County
73	Barker Woods Nature Preserve	La Porte
74	Mt. Pleasant Swamp	La Porte
75	South La Porte Woods	La Porte
76	Pinhook Bog	La Porte
77	Shoemaker Bog	La Porte
78	Dunes Nature Preserve	Porter
79	Cowles Bog and Dunes	Porter
80	Hoosier Prairie	Lake
81	Merrillville Mire	Lake
82	Moraine Nature Preserve	Lake

No.	Illinois	County
83	Raccoon Grove Forest Preserve	Will
84	Thorn Creek Woods	Will
85	Sand Ridge Nature Preserve	Cook
86	Thornton-Lansing Road Nature Preserve	Cook
87	Jurgensen Woods Nature Preserve	Cook
88	Glenbrook North High School Prairie	Cook
89	Peacock Prairie	Cook
90	Somme Forest Preserve Prairie	Cook
91	Illinois Beach Nature Preserve	Lake
92	The Hosah Park Prairie	Lake
93	Edward L. Ryerson Nature Preserve	Lake

No.	Wisconsin	County
94	Chiwaukee Prairie	Kenosha
95	Sanders Park Woods	Racine
96	Renack-Polack Maple Woods	Racine
97	Fairy Chasm	Ozaukee
98	Cedarburg Bog	Ozaukee
99	Cedarburg Beech Woods	Ozaukee
100	Kewaskum Woods	Washington
101	Cedar Grove Hawk Refuge	Sheboygan
102	Kohler Park Dunes	Sheboygan
103	Kohler Park Pines	Sheboygan
104	Spruce Lake Bog	Fond du Lac
105	Haskell Noyes Memorial Woods	Fond du Lac
106	Milwaukee River and Swamp	Fond du Lac
107	Spring Lake	Fond du Lac
108	Ripon Prairie	Fond du Lac
109	Fountain Creek Prairie	Green Lake
110	Endeavor Marsh	Marquette
111	Lawrence Creek	Marquette
112	Muir Lake Natural Area	Marquette
113	Cactus Rock	Waupaca
114	Tellock's Hill Woods	Waupaca
115	Jung Hemlock-Beech Forest	Shawano
116	Flora Lake	Langlade
117	Vanderbloemen Bog	Manitowoc
118	Point Beach Ridges	Manitowoc
119	Wilderness Ridge	Manitowoc
120	Maribel Caves	Manitowoc
121	Two Creeks Buried Forest	Manitowoc
122	The Ridges Sanctuary	Door
123	Peninsula Park Beech Forest	Door
124	Peninsula Park White Cedar Forest	Door
125	Toft's Point	Door
126	Newport Conifer Hardwoods	Door
127	Island Wildlife Refuges	Door
128	Sister Islands	Door
129	Mud Lake	Door
130	Jackson Harbor	Door
131	Charles Pond	Oconto
132	Nicolet National Forest	Oconto*
133	Seagull Bar	Marinette
134	Marinette County Beech Forest	Marinette
135	Miscauno Cedar Swamp	Marinette
136	Dunbar Sharptail Barrens	Marinette
137	Bose Lake Hemlock-Hardwoods	Forest
138	Giant Pines (Woodbury Pines)	Forest
139	Scott Lake-Shelp Lake Natural Area	Forest

*Occurs in more than one county. See text of this report for complete description.

Michigan Island National Wildlife Refuge - Charlevoix County (1)

This refuge of five small islands (363 acres*) was established in 1947 to protect nesting sites of gulls, herons, and terns. Two islands, Pismire and Shoe in Lake Michigan, and a third, Scarecrow in Lake Huron, were designated by Congress in 1970 as wilderness areas (12 acres in total) (U. S. Bur. Sport Fish. Wildl., 1972).

Beaver Islands (Island Wilderness) - Charlevoix County (2)

Beaver, Hog, High, Garden, and several smaller islands lie about 20 miles west of Emmet County and 15-20 miles south of Mackinac County in northeastern Lake Michigan. The south half of Beaver Island and High, Garden, and Hog islands are included in and administered as part of the Pigeon River State Forest and have been used for wildlife research by the Michigan Department of Natural Resources. The islands support a variety of vegetation ranging from northern mesic forest to pine barrens. Extensive areas of dunes and successional vegetation occur on Beaver Island (Mich. Nat. Areas Counc., 1973).

South Manitou Island - Leelanau County (3)

This 5260-acre island lying seven miles off the Leelanau Peninsula, includes excellent perched dunes on the western shore, a dune forest in the central section, and jack pine plains on the east (Mich. Nat. Areas Counc., 1960a). Older shorelines are marked by sand ridges. An unusual 50-acre eastern white cedar stand includes trees over 100 feet tall and four to six feet in diameter (Thompson, 1963). Three species of rare ferns [Northern holly fern (*Polystichum Lonchitis*), walking fern (*Camptosorus rhizophyllus*), and green spleen wort (*Asplenium viride*)] (Thompson, 1962) and three species of trillium (*Trillium grandiflorum, T. flexipes,* and *T. erectum*) are present as are several trillium hybrids (Thompson, 1963).

Areas specified as deserving protection were (*i*) a natural-area preserve of 1038 acres including the north and west shorelines with stabilized dunes and an excellent representation of stages in dune succession, and (*ii*) an area of 453 acres at the northeast tip designated as the Gull Point Nature Study Area, which would include the large gull nesting area, some jack pine forest, and beach. These areas are now administratively part of the Sleeping Bear National Lakeshore.

Washington-Summer Island (4)

Parts of Washington Island (Door Co.) and Summer Island (Delta Co.) as well as several smaller islands lying between Door County, Wisconsin, and Delta County, Michigan, are being proposed as a national lakeshore by the states of Michigan and Wisconsin. Action is pending.

These islands include undisturbed littoral marshes and rocky cliffs, with northern vegetation and nesting areas for gulls, terns, and other shorebirds. Some unusual shoreline plants, including dwarf lake iris and sea rocket, may also be present (Guire and Voss, 1963).

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*For conversion of English units to metric units, e.g. acres to hectares, see Appendix G, p. 74.

Hiawatha National Forest (5)

This 800,000-acre national forest includes most plant communities found in the northern half of the Lake Michigan Drainage Basin (Stearns and Kobriger, 1975). The forest lies in Delta, Schoolcraft, Mackinac, and Chippewa counties. Large areas of conifer swampland and sedge marsh are interspersed with northern mesic and xeric forest providing habitat for many species of wildlife. The forest acreage is managed for timber, wildlife production, recreation, and watershed protection.

The forest administrators have also undertaken special management programs for certain wildlife species. Areas have been set aside for geese (Au Train Goose Area), sandhill cranes [wetlands of the Hiawatha National Forest support the largest population of cranes nesting in the lake states (U. S. For. Serv. and Mich. Dep. Nat. Resour., 1976)], and sharptail grouse for which 21,270 acres are managed (including 17 different areas). In addition to the sharptail grouse and greater sandhill crane, the forest protects other species endangered or threatened in Michigan. Habitat management programs have been undertaken or are planned for the following species: northern bald eagle, American osprey, eastern pigeon hawk, great blue heron, yellow rail, common loon, marten, fisher, and Canada lynx.

Garden Peninsula - Delta County (6)

Several miles of shoreline with exposed outcrops of niagaran dolomite are being examined for natural-area potential. Marshes, swamps, and shoreline plant communities are present that contain numerous orchids and other unusual plants including the threatened dwarf lake iris and several rare sedges (*Carex* spp.) (Mich. Nat. Areas Counc., 1974a).

Sturgeon River - Delta County (7)

This 3215-acre tract includes a portion of the Sturgeon River, some Lake Michigan shoreline, and a marshy lake heavily used by waterfowl. Acquired by The Nature Conservancy, it is now included in the Hiawatha National Forest.

Seney National Wildlife Refuge - Schoolcraft County (8)

This tract of 95,000 acres lies on a sloping, sandy outwash plain near Seney. Old dunes are scattered throughout the area and much of the sand plain is covered with a thin layer of sedge marsh and brushy swamp. Established and managed as a refuge for geese and other waterfowl, the refuge provides habitat for many species of birds and mammals including the greater sandhill crane, northern bald eagle, and sharptailed grouse. The refuge includes four natural areas and a large wilderness area.

Four natural areas have been designated as follows (Buckman and Quintus, 1972): (*i*) Strangmoor, a 640-acre marsh and low brush community with forested dunes as islands (also designated as a national natural landmark by the U. S. Park Service); (*ii*) Hemlock, a 500-acre stand of old-growth hemlock; (*iii*) Northern Hardwood, a 500-acre tract of northern mesic forest; and (*iv*) Red Pine, a 640-acre tract of large red pine.

The 25,150-acre wilderness area includes many square miles of excellent string bog (strang mor). Interspersed within the string bog, the low dunes support pine, birch, and aspen at the northern (upper) ends and northern wet conifer forest at the southern (lower) ends (U. S. Bur. Sport Fish. Wildl., 1971).

Point Patterson - Mackinac County (9)

The shoreline and adjoining forest and wetland lie in a segment of the Mackinac State Forest south of Gould City. Six or seven miles of this shoreline--representing rocky outcrops, sandy beaches, and marshy bays--have been suggested for designation.

Ryerse Lake - Mackinac County (10)

The wetland communities surrounding Ryerse Lake are remarkable examples of northern calcareous sphagnum bog and cedar swamp. They contain a variety of unusual plants, including *Juncus stygius* which reaches its southernmost limit at this station. There are numerous orchids, interesting sedges, and a diverse bryophyte flora. The recommended area of 60 acres includes Ryerse Lake (25 acres), the wetlands, and a buffer of forested upland (Mich. Nat. Areas Counc., 1974b).

Little Brevort Lake - Mackinac County (11)

This 710-acre area in the Mackinac State Forest surrounds Little Brevort Lake. Along the southern edge, the tract is bounded by an ancient shoreline of Lake Michigan covered with old dunes. The dunes and beach ridges are well-forested with a variety of timber types. A large alder swamp and other wetland communities occur in the swales. An excellent scenic view of Lake Michigan may be obtained from the beach ridge.

Wilderness State Park - Emmet County (12)

Wilderness State Park, the northernmost projection into Lake Michigan, includes five areas of natural significance which were dedicated earlier (Mich. Dep. Nat. Resour., 1973):

1. Wilderness Hardwood Forest. This 5300 acres of northern mesic forest is designated as wilderness.

2. Waugoshance and Temperance Islands Research Natural Area. Originally called the Crane Island Natural Areas Preserve, these low islands, which comprise approximately 230 acres at normal water levels, lie off the tip of Waugoshance Point and serve as feeding and nesting ground for gulls, terns, and other water birds. The shallow waters support stands of emergent aquatic plants.

3. Sturgeon Bay-Sucker Creek Research Natural Area. This 550-acre forested tract on the northeast shore of Sturgeon Bay is flanked by a sand beach and long foredunes along the Lake and by distinctive marshes along Sucker Creek.

4. Big Stone-Cecil Bay Nature Study Area. Lying near the park headquarters at the northeast end of the park, this 1520-acre forested area supports a diverse vegetation which includes most forest types of the region.

5. Waugoshance Point Nature Study Area. This tract of 250 acres lies at the tip of the Point. It consists of low beaches fringed with submerged and emergent aquatic plants and supports a white cedar and balsam fir forest growing on a low ridge.

West Wequetonsing Nature Preserve - Emmet County (13)

This 15-acre tract of wetland forest is owned by the Little Traverse Nature Conservancy. It lies on the north side of Little Traverse Bay between an asphalt road and a high bluff. Under a cedar, fir, and aspen canopy, the ground layer contains a great diversity of plants including 15 orchid species.

Whiskey Creek Tract - Charlevoix County (14)

This 1300-acre state-owned area includes three miles of high quality shoreline with swamp conifer and successional forests of birch and aspen. The area may have archeological, as well as historical, significance.

Green River - Antrium County (15)

This 40-acre tract owned by the Michigan Nature Association includes a dense white-cedar swamp along the Green River. The open wet meadows support orchids, wood lily, and other interesting plants.

Cedar River - Antrium County (16)

Owned by the Michigan Nature Association, this 80-acre tract contains wetland communities similar to those along the Green River.

Grass River - Antrium County (17)

Two natural areas lie along the Grass River: an 89-acre tract belonging to the Michigan Nature Association and 144 acres owned by The Nature Conservancy. The river flows through white-cedar swamp and sedge marsh. The area supports green herons and osprey as well as mink, otter, and other animals.

Cranberry Lake - Kalkaska County (18)

This tract lies in the Au Sable State Forest and includes portions of Cranberry Lake and a white-cedar swamp forest. The aquatic communities are of special interest.

Cathead Bay - Leelanau County (19)

The Cathead Bay area at the tip of the Leelanau Peninsula, 30 miles north of Traverse City, has high frontal dunes similar to those which were once characteristic of much of the eastern and southern shores of Lake Michigan.

The sand and dune flora includes dune grasses (*Ammophila* and *Calamovilfa*), sea rocket (*Cakile*), Pitcher's thistle (*Cirsium*), sand cherry (*Prunus*), wormwood (*Artemisia*), cinquefoil (*Potentilla*), and species of other genera. A conifer zone of pine, fir, juniper, and yew lies between the sand ridges and the dune forest. The dune hardwood forest includes basswood, beech, maple, ash, and oak.

Rock-filled pools in the small protected bays contain sedges, rushes, lobelias, gentians, arrow grass, and evening primrose. Leg and Mud lakes and a bog at the north end of Mud Lake provide habitat for aquatic communities. Birds, including gulls, terns, shore and marsh birds, thrushes, woodpeckers, flycatchers, hawks, and warblers are present. Mammals include deer, squirrel, chipmunk, fox, and mice (Mich. Nat. Areas Counc., 1960b).

Designation of the dunes area and the 45-acre Leelanau State Park at the tip of the peninsula has been recommended to preserve the shoreline vegetation, bogs, conifer fringe, and northern mesic dune forest. The area is an excellent example of frontal dunes and a crucial resource for migratory birds of many kinds.

Sleeping Bear Dunes - Leelanau County (20)

Lying south of Glen Haven, this large dune complex is now included in the Sleeping Bear National Lakeshore. The area includes 400-foot-high morainal bluffs, as well as sand cliffs, ridges, blowouts, and slides.

The vegetation is varied and includes dune and shore vegetation. There are cottonwood, juniper, and rich hardwood forest of beech, sugar maple, ash, basswood, and hemlock and a variety of forest herbs and shrubs. Herbaceous plants include wood lily (*Lilium Philadelphicum*), puccoon (*Lithospermum* sp.), beach pea (*Lathyrus maritimus*), Deams goldenrod (*Solidago Deamii*), harebell (*Campanula*), broomrape (*Orobanche* sp.), and sea rocket (*Cakile edentula*) (Mich. Nat. Areas Counc., 1955, 1962).

Marion Island - Grand Traverse County (21)

The Nature Conservancy holds this 268-acre island in Grand Traverse Bay. Marion Island has a diverse substrate of shale, clay, and sand. In excellent condition, this representative Great Lakes island supports a fine northern mesic forest of maple, yellow birch, hemlock, and white pine, and a variety of shoreline communities.

Platt River Tamarack Bog - Benzie County (22)

This 125-acre wetland belongs to The Nature Conservancy. The bog is only one of a number of unusual features of the Platt River Plains. The entire area was an embayment of glacial Lake Algonquin and is bordered by a series of sand ridges along the Lake Michigan shoreline. Ancient dunes, beaches, and sand bars are evident along the moraine. The geological features from the post-glacial period make this a highly significant area, and the diversity in plant communities adds to its value (Mich. Nat. Areas Counc., 1957).

Two other areas in the near vicinity have been proposed: Pearl Lake, a wild area which includes several undeveloped lakes; and the Dead Stream

Preserve, a 71-acre Tamarack bog and stream owned by The Nature Conservancy. Orchids and American lotus are included here along with a diverse aquatic flora.

Manistee National Forest (23)

This tract of approximately 400,000 acres in west central Michigan includes many areas of natural interest. The predominant vegetation is northern xeric (oak-pine) forest, but there are sizable areas of mesic hardwood forest, conifer and hardwood swamp, grassland, aspen forest, and about 135,000 acres of pine plantations. Management is directed toward timber and wildlife production and watershed and habitat management. The forest provides protective management for several species including the northern bald eagle, osprey, greater prairie chicken, greater sandhill crane, great blue heron, and wild turkey (a successful reintroduction) (U. S. For. Serv. and Mich. Dep. Nat. Resour., 1976).

The forest occupies portions of Manistee, Wexford, Mason, Lake, Oceana, Newaygo, and Muskegon counties, with small acreages in Mecosta and Montcalm counties. Areas of specific interest are listed under the appropriate county.

Ludington State Park - Mason County (24)

This heavily used state park of 980 acres, north of Ludington, includes excellent dunes with typical dune and dune forest vegetation on the northern end of the tract. Successional stages from stabilizing dunes to climax forest are evident. A privately owned 955-acre area of similar geologic features and vegetation lies north of the park.

Luther-Baldwin Swamp - Lake County (25)

No highly significant natural areas have been described in Lake County. However, the 7300-acre Luther-Baldwin Swamp and four other areas totaling 6380 acres have been recommended for designation as managed natural areas; primary uses would be non-motorized recreational activities such as hiking, canoeing, skiing, nature study, and hunting in season. The growing need for a relaxed and quiet recreational experience will result in designation of a number of areas of this type. By virtue of its size and relative inaccessibility, the Luther-Baldwin Swamp serves as habitat for many wildlife species including bobcat, wild turkey, beaver, bear, and otter.

Prairie Chicken Management Area - Osceola County (26)

Although not a natural area, this 600 acres of grassland three miles north of Marion is the habitat for the major remaining prairie chicken colony in Michigan. A diverse grassland vegetation is present (Mich. Prairie Chicken Soc., 1972).

Hoffmaster State Forest - Muskegon County (27)

This 1000-acre park combines shoreland and dunes including wooded dunes, blowouts, and a high active dune. About 200 acres of the southern part of the park is recommended as a wild area. Vegetation types represent all stages from dune grasses to mesic forest of maple, beech, and hemlock.

Duck Lake - Muskegon County (28)

A 585-acre tract fronting on Lake Michigan and Duck Lake north of Muskegon, this area was acquired by The Nature Conservancy and has been conveyed to the Michigan Department of Natural Resources. It includes beach and aquatic habitats.

Newaygo Dry Prairie (U. S. Forest Service) - Newaygo County (29)

This 80-acre grassland area lies in the Manistee National Forest, southeast of White Cloud. Plants include prairie bluestem grasses (*Andropogon* spp.), prickly pear cactus (*Opuntia compressa*), avens (*Geum triflorum*), silky aster (*Aster sericeus*), and Virginia goatrue (*Tephrosia virginiana*) (Thompson, 1970). A very dry, sandy soil and probably occasional fires have permitted the area to remain as prairie.

Newaygo Dry Prairie (Michigan Nature Association) - Newaygo County (30)

A nearby prairie area in southeastern Newaygo County has been acquired and dedicated by the Michigan Nature Association. This area is an excellent dry prairie of 110 acres and supports vigorous populations of the same species noted in the Forest Service area.

Allegan Pine Plains - Allegan County (31)

Three neighboring areas of the Allegan State Game Area, totaling 608 acres, were recommended for a natural area preserve. Included are six biotic communities in excellent condition--oak forest, oak openings, conifer (cedar) swamp, sedge meadow, northern wet forest (tamarack swamp), and southern wet mesic (red maple) forest. Many northern plants reach their southern limits in this area, as well as prairie species and several unusual and threatened species, including orchids and ferns. The spotted turtle and massasauga rattlesnake inhabit the sedge bog (Mich. Nat. Areas Counc., 1974c).

Bowerman Prairie - Barry County (32)

A small, 35-acre, state-owned area in northeastern Barry County, this tract represents the northernmost extension of mesic prairie in Michigan. Although not as rich as prairie in Illinois or Wisconsin, this tract is largely undisturbed and contains a great diversity of plant species, the grasshopper sparrow, and several unusual butterflies.

Woldumar Nature Center - Eaton County (33)

Located in eastern Eaton county near Lansing, this privately owned 160-acre tract includes excellent mesic forest of beech and maple and southern lowland forest along the Grand River.

Kalamazoo Nature Center - Kalamazoo County (34)

This 565-acre tract includes three areas north of Kalamazoo with mixed hardwood forest and other vegetation types. Privately owned, the area is used for nature education.

Fort Custer - Kalamazoo County (35)

Three areas controlled by the Michigan Department of Natural Resources have been recommended as nature study areas. These include southern wet forest (lowland hardwood swamp) along the Kalamazoo River, a small wet prairie, and a rich mesic prairie. An excellent prairie, a fine beech-maple stand, and other potential natural areas are included in the Fort Custer military reservation (Mich. Nat. Areas Counc., 1974d).

Big Island - Kalamazoo County (36)

This Michigan Nature Association tract is a small, 24-acre, remnant of a mesic hardwood forest once surrounded by tall grass prairie (Prairie Ronde). The area includes an old bur oak stand and a good display of herbs.

Pennfield Bog - Calhoun County (37)

This 21-acre bog owned by the Michigan Nature Association lies in northeastern Calhoun County. Four distinct bog zones ring a small (4-acre) lake; there are a variety of southern Michigan bog species including two orchids--the yellow fringed orchid and the whorled pogonia (Vanderkamp, 1975--personal communication).

Fish Lake Bog Plant Preserve, the smallest Michigan Nature Association sanctuary, is nearby. A 3-acre tract, it supports a large population of pink lady's slippers.

Lefglen - Jackson County (38)

This 175-acre tract, owned by the Michigan Nature Association, lies southeast of Jackson. It includes a small lake and other shorelines, wet prairie, and rich southern mesic forest. Over 650 native species of plants have been found in the area (Vanderkamp, 1975--personal communication).

Black Spruce Bog or Waterloo Nature Study Area - Jackson County (39)

This 40-acre tract, 10 miles northeast of Waterloo, was conveyed to the state to insure the preservation of a black spruce-tamarack bog, the southernmost bog of this type in Michigan. The area includes a small oak woodlot, 3 acres of farmland, and 23 acres of conifer bog with red maple swamp.

White Pigeon - St. Joseph County (40)

This 58-acre tract along the White Pigeon River is held by the Michigan Nature Association; it includes mesic to wet prairie and southern wet mesic or bottomland forest. The forest is rich in woody plants, and over 55 species of nesting birds have been recorded.

Fernwood Nature Center - Berrien County (41)

This privately owned 18-acre tract, along the St. Joseph River near Niles, includes southern wet mesic forest and other river bottom communities (Kapp, 1969).

Warren Dunes State Park - Berrien County (42)

A 520-acre nature study area in the state park has been designated to preserve portions of the ancient dune complex which represents several different stages of the glacial lakes. Warren Dunes support typical dune plant communities from pioneer stages on active dunes to mesic forests of beech and sugar maple on old dune valleys. Oak and mixed hardwood forest is dominant on the ridges and drier slopes. The herbaceous flora ranges from beach species to those of the mesic forest (Mich. Nat. Areas Counc., 1965).

Warren Woods - Berrien County (43)

Lying north of Three Oaks, this fine old-growth southern mesic forest is leased to the state as a natural area. The area designated as a nature study area includes 179 acres of virgin beech and sugar maple forest and also contains tulip poplar, elm, black cherry, and a diverse herbaceous flora of more than 350 species. Studied in detail by Cain (1935), this woods is listed as a natural area of the Society of American Foresters (Buckman and Quintus, 1972; Mich. Nat. Areas Counc., 1964).

Grand Mere - Berrien County (44)

A diverse area of wooded dunes, this 23-acre tract is owned by the Kalamazoo Nature Center. Southern xeric, mixed black oak forest covers most of the area which is registered as a national natural landmark.

Robinson Preserve - Berrien County (45)

This 80-acre tract of southern mesic forest, prairie, and old field is owned by The Nature Conservancy. Closed gentian and showy orchids are included in the rich flora.

INDIANA NATURE PRESERVES AND NATURAL AREAS

Descriptions of Indiana areas were drawn from Lindsey *et al.* (1970) and Escobar (1971) with additional information provided by the Indiana Department of Natural Resources, Division of Nature Preserves (Barnes, 1969, 1972). By 1976, Indiana had 36 dedicated nature preserves (Barnes, 1976), 12 of which lie in or immediately adjacent to the Lake Michigan Drainage Basin (Table 1). The words *Nature Preserve* in a name indicate a dedicated area. Other sites deemed worthy of preservation are included in the following list. Acreage figures represent the area being considered or designated.

Beaverdam Lake - Steuben County (46)

This 55-acre tract in the Orland quadrangle is owned by the Indiana Department of Natural Resources. The long, narrow lake has vegetation characteristic of marly habitats. Rare plants include Nelson's horsetail (*Equisetum Nelsoni*), yellow bladderwort (*Utricularia intermedia*), Loesel twayblade (*Liparis Loeselii*), and arrowgrass (*Trigochin maritima*). Sundews, pitcher plants, and sedges are also present. Waterfowl use this area extensively during migration.

Table 1. Dedicated Indiana Nature Preserves in the Lake Michigan Drainage Basin*

Name of Preserve	*Ownership*	*Acres in Preserve*	*County*	*Date Dedicated*
Grider Woods Nature Preserve	Indiana DNR, Div. Fish Wildl.	10	Kosciusko	13 Sep 1969
Tamarack Bog Nature Preserve	Indiana DNR, Div. Fish Wildl.	100	Lagrange	23 Apr 1970
Beechwood Nature Preserve	Acres, Inc.	74	Steuben	20 May 1970
Edna W. Spurgeon Nature Preserve	Acres, Inc.	60	Noble	20 May 1970
Moraine Nature Preserve	Indiana DNR, Div. Nat. Preserves	193	Porter	20 May 1971
Dunes Nature Preserve	Indiana DNR, Div. Parks	1530	Porter	22 Jul 1971
Bendix Woods Nature Preserve	St. Joseph County Park Rec. Board	27	St. Joseph	16 Dec 1971
Lloyd W. Bender Nature Preserve	Acres, Inc.	60	Noble	24 Aug 1972
Woodland Bog Nature Preserve	Acres, Inc.	20	Steuben	24 Aug 1972
Potawatomi Nature Preserve	Indiana DNR, Div. Parks	208	Steuben	19 Apr 1973
Barker Woods Nature Preserve	Nature Conservancy	30	La Porte	26 Jun 1975
Ropchan Memorial Nature Preserve	Acres, Inc.	77	Steuben	26 Jun 1975

**Data from Indiana Department of Natural Resources, Division of Nature Preserves (1974) and Barnes (1976).*

Fawn River below Orland - Steuben County (47)

The area consists of 4.7 miles of state stream running through private land in the Orland quadrangle of Steuben and Lagrange counties. The Fawn River *"provides a float trip that rivals any other in the state for combined biological interest and feasibility. The upstream two-thirds traverses wild swampland and the stream-side vegetation is dense"* (Lindsey *et al.*, 1970).

Potawatomi Nature Preserve - Steuben County (48)

This 208-acre area near the Michigan border lies within Pokagon State Park (1173 acres). The preserve, representative of the Indiana morainal lake region, includes southern mesic (hardwood) forest, yellow birch and black ash-tamarack swamps, sedge marsh, cattail marsh, and a small marshy lake. A great variety of herbaceous plants, shrubs, and trees is matched by a diverse animal population. The largest tamarack and yellow birch in Indiana are found here (Barnes, 1973).

Marsh Lake Wetlands - Steuben County (49)

Initially suggested as "... *probably the second largest lake in Indiana still suitable for natural area preservation*" (Lindsey *et al.*, 1970), the Marsh Lake area is now included in a proposed 1119-acre acquisition project of the Indiana Department of Natural Resources. The remainder of the Wing Haven tract is also a part of this proposal. Both areas are almost adjacent to the Pokagon State Park and its Potawatomi Nature Preserve and lie in the Angola

East quadrangle. The Marsh Lake Wetlands (tentative acreage 754 acres) includes 55-acre Marsh Lake bordered by emergent vegetation and swamp forest, and a small wooded island. Waterfowl and mammals are abundant (Barnes, 1974).

Wing Haven - Steuben County (50)

Ninety acres were to be acquired as a nature preserve by the Indiana Department of Natural Resources. The area, parts of which are now privately owned, lies in the Angola East quadrangle. This tract originally included a chain of beautiful small lakes, good oak-hickory forest, and a variety of successional communities with excellent submerged aquatic vegetation. Today it has been partially developed, and only one or two lakes remain.

Woodland Bog Nature Preserve - Steuben County (51)

This 20-acre tract, owned by Acres, Inc. (a non-profit preservation organization), lies in the Angola East quadrangle. The wooded bog is an example of late successional vegetation growing on peat. The lowland hardwood forest includes a variety of ferns and herbs.

Charles McClue Reserve - Steuben County (52)

This 80-acre tract is owned by Steuben County and lies in the Angola West quadrangle. It includes a muck soil depression with lowland hardwood forest--largely yellow birch, red maple and red elm--and a variety of shrubs, sedges, and cattail. The slope and ridge support maple-beech forest.

Stayner Dry Prairie - Steuben County (53)

This 15-acre dry prairie lies in the Orland quadrangle. On a southwest-facing slope, the xeric prairie has been invaded by shrubs and widely scattered trees.

Gannon (or Stayner) Lake - Steuben County (54)

This 25-acre tract is included in the Orland quadrangle. Gannon Lake is the "*... most calcareous piece of water encountered in Indiana, with no inlet or outlet and a marl bottom supporting very little plant life and no lily pads*" (Lindsey *et al.*, 1970). Stonewort and a few pondweeds are present, and the lake is fringed with emergent macrophytes and shrubs.

Beechwood Nature Preserve - Steuben County (55)

Lying in the Angola West quadrangle, this 74-acre area belongs to Acres, Inc. A depression with muck soils, it supports various successional stages of wetland vegetation and bog forest as the most significant feature. A beech-maple forest occurs on the slope and ridge northeast of the bog.

Ropchan Memorial Nature Preserve - Steuben County (56)

This 77-acre tract is owned by Acres, Inc. The diverse glacial topography carries oak-hickory forest on the sandy loam upland and supports red maple and tamarack forest with associated wetland shrubs and herbs in the lowland and peat areas.

Lane Lake - Lagrange County (57)

Lying in the Pigeon River State Fish and Wildlife Area, this 20-acre area includes Lane Lake (5 acres) which supports a heavy growth of aquatic plants. One notable species is a pondweed (*Potamogeton panormitanus* var. *minor*) found in only three other Indiana counties.

Olin Lake - Lagrange County (58)

This area includes 55 acres in the Oliver Lake quadrangle. Purdue University owns the northern half of the lake; the woods are privately owned. The marly lake shows good zonation of submerged and emergent aquatic plants and has a southern lowland (hardwood) forest border. *"Due to the low marsh shoreline and the fact that much of the latter lake is within the property that was donated to Purdue University some years ago, this is, we believe, the largest lake in Indiana having no structures or cultures whatever upon its shores"* (Lindsey *et al.*, 1970).

Browand Woods, a mixed mesic beech-maple stand of 125 acres south of Olin Lake, is now owned by The Nature Conservancy and may later be acquired by the Indiana Department of Natural Resources. Some relatively large tulip tree, walnut, and oak remain despite recent logging.

Quog Lake - Lagrange County (59)

This 30-acre tract lies in a privately owned area of approximately 100 acres in the Oliver Lake quadrangle. The lake basin is filled with peat and shows excellent zonation, from a quaking bog mat along the lake through an emergent aquatic zone to a tamarack-red maple swamp. There are northern bog species present such as pitcher plant, cranberry, buckbean, and tamarack. The sandy ground east and north of the lake supports oak-hickory forest.

Tamarack Bog Nature Preserve - Lagrange County (60)

This 100-acre tract lies in the Pigeon River Fish and Wildlife Area in the Mongo quadrangle. *"Tamarack Bog has a wide variety of habitat types that display successional changes from open water to a dry upland forest. The aquatic habitats, from swift clear stream, with a clean sandy bottom, to static pools choked with aquatics and tamarack swamp forest, are notably diversified also"* (Lindsey *et al.*, 1970). The bog forest includes the largest stand of tamarack in the state with associated yellow birch, poison sumac, and other species. The herbaceous flora includes showy lady's slipper (*Cypripedium reginae*) and a wide variety of northern herbs. The site also shows good diversity in animals, including 34 mammalian species as well as swamp rattlesnakes, other reptiles, and amphibians.

Nasby Overlook Prairie - Lagrange County (61)

This 10-acre prairie lies on a south-facing slope in the Pigeon River Fish and Wildlife Area. The xeric prairie includes scattered clumps of shrubs and shrubby trees.

Wear Woods - Lagrange County (62)

This excellent, small (12-acre), privately owned woods lies in the Lagrange quadrangle. Growing on a sandy ridge, the maple-beech forest has an unusual number of woody species. *"The striking feature of the woods is the large number of trees with high diameter measurements, but with the relatively stout stature and low branching form that accompanies large diameters in trees that grew in rather open scattered pattern in heavily used farm woods ... the large number of impressive size trees, the high floristic variety and the very close proximity to the schools of Lagrange justify its preservation"* (Lindsey *et al.*, 1970).

Parson's Swamp Woods - Elkhart County (63)

In the Goshen quadrangle, this 17-acre privately owned tract lies on the floodplain of the Elkhart River. It includes a small area of swamp and marsh and a brushy successional community on the higher alluvium. The area contains many unusual plants including orchids, aquatics, sphagnum moss, and the only Indiana station of the flowering rush. Bird life is abundant; 174 species have been listed.

Grider's Woods Nature Preserve - Kosciusko County (64)

This 10-acre stand in the Tri-County State Fish and Game Area, North Webster quadrangle, is an excellent example of mesic forest which apparently has been undisturbed for many decades. This mixed-hardwood stand includes large white ash and red and black oak.

Gene Stratton Porter State Memorial Woods - Noble County (65)

The Department of Natural Resources owns this 6-acre strip in the Kendallville quadrangle. Old timber has been left to decay, and the tract is a good example of mature maple-beech forest with an abundant ground flora. Many large trees were lost in a 1974 tornado.

Edna W. Spurgeon Nature Preserve - Noble County (66)

This 60-acre tract (owned by Acres, Inc.) lies in the Ligonier quadrangle. *"It is an excellent second-growth beech-maple stand with a number of moderately large trees, especially tulip trees. There has been little grazing in the best portion in recent decades, if ever"* (Lindsey *et al.*, 1970). The vegetation is diverse including black cherry, red elm, basswood, white and green ash, red oak, hackberry, red maple, American elm, bitternut hickory, and ironwood, as well as a good variety of herbs and shrubs. The rough morainic topography includes both upland ridges and depressions.

Long Swamp Woods and Pond - Noble County (67)

A 40-acre area--including lowland hardwood forest with some yellow birch, northern herbs, and a small pond--this is a privately owned tract which lies in the Ormas quadrangle.

Lloyd W. Bender Nature Preserve - Noble County (68)

This 60-acre tract in the Albion quadrangle is owned by Acres, Inc. It includes oak forest, lowland forest, sedge meadow, and old-field communities of several ages.

Merry Lea Nature and Religious Center - Noble County (69)

This large tract, adjacent to High and Bear lakes in the Ormas quadrangle, includes about 150 acres classified as natural area. The lakes and adjacent marshes are biologically diverse with a variety of aquatic communities. A black walnut stand and an oak-hickory forest lie south of Bear Lake. Successional communities, both terrestrial and aquatic, provide opportunity for observation of natural revegetation process.

Saint Mary's College Nature Area - St. Joseph County (70)

This diverse 100-acre area lies in the South Bend West quadrangle. It includes 20 acres of old-growth black oak (southern xeric) forest and a large oxbow area with ponds, marsh, young floodplain forest, and wet meadow. The variety of trees is unusual and includes shingle oak, Kentucky coffee tree, red cedar, and bur oak. Abandoned field, shrub, and forest communities provide habitat for a variety of animals.

Bendix Woods Nature Preserve - St. Joseph County (71)

The St. Joseph County Department of Parks and Recreation owns this 27-acre tract in the Lydick quadrangle. The woods is an old growth hardwood forest of sugar maple, beech, red elm, and basswood protected since 1926. Lindsey *et al.* (1970) noted that the presence of elm and basswood and the very limited representation of oak, hickory, ash, and tulip tree is an unusual feature. Mammals, including deer and fox, are common.

Spicer Lake - St. Joseph County (72)

This 30-acre privately owned tract lies on morainic topography in the New Carlisle quadrangle. The tract includes a 5-acre lake with adjoining kettle-hole swamp forest of red maple, shrubs, and northern herbs.

Barker Woods Nature Preserve - La Porte County (73)

A 30-acre woods in the Michigan City West quadrangle, this area is owned by The Nature Conservancy. Most of the site lies on clay, is poorly drained, and supports a diverse lowland hardwood forest of pin oak, red maple, yellow birch, black gum, and related species. Many northern herbs and shrubs are present, and a diverse bird population is found here.

Mt. Pleasant Swamp - La Porte County (74)

This 45-acre swamp site, privately owned, is located in the New Carlisle quadrangle. Buttonbush (*Cephalanthus occidentalis*) is the dominant species; one individual with a trunk diameter of 8 inches, perhaps the largest ever recorded, was observed. Tamarack is present on the southwest side.

South La Porte Woods - La Porte County (75)

The 26-acre privately owned woods lies in the La Porte East quadrangle. The stand is "... *strategically located for future forest ecological investigation because it is in the center of the area in northwestern Indiana which receives extensive rainfall as one effect of the air pollution from the steel mills along the southern shores of Lake Michigan*" (Lindsey *et al.*, 1970). An unusual density of tree reproduction appears in the shrub layer, and the forest is chiefly black and sugar maple.

Pinhook Bog - La Porte County (76)

In the La Porte West quadrangle, this privately owned area of 170 acres is regarded as the finest bog in Indiana. It represents "*that landscape feature rare in Indiana, the well developed Sphagnum bog typical of the northern lake states and Canada*" (Lindsey *et al.*, 1970). Rare orchids include *Cypripedium acaule* and *Habenaria ciliaris*. Pinhook Bog is proposed as a non-contiguous inclusion in the Indiana Dunes National Lakeshore.

Shoemaker Bog - La Porte County (77)

This 50-acre bog, privately owned, is in the La Porte West quadrangle. The sphagnum-leatherleaf bog supports a variety of shrubs and herbs.

Dunes Nature Preserve - Porter County (78)

This area includes 1530 acres of the 2182-acre Indiana Dunes State Park. Lying in the Dunes Acres quadrangle, it occupies the eastern two-thirds of the park and includes the area described (Lindsey *et al.*, 1970) as ecology coves where H. C. Cowles did his pioneering work in dune ecology just prior to 1900. Foredunes, blowouts, interdunal marsh areas, and back dunes are present (Barnes, 1971).

Vegetation types include beach and dune communities, mesic forest in moist pockets, black oak on drier ridges, and lowland hardwood forest and marsh communities in wet areas south of the dunes. A wide variety of northern plants are present as are many invertebrates, mammals, and birds. The preserve is included in the Indiana Dunes National Lakeshore area.

Cowles Bog and Dunes - Porter County (79)

A registered national natural landmark owned by Dune Acres, this 57-acre area lies in the Dune Acres quadrangle. Growing in wet mucky soil, lowland forest dominated by red maple and yellow birch fringes the edge of the open bog. Orchids and other unusual plants occur in the bog and swamp forest. A black oak-white oak forest grows on the dune sands.

Hoosier Prairie - Lake County (80)

This 331-acre prairie site is a mosaic of the plant communities once typical of the prairie-forest border. Formerly owned by Gaylord Properties, Inc., it was recently acquired by the state of Indiana and plans for dedication as a nature preserve are in progress. Few prairie areas of this quality remain. The vegetation includes marsh; wet, wet-mesic, and dry prairie; and

black oak savanna. Glacial features include outwash and lake deposits, some of which have formed low dune and swale topography. The flora, totaling at least 300 species of vascular plants, includes 43 plants rare or uncommon in Indiana. Although surrounded by industrial and residential areas, development has been retarded because of wet soils and buffering provided by major rail lines. The tract is under heavy urban pressure, but the nature of surrounding development offers some protection and the rich flora suggests that the vegetation can be maintained successfully (Ind. Dep. Nat. Resour. Div. Nat. Preserves, 1974).

Merrillville Mire - Lake County (81)

This 30-acre privately owned area occupies a large kettle hole located in the Crown Point quadrangle. *"Lacking the characteristic flora of a northern Indiana bog, it is treacherous underfoot and seems more appropriately termed a mire"* (Lindsey *et al.*, 1970). It shelters a surprising number of mammals, including the gray fox. The mire is also unusually attractive to birds such as killdeer and herons and provides a winter sanctuary for many species.

Moraine Nature Preserve - Lake County (82)

This area of 193 acres lies in the Valparaiso moraine on the southern edge of the Basin. The tract includes many glacial landforms and a wide range of biotic communities including old fields, marsh, swamp, and successional southern mesic forest. The area is held in life tenancy and hence is not yet open for public use.

ILLINOIS NATURAL AREAS

The sites listed include dedicated Illinois Nature Preserves as well as those tracts currently being considered for preservation. Descriptions were obtained from the *Directory of Illinois Nature Preserves* (Ill. Dep. Conserv. and Ill. Nat. Preserves Comm., 1972), the *Illinois Nature Preserves, Two-Year Report, 1971-1972* (Ill. Nat. Preserves Comm., 1973), and *Preserving Illinois' Natural Heritage, Biennial Report, 1975-1976* (Ill. Nat. Preserves Comm., 1977), supplemented by correspondence.

Raccoon Grove Forest Preserve - Will County (83)

Owned by the Will County Forest Preserve District, this 45-acre area near Monee includes dry-mesic forest and floodplain forest with a small creek. It is of particular interest as an ungrazed stand bordering the former Grand Prairie. Dominant trees of the upland forest are white, black, and red oak; hickory; and some white ash and black cherry. Silver maple and green ash occupy a lowland strip along the creek. An intensive and continuing study on the 17-year cicada is in progress at this location. Nature preserve status has been recommended.

Thorn Creek Woods - Will County (84)

In Monee township, this tract comprises 850 acres of woodland in the headwaters of Thorn Creek in northeastern Will County (Ill. Nat. Preserves Comm., 1977). The area includes upland forest dominated by white, bur, and red oak. Also present are black cherry, shagbark hickory, and swamp white

oak; mesic forest of red oak, basswood, sugar and black maple; and floodplain forest of black walnut, swamp white oak, red oak, ash, and elm. The Illinois Nature Preserves Commission (1973) stated that the site has recreational values as well as high potential for educational and scientific use. The area was jointly acquired by the Department of Conservation, the Will County Forest Preserve District, and the communities of Park Forest and Park Forest South. Governor's State University, the Thorn Creek Preservation Association, and the landowning agencies have formed an intergovernmental commission to oversee management of the woods. Approximately 500 acres has been proposed for dedication as an Illinois Nature Preserve (Ill. Nat. Preserves Comm., 1977).

Sand Ridge Nature Preserve - Cook County (85)

The tract includes 70 acres owned by the Cook County Forest Preserve District. *"The area consists of long ridges and low swales of lake-shore deposited sands. The vegetation consists of prairie of little bluestem, June grass and porcupine grass in dry areas and of bluejoint grass and cord grass in wet areas. There are some black oak trees on the ridges. Many prairie wildflowers are present, including fringed gentian, closed gentian, prairie dock, cream false indigo and blazing star"* (Ill. Dep. Conserv. and Ill. Nat. Preserves Comm., 1972).

Thorton-Lansing Road Nature Preserve - Cook County (86)

Totaling 440 acres, these woods are owned by the Cook County Forest Preserve District. The site consists of marsh, sand, prairie, and forest. *"The vegetation includes dry-mesic oak woods, black oak on sand, cattail-bulrush marsh, wet to dry sand prairie, and bog-like communities in sandy depressions of the Chicago Lake Plain Section of the Northeastern Morainal Natural Division. ... Unusual shrubs and wildflowers are sassafras, sweet-fern, lupine, sour gum, and several orchids"* (Ill. Nat. Preserves Comm., 1977).

Jurgensen Woods Nature Preserve - Cook County (87)

This 120-acre area is owned by the Cook County Forest Preserve District. The stand is a wet-mesic oak forest which includes such species as purple chokecherry, black gum, cinnamon fern, and blueberry. *"This preserve and the adjacent Thornton-Lansing Road Nature Preserve, although disturbed by man's activities, contain almost all of the original natural features of the Chicago Lake Plain"* (Ill. Nat. Preserves Comm., 1977).

Glenbrook North High School Prairie - Cook County (88)

Although limited in size (1.5-2 acres), this tract consists of high quality, wet to wet-mesic prairie vegetation. Owned by the Glenbrook schools, the area has been considered as a possible preserve.

Peacock Prairie - Cook County (89)

This small prairie area of 5 or 6 acres is managed and protected by the University of Illinois, Chicago Circle Campus. A center for research and nature study has been constructed. The area supports a rich prairie flora and native insect fauna, apparently without damage from surrounding development. This site is *"... one of the last, if not the last, of the virgin black-soil*

prairies of quality we have left ..." (Betz, 1968--personal communication). Negotiations for nature preserve status are in progress.

Somme Forest Preserve Prairie - Cook County (90)

This tract consists of patches (less than 5 acres in total) of prairie scattered through brush area and a hardwood plantation, in part on U. S. Coast Guard property. Some remnant prairie species are present and preservation will be considered after the property is conveyed to a local agency.

Illinois Beach Nature Preserve - Lake County (91)

This 829-acre area north of Waukegan is owned by the Department of Conservation. The preserve includes beach, dunes, and alternating sand ridges and swales. The drier ridges support a scrub black oak community, whereas the lakeshore dunes are dominated by bearberry and trailing juniper. Sand prairie dominates most of the low ridges and swales. Aquatic communities include vast cattail marshes, wet sedge meadows, the Dead River, and Lake Michigan. Rare flowers include the downy yellow-painted cup, shrubby cinquefoil, and many orchids. The preserve includes a grove of pine trees planted about the turn of the century. The preserve provides excellent wildlife habitat and is an important refuge for migrating birds (Ill. Dep. Conserv. and Ill. Nat. Preserves Comm., 1972).

The Hosah Park Prairie - Lake County (92)

Owned by the Zion Park District, this is one of the few areas of undisturbed prairie remaining in the Basin. It is being considered for acquisition as a nature preserve.

Edward L. Ryerson Nature Preserve - Lake County (93)

The Lake County Forest Preserve District owns this 150-acre area. The preserve is *"... an old growth forest of white oak, black oak, red oak, sugar maple, white ash, bur oak and silver maple within the Des Plaines River valley. Several large hackberry and black walnut trees are present. The forest supports a luxuriant spring flora including an abundance of large-flowered Trillium"* (Ill. Dep. Conserv. and Ill. Nat. Preserves Comm., 1972).

WISCONSIN SCIENTIFIC AND NATURAL AREAS

All areas listed for Wisconsin have been officially designated by the Wisconsin Scientific Areas Preservation Council. Additional tracts are added each year. The Basin includes other locations of local interest and educational value which are not of statewide significance and hence are not designated as scientific areas. Descriptions that follow are based on Scientific Areas Preservation Council inspection reports, on the official listing of Wisconsin Scientific Areas (Wis. Sci. Areas Preserv. Counc., 1973) and on other information.

Chiwaukee Prairie - Kenosha County (94)

This tract, south of Kenosha, is a relatively undisturbed, wet to mesic prairie with an extremely rich prairie flora. Chiwaukee is one of a few

remnants of the once extensive ridge and swale landscape bordering the southwestern shore of Lake Michigan. The 82-acre tract owned by the University of Wisconsin is now subject to damage by recreational vehicles. It is registered as a national natural landmark.

Sanders Park Woods - Racine County (95)

This 30-acre stand of southern dry-mesic forest includes red and white oak, white ash, and walnut growing on a sandy terrace. The rich ground flora includes several orchids.

Renack-Polack Maple Woods - Racine County (96)

This 45-acre area is owned by The Nature Conservancy. It consists of a stand of southern mesic forest, a lowland ash-elm stand along an intermittent stream, and a patch of red-osier dogwood shrub swamp. The upland woods are largely of old-growth and include an excellent beech stand and mixed stands of sugar maple, basswood, red oak, and white ash, and a diverse ground flora.

Fairy Chasm - Ozaukee County (97)

This 20-acre tract includes a deep ravine cut by Fish Creek into the glacial till which borders Lake Michigan. Southern and northern mesic hardwood forest stands appear on south- and north-facing exposures, respectively. A diverse understory is present, and many northern species are at or near the southern limit of their range.

Cedarburg Bog - Ozaukee County (98)

Covering 1012 acres in the town of Saukville, this site includes tamarack-cedar swamp, lowland hardwoods, shrub-carr, open bog, a shallow lake, and a fine sample of forested string bog. Many northern plants and animals are found here, including orchids and pitcher plants.

Cedarburg Beech Woods - Ozaukee County (99)

This 50-acre beech and sugar maple forest has an intermixture of white ash, basswood, oak, and elm. It grades into swamp hardwood, with white cedar and tamarack in depressions. The area, owned by the University of Wisconsin--Milwaukee, is utilized extensively for ecological research.

Kewaskum Woods - Washington County (100)

Lying within the northern unit of the Kettle Moraine State Forest, this 50-acre tract consists of two disjunct 25-acre stands; a 30-acre buffer separates the tracts. The woods are high-quality southern mesic forest of sugar maple, red oak, basswood, and white ash with some beech. The more level and lower northern stand contains especially large trees, whereas the hilly southern section has a rich ground layer including ginseng and several orchids.

Cedar Grove Hawk Refuge - Sheboygan County (101)

This station, east of Cedar Grove, is a major location for trapping and banding hawks during migration and is a state wildlife refuge. The 32-acre

tract is an abandoned beach about 1000 feet wide which supports a pioneer stand of aspen-birch-cherry and brush.

Kohler Park Dunes - Sheboygan County (102)

This 25-acre tract is located in Kohler State Park. The area includes a large unstabilized dune and adjoining stabilized dunes fronting on Lake Michigan. It supports a characteristic beach and dune vegetation, including grasses and forbs.

Kohler Park Pines - Sheboygan County (103)

This tract of 95 acres lies between the Black River and Lake Michigan within Kohler State Park. The stabilized dunes support white pine and northern hardwoods, with an abundant shrub layer. The low swales support lowland hardwood and alder swamp communities.

Spruce Lake Bog - Fond du Lac County (104)

This 117-acre area includes *"an outstanding bog lake, bog, and spruce-tamarack forest within Kettle Moraine State Forest"* (Wis. Sci. Areas Preserv. Counc., 1973). The rich flora includes many bog shrubs, sedges, and orchids.

Haskell Noyes Memorial Woods - Fond du Lac County (105)

Lying in the Kettle Moraine State Forest, this 70-acre sugar maple, basswood, and red oak forest has a rich understory of ferns and spring ephemeral species.

Milwaukee River and Swamp - Fond du Lac County (106)

This 230-acre tract lies south of Mauthe Lake in the Kettle Moraine State Forest. It includes a stretch of meandering river with sand, muck, or gravel bottom, and diverse aquatic vegetation. A shrub zone along the river grades into lowland hardwood forest adjacent to a swamp conifer type with a 2-acre bog lake. The flora includes northern bog species.

Spring Lake - Fond du Lac County (107)

This 47-acre tract lies in the Kettle Moraine State Forest. It includes a clear, alkaline, bog lake of 10 acres and is fringed with sedges, predominantly *Scirpus validus*. A varied amphibian and reptile population is present as are various fishes. The lake is surrounded by tamarack and lowland hardwood forest, with some floating bog. Poison sumac is abundant.

Ripon Prairie - Fond du Lac County (108)

Owned by Ripon College, this 1.5-acre prairie lies along the railroad right-of-way northeast of Ripon. The prairie, on a glacial knoll, includes both xeric and mesic habitats.

Fountain Creek Prairie - Green Lake County (109)

This 50-acre wet prairie lies within the Grand River Marsh State Wildlife Area. It consists of a wet prairie community along the Grand River flowage.

Endeavor Marsh - Marquette County (110)

The Nature Conservancy holds title to this 40-acre tract northwest of Endeavor. The site includes tamarack swamp, sedge meadow, fen, and a small sandy island with white and red oak. At least 9 orchid species have been found as well as other rare plants.

Lawrence Creek - Marquette County (111)

This 25-acre tract, west of Westfield, lies in a state wildlife area widely known for brook trout research. The area designated includes seepage springs and serves as spawning ground for a wild brook trout population.

Muir Lake Natural Area - Marquette County (112)

This 65-acre area lies south of Montello in Muir Park and belongs to Marquette County. Springfed and marl-bottomed, Muir Lake occupies a depression in the ground moraine. Marsh, fen, and wet prairie areas contain gentians, lobelia, orchids, and other unusual plants. Sedge meadow, shrub-carr, and conifer swamp forest are also included. The area is buffered by dry oak scrub, abandoned fields, and oak woods.

Cactus Rock - Waupaca County (113)

This 20-acre hill south of New London is a conspicuous feature of the landscape. Lichens, mosses, and other pioneers growing on bare rock are intermixed with remnant dry prairie species and shrubs and trees in crevices. The granite outcrop shows glacial striae. The cactus, *Opuntia fragilis*, is one of the unusual plants in the area.

Tellock's Hill Woods - Waupaca County (114)

This 32-acre tract, south of Clintonville, is owned by the Wisconsin Department of Natural Resources. Tellock's Hill consists of a sandstone core covered with glacial till. The hill supports a well-developed stand of northern mesic forest of maple, beech, and hemlock, with a rich understory.

Jung Hemlock-Beech Forest - Shawano County (115)

This 80-acre tract, recently acquired by the Wisconsin Department of Natural Resources, includes 63 acres of old-growth northern mesic forest, perhaps the best in northeastern Wisconsin, as well as two small sphagnum bogs. The vigorous stand of beech, sugar maple, and hemlock has an intermixture of white pine and yellow birch and a diverse ground flora indicating absence of grazing.

Flora Lake - Langlade County (116)

East of Antigo, this 40-acre tract consists of a spring pond of excellent water quality surrounded by swamp conifers, cedar, spruce, and hemlock. The site is owned by Langlade County.

Vanderbloemen Bog - Manitowoc County (117)

The property of Silver Lake College, this 24-acre tract lies southeast of St. Nazienz. It includes a diverse assemblage of characteristic bog plants growing in an open bog which is itself surrounded by tamarack, spruce, and pine forest and by an outer fringe of swamp hardwoods.

Point Beach Ridges - Manitowoc County (118)

The site occupies 175 acres in Point Beach State Forest. Eleven ridges with intervening swales lie parallel to the present beach line. Ridges near the lake support beach and dune vegetation, and the developing forest shows a transition from hemlock, white birch, and red maple (nearer the Lake) toward white pine, white cedar, hemlock, and yellow birch on the ninth ridge.

Wilderness Ridge - Manitowoc County (119)

This 8-acre transect within Point Beach State Park includes abandoned Lake Michigan dune ridges and swales. Wilderness Ridge supports hemlock, white pine, and mixed hardwood species.

Maribel Caves - Manitowoc County (120)

This 8-acre site is located in a Manitowoc County park, northeast of Maribel, and consists of a wooded limestone bluff along the Niagara Escarpment. Some large white cedars grow at the base of the bluff, beech and hemlock at the top, and between is a shaded cliff community including moss, liverwort, and fern species.

Two Creeks Buried Forest - Manitowoc County (121)

This 25-acre area, owned by The Nature Conservancy, is of major interest to glacial geologists. Consisting of exposed remnants of a boreal forest which developed about 11,000 years ago, it was buried first by glacial outwash and lake sediments and later by red till deposits; it records the interval between the Cary and Valders stages of Wisconsin glaciation.

The Ridges Sanctuary - Door County (122)

Belonging to the Ridges Foundation, this tract includes over 700 acres near Bailey's Harbor. The uplifted beach ridges are covered with spruce-fir and northern lowland forest, and the swales are open or with low shrubs or tamarack swamp. Perhaps the largest concentration of rare plants in the lake states exists within the Ridges.

Peninsula Park Beech Forest - Door County (123)

Consisting of 30 acres in Peninsula State Park, this characteristic beech-maple forest includes various mixtures of sugar maple, beech, and other northern hardwood species.

Peninsula Park White Cedar Forest - Door County (124)

This tract includes 40 acres within the Peninsula State Park. The area consists of open marsh, calcareous meadow, white cedar-white spruce swamp, and upland white cedar-white birch forest on abandoned Lake Michigan beach and adjoining upland terraces.

Toft's Point - Door County (125)

This excellent northern mesic conifer and hardwood forest is fringed by white cedar-spruce lowlands and by emergent aquatic vegetation along Lake Michigan. Owned by the University of Wisconsin, it includes 300 acres which support a diverse flora and fauna.

Newport Conifer Hardwoods - Door County (126)

East of Ellison Bay, this 140-acre tract supports northern mesic forest on the old dunes, interspersed with stands of hemlock, swamp conifers, and lowland hardwoods. The property is part of the Newport State Park.

Island Wildlife Refuges - Door County (127)

Two small island refuges in Lake Michigan are administered from the Horicon National Wildlife Refuge. Of these, Gravel Island includes two islands totaling 27 acres and Green Bay Refuge is one island of 2 acres. Congress has designated these refuges for herons, gulls, and other waterfowl as wilderness areas (U. S. Bur. Sport Fish. Wildl., 1972).

Sister Islands - Door County (128)

This small (15-acre) state wildlife refuge lies northwest of Sister Bay. The refuge consists of two small, gravel islands that are important gull nesting sites in Green Bay.

Mud Lake - Door County (129)

This 1060-acre tract near Bailey's Harbor is owned by the Wisconsin Department of Natural Resources and was initially designated as the Mud Lake Wildlife Area. Mud Lake and the surrounding marsh and swampland are now a national natural landmark. Shrub-carr and northern lowland forest surround the 155-acre marl-bottomed lake. Submergent and emergent aquatic plants form diverse communities in the lake and outlet stream, waterfowl make frequent use of the lake, and beaver activity causes fluctuations in water level.

Jackson Harbor - Door County (130)

The town of Washington holds a 31-acre tract on the northeast side of Washington Island, of which 27 acres are preserved as a natural area and

4 acres are designated for recreational use. The area includes a variety of habitats ranging from moist, calcareous, sandy swales and flats to dry sand ridges. This area supports an excellent undisturbed sample of Lake Michigan beach vegetation, including the dwarf lake iris, primrose, and scarlet painted cup.

Charles Pond - Oconto County (131)

This 110-acre tract is part of the Charles Pond State Wildlife Area. At normal or below-normal levels of Lake Michigan, this is a small marshy-bordered pond adjacent to the Lake, with a diverse grouping of submergent and emergent aquatic plants. At above-normal lake levels, the pond becomes a shallow embayment of the Lake, and destructive wave action occurs. The area includes an adjoining 12 acres of undisturbed mesic forest of maple, basswood, and elm.

Nicolet National Forest (132)

The Nicolet National Forest occupies 641,410 acres in portions of Oconto, Langlade, Forest, Florence, Oneida, and Vilas counties. All of the forest except the northwestern edge lies in the Lake Michigan Drainage Basin and is drained by the Wolf, Oconto, Peshtigo, and Brule rivers. Geological features include level and pitted outwash plains, eskers, drumlins, bedrock outcrops, lakes and springs, and terminal, end, and ground moraines. Virtually all of the forest has been logged; most is now in second-growth stands, including the entire spectrum from northern lowland conifer forest of spruce and tamarack or white cedar to northern xeric forests of oak and jack pine or successional stands of birch and aspen. The finer-textured soils support vigorous stands of northern mesic forest of sugar maple, yellow birch, ash, basswood, and hemlock; pine plantations are common on the level, sandy soils.

Several areas in the forest have been designated as scientific areas, including stands of old-growth hemlock and white pine. Threatened and endangered species are protected, and special programs have been established to encourage reproduction of eagle and osprey. There has been extensive habitat management for white-tailed deer and ruffed grouse. Fisher were apparently successfully reintroduced into the Three Lakes area in the late 1960's. Bobcat are present in the forest, as are black bear and many other mammals and birds. Management of the forest emphasizes timber production, recreation, wildlife habitat, and watershed protection (U. S. For. Serv. *et al.*, 1976).

Seagull Bar - Marinette County (133)

This 20-acre tract is part of the Lake Michigan Shores Wildlife Area and consists of sand ridges and dunes sheltering a shallow lagoon. The sand spit has a diverse dune and beach flora. The area is an important stop on the western shore of Green Bay for migrating waterfowl and shorebirds.

Marinette County Beech Forest - Marinette County (134)

This 40-acre stand of northern mesic hardwood forest is dominated by beech and supports a sparse understory.

Miscauno Cedar Swamp - Marinette County (135)

The Miscauno State Wildlife Area includes this 155-acre tract and a 480-acre buffer northeast of Wausaukee. White cedar, spruce, and balsam fir form a vigorous northern wet-mesic forest surrounded by cutover pine land and aspen-oak forest on the sandy upland. Springs are numerous, and a rich ground flora is present which includes many lichens, mosses, and orchids.

Dunbar Sharptail Barrens - Marinette County (136)

This tract of 240 acres represents a portion of an 800-acre opening in the Dunbar Wildlife Area. The pitted outwash topography carries a northern forest of oak, aspen, and jack pine; the presence of tip-up mounds and patches of stumps indicates that the opening was once partly forested. Opening vegetation is representative of dry sites and includes reindeer moss (*Cladonia* spp.), native and introduced grasses, asters, goldenrods, and hawkweeds. The opening is one of the few remaining habitats suitable for sharptail grouse and adjoins a sharptail management area.

Bose Lake Hemlock-Hardwoods - Forest County (137)

This tract of about 40 acres lies west of Bose Lake in the Nicolet National Forest. An old-growth northern mesic forest, this stand contains hemlock, sugar maple, and basswood over three feet in diameter. The surrounding areas have been cut and burned, but this stand has remained intact save for the effects of age and wind. Ground pine, ferns, and mosses are abundant in the ground layer.

Giant Pines (Woodbury Pines) - Forest County (138)

Lying north of Scott Lake in the Nicolet National Forest, this 23-acre tract consists of scattered white pine standing above a mature forest of hemlock and sugar maple. This stand has been protected for some years. Early cutting had removed much hemlock and pine but had left vigorous large white pine (now 30 to 48 inches in diameter).

Scott Lake-Shelp Lake Natural Area - Forest County (139)

This tract includes two shallow wilderness lakes, Scott (32 acres) and Shelp (45 acres), and a buffer of swamp and forest totaling about 266 acres in the Nicolet National Forest. Residual stands of large hemlock and white pine occur on the upland between the lakes; fir and spruce and mixed conifer communities fringe the borders. An excellent floating bog mat lies along the south shore of Shelp Lake. Scott Lake supports a variety of aquatic vegetation, including wild rice. The lakes harbor a variety of small fish and are heavily used by nesting and migrating waterfowl.

ADDENDUM TO WISCONSIN SCIENTIFIC AND NATURAL AREAS

A natural-area inventory (funded by the Coastal Zone Management Act of 1972) just completed for the Lake Michigan coast lists all areas lying within about six miles of the shoreline (Wis. Sci. Areas Preserv. Counc., 1976). For Lake Michigan, the list totals 118 areas, including 17 sites already designated by the Wisconsin Scientific Areas Preservation Council (1973). Five of

the tracts not yet designated are deemed of exceptional natural-area value and are listed below.

Whitefish Bay Dunes and Cave Point - Door County

This area, in the Jacksonport quadrangle, is being acquired slowly as a state park. It includes both active and stabilized sand dunes, perhaps the best in Wisconsin, and a quality beach. The dunes and the dolomite bedrock at Cave Point support mesic forest of beech and maple.

Marshall's Point or Pine Ledges - Door County

In the Sister Bay quadrangle, this area of about 600 acres includes mature hemlock-hardwood mesic forest and boreal white cedar and balsam fir forest on a dolomitic bedrock. The area supports a rich bryophyte flora and numerous endangered and threatened species of flowering plants.

Hotz Tract (Europe Bay) - Door County

This privately owned tract lies in the Washington Island quadrangle and includes shoreline on Europe Lake and Lake Michigan. It supports varied shoreline communities, old-growth red pine, and an excellent mesic forest of beech and sugar maple.

Carlin Tract (Washington Island) - Door County

Adjoining the Jackson Harbor Scientific Area, this private tract has dunes, beach, and beach pools, and a diverse flora including many unusual species.

Kurtz Maple Woods - Ozaukee County

This southern mesic forest in the Cedarburg quadrangle includes about 30 acres of mature forest--sugar maple and beech--with an intermixture of ash, red oak, black cherry, basswood, and elm.

ENDANGERED AND THREATENED PLANTS AND ANIMALS OF THE LAKE MICHIGAN DRAINAGE BASIN

Extinction of species is a normal and necessary occurrence during the process of evolution. Usually a species disappears gradually as environmental conditions change or as new species evolve which are better fitted to compete for a particular niche. The role that the extinct species filled in the ecosystem is soon occupied by some species whose characteristics adapt it more completely to the changed situation. Occasionally, extinction occurs suddenly as a result of an environmental catastrophe--drought, flooding, volcanic activity, disease, or human predation.

Although extinction is a natural process, the rate at which it occurs is of major concern. Each species represents a particular combination of genetic material, and each has a function in the ecosystem in which it evolved. Before the advent of modern man, there was usually time for the evolutionary

process to conserve--by incorporation into a better-adapted species--the useful attributes derived from the gene plasm of the disappearing species.

Growing human populations and implementation of modern technology, however, have vastly increased the rate of extinction. Human predation and competition for space and food resources are eliminating the larger carnivores; pesticides concentrating in soil and food chains are killing susceptible bird species; and habitat destruction resulting from spreading urbanization, agriculture, and other land uses is wiping out smaller animals and plants. Nations throughout the world have documented increasingly rapid loss of their indigenous species; since 1800, approximately 50 species of animals have been lost from the United States alone. This vastly increased rate of extinction leaves little opportunity for replacement species to evolve and results in ecosystems that are greatly simplified.

The International Biological Program, involving a worldwide study of ecosystems just completed, has expanded our knowledge of the ways in which natural systems lose their resilience (ability to sustain disturbance) when species diversity is reduced. A relatively familiar example is the extirpation of timber wolf populations from forests of the northern lake states. The loss of timber wolf populations combined with major disturbances of human origin (logging and fire) resulted in huge increases in white-tailed deer populations. The increase in deer, in turn, drastically reduced regeneration of certain northern tree species. Additional cases can be documented, but still more remain to be discovered. Concern for endangered and threatened species is essential if we are to maintain the integrity of ecosystems upon which man depends.

In addition to the basic need to maintain ecosystem stability, there are other reasons of interest concerning endangered or threatened plants and animals. Presently unused plants and animals may become economically important in the future, and the gene pools they represent may provide sources of characteristics desired in plant or animal breeding. Also, endangered species often represent important or representative steps in the evolution of some plant or animal group.

We have come to agree that it is necessary to live in harmony with other organisms if we are to maintain a semblance of humanity for ourselves. This feeling of moral responsibility for other organisms has both practical and biological limits, but it appears vital for survival on this crowded earth. Finally, the aesthetic characteristics of many of the endangered and threatened species contribute to the quality of the human experience.

In the United States, the Endangered Species Conservation Act of 1969 (Public Law 91-135; 83 Stat. 275) recognized the essential values inherent in nonhuman forms of life. The 1969 act was supplanted by the Endangered Species Act of 1973 (Public Law 93-205; 87 Stat. 884) which took effect 28 December 1973. In this act, the United States pledged support for conservation of plants and animals throughout the world. The act seeks to conserve both the endangered and threatened species of plants and animals and the ecosystems upon which they depend.

The 1973 Endangered Species Act includes all species of plants and animals, and the term species has been extended to include species, subspecies,

and taxonomic units of smaller size. The act established two categories as follows (U. S. Dep. Inter. Fish Wildl. Serv., 1974):

> *"(a) those species in danger of extinction throughout all or a significant portion of their range--i.e.* endangered species; *and*
>
> *(b) those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range--i.e.* threatened species ..."

In May 1974, the U. S. Department of the Interior published a list of endangered fauna for the United States (U. S. Dep. Inter. Fish Wildl. Serv., 1974), and on 1 July 1975, published three lists of threatened and endangered plants (U. S. Dep. Inter. Fish Wildl. Serv., 1975), which were derived from the 1974 Smithsonian Institution report (Smithson. Inst., 1974). Plant and animal species from the Lake Michigan Drainage Basin included on the above lists are described in the inventory that follows.

Many states have initiated endangered species programs and have developed lists of species endangered or threatened within those states. These lists generally follow earlier regulations protecting rare species. Certain plants had been recognized as worthy of protection for many years, although these have usually been the more conspicuous wild flowers as exemplified by the Michigan and Wisconsin lists (see Appendix A).

The Illinois Nature Preserves Commission published a preliminary list of rare and endangered vertebrates in 1973, and the Illinois Department of Transportation, Bureau of Environmental Science (1975) published an annotated list in 1975. In 1976, the Illinois Nature Preserves Commission and Illinois Department of Transportation (1976) published an interim list of endangered, vulnerable, and rare vertebrates (see Appendix B). They define a state endangered species as *"one that has been so designated by the Illinois Endangered Species Board as being 'in practical danger of extinction in the wild or natural state.'"* In developing the final list, it is possible that as more information is received some species may be added to or deleted from the interim list, or moved to a different status.

In Michigan, a comprehensive Endangered Species Act, Act No. 203, Public Acts of 1974, took effect on 1 September 1974 and charged the Department of Natural Resources with the responsibility to carry out scientific investigations for the protection and enhancement of endangered and threatened species of both animals and plants. *"This broad new state authority provides protection for endangered and threatened species on both federal and state lists, and authorizes a full range of conservation management programs for these plants and animals including necessary land acquisition"* (Mich. Dep. Nat. Resour., 1974). Prior to the 1974 act, Michigan had protected some animal and plant species on a piecemeal basis. A major thrust in the new act is the development of programs for management of species, such as the timber wolf and Kirtland's warbler, listed by the federal government as endangered.

Michigan follows the federal definitions (U. S. Dep. Inter. Fish Wildl. Serv., 1974) for endangered and threatened species; in addition, persons preparing state lists are directed to include among the endangered species

those which Michigan believes should be on the national list by virtue of nearing extinction. Those species threatened with extirpation from Michigan are included as threatened species on the state list unless their range in Michigan is considered peripheral. Michigan has also added a category of rare or scarce species to include those which are extremely uncommon in Michigan and in need of study. Peripheral species, as well as those that have recovered from an endangered or threatened status, are included as rare. The initial list (see Appendix C) is approaching final approval under the Michigan Administrative Procedures Act (Mich. Dep. Nat. Resour., 1976b).

In 1972, Wisconsin passed legislation (Chapter 275, Laws of 1971) requiring that lists of endangered species be developed and that action be taken to protect such species. An annotated and illustrated listing of endangered animals in Wisconsin was published in 1973 (Wis. Dep. Nat. Resour. Endangered Species Comm., 1973) and updated in 1975 (Wis. Dep. Nat. Resour. Endangered Species Comm., 1975) (see Appendix D). A comprehensive state list of endangered and threatened plants, with descriptions of habitat and reasons for their status, was published in 1976 (Read, 1976). The situation in Wisconsin is representative of that throughout the basin states. In 170 years of settlement, at least 14 species of animals have been extirpated, 15 others are endangered (two mammals, three birds, three reptiles, and seven fish), and at least 35 more species are in difficulty. The status of plant species is less clear; unquestionably, some have already disappeared and 120 endangered and 106 threatened plant species are included on the state list (Read, 1976). Elsewhere in the Basin, the situation is similar.

Federal agencies are also concerned with endangered and threatened species of the Basin. The U. S. Forest Service has invested considerable effort on endangered vertebrates and recently proposed extensive studies and management programs directed toward their preservation (U. S. For. Serv., 1972) (see Appendix E). Similarly, the U. S. Fish and Wildlife Service has taken action in respect to endangered animals.

Preparation of comprehensive lists of endangered species of plants or animals is a lengthy and difficult process. The lists are subject to change as human activity eliminates the habitat of a species or imposes new stresses on particular populations. For example, the rapid decline of eagle and osprey populations, as a result of pesticide use, could not have been foreseen in 1945.

For many species, inadequate knowledge of species requirements or the inability of most people to recognize a particular organism makes determination of status difficult. Scarcity of trained personnel may limit observation even when a species can be readily recognized.

Retention of any animal or plant species depends upon maintenance of an appropriate habitat. There are many natural communities in the Basin whose existence is threatened and, consequently, the existence of certain plants and animals. As Beaman (1977) stated, *"One of the most important aspects of immediate concern in the rare plants problem is the identification of critical localities where endangered and threatened species occur. When these localities are established, strong efforts must be directed at habitat preservation."* Similarly, *"In Wisconsin, habitat degradation and destruction are probably the most important factors threatening particular species"* (Read, 1976).

Most plant and animal species are closely linked to a particular habitat; others (especially birds and mammals) may have the option of relocating or temporarily substituting one habitat for another. Even with this slightly greater freedom of the mammal or bird, maintenance of a suitable habitat--*i.e.* one to which the organism was adapted through the course of its evolutionary development--is essential for the continued survival of the species. Communities whose existence is seriously threatened will be discussed at greater length below (see section on Critical Natural Communities in the Lake Michigan Drainage Basin, p. 62).

ENDANGERED AND THREATENED ANIMAL SPECIES

The basic lists of endangered and threatened species established under federal law have been published in the Federal Register (U. S. Dep. Inter. Fish Wildl. Serv., 1975). The state of Indiana follows the federal designations. Preliminary state lists for animals have been published by Illinois (Ill. Nat. Preserves Comm. and Ill. Dep. Transp., 1976) and Michigan (Mich. Dep. Nat. Resour., 1976a, 1976b). Wisconsin published a state list in 1973 (Wis. Dep. Nat. Resour. Endangered Species Comm., 1973), and this list was revised in 1975 (Wis. Dep. Nat. Resour. Endangered Species Comm., 1975).

The 1973 Wisconsin list recognized the categories *endangered, changing status,* and *extirpated*, whereas the 1975 list included the categories *endangered, threatened, watch status,* and *extirpated.* Four species (eastern timber wolf, peregrine falcon, wood turtle, and massasauga) have been added to the 1975 Wisconsin endangered list, and one species (Butler's garter snake) has been moved from endangered to watch status. Species designated with changing status in the 1973 list have been assigned to either threatened or watch status in the 1975 list.

In Illinois, the 1976 list includes the four categories of *endangered, highly vulnerable, vulnerable,* and *rare, restricted, or uncertain status.*

Not yet recognized by other basin states, Michigan lists two mussels--*Simpsoniconcha ambigua* and *Obovaria leibin*--as endangered, seven as threatened, and three as rare. Twelve snails are listed as threatened and six as rare species. Michigan also lists five species of insects as rare.

The *United States List of Endangered Fauna* (U. S. Dep. Inter. Fish Wildl. Serv., 1974) includes relatively few species native to the Lake Michigan Drainage Basin; these species are listed in Table 2. This list does not include all species believed to have an endangered status in the Basin, but includes those listed under the authority of the Endangered Species Conservation Act of 1969. The list is being revised, and new lists will be published under the 1973 Endangered Species Act to include endangered and threatened species. The cougar, timber wolf, and American peregrine falcon have in all likelihood been extirpated from the Basin.

As indicated above, several state lists have been prepared which include species not on the federal lists. Some of the species on these state lists never occurred in the Basin proper; others were extirpated, but attempts are being made to reintroduce them. It is probable that additional species will be added to the endangered and threatened lists in the future, as pressure on habitats increase and as pollution and pesticide effects continue.

Table 2. Endangered Animals of the United States* That Are Native to the Lake Michigan Drainage Basin

Family	*Scientific Name*	*Common Name*
	Mammals	
Vespertilionidae	*Myotis sodalis*	Indiana bat
Canidae	*Canis lupus lycaon*	Eastern timber wolf
Felidae	*Felis concolor cougar*	Eastern cougar
	Birds	
Accipitridae	*Haliaeetus leucocephalus*	Southern bald eagle
Falconidae	*Falco peregrinus anatum*	American peregrine falcon
Falconidae	*Falco porogrinus tundrius*	Arctic peregrine falcon
Parulidae	*Dendroica kirtlandii*	Kirtland's (wood) warbler
	Fishes	
Acipenseridae	*Acipenser brevirostrum*	Shortnose sturgeon
Salmonidae	*Coregonus alpenae*	Longjaw cisco

**Source: U. S. Department of the Interior, Fish and Wildlife Service (1974).*

The annotated lists of endangered and threatened vertebrates that follow (see Tables 3 and 4) are based on the federal list (U. S. Dep. Inter. Fish Wildl. Serv., 1974) and the Wisconsin list (Wis. Dep. Nat. Resour. Endangered Species Comm., 1975), supplemented by lists from Illinois (Ill. Nat. Preserves Comm. and Ill. Dep. Transp., 1976), Michigan (Mich. Dep. Nat. Resour., 1976a, 1976b), and the U. S. Forest Service, Eastern Region (U. S. For. Serv., 1972). Only those species considered native to the Basin are listed (Jackson, 1961; Long, 1974; Pentecost and Vogt, 1976; Becker, 1976; Wallace, 1977).

Endangered Vertebrates

The annotated list of endangered vertebrates is given in Table 3. The agencies (sources) which have designated endangered status for the several species listed are indicated by the symbols (USDOI), (W), (Ill), (M), and (USFS), respectively (see footnote to Table 3). The list of endangered vertebrates includes species listed by one or more agencies (sources) under a different designation--threatened, highly vulnerable, vulnerable, unique, or rare; this is indicated by a word or abbreviation preceding the agency (see footnote to Table 3). The status terms used by each agency are defined in Appendix F.

Threatened Vertebrates

The annotated list of threatened vertebrates is presented in Table 4. This list includes (*i*) species listed by Wisconsin as having either threatened or watch status (Wis. Dep. Nat. Resour. Endangered Species Comm., 1975), (*ii*) species listed by Illinois as highly vulnerable, vulnerable, or rare (Ill. Nat. Preserves Comm. and Ill. Dep. Transp., 1976), (*iii*) species listed by Michigan as threatened, rare, or peripheral (Mich. Dep. Nat. Resour., 1976a,

1976b), (*iv*) species listed by Indiana as threatened (Ind. Dep. Nat. Resour., 1969), and (*v*) species listed by the U. S. Forest Service (1972) as unique. Table 4 includes only those species which are either (*i*) designated as threatened by a state agency or unique by the U. S. Forest Service (1972) or (*ii*) listed by more than one agency in a category other than threatened. The symbols used for the agencies (sources) and the abbreviations and other designations are explained in the footnote to Table 4. Although those species listed only once in a category other than threatened have been excluded from Table 4, complete agency lists (including species within and outside the Basin) are presented in Appendices B-E.

In addition to the species listed in Tables 3 and 4, there are other mammals that may be placed in threatened or endangered categories. Most of these are small mammals whose populations and distribution are relatively little known. In his publication *Mammals of the Lake Michigan Drainage Basin*, Long (1974) indicated 37 other mammals believed rare and probably threatened. An annotated list of species drawn chiefly from Long (1974) is provided in Table 5 (those species previously listed have been omitted). Three of these species (least shrew, pine vole, and southern bog lemming) have been placed on the state list of threatened mammals by Michigan.

ENDANGERED AND THREATENED PLANT SPECIES

The Endangered Species Act of 1973 instructed the Smithsonian Institution to develop a list of endangered and threatened plants and to examine methods for their conservation. The first published list included 761 endangered and 1238 threatened species; about 100 others were listed as recently extinct (Smithson. Inst., 1974; U. S. Dep. Inter. Fish Wildl. Serv., 1975). For the states of the Lake Michigan Drainage Basin--Illinois, Indiana, Michigan, and Wisconsin--10 species were listed as endangered and 24 as threatened, with no recent extinctions. Five of the 10 endangered species and 11 of the 24 threatened species are or were found in the Basin. The remaining species listed for the basin states are chiefly southern or western species found outside the Basin in such areas as southern Indiana, western Illinois, and the driftless area of Wisconsin.

The federal list includes only a small number of the plants considered threatened or endangered by specialists in the several states. Wisconsin has published an annotated list of 268 species which describes their distribution, habitat requirements, and reasons for endangered or threatened status (Read, 1976). Approximately 40 to 50 percent of these species occur in the Basin. Michigan also has prepared a detailed list which includes 328 species (Wagner *et al.*, 1977), and a list from Illinois is in progress. The initial Michigan list now being processed for approval includes 16 endangered, 197 threatened, and 90 rare species, few of which were listed in the Federal Register (U. S. Dep. Inter. Fish Wildl. Serv., 1975) (Table 6). Details on individual species may be obtained from the published and forthcoming state lists.

Table 3. Endangered Vertebrates of the Lake Michigan Drainage Basin

Scientific Name	*Common Name*	*Status**	*Comments*
		Mammals	
VESPERTILIONIDAE *Myotis sodalis*	EVENING BATS Indiana bat	(USDOI) (Ill) (M) (USFS)	A possible summer visitor to northern Indiana and southern Michigan, it is probable that this animal was never a resident in the Basin.
CANIDAE *Canis lupus lycaon*	DOGS Eastern timber wolf	(USDOI) (W) (M) (USFS)	Timber wolves once ranged throughout the forests of the Basin, but very few, if any, individuals remain. Until recently, a few animals were believed to exist in northeastern Wisconsin and in the Upper Peninsula of Michigan, although the most recent records were not in the Basin (Long, 1974).
MUSTELIDAE *Martes americana*	WEASELS, ERMINE, MINK Pine marten	(W) (Thr. M) (Unique USFS)	Once a relatively rare resident of mature spruce, fir, and cedar forests in the northern Basin, the marten was extirpated by the 1930's. During the late 1960's, it was introduced into the Ottawa and Nicolet national forests and more recently into the Hiawatha National Forest. Martens have not been observed recently, but a few may still remain. Reintroduction into the Hiawatha National Forest is planned.
FELIDAE *Felis concolor cougar*	CATS Eastern cougar	(USDOI) (Ext. W)	Long (1974) stated that the cougar was probably present throughout the Basin but that it was exterminated in Wisconsin and somewhat later in Michigan; it is still carried on the federal endangered species list.
Lynx canadensis	Canada lynx	(W) (Rare M) (Unique USFS)	Presumably, lynx were once present in many forested areas, especially northern conifer and conifer swamp communities, in Wisconsin (as far south as Milwaukee) and in upper and lower Michigan. A few animals may remain in the Upper Peninsula of Michigan, but the only recent records are north (Long, 1974) and northwest (Wis. Dep. Nat. Resour. Endangered Species Comm., 1975) of the Basin.
		Birds	
PHALACROCORACIDAE *Phalacrocorax auritus*	CORMORANTS Double-crested cormorant	(W) (High. vul. Ill) (Thr. M)	Once the cormorant was a frequent migrant and often nested in the Basin. At present, there are few nesting colonies, with only four known nesting colonies reported in Wisconsin. Again, decline in numbers is related to human activity, pesticides, loss of habitat, and hunting.
ACCIPITRIDAE *Haliaeetus leucocephalus*	HAWKS, EAGLES, HARRIERS Northern bald eagle	(W) (Ill) (Thr. M) (Unique USFS)	In Wisconsin, only one pair is known to nest along the Lake Michigan shoreline; a few remaining breeding pairs are found on inland lakes. In Michigan, less than 90 pairs remain in the state, mostly in the western Upper Peninsula, outside of the Lake Michigan Drainage Basin. Disturbance of nesting sites, use of pesticides, and poaching appear responsible for the loss of this species. The U. S. Forest Service believes the bird be endangered or, at best, threatened in Michigan and Wisconsin.

Table 3. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Birds (contd.)	
PANDIONIDAE	OSPREYS		
Pandion haliaetus	Osprey	(W) (High. vul. Ill) (Thr. M) (Unique USFS)	Ospreys were originally found throughout the Basin but were not abundant. Today they are extremely rare, presumably as a result of reproductive failure caused by pesticides and by human disturbance. Few breeding pairs are present within the Basin.
FALCONIDAE	FALCONS		
Falco peregrinus anatum	American peregrine falcon	(USDOI) (W) (Ill) (M) (USFS)	Wisconsin reports that the falcon declined and disappeared between 1955 and 1965, largely as a result of the use of pesticides (chlorinated hydrocarbons). It is doubtful that any birds remain in the Basin.
Falco peregrinus tundrius	Arctic peregrine falcon	(W)	The Arctic falcon has been observed in migration along Lake Michigan. Again, pesticides and human disturbance have taken a major toll of the population.
PARULIDAE	WOOD WARBLERS		
Dendroica kirtlandii	Kirtland's (wood) warbler	(USDOI) (M) (USFS)	This bird has an extremely limited breeding range, restricted to a small area in lower Michigan chiefly just east of the Lake Michigan Drainage Basin. It may once have been more widespread in the Basin. In recent years, the very small population has been further decimated by cowbird depredations. For several years, the Michigan Department of Natural Resources (1974), in cooperation with the U. S. Forest Service (1972), has been managing lands to maintain habitat.
		Reptiles	
EMYDIDAE	BOX AND WATER TURTLES		
Clemmys insculpta	Wood turtle	(W) (Rare M)	Originally found throughout Wisconsin, except in the southwest; this turtle has a similar broad range now, but a very low density. It is widespread in Michigan, but nowhere common.
Terrapene ornata	Ornate box turtle	(W)	This dry-land turtle of sandy sites may be present in the Basin. However, in Wisconsin it was recorded only from open sandy areas in the southwestern part. Automobile traffic, habitat destruction, and collecting are threats to its survival.
COLUBRIDAE	COLUBRIDS		
Natrix septemvittata	Queen snake	(W)	This snake is reported as uncommon in the southeastern counties of Wisconsin. Drainage and cultivation of wetlands and pollution of streams pose a serious threat. Presumably, it also occurred in northeastern Illinois, northern Indiana, and southern Michigan.
VIPERIDAE	PIT VIPERS		
Sistrurus catenatus	Massasauga	(W) (Rare Ill)	Formerly common in the marshes and swamps of western and southern Wisconsin, this snake has declined drastically and populations are now found in only six locations in the state.

Table 3. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Fishes	
SALMONIDAE	TROUTS AND SALMONS		
Coregonus spp.	Cisco (Chubs) and Lake herring		The federal list includes only one species of this genus, *C. alpenae*. Wisconsin lists three other species as endangered, two on watch status, and two extirpated. Michigan includes those and five additional species as endangered or threatened. The deepwater cisco species were generally common in Lake Michigan, but of the seven species, only the bloater (*C. hoyi*) is believed to exist in commercially useful numbers today. All species are threatened and several species may be extinct. The loss of these species is the result of a combination of predation and selective overfishing (Mich. Dep. Nat. Resour., 1974). Fishing is now being restricted and controlled in an attempt to save some of these species.
Coregonus alpenae	Longjaw cisco	(USDOI) (W) (M)	
Coregonus johannae	Deepwater cisco	(Ext. W) (M)	
Coregonus kiyi	Kiyi	(W) (Thr. M)	
Coregonus nigripinnis	Blackfin cisco (chub)	(Ext. W) (M)	
Coregonus reighardi	Shortnose cisco	(W) (M)	
Coregonus zenithicus	Shortjaw cisco	(W) (M)	
CYPRINIDAE	MINNOWS AND CARPS		
Notropis anogenus	Pugnose shiner	(W) (Vul. Ill)	The pugnose shiner does not tolerate turbidity and water pollution. Although apparently once present in the Basin, the present status of this fish is questionable.
CATOSTOMIDAE	SUCKERS		
Moxostoma valenciennesi	Greater redhorse	(W)	The greater redhorse does not tolerate turbidity and water pollution. Although apparently once present in the Basin, the present status of this fish is questionable.

**Sources: (USDOI) - U. S. Department of the Interior, Fish and Wildlife Service (1974); (W) - Wisconsin Department of Natural Resources, Endangered Species Committee (1975); (Ill) - Illinois Nature Preserves Commission and Illinois Department of Conservation (1976); (M) - Michigan Department of Natural Resources (1976a, 1976b); (USFS) - U. S. Forest Service (1972). The State of Indiana follows the federal designations (U. S. Dep. Inter. Fish Wildl. Serv., 1974) for endangered species. When a species is listed as other than endangered by an agency, this is indicated by the words Rare and Unique and by the abbreviations Thr. (Threatened), Ext. (Extirpated), High. vul. (Highly vulnerable), and Vul. (Vulnerable) preceding the agency designation (sources). These terms are defined in Appendix F.*

Table 4. Threatened Vertebrates of the Lake Michigan Drainage Basin

Scientific Name	*Common Name*	*Status**	*Comments*
		Mammals	
LEPORIDAE	RABBITS AND HARES		
Lepus townsendii	White-tailed jackrabbit	(Watch W) (Vul. Ill)	This animal presumably spread eastward into Wisconsin and was once found in most of the state. It was also present in Illinois. Numbers are declining as habitat is lost.
MUSTELIDAE	WEASELS, ERMINE, MINE		
Lutra canadensis	River otter	(Vul. Ill) (Ind)	The otter, once frequent throughout most of the Basin, is now confined primarily to the northern portions in Michigan and Wisconsin where there are suitable reaches of undisturbed streams. The recreational development of shorelines and impounding and disturbance of streams have greatly diminished otter habitat.
Martes pennanti	Fisher	(Watch W) (Unique USFS)	The fisher occurred in many of the heavily forested areas in the Basin. Trapping and habitat destruction by logging and fire eliminated the animal. In the late 1950's and early 1960's, fisher were reintroduced into northeastern Wisconsin and the Upper Peninsula of Michigan in the Nicolet and Ottawa national forests, respectively. In 1966-1967, fisher were also introduced into the Chequamegon National Forest west of the Basin. Occasional sightings indicate the attempt to reestablish fisher is successful.
FELIDAE	CATS		
Lynx rufus	Bobcat	(Watch W) (Vul. Ill) (Ind)	The bobcat was once a common animal in brushy and swampy areas in the Basin. It is still present in Michigan and Wisconsin (and perhaps outside the Basin in Illinois), but its survival is threatened by hunting, snowmobile disturbance, and habitat loss.
CERVIDAE	DEER		
Alces alces	Moose	(Watch W) (Periph. M)	This large herbivore formerly ranged through the forested areas of northern Michigan and Wisconsin. Although the moose appears to have been extirpated from the Lake Michigan Drainage Basin, it occasionally ranges into Wisconsin from Minnesota and occurs on Isle Royale in Michigan.
		Birds	
GAVIIDAE	LOONS		
Gavia immer	Common loon	(Rare M) (Unique USFS)	Once common in the Basin, loon populations have been diminished by habitat loss, disease, commercial fishing, and perhaps pesticides. Increased aquatic recreation also conflicts with loon nesting. Although not now listed as threatened, the common loon is probably in trouble.

Table 4. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Birds (contd.)	
ARDEIDAE	HERONS, EGRETS, BITTERNS		
Ardea herodias	Great blue heron	(Unique USFS)	A large fish-eating bird which nests in trees, the heron is subject to disruption of its feeding areas and human intrusion into and destruction of its nesting sites. Not yet threatened in some parts of the Basin, the great blue heron may easily become so with increased human disturbance.
Nycticorax nycticorax hoactli	Black-crowned night heron	(Rare Ill) (Rare M)	
ACCIPITRIDAE	HAWKS, EAGLES, HARRIERS		
Accipiter cooperii	Cooper's hawk	(W) (Vul. Ill) (M)	Originally a relatively frequent visitor and breeder in the Lake Michigan Drainage Basin, this hawk suffered a rapid decline since 1950 or 1955. Its status is now questionable.
Buteo lineatus	Red-shouldered hawk	(W) (Vul. Ill) (M)	Once a common resident, this hawk has declined greatly. A resident of river-bottom forest, the bird has been affected by stream alteration and impoundments. Pesticides and water pollution have also led to reduced populations.
Circus cyaneus	Harrier or Marsh hawk	(Watch W) (Vul. Ill) (M)	This hawk was once a usual resident of open marshes and grassland. It has declined greatly near Lake Michigan and in the southern part of the Basin.
TETRAONIDAE	GROUSE		
Pedioecetes phasianellus campestris	Sharp-tailed grouse	(Watch W) (Unique USFS)	Originally widespread in distribution in Michigan and Wisconsin. Loss of grassy and brushy habitat to tree planting and natural forest regrowth has reduced the number of colonies; few remain in the Basin.
Tympanuchus cupido pinnatus	Greater prairie chicken	(W) (High. vul. Ill) (M) (Rare USFS)	Once common in parts of Wisconsin and Michigan, these birds have declined as a result of early hunting and habitat eliminations. In the Basin, the major remaining colony is in west-central Michigan, while the Wisconsin population is found west of the Lake Michigan Drainage Basin in Portage County.
GRUIDAE	CRANES		
Grus canadensis tabida	Greater sandhill crane	(Rare M) (Rare USFS)	This large bird of open wetlands is especially susceptible to disturbance by man during the nesting season. In the Basin, the crane is found in certain of the large remaining wetland areas. Natural development of shrub-carr and lowland forest is reducing habitat for crane colonies.
RALLIDAE	RAILS, GALLINULES, COOTS		
Coturnicops noveboracensis	Yellow rail	(W) (Vul. Ill)	Originally found in the Wisconsin portion of the Basin as far north as Oconto County, the rail, today, appears to be disappearing.

Table 4. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Birds (contd.)	
CHARADRIIDAE	PLOVERS, TURNSTONES		
Charadrius melodus	Piping plover	(W) (High. vul. Ill) (M)	Presumably, this bird has been lost to the Basin. It was once an occasional nester in eastern Wisconsin and northeastern Illinois.
SCOLOPACIDAE	SANDPIPERS, ALLIES		
Bartramia longicauda	Upland plover	(Watch W) (Vul. Ill)	Once found in many eastern Wisconsin counties, the plover appears today to be maintaining itself despite drainage and heavy pasturing.
TYTONIDAE	BARN OWLS		
Tyto alba	Barn owl	(Watch W) (High. vul. Ill) (M)	Recently, sightings of this owl have decreased, and the bird seems to be disappearing from its range in the southern half of the Basin.
TROGLODYTIDAE	WRENS		
Thryomanes bewickii	Bewick's wren	(Watch W) (Vul. Ill)	
LANIIDAE	SHRIKES		
Lanius ludovicianus	Loggerhead shrike	(Watch W) (Vul. Ill) (M)	Wisconsin reports that this once common bird has become uncommon and that pesticide residues are present in the eggs.
		Reptiles	
SCINCIDAE	SKINKS		
Eumeces fasciatus	Five-lined skink	(Watch W) (Rare M)	Scattered populations exist in northeastern and north-central Wisconsin; skinks have disappeared from many habitat areas within their range. In Michigan, it is known from 50 or more localities scattered over the state.
ANGUIDAE	GLASS LIZARDS		
Ophisaurus attenuatus attenuatus	Western slender glass lizard	(W) (Rare Ill)	Habitat encroachment and pesticides are suspected as reasons for the decline of this species in Wisconsin.
EMYDIDAE	BOX AND WATER TURTLES		
Clemmys guttata	Spotted turtle	(High. vul. Ill) (Rare M)	In Michigan, it is known from about 25 localities in 21 counties, almost all in the southern half of the Lower Peninsula.
Emydoidea blandingi	Blanding's turtle	(Watch W) (Rare Ill)	The population of this turtle is down in some areas of its wet marsh habitat in Wisconsin. Marsh drainage and overcollecting are potential threats.
Terrapene carolina carolina	Eastern box turtle	(M)	

Table 4. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Reptiles (contd.)	
COLUBRIDAE	COLUBRIDS		
Elaphe obsoleta obsoleta	Black rat snake	(M)	This snake inhabits forests and woodlots; therefore, deforestation is the principal threat to its existence in Michigan. It is known from about 13 localities in 11 southern counties.
Natrix erythrogaster neglecta	Northern copperbelly	(M)	In Michigan, it is known from a single locality in each of four southwestern counties.
Natrix (Clonophis) kirtlandi	Kirtland's water snake	(M)	In Michigan, this snake is known from only seven localities in three southern counties.
		Amphibians	
AMBYSTOMATIDAE	MOLE SALAMANDERS		
Ambystoma opacum	Marbled salamander	(M)	Known from only one Michigan locality in Berrien County.
Ambystoma texanum	Small-mouthed salamander	(M)	Known from only three southeastern counties in Michigan, where it is common in a few localities.
SIRENIDAE	SIRENS		
Siren intermedia nettingi	Western lesser siren	(M)	Entirely aquatic and extremely restricted in distribution in Michigan, this siren is known from only one locality each in Allegan and Van Buren counties.
Rana palustris	Pickerel frog	(W) (Rare Ill)	Its habitat of cold springs is threatened by pollution and siltation.
		Fishes	
ACIPENSERIDAE	STURGEONS		
Acipenser fulvescens	Lake sturgeon	(High. vul. Ill) (M)	This fish is diminishing notably in numbers in many parts of the world. In Michigan, it now occurs in less than five percent of its former abundance.
SALMONIDAE	TROUTS AND SALMONS		
Coregonus artedii	Cisco or Lake herring	(Watch W) (High. vul. Ill) (M)	
Coregonus hoyi	Bloater	(Watch W) (M)	

Table 4. contd.

Scientific Name	*Common Name*	*Status**	*Comments*
		Fishes (contd.)	
CYPRINIDAE	MINNOWS AND CARPS		
Clinostomus elongatus	Redside dace	(Watch W) (M)	Occurs--although uncommon--in southern, central, and east-central Wisconsin.
Notropis crysocephalus	Striped shiner	(W)	Once widespread, this shiner is now found only in Green Bay and the Milwaukee River.
Notropis umbratilis	Redfin shiner	(W)	In Wisconsin, this fish is now found only in the south where its continued existence is in question.
CATOSTOMIDAE	SUCKERS		
Moxostoma carinatum	River redhorse	(W) (Vul. Ill) (M)	This species was probably never a basin resident.
CENTRARCHIDAE	SUNFISHES		
Lepomis megalotis	Longear sunfish	(W)	Earlier this sunfish was found throughout the east-central and southeastern parts of Wisconsin. It appears now to be restricted to four southeastern counties.
PERCIDAE	PERCHES		
Ammocrypta clara	Western sand darter	(Watch W) (Vul. Ill)	This darter has only recently been taken in the Waupaca River, Wisconsin, in the Lake Michigan Basin.
Etheostoma microperca	Least darter	(W)	Once reported common in southeastern Wisconsin and present elsewhere, the least darter is disappearing and seen infrequently.

**Sources: (W) - Wisconsin Department of Natural Resources, Endangered Species Committee (1975); (Ill) - Illinois Nature Preserves Commission and Illinois Department of Transportation (1976); (M) - Michigan Department of Natural Resources (1976a, 1976b); (Ind) - Indiana Department of Natural Resources (1969); (USFS) - U. S. Forest Service (1972). The differing terminology of the respective agencies (sources) has been indicated by the words Watch, Rare, and Unique, and by the abbreviations High. vul. (Highly vulnerable), Vul. (Vulnerable), and Periph. (Peripheral) preceding the agency designation. These terms are defined in Appendix F.*

Table 5. Additional Mammals of the Lake Michigan Drainage Basin That Are Considered Rare and Probably Threatened*

Scientific Name	*Common Name*	*Comments*
TALPIDAE	MOLES	
Condylura cristata	Star-nosed mole	Not rare in the north, but disappearing in the south with loss of habitat.
Scalopus aquaticus	Prairie mole	An animal of prairie and oak openings.
SORICIDAE	SHREWS	
Cryptotis parva	Least shrew	Rare and marginal. Threatened. Included in the Michigan list of threatened mammals (Mich. Dep. Nat. Resour., 1976a).
Microsorex hoyi	Hoy's pigmy shrew	In the northern portion of the Basin. Rare.
Microsorex thompsoni	Thompson's pigmy shrew	Threatened, possibly extinct.
Sorex arcticus	Arctic shrew	Local in wet areas in north and western part of the Basin.
Sorex palustris	Water shrew	Rare and local.
VESPERTILIONIDAE	EVENING BATS	
Lasionycteris noctivagans	Silver-haired bat	Rare and threatened.
Lasiurus cinereus	Hoary bat	Mostly in the north. Rare and perhaps threatened.
Nycticeius humeralis	Evening bat	Very rare. Only in southern part of the Basin.
SCIURIDAE	SQUIRRELS	
Eutamias minimus jacksonii	Least chipmunk	Gradually retreating northward.
Glaucomys sabrinus	Northern flying squirrel	Northern Basin, rare and threatened in Wisconsin and possibly in Michigan.
Spermophilus franklinii	Franklin's ground squirrel	Wetland species. Rare and threatened.
Tamias striatus doorsiensis	Eastern chipmunk subspecies	Threatened. Restricted to Door County, Wisconsin, where habitat is decreasing.
CRICETIDAE	NEW WORLD RATS AND MICE	
Microtus ochrogaster	Prairie vole	Generally rare. Limited to dry grassland at southern end of Basin.
Pitymys pinetorum	Pine vole	Rare and local, threatened. Included in the Michigan list of threatened mammals (Mich. Dep. Nat. Resour., 1976a).
Synaptomys cooperi	Southern bog lemming	Throughout Basin. Locally common to rare, threatened. Included in the Michigan list of threatened mammals (Mich. Dep. Nat. Resour., 1976a).
MURIDAE	OLD WORLD RATS AND MICE	
Napeozapus insignis	Woodland jumping mouse	Only in north. Very rare, threatened.
CANIDAE	DOGS	
Canis latrans	Coyote	Unusual in southern part of Basin. Threatened.
Urocyon cinereoargenteus	Gray fox	Possibly threatened. Subspecies *U. c. cinereoargenteus* rare and threatened.
MUSTELIDAE	WEASELS, ERMINE, MINK	
Mustela frenata	Long-tailed weasel	Throughout Basin. Presumably rare.
Mustela nivalis	Least weasel	Local distribution. Perhaps threatened.
Taxidea taxus	North American badger	Presumably infrequent in Basin. Given complete protection in Indiana (Ind. Dep. Nat. Resour., 1969).

*Based on Long (1974).

Table 6. Endangered and Threatened Plants of the Lake Michigan Drainage Basin and Basin States*

Family	Scientific Name	State Where Listed			
		Ill.	Ind.	Mich.	Wis.
	Endangered				
Asteraceae	*Aster chasei*†	X			
Asteraceae	*Gnaphalium obtusifolium* var. *saxicola*†				X
Fabaceae	*Lespedeza leptostachya*†	X			X
Fabaceae	*Petalostemum foliosum*†	X			
Malvaceae	*Iliamna remota*†	X	X		
Orchidaceae	*Isotria medeoloides*	X		X	
Polypodiaceae	*Phyllitis scolopendrium* var. *americana*			X	
Polypodiaceae	*Woodsia abbeae*			X	X
Ranunculaceae	*Trollius laxus*			X	
Scrophulariaceae	*Mimulus glabratus* var. *Michiganensis*			X	
	Threatened				
Anacardiaceae	*Rhus trilobata* var. *arenaria*	X	X		
Asclepiadaceae	*Asclepias meadii*†	X	X		
Asteraceae	*Boltonia asteroides* var. *decurrens*	X			
Brassicaceae	*Lesquerella globosa*†		X		
Cyperaceae	*Cyperus Grayioides*†	X			
Fabaceae	*Apios priceana*†	X			
Fabaceae	*Astragalus tennesseensis*†	X			
Fabaceae	*Oxytropis campestris* var. *chartacea*†				X
Iridaceae	*Iris lacustris*			X	X
Lamiaceae	*Synandra hispidula*†	X			
Orchidaceae	*Cypripedium arietinum*			X	X
Orchidaceae	*Cypripedium candidum*	X	X	X	X
Orchidaceae	*Listera auriculata*†			X	X
Orchidaceae	*Platanthera flava*	X	X	X	X
Orchidaceae	*Platanthera leucophaea*	X	X	X	X
Orchidaceae	*Platanthera peramoena*†	X	X		
Poaceae	*Muhlenbergia curtisetosa*	X			
Poaceae	*Poa paludigena*	X	X	X	X
Polemoniaceae	*Phlox bifida* var. *stellaria*		X		
Polypodiaceae	*Asplenium Kentuckiense*†	X			
Polypodiaceae	*Gymnocarpium heterosporum*			X	X
Potamogetonaceae	*Potamogeton Hillii*			X	
Primulaceae	*Dodecatheon Frenchii*†	X			
Ranunculaceae	*Aconitum noveboracense* var. *quasiciliatum*†				X
Saxifragaceae	*Sullivantia Sullivantii*†		X		

*Data from Report on Endangered and Threatened Plant Species of the United States (Smithson. Inst., 1974) with additions and other changes as of 21 May 1975 (U. S. Dep. Inter. Fish Wildl. Serv., 1975).

†Does not occur or of questionable occurrence in the Lake Michigan Drainage Basin.

CRITICAL NATURAL COMMUNITIES IN THE LAKE MICHIGAN DRAINAGE BASIN

Regardless of specific location, certain plant communities have been seriously reduced by human activity--including pressures of agriculture, housing, industry, and recreation. If these communities are eliminated, many species of plants and animals will be lost from the Basin, and some species will probably be eradicated completely.

Beach and sand dune communities are well adapted to existence under natural stress but at the same time are fragile if disturbed by development or heavy recreational use. Subjected to frequent wave and wind action, these communities consist of plants especially adapted to colonize beach areas and stabilize dunes. Both endemic and disjunct coastal plain species are included (Guire and Voss, 1963). Along Lake Michigan shorelines these plants include sea rocket (*Cakile edentula*), beach pea (*Lathyrus maritimus*), spurge (*Euphorbia polygonifolia*), rushes (*Juncus* spp.), silverweed (*Potentilla anserina*), satureja (*Satureja glabella*), thistle (*Cirsium Pitcheri*), iris (*Iris lacustris*), prostrate juniper (*Juniperus horizontalis*), false heather (*Hudsonia tomentosa*), and bearberry (*Arctostaphylos Uva-ursi*). Lake Michigan dunes possess an adapted endemic flora, and, in addition, support a variety of vegetation: northern pine forest, boreal spruce-fir forest, dry mesic (oak) forest, exotic weed communities, and, on stabilized dunes, northern or southern mesic forest. Dune areas are valuable geologic and floristic resources and are often associated with high quality recreational areas. Many dune and sand beach communities have been destroyed--especially in Illinois, Indiana, and Wisconsin--and those remaining require protection to survive.

Prairies--including wet, mesic, and dry communities--were once common in the southern portion of the Lake Michigan Drainage Basin. Farming and urban development have eliminated much prairie, and less frequent fires have allowed the adjacent oak openings to grow into forests. Most of the wet prairies along the southern and western shorelines and in interior areas of southern Michigan have been replaced by industry and housing on landfill or have been drained for agriculture. Mesic prairie has given way to corn and soybeans or to urban sprawl, and dry prairie has disappeared as industry and housing have invaded the drier sites. Some prairies are being seriously damaged by recreational vehicles. As the prairie communities have disappeared, a large number of prairie plants and animals have also been eliminated.

Undisturbed southern mesic forests of sugar maple, beech, and associated species are also relatively uncommon. The Wisconsin Department of Natural Resources, Endangered Species Committee (1973) listed more than twenty species of uncommon plants found in Wisconsin southern hardwood forests. Among these are: ginseng (*Panax quinquefolius*), narrow-leaved spleenwort (*Athyrium pycnocarpon*), goldie's fern (*Dryopteris Goldiana*), broad beech fern (*Dryopteris hexagonoptera*), golden seal (*Hydrastis canadensis*), snow trillium (*Trillium nivale*), nodding pogonia orchid (*Triphora trianthophora*), and blue ash (*Fraxinus quadrangulata*). Clearing for agriculture, digging of plants, selective logging, grazing, and now suburbanization have each taken their toll. The mesic woodlots are usually easier of access and less insect-infested than are the wet forests and so sustain damage first. The southern mesic forests and prairies lie closest to major population centers and hence are under heavy pressure.

Wetlands of all kinds, throughout the Basin, have dwindled in size as a result of heavy pressure from human use and abuse. Grazing and drainage have greatly reduced the area not only of wet prairie, but also of marsh, lowland and swamp forest, fen, and sedge meadow communities all of which now need protection. These wetland vegetation types provide habitat for a diverse group of plants, mammals, reptiles, birds, fish, and invertebrates. Beaman (1977) noted that *"an especially large number of endangered and threatened plants occur in aquatic and wetlands habitats."* The capacity of wetlands for absorption, storage, and release of water and mineral nutrients makes them hydrologically significant. Wetlands may function as nutrient sinks, a function which could provide new possibilities for alleviating nutrient loads from polluted streams. Until recently, wetlands have usually been categorized as wasteland, suitable only for solid waste disposal, filling, or drainage. Wetlands are beginning to be appreciated for their role as landscape components providing wildlife habitat, their aesthetic values, and their functional contributions to the mineral cycles in the larger system.

Natural flowing springs are becoming rare throughout the Basin. Springs with undisturbed small lakes and clear streams are landscape features worthy of preservation for scientific, educational, and recreational purposes. The alkaline and open marshes (fens) associated with springs in calcareous tills are particularly scarce.

Recreational use and land development have become major sources of eutrophication for lakes of all sizes and for the few streams with natural vegetation remaining. Lake levels are manipulated or "stabilized" by dams, and many streams are channeled or dammed. Lakes and streams with their original natural levels and shoreline vegetation are rare and require preservation as natural components of the region.

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APPENDIX A. WILD FLOWERS PROTECTED BY LAW IN MICHIGAN AND WISCONSIN

*Michigan**	*Wisconsin*†
Trailing arbutus, *Epigaea repens*	American lotus, *Nelumbo lutea*
Prince's pine, *Chimaphila umbellata*	Trailing arbutus, *Epigaea repens*
Bird-foot violet, *Viola pedata*	American bittersweet, *Solanum americanum*
Climbing bittersweet, *Celastrus scandens*	Orchid family (Orchidaceae) - all plants in the family
Flowering dogwood, *Cornus florida*	Pitcher plant, *Sarracenia purpurea*
Mountain holly, *Nemopanthus mucronata*	Trillium, *Trillium* spp. - all species (Large-flowered, Red, Nodding, Snow)
Michigan holly, *Ilex verticillata*	Ginseng, *Panax quinquefolius*††
American lotus, *Nelumbo lutea*	
Orchid family (Orchidaceae) - all plants in the family	
Lady's-slipper and Moccasin flower, *Cypripedium*	
Orchis, *Orchis*	
Rein-orchid and Fringed orchid, *Habenaria*	
Pogonia, *Pogonia, Isotria,* and *Triphora*	
Grass pink, *Calopogon*	
Arethusa, *Arethusa*	
Lady's-tresses, *Spiranthes*	
Rattlesnake plantain or orchid, *Goodyera*	
Twayblade, *Listera* and *Liparis*	
Coral-root, *Corallorrhiza*	
Adder's-mouth, *Malaxis*	
Putty-root, *Aplectrum*	
Calypso or Fairy slipper, *Calypso*	
Cranefly orchid, *Tipularia*	
Trillium, *Trillium* spp. - all species of the genus	
Gentian family (Gentianaceae) - all members of the family	
Rose-pink, *Sabatia*	
Centaury, *Centaurium*	
Gentian, *Gentiana*	
Columbo, *Swertia*	
Spurred, gentian *Halenia*	
Buckbean, *Menyanthes*	
Floating-heart, *Nymphoides*	
Club mosses, *Lycopodium* spp. - all species of the genus	
Adder's tongue fern, *Ophioglossum vulgatum*	

*Michigan "Christmas Tree Law"--Michigan Act 182, Public Acts of 1963.

†Wisconsin Statutes Sec. 29.546.

††Wisconsin Statutes Sec. 94.36.

APPENDIX B. ENDANGERED, VULNERABLE, AND RARE VERTEBRATES OF ILLINOIS*

Status	Species	Status	Species
	Fishes		
HV	Lake sturgeon, *Acipenser fulvescens*	V	Harlequin darter, *Etheostoma histrio*
HV	Alligator gar, *Lepisosteus spatula*	R	Northern brook lamprey, *Ichthyomyzon fossor*
HV	Cisco, *Coregonus artedii*	R	Pallid sturgeon, *Scaphirhynchus albus*
HV	Bigeye chub, *Hybopsis amblops*	R	Lake whitefish, *Coregonus clupeaformis*
HV	Pallid shiner, *Notropis amnis*	R	Round whitefish, *Prosopium cylindraceum*
HV	Undescribed shiner, *Notropis* sp.	R	Lake chub, *Couesius plumbeus*
HV	Bluebreast darter, *Etheostoma camurum*	R	Sturgeon chub, *Hybopsis gelida*
V	Lake trout, *Salvelinus namaycush*	R	Sicklefin chub, *Hybopsis meeki*
V	Pugnose shiner, *Notropis anogenus*	R	Bigeye shiner, *Notropis boops*
V	Blackchin shiner, *Notropis heterodon*	R	Ironcolor shiner, *Notropis chalybaeus*
V	Blacknose shiner, *Notropis heterolepis*	R	Wood shiner, *Notropis texanus*
V	Blacktail shiner, *Notropis venustus*	R	River chub, *Nocomis micropogon*
V	Largescale stoneroller, *Campostoma oligolepis*	R	Longnose sucker, *Catostomus catostomus*
V	River redhorse, *Moxostoma carinatum*	R	Spring cavefish, *Chologaster agassizi*
V	Northern madtom, *Noturus stigmosus*	R	Spotted sunfish, *Lepomis punctatus*
V	Banded killifish, *Fundulus diaphanus*	R	Banded pigmy sunfish, *Elassoma zonatum*
V	Bantam sunfish, *Lepomis symmetricus*	R	Starhead topminnow, *Fundulus dispar*
V	Western sand darter, *Ammocrypta clara*	R	Cypress darter, *Etheostoma proeliare*
V	Eastern sand darter, *Ammocrypta pellucida*	R	Spoonhead sculpin, *Cottus ricei*
	Amphibians		
HV	Silvery salamander, *Ambystoma platineum*	R	Spadefoot toad, *Scaphiopus holbrooki*
V	Blue-spotted salamander, *Ambystoma laterale*	R	Bird-voiced treefrog, *Hyla avivoca*
V	Dusky salamander, *Desmognathus fuscus*	R	Green treefrog, *Hyla cinerea*
V	Illinois chorus frog, *Pseudacris streckeri*	R	Pickerel frog, *Rana palustris*
R	Hellbender, *Cryptobranchus alleganiensis*	R	Wood frog, *Rana sylvatica*
R	Mole salamander, *Ambystoma talpoideum*	R	Narrow-mouthed toad, *Gastrophryne carolinensis*
	Reptiles		
HV	Spotted turtle, *Clemmys guttata*	R	Alligator snapping turtle, *Macroclemys temmincki*
HV	Slider, *Pseudemys concinna* × *floridana*	R	Yellow (Illinois) mud turtle, *Kinosternon flavescens*
HV	Whip snake (Coachwhip), *Masticophis flagellum*	R	Blanding's turtle, *Emydoidea blandingi*
HV	Great plains rat snake, *Elaphe guttata*	R	Lined snake, *Tropidoclonion lineatum*
HV	Broad-banded water snake, *Natrix fasciata*	R	Mud snake, *Farancia abacura*
HV	Eastern ribbon snake, *Thamnophis sauritus*	R	Western hognose snake, *Heterodon nasicus*
V	Flat-headed snake, *Tantilla gracilis*	R	Slender glass lizard, *Ophisaurus attenuatus*
V	Green water snake, *Natrix cyclopion*	R	Eastern massasauga, *Sistrurus catenatus*
V	Timber rattlesnake, *Crotalus horridus*		

APPENDIX B. contd.

Status	Species	Status	Species
	Birds		
E	American bald eagle, *Haliaeetus leucocephalus***	V	Brown creeper, *Certhia familiaris*
E	Peregrine falcon, *Falco peregrinus***	V	Veery, *Hylocichla fuscescens*
E	Bachman's warbler, *Vermivora bachmanii***	V	Loggerhead shrike, *Lanius ludovicianus* (N. Ill)
HV	Double-crested cormorant, *Phalacrocorax auritus*	V	Swainson's warbler, *Limnothlypis swainsonii*
HV	Snowy egret, *Leucophoyx thula*	V	Bewick's wren, *Thryomanes bewickii*
HV	Swainson's hawk, *Buteo swainsoni*	V	Yellow-headed blackbird, *Xanthocephalus xanthocephalus*
HV	Osprey, *Pandion haliaetus***	V	Brewer's blackbird, *Euphagus carolinus*
HV	Greater prairie chicken, *Tympanuchus cupido*	V	Henslow's sparrow, *Passerherbulus henslowii*
HV	Purple gallinule, *Porphyrula martinica*	V	Bachman's sparrow, *Aimophila aestivalis*
HV	Piping plover, *Charadrius melodus*	R	Yellow-crowned night heron, *Nyctanassa violacea*
HV	Least tern, *Sterna albifrons*	R	Black-crowned night heron, *Nycticorax nycticorax*
HV	Barn owl, *Tyto alba*	R	Least bittern, *Ixobrychus exilis*
V	Little blue heron, *Florida caerulea*	R	Black duck, *Anas rubripes*
V	American bittern, *Botaurus lentiginosus*	R	Pintail, *Anas acuta*
V	Mississippi kite, *Ictinia misisippiensis*	R	Northern shoveler, *Spatula clypeata*
V	Sharp-shinned hawk, *Accipiter striatus*	R	Canvasback, *Aythya valisineria*
V	Cooper's hawk, *Accipiter cooperi*	R	Ruddy duck, *Oxyura jamaicensis*
V	Red-shouldered hawk, *Buteo lineatus* (N. Ill)	R	Hooded merganser, *Lophodytes cucullatus*
V	Marsh hawk, *Circus cyaneus*	R	Broad-winged hawk, *Buteo platypterus*
V	King rail, *Rallus elegans*	R	Common gallinule, *Gallinula chloropus*
V	Virginia rail, *Rallus limicola*	R	Saw-whet owl, *Aegolius acadicus*
V	Yellow rail, *Coturnicops noveboracensis*	R	Yellow-bellied sapsucker, *Sphyrapicus varius*
V	Black rail, *Laterallus jamaicensis*	R	Western kingbird, *Tyrannus verticalis*
V	Common snipe, *Capella gallinago*	R	Red-breasted nuthatch, *Sitta canadensis*
V	Upland sandpiper, *Bartramia longicauda*	R	Long-billed marsh wren, *Telmatodytes palustris*
V	Wilson's phalarope, *Steganopus tricolor*	R	Golden-winged warbler, *Vermivora chrysoptera*
V	Forster's tern, *Sterna forsteri*	R	Nashville warbler, *Vermivora ruficapilla*
V	Common tern, *Sterna hirundo*	R	Mourning warbler, *Oporornis philadelphia*
V	Black tern, *Chlidonias niger*	R	LeConte's sparrow, *Passerherbulus caudacutus*
V	Long-eared owl, *Asio otus*	R	Clay-colored sparrow, *Spizella pallida*
V	Short-eared owl, *Aso flammeus*		
	Mammals		
E	Indiana bat, *Myotis sodalis*	R	Eastern big-eared bat, *Plecotus rafinesquii*
E	Grey bat, *Myotis grisescens*	R	Least weasel, *Mustela nivalis*
HV	Eastern wood rat, *Neotoma floridana*	R	Cotton mouse, *Peromyscus gossypinus*
V	River otter, *Lutra canadensis*	R	Golden mouse, *Ochrotomys nuttalli*
V	Bobcat, *Lynx rufus*	R	Rice rat, *Oryzomys palustris*
V	White-tailed jackrabbit, *Lepus townsendii*	R	Pigmy shrew, *Microsorex hoyi*
R	Southeastern shrew, *Sorex longirostris*	R	Swamp rabbit, *Silvilagus aquaticus*
R	Southeastern bat, *Myotis austroriparius*		

**Source: Illinois Nature Preserves Commission and Illinois Department of Conservation (1976).*
Symbols: E, Endangered; HV, Highly vulnerable; V, Vulnerable; R, Rare, restricted, or uncertain status.
See Appendix F for definitions of status.

***Probably extirpated as a breeding species in Illinois.*

APPENDIX C. ENDANGERED, THREATENED, RARE OR SCARCE, AND PERIPHERAL SPECIES IN MICHIGAN*

Status	Species	Status	Species
	Mollusks		
	Mussels		
E	*Simpsoniconcha ambigua* (Say)	T	*Actinonaias ellipsiformis* (Lea)
E	*Obovaria leibii* (Lea) = *O. subrotunda* (Rafinesque)	T	*Lampsilis fasciola* (Rafinesque)
T	*Pleurobema clava* (Lamarck)	T	*Dysnomia triquetra* (Rafinesque)
T	*Elliptic complanatus* (Dillwyn)	R	*Carunculina glans* (Barnes)
T	*Cyclonaias tuberculata* (Rafinesque)	R	*Villosa (Micromya) fabilis* (Lea)
T	*Anodonta subgibbosa* (Anthony)	R	*Dysnomia sulcata* (Lea) = *Dysnomia perplexa rangiana* (Lea)
	Snails		
T	*Lymnaea megasoma* (Say)	T	*Mesomphix cupreus* (Rafinesque) = *Omphalina*
T	*Pomatiopsis cincinnatiensis* (Lea)	T	*Haplotrema concavum* (Say) = *Circinnaria*
T	*Paludestrina (Fontigens) nickliniana* (Lea)	T	*Discus patulus* (Deshayes) = *Gonyodiscus perspectivus* (Say)
T	*Amnicola binneyana* (Hannibal) = *Cincinnatia emarginata* (Say)	R	*Lymnaea haldemani* (Deshayes)
T	*Zoogenetes harpa* (Say)	R	*Lymnaea contracta* (Currier)
T	*Mesodon (Polygyra) sayana* (Pilsbry)	R	*Helisoma multivolvis* (Case)
T	*Mesodon (Polygyra) elevata* (Say)	R	*Pyrgulopsis letsoni* (Walker)
T	*Triodopsis notata* (Deshayes) = *Polygyra palliata* (Say)	R	*Planogyra asteriscus* (Morse)
T	*Anguispira kochi* (Pfeiffer) = *A. solitaria* (Say)	R	*Philomycus carolinianus* (Bosc)
	Insects		
R	*Appalachia arcana* (Hubbell and Cantrall)	R	*Oecanthus laricis* (T. J. Walker)
R	*Atlanticus davisi* (Rehn and Hebard)	R	*Liodessus cantralli* (Young)
R	*Oecanthus pini* (Beutenmuller)		
	Fishes		
E	Longjaw cisco, *Coregonus alpenae* (Koelz)	T	Bloater, *Coregonus hoyi* (Gill)
E	Deepwater cisco, *Coregonus johannae* (Wagner)	T	Kiyi, *Coregonus kiyi* (Koelz)
E	Blackfin cisco, *Coregonus nigripinnis* (Gill)	T	Silver shiner, *Notropis photogenis* (Cope)
E	Shortnose cisco, *Coregonus reighardi* (Koelz)	T	Redside dace, *Clinostomus elongatus* (Kirtland)
E	Shortjaw cisco, *Coregonus zenithicus* (Jordan and Evermann)	T	River redhorse, *Moxostoma carinatum* (Cope)
E	Blue pike, *Stizostedion vitreum glaucum* (Hubbs)	T	Northern madtom, *Noturus stigmosus* (Taylor)
T	Lake sturgeon, *Acipenser fulvescens* (Rafinesque)	T	Eastern sand darter, *Ammocrypta pellucida* (Agassiz)
T	Cisco or Lake herring, *Coregonus artedii* (Lesueur)		
	Amphibians		
T	Marbled salamander, *Ambystoma opacum* (Gravenhorst)	T	Western lesser siren, *Siren intermedia nettingi* Goin
T	Small-mouthed salamander, *Ambystoma texanum* (Matthes)	R	Four-toed salamander, *Hemidactylium scutatum* (Schlegel)
	Reptiles		
T	Black rat snake, *Elaphe obsoleta obsoleta* (Say)	R	Five-lined skink, *Eumeces fasciatus* (Linnaeus)
T	Northern copperbelly, *Natrix erythrogaster neglecta* Conant	R	Eastern spiny softshell, *Trionyx spiniferus spiniferus* Lesueur
T	Kirtland's water snake, *Natrix (Clonophis) kirtlandi* (Kennicott)	R	Spotted turtle, *Clemmys guttata* (Schneider)
T	Eastern box turtle, *Terrapene carolina carolina* (Linnaeus)	R	Wood turtle, *Clemmys insculpta* (Le Conte)

APPENDIX C. contd.

Status	Species	Status	Species
	Birds		
E	Peregrine falcon, *Falco peregrinus* Tunstall	T	Barn owl, *Tyto alba* (Scopoli)
E	Kirtland's warbler, *Dendroica kirtlandii* (Baird)	T	Loggerhead shrike, *Lanius ludovicianus* Linnaeus
T	Double-crested cormorant, *Phalacrocorax auritus* (Lesson)	R	Common loon, *Gavia immer* (Brunnich)
T	Cooper's hawk, *Accipiter cooperi* (Bonaparte)	R	Black-crowned night heron, *Nycticorax nycticorax* (Linnaeus)
T	Red-shouldered hawk, *Buteo lineatus* (Gmelin)	R	American bittern, *Botaurus lentiginosus* (Rackett)
T	Bald eagle, *Haliaeetus leucocephalus* (Linnaeus)	R	Sharp-shinned hawk, *Accipiter striatus* Vieillot
T	Marsh hawk, *Circus cyaneus* (Linnaeus)	R	Pigeon hawk, *Falco columbarius* Linnaeus
T	Osprey, *Pandion haliaetus* (Linnaeus)	R	Sandhill crane, *Grus canadensis* Linnaeus
T	Greater prairie chicken, *Tympanuchus cupido* (Linnaeus)	R	Caspian tern, *Hydroprogne caspia* (Pallas)
T	Piping plover, *Charadrius melodus* Ord	R	Barred owl, *Strix varia* Barton
	Mammals		
E	Indiana bat, *Myotis sodalis* Miller and Allen	R	Thompson's pigmy shrew, *Microsorex thompsoni* (Baird) (Lower Peninsula)
E	Eastern timber wolf, *Canis lupus lycaon* Schreber		
T	Least shrew, *Cryptotis parva* (Say)	R	Hoary bat, *Lasiurus cinereus* (Palisot de Beauvois)
T	Pine marten, *Martes americana* (Turton)	R	Badger, *Taxidea taxus* (Schreber)
T	Southern bog lemming, *Synaptomys cooperi* Baird	R	Canada lynx, *Lynx canadensis* Kerr
T	Pine vole, *Microtus pinetorum* (Le Conte)	P	Eastern pipistrelle, *Pipistrellus subflavus*
R	Arctic shrew, *Sorex arcticus* Kerr	P	Evening bat, *Nycticeius humeralis* (Rafinesque)
R	Water shrew, *Sorex palustris* Richardson	P	Gray fox, *Urocyon cinereoargenteus* (Schreber)
R	Hoy's pigmy shrew, *Microsorex hoyi* (Baird) (Upper Peninsula)	P	Prairie vole, *Microtus ochrogaster* (Wagner)
		P	Moose, *Alces alces* (Linnaeus)
	Plants		
E	*Lycopodium* sp. nov. J. G. Bruce, No common name	E	*Opuntia fragilis*, Fragile prickly-pear
E	*Lycopodium sitchense*, Sitka club-moss	E	*Baptisia leucophaea*, Cream wild indigo
E	*Phyllitis scolopendrium* var. *americanum*, Hart's-tongue fern	E	*Petalostemon purpureum*, Red prairie-clover
E	*Woodsia abbeae*, No common name	E	*Castanea dentata*, American chestnut
E	*Scirpus hallii*, No common name	E	*Gentiana saponaria*, Soapwort gentian
E	*Polygonatum biflorum* var. *melleum*, Solomon's-seal	E	*Nelumbo lutea = N. pentapetala*, American lotus
E	*Isotria medeoloides*, Smaller whorled pogonia	E	*Chamaerhodos nuttallii* var. *keweenawensis*, No common name
E	*Arnica cordifolia = A. whitneyi*, Heart-leafed arnica	E	*Chelone obliqua*, Purple turtlehead

*Sources: Michigan Department of Natural Resources (1976a, 1976b) and Wagner et al. (1977).
Symbols: E, Endangered; T, Threatened; R, Rare or Scarce; P, Peripheral.
See Appendix F for definitions of status.

APPENDIX D. ENDANGERED ANIMALS IN WISCONSIN (WITH SUPPLEMENTARY LISTS OF THREATENED ANIMALS, ANIMALS WITH WATCH STATUS, AND EXTIRPATED ANIMALS)*

Endangered	*Threatened*
Mammals	
Pine marten, *Martes americana*	
Canada lynx, *Lynx canadensis*	
Eastern timber wolf, *Canis lupus lycaon*	
Birds	
Double-crested cormorant, *Phalacrocorax auritus*	Cooper's hawk, *Accipiter cooperii*
Bald eagle, *Haliaeetus leucocephalus*	Red-shouldered hawk, *Buteo lineatus*
Osprey, *Pandion haliaetus*	Prairie chicken, *Tympanuchus cupido pinnatus*
Peregrine falcon, *Falco peregrinus*	Yellow rail, *Coturnicops noveboracensis*
	Piping plover, *Charadrius melodus*
Reptiles	
Ornate box turtle, *Terrapene ornata*	Glass lizard, *Ophisaurus attenuatus*
Queen snake, *Natrix septemvittata*	
Massasauga, *Sistrurus catenatus*	
Wood turtle, *Clemmys insculpta*	
Amphibians	
	Pickerel frog, *Rana palustris*
	Burns leopard frog, *Rana pipiens burnsii*
Fishes	
Shortjaw cisco, *Coregonus zenithicus* (Jordan & Evermann)	Paddlefish, *Polyodon spathula* (Walbaum)
Longjaw cisco, *Coregonus alpena* (Koelz)	Blue sucker, *Cycleptus elongatus* (Lesueur)
Shortnose cisco, *Coregonus reighardi* (Koelz)	River redhorse, *Moxostoma carinatum* (Cope)
Kiyi, *Coregonus kiyi* (Koelz)	Slender madtom, *Noturus exilis* (Nelson)
Ozark minnow, *Dionda nubila* (Forbes)	Longear sunfish, *Lepomis megalotis* (Rafinesque)
Pugnose shiner, *Notropis anogenus* (Forbes)	Least darter, *Etheostoma microperca* (Jordan & Gilbert)
Greater redhorse, *Moxostoma valenciennesi* (Jordan)	Gilt darter, *Percina evides* (Jordan & Copeland)
	Goldeye, *Hiodon alosoides* (Rafinesque)
	Gravel chub, *Hybopsis x-punctata* (Hubbs and Crowe)
	Pallid shiner, *Notropis amnis* (Hubbs & Greene)
	Weed shiner, *Notropis texanus* (Girard)
	Redfin shiner, *Notropis umbratilis* (Girard)
	Striped shiner, *Notropis chrysocephalus* (Rafinesque)
	Crystal darter, *Ammocrypta asprella* (Jordan)
	Mud darter, *Etheostoma asprigene* (Forbes)
	Starhead topminnow, *Fundulus notti* (Agassiz)

APPENDIX D. contd.

Watch Status	*Extirpated*
Mammals	
Bobcat, *Lynx rufus*	Wolverine, *Gulo luscus*
Moose, *Alces alces*	Cougar, *Felis concolor*
White-tailed jackrabbit, *Lepus townsendii*	Elk, *Cervus canadensis*
Fisher, *Martes pennanti*	Woodland caribou, *Rangifer caribou*
	Buffalo, *Bison bison*
Birds	
Migrant shrike, *Lanius ludovicianus*	Passenger pigeon, *Ectopistes migratorius*
Harrier, *Circus cyaneus*	Eskimo curlew, *Numenius borealis*
Sharp-tailed grouse, *Pediocetes phasianellus campestris*	Whooping crane, *Grus americana*
Upland sandpiper, *Bartramia lorgicauda*	Trumpeter swan, *Olor buccinator*
Barn owl, *Tyto alba*	
Bewick's wren, *Thryomanes bewicki*	
Reptiles	
Six-lined racerunner, *Cnemidophorus sexlineatus*	
Five-lined skink, *Eumeces fasciatus*	
Blandings turtle, *Emydoidea blandingi*	
Timber rattlesnake, *Crotalus horridus*	
Eastern ribbon snake, *Thamnophis sauritus*	
Western ribbon snake, *Thamnophis proximus*	
Butler's garter snake, *Thamnophis butleri*	
Amphibians	
Bullfrog, *Rana catesbeiana*	
Cricket frog, *Acris crepitans*	
Tremblay's salamander, *Ambystoma tremblayi*	
Fishes	
American eel, *Anguilla rostrata* (Lesueur)	Skipjack herring, *Alosa chrysochloris* (Rafinesque)
Lake herring, *Coregonus artedii* (Lesueur)	Blackfin cisco, *Coregonus nigripinnis* (Gill)
Bloater, *Coregonus hoyi* (Gill)	Deepwater cisco, *Coregonus johannae* (Wagner)
Redside dace, *Clinostomus elongatus* (Kirtland)	Ghost shiner, *Notropis buchanani* (Meek)
Speckled chub, *Hybopsis aestivalis* (Girard)	Creek chubsucker, *Erimyzon oblongus* (Mitchill)
Pugnose minnow, *Opsopoeodus emiliae* (Hay)	Black redhorse, *Moxostoma duquesnei* (Lesueur)
Red shiner, *Notropis lutrensis* (Baird and Girard)	Blue catfish, *Ictalurus furcatus* (Lesueur)
Lake chubsucker, *Erimyzon sucetta* (Lacepede)	
Black buffalo, *Ictiobus niger* (Rafinesque)	
Pirate perch, *Aphredoderus sayanus* (Gilliams)	
Western sand darter, *Ammocrypta clara* (Jordan and Meek)	
Slenderhead darter, *Percina phoxocephala* (Nelson)	

**Source: Wisconsin Department of Natural Resources, Endangered Species Committee (1975).*
See Appendix F for definitions of status.

APPENDIX E. ENDANGERED, RARE, AND UNIQUE ANIMALS OF THE EASTERN REGION NATIONAL FORESTS*

Common Name	*Scientific Name*	*Status*
Eastern timber wolf	*Canis lupus lycaon*	Endangered
Red wolf	*Canis rufus*	Endangered
Kirtland's warbler	*Dendroica kirtlandii*	Endangered
Greater sandhill crane	*Grus canadensis tabida*	Rare
Northern bald eagle	*Haliaeetus leucocephalus washingtoniensis*	Unique
Osprey	*Pandion haliaetus carolinensis*	Unique
Indiana bat	*Myotis sodalis*	Endangered
Common loon	*Gavia immer*	Unique
Illinois woodrat	*Neotoma floridana illinoensis*	Unique
Spring cavefish	*Chologactor agassizi*	Unique
Ozark cavefish	*Amblyopsis rosae*	Unique
Red-cockaded woodpecker	*Dendrocopus borealis*	Endangered
American peregrine falcon	*Falco peregrinus anatum*	Endangered
Pine marten	*Martes americana*	Unique
Fisher	*Martes pennanti*	Unique
Wolverine	*Gulo gulo*	Unique
Canada lynx	*Lynx canadensis*	Unique
Prairie sharp-tailed grouse	*Pediocetes phasianellus campestris*	Unique
Northern greater prairie chicken	*Tympanuchus cupido pinnatus*	Rare
Cheat mountain salamander	*Plethodon richmondi nettingi*	Unique
Great blue heron	*Ardea herodias*	Unique
Atlantic salmon	*Salmo salar*	Endangered

**Source: U. S. Forest Service (1972). See Appendix F for definitions of status.*

APPENDIX F. DEFINITIONS OF ENDANGERED AND THREATENED ANIMALS ACCORDING TO DESIGNATING AGENCY

U. S. Department of the Interior, Fish and Wildlife Service (1974)

Endangered - Those species in danger of extinction throughout all or a significant portion of their range.

Threatened - Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Wisconsin Department of Natural Resources, Endangered Species Committee (1975)

Endangered - Species or subspecies that are in trouble. Their continued existence as a part of the state's wild fauna is in jeopardy, and without help they may become extirpated. Officially protected by Wisconsin law--Chap. 29.415, Wis. Stats.

Threatened - Any species or subspecies which appears likely, within the foreseeable future, to become endangered. Threatened animals will be officially designated, upon passage of pending legislation in the sate, and afforded varying degrees of protection as necessary.

Watch Status - Species or subspecies that may or may not be holding their own at the present time. They will be under special observation to identify conditions that could cause further decline or factors that could help to insure their survival in the state.

Extirpated - Animals that have disappeared from the state since 1800.

Illinois Nature Preserves Commission and Illinois Department of Conservation (1976)

Endangered - Species that have been designated as endangered by either the U. S. Department of the Interior (federally endangered) or by the Illinois Endangered Species Board (state endangered). Federally endangered species (see definition above) do not necessarily have breeding populations within Illinois but could be present in Illinois during part of their life history. State endangered species are so designated by the Illinois Endangered Species Board as being "in practical danger of extinction in the wild or natural state."

Threatened - Species recognized by the U. S. Department of the Interior as threatened (see definition above). There is no threatened category provided for in the Illinois Endangered Species Protection Act.

Highly Vulnerable - Species which are in immediate danger of extirpation *as breeding species* in Illinois, but not necessarily throughout their entire range.

Vulnerable - Species (*breeding populations*) which are likely to become highly vulnerable in Illinois in the foreseeable future if present detrimental trends continue.

Rare, Restricted, or Uncertain - Species which are rare (present in very low numbers) or restricted (present in very limited portions of the state) *as breeding species* in their Illinois distribution, or about which so little is known that their status cannot be determined.

Michigan Department of Natural Resources (1976a)

Endangered - Follows definition of the U. S. Department of the Interior (see above). The state list will be those species listed by the Secretary of Interior as endangered and resident in any part of their life cycle in Michigan. It will also include those indigenous species which the State of Michigan feels should be included on the national list of endangered species because they are on the verge of extinction.

Threatened - Follows definition of the U. S. Department of the Interior (see above). The state list includes those species and lower taxa that are threatened with extirpation in Michigan. For the purposes of state law, the Michigan range is considered significant except when the state portion of the range is considered to be peripheral. Peripheral species will not be listed as threatened unless their populations are also threatened in their primary range outside of Michigan.

Rare or Scarce - A species or lower taxon that while not endangered or threatened is extremely uncommon in Michigan and deserves further study and monitoring. Peripheral species not listed as threatened may be included in this category along with those species which were once threatened or endangered but now have increasing or protected, stable populations.

U. S. Forest Service (1972)

Endangered - A species for which survival prospects are grave in spite of accelerated management programs. That is, existing numbers have diminished to the point where rates of mortality may exceed a population's reproductive capacity.

Rare - Species less severely threatened than those species classified as endangered.

Unique - Those species for which local protection may be required or for which insufficient information is available to make a determination.

APPENDIX G. TABLE OF ENGLISH/METRIC EQUIVALENTS

English Unit	*Abbreviation*	*Approximate Metric Equivalent*
mile	mi	1.6093 kilometers
foot	ft	0.3048 meter
inch	in.	2.5400 centimeters
square mile	mi^2	2.5900 square kilometers
acre	-	0.4047 hectare

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