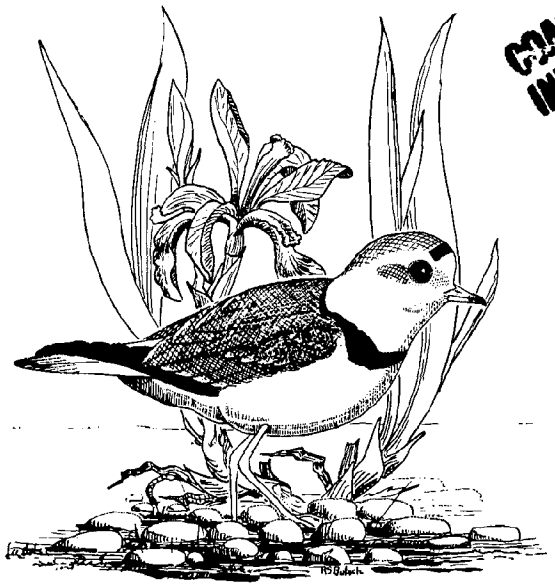
Coastal Zone
Information
Center

3 3 5 6 0

# THE MICHIGAN NATURAL FEATURES INVENTORY PROGRAM

## A TWO YEAR PROGRESS REPORT

COASTAL ZONE
INFORMATION CENTER



April 1982

Michigan Natural Features Inventory Program
Division of Land Resource Programs
Department of Natural Resources
Box 30028
Lansing, Michigan 48909

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

# THE

# MICHIGAN NATURAL FEATURES INVENTORY PROGRAM

## A TWO YEAR PROGRESS REPORT

QH 541.5 .C6 M38 1982

April 1982

Michigan Natural Features Inventory Program

Division of Land Resource Programs

Department of Natural Resources

Box 30028

Lansing, Michigan 48909

**US Department of Commerce**
**NOAA Coastal Services Center Library**
2234 South Hobson Avenue
**Charleston, SC 29405-2413**

US Department of Commerce
NOAA Coastal Services Center Library
2234 South Hobson Avenue
Charleston, SC 29405-2413

by


| | |
|---|---|
| Lawrence L. Master | Program Coordinator/Zoologist |
| Willard M. Rose | Plant Ecologist |
| Susan R. Crispin | Botanist |
| Stuart Ouwinga | Data Manager |
| Janet Gereau | Data Handler/Secretary |
| Mary Ann DeBoer | Research Assistant |

# PREFACE

This technical report describes the purpose and progress of the Michigan Natural Features Inventory Program. It has been prepared in fulfillment of contractual obligations and as a basis for future discussion. The report is intended to serve both as a reference document and as a proposal for future activities.

The Michigan Natural Features Inventory Program completes its initial two years of operation in April 1982 with the submission of this document to the Department of Natural Resources.

This progress report was prepared by the staff of the Michigan Natural Features Inventory Program with the assistance of the National Office of The Nature Conservancy. The report follows established formats used in preparation of other State Heritage Program reports by The Nature Conservancy. We are particularly indebted to the Arkansas, Arizona, and Ohio Natural Heritage Programs for their fine reports, which served as our models. Comments on this document would be appreciated and should be directed to the Director of Heritage Operations of The Nature Conservancy or to the Michigan Natural Features Inventory Program.

Inventory efforts will be continued into 1983 through a grant from the Michigan Department of NaturalResources Coastal Management Program, administered by the Division of Land Resource Programs and a matching grant to The Nature Conservancy from the C. S. Mott Foundation.

## ACKNOWLEDGEMENTS

The Michigan Natural Features Inventory Program is the result of much more than the efforts of its four full-time and two part-time staff members. The number of persons who have contributed to the development of the Michigan Natural Features Inventory is literally in the hundreds. Most will remain nameless; others cannot be left unmentioned.

We are grateful for the untiring support expressed in all stages of program development by current and former staff of The Nature Conservancy National Office and by the Michigan Field Office.

We also acknowledge the support and guidance given the Michigan Natural Features Inventory by various representatives of the State of Michigan. In particular, we wish to acknowledge Dennis Hall, our liaison with the Land Resource Programs Division of the Department of Natural Resources, Karl Hosford, Chief of Land Resource Programs, and Sylvia Taylor and Vic Janson of the Wildlife Division of the Department of Natural Resources.

To the Wilderness and Natural Areas Board, and in particular, Dr. Ronald Kapp, we owe a sincere debt of gratitude for encouraging the State to undertake the Inventory and for supporting the Inventory after its implementation.

This program could not have been possible without the financial support of the Charles Stewart Mott Foundation of Flint, Michigan which was matched by a grant to the Michigan Department of Natural Resources by the Land and Water Conservation Fund of the U.S. Department of the Interior's Heritage Conservation and Recreation Service. Additional financial support was provided by a grant from the National Speleological Society. Congressman John D. Dingell donated a second set of USGS topographic maps to the program.

Lastly, we are grateful for the countless hours of support by contract workers and by hundreds of persons who volunteered their time in all phases of program development.

TABLE OF CONTENTS


| Contents | Page |
|---|---|
| LIST OF TABLES | v |
| LIST OF FIGURES | v |
| INTRODUCTION | 1 |
| Institutional Arrangements | 2 |
| METHODOLOGY | 4 |
| Classification System and Element Lists | 4 |
| Natural/Plant Communities | 5 |
| Special Plants | 7 |
| Special Animals | 8 |
| Geomorphic/Geologic Features | 8 |
| Other Natural Features | 9 |
| Inventory | 10 |
| Definition of Element Occurrence | 10 |
| Data Acquisition | 10 |
| Element Ranking | 11 |
| Data Management | 12 |
| Data Analysis | 15 |
| Uses of the Data | 15 |
| Identification of Natural Areas | 15 |
| Environmental Review | 16 |
| Data Users | 16 |
| Federal Agencies | 16 |
| State Agencies | 18 |
| Private | 18 |
| Academic Community | 19 |
| STATUS OF NATURAL DIVERSITY IN MICHIGAN | 20 |
| General Overview | 20 |
| Natural Regions | 20 |
| Land Use History | 20 |
| Current Conditions | 22 |
| Natural/Plant Communities | 25 |
| Riverine | 25 |
| Lacustrine | 26 |
| Palustrine | 27 |
| Terrestrial | 32 |
| Summary | 37 |
| Special Plants | 38 |
| Prioritization and Categorization | 38 |
| Discussion of High Priority (A2-B1.2) Species | 43 |
| State Distribution | 44 |
| Habitat Affinities | 45 |
| Phytogeographic Relationships | 46 |
| Non-Vascular Plants | 47 |
| Bryophytes | 48 |
| Lichens | 48 |

Special Animals . . . . . 50
Prioritization and Categorization . . . . . 50
Mammals . . . . . 52
Birds . . . . . 54
Reptiles and Amphibians . . . . . 57
Fishes . . . . . 58
Mollusks . . . . . 61
Geomorphic/Geologic Features . . . . . 64
Other Natural Features . . . . . 67
Great Blue Heron Rookeries . . . . . 67
Migratory Bird Concentration Sites . . . . . 68
Bat Caves . . . . . 69
Champion Trees and Shrubs . . . . . 69
Chestnut Groves . . . . . 70
SUMMARY AND RECOMMENDATIONS . . . . . 72
APPENDICES . . . . . 82
APPENDIX A. Procedures for Developing the Community Classification . . . . . 82
APPENDIX B. A Classification of Natural Communities in Michigan . . . . . 87
APPENDIX C. MNFI Special Plants . . . . . 97
APPENDIX D. MNFI Special Animals . . . . . 119
APPENDIX E. MNFI Geomorphic/Geologic Features Classification . . . . . 134

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | Nature Preserves in Michigan | 24 |
| 2. | High Priority (A2-B2.1) Special Plants | 40 |
| 3. | Status of Special Animals in Michigan | 50 |
| 4. | Status of High Priority (A2-B2) Birds in Michigan | 55 |
| 5. | Status of Medium Priority (B3) Birds in Michigan | 56 |
| 6. | Status of Great Lakes Coregonid Fishes | 59 |
| 7. | Records of Nine Rare Michigan Fishes | 60 |
| 8. | Status of Michigan's Endangered, Threatened, and Rare Unionid Mollusks (Mussels) | 62 |
| 9. | Michigan Great Blue Heron Rookeries | 67 |
| 10. | Migratory Bird Concentration Sites of Michigan | 68 |
| 11. | American Chestnut (Castanea dentata) Trees in Michigan | 71 |


## LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | Data Cycles | 11 |
| 2. | Element Ranking Form | 13 |
| 3. | Components of the Michigan Natural Features Inventory Program Data System | 14 |
| 4. | An example of a computerized element occurrence record. | 17 |
| 5. | Natural regions of the State. | 21 |
| 6. | Counties with many element occurrences (computerized as of 14 April 1982) | 76 |
| 7. | Counties with few element occurrences (computerized as of 14 April 1982) | 77 |

# INTRODUCTION

Boreal forests and southern deciduous woods, remnant prairies and sculpted sand dunes, inland lakes and streams by the thousands, the longest freshwater shoreline of any state. Michigan's natural heritage embraces all of these and more. Two hundred years of agriculture, industry, and urbanization, however, have greatly altered the character of the land. Scattered in the fragments of our once vast and undisturbed wilderness are natural communities that harbor many rare and endangered plant and animal species; but unless we conscientiously catalogue their occurrences, these habitats may be unwittingly destroyed.

The protection of these remaining natural areas has become increasingly complex, even with existing laws and regulations, due in part to some basic unanswered questions. For example, which areas within the State's landscape deserve protection and which do not? And, how should those places be protected? In the past few years, disagreement about these questions has cost millions of dollars in litigation and delayed or aborted projects. It has also cost our citizens in the loss of unknown, irreplaceable components of our natural heritage.

As our State experiences population growth and continued economic development, it is increasingly important that we protect the finest remaining areas of natural significance. Once destroyed, Michigan's natural areas cannot be fully restored. Their resource potential, their utility for education and research, and their recreational, aesthetic, and cultural values could be forever lost to future generations.

A balance can be achieved between our need to grow and our need to protect an irreplaceable natural heritage. The Michigan Natural Features Inventory Program provides one of the informational tools to help achieve this aim.

The Michigan Natural Features Inventory Program was established in 1980 as a cooperative effort of the Michigan Department of Natural Resources and The Nature Conservancy. This comprehensive inventory of Michigan's ecological resources provides a continuous process for identifying significant natural areas and setting land protection priorities in the State.

The Inventory focuses on the elements or components of natural diversity--those natural features of particular interest because they are exemplary, unique, or endangered on a state or national basis. Information on the status and distribution of exemplary natural communities, rare and endangered plant and animal species, and special geologic features is collected and stored in an integrated data management system.

Our citizens can be proud that within Michigan's borders are found elements of ecological diversity that occur nowhere else in the world. Although these may be unfamiliar to the general public, they are precious parts of our State's natural character--its natural heritage.

The protection of Michigan's natural heritage can be accomplished in harmony with other human concerns if planning accompanies economic growth. Quite often, the natural areas most desirable for protection have limited commercial

value. Some of the richest, most diverse areas are small in acreage, so preserving Michigan's natural heritage need not entail setting aside large tracts. The Natural Features Inventory facilitates the sound evaluation of lands by providing an objective comparison of ecological resources in the State. Because the system has been designed to answer a wide range of needs, it can be equally beneficial to a wide range of decision-makers in both the public and private sectors. Whether the issue is natural-area conservation or highway routing, the inventory is an invaluable planning tool. By offering a scientific overview of Michigan's natural environment, it enables our citizens to assess alternative courses of action before commitments are made.

Natural areas provide refuge for native plants and animals and perpetuate undisturbed or otherwise exemplary communities, scenic areas, and geological features. By preserving a significant portion of our biotic diversity, they serve to maintain genetic reservoirs that may be drawn upon in the future as new sources of food, medicine or other products. Natural areas also serve as living laboratories for the study of species interactions, population dynamics, nutrient cycling, and many other natural processes. Finally, in many cases, they may serve as refuges for people, providing needed contrasts to urban living.

In order to create a system for identification and protection of the most significant natural areas in Michigan, the "Heritage Program" set out to develop the following:

1. an operations center, consisting of maps, files, a library, etc.;

2. a data management system for storage of information in manual and computer files;

3. classification systems for ecological diversity;

4. an operations handbook, detailing methodologies employed;

5. an inventory and analysis of selected components of Michigan's natural diversity;

6. a progress report, summarizing the results of the initial data gathering and analysis, together with recommendations for future work.

Objectives 1-5 have been achieved and are functioning components of the ongoing heritage inventory. The present document is presented in fulfillment of objective 6.

## Institutional Arrangements

The Michigan Natural Features Inventory Program was established in March 1980 as a cooperative effort of The Nature Conservancy and the Department of Natural Resources of the State of Michigan. The Special Land Programs Section of the Division of Land Resource Programs was the administrative overseer of the Inventory Program during the pilot period, April 1980 - April 1982. Federal funds administered by the Department of Natural Resources and derived from

the Land and Water Conservation Fund of the Heritage Conservation and Recreation Service provided one-half the total Inventory Program budget. The other half was donated to The Nature Conservancy by the Charles Stewart Mott Foundation of Flint, Michigan. This blend of public and private support has spelled strength and effectiveness for the Michigan Natural Features Inventory Program.

Plans were made for a transfer of administration of the Inventory Program from The Nature Conservancy to the State of Michigan at the conclusion of the pilot period in April 1982. However, funding for the program was not made available from the State to enable the transfer to take place at that time. Consequently, The Nature Conservancy is now raising the entire amount necessary to maintain the program at its present level through a contingency period, until October 1983.

# METHODOLOGY

The Michigan Natural Features Inventory Program provides a comprehensive system for identifying ecologically significant natural features in the State. Based on the innovative methodology developed by The Nature Conservancy, the "Heritage" system emphasizes features that are exemplary, unique, or endangered on a statewide or national level. In Michigan, components or elements of natural diversity include natural communities such as bog wetlands or southern mesic forests and species such as the bald eagle and the dwarf lake iris.

The element-based approach is an advance in the effort to ensure an objective, thorough assessment of a state's ecological diversity. Unlike previous inventories, which focused on sites rather than individual elements, the Heritage inventory identifies little-known areas and clarifies the significance of better-known sites. Whereas site-by-site inventories are conducted over a set time period and are quickly outdated, the Michigan Natural Features Inventory is ongoing, with an information base that can be readily updated.

The Michigan Natural Features Inventory process has three main facets for identifying the portions of the landscape that best perpetuate the full range of Michigan's natural diversity: classification, inventory, and data analysis.

## Classification Systems and Element Lists

Michigan's natural diversity includes all its native plants and animals, its terrestrial and aquatic communities, and its geologic structures and formations. It would be impractical to gather information on each element individually. Further, some elements are clearly more vulnerable to extirpation than others and must be afforded special attention. For these reasons, two approaches to the classification of natural diversity have been employed: a "coarse filter" and a "fine filter."

The coarse filter approach is based on the fact that many plants and animals are either closely associated with particular community types or are common enough that they can be protected simply by maintaining the full range of community types in the State. We assume that by preserving viable examples of these community types, those species associated with them will also be preserved. Of course, natural communities are complex, interacting units that are significant in their own right. Their protection is intended not only to preserve the diversity of individual species but to protect the full range of plant communities as well. An example of the course filter approach follows:

> Mesic forests, dominated by maple and/or beech, are characteristic features in the southern half of Michigan's Lower Peninsula. Many plants and animals that are common and widespread in Michigan occur in these forests. The animals depend on these forests for nest-sites, food, or shelter. Simply by protecting a good example of a maple and/or beech forest, we will protect species that are closely associated with it. In this way, we begin to fulfill a Heritage goal:

> the protection of at least one population of each species of plant and animal native to Michigan. This is a basic step in maintaining natural diversity. To do this, we used a coarse approach--a plant community approach--whereby we worked with species assemblages rather than individual species.

However, some of our flora and fauna pass through the coarse filter. They are species not associated closely enough with a particular community type that they can be adequately protected by preserving just any example of that community type. These species, which are endangered, threatened, rare, peripheral, endemic, or otherwise of special concern, belong to that fraction of biological diversity which must still be dealt with on a species-by-species, or fine filter, basis. An example of the fine filter approach follows:

> Fewer than 20 pairs of piping plovers nest at a dozen or so sites on beaches adjoining the Great Lakes. Piping plovers are closely associated with fairly wide, sandy, unvegetated beaches with scattered stones, but not all such beaches have piping plovers nesting on them.
>
> When The Nature Conservancy protected a dune complex and 500 feet of sandy Lake Michigan shoreline (Lucia K. Tower Preserve in Manistee County), habitat was preserved for typical dune succession and for many plant and animal species, but not for piping plovers. The plovers slipped through the coarse filter, the natural community approach.
>
> To protect the best population of piping plovers in Michigan, we must work with this species individually. We must know where they occur, what their needs are, and which of the habitats where they occur are protectable. We must identify specific sandy beaches that still support piping plovers. Then we can focus on determining which of these habitats can be protected and how to do so. Note that accomplishing fine-filter goals may often mean that a given coarse-filter, natural community element is also protected, and vice versa. Had the Lucia Tower Preserve contained piping plovers, the shorebird would now be a lower priority fine-filter element. Our minimal goal, the protection of at least one population of a species, would already have been achieved.

Within the Michigan Natural Features Inventory (MNFI) classification system, the elements of natural diversity are grouped into five separate classes. Natural communities make up one class in which individual community types are the elements. The other classes presently in use in Michigan are special plants, special animals, geologic features, and miscellaneous elements ("other") including heron rookeries, bat caves, champion trees/shrubs and migratory bird concentration sites.

## Natural/Plant Communities

The Michigan Natural Features Inventory community classification system is a comprehensive treatment of the community types in the State. However, emphasis is on those types that are persistent or rare. The system is designed primarily for identification and protection of little-disturbed remnants of presettlement community types.

PLANT COMMUNITIES are recurrent assemblages of species found in the landscape. As such, they differ on a fundamental level from species. Plant communities are generally recognized on the basis of particular dominant or characteristic species and a certain range of environmental conditions; there is some variation in species composition within most community types.

We cannot rely on PLANT COMMUNITIES to act as the sole coarse filter for capturing diversity. One reason for this is that many areas cannot or should not be named and defined by their vegetative cover. For instance, most aquatic communities are difficult to characterize vegetationally, and, when they can be, it is often not practical to do so because the vegetation is not a prominent feature of the community. The same is true for many other habitats including dunes, cliffs, and caves. For this reason we have chosen to supplement the plant community classification with a habitat or ecologically based classification called the NATURAL COMMUNITY classification.

The COMMUNITY CLASSIFICATION used by MNFI is thus composed of two complementary parallel classifications. Although each could be used alone, the combination of the two provides more information and facilitates the entry of data into the system, especially in the early stages of the program. This will create some redundancy where natural community elements and plant community elements correspond (at least the resource inefficiency will be confined to relatively inexpensive paper exercises rather than the very expensive land protection endeavors themselves). For elements where the natural/plant community correspondence is less, our ability to detect and document underprotected ecological systems will be enhanced. Taken together, we employ the two systems' relative strengths as cross checks to ensure adequate identification of conservation priorities. Appendix A details procedures followed for developing the community classifications.

Because of the diverse flora and vegetation found in North America and the abstract nature of a plant community, a standardized plant community classification system has not been accepted in the United States. However, most general vegetation ecology texts state that the North American tradition of classification is based on dominance. For this reason, we decided to rely on dominance in the development of the plant community classification.

Other currently used classifications based on dominance include ones proposed for use by the Heritage Conservation and Recreation Service, the Federal Interagency Classification proposed for use by Soil Conservation Service, Bureau of Land Management, U.S. Forest Service, U.S. Geological Service and U.S. Fish and Wildlife Service, and those developed by the Society of American Foresters (1940. Forest cover types of the Eastern United States), Daubenmire (Daubenmire, R. 1968. Plant communities: A textbook of plant synecology. Harper & Row, N.Y.), Kuchler (1964. Manual to accompany the map Potential Natural Vegetation of the conterminous United States. Amer. Geog. Soc.), and Brown, Lowe, and Pase (Brown, D., C. Lowe, and C. Pase. 1980. A digitized systematic classification for ecosystems with an illustrated summary of the natural vegetation of North America. General Tech. Rept. RM-73, Rocky Mt. Forest and Range Exp. Sta., USFS, USDA.). The classification also needed to be hierarchical to facilitate data management, incorporation of data into the system (whether general or specific), and crosswalking to major classifications such as Kuchler, the Society of American Foresters, and Daubenmire, which differ in their level of detail.

In Michigan, fortunately, a fair amount of community work was done before the Natural Features Inventory Program began. The work by the Wilderness and Natural Areas Advisory Board, especially Dr. Ronald Kapp (Alma College), and the reference, Vegetation of Wisconsin by J. T. Curtis (1959. Univ. Wisc. Press), has provided us with a basic classification framework. In addition, years of active work by ecologists at Michigan's universities and colleges and by the Michigan Natural Areas Council served as a valuable source of information on community types. All of this work was synthesized with our own field surveys to produce the Michigan community classification system.

The information that the Natural Features Inventory collects on communities ranges from general to specific. For example, a site may be reported as a high quality stand of "virgin timber" but the dominant species may be unknown. A different site may be reported to have a beech-maple (Fagus grandifolia-Acer saccharum) community and a complete analysis of its composition may be available. The Inventory's hierarchical community classification system deals effectively with this range of data specificity because it allows storage of information at several different levels. The hierarchical system can be refined as needed. For instance, as more field work is conducted and additional types become evident, they will be coded and added to the system. The MNFI Community Classification is presented in Appendix B.

## Special Plants

Michigan's comprehensive endangered species law, Act No. 203, Public Acts of 1974, became effective September 1, 1974. It charges 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.

In accordance with the Act, special technical committees consisting of scientific experts were appointed to advise the Department for six major groups--plants, mammals, birds, reptiles and amphibians, fishes, and invertebrates. The scientific advisory committees were charged with the task of assembling proposed state lists of endangered and threatened species. With respect to plants, no comprehensive listing of rare Michigan species was previously attempted. The committees' initial lists were formally adopted as Administrative Rules on November 18, 1976, following a lengthy public review process. The plant list consisted of 16 species designated endangered and one designated threatened, and was formally amended on January 22, 1980, following the first biennial review process, to include 191 plant taxa designated threatened. (Five species of dodder (Cuscuta) designated threatened by the technical committee were deleted from the amended rule to avoid conflict with an existing weed control act which includes all "dodders.") Additional informal lists of rare and/or peripheral ("special concern") species were also compiled by the technical advisory committees, and 90 plant taxa were included on this list. Twenty-five plant species were also placed in the unofficial category of "probably extinct" in Michigan.

No plant species have been listed by the U.S. Fish and Wildlife Service as federally endangered or threatened under the Endangered Species Act of 1973, though at least 20 have been candidates for listing at various times and one species--the smaller whorled pogonia (Isotria medeoloides)--is currently proposed

for listing. Sixteen Michigan plant species were listed by the Smithsonian Institution as "Endangered and Threatened Plants of the United States" (Ayensu and DeFilipps, 1978).

The initial Michigan Natural Features Inventory working list of special plants was based on the technical committee's list, which was modified by consultation with individual committee members and numerous field botanists throughout the State. The working list has undergone continuous refinement based on current species status and distribution data compiled especially from extensive field work coordinated by the Michigan Natural Features Inventory during 1980 and 1981. In the 1981-82 biennial review process currently underway, the technical committee has proposed revision of the administrative rule for endangered and threatened plants consistent with the current working list presented in Appendix C.

The Michigan Natural Features Inventory has also developed working lists of rare Michigan lichens and mosses in consultation with state experts, most notably Dr. Henry Imshaug (Michigan State University) for lichens and Dr. Howard Crum (University of Michigan) for mosses. These lists are also presented in Appendix C.

## Special Animals

As for plants (see preceding Special Plants section), the initial state lists of endangered, threatened, and rare animal species were compiled by the Technical Advisory Committees under the guidance of the State's Endangered Species Program. In 1980, prior to the start-up of the Michigan Natural Features Inventory (MNFI) and following the first biennial review of the state lists, 103 animal species were listed as endangered, threatened, or rare/peripheral by the Department of Natural Resources. Of these, six Michigan animal species are also listed as endangered or threatened by the U.S. Fish and Wildlife Service in accordance with the Endangered Species Act of 1973.

The first draft of the MNFI special animal list was developed after a systematic review of all existing lists and after a review of the status and distribution of all vertebrates, mollusca, and lepidoptera of Michigan. Mogens Nielsen, Executive Secretary of the Michigan Entomological Society and one of the most knowledgeable lepidopterists in the Midwest, compiled the lepidoptera list. Initial drafts of the animal lists were reviewed by more than 75 scientists and knowledgeable individuals. The initial lists have been continually refined, especially following the 1981 field season and in conjunction with the second biennial review (1981-2) of Michigan's endangered and threatened species rules (lists). The current working MNFI animal lists are presented in Appendix D.

## Geomorphic/Geologic Features

Michigan's geologic/geomorphic diversity was comprehensively documented in the book Geology of Michigan (Dorr, J. A., Jr. and D. F. Eschman. 1977. University of Michigan Press, Ann Arbor). However, no systematic inventory of high quality examples of diversity was attempted previous to the efforts of the Michigan Natural Features Inventory.

An initial classification of diversity was developed based upon Geology of Michigan, in consultation with various state experts, and has undergone continual refinement (see Appendix E). The classification organizes information on occurrences of exemplary geomorphic/geologic features in Michigan, and reveals gaps in our knowledge of these features. Several major divisions are based on earth processes which shaped Michigan's landscape: glaciers, water (fluvial and coastal), wind, karst, mass wasting, and weathering; secondary divisions enumerate features formed by these processes. Other portions of the classification encompass rock structure and stratigraphic earth history. Unusual features of special importance and interest, such as fossils and minerals, are included separately under a "miscellaneous" heading.

In developing the classification, we attempted to create categories which differentiate between features of significance, such that if quality examples of each feature were protected, preservation of Michigan's geomorphic/geologic diversity would be ensured.

**Other Natural Features**

The Michigan Natural Features Inventory Program collected and will continue to refine information on five distinct types of natural phenomena which, because of their singular manner of refusing to fit within the major classifications, are lumped under the natural term OTHERS:

Bat "Caves"
Great Blue Heron Rookeries
Migratory Bird Concentration Sites
Chestnut Groves
Champion Trees and Shrubs

As there are few natural caves in Michigan, and most of these are too small to support substantial bat populations, this category is based on the observations of larger populations in abandoned mine shafts in the Upper Peninsula. The occasional sighting of an uncommon species in these "caves" further justifies their inclusion in the data base.

The great blue heron (Ardea herodias), although common and distributed statewide, is a communal tree-nesting species of special concern to many citizens. The Wildlife Division of the Michigan Department of Natural Resources has sporadically kept records of these rookeries for many years.

A few special areas of the State, because of their geographical configuration, location within the migratory flight routes of various birds, and/or more subtle avian tradition, were singled out as important concentration sites of migratory birds. Although they are included in the system under one heading, the sites can be further distinguished in their usage by waterfowl, shorebirds, raptors, and sandhill cranes (Grus canadensis).

The American chestnut (Castanea dentata) was once naturally distributed in the extreme southeastern part of Michigan. Surviving specimens in that area are now classified as state endangered. There were many attempts to establish the species throughout the State. Where the climate was propitious, notably in the northwestern part of the Lower Peninsula, many sizeable colonies flourished.

These extant "groves," repositories of a hypovirulent strain that is resistant to the notorious chestnut blight, are of such considerable scientific, historical, and aesthetic value as to be included in the data base as an "Other."

The continuing efforts of devoted Champion Tree champions over many years have resulted in enough evidence, they say, to proclaim Michigan the Big Tree State (presumably with a greater variety of record size trees than most other states). All species not native to Michigan are excluded and ascertainable planted specimens (lawn localities) of fast-growing species are not given top priority. For more accurate statistical purposes, these trees are classified as either Federal or State Champions and (with characteristic botanical arbitrariness) as trees or shrubs.

## Inventory

### Definition of Element Occurrence

The inventory phase of the program is a continuing process in which data are collected and compiled into a usable form. The basic unit of data collection is the Element Occurrence (EO), a location record of an element in the classification system. Thus, an Element Occurrence is a site where an element has been recently observed, collected, and/or reported in the literature.

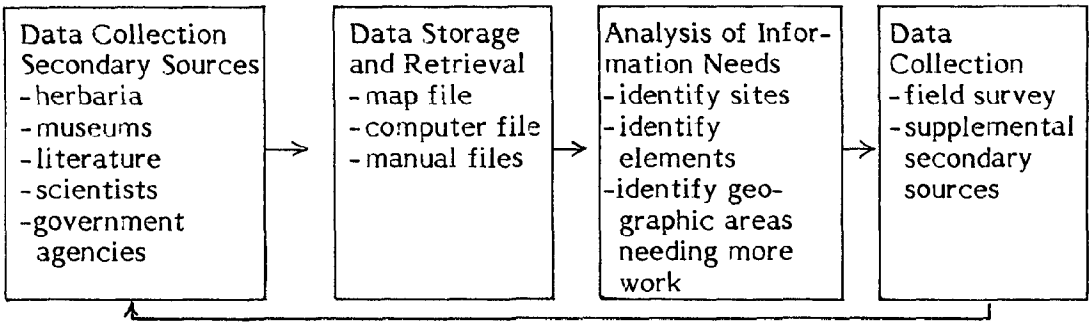
Element occurrence criteria differ from element to element. For instance, if we have a reliable report of boggy area in southern Michigan where the rare prairie fringed orchid occurs, we can record this as an Element Occurrence; we feel confident in doing so because orchids are relatively sedentary and the boggy area is likely to contribute to the survival of the element. A sighting of a peregrine falcon flying over suburban Detroit, on the other hand, does not qualify as an Element Occurrence; there is nothing about suburban Detroit which can significantly contribute to the survival of the peregrine falcon.

### Data Acquisition

The first priority in data acquisition was to assemble existing information on element occurrences. Much of the existing information was widely dispersed throughout the files of agencies, universities, museums, libraries, and knowledgeable individuals. Early in the contract period, we emphasized those sources expected to provide the greatest amounts of reliable element occurrence data.

Data gathering and analysis are the principal functions of the Inventory program. As data are compiled, their analysis continually identifies new sources of additional information and, equally importantly, reveals gaps in information. Poorly known localities and species are identified so that field work can be carried out to gather data efficiently. Similarly, knowledge of work being done by other biologists enables the staff to avoid duplication of their efforts. These cycles of data acquisition, analysis, and further work are described in Figure 1.

Figure 1. Data Cycles.




Stage 1, data collection. In the initial data-gathering phase, information is compiled on as many significant elements as possible. Data on Element Occurrences--the reported localities of elements--are gathered from herbarium records, museum records, scientific literature, and scientists.

Stage 2, data storage and retrieval. The Element Occurrence information is recorded in the map file, computerized, and cross-referenced in the various manual files of the Natural Heritage Data System.

Stage 3, analysis of information needs. After a comprehensive list of Element Occurrences is stored in the data system, (a) sites are identified that support elements worthy of closer inspection and (b) elements are identified that require further investigation to determine their statewide status.

Stage 4, data collection. In this data-gathering phase, intensive field surveys are conducted and secondary sources are searched for supplemental data to fill the information needs identified in Stage 3.

## Element Ranking

In our inventory and protection efforts, elements should receive attention according to their relative rarity and endangerment throughout their entire range. A species or community found only in Michigan and known from only one or two places deserves attention before an element which, while rare enough in the State to merit inclusion on the list, is common elsewhere. To rank elements in the relative order of their range-wide importance, The Nature Conservancy developed a ranking system which assigns each element to one of the following categories:

A1 = Critically endangered throughout range, e.g., Planorbella multivolvis (a snail)

A2 = Endangered throughout range, e.g., smaller whorled pogonia (Isotria medeoloides), Kirtland's warbler (Dendroica kirtlandii), alpine community

AX = Apparently extinct throughout range, e.g., passenger pigeon (Ectopistes migratorius), longjaw cisco (Coregonus alpenae)

B1 = Threatened throughout range or critically State endangered, e.g., gray wolf (Canis lupus), prairie fringed orchid (Habenaria leucophaea), delta wetlands

B2 = Other state endangered or critically State threatened, e.g., Kirtland's snake (Clonophis kirtlandi), floating bladderwort (Utricularia inflata), mesic prairie

B3 = Other state threatened, e.g., butterwort (Pinguicula vulgaris), bald eagle (Haliaeetus leucocephalus), dry prairie

BU = Possibly in peril; need more information, e.g., red-shouldered hawk (Buteo lineatus), boreal forest

BX = Apparently extirpated from State, e.g., blackfin cisco (Coregonus reighardi), cream white indigo (Baptisia leucophaea), oak opening

C = Apparently secure in the State and throughout range, e.g., southern bog lemming (Synaptomys cooperi), Ohio buckeye (Aesculus glabra), bog wetland

D = Demonstrably secure in State and throughout range, e.g., boreal chorus frog (Pseudacris triseriata), mesic northern forest

These ranks are assigned through use of an Element Ranking Form (Figure 2). Instructions for completing this form are provided in the Operations Manual. The Element Ranking Form is actually a digest of a much longer form, the Element Abstract, which is a key part of the inventory program. The Element Abstract provides comprehensive information about the biology and ecology of each plant, animal, and community for which the heritage program manages the information. The Element Ranking Form was created as a convenient way to handle the important task of element ranking.

## Data Management

Efficient storage of data is necessary for retrieval and analysis. Figure 3 summarizes the components of the Michigan Natural Features Inventory data storage systems. These components are explained in detail in the Operations Manual.

Figure 2
Element Ranking Form

State: _____

Element Name: _____ Date: _____

Common Name: _____ Prepared by: _____

Class: _____ Element Code: _____

EO SPECIFICATIONS:

HABITAT OR COMMUNITY DESCRIPTION

TAXONOMIC DISTINCTNESS:

PERMANENCE OF EO'S:

FEDERAL STATUS: LE LT PE PT C1 C2 C AC N
Comments:

DEGREE OF LEGAL PROTECTION:

RANKING CONSIDERATIONS

Estimated Total EO's: A B C D
Comments:

Estimated State EO's: A B C D
Comments:

Total Range: A1 A2 B C D
Comments

Estimated adequately protected EO's in State: U A B C D
Comments

Relative Threat of Destruction: A B C D
Comments:

Ecological Fragility: A B C D
Comments:

State Range: A B C D
Comments:

OVERALL ELEMENT PRIORITY RANK: A1 A2 AX B1 B2 B3 BU BX C D
Summarize reasons:

NUMBERS OF PROTECTED EO'S NEEDED IN STATE (include reasons):

OTHER PROTECTION/STEWARDSHIP NEEDS:

Figure 3.
Components of the Michigan Natural Features Inventory Program Data System

| | ELEMENTS | ELEMENT OCCURRENCES | MANAGED AREAS | SOURCES |
|---|---|---|---|---|
| General File | Element Files<br>1 folder/element contains articles, photos, the element abstract ○ | Geographic Manual File (GMF)<br>1 folder/7.5' topo map contains area info., e.g., soils survey, vegetation maps, field survey forms ○ | Managed Area File<br>1 folder/area contains general policy and mgmt. planning info.; correspondence, etc. ○ | 1. Contact/Correspondence File (for pers. comm., agencies, orgs., institutions)<br>2. Reprint File<br>3. Library<br>4. Slide File ○ |
| Map File | County-of-Distribution Map<br>1 8½" x 11"/element inventory-generated range map ○ | 7.5' and 15' USGS topographic quad maps<br>each EO is plotted, with boundaries if available ○ | 7.5' and 15' USGS topos shares EO map file; boundaries of each managed area are plotted on the maps ○ | Contact/Correspondence File<br>is organized by county. No other map file ○ |
| Abstract | Element Abstract<br>summary of natural history info., taxonomy, best sources, mgmt. considerations, etc. ◐ | Element Occurrence Record (EOR)<br>1/EO includes: location, general description, condition, dates, sources, land ownership, etc. ● | | Source File<br>catalogs all sources reviewed and to be reviewed. Usefulness, filing location, full citation, all noted ● |
| Other Files & Forms | Element Ranking Form<br>parts of element abstract used to determine element status (priority rank) ○ | Element Occurrence Log Sheet<br>1/element; locations of all occurrences of the element are listed ○ | KEY ○ Manual<br>● Computerized<br>◐ Partially Computerized | |

## Data Analysis

To be useful, the data must be analyzed as well as compiled. A considerable portion of Michigan Natural Features Inventory staff time is spent on data analysis and review. Data analysis serves (1) to reorder research priorities (identify elements and areas needing more research), and (2) to identify natural areas. This latter aspect is discussed below.

## Uses of the Data

### Identification of Natural Areas

One of the major goals of the inventory is to identify significant areas for the most exemplary and endangered elements of natural diversity. This identification process involves element and site considerations.

Element considerations--The level of priority attached to protection of a given element is determined primarily by its rarity throughout its entire range as well as its rarity and protection status within the State (see Element Ranking). Additional considerations include range, taxonomic distinctness, fragility, and relative threat of destruction.

Site considerations--Once the most endangered/least protected elements have been identified via the element ranking process, the individual occurrences of these elements are evaluated for the quality, condition, viability, vigor, etc. of individuals; or the age, maturity, productivity, diversity, number of alien species, etc. for communities. Condition refers to the degree of habitat disturbance of the Element Occurrence. Viability refers to the long-term prospects for continued existence of the occurrence. And defensibility is the extent to which the occurrence can be protected from extrinsic factors which might otherwise degrade or destroy it, including both direct (e.g., vandalism) and indirect (e.g., pollution) impacts.

Information on element and site considerations are combined on the Natural Diversity Scorecard. The scorecard presents highly condensed information about elements of natural diversity, the certainty of their occurrences, the names of the sites which contain these occurrences, the property tracts involved at these sites, the degree to which each tract is currently protected, and the degree of protection and/or management appropriate for each tract.

The Natural Diversity Scorecard provides information which allows readers to monitor the progress achieved in protecting important elements of a state's natural diversity. It helps conservationists to establish conservation priorities and decide how to allocate time, money, and effort. The scorecard relates ecological priorities to conservation efforts, thus providing a basis for protection planning and also feedback as to whether conservation activities have been well focused to date.

## Environmental Review

In addition to its role in selecting priority preserves, the data base is designed to be used by local, state, federal, and private land management organizations in making informed land use planning and environmental assessment decisions. The following section details the program's role in this environmental review process.

### Data Users

The occurrence information stored in the Inventory's computer can be retrieved in many different ways, including by element or by geographic area. A user interested in the distribution of an element, such as an endangered animal or once-common but now scarce plant community, could request a printout of all the locations of that element in the State. An organization or individual involved in a project with potential environmental impacts can request information on the occurrence of elements within the project's area, whether it is an entire watershed, a township, or a location defined exactly by map coordinates. Figure 4 illustrates the typical information available for a computerized occurrence, in this case, a natural community in public ownership.

Requests for Inventory information vary considerably as to the detail of the analysis required. Many times the user need only know whether or not sensitive species are known or expected to occur in an area. Other times a more detailed analysis is needed; for example, a list of the species occurring in the area, their specific localities, their protection status, reasons why they are significant, or an analysis of their biology and importance on a statewide or local basis. The biological significance of the information provided is an absolutely essential complement to the data themselves.

A screening process is used for requests, especially those involving information about particularly rare or sensitive features. Users of the data base are required to demonstrate a valid use for the occurrence information.

Requests for information from the Michigan Natural Features Inventory data base have been received and acted upon since mid-1980. Individuals and organizations seeking information fall into roughly the same groups as sources of information: state and federal agencies, private foundations and organizations, educational institutions, industry, consulting firms, and private individuals. The following examples, while certinaly not an exhaustive review, should serve to illustrate the range of uses for the Inventory's data.

## Federal Agencies

1. Conducted intensive inventory of the 700 square mile Clinton River watershed; used aerial photos to identify potential community sites, and field checked these and other sites previously identified by the Natural Features Inventory staff for historical occurrences of rare plant and animal species, heron rookeries, etc. Produced a 240-page report on natural features of the Clinton River watershed. Corps of Engineers (contract).

Figure 4. An example of a computerized element occurrence record.

```
        EO-CODE: CTD0000000.010                                          EL-CODE: CTD0000000
           NAME: MESIC NORTHERN FOREST

    COMMON-NAME: CTDAFBAA00.007

       MARG-NUM:     10                                                    IDENT: Y
        EO-RANK: A
    EO-RANK-COMM:                                                  FIELD-EVAL-DATE: 1981-07-21
        LAST-OBS: 1981-07-21                                            FIRST-OBS:
        EL-RANK: D                                                          STATE: MI
ALL-COUNTY-CODES: MI048 MI017                                      COUNTY-CODE: MI048
ALL-COUNTY-NAMES: LUCE  CHIP
  ALL-QUAD-CODES: 4608552 4608553                                     QUAD-CODE: 4608552
  ALL-QUAD-NAMES: TIMBERLOST  BETSY LAKE SOUTH                        PRECISION: S
             LAT: 463517                                                   LONG: 0851400
               S: 463352                                                      N: 463541
               E: 0851132                                                     W: 0851605
      TOWN-RANGE: T48N,R08W,S01,12                                     PLAN-REG: 11
       WILD-DIST: 04                                                   FOR-DIST: 42
      QUAD-SCALE: 75                                                  PHYS-PROV:
       WATERSHED: 04020202                                           NAT-REGION: 2
      DIRECTIONS: TAHQUAMENON FALLS NATURAL AREA. LOCATED AT UPPER TAHQUAMENON FALLS SOUTH OF THE PARKING LOT AND NEAR THE UPPER
                  FALLS AREA
        GEN-DESC: FAGUS GRANDIFOLIA-ACER SACCHARUM. A NORTHERN HARDWOOD STAND WITH AMERICAN BEECH, SUGAR MAPLE AND YELLOW BIRCH;
                  WITH SCATTERED HEMLOCK.
            ELEV: -11111                                                    SIZE:       1602
         EO-DATA: APPROXIMATELY 50% BEECH COVER, 30% SUGAR MAPLE AND 14% YELLOW BIRCH. LARGE INDIVIDUAL TREES; SOILS VARY FROM CLAY
                  TO SANDSTONE DEBRIS, MOSTLY LOAM.

       COMMENTS: THIS IS AN EXCELLENT EXAMPLE OF A MATURE BEECH-MAPLE STAND. IT IS ADJACENT TO THE BETSY LAKE NATURAL AREA.

      OWNER-TYPE: S
           OWNER: MICH. DNR - PARKS DIVISION                         MULT-OWNERS: N
              MA: Y
         MA-NAME: TAHQUAMENON FALLS NA (T. FALLS ST. PK.)             NUM-OWNERS: 1
     PROT-STATUS: 2                                                 DESIG-STATUS: SPK DSS
      OWNER-PROT: Y                                                   PROT-NEED: A
  PROT-NEED-COMM:
     BEST-SOURCE: LARSEN, W.C. 1981-07-21.  MNFI SITE SURVEY.

ALL-SOURCE-CODES: F81LAR05  B79NAC71
BEST-SOURCE-CODE: F81LAR05                                           DATA-SENS:
      BOUNDARIES: Y                                                     PHOTOS:
       QUAL-SURV: Y                                                 QUAN-SURV: Y
      OWNER-INFO:                                                TRANSCRIBER: WCL 81-11-09
          EA-REV:                                                     CD-REV: Y
       MA-EO-REV:                                                     MAPPER: ELH 81-11-09
              QC:                                                     UPDATE: SJO 81-12-16
```

2. Initiated a survey of historical and potential cliff nesting sites for peregrine falcons in Michigan. U.S. Fish and Wildlife Service (contract through Michigan Department of Natural Resources).

3. Commented on populations and population trends for nine bird species of regional concern. U.S. Fish and Wildlife Service (request to Department of Natural Resources Office of Endangered Species).

4. Checked maps and provided information on occurrences of natural features in a ten mile wide corridor for the North Country Trail from the western Upper Peninsula to the Ohio border. National Park Service (request).

5. Checked maps and files for the presence of any natural features possibly impacted by a marina development at Sleeping Bear Dunes National Lakeshore. National Park Service (request).

6. Provided information on endangered and threatened plant species recorded or potentially present at 72 sites (mostly islands) in the State. Bureau of Land Management (request).

**State Agencies**

1. Developed working criteria for listing endangered and threatened species in Michigan and proposed extensive revision of the current State lists of endangered, threatened, and special concern plant and animal species. These recommended status changes were mostly accepted by the Technical Advisory Committees for the Department of Natural Resources Program on Endangered and Threatened Species. Wildlife Division, Department of Natural Resources (request).

2. Assisted by color infrared aerial photos, pin pointed locations, and, through the use of volunteers, field-checked many of the 185+ heronries in the State. Living Resources Program, Department of Natural Resources (contract).

3. Conducted numerous project/permit reviews for presence/absence of significant natural features. Land Resource Programs, Wildlife, and Environmental Enforcement Divisions, Department of Natural Resources; Environmental Section, Department of Transportation (requests).

**Private**

1. Provided information on occurrences adjacent to a proposed marina expansion. Gove Associates (request).

2. Provided occurrence information on an area of lakeshore in Emmet County. Little Traverse Conservancy (request).

3. Provided occurrence information on special plants in Genesee County. WAPORA (a consulting firm).

4. Provided print-out of occurrences in the Galien River watershed, Berrien County. Ecological Research Services, Inc.

**Academic Community**

1. Provided information on the occurrence and significance of natural features on Sugar Island, Michigan. University of Michigan Biological Station; Lake Superior State College.

2. Provided occurrence information for a 3000-acre site in Leelanau County. Kalamazoo College.

3. Provided information on status of birds observed in a natural area in Oakland County. University of Michigan, Dearborn.

4. Provided occurrence information for three townships in Antrim County. Au Sable Trails Institute.

# STATUS OF NATURAL DIVERSITY IN MICHIGAN

## General Overview

### Natural Regions

Michigan can be divided into four natural regions based on geologic-biotic-climatic considerations (Figure 5).

Western Upper Peninsula. The bedrock in this region is of very ancient (Precambrian) origin. This area is generally of higher elevation, greater relief, and has a thinner cover of unconsolidated sediments (drift) than the remainder of the State. Presettlement forest was primarily sugar maple-yellow birch-hemlock-basswood with limited pine, spruce-fir, and cedar stands. Mean winter temperatures are low, and average annual snowfall is maximized in this area of the State.

Eastern Upper Peninsula. The bedrock of this region is of early Paleozoic (Cambrian, Ordovician, Silurian) origins and largely covered by glacial drift,with extensive areas of glacial lake plain. Presettlement forest was a mixture of maple-beech-birch-hemlock on the uplands with large areas of pine, spruce-fir, and cedar. Mean annual temperatures are lower and growing degree days are fewer than in the northern Lower Peninsula.

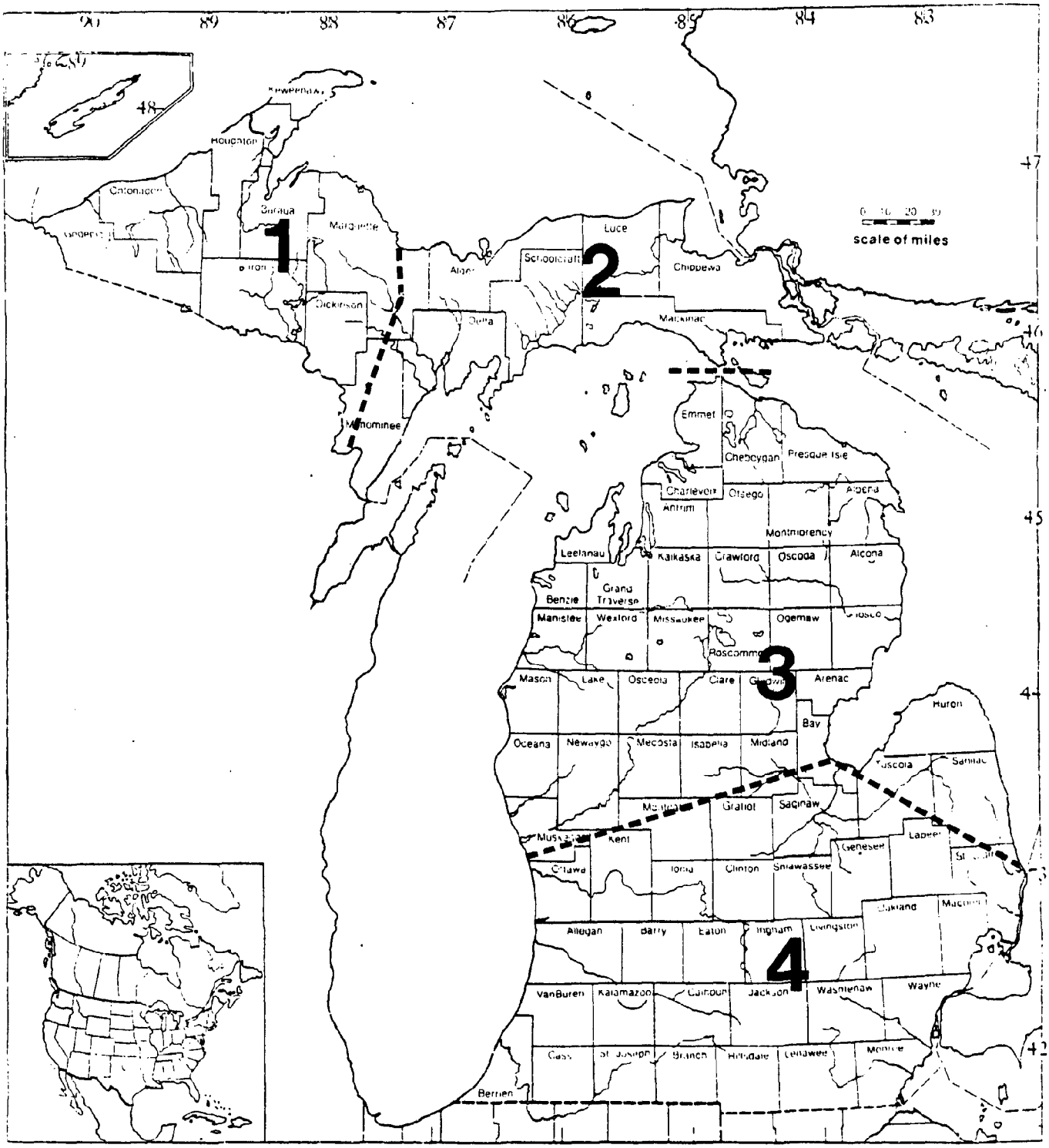
Northern Lower Peninsula. This area is similar physiographically to the eastern Upper Peninsula. The bedrock is late Paleozoic (Devonian, Carboniferous) and Mesozoic (Jurassic) origins with extensive glacial drift cover. Presettlement forest was similar to the eastern Upper Peninsula but with larger areas of pine and oak in the sandy interior soils. The straits of Mackinac separating the Upper and Lower peninsulas are a barrier to many animal species including nine of Michigan's 62 mammal species.

Southern Lower Peninsula. This area is separated from the former by a generally recognized ecotone which crosses the center of the Lower Peninsula between Townships 10 and 16 North. Many species meet their limits of distribution in this area, the predominant soil type changes from sandy soil in the north to loamy soil in the south, and there is a fairly sharp gradient in climate (temperature, snow cover). Presettlement forest was dominated by maple-beech and oak-hickory forests with areas of elm-ash-cottonwood.

### Land Use History

Before it was permanently settled, Michigan was mainly covered with climax deciduous and coniferous forests. Natural prairies and oak openings occurred in the southern part of the Lower Peninsula. Because they offered the advantages of cleared land plus the proximity to woodland resources, these comparatively small grasslands were among the first areas of the State to be settled. The seemingly endless wooded acreage around the settlements had survived centuries of limited occupation by Native Americans, the French, the British, and early American frontiersmen. In the nineteenth century, however, the attitude toward this formidable wilderness barrier shifted. Governmental policy regarding forests, coupled with the pioneer preoccupation with farming, virtually demanded that the woodlands be cleared as soon as possible.

Figure 5. Natural regions of the State.



In southern Michigan, this cutting was only slightly held back by the need for forest products -- from wheels and wagons to firewood for the home. This accounts for the remnant woodlots on the "back forty," often relegated to poorly drained lowlands where farming was impossible. Even these uncut woodlands did not always escape the debilitating effects of livestock pasturage.

Beginning in the 1830's and climaxing in the 1890's, northern Michigan became nationally prominent as the scene of forest exploitation so intense that it was possibly unequalled at any other time and place in American history. By 1910, the "inexhaustable timber," mainly virgin white pine, was exhausted. The loggers then turned their attention to the hardwoods. The original forest was practically all harvested during the lumbering era and in many cases was severely damaged by fires that followed. Underlying this devastation were the assumptions, voiced in the State land policy, that private ownership was preferable to public ownership and that virtually all of the land was potentially suitable for farming.

In a desperate attempt to recover from the loss of one of its greatest natural resources and the attendant damage to its largest industry, the State created an independent Forest Commission in 1887. This was followed by the Michigan State Sportsmen's Association's demand for state parks in 1888, a Tax Homestead Law in 1893, and a permanent Forestry Commission in 1899. Under the control of the latter were placed, in 1903, "all deliquent state tax, homestead, swamp and primary school lands" in a few specified areas. Finally, in the twentieth century, the land policy allowed for both public and private ownership in the state.

Mixed ownership remains a significant characteristic of Michigan's public lands. Most of the publicly owned lands were acquired when owners failed to pay local government taxes during the land depressions of the 1920's and 1930's. Subsequent purchases by federal and state governments were usually of low value; most of the better parcels--especially those with lake and stream frontage--remained in private lands. Many cottage sites, hunting and fishing cabins, and rural residences are scattered through the public forests.

## Current Conditions

Information contained below is from the following sources: Santer, Richard A. 1977. Michigan: Heart of the Great Lakes. Kendall/Hunt Pub. Co., Dubuque, Iowa.; and Sommers, Lawrence M., ed. 1977. Atlas of Michigan. Michigan State University Press. Wm. B. Eardmans Pub. Co., Grand Rapids, Michigan.

Michigan's 58,216 square miles (151,362 sq. km.) of land placed it 23rd in size among the 50 states, and make it the largest state, except for Georgia, east of the Mississippi River. By adding the 38,575 square miles of the Great Lakes within its political boundaries, it surpasses Georgia in size. Unique among the states is Michigan's 3,100 miles of freshwater shoreline.

A little more than half (50.7%) of the State's total land area is forested, and a little less than a third (31.9%) is agricultural land. The remaining area is divided among inland waters (2.4%), recreation excluding forests (2.5%), urban (2.9%), transportation (3.0%), and other uses (6.3%). The economy of the state depends upon three major sources: manufacturing, agriculture, and recreation. The automobile industry dominates, with about 31 percent of all U.S.-assembled autos produced in Michigan. An abundance of lakes, woods, and snow support year-

round recreation, the second major industry. Agriculture, predominant along with manufacturing in the southern part of the State, is varied. It ranges from dairying through mixed farming to highly specialized production: Michigan leads the nation in tart cherries, dry edible beans, blueberries, and pickling cucumbers, and in all produces over 50 agricultural commodities.

Michigan's three national forests (in five distinct sections), constitute the largest area in the state (4,200 square miles), administered by the federal government (in this case, the U.S. Forest Service of the U.S. Department of Agriculture). The National Park Service, U.S. Department of the Interior, has three areas under its jurisdiction: Isle Royale Wilderness National Park (210 square miles), Pictured Rocks National Lakeshore (40 square miles), and Sleeping Bear Dunes National Lakeshore (95 square miles). The U.S. Fish and Wildlife Service, U.S. Department of the Interior, administers 175 square miles divided among several national wildlife refuges: Seney, Shiawassee, Lake St. Clair, and Wyandotte. Michigan Island Wilderness and Huron Islands Wilderness also come under the jurisdiction of the Fish and Wildlife Service.

The State of Michigan, through the Department of Natural Resources, administers more than 6,640 square miles of land on a multiple-use basis. The 29 state forests comprise 5,860 square miles, the largest state forest acreage in the nation. State parks and recreation areas, numbering 94, cover 384 square miles. In 1946, the northern game areas were merged with the state forests; consequently, most of the 59 state game areas and wildlife refuges (410 square miles) are located in the southern part of the State.

There are approximately 180 square miles of local (city, county, township, and regional) parklands in the state.

Although a large amount of Michigan's land area (20%) is under the jurisdiction of the state and federal governments, only a small fraction of the land is protected in "natural areas." Including those areas purchased and maintained by private organizations, the total amount of land set aside solely for preservation represents less than one percent of the state's total land acreage, as detailed below (Table 1).

Table 1.
Nature Preserves in Michigan.[1]

| Ownership/Administration | | No. Areas | No. Acres |
|---|---|---|---|
| U.S. Government | | | |
| U.S. Department of Agriculture | | | |
| U.S. Forest Service | | 5 | 9,119 |
| U.S. Department of the Interior | | | |
| U.S. Fish and Wildlife Service | | 13 | 109,228 |
| National Park Service | | 2 | 131,880 |
| | Subtotal: | 20 | 250,227 |
| State of Michigan -- Department of Natural Resources | | | |
| Forest Management Division | | 7 | 3,123 |
| Wildlife Division | | 6 | 4,116 |
| Parks Division | | 19 | 69,827 |
| | Subtotal: | 32 | 77,066 |
| Major Conservation Organizations | | | |
| The Nature Conservancy | | 20 | 4,163 |
| Michigan Nature Association | | 68 | 3,628 |
| Michigan Audubon Society | | 10 | 2,300 |
| | Subtotal: | 98 | 10,091 |
| Colleges and Universities | | 9 | 538 |
| Local Governments | | 7 | 1,753 |
| Other (local conservancies, private organizations) | | 10 | 18,175 |
| | Total: | 176 | 357,623 |

[1]Updated from Crispin, S. R. 1980. Nature Preserves in Michigan, 1920-1979. The Michigan Botanist 19:99-242.

## Communities

The Michigan Natural Features Inventory (MNFI) manages information on 61 natural communities: 12 riverine, 5 lacustrine, 19 palustrine, 26 terrestrial, and 1 subterranean. In addition, information is collected on each of the plant community types that characterize the palustrine and terrestrial categories. Emphasis is placed on exemplary occurrences of relatively undisturbed or rare communities. Communities are assigned data collection and processing priorities based on abundance and threat. The following discussion of communities is in the order given in the Natural Community Classification (Appendix B) and does not reflect a priority system.

### Riverine

A riverine (watercourse) community is characterized by naturally channelized flowing open water, either devoid of vegetation or dominated by submerged vegetation.

Great Lakes watercourses are unique large volume riverine systems that flow from one Great Lake to another. The only Michigan examples are the Detroit, St. Mary's, and St. Clair Rivers. All three have been severely impacted by Great Lakes shipping and the associated influences of channelization, urbanization, and industrialization. Only relatively small sections of the St. Mary's River between Lake Superior and Lake Huron, and the St. Clair River in the area of Harsen's Island are somewhat undisturbed.

Six different watercourse types are defined by water temperature (coldwater and warmwater as defined by the Michigan Water Resources Commission) and bottom substrate (gravel, sand, silt). These factors create divisions that are biologically meaningful. There are distinct differences in species that inhabit coldwater and warmwater watercourses, and also watercourses with different flow rates as represented by different bottom substrates.

Undisturbed watercourses are common in the Upper Peninsula and some occur in the northern half of the Lower Peninsula. Many of these were heavily disturbed by silting from lumbering operations in the 1800s but have recovered to near pristine condition. The least disturbed watercourses occur in the Porcupine Mountains, Huron Mountains, Sylvania Tract, and Tahquamenon Falls area. Almost all of the watercourses in the southern half of the Lower Peninsula are continually being disturbed from agriculture, industry, and urbanization. The best examples of watercourses in this section of the State are the headwaters of some river systems.

Brownwater watercourses are characterized by tea colored water which is a result of dissolved organic and mineral acids. The dissolved acids and associated pH of less than 7 originate from drainage of swamp (often cedar) or bog areas. This system appears secure, similar to the previous six riverine types, due to its abundance in the northern part of the State. At least part of one exemplary brownwater watercourse is protected in Tahquamenon Falls State Park. However, the scarcity of this community in the southern part of the State demonstrates the influence of continued development and drainage of swamps for agriculture. Research is needed to determine the full biological distinctiveness of this community.

Spring/Brooks are perennial communities involving both the point of groundwater surface issuance (spring) and the resulting watercourse (brook). They are distinct systems with relatively constant flow, temperature, and chemical consistency that frequently support exclusive flora and fauna. They are found throughout the State but apparently are more common in the north. These springs have not been associated with any economic needs and are therefore relatively secure from development. Several are indirectly protected by inclusion in parks.

In contrast to the consistency of spring/brooks, ephemeral watercourses only have water flowing during part of the year, usually spring and part of the summer. Insects, crayfish, and other invertebrates with short life cycles are able to use these while predators such as fish are not able to establish themselves. These communities are distinct from other riverine communities in that they lack persistent submerged flora. During water flow the flora is predominantly a palustrine type capable of enduring both periodic inundation and drought. Sometimes terrestrial vegetation appears as flow decreases. Ephemeral watercourses are found throughout the State, with no apparent threats.

Waterfalls and rapids are an extremely harsh environment due to the tremendous force of the water. Most references treat waterfalls as abiotic. However, even in the most extreme conditions, such as hot springs, if water is present there is usually a biotic community. In fact, most harsh environments, including waterfalls and rapids, support interesting species with unique adaptations. There are approximately 150 waterfalls, mostly in the western and central Upper Peninsula. Only the best examples, perhaps 20-40 will be entered into the MNFI data base. These areas are generally unsuitable for uses other than scenic, and several are protected in natural areas. Rapids are less common with less than 20 significant occurrences. Most occur in the western Upper Peninsula and a few are located in the lower part of the State. The community processes in both these types are not well understood, and additional general biological information needs to be collected on these features.

## Lacustrine

A lacustrine (lake) community has still, open water, usually exceeds four meters in depth, is dominated by submerged vegetation, and frequently possesses a profundal zone.

Great Lakes include Lakes Superior, Michigan, Huron, Erie, and St. Clair. These immense bodies of freshwater exhibit complex ecological relationships. Remote portions of the same lake can be biologically different. Data from the Michigan DNR indicates that only Lake Superior and northern Lake Michigan and Lake Huron are relatively natural in terms of species diversity and water quality. All other areas have been drastically degraded. The entire system has been and is still being altered in varying degrees by pollution of all types, overfishing, fish restocking of nonnatural species, etc. Continued ecological studies should help point to the value of this community. Preservation can only be accomplished by major legislation involving state, federal, and Canadian governments.

Inland oligotrophic lakes include those with clear water, inorganic substrate, little submerged vegetation, little nutrient cycling, and low productivity. This is considered the juvenile stage in lake succession. Inland eutrophic lakes are characterized by murky water, organic substrate, algal blooms, dense growth of

aquatic vegetation, high oxygen deficit, and productivity that exceeds consumption. This is the senescent stage of lake succession. Inland mesotrophic lakes are an intermediate equilibrium stage in lake succession. They have clear water, diverse aquatic vegetation, and shoreline wetlands are common.

Undisturbed examples of all three types can be found distributed throughout the State. They are least common in the southern part of the State because of the desirability of lakeshores for housing. According to the Michigan Department of Natural Resources, large oligotrophic lakes (greater than 50 acres) are the least common type with 106 examples. These are also the most scenic and the most desirable for recreation, which puts them under development pressure. There are 516 large mesotrophic lakes, making them the most common. This lake type is also desirable for shoreline home develoment and recreational use. The Department of Natural Resources lists 361 large eutrophic lakes but many of these are a result of cultural eutrophication and would not be considered exemplary occurrences. There is a need to continue surveying to ensure that the best examples of each type are protected.

Inland marl lakes are high in total hardness, alkalinity, calcium, and magnesium. The water in many of these lakes is an unusual deep blue-green color. Calcium carbonate precipitates, especially on vegetation foliage, and eventually accumulates as marl deposits on the bottom. Many of the nutrients are found in an insoluble form, preventing plankton and common plants such as stonewort (Chara) from proliferating, thus extending the oligotrophy of the lake.

This particular lake process is unique and is restricted to areas underlain by limestone or carbonate rich substrate. More occurrences are reported from southern Michigan where they may constitute as many as 25 percent of all lakes. The actual range is unclear and the number of undisturbed occurrences is probably limited to around 50. Occurrence information should continue to be collected during the future course of inventory work.

**Palustrine**

A palustrine community has hydric soils and is noninundated or inundated by less than four meters of water (except for bog lakes). It is dominated by emergent, floating-leaved, free floating, or submergent vegetation, and never possesses a profundal zone.

The first nine general palustrine community types are defined by the following terms: insular -- not influenced by a river or lake; lacustrine -- lake influenced; riverine -- river influenced; marsh -- dominated by herbaceous vegetation; swamp -- dominated by woody vegetation; mixed -- dominated by a mixture of herbaceous and woody vegetation.

Insular marsh wetland, peripheral lacustrine marsh wetland, and peripheral riverine marsh wetland are generally similar. They are dominated by various mixtures of cattails, sedges, grasses, rushes, and other submerged species. Genera that have been documented as dominant or codominant in marsh systems are cattail (Typha), sedge (Carex, Dulichium and Cladium), spike rush (Eleocharis), bulrush (Scirpus), rush (Juncus), reed (Phragmites), loosestrife (Lythrum), blazing star (Liatris). Although examples are very common and occur throughout the State, their significance in terms of flood, silt and pollution control, wildlife production, etc., should not be underrated. Generally this

community is undesirable for development; however, large expanses of these types have already been lost. For example, the vast areas of marsh around Lake St. Clair have been reduced to a few sites that are preserved as state game areas.

Although not a high priority for data collection, information on outstanding examples of these three communities should continue to accumulate as the inventory progresses. The wild rice (Zizania) community is the only general marsh type that appears to be uncommon and deserves directed attention. A complete wetlands inventory of the State is being completed by the Michigan Department of Natural Resources for the USFWS. This information should be useful to the MNFI because most extant marsh types can quickly be checked for disturbance on the available aerial photographs.

Insular mixed wetland, peripheral lacustrine mixed wetland, and peripheral riverine mixed wetland are common, widespread, and have similar dominant vegetation. They are significant and reasonably well protected, similar to marshes. Again, these communities are not a high priority but information on outstanding examples should continue to be collected during the inventory process.

Distinct differences occur between the northern and southern Michigan Insular Swamp wetland, peripheral lacustrine swamp wetland, and peripheral riverine swamp wetland. Northern swamp forests are often dominated by white cedar (Thuja occidentalis) and balsam fir (Abies balsamea), with hemlock (Tsuga canadensis), yellow birch (Betula lutea), and American elm (Ulmus americana) being of some significance. These types are found throughout northern Michigan with "cedar swamps" being one of the most common. There is some question, however, about how many of these are actually undisturbed.

In the northern part of the State, three occurrences of insular swamp wetland, four of peripheral lacustrine swamp wetland, and one peripheral riverine swamp wetland have been documented. This small number represents past lack of interest and study rather than the actual number of occurrences. Therefore, it is important to increase their priority and collect data to accurately reflect their true status. At present, the following plant communities have been recorded: cedar, tamarack (Larix laricina)-cedar and cedar-balsam fir. These types are fairly secure because of the small amount of development pressure on northern swamp land.

Southern swamp forests are often dominated by black willow (Salix nigra) or cottonwood (Populus deltoides) on the wettest sites and silver maple (Acer saccharinum), American elm, or black ash (Fraxinus nigra) on sites that are less wet. These types are found throughtout the southern half of the Lower Peninsula. An intensive inventory of the Clinton River watershed documented 3 occurrences of inland swamp wetland, 1 pf peripheral lacustrine swamp wetland, and 19 of peripheral riverine swamp wetland. Similar to northern swamps, they are not well studied, and, due to the prevalence of development, should be rated a high priority for data collection to determine their actual status. Occurrences of the following plant communities were documented: silver maple, silver maple-red elm (Ulmus rubra), ash-silver maple, black ash-yellow birch, black ash-yellow birch-red maple (Acer rubrum), black ash-American elm, trembling aspen (Populus tremuloides)-willow (Salix spp.), aspen-tamarack, and cedar. The most

common dominant species found were silver maple and black ash. Five examples of cedar communities were found even though the northern species (cedar, tamarack, aspen, yellow birch) are uncommon dominants in southern Michigan.

Ephemeral wetlands occur in areas where the water table fluctuates and the habitat alternates seasonally or semi-annually from dry to inundated. Amphibians and invertebrates successfully use these areas to reproduce because predators (fish) are not able to establish themselves. Banded shorelines are often present where vegetation once grew. This community is common throughout the State with several examples protected in nature preserves. There are ten occurrences listed in the MNFI data base. Some of these support rare coastal plain disjunct plants. The community is unique in being able to function in the alternating wet and dry cycle. Seasonal water tends to discourage other uses of this community type. The dominant genera, such as cattail (Typha), sedge (Carex), spike rush (Eleocharis), bulrush (Scirpus), and rush (Juncus), that characterize ephemeral wetland plant communities, are typical of marsh habitat.

Oxbow wetlands are a result of the natural sedimentation that cuts off meanders in low river floodplains resulting in shallow crescent shaped wetland ponds or marshes. The species composition of this community is similar to other marsh wetlands, but their origin, colonization, and functional relationships are unique. The community is subject to change from a flowing water riverine system to a standing water marsh still subject to flooding. The largest threat to this process is development, where dams and dredging influence silting and river levels. There are many occurrences scattered throughout the state but the extent of this type is not precisely known. The lower 20 miles or more of floodplain along the Manistique River contains numerous examples, some of which are on State land. However, no oxbow wetlands are known to be specifically protected. Continued identification of this community is recommended as information becomes available. Aerial photographs and topographic maps can easily be used to locate relatively undisturbed occurrences of oxbow wetlands.

Beaver pond wetlands develop in and around impoundments created by the damming of a watercourse by beavers. The ponds are rich in aquatic vegetation (compared with the watercourse) as a result of silt deposition and reduced current. The species composition of this type is similar to other marsh habitats but the formation process is unique. Once dammed, the community changes from watercourse to wetland. As the water level rises, terrestrial vegetation is killed and aquatic and wetland species begin to colonize. Undisturbed beaver dams have an average life span of 10-20 years, after which the wetland may revert to a watercourse. Lowering of the water level kills the wetland vegetation, and the terrestrial vegetation reinvades. There are many beaver pond wetland occurrences throughout central and northern Michigan. Remote examples should continue to be added to the MNFI data base as information becomes available.

Inland saline wetlands are a result of natural salt springs which expel water at the ground surface creating wet soils. They are not a result of the process as seen in the western United States where evaporation exceeds precipitation. Inland saline wetlands are colonized by saline tolerant species, e.g., bulrush (Scirpus olneyi) and spike rush (Eleocharis parvula), some of which may be disjunct from their normal range. This type is geologically, floristically, and ecologically distinct from all other communities. Saline wetlands are a seral community of long duration due to the unsuitability for other successional stages.

Historically, these areas were used by Indians and early settlers as a source of salt and were called "deer licks", indicating their use by wildlife. Douglas Houghton, the first Michigan geological surveyor, was assigned to locate and test each salty wetland area as potential sites for salt works. His records indicate that there were as many as 25 salt springs or wetlands occurring in the center part of the Lower Peninsula from Detroit to Grand Rapids and north to Midland. Only one occurrence is known to still exist. It contains two indicator species and is dominated by sedge (Carex) with signficiant amounts of iris (Iris) and cattails (Typha). It is located on a state game area but is not specifically protected. The DNR's Wildlife Division has informally agreed to leave the area as it is. The largest threat to this wetland, if its specific location is publicized, may be overvisitation by people interested in seeing this rare community type. It is not likely that others will be found because most were destroyed in the 1800s when brine wells were drilled. In summary, an inland saline wetland is the most unusual wetland community in the State, and perhaps the region, because of its saline characteristics and associated species. It is extremely rare in the Midwest, with possible threats of destruction, and few sites, if any, that are adequately protected. Permanent land preservation with stewardship and scientific study is recommended for the one known Michigan site. An intensive regional inventory should be conducted to locate additional occurrences.

Freshwater delta wetlands occur where a river flows into a lake or bay and silt is deposited until it is above the water line. They are covered with substantial wetland vegetation and often have natural river channels throughout. The delta forming process is unique; however, the dominant vegetation is composed of typical wetland species. Historically, there were at least five deltas known in Michigan: two in Little Bay de Noc, one in Green Bay, and two in Lake St. Clair. Two of these remain relatively undisturbed; one has been reduced to a small remnant of natural vegetation; and the other two have been destroyed. Cattail-sedge (Typha-Scirpus) and cattail-reed-loosestrife (Typha-Phragmites-Lythrum) are the two plant community types found on these deltas. Large sections of the St. Clair River delta are partially protected as part of a state game area. Threats to these areas include dredging and recreational, residential, and industrial development. Overall, there are only a few examples remaining and they are not specifically protected as a unique wetland community. An intensive inventory and ecological study should be conducted as a preliminary step to the preservation of existing deltas.

Prairie wetlands are situated on mineral soils, are devoid of woody vegetation, and are usually dominated by grasses. Some of the dominant genera are reed grass (Calamagrostis), cord grass (Spartina), bluestem (Andropogon), Indian grass (Sorghastrum), and sedge (Carex). Human disturbance, natural succession, and climatic change are responsible for the decrease in prairie wetland areas in Michigan. These areas were never extensive in the past since Michigan is on the periphery of prairie vegetation. There is a tremendous interest in prairies in Michigan as shown by the activities of several nature preservation groups and the formation of the Michiana Prairie Society. Eleven prairie wetlands have been identified in the State, some of which are protected on nature preserves. Six of these were part of an intensive study (funded in part by the MNFI) to better define and explain prairie vegetation types. This study is still being compiled and should be finished by the spring, 1982. Previous to this study, it was believed that 11 occurrences represented the vast majority of remaining examples in the state. This study, however, revealed several previously unknown sites along Saginaw Bay. An intensive search for additional prairie wetlands in this area will be conducted during the summer, 1982.

The principle characteristics of a bog wetland are a substantial acidic peat substrate (often greater than 20 feet thick) and a ground layer dominated by moss (Sphagnum). Indicator species include ericaceous (heath-like) shrubs and carnivorous plants. Lakes with floating mats are often associated with this type and are treated as part of the bog community, regardless of depth. The most common dominants are moss (Sphagnum), sedge (Carex), leatherleaf (Chamaedaphne calyculata), cranberry and blueberry (Vaccinium), tamarack, and black spruce (Picea mariana). Bog wetlands are circumboreal, very common, and well studied. They are widespread and not presently threatened in Michigan,with examples in almost every county. As many as 20 bogs are within nature preserves in the state. Only occurrences that best exhibit all of a bog's unique features should continue to be added to the MNFI data base.

Fen wetlands are dominated mostly by grasses, sedges, and/or calciphilic (calcium-loving) mosses, and occur on neutral or alkaline peat soil with an internal flow of calcareous (containing calcium carbonate) water. The actual range is unclear but they are circumboreal and are fairly widespread in Michigan. There are 17 occurrences recorded in the data base, five of which are reported on nature preserves. This community type is unsuitable for development, except as a source of fuel grade peat, similar to bogs. After initial survey efforts during the summer, 1981, it appears that fens are less common than originally thought, especially grass-dominated examples. Because of these findings and ambiguous reports confusing bogs and fens, a deliberate survey effort should be made to locate more examples.

Interdunal wetlands form in low areas between lakeshore sand dune ridges, with shallow pools often present. They are dominated by herbaceous, woody, and mixed plant communities. These wetlands occur along the Great Lakes coasts, particularly along the Lake Michigan shore, and usually have a high aesthetic value. This community is ecologically distinct by being a juxtaposition of xeric and hydric environmental extremes. Interdunal wetlands, as well as the entire dune complexes, are fairly common in Michigan; however, this is one of the only places in the world where they can develop. There are as many as 50 occurrences in the State, several of which are protected in nature preserves and state parks. Dune systems are threatened by housing development, sand mining, and recreational use. Dunes and interdunal wetlands will be included as a high priority during the 1982 inventory of Michigan's coast.

Strangmoor wetlands are usually large areas characterized by peat soil which is arranged in strips perpendicular to the direction of drainage between two higher areas (often former beach ridges). The vegetation is most often of a bog nature but can also be fen-like. The peat is usually not as deep as in bogs or fens and the strip pattern is thought to be a result of frost upheaval. Strangmoors are found throughout boreal North America, reaching their southern limit in Michigan. Only three examples are reported from Michigan, all from the central Upper Peninsula. Most of the strangmoor wetland at Seney National Wildlife Refuge is declared a wilderness area. These three known examples probably represent most of the occurrences in Michigan. The only potential threat is the future use of this community for fuel grade peat. Inventory efforts should be directed toward verifying leads as they become available. Aerial photography can be used to identify and map strangmoors because of their distinctive peat pattern.

## Terrestrial

Upland communities are represented in the terrestrial category. They are characterized by mesic to dry soils that are never inundated and are incapable of existence under descriptions given for riverine, lacustrine, and palustrine categories. The first six terrestrial forest communities are divided between those that occur north or south of the tension zone. Within these two areas the forest types are further subdivided by soil moisture conditions: mesic (moist), dry-mesic, and dry.

Mesic southern forest is most often referred to as beech-maple forest. It was a major type throughout southern Michigan prior to agricultural development. Today, only scattered examples remain. These are for the most part well known areas that have received considerable attention. They are aesthetically pleasing because of the large trees, spring flora, and fall colors. Almost all of the relatively undisturbed occurrences are represented in the 27 examples listed with the MNFI. The most well known beech-maple forest, Warren Woods, is a dedicated natural area within a state park and has been studied by numerous researchers. The plant community cover types of the mesic southern forest, as determined by overstory dominance, include: American beech (Fagus grandifolia)-sugar maple (Acer saccharum), American beech, sugar maple, American beech-red oak (Quercus rubra), and sugar maple-red oak. The first type is the most common but each of the others is also well represented. Over the past few years, several occurrences were lost due to housing development, lumbering, and wind storms. Inventory work on mesic southern forests is relatively complete. The next step is to encourage additional protection for these occurrences.

The dry-mesic southern forest is a part of the oak-hickory forest region of the eastern U.S. The most common dominants are white oak (Quercus alba), red oak, and hickories (Carya). Historically, it was also a major forest type of southern Michigan, but today undisturbed examples appear to be very rare. Of the four known undisturbed occurrences, two are dominated by oak-hickory and two by oaks. The two oak-hickory types have some degree of protection. Dry-mesic southern forests are rare probably because of both human intervention and natural succession. It is urgent that active inventory work continue while protection of the few remaining high quality occurrences is pursued.

Drier areas that are dominated by oaks such as black oak (Quercus velutina), bur oak (Quercus macrocarpa), and white oak make up the dry southern forest. The classification of this type is unclear because there are so few undisturbed occurrences to study. Confusion also results from the gradation of this type with the dry-mesic southern forest and the oak savanna. Similar to the dry-mesic southern forest, this is a rare community that needs to be identified and studied, and have its best examples preserved.

Mesic northern forest is dominated by sugar maple, hemlock, and yellow birch. American beech is also dominant in the eastern Upper Peninsula and northern Lower Peninsula, and basswood (Tilia americana) is locally abundant in the western Upper Peninsula. Lumbering is still a serious threat to the undisturbed examples of this forest that are scattered throughout the northern part of the State. Mesic northern forests and many of its plant community dominance types are protected in four macropreserves: Porcupine Mountains Wilderness State Park, Sylvania Tract, Huron Mountain Club, and Tahquamenon Falls State Park. These four areas may be large enough to not only protect the community but also

the entire ecosystem. The Huron Mountain Club and the Sylvania Tract have been surveyed in part; however, information on all four should continue to be collected to document the plant community types in each.

The dry-mesic and dry segments of the northern forest are found on sandy soils and are dominated by pines. Dry-mesic northern forests are fairly distinctive in having white pine (Pinus strobus) as a major dominant. This forest type also has mixtures of maples, hemlock, and red pine (Pinus resinosa). White pine forests covered large areas of northern Michigan prior to lumbering, but are now reduced to a few small tracts. Only ten exemplary occurrences are known in the State, but three of the best examples are preserved at Estivant Pines, Hartwick Pines State Park, and the Bois Blanc Island dedicated natural area. Historically and aesthetically, this type has been of great interest and it would be surprising to discover any significant new occurrences. The preserved areas should continue to be studied and monitored, and new areas should be protected.

Dry northern forests are also distinctive in having red pine, jack pine (Pinus banksiana), and oaks as a dominant. Similar to the white pine forest, red pine also covered large areas of northern Michigan prior to lumbering. It appears that this type is rarer than white pine. One representative example, the Roscommon Red Pine Nature Study Area, is owned by the State and has been dedicated as a natural area. The jack pine and jack pine-oak types are very common throughout northern Michigan but the disturbance history of most of the stands is difficult to discern. Thus we usually don't know whether the stands are of natural origin or have developed in areas following cutting or other disturbance. Jack pine only live to an average age of 70 years and regeneration is dependent on fire. With the Kirtland's warbler management project burning large areas of jack pine, this community is relatively secure. The Inventory should continue including information on the best stands as it becomes available.

The boreal forest in Michigan is characterized by the presence of balsam fir and/or white spruce (Picea glauca) as a member of the dominant canopy. In some stands, white pine, white cedar, and white birch (Betula papyrifera) are dominant species. Boreal forests are common circumboreal communities with extensions southward along the Rockies and Appalachians. Its southernmost occurrences in this area are on the southwest corners of Lake Michigan islands. Apparently these stands are related to prevailing cool moist winds coming off the lake. The best development, although limited, is along the Lake Superior shore and in Isle Royale National Park. Because of their scarcity, these communities are not severely threatened by lumbering but the Inventory should continue to actively search for leads to new occurrences.

Oak opening, oak barren, and pine barren are all characterized as savanna-like with less than 50 percent canopy cover. The oak opening and barren are found south of the tension zone while the pine barren is found north of this zone. Oak openings were described as occurring on mesic or dry-mesic soil with a corresponding prairie component and scattered bur, white, and black oaks. This community was typically found during presettlement times in great abundance along prairie-forest borders. Today, it is rare throughout its range and may be extirpated from Michigan due to agricultural development and natural succession resulting from lack of fire. Only remnants of what might have been oak openings have been found. The savanna quality of the oaks in one study area was maintained by grazing which destroyed the natural prairie; in several other areas it appears that natural succession has replaced the oak savanna by oak forests.

An intensive search for this community should be conducted and areas that are discovered should be given highest priority for preservation. Considering the unique problems associated with this type, the highest probability of finding an occurrence will be in old cemetaries that were established in prairie areas. The oaks may have been left and the prairie maintained by mowing.

Oak barrens occur on dry sandy soils with a corresponding prairie component and scattered Hill's oak (Quercus ellipsoidalis) or black oak. This community was also common along parts of the prairie-forest border but is presently rare. The best remaining examples are limited but can be found along some of the original prairie-forest border in Newaygo County. The extent of oak barren in this county will be documented with a complete inventory of natural prairie and savanna during the summer, 1982. Preservation of this type should be given a high priority.

Pine barrens occur on dry sandy soil north of the tension zone with jack pine present. Blueberry is one of the most prevalent groundlayer species in this community. There appears to be a gradation between this type and the dry northern jack pine forest. Searching for specific examples of this type has not been a priority for the same reasons that the dry northern forest has not been a priority.

There is only one example of alpine community in Michigan. It is an extremely distinctive and unique community, characterized by existing on an exposed mountain top (bald) with bearberry (Arctostaphylos uva-ursi) and horizontal juniper (Juniperus horizontalis) dominating, with scattered clumps of stunted white pine, white cedar, and red oak. It appears that this community is adapted to the harsh environment (wind and snow) of a ridge top along the Lake Superior shore. Other ridges/mountain tops in the Keweenaw Peninsula, Huron Mountains, and Porcupine Mountains were surveyed, but bald ridge tops in these areas were not well developed or of secondary origin. The one example of alpine community is presently the subject of a scientific study which should help to explain its origin. This is a very rare community, probably the only example in the Midwest, and it is privately owned. It is a very aesthetic community that offers a beautiful scenic overlook but is subject to overuse by visitors. It is believed that a similar community existed on the Brockway Mountain ridge top prior to the tourist road being developed along the ridge. Some stunted trees and open areas are still visible along the road edge. Considering the factors of rarity, uniqueness, and lack of protection, this should be, without question, the single highest priority community for preservation.

Shrublands are natural shrub areas with blueberry, sweet fern (Myrica), bearberry, new jersey tea (Caerothus), and sumac (Rhus), dominant. A study of this community type needs to be conducted to determine whether it is a natural occuring type or a community that has developed as a result of human disturbance.

A prairie is defined as an open area, dominated by grasses with a mixture of forbs and with less than one tree per acre. Prairies are located near or south of the tension zone and were a part of the prairie peninsula that extended into southern Michigan. Many of Michigan's prairies have been the subject of studies, the most recent of which will be completed by the the spring, 1982, and will provide information to properly classify different prairie types. Prairies have

attracted the interest of conservation groups which has led to the preservation of examples of both mesic and dry prairies. However, some exemplary occurrences of prairie are still threatened by agricultural development, railroad right of way management, and natural succession in the absence of fire.

Mesic prairie, sometimes referred to as tallgrass prairie, is characterized by having dominants such as big bluestem (Andropogon gerardii) and Indian grass (Sorghastrum nutans) growing on deep black moist soil. This type is scattered throughout the eastern portion of the North American grassland biome that extends in the U.S. from Minnesota to east Texas. The 14 known occurrences in Michigan of mesic prairie that are restricted to the two southern tiers of counties. Some of these are of questionable quality and will be properly designated as more information becomes available from research in progress. Many of the mesic prairies that exist are probably known; however, new leads should be treated as a high priority.

Dry-mesic prairies are an uncertain type in Michigan. As current studies are completed the status of this type should become clear. At present, there is only one prairie listed as dry-mesic.

Dry prairie is dominated by little bluestem (Andropogon scoparius) with mixtures of other dominants such as sedge (Carex pensylvanica), moss (Polytichum) and lichen (Cladonia) growing on dry sandy soil. There are ten known occurrences, four of which are in Newaygo County. Methods were developed and tested to identify dry prairies using aerial photography. A prairie survey of Newaygo County using aerial photography will be conducted during the summer, 1982. Although good examples are protected in this area, some of the best are threatened by plantings of pines.

Natural bracken-grasslands are reported from Wisconsin, north of their tension zone, on a variety of soil types. There are no trees present and the community is dominated by bracken fern (Pteridium aquilinum) and native grasses. It appears they were associated with grassy openings or prairies following fire during the maximum expansion of prairies. They have now secondarily expanded into areas that were logged and burned. These secondary bracken-grasslands in Michigan have been described, but there are no leads to what could be considered natural occurrences of this type. If they do exist in Michigan, they are probably not seriously threatened except by long term succession. This community should continue to be investigated to determine its origin in Michigan.

The remaining community types have no true soil development and the substrate is sand, gravel, or bare rock. Vegetation is rather sparse in many of these and is usually limited to specialized species selected by the specialized environmental conditions of the site.

Great lakes dune communities include hills, ridges, and valleys that are formed from active windblown sand along the Great Lakes. The plants of this community type must be adapted to the extreme environmental conditions of high temperature and light, and low soil moisture. The community differs from oceanic dunes in not being influenced by salt spray. It is bordered by the shore and by the inland forest. It is most often distinguished by the presence of beach grass (Ammophila breviligulata) as the dominant vegetation. The best formations occur along the east shore of southern Lake Michigan. Michigan has the largest

concentration of freshwater sand dunes in the world. There are 18 occurrences of dunes listed with the MNFI. Five of these are state park areas, four are included in national parks, and two are nature preserves. Dunes, like the mesic northern forests, are in preserves that are large enough to preserve the entire ecosystem and not just a single plant community. Dune systems are threatened by housing development, sand mining, and recreational use. To help complete the inventory of Great Lakes dunes, they will be included as the highest priority items during the 1982 MNFI survey of Michigan's coast.

The beach community is a relatively flat sand and/or gravel site, moist in some areas, and found along lake shores. Sea rock (Cakile edentula) and beach pea (Lathyrus maritimus) are two characteristic species found on the Great Lakes shore. Species of the mint family are prominent members along inland lakes. The best occurrences are found in the least disturbed shorelines of the northern Great Lakes and inland lakes. The beach community is seriously threatened by cottage develoment and recreational use, although some are protected in nature preserves and parks. Beach community occurrence information should continue to be collected as surveys are done on undisturbed inland lakes and during the 1982 MNFI survey of Michigan's coast.

Sand barrens are relatively flat, dry, sandy areas, found inland from the shores and supporting clumps of grasses and arid plants such as prickly-pear cactus (Opuntia humifusa). This community appears to be related to dry prairie but is on the drier end of the continuum. A study of sand barrens should be conducted to determine whether they are a distinct community type of natural origin.

Calcareous pavement community is defined as having a horizontal, exposed bedrock substrate that is calcareous and not associated with a cliff. The one known exemplary occurrence of this type is on Drummond Island. At this time, relatively little is known about this pavement community, but it is being studied by our data handler/secretary as a part of her Master's thesis. This community should prove to be a very unique type. One other small area in the Upper Peninsula is reported to be of this type but needs to be verified. It is strongly recommended that the Drummond Island site be protected.

Noncalcaerous pavement communities are characterized as having a nearly horizontal, exposed bedrock substrate that is noncalcareous and is not associated with a cliff. It is common along the rocky shores of Lake Superior. Several occurrences of this community are protected in nature preserves and in national and state parks. Examples of this type will continue to accumulate in conjunction with information collected on special plants associated with this habitat. The prevalence of inland occurrences is uncertain.

The four cliff communities, calcareous open cliff, calcareous shaded cliff, noncalcareous open cliff and noncalcareous shaded cliff, are defined by whether the substrate is calcareous (i.e., contains calcium carbonate, calcium, or limestone) and whether they are shaded by forest cover. These types are scattered throughout the Upper Peninsula. The most commonly found groups of plants are ferns, mosses, and lichens. Examples of this community are protected in national and state parks and in nature preserves. They are not under any immediate threat but information should continue to be collected to better document and understand the cliff communities.

A sinkhole community is a hole in the earth's surface with a relatively large opening. It occurs in limestone areas and is caused by a cave-in and sinking of the overlaying surface. Exposed verticle rock faces are usually present. Sinkholes are found throughout the northeastern Lower Peninsula and the eastern Upper Peninsula. Most of the occurrences of this type are not threatened. The communities at the bottom of the sinkhole and on the exposed rock faces are presumed to be somewhat different from the surface community. However, no studies have been conducted to document the changes that occur in environmental conditions and community composition. This type of study should be completed as soon as possible to determine whether this community is a distinct type. Occurrence information should be collected as it becomes available.

**Subterranean**

Caves are defined as hollows beneath the earth's surface with relatively small openings to the surface. There are only three known caves in Michigan and very little is known about them from a biological standpoint. A study should be conducted to determine whether these have distinct cave ecosystems.

**Summary**

The once common oak openings, especially those with bur oak, are now rare throughout their range and are probably extirpated from Michigan. The rarest and most unique communities still in existence in Michigan are the alpine community, the inland saline wetland, and the calcareous pavement community. Their singular occurrence in Michigan may represent the only extant example of each in the region, and none of them are guaranteed protection. The community next in priority is freshwater delta wetland. There are a couple of examples of this regionally significant community and only one is partially protected. Dry-mesic and dry southern forest, true grass dominated fen wetlands and wild rice dominated marsh types are all believed to be rare with no strongly protected examples, making these important categories for future work to determine their status. The dune community is of regional or possibly world-wide significance and is common in the state with several examples protected to some degree. Even though prairies are rare throughout North America, especially in Michigan, many preserves have been established because of the large amount of interest shown toward this community. Data collection should proceed to ensure that the best examples of prairies are protected.

## Special Plants

The Michigan Natural Features Inventory (MNFI) maintains data files on 334 special plant taxa considered endangered, threatened, extirpated, or of special concern in the state. Recent inventory work has vastly increased our knowledge of the status of rare plants in Michigan; in addition to extensive herbarium and literature searches, field work efforts in 1981 included surveying some 800 sites to collect information on over 500 special plant occurrences.

### Prioritization and Categorization

Priorities for data collection and processing have been assigned to special plants through the B2.1 level, as outlined in Figure 2. These rankings reflect species' importance on a total-range (i.e., continental or world-wide) scale more than do the state-listing categories of endangered, threatened, etc., which give special emphasis to state rarity.

Furthermore, uniform criteria for the official state-listing of plant species were developed in 1981 by the Department of Natural Resources' Plant Technical Advisory Committee, and are presented below.

Endangered: A species "which is in danger of extinction throughout all or a significant portion of its range."

Criteria for endangered:

Extreme rarity in Michigan ( ≤ two known viable populations) and at least one of the following conditions:

A. Endemism or near-endemism to Michigan;

or B. Rarity throughout North America;

or C. Rarity in Michigan and the Great Lakes drainage basin with demonstrable threat to all or most State populations;

or D. Special factors cause unusual vulnerability (e.g., disease, highly specialized requirements, exceptional danger of exploitation).

Threatened: A species "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

Criteria for threatened:

A. Extreme rarity in Michigan, but not meeting other endangered criteria;

or B. Endemism or near-endemism to Michigan;

or C. State rarity ( ≤ ten known viable populations, or, if no current population data are available, occurrence in ≤ five counties and ≤ 20 collection localities with known decline) AND at least one of the following conditions:

1. rarity in the Great Lakes region;

or 2. demonstrable threat to all or most state populations;

or 3. disjunction of phytogeographic significance;

or 4. unusual habitat vulnerability (e.g., prairie, fen, lakeshore);

or 5. extremely localized state distribution ( $\leq$ two counties);

or 6. special factors (scientific importance, absence of recent records);

or D. No populations known extant or recently reported.

Definitions:

Rarity: nowhere common; limits given on numbers of populations are guidelines only and not intended to be rigid, artificial cut-offs.

Viable population: an actively reproducing population large enough to maintain itself indefinitely in a natural community with minimal disturbance.

The "Special Concern" category is without formal criteria, and serves to call attention to species known or suspected to be sufficiently rare or declining on a statewide basis for concern.

For a listing of all state special plants with official status designations, see Appendix C . Those species assigned MNFI priority ranks of A2-B1.2 are listed in Table 2.

Table 2.
High-Priority (A2-B2.1) Special Plants

| Species/Common Name | Family | Federal/State-MNFI Status | Status | Rank | Natural Region(s) | Habitat(s) |
|---|---|---|---|---|---|---|
| Isotria medeoloides<br>Smaller Whorled Pogonia | Orchidaceae | PE | SE | A2 | 4 | CTA |
| Chamaerhodos nuttalli var. keweenawensis<br>no common name | Rosaceae | | SE | B1 | 1 | CTX |
| Habenaria leucophaea<br>Prairie Fringed Orchid | Orchidaceae | CI | SE | B1 | 4 | CPP, CPQ |
| Lycopodium sp. nov.<br>(a) clubmoss | Lycopodiaceae | | SC | B1 | 4 | |
| Mimulus glabratus var. michiganensis<br>Michigan Monkey-flower | Scrophulariaceae | C1 | ST | B1 | 2, 3 | CPH, CR |
| Orchis rotundifolia<br>Small Round-leaved Orchis | Orchidaceae | | SE | B1 | 1, 2, 3 | CPQ, CPT |
| Phyllitis scolopendrium var. americana<br>Hart's-tongue Fern | Polypodiaceae | C2 | SE | B1 | 2 | CTD |
| Polygonatum biflorum var. melleum<br>(a) solomon-seal | Liliaceae | | SE | B1 | 4 | CTB |
| Antennaria rosea<br>(one of the) pussytoes | Asteraceae | | ST | B2.1 | 1 | CUB |
| Arnica cordifolia<br>Heart-leaved Arnica | Asteraceae | | ST | B2.1 | 1 | CTE |
| Aster sericeus<br>Western Silvery (or Silky) Aster | Asteraceae | | ST | B2.1 | 4 | CTP |
| Besseya bullii<br>Kitten Tails | Scrophulariaceae | C2 | ST | B2.1 | 4 | CTP |
| Carex crus-corvi<br>(a) sedge | Cyperaceae | | ST | B2.1 | 4 | CPT |
| Carex heleonastes<br>(a) sedge | Cyperaceae | | ST | B2.1 | 2 | CPT |
| Castanea dentata<br>American Chestnut | Fagaceae | | SE | B2.1 | 1 | CTC |
| Chelone obliqua<br>Purple Turtlehead | Scrophulariaceae | C2 | SE | B2.1 | 4 | CPJ |
| Cirsium pitcheri<br>Pitcher's Thistle | Asteraceae | C1 | ST | B2.1 | 2, 3, 4 | CTR |

| Species/Common Name | Family | Federal/State-MNFI Status | Status | Rank | Natural Region(s) | Habitat(s) |
|---|---|---|---|---|---|---|
| Disporum hookeri<br>Fairy Bells | Liliaceae | | ST | B2.1 | 1 | CTD |
| Dodecatheon meadia<br>Shooting-star | Primulaceae | | ST | B2.1 | 4 | CPP |
| Draba cana<br>no common name | Brassicaceae | | ST | B2.1 | 2 | CTV |
| Eleocharis atropurpurea<br>(a) Spike-rush | Cyperaceae | | SE | B2.1 | 4 | CPK |
| Eleocharis caribaea<br>(a) Spike-rush | Cyperaceae | | ST | B2.1 | 4 | CPK, CPD |
| Eleocharis parvula<br>(a) Spike-rush | Cyperaceae | | ST | B2.1 | 4 | CPN |
| Eleocharis radicans<br>(a) Spike-rush | Cyperaceae | | ST | B2.1 | 4 | CPQ |
| Gentiana alba<br>Yellowish Gentian | Gentianaccae | | ST | B2.1 | 4 | CTP |
| Gerardia gattingeri<br>(a) Gerardia | Scrophulariaceae | | ST | B2.1 | 4 | CL |
| Iris lacustris<br>Dwarf Lake Iris | Iridaceae | C1 | ST | B2.1 | 2, 3 | |
| Juncus militaris<br>(a) Rush | Juncaceae | | ST | B2.1 | 3 | CPD, CPK |
| Juncus vaseyi<br>(a) Rush | Juncaceae | | ST | B2.1 | 1, 2 | |
| Lemna valdiviana<br>(a) Duckweed | Lemnaceae | | ST | B2.1 | 4 | CL |
| Lycopodium sabinaefolium<br>Savin-leaved Clubmoss | Lycopodiaceae | | SE | B2.1 | 2 | |
| Lygodium palmatum<br>Climbing Fern | Schizaeaceae | | ST | B2.1 | 4 | |
| Oplopanax horridus<br>Devil's-club | Araliaceae | | ST | B2.1 | 1 | CTG |
| Opuntia fragilis<br>Fragile Prickly-pear | Cactaceae | | ST | B2.1 | 1 | CTX |
| Petasites sagittatus<br>Sweet Coltsfoot | Asteraceae | | ST | B2.1 | 2 | CPA |

| Species/Common Name | Family | Federal/State-MNFI Status | Status | Rank | Natural Region(s) | Habitat(s) |
|---|---|---|---|---|---|---|
| Poa alpina (a) Grass | Poaceae | | ST | B2.1 | 1 | CUB |
| Poa canbyi (a) Grass | Poaceae | | ST | B2.1 | 1 | CTX |
| Polygala incarnata Pink Milkwort | Polygalaceae | | ST | B2.1 | 4 | CPP |
| Polygonum careyi (a) Smartweed | Polygonaceae | | ST | B2.1 | 4 | CPK |
| Potamogeton capillaceus (a) Pondweed | Potamogetonaceae | | ST | B2.1 | 4 | CLD, CPK |
| Potamogeton pulcher (a) Pondweed | Potamogetonaceae | | ST | B2.1 | 1, 2, 4 | CL |
| Sanguisorba canadensis Canadian Burnet | Rosaceae | | ST | B2.1 | 4 | CPR |
| Scirpus hallii (a) Bulrush | Cyperaceae | | SE | B2.1 | 4 | CPK |
| Scirpus olneyi (a) Bulrush | Cyperaceae | | ST | B2.1 | 4 | CPN |
| Scleria reticularis (a) Nut-rush | Cyperaceae | | SE | B2.1 | 4 | CPK |
| Sisyrinchium atlanticum (a) Blue-eyed-grass | Iridaceae | | ST | B2.1 | 4 | CPK |
| Solidago decumbens (a) Goldenrod | Asteraceae | | SC | B2.1 | 1 | CTX |
| Solidago houghtonii Houghton's Goldenrod | Asteraceae | | ST | B2.1 | 2, 3 | CTR |
| Utricularia inflata Floating Bladderwort | Lentibulariaceae | | SE | B2.1 | 4 | CPK |
| Wisteria frutescens Wisteria | Fabaceae | | ST | B2.1 | 4 | CPB |

## Discussion of High Priority (A2-B1.2) Species

Only one Michigan plant species -- the smaller whorled pogonia (Isotria medeoloides) -- is endangered throughout its entire range. The sole State colony of Isotria has declined from 20 to 2 individuals since its discovery in 1969, due at least in part to exploitation. Its occurrence in a young second-growth forest--formerly an orchard--suggests that it became established in the relatively recent past, perhaps from a nearby seed source, and careful, timely searches may locate other colonies in the area.

Four additional Michigan species are threatened throughout their ranges. The hart's-tongue fern (Phyllitis scolopendrium var. americanum) is known from four sites in the eastern Upper Peninsula on the dolomitic Niagaran escarpment, apparently above the ancient shorelines of post-glacial Lake Nipissing. The prairie fringed orchid (Habenaria leucophaea), once occurring in at least 22 southern Michigan counties, has declined to only 11 known populations, with 7 of those supporting fewer than 10 individuals each. Similarly, the heart-leaved plantain (Plantago cordata) is known historically from seven Michigan counties, but has not been collected in the State since 1925 and may be extirpated. Potamogeton lateralis, a pondweed species that has been historically rare in its limited range, is known in Michigan from an 1872 collection and has also not been relocated.

Four Michigan taxa of extremely limited State distribution are likely endemic or near-endemic. Chamaerhodos nuttallii var. keweenawensis (no common name) occurs in a colony of 60-70 individuals on a windswept ridgetop that is heavily visited by tourists. The distinctness of var. keweenawensis has been questioned, however, on the basis of specimens with similar characters reported from Manitoba.

The Michigan monkey flower (Mimulus glabratus var. michiganensis) is considered endemic to the Mackinac Straits region, where two colonies are known extant. Taxonomic uncertainty exists here also, however, as it is unclear whether there is a morphological continuum between this and the common variety fremontii. Field work to be conducted by a study at the University of Michigan Biological Station in summer, 1982 will hopefully resolve that uncertainty.

An endemic variety of solomon-seal, Polygonatum biflorum var. melleum, collected early this century in southeastern St. Clair County and adjacent Ontario, is known only from those records. Locality data for the Michigan collections are vague, however, and it has not been relocated, though careful searches of open woods habitat in that area are yet to be conducted.

A new species of clubmoss, as yet unnamed, was discovered at one station in Van Buren County. Though the taxonomic status of Lycopodium sp. nov. is still unclear, it is considered endangered in the State.

Another high-priority special plant is the small round-leaved orchid (Orchis rotundifolia), considered one of the rarest orchids in eastern North America (it is primarily western and arctic). Over the past ten years, several closely monitored Michigan colonies have inexplicably died out, and there now remain only three known occurrences, two of them with fewer than five individuals.

The American chestnut (Castanea dentata) is endangered in Michigan due to the chestnut blight fungus (Endothecia parasitica), which has nearly eliminated it as a naturally-occurring species in the State. Only a few native occurrences remain, but groves of cultivated and naturalized trees persist--some surviving hypovirulent strains of the parasite--and have been inventoried under the "other" category.

In addition to these critically endangered taxa, other high-ranking special plants include: (1) those endemic to the shores of the Great Lakes (with approximately 95% of their world populations in Michigan)--e.g., dwarf lake iris (Iris lacustris), Houghton's goldenrod (Solidago houghtonii), and Pitcher's thistle (Cirsium pitcheri); (2) those which are endangered both in Michigan and regionally (though not in the main part of their ranges)--e.g., Canadian burnet (Sanguisorba canadensis) and pink turtlehead (Chelone obliqua); and (3) those both extremely rare and strikingly disjunct in Michigan--e.g., Hall's bulrush (Scirpus hallii), floating bladderwort (Utricularia inflata), devil's-club (Oplopanax horridus), and heart-leaved arnica (Arnica cordifolia).

Twenty-six plant species appear to be extirpated from the State; however, two which were thus categorized, snow trillium (Trillium nivale) and a spike-rush (Eleocharis parvula), have been rediscovered since 1979, and more will hopefully be relocated.

## State Distribution

In terms of Michigan's four natural regions, 12 high-priority plant species occur in the western Upper Peninsula. Among those are Chamaerhodos nuttallii var. keweenawensis, Poa canbyi, devil's-club (Oplopanax horridus), heart-leaved arnica (Arnica cordifolia), and fairy bells (Disporum hookeri). The greatest concentrations occur on Isle Royale and the Keweenaw Peninsula, with 15 state-threatened species known from the Isle Royale islands alone.

In the eastern Upper Peninsula, 11 high-priority species occur, including hart's-tongue fern (Phyllitis scolopendrium), arctic sedge (Carex heleonastes), Michigan monkey flower (Mimulus glabratus var. michiganensis), and a draba, Draba cana. Small though significant concentrations are found on the Maxton Plains of Drummond Island (Chippewa County) and in the bogs south of Shingleton (Schoolcraft County).

The northern Lower Peninsula supports the fewest high-priority species, with six. Among them, however, are Michigan monkey flower (Mimulus glabratus var. michiganensis), bayonet rush (Juncus militaris), and small round-leaved orchid (Orchis rotundifolia).

Thirty-two high-priority species are known from the southern Lower Peninsula, including our only A2 species, the smaller whorled pogonia (Isotria medeoloides), and three B1 species, the prairie fringed orchid (Habenaria leucophaea), heart-leaved plantain (Plantago cordata), and the solomon-seal (Polygonatum biflorum var. melleum). This relatively high concentration of Michigan's most endangered plants is partly attributable to extensive land development which has greatly reduced native habitats in southern Michigan, and to more intensive botanizing here.

## Habitat Affinities

Michigan's special plants occur mostly in terrestrial and palustrine habitats, where vascular plant diversity is greatest; relatively few inhabit riverine and lacustrine communities. High-priority special plants in each of the MNFI-designated community subclasses are discussed below, along with several natural communities richest in special plants.

Riverine (CR) - Only two of Michigan's high-priority special plants -- the Michigan monkey flower (Mimulus glabratus var. michiganensis) and heart-leaved plantain (Plantago cordata) -- typically occur in riverine communities. The latter, though not found in the State since 1925, may still persist on little-developed and little-explored rivers in southern Michigan, especially the Black River in St. Clair County, where it was once collected and should be searched for again. Extensive water pollution, siltation, riparian development, and channelization have destroyed this species' habitat in the seven counties it once inhabited.

Lacustrine (CL) - Two of our four high-priority plants which inhabit the waters of Michigan's inland and Great Lakes -- a duckweed, Lemna valdiviana and a pondweed, Potamogeton lateralis -- have not been verified in recent years and may be extirpated. These, plus a third -- Potamogeton capillaceus -- range in the southern Lower Peninsula, where extensive shoreline development and pollution of lakes has diminished lacustrine habitat quality. Careful field work in that area of the State may result in relocating those inobtrusive species now thought extirpated.

Palustrine (CP) - Wetland habitats support the largest number (24) of high-priority special plants. Those natural palustrine communities richest in special plants are discussed below.

Ephemeral wetland and peripheral lacustrine marsh (CPK, CPD) - A large assemblage of special plants, many of them with Atlantic coastal plain affinities (discussed later) inhabit the peripheries of inland seepage lakes with annually and seasonally fluctuating water levels. Most grow on lake or pond-bottoms exposed by a lowered water table. These habitats are concentrated near Lake Michigan in the southwestern Lower Peninsula, but also occur sparsely in southeastern Michigan and in Cheboygan and Schoolcraft counties. Nine species belong to this assemblage and include the purple spike-rush (Eleocharis atropurpurea), Hall's bulrush (Scirpus hallii), reticulate nut-rush (Scleria reticularis), and inflated bladderwort (Utricularia inflata). The greatest concentrations of these species are found at very local sites in Muskegon, Allegan, and Berrien counties.

Bog and strangmoor wetlands (CPQ, CPT) - Boggy habitats throughout Michigan provide habitat for a significant number of special plants, including four high-priority species -- the arctic sedge (Carex heleonastes), Eleocharis radicans, small round-leaved orchid (Orchis rotundifolia), and prairie fringed orchid (Habenaria leucophaea) (which inhabits bogs as well as wet prairies in this portion of its range). The strangmoor wetlands of northwestern Schoolcraft County support two plants found nowhere else in Michigan.

Riverine swamp (CPH) - Swampy river floodplains support three high-priority special plants and a number of lesser-priority species. The pink turtlehead (Chelone obliqua) and wisteria (Wisteria frutescens) are each known from only a few individuals at sites in Washtenaw and Cass counties, respectively. The third, raven's-foot sedge (Carex crus-corvi), has not been verified in the State since 1956, and field work is needed to relocate populations still extant. Two medium-priority species, the false petunia (Ruellia strepens) and wild-hyacinth (Camassia scilloides), occur only along the rivers of Lenawee County, which are little explored and may yield other species new to the State.

Inland saline wetland (CPN) - Michigan's one salt marsh community supports two high-priority plants which, due to their saline habitat requirements, are extremely rare in the Midwest and known from nowhere else in Michigan. They are Eleocharis parvula, a spike-rush, and Olney's bulrush (Scirpus olneyi). The threatened hedge-hyssop (Gratiola lutea) was also reported from the site in 1982 - it is otherwise known only from several small lakes near the Michigan-Wisconsin border in Gogebic County.

Rock or cliff communities (CTU-Y, CUB) - Relatively unusual habitat types throughout much of Michigan's glacial drift-covered landscape, rock communities, where they occur, support a number of extremely rare plant species. High-priority plants of rock habitats are Chamaerhodos nuttallii var. keweenawensis, Solidago decumbens (a goldenrod), Draba cana, fragile prickly pear (Opuntia fragilis), and a grass, Poa canbyi. Three species collected in rock habitats are thought extirpated -- western wheatgrass (Agropyron spicatum), mountain spleenwort (Asplenium montanum), and prairie rush grass (Muhlenbergia cuspidata) --and two others, mountain timothy (Phleum alpinum), and mountain speargrass (Poa alpina), have not been found in recent years and may also be gone from the Michigan flora. Since most rock communities are concentrated in the poorly botanized western Upper Peninsula, their floras are still not well known, and in need of further exploration. Keweenaw County "mountaintops" and rock shores support the greatest concentrations of rock species.

Forest communities (CTA-G) - Seven high-priority plant species inhabit Michigan's diverse forest communities. Those of northern mesic forests include hart's-tongue fern (Phyllitis scolopendrium), fairy bells (Disporum hookeri), devil's club (Oplopanax horridus), and heart-leaved arnica (Arnica cordifolia). In dry to mesic southern forests are smaller whorled pogonia (Isotria medeoloides), solomon-seal (Polygonatum biflorum var. melleum), and American chestnut (Castanea dentata).

## Phytogeographic Relationships

Michigan's location in the heart of the Great Lakes Region places it under a number of floristic influences. Many species occur in Michigan at the margins of their contiguous ranges, or as isolated outliers. In addition, the geologic/floristic history of the State and the presence of certain unique habitats have resulted in major disjunct plant occurrences. Primary among the floristic influences responsible for many rare plants in Michigan are arctic/boreal, western (Cordilleran), Atlantic coastal plain, Appalachian, southern, and Great Plains.

Nine high-priority special plants and many medium-priority species have strong arctic/boreal affinities. Many of those species are at their southern-most occurrences on the Lake Superior shores, more or less disjunct from James Bay to the north. They are most concentrated on the shores of the Keweenaw Peninsula and Isle Royale, but are also scattered across the Upper Peninsula in general. Among the most important of these boreal species are the arctic sedge (Carex heleonastes), mountain timothy (Phleum alpinum), mountain speargrass (Poa alpina), sweet coltsfoot (Petasites sagittatus), and small round-leaved orchid (Orchis rotundifolia).

Closely allied phytogeographically with the boreal element and sometimes difficult to distinguish is the western or Cordilleran element. Species which are markedly disjunct in Michigan from either the Black Hills or farther west include the heart-leaved arnica (Arnica cordifolia), devil's club (Oplopanax horridus), wild-lilac (Ceanothus sanguineus), blue-eyed mary (Collinsia parviflora), Alaska orchid (Habenaria unalascensis) and pine-drops (Pterospora andromedea) (with the latter four also occurring in the St. Lawrence region). In Michigan, these and similarly disjunct species are concentrated in the western Upper Peninsula, with sporadic occurrences eastward and southward to the tension zone.

Another striking and major component of Michigan's rare flora is the Atlantic coastal plain element. Four state-listed endangered plant species -- floating bladderwort (Utricularia inflata), Hall's bulrush (Scirpus hallii), purple spike-rush (Eleocharis atropurpurea) and reticulated nut-rush (Scleria reticularis) -- are disjunct from the coastal plain at extremely local sites in southwestern Michigan. Nine other high-priority plants, including bayonet rush Juncus militaris, the spike-rush Eleocharis parvula, and the pondweed Potamogeton capillaceus, may also be classified as coastal plain disjuncts.

Species of Appalachian floristic affinities comprise a relatively small but important contingent of special Michigan plants. Among them are the climbing fern (Lygodium palmatum), bowman's root (Porteranthus trifoliatus) --- both known from only one Michigan locality -- and painted trillium (Trillium undulatum).

Most notable among the many special plants with southern affinities are the purple turtlehead (Chelone obliqua), raven's-foot sedge (Carex crus-corvi), and Wisteria frutescens. Great Plains species enter Michigan mostly in the prairie peninsula, but also range sparingly into the western Upper Peninsula uplands. They include high-priority species western silvery aster (Aster sericeus), yellowish gentian (Gentiana alba), prairie buttercup (Ranunculus rhomboideus) and fragile prickly-pear (Opuntia fragilis.).

**Nonvascular Plants**

No official State lists exists for nonvascular plants, and hence they are afforded no legal protection. However, the MNFI has developed lists of mosses and lichens of special concern in the State (see Appendix C), in order to efficiently direct inventory and research activities--and protection efforts, if need be--on this component of Michigan's natural diversity. Lists for nonvascular plants are based on highly selective criteria compared to the vascular plant list, since much less work has been done on nonvascular plants and consequently, our knowledge of their occurrence is presumably more incomplete.

## Bryophytes

The MNFI list of special mosses consists of 34 species of particular significance in Michigan because they are either: (1) endemic to the Great Lakes region, (2) rare on a continental or world wide basis, (3) western Cordilleran disjuncts, or (4) arctic-boreal disjuncts.

Only one moss species in Michigan is considered endemic to the Great Lakes region. Grimmia hermannii has been found at two sites in Keweenaw County, and also occurs rarely in Wisconsin and Minnesota.

Nineteen Michigan mosses are rare throughout their ranges. Barbula michiganensis occurs on the Pictured Rocks in Alger County, and is otherwise known from one collection in Chihuahua, Mexico, with questionable reports from Canada's Northwest Territories. Gyroweisia tenuis occurs in Marquette and Houghton counties, and at isolated localities in Iowa, Manitoba, and Canadian Northwest Territories. Other species deemed rare though their ranges are of broader total distribution, as typical for spore-bearing and readily wind-dispersed nonvascular plants.

The phenomenon of bryophyte Cordilleran disjunct occurrences in Michigan parallels that of vascular plants, discussed earlier. The nine moss species which are strikingly disjunct from montane western North America are Dryptodon patens, Fontinalis neo-mexicana, Grimmia hartmanii var. anomala, G. tenerrima, Orthotrichum alpestre, O. pallens, O. rupestre, Pseudoleskea patens, and Tortula norvegica.

Two moss species are notably disjunct in Michigan from an arctic-boreal range. They are Mnium andrewsianum and Tetraplodon angustatus.

Comprehensive herbarium data for special moss species still need to be assembled from major Michigan collections, so that occurrence information can be entered into the MNFI data management system. Also, special liverworts are yet to be incorporated into the bryophyte list, and consultation with appropriate experts, some outside Michigan, is required.

## Lichens

The Michigan list of special lichens includes only foliose (leaf-like) and fruticose (shrubby or hair-like) species--not crustose (close-adhering)--and was assembled according to the same criteria given for the bryophyte list. In addition to the categories listed there, however, lichens are of one additional type--species of Appalachian, St. Lawrence, and northern Great Lakes distribution which inhabit rich mesic forests and have become rare through loss of forest cover and associated humidity. These include Parmotrema stuppeum, Stereocaulon pileatum, and Usnea angulata.

One lichen -- Cetraria ericetorum -- was recently described as a species endemic to, and of scattered occurrence on, the sandy shores of the Great Lakes, paralleling the distribution of our three endemic vascular plant species. Lichen species rare throughout their North American ranges include Physcia phaea, Placynthium aspratile, Ramalina farinacea, and Sticta fuliginosa.

At least six rare Michigan lichens are strikingly disjunct from the western Cordillera. Among them are Dermatocarpon moulinsii, D. reticulatum, Melanelia substygia, and Parmelita stictica. Xanthoparmelia centrifuga is an arctic-boreal lichen that is disjunct in Michigan.

MNFI herbarium data on lichens are not yet complete, with the University of Michigan collection yet to be searched. When this is done, data will be processed into MNFI computer and map files.

## Special Animals

The Natural Features Inventory manages information on approximately 200 special animal species, about half of which are vertebrates, as detailed in Appendix D and summarized in Table 3. Special animal species are those whose populations in Michigan are endangered, threatened, rare, severely depressed from former levels, peripheral, or of unknown status. This list includes peripheral species which may be common elsewhere in North America. Some taxa are borderline cases, and so the special animal list is inclusive rather than exclusive. From a conservation viewpoint, it is safer to learn that an animal is abundant after working for its protection than to learn that it is extinct after ignoring it.

Table 3.
The status of special animals in Michigan.

| Animal Group | Approx. No. Species Currently Breeding Michigan | No. MNFI Special Animals Extant in MI | Endangered or Threatened Species | | No. Species Ranked | | | |
|---|---|---|---|---|---|---|---|---|
| | | | No. | % | AX-BX | A1-A2 | B1-B2 | B3-BU |
| Vertebrates | 472 | 103 | 34 | 7 | 12 | 2 | 16 | 23 |
| Mammals | 62 | 13 | 4 | 6 | 4 | 0 | 3 | 2 |
| Birds | 230 | 43 | 14 | 6 | 1 | 1 | 6 | 11 |
| Reptiles | 29 | 7 | 2 | 7 | 0 | 0 | 2 | 2 |
| Amphibians | 25 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fishes | 126 | 35 | 14 | 11 | 7 | 1 | 5 | 8 |
| Invertebrates | | | | | | | | |
| Butterflies | 150 | 30 | 0 | 0 | -- | -- | -- | -- |
| Moths | 1300 | 47 | 0 | 0 | -- | -- | -- | -- |
| Mussels | 43 | 11 | 9 | 21 | ? | 4 | 3 | 4 |
| Snails/Slugs | 250 | 13 | 2 | 1 | ? | 1 | 1 | ? |
| TOTALS | | 204 | 45 | | 12+ | 7 | 20 | 27+ |

### Prioritization and Categorization

Listed animals are assigned data collection and processing priorities based on criteria outlined in Figure 2, including estimated number of total and State occurrences, taxonomic distinctness, range, number of protected occurrences in the State, ecological fragility, and relative threats of destruction.

A set of semi-quantitative working criteria were also developed to assist in the process of state-listing animal species as endangered, threatened, rare or watch, and peripheral. Definitions and criteria for these terms are presented below.

Endangered: A species "which is in danger of extinction throughout all or a significant portion of its range. "

Criteria for endangered:

A. Considered by the Secretary of the Interior to be endangered in the United States (e.g., all endangered mammals, two endangered birds, and two endangered fish);

or B. Known recently (last 20 years) from 20 or fewer sites in its entire range (e.g., all endangered mollusks and some endangered fish);

or C. Has declined seriously and noncyclically throughout the major portion of its range and

1. is estimated to be extant at three or fewer breeding sites (breeding populations separated by areas of unfavorable habitat) in Michigan (e.g., some endangered fish);

or 2. there are estimated to be fewer than 50 breeding individuals in the State (e.g., some endangered birds and reptiles).

Threatened: A species "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. "

Criteria for threatened:

A. Is not endangered by one of the above criteria;

but B. Considered by the Secretary of the Interior to be threatened in the United States;

or C. Known recently from 60 or fewer sites in its entire range;

or D. Has declined seriously and noncyclically at least regionally (e.g., Great Lakes region or throughout its nonperipheral Michigan range) and

1. is estimated to be extant at ten or fewer breeding sites in Michigan;

or 2. there are estimated to be fewer than 300 breeding individuals in the State;

or 3. special factors cause this species to be especially vulnerable to extirpation regionally (e.g., recent low reproductive success and dependence on two threatened nesting sites for common terns, Sterna hirundo; long time to maturity and fishing pressures for lake sturgeon, Acipenser fulvescens.

Rare or Watch: This list includes a species:

1) that, though widespread and habitually rare, is nonperipheral and sufficiently uncommon that any reduction in its population or habitat conditions would threaten the species existence in Michigan.

or 2) that is nonperipheral and appears to have undergone a serious, noncyclic decrease in Michigan, such that the species could become threatened if the decline continued unchecked.

Peripheral: A peripheral species is one that is in Michigan at the periphery of its range, which extends only a short ways into the State; numbers are usually scarce, and occurrence may only be sporadic and limited to one or two counties or watersheds. Such species will be designated "endangered" or "threatened" only if and when they become endangered or threatened in the main extent of their range. These are species known recently from five or fewer sites in the State.

Animals listed as endangered or threatened in Michigan are afforded legal protection as detailed in Act No. 203, the Endangered Species Act of 1974. Listing of animals as rare/watch or peripheral is an unofficial way of drawing attention: (1) to species which should be monitored as they are rare and/or declining in the State and may become threatened in the future, and (2) to species, which, although very rare in Michigan, are here at the periphery of their range and are reasonably common elsewhere. These last two categories, rare/watch and peripheral, might be lumped under the heading "special concern" as has been done for plants and in some other states for animals (e.g., Indiana).

A cursory examination of Appendix D reveals, not surprisingly, a rough equivalency between the overall element priority rank and the proposed State status for each animal species (excluding Lepidoptera which have not been ranked) as outlined below.

| | Overall Element Priority Rank | | | | | | |
|---|---|---|---|---|---|---|---|
| Proposed State Status | A1 | A2 | B1 | B2 | B3 | BU | AX/BX/C/D |
| Endangered (23) | 1 | 5 | 7 | 6 | | | 4 |
| Threatened (22) | | | 1 | 4 | 15 | 2 | |
| Rare/Watch (44) | | 1 | 1 | | 2 | 8 | 32 |
| Peripheral (42) | | | | | | | 42 |

As can be seen, the overall element priority rank serves to fine-tune the proposed state status, especially for proposed endangered species.

The present status and conservation needs for each of the groups of MNFI-listed animals (not Lepidoptera) are discussed in the next sections.

## Mammals

Mammals, proportionally, have suffered the greatest loss of species of any group of vertebrates in the State. Seven species, as a result of uncontrolled hunting/trapping, have been extirpated from Michigan in the last 200 years, including the following:

* Marten (Martes americana)
* Fisher (Martes pennanti)
  Wolverine (Gulo gulo)
  Mountain Lion (Felis concolor)
* Elk (Cervus elaphus)
  Caribou (Rangifer tarandus)
  Bison (Bison bison)

Three of these seven species, marked with an asterisk, have apparently been successfully reintroduced into the State. The Michigan Natural Features Inventory (MNFI) is collecting occurrence information on two of these species, marten and elk. The marten is state-threatened because of low population size and uncertain success of the most recent (1980-81) of three reintroduction attempts for this species in the Upper Peninsula. The fisher, reintroduced into western Upper Peninsula counties in the early 1960's, is now apparently fairly common in the western Upper Peninsula and is spreading eastward. Seven elk, derived from stock largely imported from western Wyoming, were released in 1918 in the Pigeon River State Forest. This small planting apparently gave rise to the present Pigeon River "herd" of approximately 600 animals. This herd has numbered as high as 3500 animals and was the subject of a controlled harvest in 1964-65 (Moran, R. J. 1973. The Rocky Mountain Elk in Michigan. Mich. DNR, Res. and Dev. Rept. No. 267).

Three other mammals, gray wolf (Canis lupus), lynx (Felis lynx), and moose (Alces alces), formerly occurred throughout the state but have been nearly eliminated. A protected and closely monitored population of approximately 14 wolves occurs on Isle Royale. A reintroduction attempt on the Michigan mainland in 1974 failed due to illegal persecution, but recent track sightings in the western Upper Peninsula and extreme eastern Chippewa County indicate that wolves may yet reestablish themselves from neighboring packs in Wisconsin and Ontario. Moose, similarly, occur on Isle Royale and sporadically on the Michigan mainland. In recent years, repeated track sightings in several areas in the eastern Upper Peninsula indicates the existence of at least eight small population nuclei. Increased protection from illegal shooting and, possibly, reintroductions into areas of favorable habitat with low deer (and brainworm) populations may be necessary to ensure this species' future presence on the Michigan mainland. No known populations of lynx exist in Michigan at present, although reports of scattered individuals persist, especially following snowshoe hare population crashes in adjacent Ontario every 11 years or so.

In addition to the wolf, Michigan's other federally endangered mammal is the Indiana bat (Myotis sodalis). This species, evidenced from recent summer records of lactating females, probably nests colonially in relatively undisturbed riparian situations throughout the southern four tiers of counties. To date, however, we have no records of summer nursery sites. This species is primarily threatened by the loss of suitable winter hibernacula, outside Michigan; but loss of breeding habitat may also be a contributing factor to this species decline.

The other MNFI listed mammals, all ranked no higher than "C," are either habitually rare (hoary bat, Lasiurus cinereus) or they occur in Michigan on the periphery of their ranges and are common outside the State in the main portion of their ranges. These latter species include smoky shrew (Sorex fumeus), least shrew (Cryptotis parva), eastern pipistrelle (Pipistrellus subflavus), evening bat

(Nycticeius humeralis), prairie vole (Microtus ochrogaster), and woodland vole (Microtus pinetorum). The smoky shrew was first discovered in the State in 1981 by the MNFI zoologist. Five other mammals, listed below, also reach the edge of their ranges near the Michigan border, but these five species have not yet been recorded in Michigan.

Hairy-tailed Mole (Parascalops breweri)
Small-footed Myotis (Myotis leibii)
Franklin's Ground Squirrel (Spermophilus franklinii)
Heather Vole (Phenacomys intermedius)
Rock Vole (Microtus chrotorrhinus)

Two mammal species, currently listed as state threatened, but proposed for removal from the State list, have been found recently to be more common than recently believed. Research conducted by the MNFI zoologist and others have demonstrated that the southern bog lemming (Synaptomys cooperi) is an uncommon, albeit difficult to trap, resident throughout the State. Additional research, initiated by the MNFI and co-sponsored by the Living Resources Program, has more than tripled the number of known localities for the pigmy shrew (Sorex hoyi) in Michigan's Lower Peninsula.

**Birds**

The highest priority MNFI-listed vertebrate is a federally endangered, "A2" species which nests only in Michigan, the Kirtland's warbler (Dendroica kirtlandii). After declining from 432 and 501 singing males counted in the 1951 and 1961 decennial censuses, respectively, to a low of 167 in 1974, the birds have been making a gradual comeback, due in large part to intensive management, including selective habitat burning and cowbird control, by state and federal personnel. In 1981, 232 singing males were counted in 21 noncontiguous colonies, with the four largest colonies, all former burns, containing 62.5 percent of the singing males. For the MNFI data base, the ecological boundaries of all colonies were delineated through the use of 1:24,000 color infrared aerial photos. Continued management will be necessary to ensure this species survival.

The second highest priority bird is the peregrine falcon (Falco peregrinus), also a federally listed endangered species. Peregrines are known to have nested at eight eyries (predatory bird nesting sites) in Michigan, most recently in the early 1970's along the shore of Lake Superior. This is the last known natural nesting of this species east of the Mississippi. This species is the object of an ongoing study, coordinated by the MNFI and funded by the U.S. Fish and Wildlife Service, to determine if and where peregrines might still nest in Michigan. All historic and 17 additional potential cliff nesting sites will be checked in 1982. Despite reports in recent years of summering birds, it is unlikely that any nesting peregrines will be found. A number of sites in the State, however, would be very suitable for reintroduction attempts which have been successfully carried out in several eastern states.

Table 4 summarizes the status and conservation needs of the six highest priority birds, including four species which have all declined seriously in recent years and are state proposed endangered: greater prairie chicken, piping plover, barn owl, and loggerhead shrike.

Table 4.

| Species | Rank | # Currently Known Active Michigan Breeding Sites | Estimated 1981 State Wide Population (# Individuals) | Probable Factors Causing Decline | Conservation Needs* |
|---|---|---|---|---|---|
| Kirtland's Warbler, Dendroica kirtlandii | A2 | 21 | 460 | winter weather, habitat loss, cowbirds | habitat mgmt., cowbird control, research |
| Peregrine Falcon, Falco peregrinus | B1 | 0 | 0 | pesticides | reintroduction |
| Piping Plover Charadrius melodus | B1 | 14 | 36 | human disturbance, habitat loss | restrict human access to nest-beaches, habitat protection |
| Greater Prairie Chicken, Tympanuchus cupido | B2 | 1 | 20 | habitat loss, farming practices, predation, competition? | habitat conservation/ management, predator management |
| Barn Owl, Tyto alba | B2 | 1 | 20 | shortage of suitable nest sites, habitat loss | nest box provision in areas of suitable habitat |
| Loggerhead Shrike, Lanius ludovicianus | B2 | 1 | 40 | pesticides, habitat loss, winter weather? | inventory, research |

*In addition to continued careful population monitoring.

Table 5 summarizes the status of eight medium-priority (B3) species, all proposed state threatened, and one "BU" species, the black-crowned night heron.

Table 5.
Status of medium priority (B3) birds in Michigan

| Species | # Currently Known Active Michigan Breeding Sites (* = Estimated) | Estimated 1981 Statewide Population (# pairs) | Recent Population Trends |
|---|---|---|---|
| Double-crested Cormorant Phalacrocorax auritus | 8 | 356 | rapidly increasing (700% since 1978) |
| Bald Eagle, Haliaeetus leucocephalus | 111 | 105 | stable through 1970's; increased in 1981 |
| Osprey, Pandion haliaetus | 101 | 125 | increasing since 1976 |
| King Rail, Rallus elegans | 10 * | 100 | decreasing |
| Common Tern, Sterna hirundo | 43 | 2100 | stable over last 4 years; down since early 1960's |
| Caspian Tern, Sterna caspia | 5 | 1900 | stable |
| Short-eared Owl, Asio flammeus | 10 * | 100 | decreasing? |
| Lark Sparrow, Chondestes grammacus | 0 | 10 | decreasing |
| Black-crowned Night Heron Nycticorax nycticorax | 4-11 | 200 | ? |

For these species, there is a critical need for up-to-date information on populations statewide. Eagles and ospreys are routinely inventoried every year by state and federal personnel. In 1982, the MNFI will coordinate a statewide inventory of cormorants, black-crowned night herons, and common and caspian terns. Information is also being sought on king rails and short-eared owls, birds whose current status is not well understood. Lark sparrow, formerly a widespread and uncommon nesting species in the lower four tiers of counties, may be extirpated from Michigan.

Other MNFI listed birds (Appendix D) includes species which are thought to be declining but are still relatively common in comparison with the species discussed previously. These included common loon (Gavia immer) and red-shouldered hawk (Buteo lineatus). Although occurrence information is

accumulated for these species, the data is not processed into the MNFI map or computer files at present.

Other MNFI listed birds include habitually rare nesting species showing no strong evidence of recent declines, including yellow rail (Coturnicops noveboracensis) and long-eared owl (Asio otus).

A final category of MNFI listed birds includes peripheral species which are each known currently from five or fewer nesting sites in the State. These species, some of them recent immigrants to Michigan, are often common in the main portion of their ranges and would not be candidates for "threatened" or "endangered" status in Michigan. Nevertheless, because of their restricted distribution in the State, they are species of interest.

The 5-year Michigan Breeding Bird Atlas, with which the MNFI will share information, will get underway in 1983. The Atlas project is expected to add substantially to our knowledge of breeding bird distributions in the State. Additional "peripheral" species such as cattle egret (Bubulucus ibis), black rail (Laterallus jamaicensis), summer tanager (Piranga rubra), and blue grosbeak (Guiraca caerulea) may be found to be nesting in Michigan, and the status of rare and declining species should be further clarified.

**Reptiles and Amphibians**

Only two "herps" (reptiles/amphibians) are currently proposed for state listing: the copperbelly water snake (Nerodia erythrogaster neglecta) and the Kirtland's snake (Clonophis kirtlandi). Known historically (1933-81) from six scattered localities in the lower three tiers of counties, the copperbelly water snake has only been collected at one location in the State since 1963, a pond on the Ohio border where the snake is subjected to collecting pressure. This species is now considered threatened elsewhere in its limited and discontinuous midwestern range.

Kirtland's snake is known historically (1879-1981) from ten localities in the lower three tiers of counties but has only been collected twice in Michigan since 1965. A 1981 specimen was brought into a high school biology teacher in Benton Harbor who happened also to be working under contract to the MNFI. This snake is particularly difficult to census as it lives underground much of the year, often hiding in crayfish burrows and coming out at night to feed. It is normally collected only in the spring months when it may be found hiding under cover, ofter near small streams, marshes, or ditches. Inventory work, especially in the relatively unknown biologically, lower tier of counties, is needed in order to identify sites for both the copperbelly water snake and Kirtland's snake.

Currently state threatened but proposed for de-listing is the eastern fox snake (Elaphe vulpina gloydi) and the black rat snake (Elaphe obsoleta obsoleta). The black rat snake still occurs fairly commonly in the southern tier of counties and is common in the bulk of its range south of Michigan. The fox snake has a very limited range in Michigan, Ohio, and Ontario, where it occurs only in marshes adjoining the Great Lakes and inland only along the Shiawassee and Saginaw rivers. Recent survey work by the Ohio and Michigan Heritage Programs has revealed significant protected populations of this species at a number of sites in both states. Over 20 populations are now thought to be extant in Michigan. Periodic monitoring of these populations will be necessary to ensure their protection against threats such as collecting for the pet trade.

Occurrence information is accumulated by the MNFI for three species of turtles: spotted turtle (Clemmys guttata), wood turtle (Clemmys insculpta), and eastern box turtle (Terrepene carolina carolina). All these species have declined significantly in the State in the face of habitat destruction and collecting, but all these species are still sufficiently widespread and even locally common to preclude intensive inventory and/or protection efforts at this time.

The other MNFI listed herps (Appendix D) are five peripheral amphibians which are all relatively common in the main parts of their ranges outside of Michigan. No other amphibians are thought to be endangered, threatened, or even rare in Michigan.

"Potentially peripheral" are four additional species of reptiles which occur within 50 miles of Michigan in Indiana but have not yet been recorded in the State. These species are listed below:

Six-lined Racerunner (Cnemidophorous sexlineatus sexlineatus)
Western Slender Glass Lizard (Ophisaurus attenuatus attenuatus)
Eastern Plains Garter Snake (Thamnophis radix radix)
Western Ribbon Snake (Thamnophis proximus proximus)

**Fishes**

Ten of 42 MNFI listed fish species are ciscoes or chubs of the genus Coregonus (Salmonidae). Of 11 currently recognized "species" found in Michigan, two are extinct, two are extirpated, three are locally extirpated or proposed state threatened, two are endemic to one lake each, and two are still common but declining locally. The status of each species is summarized in Table 6.

Despite evidence for some long-standing genetic differentiation within Coregonus, morphological and biochemical variability, much of it environmentally induced, does not support the recognition of more than two species, C. artedii and C. clupaeformis in the Great Lakes basin (T. Todd, G. R. Smith, and others, unpublished). The above named species (Table 6) are thus stocks of uncertain taxonomic status which are somewhat isolated by different spawning times and places. As R. M. Bailey and G. R. Smith (1981. Origin and Geography of the Fish Fauna of the Laurentian Great Lakes Basin. Can. J. Fish. & Aquat. Sci. 38:1539-1561) point out, this taxonomic uncertainty has hampered effective management and conservation of the stocks. Commercial fishermen, converging upon local concentrations of these fish, have caused severe depletions of these local coregonine populations. Depletion of stocks by overfishing causes increased vulnerability to extinction of the now rare forms which tend increasingly to be attracted to, to hybridize with, and to be exploited with common forms spawning at adjacent times or places. This scenario may be the prime reason for the extirpations detailed in Table 6. Prioritization and implementation of effective conservation measures for this important group of fishes will require additional research into the systematics and behavior of the stocks that remain including the local endemic varieties physically isolated in Ives and Siskiwit Lakes.

Two federally endangered fish occur in Michigan, the longjaw cisco (C. alpenae) and the blue pike (Stizostedion vitreum glaucum). Both of these fishes are believed to be extinct. The longjaw cisco's last known occurrence was in Georgian Bay, Ontario in 1975. The blue pike, endemic to and formerly common

Table 6.
The status of Great Lakes coregonid fishes
(adapted from Todd, T., unpublished).

| Coregonus Species | MNFI Rank | State Proposed Status | Comments[1] |
|---|---|---|---|
| C. alpenae | AX | E | Endemic to Great Lakes; extinct; formerly lakes E, H, & M |
| C. johannae | AX | | Endemic to Great Lakes; extinct; formerly lakes H, M |
| C. nigripinnis | BX | E | Extirpated from Great Lakes; formerly Lakes H, M |
| C. reighardi | BX | E | Endemic to Great Lakes; extirpated from Michigan; extant only in Georgian Bay, Lake Huron, Ontario; formerly Lk. M |
| C. bartletti | A2 | R | Endemic to Siskiwit Lake, Isle Royale |
| C. hubbsi | B1 | R | Endemic to Ives Lake, Huron Mountains, Marquette County |
| C. zenithicus | B2 | T | Common in Lake Superior; formerly Lks. H & M |
| C. kiyi | B3 | R | Endemic to Great Lakes; abundant in Lk. S; formerly Lks. O, H, & M |
| C. artedii | BU | T | Common in Lk. Superior and in many inland lakes; declining in Lk. M.; rare in Lk. H.; endangered in Lks. O & E |
| C. hoyi | C | R | Endemic to Great Lakes; abundant in Lk. S.; common in Lks. H & M; extirpated from Lk. O |
| C. clupeaformis | C | | Abundant in Lks. S & M; common in Lk. H.; declining in Lks. O & E |

[1]Great Lakes: E=Erie, H=Huron, M=Michigan, O=Ontario, S=Superior

in Lakes Erie and Ontario, has been considered by some to be a distinct species and by others to be but a color morph of the walleye and unworthy of subspecific status.

Of the 14 fishes proposed as threatened in Michigan, two species are extinct, seven species are large lake or lower river species which are difficult to protect other than by carefully regulating the fishery, and five species are small river/stream fishes. The latter five species are numerically the rarest of the 12 extant listed fishes in Michigan, and they are also perhaps the easiest to protect by controlling upstream sources of siltation and pollution. All five of these species are known in the State only from the southeastern counties. In the last few years, almost all of the major drainages possibly containing or from which there are historic records of these species have been searched (e.g., the Clinton, Huron, and Raisin drainages). The Maumee drainage, which enters Michigan in Monroe, Lenawee, and Hillsdale counties and for which there are historic (pre-1950) records for four of these species (Table 7), is the only major recently

unsurveyed drainage system which might still retain these listed species. With the financial assistance of Michigan's Living Resources Program, the MNFI will coordinate a fish survey of the Michigan tributaries of the Maumee in the summer of 1982.

Table 7.
Records of nine rare Michigan fishes.

| Species | MNFI Rank | State Proposed Status | Current Michigan Distribution and Recent Collections |
|---|---|---|---|
| Northern Madtom, Noturus stigmosus | B1 | E | A short stretch of the Huron River; one 1978 specimen from the Detroit River. |
| Bigeye Chub, Hybopsis amblops | B2 | E | Tributaries of the Maumee River in Hillsdale & Lenawee counties?, not collected since 1941 in Michigan. |
| Eastern Sand Darter, Ammocrypta pellucida | B2 | T | Five short stretches of the Huron River; possibly Lk. St. Clair & Maumee tributaries. |
| Lake Sturgeon, Acipenser fulvescens | B3 | T | Statewide but locally common only in Cheboygan County. |
| Redside Dace, Clinostomus elongatus | B3 | T | One specimen in 1970 from upper Rouge where probably now extirpated; possibly Maumee tributaries. |
| River Redhorse, Moxostoma carinatum | B3 | T | One specimen from lower Grand River in 1978. |
| Channel Darter, Percina copelandi | B3 | T | Lake Huron drainages, but no records since 1957. |
| Pugnose Shiner, Notropis anogenus | BU | R | Locally in the northern L.P.; 36 historic L.P. occurrences, but since 1964 only in Cheboygan County. |
| Silver Shiner, Notropis photogenis | BU | T | A short stretch of the Raisin R., and possibly tributaries of the Maumee. |

The MNFI also manages information on an additional 5 fish species which are believed to be declining, and 14 species which occur in Michigan at the periphery of their ranges and are common outside the State in the main portions of their ranges (Appendix D).

## Mollusks

The most diverse freshwater mollusk fauna in the world, over 1000 species, exists in eastern North America. Approximately half of the world's known species of freshwater bivalves (mussels or naiads of the family Unionidae), some 500 species, are endemic to this region. Despite the utilization of enormous quantitites of these mussels for food by Indians and by predators such as muskrats, raccoons, mink, and others, the mussel fauna apparently changed little during the 6-8000 years prior to pioneer settlement. In the past 150 years, however, pollution (agricultural, industrial, domestic), damming, channelization, fish management, and commercial over-harvesting for the button and cultured pearl industries have combined to decimate much of the fauna. In the Ohio River system, 40-50 percent of the naiad species are either extinct or in danger of becoming so in the foreseeable future (Stansbery, D. H. 1970. Malacologia 10:9-22).

Mussels are proportionately the most endangered of Michigan's animal species (cf. Table 3), with 21 percent of the fauna considered to be endangered or threatened. Several aspects of naiad life cycles make them especially vulnerable to chemical pollution and siltation (Stein, C. B. 1971. In S. E. Jorgensen and R. W. Sharp, eds., Proceedings of a symposium on rare and endangered mollusks (naiads) of the United States. U.S. Dept. Int., F. & W. Serv., Bur. Sport Fisheries & Wildlife, Twin Cities, MN). Mussels are benthic filter feeders, and those species which are adapted to highly oxygenated riffle areas are particularly sensitive to siltation and pollution. Moreover, they are acutely intolerant of even low levels of potassium (Imlay, M. Ibid). And, although long-lived, most species are obligate parasites on one or more species of fish during their early development, and do not mature for several years.

Table 8 summarizes the status of 11 rarest mussels in Michigan.

All but 1 of the 11 species in Table 8 are known, at least historically, from southeastern Michigan, and 8 of the 11 species are restricted in Michigan to this part of the State. In 1981 and 1982, the MNFI is coordinating efforts to survey key streams in southeastern Michigan for occurrences of rare mussels. With support from the Living Resources Program, several areas will be surveyed in the summer of 1982, and additional funding is being sought from other sources (FWS, Corps of Engineers, etc.). Because of the paucity of field work which has been conducted on mollusks in Michigan since the 1940's, it is crucial to undertake a comprehensive survey of the remaining molluscan fauna of southeastern Michigan. Several species formerly found here are likely to go completely extinct if efforts are not made to identify and protect extant populations. In addition to inventory work, conservation of these species will also require research into their ecological and life history requirements, particularly the identification of host species. Scientists have only begun to investigate the potential of mussels as pollution monitors, and for research in pharmacology, parasitology, etc.

Other mollusks for which the MNFI is collecting information are snails (gastropods). Less well known than the bivalves, this group contains at least two species which are endemic to Michigan. Planorbella multivolvis is an aquatic snail known only from one lake in the Huron Mountains, from which it has not been collected since 1906. We failed to find this species in a search of the shallow waters of the lake in 1981, but it is probably a deep water species and hence difficult to collect. Stagnicola contracta is another deep water endemic

Table 8.
The status of Michigan's endangered, threatened, and rare Unionid mollusks (mussels).

| Species | MNFI Rank | State Proposed Status | Distribution & Status in Michigan |
|---|---|---|---|
| Simpsoniconcha (Simpsonaias), ambigua, Salamander Mussel | A2 | E | SE Michigan; not collected alive in over 50 years. |
| Pleurobema clava, no common name | A2 | E | St. Joseph of the Maumee (Hillsdale Co.); still present in late 1970's. |
| Carunculina (Toxolasma) glans, Little Purple | A2 | E | SE Michigan; now restricted to a short stretch of the Clinton River. |
| Dysnomia (Epioblasma) sulcata, White Cat's Paw Pearly Mussel | A2 | E | SE Michigan; not collected alive in over 50 years. |
| Dysnomia (Epioblasma) torulosa, Northern Riffle Shell | B1 | E | SE Michigan; not collected alive in over 50 years. |
| Anodonta subgibbosa, no common name | B2 | T | Endemic to several lakes in Muskegon & Ottawa counties; questionable species; not collected alive in over 50 years. |
| Villosa fabalis, no common name | B2 | E | SE Michigan; collected alive recently only in the Clinton River. |
| Obovaria subrotunda (leibii), no common name | B3 | T | SE Michigan; collected recently only in Belle River. |
| Dysnomia (Epioblasma) triquetra, Snuffbox | B3 | T | Southern LP; collected at 9 sites in 5 drainages in past 30 years. |
| Cyclonaias tuberculata, Purple Warty- or Pimple-back | BU | R | Southern LP; collected at 2 sites in past 30 years. |
| Lampsilis fasciola, no common name | BU | R | SE Michigan; collected at 12 sites in 5 drainages in past 30 years. |

snail, known only from four lakes in the northern Lower Peninsula. An additional four aquatic snails and seven land snails are thought to be rare and/or declining in the southern Lower Peninsula (van der Schalie, H. 1975. An ecological approach to rare and endangered species in the Great Lakes region. Michigan Academician 8:7-22.).

## Geomorphic/Geologic Features

Inventory efforts by MNFI have located approximately 275 occurrences of unique or exemplary geomorphic and geologic features in Michigan. Occurrence data were first compiled from literature (especially Dorr, J. A. and D. F. Eschman. 1970. Geology of Michigan. University of Michigan Press, Ann Arbor.), then additional recommendations and information were solicited by letter and interview from experts, primarily educators, throughout the state. Many occurrences in the Inventory represent sites used by these educators to demonstrate geologic principles, processes, and products to their students, and are therefore of proven value for education and study.

Large size is a characteristic peculiar to many geologic element occurrences which not only complicates the inventory procedure -- especially boundary definition -- but precludes preservation by standard methods. However, landforms of such dimensions are generally not fragile, and the goal of inventory and evaluation may be to simply call attention to their exemplary nature and educational value, rather than to actively protect them. For instance, roadside pulloffs with interpretive signs are particularly effective in calling attention to outstanding vantage points from which classic geologic features can be observed. This serves both to publicly mark the features as unique and valuable, and to increase public awareness, appreciation, and understanding of natural values and diversity in general.

We attempted to collect information on exemplary occurrences of all elements in the classification. However, because some are obviously widespread and common in the state, and others very restricted and unusual, we concentrated inventory efforts on the latter. For example, for relatively common features (moraines, outwash, meanders), we solicited recommendations only of particularly outstanding examples, but we sought information on all exemplary occurrences of relatively rare features (karst, drumlins, spits, tombolos). It was typically left to the recommender's discretion as to what constitutes an "exemplary" occurrence.

Based on the inventory, two occurrences rank as significant on a worldwide scale. One is the Mason Esker, once 20 miles in length, but mined so extensively for gravel that virtually the only remaining portions lie in a municipal cemetery and golf course in Lansing. This esker (a winding ridge deposited by a river within a glacier) was widely recognized as one of the best-developed in the world, and the unfortunate fact that so little of it remains demonstrates that physical features are not invulnerable to degradation or destruction.

Michigan's other occurrence of worldwide importance is the St. Clair River Delta. The largest freshwater delta in the world, it was mostly formed by glacial meltwaters and is still growing, though at a much slower rate. A considerable portion of it, especially the very wet outer reaches, is in public ownership.

Many occurrences of particular state importance were indicated by the inventory. Seventeen (including the two described above) were identified as some of the most outstanding examples of Michigan's geomorphic and geologic diversity, based on comparison with other occurrences and comments from state experts. They are described below in order of their appearance in the classification.

Delaware Esker (Keweenaw County.) - A linear ridge about two miles long and 200 feet wide with steeply sloping sides, formed from the bed load of a river which flowed inside a glacier.

Mason Esker (Ingham Co.) - Described above.

Irish Hills (Lenawee, Jackson, Washtenaw Cos.) - An area of extensive interlobate kame and kettle topography, characterized by large glacially-built mounds or hills, and deep depressions left by melting glacial ice blocks.

Unnamed kettle (Leelanau Co.) - An inverted cone-shaped glacial kettle over 100 feet deep, probably associated with karst activity (bedrock solution and collapse) beneath the glacial drift. (This site was discovered by MNFI.)

Platte Embayment (Benzie Co.) - The largest and most complex embayment on Lake Michigan, with excellent preservation of previous lake stage features.

Glacial Potholes (Sanilac Co.) - Numerous potholes, up to 20 inches in diameter and two feet deep, in sandstone bedrock.

Sturgeon River Gorge (Baraga Co.) - The best-developed gorge in the State.

St. Clair River Delta (St. Clair Co.) - Described above.

Tawas Spit (Iosco Co.) - An actively-developing complex hooked spit, the largest in Michigan and perhaps in the Great Lakes.

South Manitou Dunes (Leelanau Co.) - An extensive, minimally-disturbed dune complex perched 200 feet above Lake Michigan on a glacial moraine. One of the best-developed in the State and in North America.

Grand Sable Dunes (Alger Co.) - The largest, least-disturbed complex of perched dunes in the State and in perhaps in North America. It also includes areas of windswept gravelly morainal plateau unique in the State.

El Cajon Bay (Alpena Co.) - Contains two underwater sinkholes (created by dissolved and collapsed limestone); the largest is 200 feet in diameter and 80 feet deep, and the source of the State's largest spring.

Bottleneck Sinkhole (Presque Isle Co.) - An hourglass-shaped sink, approximately 100 feet deep, with a waterfall which enters above the bottleneck and falls 80 feet; some dripstone is present.

Fiborn Karst (Mackinac Co.) - Michigan's best developed karst drainage system, with sinkholes, gorges, caves, disappearing and reappearing streams, and underground waterfalls.

Mystery Valley (Presque Isle Co.) - A large karst collapse area (approximately one mile long) with a sinkhole at one end which periodically drains the lake occupying the area. Large bedrock cracks also occur on the valley margin.

Dehring Sinks (Alpena Co.) - Four classic sinkholes with sheer bedrock walls and good exposures of fossiliferous limestone.

Brockway Mountain Overlook (Keweenaw Co.) - An outstanding vantage point for the conglomerate linear ridges of the Keweenaw Peninsula.

Karst (dissolved and collapsed calcareous bedrock) is the only element type determined from the Inventory to be in need of active protection efforts because of the relative rarity, fragility of, and threat to karst features in the State. No high quality karst features are currently in public ownership, and some have suffered damage from refuse dumping. For this reason, karst features were heavily emphasized in the inventory process, as indicated by the five outstanding occurrences listed above.

In terms of preservation, it is noteworthy that 8 of the 17 high-quality occurrences listed above are wholly or substantially in public ownership. Federally-owned areas are the Platte Embayment, South Manitou Dunes, and Grand Sable Dunes. State-owned sites are the Irish Hills (in part), El Cajon Bay, Glacial Potholes (in part), St. Clair River Delta (in part), and Tawas Spit.

Work yet to be done includes assembling more specific information on occurrences identified as outstanding, and also focusing inventory efforts on several categories covered inadequately by the initial inventory (e.g., fossil and mineral sites, unperched dunes).

## Other Natural Features

### Great Blue Heron Rookeries

The first attempted statewide survey of great blue heron rookeries was conducted by the Department of Natural Resources in 1941. Most (91%) of these rookeries have since been destroyed or relocated. The Department's Wildlife Division initiated a new inventory in 1978 by querying wildlife field biologists and accumulating reports. By 1980, this inventory had accumulated information on 119 rookeries whose locations were known to the nearest section (square mile). With supplemental funding from the Living Resources Program, the Natural Features Inventory took over this effort in 1980. Through the use of color infrared (CIR) aerial photos, literature searches, volunteer field workers, and data gleaned from knowledgeable persons, we now have information on 176 rookeries believed to be extant in Michigan. This information is summarized below in Table 9.

Table 9.
Michigan great blue heron rookeries.

| | Number of Rookeries | | | | | |
|---|---|---|---|---|---|---|
| Region | reported to be recently extant | known from DNR surveys of 1941 | known from DNR surveys of 1978 | located on 1978 CIR air photos | with information since 1978 | ground surveyed in 1981 |
| Western U.P. | 30 | 7 | 14 | 18 | 12 | 2 |
| Eastern U.P. | 40 | 15 | 22 | 19 | 28 | 2 |
| Northern L.P. | 52 | 26 | 33 | 25 | 17 | 2 |
| Southern L.P. | 50 | 34 | 50 | 31 | 30 | 14 |
| State Totals | 176 | 82 | 119 | 93 | 87 | 20 |

In May 1980, Michigan Natural Features Inventory (MNFI) discovered a novel technique for precisely locating heronries and mapping them on topographic maps: the use of 1:24,000 color infrared aerial transparencies. On such transparencies, great blue heron nests, generally situated in the canopy, show up under a 3-6 power ocular or stereo-viewer as small white circular dots against a reddish (leafy) background. They can usually be distinguished from other small white dots by their size, shape, raised (canopy) aspect when viewed under a stereoscope, conglomeration in one area, and often, proximity to water. This method underestimates the number of nests in the rookery by 0-88 percent (median = 43%, n = 29), because, from a fixed aerial viewpoint, some nests are invariably obscured by vegetation or other nests, particularly in large rookeries. To date, 93 of 176 known rookeries have been located on the color infrared transparencies, taken in 1977 and 1978 (approximately 32 rookeries have not yet been looked for on the transparencies). One-third of the rookeries could not be located on the color infrared transparencies (cf. Table 9), due to several factors including: (1) poor photo quality, especially overexposures; (2) too few (less than 5) nests actually present to positively identify the rookery against the usual

assortment of other white spots; (3) photos taken in the fall when the leaves lacked chlorophyll, causing additional confusing reflectance; (4) abandoned rookeries; (5) new rookeries. Hence, not finding a rookery on the color infrared aerial transparencies is not cause for considering the site to be abandoned or destroyed.

An effort was made in 1981 to have as many rookeries as possible field surveyed by MNFI's statewide network of volunteers. Due to the lateness of this effort, only a few colonies were surveyed, and those mostly in the southeastern portion of the State where many rookeries are routinely surveyed (e.g., Oakland County).

A concentrated effort is being made in 1982 to survey all known rookeries in the State in order to determine (1) the number of active and inactive nests, (2) exact locations of nest trees, (3) habitat including types and conditions of nest trees, (4) surrounding land use, (5) threats, and (6) landowner sympathies. This information should permit more effective conservation of this important natural resource.

## Migratory Bird Concentration Sites

Twenty-three areas have been identified to date as exemplary migratory bird concentration sites. These areas are listed below (Table 10).

Table 10.
Migratory bird concentration sites of Michigan.

| Location and Site | Notable Species |
|---|---|
| Western U.P. | |
| Brockway Mountain | raptors |
| Eastern U.P. | |
| Whitefish Point | raptors, waterfowl, land birds |
| Garden Peninsula | raptors |
| St. Mary's River | waterfowl |
| Rudyard - Fibre area | sandhill cranes, raptors, owls |
| Limestone | sandhill cranes |
| Ensign | sandhill cranes |
| Birch Farm | sandhill cranes |
| Northern L.P. | |
| Waugoshance Point | shorebirds, land birds |
| Straits of Mackinac | raptors |
| Tawas Point | land birds |
| Nayanquing Point Wildlife Area | waterfowl, marsh birds |
| Southern L.P. | |
| Fish Point State Wildlife Area | waterfowl, esp. swans |
| Shiawassee National Wildlife Refuge | waterfowl |
| St. Clair River & St. Clair Flats W.A. | waterfowl, gulls |
| Detroit River | waterfowl |
| Pt. Mouillee State Game Area | raptors, waterfowl, shorebirds |
| Woodtick Peninsula & Erie Marsh | waterfowl, raptors, herons |
| Maple River State Game Area | waterfowl |
| Muskegon Wastewater Treatment Lagoons | waterfowl, shorebirds |
| Allegan State Game Area | waterfowl, esp. geese |
| Bernard W. Baker Sanctuary | sandhill cranes |
| Phyllis Haehnle Memorial Sanctuary | sandhill cranes |

## Bat Caves

Only a handful of caves exist in Michigan, and none of these contain significant bat populations. In the copper range of the western Upper Peninsula, bats have taken to hibernating in abandoned copper mines. Four mines have been identified to date as locations of large concentrations of over-wintering bats. At least one mine is estimated to contain up to 200,000 over-wintering little brown myotis (Myotis lucifugus). Other chiroptera using the mines include much smaller numbers of Keen's myotis (Myotis keeni), big brown bats (Eptesicus fuscus), and eastern pipistrelles (Pipistrellus subflavus).

## Champion Trees and Shrubs

The most recent discussion of champion trees and shrubs in Michigan is found in Michigan Trees - A Guide to the Trees of Michigan and the Great Lakes Region (Barnes, B. V. and W. H. Wagner, Jr. 1981. University of Michigan Press, Ann Arbor). Under the heading of "Size and Form," the initial discussion of each species, the authors have included, if known, some of the metrical statistics for each record specimen (e.g., for Pinus strobus, Michigan Big Tree: girth 6.0 m, diameter 192 cm, height 34 m, Keweenaw County).

This information was gathered mainly from the many years' work of Paul W. Thompson (Cranbrook Institute of Science) as embodied in Russell McKee's "Michigan Giants" (1979. Michigan Natural Resources 48:40-47). McKee's article includes locations (sometimes rather vague) and a few other nonmetrical statistics (e.g., crown spread) which Barnes and Wagner chose to omit.

These two sources, plus occasional newspaper and newsletter articles, comprise the basic data from which the MNFI records were transcribed. Local maps and plat books helped narrow down some of the vaguer locations.

Barnes and Wagner (1981), in an important but easily overlooked statement, note that "the girth alone of a tree determines the 'Michigan Big Tree'; the national champion for each species is determined on a point system by adding the girth (inches), the height (feet), and one-fourth of the average crown spread (feet)." In a cautionary conclusion, the authors maintain that gigantism in these woody subjects is the result of extremely favorable growing conditions and (usually) unusual age. Many yard and garden specimens were planted out of their typical, competitive habitat; some, both native and exotic, are quite far from their natural range. A famous example is the national champion northern catalpa (Catalpa specios) on the grounds of the State Capitol Building in Lansing. More true to its type and State, the "Leaning Giant," a white pine, towers over a pristine pocket in the northernmost part of the Upper Peninsula. It is such occurrences that the MNFI will, of course, be most concerned with.

It has been suggested, quite logically, that the reason Michigan has so many champion trees is because so many people are interested in looking for them. Nevertheless, all woody things considered, the statistics will be accepted until disproved. The program will not actively pursue this low priority issue, but rather, once the basic data is entered, will accept changes and modifications as they are passively encountered in the pursuit of more important matters.

The assignment of an ambiguous species to the "tree" or "shrub" category follows that used by Barnes and Wagner. The results follow:

| | |
|---|---|
| National Champion Trees | 52 |
| State Champion Trees | 45 |
| National Champion Shrubs | 17 |
| State Champion Shrubs | 4 |
| Total: | 118 |

## American Chestnut (Castanea dentata) Groves

American chestnut groves are defined as groups or individuals of chestnut trees that originated from plantings outside of their native southeastern Michigan range. Naturally occurring chestnut trees were abundant in southeastern Michigan but today are rare because of the chestnut blight fungus (Endothia parasitica). The disease spread throughout the entire U.S. range in less than 50 years, eliminating the tree as a commercial species. Stump sprouts continue to perpetuate chestnut but the disease usually prevents them from reaching maturity.

Planted chestnut trees are now found throughout the western Lower Peninsula outside of their native range. These "unnatural" occurrences are included in the MNFI because of the number of blight free individuals that they contain and the confirmation in two groves of a hypovirulent strain of the chestnut blight fungus (Table 11). The hypovirulent strain is presently being studied as a possible way to counteract the effects of the virulent strain and allow the tree to develop to maturity.

Table 11.
American chestnut (Castanea dentata) trees in Michigan.

( ) = number of stands within the native range.

| Number of Stands with Trees Less than 6 Inches DBH | | | |
|---|---|---|---|
| No. of Trees in Stand | Blight Free | Blighted | Healing |
| 5 - 30 | 18 (1) | 29 | |
| 31 - 150 | 7 | 11 | |
| 1500 - 3000 | 2 | 1 | |

| Number of Stands with Trees Greater than 6 Inches DBH | | | |
|---|---|---|---|
| No. of Trees in Stand | Blight Free | Blighted | Healing |
| 1 - 3 | 117 (4) | 38 (1) | 14 |
| 4 - 10 | 10 | 8 | 6 |
| 11 - 25 | 7 | 1 | 5 |
| 26 - 50 | 1 | 3 | 1 |

1. Taken from Brewer, L. 1982. The present status and future prospect for the American chestnut in Michigan. Mich. Bot. 21 (in press).

# SUMMARY AND RECOMMENDATIONS

Boreal forests and southern deciduous woods, remnant prairies and sculptered sand dunes, inland lakes and streams by the thousands, the longest freshwater shoreline of any state--Michigan's diverse natural heritage embraces all of these features. Two hundred years of agriculture, industry, and urbanization, however, have greatly altered the character of the land. Scattered in the fragments of our once vast and undisturbed wilderness are relatively undisturbed natural communities, some harboring rare and endangered plant and animal species. But unless we conscientiously catalogue the occurrences of these natural features, they may be unwittingly destroyed. Once destroyed, Michigan's natural areas cannot be fully restored, and their resource potential, their utility for education and research, and their recreational, aesthetic, and cultural values are forever lost to future generations.

To meet this need, the Michigan Natural Features Inventory was established in 1980 as a cooperative effort of the Michigan Department of Natural Resources and The Nature Conservancy. The goal of the Inventory is to develop a continuously updated information base that contains the location and status of the host of natural features on the Michigan landscape, including not only features considered to be endangered, threatened, or of unusual significance, but also best examples of more common natural features. This report marks the completion of an initial two-year pilot period, during which time the Inventory staff has been collecting, condensing, and recording information about hundreds of natural communities, rare plant and animal species, geologic features, and other natural occurrences such as heron rookeries, champion trees, and migratory bird concentration sites. All the information is stored in manual files, on topographic maps, and in a computer.

As a result of the Inventory, Michigan has, for the first time, a single, comprehensive and authorative repository of information on the State's natural diversity. This information is available to public and private conservation agencies, the scientific and educational community, land managers, environmental consultants, developers, planners--to anyone, in fact, who can demonstrate a valid use for the data.

Yet, because of Michigan's size and ecological diversity, this Inventory effort has only begun to adequately survey the natural communities and rare and endangered plant and animal species scattered over the landscape. Moreover, because of the constantly changing, dynamic nature of the communities and species being inventoried (communities change, new discoveries and extirpations occur, and animals move about from year to year), the data must be continually refined and updated to remain current and become increasingly accurate.

Although work still lies ahead, much has been accomplished during the initial two years of the Natural Features Inventory Program's operation. Some of these accomplishments are detailed below.

## A. Scientific Accomplishments

1. Systematic searches were made of all in-state (40+) and the major out-of-state museums and herbaria and of the zoological and botanical literature (800+ articles, books, theses, and unpublished documents) for records of rare plant and animal species and communities.

2. Developed a community classification system and rare lichen, bryophyte, and butterfly/moth (Lepidoptera) lists.

3. Papers detailing our work with natural communities and rare plant and animal species were presented by the three staff scientists at the 1981 and 1982 meetings of the Michigan Academy of Science, Arts, and Letters.

4. Compiled abstracts detailing the status and ecological requirements of the communities and rare species for which the program is inventorying.

5. Identified approximately 275 occurrences of high quality geologic and geomorphic features in the state.

6. Mapped approximately 4300 element occurrences of which approximately 2500 have been computerized for rapid and efficient retrieval of information.

7. Verified in the field the existence or destruction of many of the State's rarest communities and species at locations where they were known to occur in the past (e.g., 600 rare plant occurrences were surveyed during the 1981 field season); attempted successfully to locate new sites for some of these species and communities. The following are some highlights from the field work.

    a. Discovery of a new mammal for the State, only the second new mammal found in the past half century in Michigan.

    b. Finding of two new plant species in Michigan, one of which is new to the contiguous United States.

    c. Discovery of populations of two nationally endangered mollusks (mussels), each species known from less than 20 sites in the past 20 years in their entire ranges.

    d. Finding of one intact inland saline wetland, a community previously unknown from Michigan.

    e. Documentation of 1 very rare alpine community, 4 delta wetlands, 36 prairies, 18 dune communities, 27 mesic southern forests, and many other formerly common but now rare communities.

    f. Verification of the status of many of Michigan's heron rookeries after discovering a novel technique for precisely locating such rookeries through the use of color infrared aerial photographs.

g. Performance of an in-depth natural features inventory of the Clinton River watershed for the U.S. Army Corps of Engineers.

h. Discovery that several believed rare species are more common than previously thought, and vice versa.

## B. Applications and Uses of the Data Base

1. Proposed extensive revision of the current state lists of endangered, threatened, and rare plant and animal species. For plants, status changes were recommended for 103 species (328 currently listed). For animals, 58 status changes were recommended (66 species are currently listed as endangered or threatened) with a net decrease of over 30 percent in the number of animal species considered to be endangered or threatened in Michigan. Ninety-five percent of the proposed changes were accepted by the Technical Advisory Committees for the DNR's Program on Endangered and Threatened Species.

2. Assembled in one central location, data on all known occurrences, past and present, of endangered, threatened, and rare plant and animal species in the State. This information is mapped and largely computerized to permit ready access by government and private decision makers. The information will also be added to the computerized data base of the Michigan Resource Inventory Act, 1979, P.A. 204.

3. Information on occurrences of natural diversity elements has been provided upon request to developers, environmental consultants, and government agencies for use in environmental impact assessment. This information has also been included in the Division of Land Resource Programs' permit coordination and review computer process (CIWPIS) for use in examination of all land/water projects.

4. Program staff have begun working with land managers within the DNR and federal agencies in providing information on the location of occurrences of rare species and exemplary communities on public lands to ensure that management decisions can be based upon the full knowledge of their existence. Staff are also providing data to The Nature Conservancy's Michigan Field Office and to other conservation groups on privately owned areas containing unique features which should be protected.

## C. Public Involvement

1. Hundreds of biologists and knowledgeable individuals throughout Michigan, the Great Lakes region, and elsewhere were contacted to obtain additional information on element occurrences.

2. Public presentations were made to numerous groups including Audubon societies, botanical clubs, university classes, state land management agencies, private conservation organizations, and other interested groups.

3. Produced a brochure and an illustrated 3-panel display to further inform interested citizens about the Inventory.

4. Successfully solicited over 200 volunteers statewide who assisted with the office and field work.

5. Initiated a natural area newsletter (Michigan Natural Area News), sponsored by the Michigan Natural Areas Council, to foster statewide communication on natural area and endangered species preservation among all active individuals and organizations.

**D. Contributions to the National Program**

1. Tested the latest procedures and interactive computer methodology developed by the Conservancy's national office staff to accumulate and store natural diversity information.

2. Developed new formats, since adopted by the Conservancy's national office, for recording museum/herbarium search and field survey data.

## Recommendations

During the two years the Natural Features Inventory has been in operation, it has proven to be one of the most cost-effective and successful of all the state heritage programs. But despite the accomplishments of the Inventory staff to date, much remains to be done. It is simply impossible for a five person staff, even with the assistance of many volunteers and contractees, to completely inventory natural diversity in a state the size of Michigan in just two years. This fact was borne out by the Program's intensive inventory of the Clinton River watershed, which alone yielded over 60 new occurrences for the Inventory's data base. The State's Coastal Management Program recognized the need for additional work along the Great Lakes shorelines and is providing the inventory with $50,000 in 1982 to continue the effort specifically in that area of the state.

Additional inventory work is urgently needed in many areas. Only 25 percent of the occurrences in the Inventory's data base have been confirmed extant in recent years. Thus, verification of the existence or destruction of elements at their historic localities will continue to occupy a considerable portion of the Inventory's staff time.

A breakdown of element occurrences by county (Figures 6 and 7) illustrates considerable variation in the number of occurrences, primarily because of a region's proximity and attractiveness to previous researchers. The greatest number of occurrences is in Keweenaw County, followed by Berrien, Oakland, Kalamazoo, Washtenaw, Marquette, Monroe, and Wayne counties (Figure 6). A particularly strong influence on the distribution of occurrences has been exerted by researchers at the University of Michigan (southeast Michigan), the University of Michigan Biological Station (Straits of Mackinac area), Western Michigan University (Kalamazoo County), the Cranbrook Institute of Science (Oakland County), Northern Michigan University and the Huron Mountain Club (Marquette County), Michigan Technological University (Keweenaw County), and individual

Figure 6. Counties with many element occurrences (computerized as of 14 April 1982).

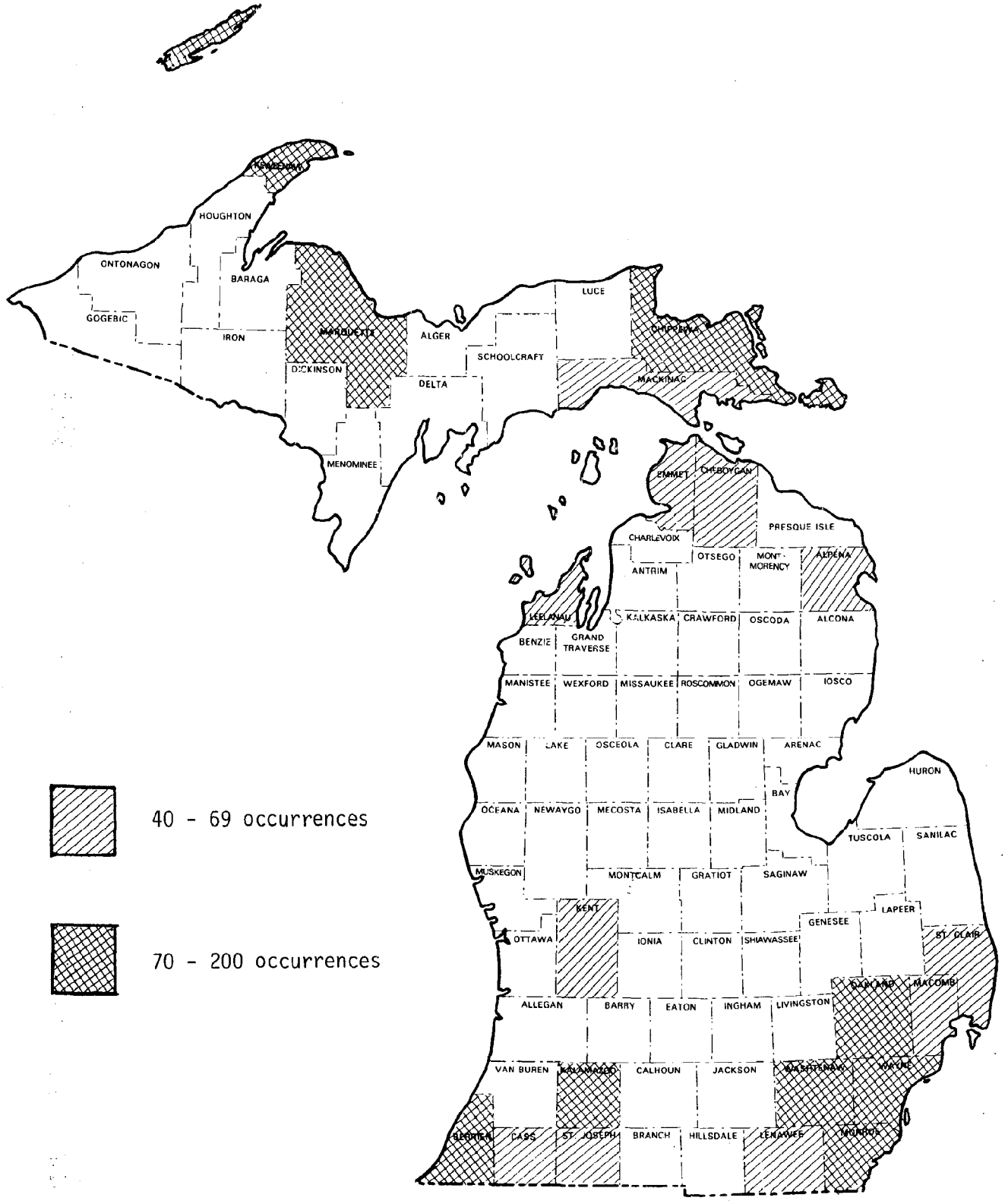
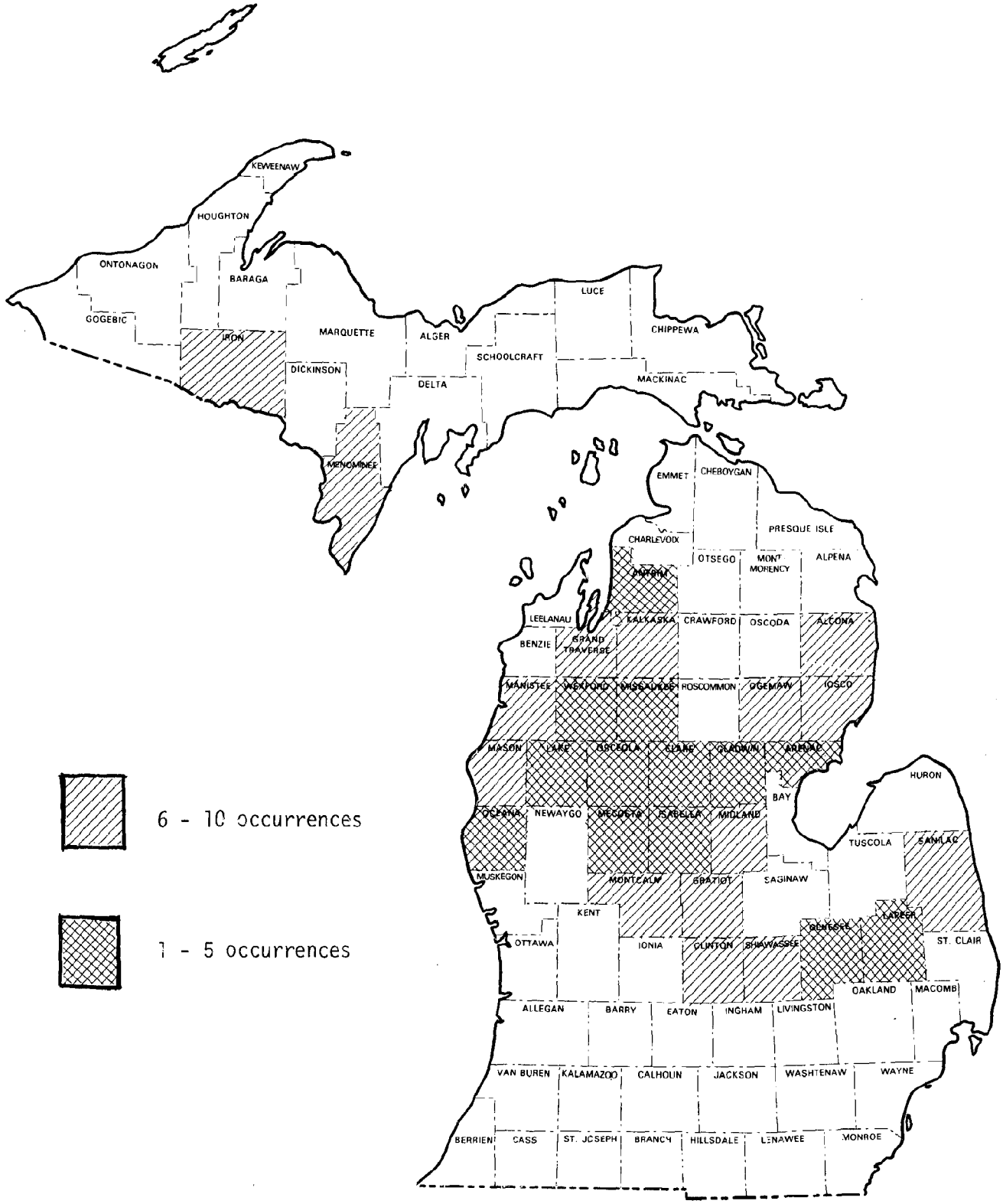


Figure 7. Counties with few element occurrences (computerized as of 14 April 1982).



researchers active in Keweenaw (including Isle Royale) and Berrien counties. Only a few occurrences are recorded in many counties across the middle of the Lower Peninsula and in some Upper Peninsula counties (Figure 7). This paucity of occurrences is more a reflection of inadequate research than of reduced diversity in many of these counties (e.g., Menominee, Antrim, Alcona, and Clare counties). Additional field work in these undersampled areas will undoubtedly add many new occurrences to the Inventory's data base (and result in deletions as some communities and species are found to be less rare than currently believed).

The current status and inventory needs are summarized below for each of the element classes.

## Communities

In general, exemplary, relatively undisturbed communities are rare in Michigan compared to their presettlement distribution. Agriculture, urbanization and lumbering are responsible, in large part, for this reduction. Among the terrestrial and wetland communities, one is believed to be extirpated from the State, three types are limited to only one occurrence, and six others have been reduced to less than five examples of each. Information on 17 additional community types raises concern for their future protection. On the positive side, 15 types appear to be relatively secure and 3 types are preserved in large ecosystem preserves.

Even though significant accomplishments have been made in the identification and prioritization of communities, there is still much work to do. Data should continue to be collected on all types considering that the status of each community may change as new information becomes available. Only 8 out of 45 palustrine and terrestrial natural communities are considered, at this time, to be adequately studied.

The following is a description of communities that are in most need of additional inventory and protection efforts. There should be an intensive regional search for inland saline wetlands and calcareous pavement communities, plus scientific investigations and protection efforts. Inventorying for oak openings should be the single highest priority in Michigan. Combining the activities of searching historic records (original land survey reports and published literature), locating cemeteries established in prairie areas, and using aerial photography will increase the chances that an oak opening will be found. The usual situation that leads to the development of extensive freshwater delta wetlands is rare; therefore, all occurrences within the region should be documented as a first step in protecting this community type. Because of the unique status of Michigan's dune communities, a relatively complete survey of most dune and interdunal wetland occurrences will be conducted during summer, 1982. The discovery of several previously unknown examples of dry and wet prairie during 1981 led to the development of a project to inventory Newaygo County and the Saginaw Bay area for additional occurrences. The data on dry mesic and dry southern forests, grass dominated fen wetlands, wild rice dominated marsh wetlands, and southern swamp wetlands are incomplete, but these types appear to be rare and deserving of additional attention. Information is also needed on oak barrens, boreal forests, and ephemeral wetlands, but not as urgently. At some point, studies of shrublands, bracken grasslands, sinkholes, and caves should be conducted to determine whether they are distinct community types.

The completion of the work that is listed here is a long-term project. During 1982 shoreline and prairie projects will occupy most of the plant ecologist's time. However, future work on the other priorities is just as important to the protection and wise use of Michigan's natural communities.

## Special Plants

Nearly ten percent of Michigan's flora is endangered or threatened with extirpation in the State. Twenty-four species appear to have already been lost, due largely to reduction of natural habitats from extensive development and agriculture. However, two species previously thought extirpated have been recently rediscovered (and protected), and others may be likewise relocated or even re-introduced. As protection efforts become more focused on those species most critically endangered, we are becoming more effective in preventing extirpations and the resulting improverishment of Michigan's flora. Also, our growing understanding of species' biology and habitat requirements greatly facilitates effective conservation programs.

These efforts must be sustained, however, to ensure protection of Michigan's endangered and threatened plant species. Approximately ten high-priority plants have not been recently verified extant in Michigan, and searches need to be conducted for these species. Others need work to determine their validity as distinct taxa; among those are two B1 species, Chamaerhodos nuttallii var. keweenawensis and the Michigan monkey-flower, Mimulus glabratus var. michiganensis, both of which are purported as varieties endemic to Michigan. Taxonomic work is also needed to describe the newly-discovered clubmoss, Lycopodium sp. nov.

Several species almost certainly occur at more sites than our records currently indicate. For instance, the sweet coltsfoot, Petasites sagittatus, was just discovered in a remote and relatively unbotanized part of the central Upper Peninsula, and likely grows at other sites in the general area. Careful correlation of known habitat requirements, topographic maps, aerial photographs, and soil maps would also be likely to locate new stations for kitten tails (Besseya bullii) and the prairie fringed orchid (Habenaria leucophaea).

To detect population trends and possible extirpations of highly sensitive species such as the prairie fringed orchid, Hall's bulrush (Scirpus hallii), and purple spike-rush (Eleocharis atropurpurea), occurrences will need to be monitored by periodic surveys.

## Special Animals

Two hundred years of development have taken their toll on Michigan's fauna. At least 15 vertebrates (3 percent of the fauna) have been extirpated. These include 7 mammals, 1 bird, and 7 fishes. An additional 1 bird, 1 fish, and 3 mussels are probably extirpated. Commercial overexploitation appears to be largely responsible for these losses, but pollution and siltation in our rivers have exerted their toll on the mussels and fish, many of which are restricted to southeastern Michigan where impacts on water quality are most severe. Yet, there is room for cautious optimism. Three of the extirpated mammals have been successfully reintroduced, and attempts will likely be made soon to reintroduce at least two more extirpated species. The problems that beset the ciscos are now better

understood, and enlightened management may prevent further extirpations of these fish. If increased efforts can be made to clean up our rivers, particularly in southeastern Michigan, the mussels and fish that once inhabited these waters may yet persist and repopulate their former habitats. Most importantly, continued funding for research (e.g., inventory, population monitoring), for habitat management (e.g., Kirtland's warbler), and for protection of the best sites for these endangered species is essential to the conservation of Michigan's rare and endangered animals.

At this point in time, continued inventory work is critical. For only 2 (piping plover, Kirtland's warbler) of Michigan's 16 highest priority (A1-B1 ranked) animals do we have reasonably accurate information on the true size and status of populations statewide. For 6 of these species, there are no recorded occurrences in Michigan in over 30 years, primarily because no one seems to have seriously looked for these species. In 1982 and 1983, the Michigan Natural Features Inventory plans to coordinate intensive searches for at least 13 of these 16 priority species, continuing work that was begun in 1981.

The status of most medium priority (B2-B3 ranked) animals is even less well known, but at least 21 of these 26 species will be intensively searched for by MNFI staff, contractees, and volunteers in 1982 and 1983.

**Others**

A statewide heronry inventory, initiated in 1981, will continue. It is planned that all known heronries in the State (approximately 180) will be surveyed in 1982 by volunteers under the direction of the Natural Features Inventory staff.

As records of occurrence for natural diversity elements (exemplary natural communities, endangered, threatened, and rare plant and animal species, and other natural features such as heron rookeries) are continuously accumulated, updated, and refined, the Natural Features Inventory expects to become an increasingly important tool for the protection of natural diversity in Michigan. By expeditiously providing a wide range of users and decision-makers with the information needed to balance maximum protection of our natural heritage with necessary economic development, alternative courses of action can be wisely assessed before commitments are made and conflicts arise. The data base is already used on a daily basis for environmental review by the Department of Natural Resources, by the Department of Transportation, by utilities, etc. Conservation organizations such as The Nature Conservancy are now relying on the Program's data base to identify the finest remaining examples of biological diversity in Michigan.

Finally, it is imperative that the Program be integrated into the Department of Natural Resources with adequate funding to ensure its continuance. The private and federal funds which currently extend the Program until March, 1983 will not be available again. Of the 23 other state "heritage" programs started before 1981, 20 have been incorporated into or are now supported by state government following their initial two year pilot periods, including programs in nearby Ohio, Indiana, and Minnesota. Within state government, these programs have assumed

significant, cost-effective roles in environmental review, in planning, in research (inventory), and as biological clearinghouses for current, up-to-date information on the status of natural diversity in their states. In order to provide these important services, state funding for support of a core staff is essential.

# APPENDIX A

## PROCEDURES FOR DEVELOPING THE COMMUNITY CLASSIFICATION

The following coding structure is used for the Community Classification:

Natural Community Classification

Plant Community Classification

| byte | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Community Type

Cover Type

Cover Class

System

Natural Community

Natural Community Type

Class

CLASS (byte 1)

Class simply means class of element, and for communities is always a "C". Other classes include P=Plants and A=Animals.

NATURAL COMMUNITY CLASSIFICATION

The Natural Community Classification is comprised of the Natural Community Type and the Natural Community.

NATURAL COMMUNITY TYPE (byte 2)

The Natural Community Type is the most general level in the classification and represents habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors. The values for this level in the classification have been standardized. The values, codes, and definitions follow.

| Value | Code | Definition |
|---|---|---|
| Lacustrine | L | Lentic waters of natural topographic depressions lacking persistent emergent vegetation except around perimeter. |
| Riverine | R | Natural lotic waters from source or origin downstream to limits of tidal influence, and bounded by channel bank. |
| Palustrine | P(Q) | Non-tidal perennial wetlands characterized by emergent vegetation. |
| Terrestrial | T(U) | Above ground areas lacking perennial wetlands or standing water. |
| Subterranean | S | Below ground areas. |

Since coding is alphabetic (A-Z minus I and O), the codes in parenthesis are used if there are more than 24 Natural Communities within a Natural Community Type.

NATURAL COMMUNITY (byte 3)

A Natural Community is a distinct and reoccurring assemblage of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment. Natural Communities are characterized and defined by a combination of physiognomy, vegetation structure and composition, topography, substrate, and soil moisture and reaction. A Natural Community is named by its most characteristic features, biotic or abiotic, such as delta wetland, interdunal wetland, mesic southern forest, and limestone pavement.

PLANT COMMUNITY CLASSIFICATION

The Plant Community Classification is coded independently of the Natural Community classification. The PC classification is comprised of System, Cover Class, Cover Type, and Community Type. In the description of the Plant Community classification, the following definitions are used.

Canopy = That portion of the vegetation that first intercepts solar radiation. That portion of the vegetation that is seen when viewed vertically from above.

Canopy Cover = That portion of the ground covered by the canopy. In closed vegetation the canopy cover is always 100%.

Canopy Species = Those species which contribute to the canopy within a stand.

Codominant Species = A species whose relative canopy coverage is 20-49%.

Dominant Species = A species whose relative canopy coverage is 50% or greater.

Growth Forms = The artificial categories into which the plant kingdom is divided in this PC classification. These categories are trees, shrubs, herbs, bryophytes, lichens, and algae.

SYSTEM

The System is based on the structure of the canopy. A major advantage of using structure here is that a stand can be identified to the System without any knowledge of species identification. The following systems along with their codes and definitions are used.

| System | Code | Definition |
|---|---|---|
| Angiosperm Forest | A | All dominants and codominants are angiosperm trees. |
| Gymnosperm Forest | B | All dominants and codominants are gymnosperm trees. |
| Mixed angiosperm - gymnosperm forest | C | All codominants are angiosperm and gymnosperm trees. |
| Mixed tree - non-arborescent canopy | D | Codominants include both trees and species of other growth forms. |
| Mixed non-arborescent canopy | E | Codominants include more than one canopy growth form but no trees. |
| Shrub canopy | F | All dominants and codominants are shrubs. |
| Herb canopy | G | All dominants and codominants are herbs. |
| Bryophyte canopy | H | All dominants and codominants are mosses and/or liverworts. |
| Lichen canopy | H | All dominants and codominants are lichens. |
| Algal canopy | K | All dominants and codominants are algae. |
| Non-vegetated | L | Absolute canopy cover less than approximately 10%. This System is used with Natural Communities which cannot or should not be characterized by Plant Communities, e.g., dunes, beaches, mudflats, cliffs, rock outcrops, etc. |

| | | |
|---|---|---|
| Open water | M | Perennially flooded areas having an absolute canopy cover less than approximately 10%. This System is used with Natural Communities within the Estuarine, Lacustrine, and Riverine Natural Community Types which cannot be characterized by Plant Communities. |

COVER CLASS (byte 5-6)

The Cover Class is derived from and named after the dominant genus or codominant genera in the canopy. The Cover Classes are assigned alphabetic codes, unique to a System. Within a System, up to 576 Cover Classes can be coded (AA, AB, AC....ZZ). It is suggested that when more than three genera are codominant, or there are no dominants or codominants, genera should not be listed in the name but instead called "Mixed," e.g., Mixed Mesophytic, Mixed Hardwoods. Scientific names are always used in naming the Cover Class.

Codominant genera within the same stratum are listed alphabetically and separated by a dash (-) with no spaces. Codominant genera within different strata are listed in order of height and separated by a greater-than sign (>) with no spaces. The Cover Class coding system is open-ended with newly named Cover Classes receiving the next available code within the appropriate System.

COVER TYPE (byte 7-8)

The Cover Type is derived from and named after the dominant or codominant species in the canopy. This rule is followed whenever possible for consistency. There are a few exceptions: (1) If within a dominant genus there are no dominant or codominant species, or there are too many to list conveniently, the Cover Type can be named by using the term "mixed" followed by the name of the genus and, if needed, an ecological modifier. For example, a Mixed Quercus Swamp means that within the Quercus Cover Class there is a Cover Type restricted to swamps where there are many species of oaks, none of which are dominant. (2) When the Cover Class is mixed, a descriptor can be added. For example, the Mixed Hardwoods Cover Class could contain a Mixed Northern Hardwoods Cover Type.

Cover Types are assigned alphabetic codes, unique to a Cover Class. Within a Cover Class, up to 576 Cover Types can be coded. Codominant species within the same stratum are listed alphabetically and separated by a dash (-) with no spaces. Codominant species within different strata are listed in order of height and separated by a greater-than sign (>) with no spaces. The Cover Type coding system is open-ended with newly named Cover Types receiving the next available code within the appropriate Cover Class.

COMMUNITY TYPE (byte 9-10)

The Community Type is the lowest level of the classification and will often require quantitative sampling procedures for its determination. The Community Type represents a homogeneous stand of vegetation developing in an environment whose physical components (soil, topography, micro-climate, etc.) are fairly uniform. Rarely will the Plant Community Classification be standardly subdivided this finely. Often, variation within the Cover Type can simply be

handled in the Element Abstract. The Community Type will be of most importance in regions where canopy vegetation is uniform over large areas.

The name of the Community Type is derived from the names of the dominant or codominant species beneath the canopy, added to the Cover Type names. Occasionally names can include characteristic species. These are species that have low cover (not dominant or codominant) in the stand, but are virtually always present, and are good indicators of that community. Characteristic species can occur within the canopy or beneath it. Characteristic species should be starred (*) in community names. The Community Types are assigned alphabetic codes unique within a Cover Type.

# APPENDIX B

## A CLASSIFICATION OF NATURAL COMMUNITIES IN MICHIGAN

Willard M. Rose
Plant Ecologist
and
Donald H. Les
Aquatic Ecologist
Michigan Natural Features Inventory

C Community

CR Riverine (Watercourses)

- CRA Great Lakes Watercourse
- CRB Coldwater Gravel-Bottom Watercourse
- CRC Coldwater Sand-Bottom Watercourse
- CRD Coldwater Silt-Bottom Watercourse
- CRE Warmwater Gravel-Bottom Watercourse
- CRF Warmwater Sand-Bottom Watercourse
- CRG Warmwater Silt-Bottom Watercourse
- CRH Brownwater Watercourse
- CRJ Spring/Brook Watercourse
- CRK Ephemeral Watercourse
- CRL Waterfall
- CRM Rapids
- CRN Other

CL Lacustrine (Lakes)

- CLA Great Lake
- CLB Inland Oligotrophic Lake
- CLC Inland Mesotrophic Lake
- CLD Inland Eutrophic Lake
- CLE Inland Marl Lake
- CLF Other

CP Palustrine (Wetlands)

- CPA Insular Marsh Wetland
- CPB Insular Swamp Wetland
- CPC Insular Mixed Wetland
- CPD Peripheral Lacustrine Marsh Wetland
- CPE Peripheral Lacustrine Swamp Wetland
- CPF Peripheral Lacustrine Mixed Wetland
- CPG Peripheral Riverine Marsh Wetland
- CPH Peripheral Riverine Swamp Wetland
- CPJ Peripheral Riverine Mixed Wetland
- CPK Ephemeral Wetland
- CPL Oxbow Lake Wetland

CPM Beaver Pond Wetland
CPN Inland Saline Wetland
CPV Freshwater Delta Wetland
CPP Prairie Wetland
CPQ Bog Wetland
CPR Fen Wetland
CPS Interdunal Wetland
CPT Strangmoor Wetland
CPU Other

CT Terrestrial

CTA Mesic Southern Forest
CTB Dry-Mesic Southern Forest
CTC Dry Southern Forest
CTD Mesic Northern Forest
CTE Dry-Mesic Northern Forest
CTF Dry Northern Forest
CTG Boreal Forest
CTH Oak Opening
CTJ Oak Barren
CTK Pine Barren
CTL Alpine Community
CTM Shrubland
CTN Mesic Prairie
CUA Dry-Mesic Prairie
CTP Dry Prairie
CTQ Bracken-Grassland
CTR Great Lakes Dune Community
CTS Beach Community
CTT Sand Barren
CTU Calcareous Pavement Community
CUB Noncalcareous Pavement Community
CTV Calcareous Open Cliff Community
CTW Calcareous Shaded Cliff Community
CTX Noncalcareous Open Cliff Community
CTY Noncalcareous Shaded Cliff Community
CTZ Sinkhole Community
CUZ Other

CS Subterranean

CSA Cave Community
CSZ Other

# A KEY TO THE NATURAL COMMUNTIIES IN MICHIGAN

The term "natural community" refers to biological communities of a natural origin, which have retained their "pre-settlement" characteristics and are relatively unaltered by cultural infuences. Nearly all areas possess some degree of human disturbance. Communities with other superficial impacts (e.g., footpaths, litter, fishing, canoeing, etc.) are still considered to be "natural". More obvious impacts (e.g., dwellings, foundations, non-indigenous plants or animals, stumps, roads, fences, excavations, abandoned agricultural land, etc.) tend to decrease the natural aspect of a community. Areas in which obvious impacts severely detract from the original features of the community are not considered "natural. "

There are four subclasses of the community class recognized in the Michigan Natural Features Inventory. The first three subclasses, Riverine, Lacustrine, and Palustrine, represent "aquatic" communities. An aquatic community is defined as an indicative plant community capable of perpetuating its life cycles and continuing its existence in still or flowing standing water, or upon inundated or non-inundated hydric soils. Riverine refers to communities which occur in watercourses. It has a restricted application to the open water portion of a watercourse, and not to the vegetated margins. A Riverine community is defined as a community which is characterized by channelized, flowing, open water, devoid of vegetation or dominated by submerged vegetation and supportive of few other vegetational types. Examples of watercourses include straits, rivers, streams, creeks, and brooks. Lacustrine refers to communities which occur in lakes. It also has restricted application to the open water portion and not to the shoreline vegetation. A Lacustrine community is defined as a community which is characterized by non-channeled, still, open water, typically exceeding 4.0 meters in depth, dominated by submerged vegetation, and frequently possessing a profundal zone. Lacustrine does not include shallow bodies of water (ponds) which are vegetated throughout, even if the dominant vegetation is submergent. An exception to the definition occurs with bog lakes which, regardless of depth, are included as a portion of the bog wetlands in the Palustrine subclass. Palustrine refers to communities which are commonly referred to as wetlands. A Palustrine community is defined as a community which is characterized by hydric soils, non-inundated or inundated by (usually) less than 4.0 meters of water (except for bog lakes which may be deeper), and dominated by emergent, floating-leaved, free-floating, or submergent vegetation, often a combination of these four types, and never possessing a profundal zone. The fourth subclass, Terrestrial, represents all "upland" communities. A Terrestrial community is defined as a community which is characterized by mesic to dry soils that are never inundated, and incapable of existence under conditions described for aquatic community.

Be aware that a certain amount of discretion is necessary in determining the appropriate subclass for a community. This is also true for using the following key to natural community types:

| | |
|---|---|
| RIVERINE COMMUNITIES: | KEY "A" |
| LACUSTRINE COMMUNITIES: | KEY "B" |
| PALUSTRINE COMMUNITIES: | KEY "C" |
| TERRESTRIAL COMMUNITIES: | KEY "D" |

## KEY A: RIVERINE COMMUNITIES

1.a. Community occuring in the Detroit, St. Mary's or St. Clair rivers.....
.....CRA Great Lakes Watercourse

b. Community occurring inland.....2.

2.a. Community of perennial water regime.....3.

b. Community of an intermittent water regime..CPK Ephemeral Watercourse

3.a. Community occuring in a spring or its brook..CRJ Spring/Brook Watercourse

b. Community not a direct result of the issuance of groundwater.....4.

4.a. Community occurring in a watercourse which is brown-stained due to its presence of dissolved organic acids and similar materials.....
.....CRH Brownwater Watercourse

b. Community in clear water or water colored only by the presence of suspended particulate matter, or colored other than brown.....5.

5.a. Community of waterfalls or rapids.....6.

b. Community in watercourse uninterrupted by waterfalls or rapids.....7.

6.a. Waterfall communities.....CRL Waterfall

b. Rapids communities.....CRM Rapids

7.a. Coldwater communities[1].....8.

b. Warmwater communities[2].....10.

8.a. Substrate predominantly of coarse material (rock & gravel).....
.....CRB Coldwater Gravel-Bottom Watercourse

b. Substrate predominantly of finer materials.....9.

9.a. Substrate predominantly of sand...CRC Coldwater Sand-Bottom Watercourse

b. Substrate predominantly of silt....CRD Coldwater Silt-Bottom Watercourse

10.a. Substrate predominantly of coarse material (rock & gravel).....
.....CRC Warmwater Gravel-Bottom Watercourse

b. Substrate of finer materials.....11.

11.a. Substrate predominantly of sand.....
.....CRF Warmwater Sand-Bottom Watercourse

b. Substrate predominantly of silt.....
.....CRG Warmwater Silt-Bottom Watercourse

[1]Refer to list of coldwater watercourses, Michigan Water Resources Commission, Michigan DNR, designated use maps.

[2]Refer to list of warmwater watercourses, Michigan Water Resources Commission, Michigan DNR, designated use maps.

## KEY B: LACUSTRINE COMMUNITIES

1.a. Community occurring in lakes Erie, Huron, Michigan, Superior, or St. Clair.....CLA Great Lake

b. Community of inland lakes.....2.

2.a. Lakes with an obvious marl character due to severe encrustations on hydrophytes, deep blue color, chemical analysis, or other aspects..... .....CLE Inland Marl Lake

b. Marl character of lake lacking or not apparent.....3.

3.a. Lakes with clear water, predominantly inorganic substrates, and sparce growths of submerged vegetation.....CLB Inland Oligotrophic Lake

b. Lakes with either murky water, relatively organic substrates or considerable growths of submerged vegetation.....4.

4.a. Lakes with clear water, mixed (organic/inorganic) substrates, and a balanced population of submerged vegetation..... .....CLC Inland Mesotrophic Lake

b. Lakes with murky water, predominantly organic substrates and "weedy" growths of submerged aquatic vegetation..CLD Inland Eutrophic Lake

## KEY C: PALUSTRINE COMMUNITIES

1.a. Community specialized (categories CPK-CPT).....2.

b. Community unspecialized (categories CPA-CPJ).....12.

2.a. Community occurring on peat soil.....3.

b. Community occurring on mineral soil.....5.

3.a. Peatland patterned into parallel bands of ridges (strangs) and hollows (flarks) which occur perpendicular to the direction of drainage..... .....CPT Strangmoor Wetland

b. Peatland not patterned in parallel bands.....4.

4.a. Community principally a bog, i.e., dominated by Sphagnum moss and ericaceous shrubs, pH acidic (less than 6), and possessing typical bog species such as carnivorous plants.....COP Bog Wetland

b. Community principally a fen, i.e., dominated by sedges and grasses or non-sphagnum moss, circumneutral or alkaline pH (greater than 6), and possessing typical fen species including carnivorous plants..... .....CPR Fen Wetland

5.a. Community possessing a saline substrate.....CIN Inland Saline Wetland

b. Community entirely on a freshwater substrate.....6.

6.a. Community developing in a beaver dammed impoundment..... .....CPM Beaver Pond Wetland

b. Community origin not due to beaver damming .....7.

7.a. Community developing in a cut-off meander of a riverine system..... .....CPL Oxbow Lake Wetland

b. Community not developing in an oxbow.....8.

8.a. Community developing in a river delta.....CPV Delta Wetland

b. Community not developing in a river delta.....9.

9.a. Community dominated by wet or wet-mesic prairie species..... .....CPP Prairie Wetland

b. Community not dominated by prairie indicator species.....10.

10.a. Community developing between sand dune ridges.CPC Interdunal Wetland

b. Community not developing between sand ridges.....11.

11.a. Community with a history of fluctuation in the water table so that inundation occurs only during some years/seasons and near dryness occurs in other years/seasons.....CPK Ephemeral Wetland

b. Community with an essentially stable hydrological regime.....12.

12.a. (Unspecialized types) Community physically isolated from or not significantly influenced by the proximity of a riverine or lacustrine system (insular types, Figure A.).....13.

b. Community significantly influenced by and adjacent to either a riverine or a lacustrine system (peripheral types, Figures B., C.).....15.

13.a. Vegetation over 75% herbaceous.....CPA Insular Marsh Wetland

b. Vegetation less than 75% herbaceous.....14.

14.a. Vegetation over 75% woody plants.....CPB Insular Swamp Wetland

b. Vegetation a mixture of herbaceous and woody plants.....
.....CPC Insular Mixed Wetland

15.a. Community adjacent to a watercourse (peripheral riverine types, Figure B.).....16.

b. Community adjacent to a lake (peripheral lacustrine types, Figure C).....18.

16.a. Vegetation over 75% herbaceous....CPG Peripheral Riverine Marsh Wetland

b. Vegetation less than 75% herbaceous.....17.

17.a. Vegetation over 75% woody plants. CPH Peripheral Riverine Swamp Wetland

b. Vegetation a mixture of herbaceous and woody plants.....
.....CPJ Peripheral Riverine Mixed Wetland

18.a. Vegetation over 75% herbaceous...CPD Peripheral Lacustrine Marsh Wetland

b. Vegetation less than 75% herbaceous.....19.

19.a. Vegetation over 75% woody plants...CPE Peripheral Lacustrine Swamp Wetland

b. Vegetation a mixture of herbaceous and woody plants.....
.....CPF Peripheral Lacustrine Mixed Wetland

## KEY D: TERRESTRIAL COMMUNITIES

1.a. Mature trees present.....2.

b. Mature trees absent, woody plants, if any, are stunted trees or shrubs....11.

2.a. Trees form a closed forest canopy, greater than 50% cover.....3.

b. Trees form an open canopy, savanna like, less than 50% cover.....9.

3.a. Forests south of the tension zone, hardwood trees only.....4.

b. Forests north of the tension zone, hardwoods dominant with conifers often present or conifers dominant.....6.

4.a. Forests on mesic soils, beech and/or maple often dominant.....CTA Mesic Southern Forest

b. Forests on dry-mesic or dry soils, other species dominant.....5.

5.a. Forests on dry-mesic soils, white oak, red oak, hickory often dominant.....CTB Dry-Mesic Southern Forest

b. Forests on dry soils, other oaks often dominant...CTC Dry Southern Forest

6.a. White spruce and/or balsam fir dominant, forests of far northern counties or Great Lakes shore.....CTG Boreal Forest

b. Other conifers and/or hardwoods dominant.....7.

7.a. Forests on mesic soils, sugar maple, beech, hemlock, and/or yellow birch dominant.....CTD Mesic Northern Forest

b. Forests on dry-mesic or dry soils, pines often dominant, oaks dominant in some cases.....8.

8.a. Forests on dry-mesic soils, white pine often dominant.....CTE Dry-Mesic Northern Forest

b. Forests on dry soils, jack pine, red pine, or hill's oak dominant.....CTF Dry Northern Forest

9.a. North of the tension zone, very dry soils, major tree species is jack pine, shrub understory possible.....CTK Pine Barren

b. Major tree species are oaks, south of or close to the tension zone.....10.

10.a. Mesic or dry-mesic soils, major tree species are bur, white, or black oak often with a prairie component.....CTH Oak Opening

b. Very dry sandy soils, major tree species are hill's or black oak with a dry prairie component or shrub understory.....CTJ Oak Barren

11.a. Closed communities, close to 100% vegetation cover.....12.

b. Open communities, areas of bare sand or exposed rock.....17.

12.a. Shrubs dominant.....13.

b. Grasses dominant, in some cases mixed with bracken fern.....14.

13.a. Exposed tops of mountains, balds, bearberry and horizontal juniper dominant, with stunted trees in scattered clumps.....CTL Alpine Community

b. Other natural shrub areas, blueberry, sweet fern, bearberry, New Jersey tea, sumac dominant.....CTM Shrubland

14.a. North of the tension zone, grasses, such as brome and wild oat grass, and bracken fern codominant.....CTQ Bracken-Grassland

b. South of the tension zone for the most part, grasses dominant.....15.

15.a. Deep mesic soils, big bluestem, indian grass, and/or panic grass dominant[1,2] .....CTN Mesic Prairie

b. Grassland on drier and sandier soil.....16.

16.a. Dry sandy soils, little bluestem dominant[1,2].....CTP Dry Prairie

b. Deeper dry-mesic sandy soils[1,2,].....CUA Dry-Mesic Prairie

17.a. Open sand communities, some mats or clumps of vegetation.....18.

b. Open, exposed rock communities, some mats or clumps of vegetation or extensive lichen communities.....20.

18.a. Inland sand dune area, often fairly level topography, composites and grasses most often dominant, other arid plants common, e.g., prickly pear cactus .....CTT Sand Barren

b. Sand system along the Great Lakes shore, developed as a result of the present lake levels, or strands along inland lakes.....19.

19.a. Area of relatively flat topography, low moist sand in some areas, sea rocket and beach pea common along Great Lakes; in addition, mint family common along inland lakes.....CTS Beach Community

b. Topographical relief as much as 300 feet, beach grass dominant, reed grass, wormwood, wild pea common, shrubs and trees, scattered..... .....CTR Dune Community

20.a. Exposed rock as part of the normal earth surface.....21.

b. Exposed rock below the normal earth surface.....26.

21.a. Near horizontal, exposed bedrock.....22.

b. Near vertical bedrock, cliff and ledge.....23.

22.a. Calcareous substrate.....CTU Calcareous Pavement Community

b. Noncalcareous substrate.....CUB Noncalcareous Pavement Community

23.a. Calcareous substrate.....24.

b. Noncalcareous substrate.....25.

24.a. Forest cover not on or over the cliff...TCV Calcareous Open Cliff Community

b. Shaded by forest cover on or over the cliff.....
.....CTW Calcareous Shaded Cliff Community

25.a. Forest cover not on or over the cliff.....
.....CTX Noncalcareous Open Cliff Community

b. Shaded by forest cover on or over the cliff.....
.....CTY Noncalcareous Shaded Cliff Community

26.a. A hole in the earth's surface, relatively large opening, vertical rock face usually exposed, caused by a cave-in and sinking of the overlaying surface
.....CTZ Sinkhole Community

b. A hollow beneath the earth's surface (Subterranean Community Type), relatively small opening at the surface.....CSA Cave Community

[1]Thompson, P. W. 1975. The floristic composition of prairie stands in southern Michigan. In Wali, M. K. (ed.) Prairie: A Multiple View: The University of North Dakota Press, Grand Forks.

[2]Curtis, J. T. 1959. The Vegetation of Wisconsin. The University of Wisconsin Press, Madison.

# APPENDIX C

## MNFI SPECIAL PLANTS

---

Monocotyledons
Dicotyledons
Pteridophytes
Bryophytes
Lichens

Federal and State status codes are as follows:

| | | |
|---|---|---|
| SE | = | state endangered |
| ST | = | state threatened |
| SC | = | state special concern |
| PE | = | federally proposed endangered |
| C1 | = | federal candidate, category 1 |
| C2 | = | federal candidate, category 2 |

See text for a discussion of MNFI ranking codes.

| Species/Common name | Family | Status/Rank Federal-State-MNFI |
|---|---|---|
| ECHINODORUS TENELLUS<br>DWARF BURHEAD | ALISMATACEAE | ST BX |
| SAGITTARIA MONTEVIDENSIS<br>(AN) ARROWHEAD | ALISMATACEAE | ST |
| COMMELINA ERECTA<br>(A) DAY-FLOWER | COMMELINACEAE | ST BX |
| TRADESCANTIA BRACTEATA<br>(A) SPIDERWORT | COMMELINACEAE | ST |
| TRADESCANTIA VIRGINIANA<br>(A) SPIDERWORT | COMMELINACEAE | SC |
| CAREX ALBOLUTESCENS<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX ARCTA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX ATRATIFORMIS<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX CONCINNA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX CRUS-CORVI<br>(A) SEDGE | CYPERACEAE | ST B2.1 |
| CAREX DAVISII<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX DECOMPOSITA<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX FESTUCACEA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX FRANKII<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX GRAVIDA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX HAYDENII<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX HELEONASTES<br>(A) SEDGE | CYPERACEAE | ST B2.1 |
| CAREX HYALINOLEPIS<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX SUBIMPRESSA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX MEDIA<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX OLIGOCARPA<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX PALLESCENS<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX PLATYPHYLLA<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX RICHARDSONII<br>(A) SEDGE | CYPERACEAE | SC |
| CAREX ROSSII<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX SCIRPOIDEA<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX SEORSA<br>(A) SEDGE | CYPERACEAE | ST |
| CAREX SQUARROSA<br>(A) SEDGE | CYPERACEAE | SC |

| | | | | |
|---|---|---|---|---|
| CAREX STRAMINEA<br>(A) SEDGE | CYPERACEAE | | SC | |
| CAREX SYCHNOCEPHALA<br>(A) SEDGE | CYPERACEAE | | ST | |
| CAREX TRICHOCARPA<br>(A) SEDGE | CYPERACEAE | | SC | |
| CAREX TYPHINA<br>(A) SEDGE | CYPERACEAE | | ST | |
| CYPERUS FLAVESCENS<br>(A) SEDGE | CYPERACEAE | | SC | |
| ELEOCHARIS ATROPURPUREA<br>(A) SPIKE-RUSH | CYPERACEAE | | SE | B2.1 |
| ELEOCHARIS CARIBAEA<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | B2.1 |
| ELEOCHARIS COMPRESSA<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | |
| ELEOCHARIS ENGELMANNII<br>(A) SPIKE-RUSH | CYPERACEAE | | SC | |
| ELEOCHARIS MELANOCARPA<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | |
| ELEOCHARIS TRICOSTATA<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | BX |
| ELEOCHARIS PARVULA<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | B2.1 |
| ELEOCHARIS RADICANS<br>(A) SPIKE-RUSH | CYPERACEAE | | ST | B2.1 |
| FIMBRISTYLIS PUBERULA<br>(A) SEDGE | CYPERACEAE | | ST | |
| FUIRENA SQUARROSA<br>UMBRELLA-GRASS | CYPERACEAE | | ST | |
| HEMICARPHA MICRANTHA<br>(A) SEDGE | CYPERACEAE | | SC | |
| PSILOCARYA SCIRPOIDES<br>(A) BALD-RUSH | CYPERACEAE | | ST | |
| RHYNCHOSPORA GLOBULARIS<br>(A) BEAK-RUSH | CYPERACEAE | | ST | BX |
| RHYNCHOSPORA MACROSTACHYA<br>(A) BEAK-RUSH | CYPERACEAE | | SC | |
| SCIRPUS OLNEYI<br>(A) BULRUSH | CYPERACEAE | | ST | B2.1 |
| SCIRPUS HALLII<br>(A) BULRUSH | CYPERACEAE | | SE | B2.1 |
| SCIRPUS TORREYI<br>(A) BULRUSH | CYPERACEAE | | SC | |
| SCLERIA PAUCIFLORA<br>(A) NUT-RUSH | CYPERACEAE | | ST | |
| SCLERIA RETICULARIS<br>(A) NUT-RUSH | CYPERACEAE | | SE | B2.1 |
| IRIS LACUSTRIS<br>DWARF LAKE IRIS | IRIDACEAE | C1 | ST | B2.1 |
| SISYRINCHIUM ATLANTICUM<br>(A) BLUE-EYED-GRASS | IRIDACEAE | | ST | B2.1 |
| SISYRINCHIUM FARWELLII<br>(A) BLUE-EYED-GRASS | IRIDACEAE | | ST | BX |
| SISYRINCHIUM HASTILE<br>(A) BLUE-EYED-GRASS | IRIDACEAE | | ST | BX |

| | | | | |
|---|---|---|---|---|
| SISYRINCHIUM STRICTUM<br>(A) BLUE-EYED-GRASS | IRIDACEAE | | SC | |
| JUNCUS BRACHYCARPUS<br>(A) RUSH | JUNCACEAE | | ST | |
| JUNCUS BIFLORUS<br>(A) RUSH | JUNCACEAE | | SC | |
| JUNCUS MILITARIS<br>(A) RUSH | JUNCACEAE | | ST | B2.1 |
| JUNCUS SCIRPOIDES<br>(A) RUSH | JUNCACEAE | | ST | |
| JUNCUS STYGIUS<br>(A) RUSH | JUNCACEAE | | ST | |
| JUNCUS VASEYI<br>(A) RUSH | JUNCACEAE | | ST | B2.1 |
| LUZULA PARVIFLORA<br>NO COMMON NAME | JUNCACEAE | | ST | |
| LEMNA VALDIVIANA<br>(A) DUCKWEED | LEMNACEAE | | ST | B2.1 |
| ALLIUM SCHOENOPRASUM<br>CHIVES | LILIACEAE | | ST | |
| CAMASSIA SCILLOIDES<br>WILD-HYACINTH | LILIACEAE | | ST | |
| DISPORUM HOOKERI<br>FAIRY BELLS | LILIACEAE | | ST | B2.1 |
| DISPORUM MACULATUM<br>NODDING MANDARIN | LILIACEAE | | ST | BX |
| POLYGONATUM BIFLORUM VAR. MELLEUM<br>(A) SOLOMON-SEAL | LILIACEAE | | SE | B1 |
| TOFIELDIA PUSILLA<br>(A) FALSE ASPHODEL | LILIACEAE | | ST | |
| TRILLIUM UNDULATUM<br>PAINTED TRILLIUM | LILIACEAE | | ST | |
| TRILLIUM NIVALE<br>SNOW TRILLIUM | LILIACEAE | | ST | |
| TRILLIUM RECURVATUM<br>PRAIRIE TRILLIUM | LILIACEAE | | ST | |
| TRILLIUM SESSILE<br>TOADSHADE | LILIACEAE | | ST | |
| TRILLIUM VIRIDE<br>(A) TRILLIUM | LILIACEAE | | ST | |
| ORCHIS ROTUNDIFOLIA<br>SMALL ROUND-LEAVED ORCHIS | ORCHIDACEAE | | SE | B1 |
| ARETHUSA BULBOSA<br>ARETHUSA OR DRAGON'S MOUTH | ORCHIDACEAE | | SC | |
| CALYPSO BULBOSA<br>CALYPSO OR FAIRY-SLIPPER | ORCHIDACEAE | | ST | |
| CYPRIPEDIUM ARIETINUM<br>RAM'S HEAD LADY-SLIPPER | ORCHIDACEAE | | SC | |
| CYPRIPEDIUM CANDIDUM<br>WHITE LADY-SLIPPER | ORCHIDACEAE | | ST | |
| CYPRIPEDIUM CALCEOLUS VAR. PARVIFLORUM<br>SMALL YELLOW LADY-SLIPPER | ORCHIDACEAE | | SC | |
| ISOTRIA MEDEOLOIDES<br>SMALLER WHORLED POGONIA | ORCHIDACEAE | PE | SE | A2 |
| ISOTRIA VERTICILLATA<br>WHORLED POGONIA | ORCHIDACEAE | | SC | |

| | | | | |
|---|---|---|---|---|
| LISTERA AURICULATA<br>AURICLED TWAYBLADE | ORCHIDACEAE | C2 | SC | |
| HABENARIA UNALASCENSIS<br>ALASKA ORCHID | ORCHIDACEAE | | ST | |
| HABENARIA CILIARIS<br>ORANGE FRINGED ORCHID | ORCHIDACEAE | | ST | |
| HABENARIA FLAVA<br>TUBERCLED ORCHID | ORCHIDACEAE | | SC | |
| HABENARIA LEUCOPHAEA<br>PRAIRIE FRINGED ORCHID | ORCHIDACEAE | C1 | SE | B1 |
| SPIRANTHES CASEI<br>(ONE OF THE) LADIES' TRESSES | ORCHIDACEAE | | SC | |
| SPIRANTHES LUCIDA<br>SHINING LADIES' TRESSES | ORCHIDACEAE | | SC | |
| SPIRANTHES MAGNICAMPORUM<br>(ONE OF THE) LADIES' TRESSES | ORCHIDACEAE | | SC | |
| SPIRANTHES OVALIS<br>LESSER LADIES' TRESSES | ORCHIDACEAE | | ST | |
| SPIRANTHES TUBEROSA<br>LITTLE LADIES' TRESSES | ORCHIDACEAE | | ST | |
| TIPULARIA DISCOLOR<br>CRANEFLY ORCHID | ORCHIDACEAE | | ST | |
| TRIPHORA TRIANTHOPHORA<br>THREE BIRDS ORCHID,NODDING POGONIA | ORCHIDACEAE | | ST | |
| AGROPYRON SPICATUM<br>BLUEBUNCH WHEATGRASS | POACEAE | | ST | BX |
| ARISTIDA DICHOTOMA<br>(A) THREE-AWNED GRASS | POACEAE | | ST | |
| ARISTIDA NECOPINA<br>(A) THREE-AWNED GRASS | POACEAE | | ST | |
| ARISTIDA LONGISPICA<br>(A) THREE-AWNED GRASS | POACEAE | | ST | |
| ARISTIDA TUBERCULOSA<br>(A) THREE-AWNED GRASS | POACEAE | | ST | |
| BECKMANNIA SYZIGACHNE<br>(A) SLOUGH GRASS | POACEAE | | ST | |
| BOUTELOUA CURTIPENDULA<br>SIDE-OATS GRAMA | POACEAE | | ST | |
| BROMUS PUMPELLIANUS<br>(A) BROME GRASS | POACEAE | | ST | |
| CALAMAGROSTIS LACUSTRIS<br>(A) REED GRASS | POACEAE | | ST | |
| CALAMAGROSTIS STRICTA<br>(A) REED GRASS | POACEAE | | ST | |
| UNIOLA LATIFOLIA<br>WILD-OATS | POACEAE | | ST | |
| DANTHONIA INTERMEDIA<br>(A) WILD OAT GRASS | POACEAE | | SC | |
| DIARRHENA AMERICANA<br>(A) GRASS | POACEAE | | ST | |
| PANICUM SPRETUM<br>(A) PANIC GRASS | POACEAE | | ST | |
| PANICUM LEIBERGII<br>(A) PANIC GRASS | POACEAE | | ST | |
| PANICUM MICROCARPON<br>(A) PANIC GRASS | POACEAE | | SC | |

| | | | | |
|---|---|---|---|---|
| DIGITARIA FILIFORMIS<br>(A) GRASS | POACEAE | | ST | BX |
| ELYMUS GLAUCUS<br>(A) WILD RYE | POACEAE | | SC | |
| ELYMUS MOLLIS<br>(A) WILD RYE | POACEAE | | SC | |
| ERAGROSTIS CAPILLARIS<br>(A) LOVE GRASS | POACEAE | | SC | |
| ERAGROSTIS PILOSA<br>(A) LOVE GRASS | POACEAE | | SC | |
| FESTUCA SCABRELLA<br>ROUGH FESCUE | POACEAE | | ST | |
| POA ALPINA<br>(A) GRASS | POACEAE | | ST | B2.1 |
| POA CANBYI<br>(A) GRASS | POACEAE | | ST | B2.1 |
| POA PALUDIGENA<br>(A) GRASS | POACEAE | C2 | SC | |
| MUHLENBERGIA CUSPIDATA<br>(A) MUHLY GRASS | POACEAE | | ST | BX |
| MUHLENBERGIA RICHARDSONIS<br>(A) MUHLY GRASS | POACEAE | | ST | |
| ORYZOPSIS CANADENSIS<br>(A) RICE GRASS | POACEAE | | ST | |
| PANICUM PHILADELPHICUM<br>(A) PANIC GRASS | POACEAE | | SC | |
| PANICUM VERRUCOSUM<br>(A) PANIC GRASS | POACEAE | | ST | |
| PHLEUM ALPINUM<br>MOUNTAIN TIMOTHY | POACEAE | | ST | |
| SPOROBOLUS HETEROLEPIS<br>PRAIRIE DROPSEED | POACEAE | | ST | |
| STIPA COMATA<br>(A) PORCUPINE GRASS | POACEAE | | ST | |
| TRIPLASIS PURPUREA<br>SAND GRASS | POACEAE | | ST | |
| TRISETUM SPICATUM<br>(A) GRASS | POACEAE | | SC | |
| ZIZANIA AQUATICA VAR. AQUATICA<br>(A) WILD-RICE | POACEAE | | ST | |
| ZIZANIA AQUATICA VAR. INTERIOR<br>(A) WILD-RICE | POACEAE | | ST | |
| GLYCERIA ACUTIFLORA<br>(A) MANNA GRASS | POACEAE | | ST | |
| POTAMOGETON CONFERVOIDES<br>(A) PONDWEED | POTAMOGETONACEAE | | ST | |
| POTAMOGETON CAPILLACEUS<br>(A) PONDWEED | POTAMOGETONACEAE | | ST | B2.1 |
| POTAMOGETON HILLII<br>(A) PONDWEED | POTAMOGETONACEAE | C2 | ST | |
| POTAMOGETON LATERALIS<br>(A) PONDWEED | POTAMOGETONACEAE | C2 | ST | BX |
| POTAMOGETON PULCHER<br>(A) PONDWEED | POTAMOGETONACEAE | | ST | B2.1 |
| POTAMOGETON VASEYI<br>(A) PONDWEED | POTAMOGETONACEAE | | ST | |

| | | |
|---|---|---|
| SMILAX HERBACEA<br>(A) CARRION-FLOWER | LILIACEAE | SC |
| RUPPIA MARITIMA<br>DITCH-GRASS | RUPPIACEAE | ST |

| | | | | |
|---|---|---|---|---|
| JUSTICIA AMERICANA<br>(A) WATER-WILLOW | ACANTHACEAE | | ST | |
| RUELLIA HUMILIS<br>(A) RUELLIA OR WILD-PETUNIA | ACANTHACEAE | | ST | |
| RUELLIA STREPENS<br>(A) RUELLIA | ACANTHACEAE | | ST | |
| ERYNGIUM YUCCIFOLIUM<br>RATTLESNAKE-MASTER | APIACEAE | | ST | |
| BERULA PUSILLA<br>CUT-LEAVED WATER PARSNIP | APIACEAE | | ST | |
| OSMORHIZA DEPAUPERATA<br>(A) SWEET CICELY | APIACEAE | | SC | |
| OPLOPANAX HORRIDUS<br>DEVIL'S-CLUB | ARALIACEAE | | ST | B2.1 |
| PANAX QUINQUEFOLIUS<br>GINSENG | ARALIACEAE | | ST | |
| ARISTOLOCHIA SERPENTARIA<br>VIRGINIA SNAKEROOT | ARISTOLOCHIACEAE | | ST | |
| ASCLEPIAS HIRTELLA<br>(A) GREEN MILKWEED | ASCLEPIADACEAE | | ST | |
| ASCLEPIAS OVALIFOLIA<br>(A) MILKWEED | ASCLEPIADACEAE | | ST | |
| ASCLEPIAS SULLIVANTII<br>SULLIVANT'S MILKWEED | ASCLEPIADACEAE | | ST | |
| AGOSERIS GLAUCA<br>PALE AGOSERIS | ASTERACEAE | | ST | |
| ANTENNARIA ROSEA<br>(ONE OF THE) PUSSYTOES | ASTERACEAE | | ST | B2.1 |
| ARNICA CORDIFOLIA<br>HEART-LEAVED ARNICA | ASTERACEAE | | ST | B2.1 |
| ASTER MODESTUS<br>(AN) ASTER | ASTERACEAE | | ST | |
| ASTER NEMORALIS<br>BOG ASTER | ASTERACEAE | | SC | |
| ASTER SERICEUS<br>WESTERN SILVERY (OR SILKY) ASTER | ASTERACEAE | | ST | B2.1 |
| BOLTONIA ASTEROIDES<br>(A) BOLTONIA | ASTERACEAE | | SC | |
| CACALIA PLANTAGINEA<br>PRAIRIE (TUBEROUS) INDIAN-PLANTAIN | ASTERACEAE | | ST | |
| CIRSIUM HILLII<br>HILL'S THISTLE | ASTERACEAE | | SC | |
| CIRSIUM PITCHERI<br>PITCHER'S THISTLE | ASTERACEAE | C1 | ST | B2.1 |
| COREOPSIS PALMATA<br>PRAIRIE COREOPSIS | ASTERACEAE | | ST | |
| ECLIPTA ALBA<br>YERBA-DE-TAJO | ASTERACEAE | | SC | |
| ERIGERON HYSSOPIFOLIUS<br>(A) FLEABANE | ASTERACEAE | | ST | |
| EUPATORIUM SESSILIFOLIUM<br>UPLAND BONESET | ASTERACEAE | | ST | |
| SOLIDAGO REMOTA<br>(A) GOLDENROD | ASTERACEAE | | ST | |
| HELIANTHUS HIRSUTUS<br>(A) SUNFLOWER | ASTERACEAE | | SC | |

| | | | |
|---|---|---|---|
| HELIANTHUS MICROCEPHALUS<br>SMALL WOOD-SUNFLOWER | ASTERACEAE | ST | |
| HELIANTHUS MOLLIS<br>DOWNY (OR SOFT) SUNFLOWER | ASTERACEAE | ST | |
| LACTUCA PULCHELLA<br>(A) BLUE LETTUCE | ASTERACEAE | ST | |
| LIATRIS PUNCTATA<br>(A) BLAZING-STAR | ASTERACEAE | ST | BX |
| PETASITES SAGITTATUS<br>SWEET COLTSFOOT | ASTERACEAE | ST | B2.1 |
| POLYMNIA UVEDALIA<br>LEAFCUP | ASTERACEAE | ST | |
| RUDBECKIA SULLIVANTII<br>(A) CONEFLOWER OR BLACK-EYED-SUSAN | ASTERACEAE | SC | |
| SENECIO CONGESTUS<br>MARSH-FLEABANE | ASTERACEAE | ST | BX |
| SENECIO INDECORUS<br>(A) RAGWORT | ASTERACEAE | ST | |
| SILPHIUM INTEGRIFOLIUM<br>ROSINWEED | ASTERACEAE | ST | |
| SILPHIUM LACINIATUM<br>COMPASS-PLANT | ASTERACEAE | ST | |
| SILPHIUM PERFOLIATUM<br>CUP-PLANT | ASTERACEAE | ST | |
| SOLIDAGO LEPIDA<br>(A) GOLDENROD | ASTERACEAE | ST | |
| SOLIDAGO HOUGHTONII<br>HOUGHTON'S GOLDENROD | ASTERACEAE | ST | B2.1 |
| SOLIDAGO DECUMBENS<br>(A) GOLDENROD | ASTERACEAE | SC | B2.1 |
| TANACETUM HURONENSE<br>LAKE HURON TANSY | ASTERACEAE | ST | |
| JEFFERSONIA DIPHYLLA<br>TWINLEAF | BERBERIDACEAE | SC | |
| MERTENSIA VIRGINICA<br>VIRGINIA BLUEBELLS | BORAGINACEAE | ST | |
| ARABIS MISSOURIENSIS<br>(A) ROCK-CRESS | BRASSICACEAE | SC | |
| ARABIS PERSTELLATA<br>(A) ROCK-CRESS | BRASSICACEAE | ST | |
| ARMORACIA AQUATICA<br>LAKE-CRESS | BRASSICACEAE | ST | |
| BRAYA HUMILIS<br>NO COMMON NAME | BRASSICACEAE | ST | |
| DENTARIA MAXIMA<br>LARGE TOOTHWORT | BRASSICACEAE | ST | |
| DRABA ARABISANS<br>NO COMMON NAME | BRASSICACEAE | ST | |
| DRABA CANA<br>NO COMMON NAME | BRASSICACEAE | ST | B2.1 |
| DRABA INCANA<br>NO COMMON NAME | BRASSICACEAE | ST | |
| SUBULARIA AQUATICA<br>AWLWORT | BRASSICACEAE | ST | |
| OPUNTIA FRAGILIS<br>FRAGILE PRICKLY-PEAR | CACTACEAE | ST | B2.1 |

| | | | |
|---|---|---|---|
| ARENARIA MACROPHYLLA<br>(A) SANDWORT | CARYOPHYLLACEAE | ST | |
| SAGINA NODOSA<br>PEARLWORT | CARYOPHYLLACEAE | ST | |
| SILENE STELLATA<br>STARRY CAMPION | CARYOPHYLLACEAE | ST | |
| SILENE VIRGINICA<br>FIRE PINK | CARYOPHYLLACEAE | ST | |
| STELLARIA CRASSIFOLIA<br>(A) CHICKWEED OR STARWORT | CARYOPHYLLACEAE | ST | |
| STELLARIA LONGIPES<br>(A) CHICKWEED OR STARWORT | CARYOPHYLLACEAE | SC | |
| LECHEA MINOR<br>(A) PINWEED | CISTACEAE | SC | |
| LECHEA LEGGETTII<br>(A) PINWEED | CISTACEAE | ST | |
| CALLITRICHE HERMAPHRODITICA<br>(A) WATER-STARWORT | CALLITRICHACEAE | SC | |
| CALLITRICHE HETEROPHYLLA<br>(A) WATER-STARWORT | CALLITRICHACEAE | SC | |
| CUSCUTA GLOMERATA<br>(A) DODDER | CONVOLVULACEAE | SC | |
| CUSCUTA CAMPESTRIS<br>(A) DODDER | CONVOLVULACEAE | SC | |
| CUSCUTA INDECORA<br>(A) DODDER | CONVOLVULACEAE | SC | |
| CUSCUTA PENTAGONA<br>(A) DODDER | CONVOLVULACEAE | SC | |
| CUSCUTA POLYGONORUM<br>(A) DODDER | CONVOLVULACEAE | SC | |
| LONICERA INVOLUCRATA<br>(A) FLY-HONEYSUCKLE | CAPRIFOLIACEAE | ST | |
| VIBURNUM EDULE<br>SQUASHBERRY OR MOOSEBERRY | CAPRIFOLIACEAE | ST | |
| DROSERA ANGLICA<br>(A) SUNDEW | DROSERACEAE | SC | |
| EMPETRUM NIGRUM<br>BLACK CROWBERRY | EMPETRACEAE | ST | |
| CHIMAPHILA MACULATA<br>PIPSISSEWA OR SPOTTED WINTERGREEN | ERICACEAE | SC | |
| PTEROSPORA ANDROMEDEA<br>PINE-DROPS | ERICACEAE | ST | |
| VACCINIUM ULIGINOSUM<br>ALPINE BLUEBERRY | ERICACEAE | ST | |
| VACCINIUM VITIS-IDAEA<br>MOUNTAIN-CRANBERRY | ERICACEAE | ST | BX |
| AMORPHA CANESCENS<br>LEADPLANT | FABACEAE | SC | |
| BAPTISIA LEUCANTHA<br>WHITE OR PRAIRIE FALSE INDIGO | FABACEAE | ST | |
| BAPTISIA LEUCOPHAEA<br>CREAM WILD INDIGO | FABACEAE | ST | BX |
| PETALOSTEMUM PURPUREUM<br>RED (OR PURPLE) PRAIRIE CLOVER | FABACEAE | ST | BX |
| GYMNOCLADUS DIOICA<br>KENTUCKY COFFEE-TREE | FABACEAE | SC | |

| | | | |
|---|---|---|---|
| STROPHOSTYLES HELVOLA<br>(A) WILD BEAN | FABACEAE | SC | |
| WISTERIA FRUTESCENS<br>WISTERIA | FABACEAE | ST | B2.1 |
| CASTANEA DENTATA<br>AMERICAN CHESTNUT | FAGACEAE | SE | B2.1 |
| GENTIANA ALBA<br>YELLOWISH GENTIAN | GENTIANACEAE | ST | B2.1 |
| GENTIANA LINEARIS<br>(A) CLOSED GENTIAN | GENTIANACEAE | ST | |
| GENTIANA PUBERULA<br>DOWNY GENTIAN OR PRAIRIE GENTIAN | GENTIANACEAE | ST | BX |
| GENTIANA SAPONARIA<br>SOAPWORT GENTIAN | GENTIANACEAE | ST | BX |
| SABATIA ANGULARIS<br>ROSE-PINK | GENTIANACEAE | ST | |
| MYRIOPHYLLUM ALTERNIFLORUM<br>(A) WATER-MILFOIL | HALORAGACEAE | SC | |
| MYRIOPHYLLUM FARWELLII<br>(A) WATER MILFOIL | HALORAGACEAE | ST | |
| PHACELIA FRANKLINII<br>(A) PHACELIA | HYDROPHYLLACEAE | ST | |
| CARYA LACINIOSA<br>BIG SHELLBARK HICKORY OR KING-NUT | JUGLANDACEAE | SC | |
| PYCNANTHEMUM VERTICILLATUM<br>(A) MOUNTAIN-MINT | LAMIACEAE | SC | |
| SCUTELLARIA PARVULA VAR. LEONARDII<br>(A) SKULLCAP | LAMIACEAE | SC | |
| TRICHOSTEMA BRACHIATUM<br>FALSE PENNYROYAL | LAMIACEAE | ST | |
| TRICHOSTEMA DICHOTOMUM<br>BLUE CURLS OR BASTARD PENNYROYAL | LAMIACEAE | ST | |
| LINUM SULCATUM<br>(A) FLAX | LINACEAE | SC | |
| LINUM VIRGINIANUM<br>(A) FLAX | LINACEAE | SC | |
| PINGUICULA VULGARIS<br>BUTTERWORT | LENTIBULARIACEAE | ST | |
| UTRICULARIA INFLATA<br>FLOATING BLADDERWORT | LENTIBULARIACEAE | SE | B2.1 |
| ROTALA RAMOSIOR<br>TOOTH-CUP | LYTHRACEAE | SC | |
| HIBISCUS PALUSTRIS<br>SWAMP ROSE-MALLOW OR MARSH MALLOW | MALVACEAE | SC | |
| RHEXIA VIRGINICA<br>MEADOW BEAUTY | MELASTOMATACEAE | SC | |
| NELUMBO LUTEA<br>AMERICAN LOTUS | NYMPHAEACEAE | ST | |
| NUPHAR MICROPHYLLA<br>(A) YELLOW POND-LILY | NYMPHAEACEAE | ST | |
| NYMPHAEA TETRAGONA<br>(A) WATER-LILY | NYMPHAEACEAE | ST | |
| EPILOBIUM PALUSTRE<br>(A) WILLOW-HERB | ONAGRACEAE | SC | |
| LUDWIGIA ALTERNIFOLIA<br>SEEDBOX | ONAGRACEAE | ST | |

| | | | | |
|---|---|---|---|---|
| LUDWIGIA SPHAEROCARPA<br>NO COMMON NAME | ONAGRACEAE | | ST | B2.1 |
| OROBANCHE FASCICULATA<br>(A) BROOM-RAPE | OROBANCHACEAE | | ST | |
| OXALIS VIOLACEA<br>VIOLET WOOD-SORREL | OXALIDACEAE | | ST | BX |
| ADLUMIA FUNGOSA<br>CLIMBING FUMITORY | FUMARIACEAE | | SC | |
| CORYDALIS FLAVULA<br>PALE CORYDALIS, YELLOW FUMEWORT | FUMARIACEAE | | ST | |
| POLYGALA CRUCIATA<br>(A) MILKWORT | POLYGALACEAE | | SC | |
| POLYGALA INCARNATA<br>PINK MILKWORT | POLYGALACEAE | | ST | B2.1 |
| POLYGONUM CAREYI<br>(A) SMARTWEED | POLYGONACEAE | | ST | B2.1 |
| POLYGONUM VIVIPARUM<br>ALPINE BISTORT | POLYGONACEAE | | ST | |
| RUMEX MARITIMUS<br>GOLDEN DOCK | POLYGONACEAE | | SC | |
| PHLOX BIFIDA<br>CLEFT PHLOX | POLEMONIACEAE | | ST | |
| PHLOX MACULATA<br>WILD SWEET WILLIAM, SPOTTED PHLOX | POLEMONIACEAE | | ST | |
| POLEMONIUM REPTANS<br>JACOB'S LADDER OR GREEK VALERIAN | POLEMONIACEAE | | ST | |
| LITTORELLA AMERICANA<br>NO COMMON NAME | PLANTAGINACEAE | | SC | |
| PLANTAGO CORDATA<br>HEART-LEAVED PLANTAIN | PLANTAGINACEAE | C1 | ST | BX |
| DODECATHEON MEADIA<br>SHOOTING-STAR | PRIMULACEAE | | ST | B2.1 |
| CLEMATIS VERTICILLARIS<br>PURPLE CLEMATIS | RANUNCULACEAE | | SC | |
| HYDRASTIS CANADENSIS<br>GOLDEN-SEAL | RANUNCULACEAE | | ST | |
| RANUNCULUS AMBIGENS<br>(A) SPEARWORT | RANUNCULACEAE | | ST | |
| RANUNCULUS LAPPONICUS<br>LAPLAND BUTTERCUP | RANUNCULACEAE | | ST | |
| RANUNCULUS MACOUNII<br>(A) BUTTERCUP | RANUNCULACEAE | | ST | |
| RANUNCULUS RHOMBOIDEUS<br>PRAIRIE BUTTERCUP | RANUNCULACEAE | | ST | |
| THALICTRUM REVOLUTUM<br>WAXY MEADOW-RUE | RANUNCULACEAE | | ST | |
| THALICTRUM VENULOSUM<br>(A) MEADOW-RUE | RANUNCULACEAE | | ST | |
| CEANOTHUS SANGUINEUS<br>(A) WILD-LILAC | RHAMNACEAE | | ST | |
| CHAMAERHODOS NUTTALLII VAR. KEWEENAWENSIS<br>NO COMMON NAME | ROSACEAE | | SE | B1 |
| CRATAEGUS DOUGLASII<br>(A) HAWTHORN | ROSACEAE | | SC | |
| DALIBARDA REPENS<br>FALSE VIOLET OR DEWDROP | ROSACEAE | | ST | |

| | | | | |
|---|---|---|---|---|
| FILIPENDULA RUBRA<br>QUEEN-OF-THE-PRAIRIE | ROSACEAE | | ST | |
| GEUM TRIFLORUM<br>PRAIRIE SMOKE | ROSACEAE | | ST | |
| GEUM VERNUM<br>(AN) AVENS | ROSACEAE | | SC | |
| PORTERANTHUS TRIFOLIATUS<br>BOWMAN'S ROOT | ROSACEAE | | ST | |
| POTENTILLA PENSYLVANICA<br>(A) CINQUEFOIL | ROSACEAE | | ST | |
| PRUNUS ALLEGHANIENSIS VAR. DAVISII<br>(AN) ALLEGHANY PLUM | ROSACEAE | | SC | |
| RUBUS ACAULIS<br>DWARF RASPBERRY | ROSACEAE | | ST | |
| SANGUISORBA CANADENSIS<br>CANADIAN BURNET | ROSACEAE | | ST | B2.1 |
| POPULUS HETEROPHYLLA<br>SWAMP OR BLACK COTTONWOOD | SALICACEAE | | ST | |
| SALIX PELLITA<br>(A) WILLOW | SALICACEAE | | SC | |
| SALIX PYRIFOLIA<br>BALSAM-WILLOW | SALICACEAE | | SC | |
| PARNASSIA PALUSTRIS VAR. NEOGAEA<br>(A) GRASS-OF-PARNASSUS | SAXIFRAGACEAE | | SC | |
| RIBES OXYACANTHOIDES<br>(A) WILD GOOSEBERRY | SAXIFRAGACEAE | | SC | |
| SAXIFRAGA AIZOON<br>YELLOW MOUNTAIN SAXIFRAGE | SAXIFRAGACEAE | | ST | |
| SAXIFRAGA TRICUSPIDATA<br>(A) SAXIFRAGE | SAXIFRAGACEAE | | ST | |
| GERARDIA GATTINGERI<br>(A) GERARDIA | SCROPHULARIACEAE | | ST | B2.1 |
| BESSEYA BULLII<br>KITTEN TAILS | SCROPHULARIACEAE | C2 | ST | B2.1 |
| BUCHNERA AMERICANA<br>BLUE-HEARTS | SCROPHULARIACEAE | | ST | BX |
| CASTILLEJA SEPTENTRIONALIS<br>(AN) INDIAN PAINTBRUSH | SCROPHULARIACEAE | | ST | |
| CHELONE OBLIQUA<br>PURPLE TURTLEHEAD | SCROPHULARIACEAE | C2 | SE | B2.1 |
| COLLINSIA PARVIFLORA<br>SMALL BLUE-EYED MARY | SCROPHULARIACEAE | | ST | |
| EUPHRASIA ARCTICA<br>EYEBRIGHT | SCROPHULARIACEAE | | ST | |
| GRATIOLA LUTEA<br>HEDGE-HYSSOP | SCROPHULARIACEAE | | ST | |
| LINDERNIA ANAGALLIDEA<br>FALSE PIMPERNEL | SCROPHULARIACEAE | | SC | |
| MIMULUS ALATUS<br>(A) MONKEY-FLOWER | SCROPHULARIACEAE | | ST | |
| MIMULUS GLABRATUS VAR. MICHIGANENSIS<br>MICHIGAN MONKEY-FLOWER | SCROPHULARIACEAE | C1 | ST | B1 |
| AUREOLARIA AURICULATA<br>(A) FALSE FOXGLOVE | SCROPHULARIACEAE | | ST | BX |
| CELTIS TENUIFOLIA<br>DWARF HACKBERRY | ULMACEAE | | SC | |

| | | |
|---|---|---|
| VALERIANA CILIATA<br>(A) VALERIAN | VALERIANACEAE | ST |
| VALERIANELLA CHENOPODIFOLIA<br>(A) CORN-SALAD | VALERIANACEAE | ST |
| VERBENA SIMPLEX<br>(A) VERVAIN OR VERBENA | VERBENACEAE | SC |
| HYBANTHUS CONCOLOR<br>GREEN VIOLET | VIOLACEAE | SC |
| VIOLA LABRADORICA<br>(A) VIOLET | VIOLACEAE | SC |
| VIOLA PEDATIFIDA<br>PRAIRIE BIRD'S-FOOT VIOLET | VIOLACEAE | ST |

| | | | |
|---|---|---|---|
| CRYPTOGRAMMA ACROSTICHOIDES<br>AMERICAN ROCK-BRAKE | POLYPODIACEAE | | ST |
| CRYPTOGRAMMA STELLERI<br>SLENDER CLIFF-BRAKE | POLYPODIACEAE | | SC |
| PELLAEA ATROPURPUREA<br>PURPLE CLIFF-BRAKE | POLYPODIACEAE | | ST |
| ASPLENIUM MONTANUM<br>MOUNTAIN SPLEENWORT | POLYPODIACEAE | | ST BX |
| CAMPTOSORUS RHIZOPHYLLUS<br>WALKING FERN | POLYPODIACEAE | | SC |
| ASPLENIUM RUTA-MURARIA<br>WALL-RUE | POLYPODIACEAE | | ST |
| PHYLLITIS SCOLOPENDRIUM VAR. AMERICANA<br>HART'S-TONGUE FERN | POLYPODIACEAE | C2 | SE B1 |
| ASPLENIUM VIRIDE<br>GREEN SPLEENWORT | POLYPODIACEAE | | SC |
| DRYOPTERIS CELSA<br>LOG FERN | POLYPODIACEAE | | ST |
| DRYOPTERIS ASSIMILIS<br>(A) SHIELD-FERN | POLYPODIACEAE | | SC |
| DRYOPTERIS FILIX-MAS<br>MALE FERN | POLYPODIACEAE | | ST |
| GYMNOCARPIUM XHETEROSPORUM<br>(AN) OAK-FERN | POLYPODIACEAE | | SC |
| WOODSIA ALPINA<br>NORTHERN WOODSIA | POLYPODIACEAE | | ST |
| WOODSIA OBTUSA<br>BLUNT-LOBED WOODSIA | POLYPODIACEAE | | ST |
| WOODSIA X ABBEAE<br>(A) WOODSIA | POLYPODIACEAE | | SC |
| WOODWARDIA AREOLATA<br>NETTED CHAIN FERN | POLYPODIACEAE | | ST BX |
| EQUISETUM TELMATEIA<br>GIANT HORSETAIL | EQUISETACEAE | | ST BX |
| EQUISETUM XLITORALE<br>(A) HORSETAIL | EQUISETACEAE | | SC |
| LYCOPODIUM APPRESSUM<br>(A) CLUBMOSS | LYCOPODIACEAE | | ST |
| LYCOPODIUM COMPLANATUM<br>TRAILING CHRISTMAS-GREEN | LYCOPODIACEAE | | SC |
| LYCOPODIUM SABINAEFOLIUM<br>SAVIN-LEAVED CLUBMOSS | LYCOPODIACEAE | | SE B2.1 |
| LYCOPODIUM SELAGO<br>FIR CLUBMOSS | LYCOPODIACEAE | | SC |
| LYCOPODIUM SP. NOV.<br>(A) CLUBMOSS | LYCOPODIACEAE | | SC B1 |
| OPHIOGLOSSUM VULGATUM VAR. PYCNOSTICHUM<br>SOUTHEASTERN ADDER'S-TONGUE | OPHIOGLOSSACEAE | | ST |
| LYGODIUM PALMATUM<br>CLIMBING FERN | SCHIZAEACEAE | | ST B2.1 |

## Notes on Special Moss List

Special mosses were selected by searching Crum and Anderson (1981), Crum (1976), and Darlington (1964) for species reported from three or fewer Michigan counties and/or described as "rare," "rare and local," etc. Dr. Howard Crum (University of Michigan) was consulted in compiling this list.

Those moss species selected generally fall into one of the four categories listed below. (Before each species name is a number indicating the appropriate category for that species.) Those species that are peripheral and fairly common in areas adjacent to Michigan were not considered.

1) Cordilleran disjuncts

2) Great Lakes region endemics

3) Arctic-boreal disjuncts

4) Species rare throughout their North American ranges

Highest priority species are generally those in category 4 and those disjuncts which are rarest.

Nomenclature follows that of Crum and Anderson (1981).

## References

Crum, H. A. Curator, Cryptogamic Herbarium, University of Michigan. North University Building. Ann Arbor, Michigan 48109.

_____ 1976. Mosses of the Great Lakes Forest. University of Michigan Herbarium, Ann Arbor, Michigan. 404 p.

_____ and L. E. Anderson. 1981. Mosses of Eastern North America. 2 vols. Columbia University Press, New York. 1328 p.

Darlington, H. T. 1964. The Mosses of Michigan. Cranbrook Inst. Sci. Bull. 47. 212 p.

Grout, A. J., ed. 1928-1936. Moss Flora of North America, North of Mexico. 3 vols. Privately published, Newfane, Vermont.

Rare Mosses in Michigan*

4 Barbula michiganensis Steere

This species is reported from one locality in Michigan (Pictured Rocks, Alger County) and from one other site in North America (Chihuahua, Mexico). There is a questionable occurrence in the Northwest Territories of Canada.

4 Barbula reflexa (Brid). Brid.

Occurring in Michigan from Drummond Island, Chippewa County, this species is uncommon throughout its North American range (Newfoundland; Michigan, Ontario, and Vermont to Virginia, North Carolina, and Tennessee; British Columbia, Alberta, and Wyoming).

4 Buxbaumia minakatae Okam.

This "great rarity" has been reported from one locality near Galesburg in Kalamazoo County, Michigan. This occurrence appears to be on the western fringe of its North American range (Massachusetts, Michigan, New York, Nova Scotia, Vermont, Virginia, North Carolina, and Newfoundland).

4 Calliergidium pseudostramineum (C.M.) Grout

This moss has been reported from Delta County, Michigan. Occurrences in Maine, New Hampshire, Labrador, and Alaska are the only other North American reports thus far.

4 Dicranum fragilifolium Lindb.

This "rare" moss occurs on Isle Royale (Keweenaw County) and in Ontario and New Brunswick; Alaska and northwestern Canada to British Columbia, Saskatchewan, and northern Manitoba. Michigan is at the southern edge of its range.

1 Dryptodon patens (Hedw.) Brid.

This disjunct species, reported from Keweenaw and Marquette counties in Michigan, occurs in western North America from the Aleutian Islands and southeastern Alaska to Alberta and south to Oregon, Montana, and California. Elsewhere in eastern North America, it has been reported from Newfoundland.

4 Fissidens exilis Hedw.

In Michigan, this species has been found in Eaton and Washtenaw counties. Described as "rare and local" throughout its range, Fissidens exilis has been reported from Indiana, Kentucky, Maryland, New York, Ohio, and Pennsylvania.

*Compiled largely from Crum and Anderson (1981); all quotations taken from that source. Range descriptions contain only North American localities.

1 Fontinalis neo-mexicana Sull. & Lesq.

In Michigan, this species has been reported from Manistee (?) and Houghton counties, disjunct from its more extensive western range (Aleutian Islands and islands of southeastern Alaska south to California and inland to Alberta, Montana, Colorado, and New Mexico).

1 Grimmia hartmanii Schimp. var. anomala (Hampe ex Schimp.) Monk.

This species, disjunct and "very rare in the Lake Superior region," has been reported from Marquette and Keweenaw counties in Michigan and from Ontario. To the west, in the main part of its range, this moss occurs from southeastern Alaska to Alberta south to California and Colorado.

2 Grimmia hermannii Crum

In Michigan, this regionally endemic moss has been reported from two localities in Keweenaw County. It also occurs in Minnesota and several localities in Wisconsin, suggesting a very limited range in the Great Lakes region.

1 Grimmia tenerrima Ren. & Card.

This montane species has been reported in Michigan from Isle Royale (Keweenaw County). Elsewhere, it occurs in the White Mountains of New Hampshire; Gaspe (according to Grout's Moss Flora); Newfoundland, Greenland, British Columbia to Wyoming, south to California and Colorado.

4 Gyroweisia tenuis (Hedw.) Schimp.

"One of our rarest species," Gyroweisia tenuis has been reported from Marquette and Houghton counties in Michigan. Other scattered North American localities are in Iowa, Canadian Northwest Territories, and Manitoba.

4 Mielichhoferia mielichhoferi (Funck ex Hook.) Loeske

This "unquestionably rare but widely scattered" species has been reported from Alger and Keweenaw counties in Michigan. It ranges south into Labrador, Maine, Ontario, Michigan, New York, Tennessee and North Carolina, Colorado, and British Columbia.

3 Mnium andrewsianum Steere

This arctic species occurs from Greenland to Alaska in the Western Hemisphere, and has been reported far to the south in Colorado, Ontario, and Michigan (Alger County).

1 Orthotrichum alpestre Hornsch. ex BSG

This moss species is disjunct in Michigan (Keweenaw County) from a broad western range (Yukon to California, Arizona, and New Mexico; South Dakota).

1 Orthotrichum pallens Bruch ex Brid.

This Cordilleran western species is found disjunctively in Michigan in Alpena and Keweenaw counties. It ranges throughout the West, from the Yukon to northern Manitoba and south to Colorado and Arizona; Mexico; and scattered in South Dakota, Minnesota, northern Michigan, Ontario, Quebec, and Newfoundland.

1 Orthotrichum rupestre Schleich. ex Schwaegr.

This species has been found on Isle Royale (Keweenaw County), in addition to other Lake Superior localities in Minnesota and Ontario; also single localities in Newfoundland, New Hampshire. Rare eastern North American occurrences of this species are disjunct from a broad western range of southern Alaska and the Yukon south to California and New Mexico and east to South Dakota's Black Hills.

4 Pohlia filiformis (Dicks.) Andr.

This rare montane species occurs in Michigan in Alger, Gogebic, and Keweenaw counties. It ranges from Labrador and New Brunswick to Minnesota, Wisconsin, and Michigan and disjunct to Missouri, south in the mountains through New England, New York, Virginia, North Carolina, and Tennessee; the Aleutian Islands; British Columbia and Colorado; Greenland.

1 Pseudoleskea patens (Lindb.) Kindb.

This alpine species, found in Keweenaw County, Michigan (Lookout Mountain), also occurs sporadically in New Hampshire, Ontario, Newfoundland, and Nova Scotia. It is disjunct from a broad western range including the Aleutians and southeastern Alaska to California and inland to Alberta and Montana.

4 Physcomitrella patens (Hedw.) BSG

This species has been found in Michigan in Wayne County (Crum, pers. comm.). Although widely distributed, it is "uncommon" in eastern North America, from Quebec to Michigan (and, according to Grout, Minnesota), south to South Carolina and Louisiana; British Columbia.

4 Physcomitrium immersum Sull.

Occuring in Washtenaw County (Crum, pers. comm.), this species, "rare and scattered in distribution," ranges from New Brunswick to Minnesota, south to New Jersey, Maryland, Kentucky and Louisiana; Washington, Oregon and Colorado; also from British Columbia and Texas.

4 Schistostega pennata (Hedw.) Web. & Mohr

This species is quite rare within its wide range. In addition to occurring in Michigan (Alger, Gogebic, and Luce counties), it has been reported from British Columbia, Alberta, Washington, Montana, and Newfoundland to Ontario, Michigan, and Wisconsin, south to Rhode Island, New York, and Ohio.

4 Sphagnum pulchrum (Lindb. ex Braithw.) Warnst.

In Michigan, the rare Sphagnum pulchrum has been collected in Mackinac and Emmet counties. It ranges from Newfoundland to Quebec and the Maritime Provinces of Canada, south mainly along the coast to New Jersey, also inland in New Hampshire, New York, Ontario, Michigan, and, according to Andrews, Wisconsin.

4 Sphagnum riparium Angstr.

This species, although scattered and rare, ranges widely from Newfoundland and Labrador across Canada to Alaska south to Connecticut, New York, Michigan (Cheboygan and Emmet counties), Wisconsin, Minnesota, and Washington.

4 Sphagnum subfulvum Sjors

This "scattered and uncommon" species has been reported from Michigan's Upper Peninsula in Luce, Chippewa, and Mackinac (Crum, pers. comm.) counties, New York, Maine, Newfoundland (and reportedly, Greenland), northern Quebec and Ontario, Northwest Territories, and Alaska.

4 Splachnum rubrum Hedw.

This very rare dung moss, probably found only in the range of the moose, occurs on Isle Royale (Keweenaw County) in Michigan, and scattered localities in Alaska, Alberta, Saskatchewan, Ontario, Quebec, New Brunswick, Labrador, Nova Scotia, and Maine.

4 Tetradontium brownianum (Dicks.) Schwaegr.

This "very rare" species has been reported from the Upper Peninsula of Michigan. Other northeastern U.S. and adjacent Canada localities are in Newfoundland, New Brunswick, Prince Edward Island, Maine, New Hampshire, New York, Quebec, Ontario, and disjunct in Washington.

3 Tetraplodon angustatus (Hedw.) BSG

Found in Michigan's Upper Peninsula in Mackinac County (Crum, pers. comm.), this rare species of northern and montane distribution ranges from Greenland and Newfoundland across the continent to Alaska, south to British Columbia, the Great Lakes region, New York and New England.

1 Tortula norvegica (Web.) Wahl. ex Lindb.

This species is widely disjunct in Michigan (Delta County) from its western montane range of southeastern Alaska and the Aleutians to California and inland to Alberta and Colorado.

4 Trichodon cylindricus (Hedw.) Schimp.

"Very rare in eastern North America," Trichodon cylindricus occurs in Michigan's Keweenaw County. It also has been reported from Quebec, New Brunswick, New Hampshire, Newfoundland, and Labrador; arctic Alaska and Yukon south to Oregon and Montana; California.

Compiled by:

Janet Gereau and Susan Crispin
Michigan Natural Features Inventory
15 March 1982

## Rare Mosses of Michigan

(Occurring in 4 - 5 Counties)

4 Bryum uliginosum (Brid.) BSG

Although this species has a broad range, it still is a great rarity in eastern North America. Besides localities in Michigan (Cheboygan, Kalamazoo, Mecosta, and Presque Isle counties), it ranges from Labrador and New Brunswick to Manitoba and south to New York, Ohio, Michigan, Wisconsin, Iowa, and Nebraska, with apparent disjunctions in British Columbia and Colorado (Andrews, in Grout's Flora, gave a broader range).

Sphagnum subnitens Russ. & Warnst. ex Warnst.

Reported from Cheboygan, Emmet, Roscommon, and Keweenaw counties (Mackinac County; Crum, pers. comm.), Sphagnum subnitens occurs in upland New York and, in the West, from British Columbia south to California. (Reports from Greenland to New Jersey may represent S. subfulvum occurrences.)

4 Splachnum ampullaceum Hedw.

In Michigan, this species has been collected in Cheboygan, Emmet, Keweenaw, and Presque Isle counties. This "rare" species ranges from British Columbia, Alberta, and Newfoundland to Ontario and Michigan, south to Pennsylvania, West Virginia, New York, and Massachusetts.

# Lichens

The following list was developed with the assistance of Dr. Henry Imshaug of Michigan State University. Non-vascular plants do not presently have any state or federal designations; MNFI status codes will be assigned when sufficient data has been compiled.

Anzia colpodes (Ach). Stizenb.
Bryoria lanestris (Ach.) Brodo & Hawks. (Alectoria l.)
Cetraria arenaria Karnef.
Cetraria aurescens Tuck.
Cetraria ericetorum Opiz.
Dermatocarpon moulinsii (Mont.) Zahlbr.
Dermatocarpon reticulatum Magn.
Evernia prunastri (L.) Ach.
Heterodermia leucomelaena (L.) Poelt
Hypotrachyna revoluta (Flk.) Hale (Parmelia r.)
Lobaria scrobiculata (Scap.) DC.
Melanelia substygia (Ras.) Essl. (Parmelia s.)
Parmelia stictica (Del.) Nyl.
Parmotrema reticulatum (Tayl.) Choisy (Parmelia r.)
Parmotrema stuppeum (Tayl.) Hale (Parmelia s.)
Physcia phaea (Tuch.) Thom.
Placynthium aspratile (Ach.) Henss.
Platismatia glauca (L.) Culb. & Culb.
Polychidium muscicola (Sw.) S. Gray
Ramalina farinacea (L.) Ach.
Solorina spongiosa (Sm.) Ach.
Stereocaulon pileatum Ach.
Sticta fuliginosa (Dicks) Ach.
Teloschistes chrysophthalmus (L.) Th. Fr.
Teloschistes flavicans (Sw.) Norm.
Usnea angulata Ach.
Usnea rubicunda Stirt.
Xanthoparmelia centrifuga (L.) Hale (Parmelia c.)

Additional species:

Ramalina thrausta (Ach.) Nyl.
Menegazzia terebrata (Hoffm.) Mass.
Umbilicaria torrefacta (Lightf.) Schrad.

Note: Nomenclature follows that of M. E. Hale. 1979. How to Know the Lichens. Wm. C. Brown Co., Dubuque.

# APPENDIX D

## MNFI SPECIAL ANIMALS

For each species, presented by group (mammals, etc.), the scientific and common names, family, federal and state proposed endangerment statuses, and MNFI rank (for ranked species), are presented. Unranked species will mostly be ranked "C" or "D."

Federal and State status codes are as follows:

FE = federally endangered
FT = federally threatened
SE = state endangered
ST = state threatened
SR = state rare/watch
SP = state peripheral

See text for a discussion of these statuses and ranks.

A separate listing of extinct or extirpated species is also provided.

MAMMALS*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| SORICIDAE. Shrews | | | |
| Sorex fumeus Miller, Smoky Shrew | | SP | C |
| Cryptotis parva (Say), Least Shrew | | SP | C |
| VESPERTILIONIDAE. Vespertilionid Bats | | | |
| Myotis sodalis Miller and Allen, Indiana Bat | LE | SE | B1 |
| Pipistrellus subflavus (Cuvier), Eastern Pipistrelle | | SP | C |
| Nycticeius humeralis (Rafinesque), Evening Bat | | SP | C |
| CRICETIDAE. New World Rats and Mice | | | |
| Microtus ochrogaster (Wagner), Prairie Vole | | SP | C |
| Microtus pinetorum (LeConte), Woodland Vole | | SR | C |
| CANIDAE. Canids | | | |
| Canis lupus Linnaeus, Gray Wolf | LE | SE | B1 |
| MUSTELIDAE. Mustelids | | | |
| Martes americana (Turton), Marten | | ST | B3 |
| FELIDAE. Cats | | | |
| Felis lynx Linnaeus, Lynx | | ST | B2 |
| CERVIDAE. Cervids | | | |
| Cervus elaphus Linnaeus, Wapiti or Elk | | SR | C |
| Alces alces (Linnaeus), Moose | | SR | C |

*Names in accordance with: Jones, J. K., Jr., et al. 1979. Revised checklist of North American Mammals North of Mexico, 1979. Occ. Pap. Mus. Texas Tech. Univ. 62:1-17.

## NESTING BIRDS*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| GAVIIDAE. Loons | | | |
| Gavia immer (Brunnich), Common Loon | | SR | BU |
| PODICIPEDIDAE. Grebes | | | |
| Podiceps grisegena (Boddaert), Red-necked Grebe | | SP | C |
| PHALACROCORACIDAE. Cormorants | | | |
| Phalacrocorax auritus (Lesson), Double-crested Cormorant | | ST | B3 |
| ARDEIDAE. Herons and Bitterns | | | |
| Ardea (Casmerodius) alba (Linnaeus), Great Egret | | SP | C |
| Nycticorax nycticorax (Linnaeus), Black-crowned Night Heron | | SR | BU |
| Nyctanassa violacea (Linnaeus), Yellow-crowned Night Heron | | SP | C |
| ANATIDAE. Swans, Geese and Ducks | | | |
| Aythya americana (Eyton), Redhead | | SR | C |
| Aythya valisineria (Wilson), Canvasback | | SP | C |
| Aythya affinis (Eyton), Lesser Scaup | | SP | C |
| Oxyura jamaicensis (Gmelin), Ruddy Duck | | SP | C |
| ACCIPITRIDAE. Hawks and Harriers | | | |
| Accipiter cooperi (Bonaparte), Cooper's Hawk | | SR | BU |
| Buteo lineatus (Gmelin), Red-shouldered Hawk | | SR | BU |
| Haliaeetus leucocephalus (Linnaeus), Bald Eagle | LT | ST | B3 |
| Circus cyaneus (Linnaeus), Northern Harrier | | SR | BU |
| PANDIONIDAE. Ospreys | | | |
| Pandion haliaetus (Linnaeus), Osprey | | ST | B3 |
| FALCONIDAE. Falcons | | | |
| Falco peregrinus Tunstall, Peregrine | LE | SE | B1 |
| Falco columbarius Linnaeus, Merlin | | ST | B3 |
| TETRAONIDAE. Grouse | | | |
| Tympanuchus cupido (Linnaeus), Greater Prairie Chicken | | SE | B2 |

*Names in accordance with: Payne, R. B. 1982. A checklist of Michigan birds. Manuscript in preparation, which mostly follows current manuscript revision (Dec. 1981) of the AOU Check-list Committee, except for herons.

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| RALLIDAE. Rails and Coots | | | |
| Rallus elegans Audubon, King Rail | | ST | B3 |
| Coturnicops noveboracensis (Gmelin), Yellow Rail | | SR | C |
| CHARADRIIDAE. Plovers and Turnstones | | | |
| Charadrius melodus Ord, Piping Plover | | SE | B1 |
| PHALAROPODIDAE. Phalaropes | | | |
| Phalaropus tricolor Vieillot, Wilson's Phalarope | | SR | C |
| LARIDAE. Gulls and Terns | | | |
| Larus minutus Pallas, Little Gull | | SP | C |
| Sterna forsteri Nuttall, Forster's Tern | | SR | C |
| Sterna hirundo Linnaeus, Common Tern | | ST | B3 |
| Sterna caspia Pallas, Caspian Tern | | ST | B3 |
| TYTONIDAE. Barn Owls | | | |
| Tyto alba (Scopoli), Barn Owl | | SE | B2 |
| STRIGIDAE. Typical Owls | | | |
| Surnia ulula (Linnaeus), Hawk Owl | | SP | C |
| Strix nebulosa Forster, Great Gray Owl | | SP | C |
| Asio otus (Linnaeus), Long-eared Owl | | SR | BU |
| Asio flammeus (Pontoppidan), Short-eared Owl | | ST | B3 |
| PICIDAE. Woodpeckers | | | |
| Picoides arcticus (Swainson), Black-backed Three-toed Woodpecker | | SR | C |
| Picoides tridactylus (Linnaeus), Northern Three-toed Woodpecker | | SP | C |
| TYRANNIDAE. Tyrant Flycatchers | | | |
| Tyrannus verticalis Say, Western Kingbird | | SP | C |
| TROGLODYTIDAE. Wrens | | | |
| Thryomanes bewickii (Audubon), Bewick's Wren | | SP | C |
| LANIIDAE. Shrikes | | | |
| Lanius ludovicianus Linnaeus, Loggerhead Shrike | | SE | B2 |
| VIREONIDAE. Vireos | | | |
| Vireo bellii Audubon, Bell's Viero | | SP | C |
| PARULIDAE. Wood Warblers | | | |
| Dendroica dominica (Linnaeus), Yellow-throated Warbler | | SP | C |
| Dendroica kirtlandii (Baird), Kirtland's Warbler | LE | SE | A2 |

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| ICTERIDAE. Meadowlarks, Blackbirds, and Orioles | | | |
| *Xanthocephalus xanthocephalus* (Bonaparte), Yellow-headed Blackbird | | SR | C |
| FRINGILLIDAE. Grosbeaks, Finches, Sparrows, and Buntings | | | |
| *Spiza americana* Gmelin, Dickcissel | | SR | BU |
| *Pinicola enucleator* (Linnaeus), Pine Grosbeak | | SP | |
| *Chondestes grammacus* (Say), Lark Sparrow | | ST | BU |

## REPTILES*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| EMYDIDAE. Box and Water Turtles | | | |
| Clemmys guttata (Schneider), Spotted Turtle | | SR | BU |
| Clemmys insculpta (LeConte), Wood Turtle | | SR | BU |
| Terrapene carolina carolina (Linnaeus), Eastern Box Turtle | | SR | BU |
| COLUBRIDAE. Colubrids. | | | |
| Nerodia erythrogaster neglecta (Conant), Copperbelly Water Snake | | SE | B1 |
| Clonophis kirtlandi (Kennicott), Kirtland's Snake | | SE | B2 |
| Elaphe vulpina gloydi Conant, Eastern Fox Snake | | SR | BU |
| Elaphe obsoleta obsoleta (Say), Black Rat Snake | | SR | BU |

*Names in accordance with: Collins, J. T., et al. 1978. Standard common and current scientific names for North American Amphibians and Reptiles. Soc. for Study of Amph. and Rept., Misc. Publ., Herp. Circular No. 7, 36 pp.

## AMPHIBIANS*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| SIRENIDAE. Sirens | | | |
| *Siren intermedia nettingi* Goin, Western Lesser Siren | | SP | BX |
| AMBYSTOMATIDAE. Mole Salamanders | | | |
| *Ambystoma opacum* (Gravenhorst), Marbled Salamander | | SP | BX |
| *Ambystoma texanum* (Matthes), Smallmouth Salamander | | SP | C |
| PLETHODONTIDAE. Lungless Salamanders | | | |
| *Eurycea bislineata bislineata* (Green), Northern Two-lined Salamander | | SP | BU |
| HYLIDAE. Treefrogs and their Allies | | | |
| *Pseudacris triseriata maculata* (Agassiz), Boreal Chorus Frog | | SP | D |

*Names in accordance with: Collins, J. T., et al. 1978. Standard common and current scientific names for North American Amphibians and Reptiles. Soc. for Study of Amph. and Rept., Misc. Publ., Herp. Circular No. 7, 36 pp.

FISHES*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| ACIPENSERIDAE. Sturgeons | | | |
| Acipenser fulvescens Rafinesque, Lake Sturgeon | | ST | B3 |
| LEPISOSTEIDAE. Gars | | | |
| Lepisosteus oculatus (Winchell), Spotted Gar | | SP | C |
| HIODONTIDAE. Mooneyes | | | |
| Hiodon tergisus LeSueur, Mooneye | | SP | B3 |
| SALMONIDAE. Trouts | | | |
| Coregonus artedii LeSueur, Cisco or Lake Herring | | ST | BU |
| Coregonus bartletti (Koelz), Siskiwit Lake Cisco | | SR | B1 |
| Coregonus hubbsi (Koelz), Ives Lake Cisco | | SR | B1 |
| Coregonus kiyi (Koelz), Kiyi | | SR | B3 |
| Coregonus zenithicus (Jordan and Evermann), Shortjaw Cisco | | SE | B2 |
| CYPRINIDAE. Minnows and Carps | | | |
| Clinostomus elongatus (Kirtland), Redside Dace | | ST | B3 |
| Hybopsis amblops (Rafinesque), Bigeye Chub | | SE | B2 |
| Hybopsis storeriana (Kirtland), Silver Chub | | SP | C |
| Notropis anogenus Forbes, Pugnose Shiner | | SR | BU |
| Notropis chalybaeus (Cope), Ironcolor Shiner | | SP | C |
| Notropis emiliae (Hay), Pugnose Minnow | | SP | C |
| Notropis photogenis (Cope), Silver Shiner | | ST | BU |
| Notropis texanus (Girard), Weed Shiner | | SR | BU |
| Phoxinus erythrogaster (Rafinesque), Southern Redbelly Dace | | SP | C |
| CATOSTOMIDAE. Suckers | | | |
| Erimyzon oblongus (Mitchill), Creek Chubsucker | | SP | C |
| Ictiobus cyprinellus (Valenciennes), Bigmouth Buffalo | | SP | C |
| Ictiobus niger (Rafinesque), Black Buffalo | | SP | C |
| Moxostoma carinatum (Cope), River Redhorse | | ST | B3 |
| Moxostoma duquesnei (LeSueur), Black Redhorse | | SR | BU |
| Moxostoma valenciennesi Jordan, Greater Redhorse | | SR | BU |
| ICTALURIDAE. Catfishes | | | |
| Noturus miurus Jordan, Brindled Madtom | | SR | BU |
| Noturus stigmosus Taylor, Northern Madtom | | SE | B1 |

*Names in accordance with: Robins, C. R. et al. 1980. A list of common and scientific names of fishes from the United States and Canada. Amer. Fisheries Soc., Spec. Publ. No. 12.

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| CYPRINODONTIDAE. Killifishes | | | |
| *Fundulus notti* (Agassiz), Starhead Topminnow | | SP | C |
| CENTRARCHIDAE. Sunfish | | | |
| *Lepomis humilis* (Girard), Orangespotted Sunfish | | SP | C |
| PERCIDAE. Perches | | | |
| *Ammocrypta pellucida* (Putnam), Eastern Sand Darter | | ST | B2 |
| *Etheostoma spectabile* (Agassiz), Orangethroat Darter | | SP | C |
| *Etheostoma zonale* (Cope), Banded Darter | | SP | C |
| *Percina copelandi* (Jordan), Channel Darter | | ST | B3 |
| *Percina shumardi* (Girard), River Darter | | SP | C |
| COTTIDAE. Sculpins | | | |
| *Cottus ricei* (Nelson), Spoonhead Sculpin | | SR | BU |

## MOLLUSKS*

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| **PELECYPODA** | | | |
| UNIONIDAE | | | |
| *Cyclonaias tuberculata* (Rafinesque), Purple Warty Back | | SR | BU |
| *Pleurobema clava* (Lamarck), Club Shell | | SE | A2 |
| *Anodonta subgibbosa* (Anthony), no common name | | ST | B1 |
| *Simpsoniconcha (Simpsonaias) ambigua* (Say), Salamander Mussel | | SE | A2 |
| *Carunculina (Toxolasma) glans (lividus)* (Lea), Little Purple | | SE | A2 |
| *Dysnomia (Epioblasma, Plagiola) sulcata (obliquata)* (Lea), White Cat's Paw Pearly Mussel | LE | SE | A2 |
| *Dysnomia (Epioblasma, Plagiola) torulosa* (Rafinesque), Northern Riffle Shell | | SE | B1 |
| *Dysnomia (Epioblasma, Plagiola) triquetra* (Rafinesque), Snuffbox | | ST | B3 |
| *Lampsilis fasciola* (Rafinesque), no common name | | SR | BU |
| *Obovaria subrotunda (leibii)* (Rafinesque), no common name | | ST | B3 |
| *Villosa fabalis* (Lea), no common name | | SE | B2 |
| **GASTROPODA** (no common names for listed species) | | | |
| HYDROBIIDAE | | | |
| *Fontigens nickliniana* (Lea) | | SR | BU |
| *Pyrgulopsis letsoni* (Walker) | | SR | BU |
| POMATIOPSIDAE (HYDROBIIDAE) | | | |
| *Pomatiopsis cincinnatiensis* (Lea) | | SR | BU |
| LYMNAEIDAE | | | |
| *Stagnicola (Lymnaea) contracta* (Currier) | | ST | B1 |
| *Acella (Lymnaea) haldemani* (Deshayes) | | SR | BU |
| PLANAORBIDAE | | | |
| *Planorbella (Helisoma) multivolvis* (Case) | | SE | A1 |
| PHILOMYCIDAE | | | |
| *Philomycus carolinianus* (Bosc) | | SR | BU |

*Names adopted from: Burch, J. B. 1975. Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. Malacological Publications, Hamburg, Michigan. 204 pp.

| | Federal Status | State Status | MNFI Rank |
|---|---|---|---|
| ENDODONTIDAE | | | |
| Anguispira kochi (Pfeiffer) | | SR | BU |
| Discus patulus (Deshayes) | | SR | BU |
| ZONITIDAE | | | |
| Mesomphix cupreus (Rafinesque) | | SR | BU |
| POLYGYRIDAE | | | |
| Triodopsis denotata (Ferussac) | | SR | BU |
| Mesodon elevatus (Say) | | SP | BU |
| Mesodon sayanus (Pilsbry) | | SR | BU |

# BUTTERFLIES*

| | Status** |
|---|---|
| **HESPERIIDAE. True Skippers** | |
| Erynnis horatius (Scudder & Burgess), Horace's Dusky Wing..... | P |
| Erynnis baptisiae (Forbes), Wild Indigo Dusky Wing..... | P |
| Pyrgus centaureae wyandot (Edwards), Grizzled Skipper..... | R |
| Oarisma poweshiek (Parker), Poweshiek Skipper..... | R |
| Hesperia ottoe Edwards, Ottoe Skipper..... | R |
| Poanes zabulon (Boisduval & LeConte), Zabulon Skipper..... | U |
| Euphyes dukesi (Lindsey), Dukes' Skipper..... | P |
| **PAPILIONIDAE. Swallowtails** | |
| Battus philenor (Linnaeus), Blue or Pipe Vine Swallowtail..... | P |
| Eurytides marcellus (Cramer), Zebra Swallowtail..... | P |
| **PIERIDAE. Whites and Sulphurs** | |
| Pontia protodice (Boisduval & LeConte), Checkered White..... | R |
| Euchloe ausonides (Lucas), The Large Marble..... | P |
| **LYCAENIDAE. Gossamer Winged Butterflies** | |
| Epidemia epixanthe michiganensis (Rawson), Bog Copper..... | R |
| Incisalia irus (Godart), Frosted Elfin..... | R |
| Incisalia henrici (Grote & Robinson), Henry's Elfin..... | R |
| Incisalia eryphon (Boisduval), Western Elfin..... | P |
| Erora laeta (Edwards), Early Hairstreak..... | R |
| Everes amyntula (Boisduval), Western Tailed Blue..... | P |
| Lycaeides argyrognomon nabokovi Masters, Northern Blue..... | U |
| **RIODINIDAE. Metalmarks** | |
| Calephelis muticum McAlpine, Swamp Metalmark..... | R |
| **LIBYTHEIDAE. Snout Butterflies** | |
| Libytheana bachmanii (Kirtland), Snout Butterfly..... | P |
| **NYMPHALIDAE. Brush Footed Butterflies** | |
| Speyeria idalia (Drury), Regal Fritillary..... | R |
| Proclossiana eunomia dawsoni (Barnes & McDunnough), Bog Fritillary..... | U |
| Clossiana frigga (Thunberg), No Common Name..... | U |
| Clossiana freija (Thunberg), Freija Fritillary..... | U |
| Charidryas gorgone (Hubner), Gorgone Checkerspot..... | P |
| Polygonia gracilis Grote & Robinson, Hoary Comma..... | R |
| Polygonia satyrus (Edwards), Satyr Angle Wing..... | R |
| **SATYRIDAE. Satyrs and Wood Nymphs** | |
| Neonympha mitchellii French, Mitchell's Satyr..... | R |
| Erebia discoidalis (Kirby), Red Disked Alpine..... | U |
| Oeneis macounii (Edwards), Macon's Arctic..... | P |

* Names are in accordance with: Miller, L. D. and F. M. Brown. 1981. A catalogue/checklist of the butterflies of America north of Mexico. The Lepidopterists Society, Memoir No. 2. 280 pp.

** R = rare, P = peripheral, U = unknown

# MOTHS

| | Status |
|---|---|
| SPHINGIDAE. Sphinx or Hawk Moths | |
| Sphinx luscitiosa Clemens, Clemens' Hawkmoth | R |
| Sphinx canadensis Boisduval | R |
| Hemaris gracilis Grote & Robinson, The Graceful Clearwing | R |
| Proserpinus flavofasciata Walker, The Yellow-banded Day-sphinx. | U |
| SATURNIIDAE. Giant Silkworm Moths | |
| Hyalophora columbia (Smith), Columbian Silk-moth | R |
| Hemileuca lucina Henry Edwards | U |
| CITHERONIDAE. Royal Moths | |
| Sphingicampa bisecta (Lintner) | U |
| Eacles imperialis pini Mitchner | R |
| ARCTIIDAE. Tiger Moths | |
| Pygarctia spraguei Grote | U |
| Parasemia plantaginis scudderi (Packard) | U |
| NOCTUIDAE. Noctuid Moths | |
| Acronicta falcula Grote | R |
| Acronicta funeralis Grote & Robinson | R |
| Polia nevadae canadensis Smith | R |
| Polia radix Walker | R |
| Polia rugosa Morrison | R |
| Polia pulverulenta Smith | R |
| Oncocnemis piffardi Walker | U |
| Platypolia anceps Stephenson | U |
| Septis mixta Grote | U |
| Papaipema astuta Bird | U |
| Papaipema cerussata Grote | U |
| Papaipema nelita Strecker | U |
| Papaipema appassionata Harvey | R |
| Parapamea buffaloensis Grote | R |
| Chytonix chlorostigma Harvey | U |
| Basilodes pepita Guenee | P |
| Exyra rolandiana Grote | R |
| Autographa pseudogamma Grote | U |
| Autographa flagellum Walker | U |
| Autographa mappa Grote & Robinson | R |
| Syngrapha altera (Ottolengui) | U |
| Syngrapha selecta (Walker) | R |
| Syngrapha abstrusa Eichlin & Cunningham | U |
| Syngrapha cryptica Eichlin & Cunningham | U |
| Syngrapha montana (Packard) | R |
| Autographa rubida Ottolengui | R |
| Catocala robinsoni Grote, Robinson's Underwing | R |
| Catocala angusi Grote, Angus' Underwing | P |
| Catocala lacrymosa Guenee, The Tearful Underwing | P |
| Catocala nebulosa Edwards, The Clouded Underwing | R |
| Catocala illecta Walker, The Magdalen Underwing | P |
| Catocala junctura Walker | P |
| Zale calycanthata Abbott & Smith | R |

MOTHS (cont.)

| | Status |
|---|---|
| NOTODONTIDAE. Prominents | |
| *Ichthyura brucei* Henry Edwards..... | R |
| *Heterocampa subrotata* Harvey..... | P |
| LASIOCAMPIDAE. Tent Caterpillars and Lappet Moths | |
| *Heteropacha rileyana* Harvey..... | P |
| GEOMETRIDAE. Geometer Moths | |
| *Leucobrephos brephoides* Walker..... | R |

M. C. Nielsen
9/11/80

Extinct and Extirpated Animal Species

| | MNFI Rank |
|---|---|
| **Mammals** | |
| Wolverine (Gulo gulo) | BX |
| Mountain Lion (Felis concolor | BX |
| Caribou (Rangifer tarandus) | BX |
| Bison (Bison bison) | BX |
| **Birds** | |
| Passenger Pigeon (Ectopistes migratorius) | AX |
| **Fishes** | |
| Paddlefish (Polyodon spathula) | BX |
| Longjaw Cisco (Coregonus alpenae)[1] | AX |
| Deepwater Cisco (Coregonus johannae) | AX |
| Blackfin Cisco (Coregonus nigripinnis)[2] | BX |
| Shortnose Cisco (Coregonus reighardi)[2] | BX |
| Grayling (Thymallus arcticus) | BX |
| Blue Pike (Stizostedion vitreum glaucum)[1] | AX |

[1]Federally Endangered Species.

[2]State endangered species.

# APPENDIX E

## GEOMORPHIC-GEOLOGIC FEATURES CLASSIFICATION
Michigan Natural Features Inventory

I. GEOMORPHIC FEATURES

A. GLACIAL

1. Moraine
2. Drumlin
3. Stagnation Topography
4. Outwash
5. Ice Contact Features
   a. Esker
   b. Kame
   c. Kettle
   d. Pitted Outwash
   e. Ice Block Valley
6. Abrasion Feature
7. Glacial Lake Plain
8. Glacial Drainage Channel
9. Glacial Embayment
10. Glacial Misc.

B. FLUVIAL

1. Floodplain
2. Meander
3. Terrace
4. Waterfall/Rapids
5. Gorge
6. Delta

C. COASTAL

1. Modern
   a. Baymouth Bar
   b. Spit
   c. Cliff/Stack/Arch
   d. Tombolo
   e. Bluff
2. Ancient
   a. Abandoned Shoreline
   b. Miscellaneous ACF

D. EOLIAN

1. Dune
   a. Perched Dune
   b. Unperched Dune

E. KARST

F. MASS WASTING

G. WEATHERING

H. MISCELLANEOUS

1. Spring
2. Peatland

II. STRUCTURE

A. TECTONIC

1. Fold
2. Fracture
3. Tilted Bedrock

B. IGNEOUS

1. Instrusive
2. Extrusive

C. SEDIMENTARY

1. Primary
2. Secondary

III. EARTH HISTORY

A. EARLY PRECAMBRIAN
B. MIDDLE PRECAMBRIAN
C. LATE PRECAMBRIAN
D. CAMBRIAN
E. ORDOVICIAN
F. SILURIAN
G. DEVONIAN
H. MISSISSIPPIAN
I. PENNSYLVANIAN

IV. MISCELLANEOUS

A. UNCONFORMITIES
B. SPECIAL OUTCROPS
C. FOSSILS
D. MINERALS

US Department of Commerce
NOAA Coastal Services Center Library
2234 South Hobson Avenue
Charleston, SC 29405-2413

NOAA COASTAL SERVICES CTR LIBRARY
3 6668 14111552 9