SITE ANALYSIS AND INTERPRETIVE DEVELOPMENT OF THE ALLEGAN PINE PLAINS ECOSYSTEM

Thesis for the Degree of M. S.

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ABSTRACT

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The public is deprived of experiencing many fine natural areas because agencies managing the areas deem them too fragile to be developed for use. It is my thesis that the primary preservation objective can be integrated with a secondary interpretive-use objective, so that the two are compatible. In fact, rather than compromising the preservation function, interpretive development, by preventing haphazard and unconforming use, can be a means to preservation. Methods of visitor control are discussed in context of an actual interpretive plan for a quality natural area, containing fragile biotic communities and rare plants, in Allegan County, Michigan. This is presented as a model for use in developing other areas.

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A THESIS

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INTRODUCTION

Purpose of Thesis

The purpose of this thesis is to present an interpretive master plan appropriate to a high quality natural area. A natural area as significant as the Allegan County, Michigan location discussed here demands a plan of unusual caliber, and one that takes into account factors not normally considered if visitors are to get the most out of the site while the resource is at the same time preserved in its original integrity. Hopefully the principles presented here will be applicable elsewhere, so that the plan for the Allegan Pine Plains site can serve as a development model for other fine areas. Especially likely to benefit from such a model would be the agency, such as the state department of natural resources, charged with providing outdoor recreation within the large region, where several quality areas might occur. Agencies working with relatively small budgets and staffs to develop small areas might find this method a viable alternative.

The problem of interpreting rare and fragile ecological systems has not, on the whole, been adequately dealt with in the past. Rather than wrestle with the problem, it is usually avoided simply by closing a given area to all use, including that of interpretation. In other words, the decision is made that preservation is more important than interpretation. The assumption, however,

upon which that decision is based--that preservation and interpretation are incompatible--may be at fault. There may be cases where interpretation can actually be a means to preservation. Furthermore, total preservation as a goal may not be as desirable as partial preservation accompanied by an excellent interpretive program. Most sites can probably sustain a certain amount of minor vandalism without loss of their essential integrity; such disturbances may be a small price to pay for the recreational-educational benefits of an interpretive program. Just because the biotic systems of the site are rare or fragile, or harbor rare species, the public need not be automatically excluded. It is my thesis that, as a general rule (there are exceptions), any area can be opened to the public, provided that development is well thought out and conducted with care and sensitivity.

If we limit ourselves to interpreting the commonplace, we deny ourselves many opportunities to offer a quality recreational experience. "The weeds in a city lot," wrote Aldo Leopold, "convey the same lesson as the redwoods." But the difference between interpreting weeds and redwoods may be the difference between an educational and a recreational experience--or, at any rate, between two levels of recreational experience, one considerably more rewarding than the other. Interpretation as a public service in the area of outdoor recreation is much easier to justify if we have redwoods rather than weeds to work with, simply because more people are more excited by the extraordinary. Half of the success of any interpretive

venture depends on the quality of the resource you have to work with; the other half depends on a program outstanding enough to match it.

If we don't interpret the rare, we're not doing our job, since the natural scene consists of much more than communities that are common and compatible with "civilization." We don't want to be guilty of misleading the public by implying that this is all there is to it. The awesome diversity of the natural world is our province, and this diversity includes much that is rare and even vanishing--the more so as time and civilization march on. If the present trend continues, with diversity yielding ever more to uniformity, interpretation in the future will be dealing increasingly with the rare. In addressing some of the problems of interpreting rare and delicate natural communities, this paper ought to find increasing relevance!

Rationale for an Interpretive Program in the Allegan Pine Plains

The Allegan Pine Plains area lends itself extremely well as a testing grounds for my thesis that rare and fragile ecological systems <u>are</u> compatible with interpretation.

1. The particular site to be discussed here is a natural area of undisputed high quality. (At the time of this writing, it does not enjoy the legislative protection of a dedicated natural area, although it is in the process of obtaining it). Using the priority ranking scheme for natural areas developed by the Wisconsin Scientific Areas Preservation Council (Tans, 1974), the site would

receive high or highest ranking in all of the most important criteria except for degree of threat. These are:

A. Quality, as measured by:

> 1) diversity of native plant or animal species, i.e. are the expected (modal) species present? 2) plant community structure and integrity; 3) the extent of significant human interference (disturbance) to the community . . . and 4) the extent to which a community corresponds with our concept of the identified natural community as it existed before settlement.

B. Size and buffer, measured in terms of adequacy to protect an area:

> from the direct and indirect activities of man and from the elements.

C. Commonness, measured by:

> the acreage of the type in presettlement vegetation, the method of historical conversion of the type and its resultant degree of destruction, restricted nature of occurrence, the presence of rare or endangered species, and the amount of the type in the present landscape of the region.

D. Community diversity, measured in terms of:

> number of plant community types or other natural features within a tract.

Because of the presence of communities that are uncommon and little known in southern Michigan, and because of the high percentage of rarities, preservation of the Allegan Pine Plains site is of utmost importance. At the same time, because of these very qualities, the Pine Plains location makes an ideal site for an interpretive program. It is essential that an interpretive program be compatible with the primary goal of preservation.

2. The potential for interpretive activity at the Pine Plains is much enhanced by its close proximity to several large

population centers. It is located about 25 miles from Holland, 45 miles from Grand Rapids and Kalamazoo, and 50 miles from Muskegon. The Grand Rapids metropolitan area alone has a population of about 435,000 (1970). Lansing, Battle Creek, Jackson, the Indiana cities of South Bend, Elkhart, and Gary, and the easternmost part of Chicago are all located within 100 miles of the site. The large numbers of people within day-trip distance of the Pine Plains guarantees enough usage to justify an interpretive center there. It should be remembered that the Pine Plains is strategically located within the boundaries of the emerging megalopolis which will eventually stretch from Pittsburgh to Chicago. As this land-use pattern takes shape, the natural area value and recreational potential of the Pine Plains will increase.

3. Most of the site is already in state ownership. Enough, in fact, that an interpretive program could be instituted immediately, without prior land acquisition. The addition of Miner Lake would be highly desirable and would contribute much to the interpretive potential, as well as insuring the safety of an excellent, state-owned bog which is an integral part of the lake system; its acquisition is not, however, at this time necessary.

4. Paradoxical as it may sound, there seem to be some cases in which preservation depends, at least partially, on planned development to deliberately attract more people to a site. The Miner Lake area will undoubtedly receive increasing use in the future. The land just to the west and north of the bog is now being subdivided for residential development; the remoteness which has protected the bog

in the past cannot be counted on much longer. Furthermore, as word gets around, more naturelovers can be expected to visit the site and "love it to death." Uncontrolled, haphazard use is bound to lead to degradation of the resource. Planned development, however, can mean the accommodation of many more visitors with little, if any, environmental damage. If the Miner Lake area is really going to be preserved, therefore, planned development must certainly be seriously considered. The alternative, fencing the entire area and posting a warden to see that no one enters without a permit, is certainly not the best. Preservation may be achieved, but at the cost of use.

THE SITE

Location

The Allegan Pine Plains is a 12 by 16 mile tract in west-central Allegan County, about 10 miles inland from Lake Michigan (see Figure 1). It embraces nearly all of Heath and Valley Townships and much of Manlius, Monterey, Clyde, Allegan, and Lee Townships. Most of this region is administered by the Department of Natural Resources as the Allegan State Game Area (see Figure 2).

Three blocks of land in Manlius Township, totaling about 528 acres and located within a mile of each other, were selected as the site for an interpretive center on the basis of their outstanding quality; their natural features represent the best that the Pine Plains has to offer. The Miner Lake Unit consists of 168 acres in the north half of Section 34. The Kalamazoo River Escarpment Unit includes 80 acres in the southeast corner of Section 27 and about 120 acres in the southwest corner of Section 26. The Savanna Unit embraces the northeast corner of Section 35 (160 acres) (see Figure 3). Private inholdings separate them from each other. Such inholdings are unfortunately abundant throughout the Allegan State Game Area.

The Miner Lake area is located within a mile of M-89, nine miles from I-196 (US 31), and 23 miles from US 131. The nearest town is Fennville, two miles to the west. Three roads, all unpaved but passable in all but the snowiest weather, provide access to all

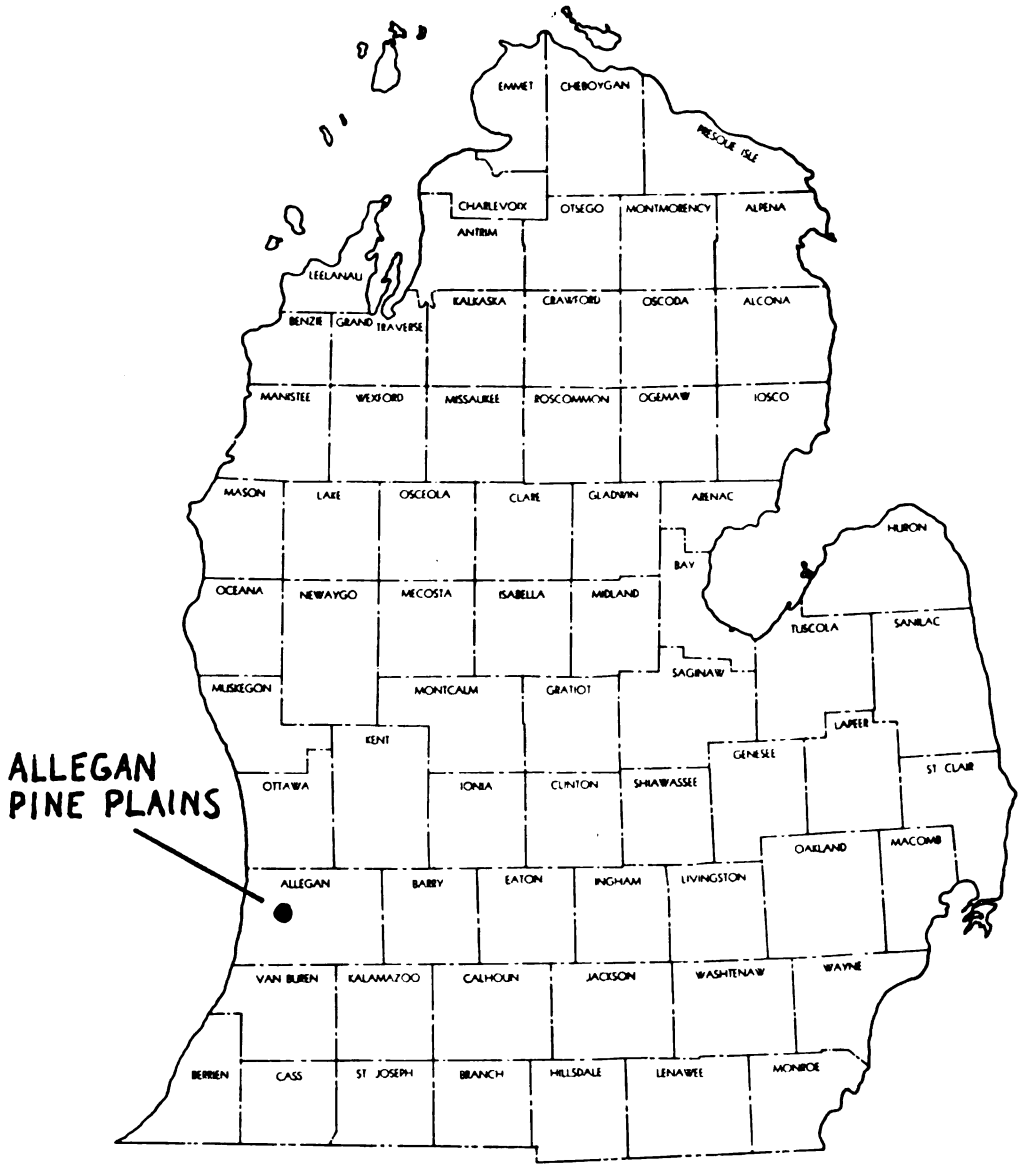
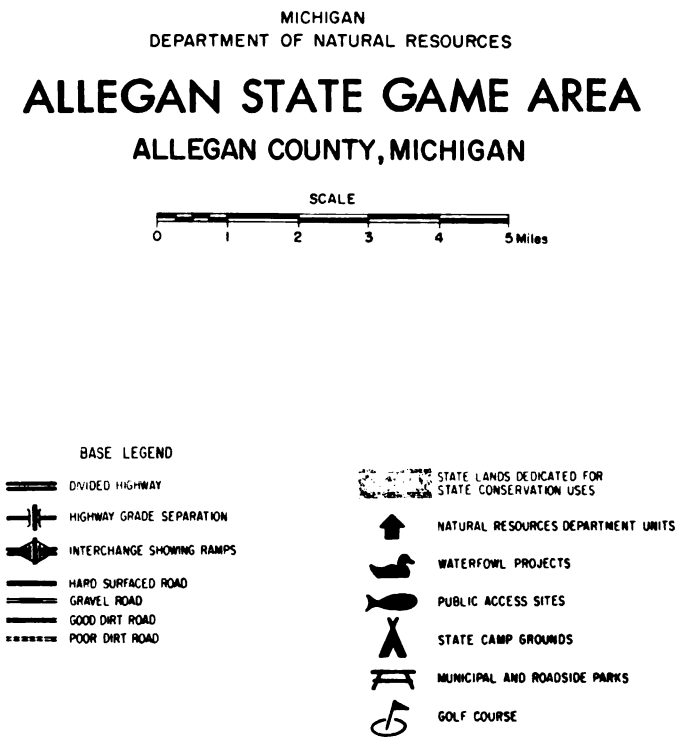


Figure 1.--Location of Allegan Pine Plains in Michigan.

Figure 2.--Allegan State Game Area.



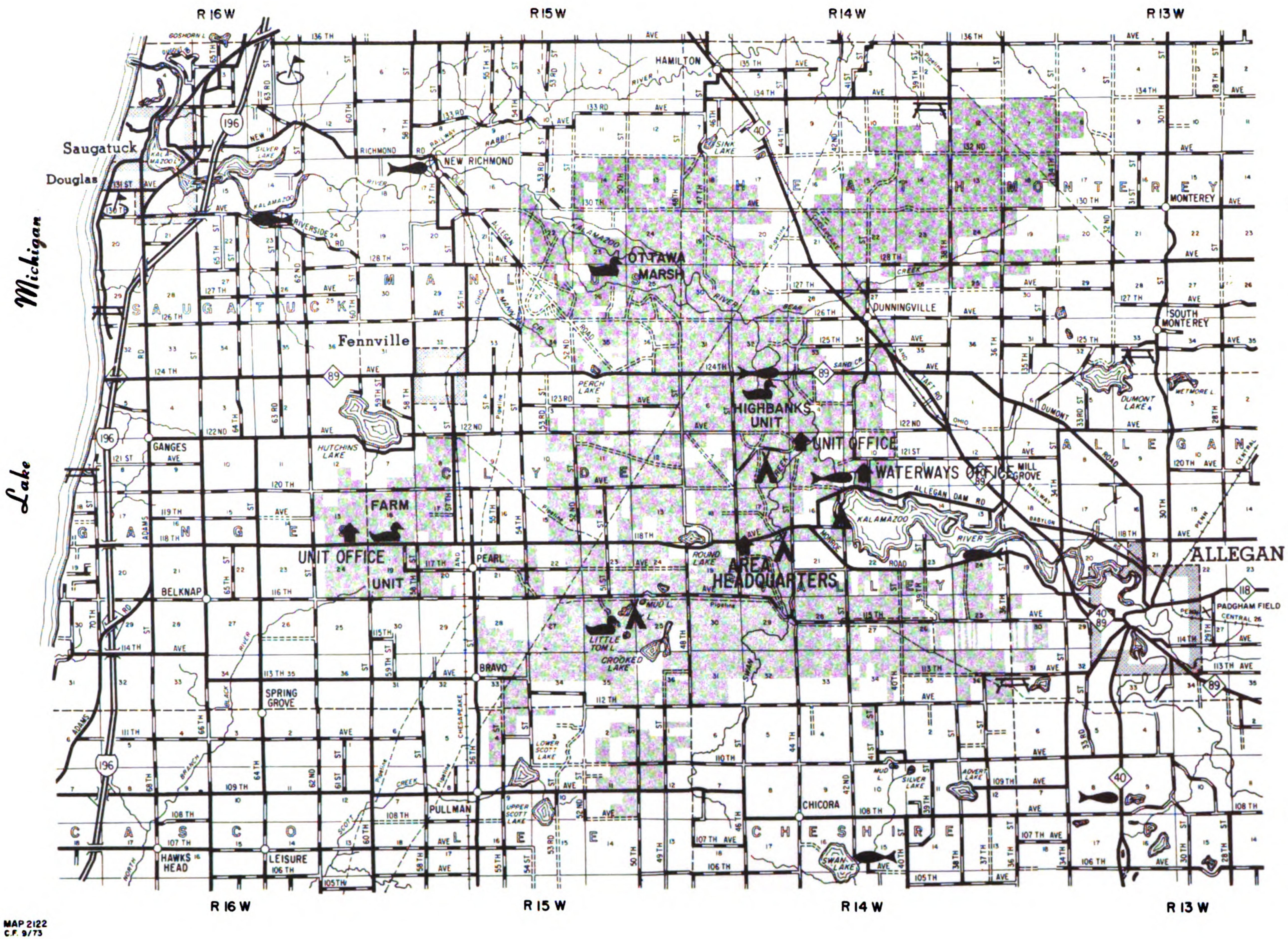

R 16 W
R 15 W
R 14 W
R 13 W
T 3 N
T 2 N
T 1 N
Lake Michigan
Saugatuck
Douglas
Fennville
HAMILTON
NEW RICHMOND
DUNNINGVILLE
MONTEREY
SOUTH MONTEREY
ALLEGAN
PADGHAM FIELD
MILL GROVE
GANGES
PEARL
BELKNAP
BRAVO
SPRING GROVE
PULLMAN
CHICORA
HAWKS HEAD
LEISURE
OTTAWA MARSH
HIGHBANKS UNIT
UNIT OFFICE
WATERWAYS OFFICE
AREA HEADQUARTERS
FARM UNIT
UNIT OFFICE
SAUGATUCK
MANLIUS
HEATH
MONTEREY
ALLEGAN
CLYDE
VALLEY
GANGES
CASCO
LEE
CHESHIRE
KALAMAZOO RIVER
RABBIT RIVER
HUTCHINS LAKE
PERCH LAKE
DUMONT LAKE
WETMORE L
SINK LAKE
ROUND LAKE
MUD L
LITTLE TOM L
CROOKED LAKE
LOWER SCOTT LAKE
UPPER SCOTT LAKE
SWAN LAKE
SILVER LAKE
GOSHORN L
ALLEGAN DAM RD
MAP 2122
C.F. 9/73

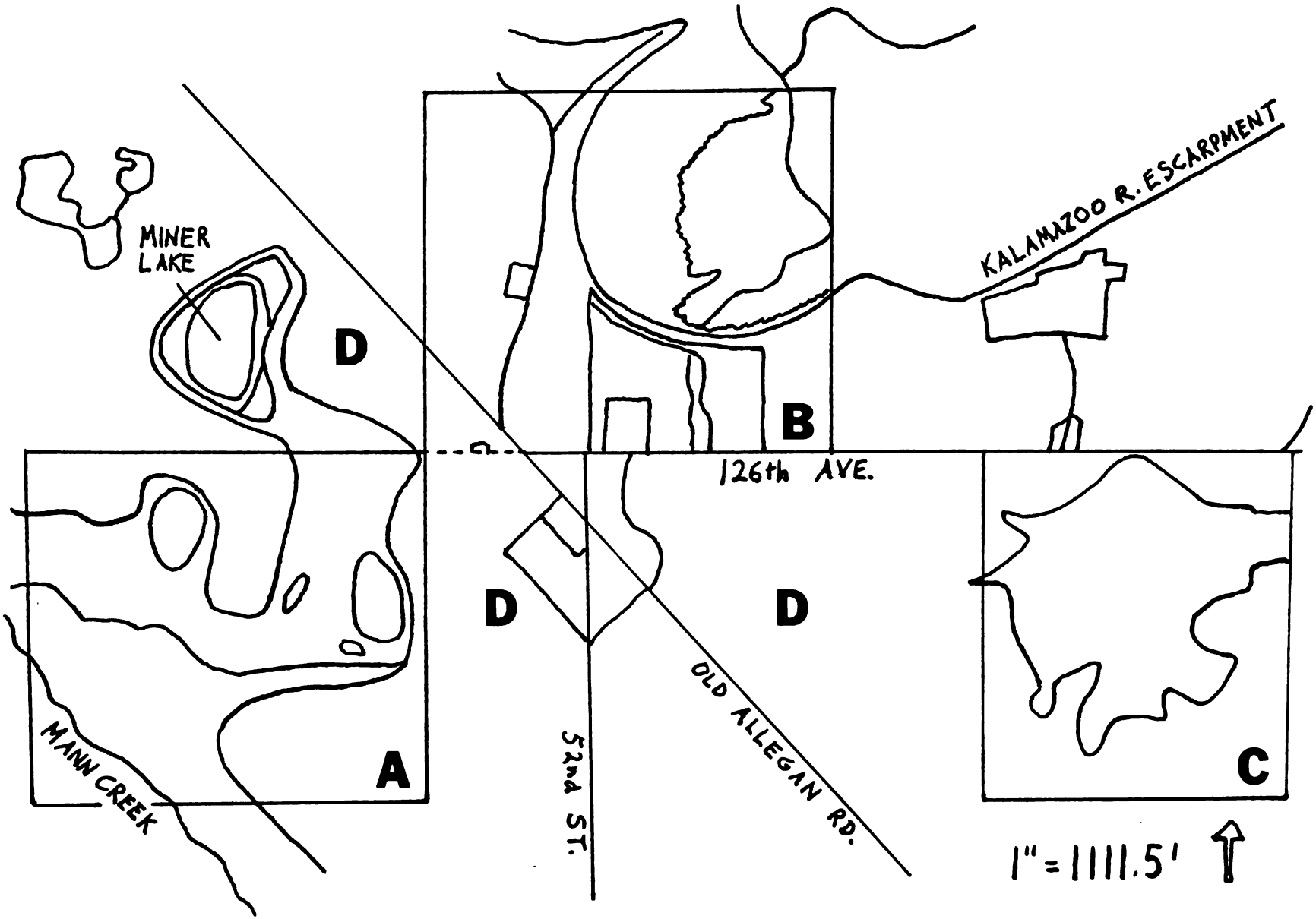
Figure 3.--The Miner Lake Area.

A. Miner Lake Unit

B. Kalamazoo River Escarpment Unit

C. Savanna Unit

D. Private Land
(recommended for purchase by the state)


MINER LAKE
KALAMAZOO R. ESCARPMENT
D
B
126th AVE.
D
D
A
C
MANN CREEK
52nd ST.
OLD ALLEGAN RD.
1" = 1111.5'

three units. The site is located far enough from man-made developments to maintain a sense of quiet remoteness.

Method of Investigation

In determining the precise nature of the natural resources to be interpreted, a combination of field study and library research was utilized. Field work provided an inventory of plants, animals, and other natural features actually found on the site; library research indicated what else could be expected, and provided a sophisticated understanding of the features. Naturally, the more research the better. The goal is to collect as many details about the site as possible.

Field Work

It is probably impossible to spend too many hours in the field. However, one thorough exploratory trip per month was deemed satisfactory. The present study entailed at least one trip per month from May through October and thus covered the season when the great bulk of interpretive center visitation would occur. Research consisted of identifying every plant and animal possible and noting general frequency, condition, and any peculiarities, as well as the recording of phenological features. No attempt was made to be rigorous in a scientific research sense; instead of employing quantitative sampling techniques, we* merely recorded what species were present and used our best judgment in assigning abundance status. Other

*Ken VanderKamp was with me on most of these trips; his contribution to the material presented in this paper is substantial.

considerations, such as population densities, tree sizes, basal areas, energy consumptions, and breeding data, were not dealt with. Much of this is available in the literature, and it was thought generally superfluous to our purpose. Throughout the exploration, we kept a special eye out for items that, in our estimation, would interest the visitor to an interpretive center, although we did not limit ourselves to that kind of data. We felt that the more we could come up with, the more we would have to work with, and the more choice would be available to us. It is better to have too much data and to discard some than to have too little, so that you are forced to "make do."

Good maps are invaluable in this connection. U.S. Geological Survey topographic maps were used with aerial photographs to give me the information I needed for making my own maps. Use of an airplane could have added more detail to the vegetation pattern described.

Library Research

Reviewing books and journal articles is essential for two basic reasons: it supplements the field work inventory by providing names of species which are probably present but which were overlooked, or species which may be present; and it contributes much material that can be incorporated into interpretive presentations. This would include data on rarity and uniqueness, distribution patterns, relationships, habits and life histories, comparisons, causes and explanations. The more specialized the interpretation, i.e.,

the more it deals with the specifics of a particular place, as opposed to general facts and concepts applicable anywhere, the more necessity for this kind of specialized library work. A general nature trail can be put together with basic knowledge derived from any biology or outdoor education course, which is totally inadequate for communicating the particulars that make a place unique. Certain kinds of basic information, of course, can only be obtained by examining the literature--the geology of an area, for instance (unless perhaps you happen to be a professional geologist).

Strengths and Weaknesses of the Research Presented Here

One's personal interests and biases tend to determine which areas of research will be strong and which weak. Since my speciality is botany, I was able to compile a list of vascular plants which is close to being complete. Considerably less success was experienced with identification of non-vascular plants (bryophytes, lichens, fungi). There were many more species of animals which were discovered through the literature than by personal observation. Where the literature was weak (as in the case of insects), the material available for interpretation is also weak. There is literally nothing here on fishes. This kind of failure hurts less when we consider that the inventory need not be completed before a development plan is drafted and operationalized. The more complete the better, but I doubt that overlooking a rare liverwort or cranefly is going to seriously affect the quality of the plan. Research certainly will continue after the program goes into effect; as new

discoveries are made, they will be evaluated in terms of their management and interpretive potential and the program can be changed accordingly.

Although the inventory need not be completed, it is essential that where the personal qualifications of the researcher are inadequate to discover at least the more conspicuous elements, the expertise of others should be called upon. If I had it to do over, I would spend more time and effort getting a bryologist, for example, to do work in the area instead of tackling the mosses myself and doing an inadequate job. Ideally, the researcher will be a competent "generalist" whose work is supplemented by that of specialists.

Another weakness in the present study is the lack of information on site characteristics present from November through April. Though not absolutely essential, it is highly desirable to know the area in late fall, winter and early spring as well as during the growing season, so that the full range of seasonal phenomena is understood for interpretive purposes. Furthermore, I feel the present study suffers from inadequate knowledge of night phenomena. Of the three or four trips scheduled for night exploration, only one was not rained out! As a result, we know very little about what exists on the site in the way of nocturnal birds, night-sounding frogs and insects, phosphorescent fungi, etc.

Natural Features

Climate

Four factors, according to Seeley (in Davis, 1964), are important in understanding Michigan climate: latitude, altitude,

environmental conditions, and location relative to storm paths. Latitude, altitude, and storm path subjection apply everywhere, and as there is nothing exceptional in the way they relate to the climate of southern Michigan (at least in terms of macroclimate), they need not be discussed here. Environmental factors, however, produce effects which are much more local in their application, and since they serve to differentiate Michigan climate from surrounding climates sharing the effects of the other three factors, further discussion is warranted.

Chief among environmental factors is the proximity of Lake Michigan, which produces the famous "lake effect." Prevailing winds are from the west (southwest in summer, west to northwest in winter); as they cross the lake, they pick up moisture, warm or cool depending on the temperature of the lake. Since the lake water takes a long time to cool, winter winds pick up relatively warm moisture, with the result that winter is warmer in Michigan than it is, for example, in Wisconsin. It is also warmer near the lake than inland. Thus, mean winter temperatures are two or three degrees warmer in the Allegan area than they are in the Lansing area. The reverse holds true for summer. Since the lake, now finally cooled, takes time to warm up, the winds pick up cool moisture and keep the temperatures cooler along the shore than inland. This greater summer moisture and coolness is at least partly responsible for the southward extension of northern vegetation along the Lake Michigan coast but not inland. Hemlock, for example, was abundant in western Allegan County but not eastern (Kenoyer, 1934).

Another lake effect is the late fall and early winter cloudiness so characteristic of Michigan. Cold air passing over a warm lake creates condensation which rises to form cloud cover. As the lake cools, the cloudiness disappears.

Other environmental factors important to an understanding of Pine Plains climate and its effect on the vegetation are microclimatic. The most influential is the "frost pocket effect." Seeley (in Davis, 1964), explains that

> . . . slight elevations of ground which provide good air drainage are not subject to the extremes of low temperature or killing frosts to the extent that low, undrained areas are, because the cold air, being heavier than warm air, drains off from the hillside into the lower levels. Low ground is sometimes colder by 8° to 10° than higher ground nearby.

Thus the cooler temperatures in the Miner Lake basin and along the base of the Kalamazoo River escarpment. Crow (1969a) noted that in 1967 at Pennfield Bog (near Battle Creek), frost came about 20 days earlier than the average date for the Battle Creek region.

The Pine Plains as a whole is probably a frost pocket, situated as it is in a trough between the Lake Border and Valparaiso Moraines. The number of frost free days would be lower than the 158 which is average for Allegan. Orchards are a prominent feature of the Lake Border Moraine; the frost pocket effect would preclude their presence in the Pine Plains, even if all other factors allowed it.

Other microclimatic factors operative in the Miner Lake area would include angle and direction of slope, which determine exposure to sunlight; heavy evaporation from wetlands, with its cooling

effect; and tree canopy condition, responsible for amount of radiation which reaches the ground.

From the data recorded in Table 1 note that the normal total precipitation in Allegan is 33.55 inches per year. Most of this falls during May and June, with a second wet period in August and September. The Allegan area shares the "pronounced mid-summer 'slump' of rainfall" characteristic of nearly all of Lower Michigan (Brunnschweiler, in Davis, 1964). This phenomenon, notes Brunnschweiler, is "dynamically the most puzzling anomaly in our 'continental' climate." Combined with summer heat and soil that cannot hold what moisture it does get, it is responsible for the yellow-brown, tinder-dry aspect of the July savanna.

The city of Allegan gets an average of 57.1 inches of snow a year. The average is less to the east, more to the west, in the Pine Plains, which, being closer to the lake, is more subject to another lake effect: the frequent snow showers produced by atmospheric instability caused by cold air passing over warm water (Eichmeier, 1963).

The data in Table 1 (from Climatography of the United States No. 86-16--Michigan, 1964) is generally applicable to the Pine Plains, though microclimatic differences will certainly result in some discrepancy.

Since the Pine Plains vegetation is considered a relict of vegetation associated with previous climates, a word on prehistoric climate is in order. Information here is based on Dorr and Eschman,

TABLE 1.--Climatological Data for Allegan Sewage Plant.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Annual
Normal Total Precip.	2.32	1.93	2.38	3.20	3.57	3.53	2.52	3.45	3.06	2.73	2.66	2.20	33.55
Mean Snowfall (38 years)	15.9	12.3	7.6	.9	.3	0	0	0	0	.4	6.7	13.0	57.1
Mean No. Days with Precip. $\geq$ 0.10" (6-7 years)	6	7	6	7	7	7	5	6	5	7	8	6	77
Mean No. Days with Precip. $\geq$ 0.50" (9-10 years)	1	1	1	3	2	2	2	2	1	2	1	1	19
Normal Mean Temp.	26.5	26.7	34.5	47.4	58.5	68.5	72.6	71.2	63.6	52.9	39.8	29.7	49.3
Mean Daily Max. Temp (69 years)	32.3	33.4	43.9	58.6	70.3	80.1	84.8	83.1	75.4	63.6	47.7	35.7	59.1
Mean Daily Min. Temp (69 years)	17.6	16.8	25.4	36.3	45.8	56.2	60.4	58.3	51.5	40.9	31.1	21.8	38.5
Highest Temp. (66 years)	67	66	81	92	97	101	106	106	99	91	81	64	106
Lowest Temp. (65 years)	-22	-35	-13	9	20	30	34	35	24	11	-8	-19	-35
Mean No. Days with Temp. $\geq$ 90° (10 yrs)	0	0	0	0	1	3	5	4	2	0	0	0	14
Mean No. Days with Temp. $\leq$ 32° (9-10 yrs)	29	26	25	9	1	0	0	0	1	6	17	26	139

1970. From the retreat of the glacier to about 11,000 B.P, the climate in this region was cool and moist and supported a forest of fir and spruce. As climate grew warmer and drier, pine came to dominate. About 5,000 B.P. pine began to decrease, except locally (as here in the Pine Plains), its place being taken by oaks and other hardwoods. The "xerothermic interval," a warm, dry phase, occurred between 4,000 and 3,500 B.P. and saw the advance of the Prairie Peninsula north and east through Lower Michigan. This climatic optimum rapidly gave way, about 2,500 B.P., to a cooler, moister climate such as we have today. The prairie element was largely, but not totally, supplanted by beech-maple and oak-hickory forest types. The way these climatic changes affected animal distribution is well documented in Smith, 1957.

Geology

Background was supplied by Dorr and Eschman (1970) and by Kelley, in Davis (1964); details by Riggs (1938), Terwilliger (1954), and Martin (1955).

According to Terwilliger, the Pine Plains was formed on a glacial lake bed laid down during the time of Lake Glenwood, the earliest stage of Glacial Lake Chicago (17,000 years ago). Associated with Lake Glenwood was a smaller lake to the north (Terwilliger suggests the name Lake Pullman, after the town of Pullman in Lee Township) covering the area where the Pine Plains now occurs, and extending south into Columbia Township in Van Buren County. At its peak, it had an elevation of 680 feet, compared with 640 feet for

Lake Glenwood and 580 for present Lake Michigan. With the ice front to the west (and 2,000 years later, the Lake Border Moraine) and the Valparaiso Moraine to the east, Lake Pullman received the main discharge from the Lake Michigan ice lobe as well as the Grand and the Kalamazoo River discharges (see Figure 4 for map adapted from Peru, 1965). The glacial Kalamazoo River delta was located in Valley Township, just west of the city of Allegan. The meltwater overflowed south into Van Buren County and eventually reached the Chicago Outlet (the Des Plaines River to the Illinois River to the Mississippi). Fennville is situated on the Lake Border Moraine just to the west of where it gives way to the lake plain via a long, gentle descent, readily observable along the east-west M-89. The glacial lake shore can be seen as a series of dunes along the base of the Lake Border Moraine and elsewhere throughout the Pine Plains (Martin).

The elevation of the Pine Plains ranges from about 630 feet in the west to 680 feet in the east. The Miner Lake area is about the lowest of any part of the Pine Plains. The Miner Lake basin is between 610 and 620 feet, the Kalamazoo River floodplain between 580 and 600 feet. By contrast, the elevation of the Lake Border Moraine just to the west of the Miner Lake area is about 700 feet.

The massive flow of water through Lake Pullman prevented the build-up of aquatic vegetation associated with ponding. Organic soils were formed only in the depressions where small lakes remained after the big lake had drained away following retreat of the ice and lowering of Great Lakes levels. Miner Lake is an example of these relict lakes. With no inlet or outlet, bog vegetation was able to come in and create peat deposits.

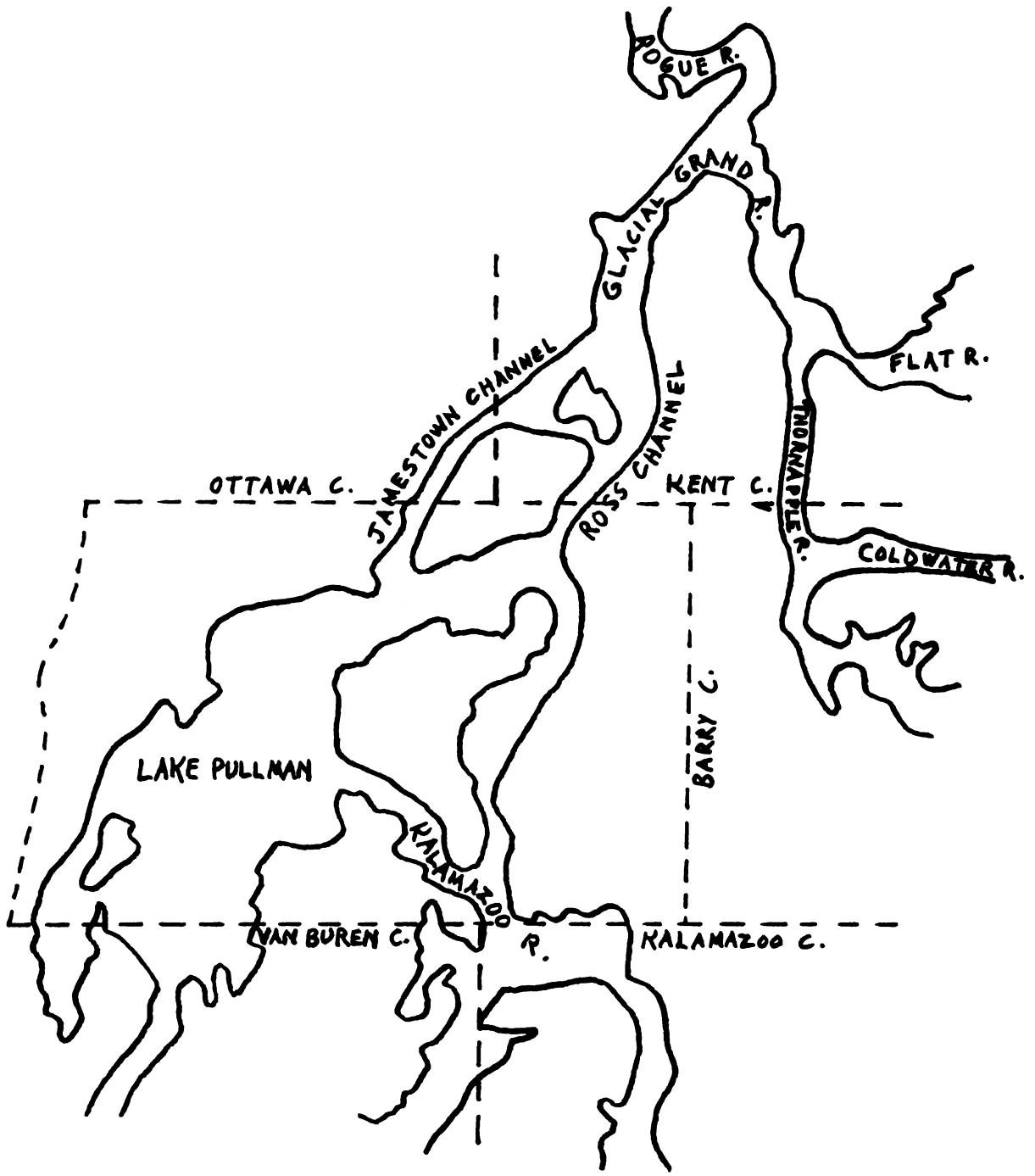


Figure 4.--Lake Pullman and Related Drainage Pattern.

Water flowing into Lake Pullman deposited 30 to 60 feet of sand on its floor. Beneath this is about 50 to 350 feet of drift laid down during earlier glacial activity. This is underlain by bedrock which in this area is mostly Coldwater Shale, a light gray or bluish gray rock associated with beds of calcareous sandstone and dolomitic shale. The 700-860 foot thick Coldwater Formation was formed in Early Mississippian time (340 million years ago) when all of the Lower Peninsula of Michigan was covered by shallow sea. Animals living in Allegan County then included molluscs like the nautilus; trilobites; brachiopods; many echinoderms, including the extinct cystoids and blastoids as well as sea lilies and brittle stars; and sharks and other primitive fish. Fossils of these creatures can be found where the bedrock crops out in Branch and Calhoun Counties. Here the shale is quarried for clay used in making brick, tile, and cement. Prior to the Pleistocene period, the Kalamazoo River had carved into this bedrock a deep valley which approximately underlies the present course of the river.

All traces of geologic ages occurring between the Mississippian and Pleistocene have been eroded away, as they have throughout Michigan. We can assume, however, that following the draining of the seas, this area consisted of swampland with huge amphibians and the first reptiles.

Riggs, concentrating on oil and gas deposits in Allegan County, goes into considerable detail in describing the layers which make up the Coldwater Formation and other layers beneath it.

It is not necessary to repeat this here. Terwilliger provides well logs from several sites on the Columbia Township lake plain. Again, this data need not be included here.

Soils

Information on soils was obtained from the Soil Conservation Service office in Fennville, with supplemental material from Veatch (1953) and Whiteside, Schneider, and Cook (1963).

The soil of the dry parts of the Miner Lake area, and of the Pine Plains generally, is Plainfield Sand, with an average slope of 3% (50% on the Kalamazoo River escarpment). The soil interpretation sheet issued by the Soil Conservation Service describes Plainfield types as "well drained soils with sandy surface layer over acid sands to 60 inches or more. Low dunes, outwash and lake plains. Drouthy and subject to wind erosion." Permeability is rapid (6.30-20.00 inches per hour). Soil reaction is acid (pH 5.1-6.5); Hodgson (1969) found the A_1 horizon to range in acidity from 4.4 to 6.4 in the Allegan Pine Plains. Organic matter content is very low; humus (mull-type) is thin. Veatch states that it belongs in the Gray-Brown Podzolic Group and is related to the Rubicon-Grayling types found on outwash plains in the northern Lower Peninsula. (Whiteside et al. label the Pine Plains soil as Rubicon-Grayling).

Path and trail use limitations are described as moderate to severe on A, B, C, D, and E slopes, severe on F slopes. "Good capacity to support foot traffic when wet, but loose sand is difficult to walk on when dry; dries out quickly in spring and after rain." The

Allegan Pine Plains is given the lowest ranking in a four-point soil classification scheme; it is the southernmost example of fourth-class land, so common in northern Michigan (Millar, n. d.).

The Kalamazoo River floodplain soil is Carlisle Muck, described as

> very poorly drained soils with more than 42 inches of muck and peat. Derived from deciduous woody plants mixed with some fibrous materials. Nearly level and depressional areas subject to water ponding. Moraines, till and outwash plains. Water table at or near surface unless drained.

Water holding capacity is very high, water intake rate very rapid. Soil reaction is acid to neutral (pH 5.6-7.3). Path and trail use limitations are described as "severe--unstable organic material with high water table; poor capacity for supporting foot traffic when wet; subject to burning and blowing when dry; difficult to maintain turf."

The soil of the Miner Lake basin is Houghton Muck, with an average slope of .63%. Houghton soils are

> very poorly drained . . . with more than 42 inches of muck and peat. Derived from grasses, sedges, reeds, and other non-woody materials. Nearly level and depressional areas subject to water ponding. Water table at or near surface unless drained.

Properties are essentially those of Carlisle Muck; pH is 5.5-7.00, peat being more acid than muck. At Miner Lake, the red maple swamp occurs on muck, the sedge and tamarack bogs on peat. Path and trail use limitations are the same as those for Carlisle Muck.

Vegetation

Introduction. The primary vegetation of the Pine Plains, growing on Plainfield Sand, was originally a white pine-white oak

mix, with the pine predominating. This is an unusual vegetation type in southern Michigan, where beech-maple and oak-hickory forest are characteristic. White pine is typical of the northern part of the Lower Peninsula; the Allegan stand represents an isolated southward extension of a northern forest type, as the presence not only of the pine but of many other plants indicates. The Allegan Pine Plains, in fact, marks the southernmost occurrence of the white pine as an important forest element.

Kenoyer (1934) used original land surveys to map the vegetation of southwestern Michigan at the time of settlement. Figure 5 shows his findings for Allegan County, and Table 2 presents data for comparing the amount of oak-pine forest with amounts of other vegetation types in southwest Michigan.

The white pine no longer exists here as a dominant. The trees were logged in the 1880's (Kenoyer); ensuing fires burned the slash and prepared the land for its present xeric oak forest, dominated by black oak, which is better adapted than white oak to early successional stages. In the Miner Lake area, large old pines can still be found in the red maple swamp which occupies the southern part of the lake basin.

Although Kenoyer's map indicates no dry prairie for Allegan County, fire-created openings in the forest did support dry prairie vegetation. The prairie element, although highly conspicuous, is poor in comparison with the prairie vegetation of the inland counties (as this is poor relative to Illinois prairie). As the pine-oak

Figure 5.--Allegan County Presettlement Vegetation Pattern.

Unshaded Area	Beech-maple forest (with hemlock in westernmost townships)
Horizontally shaded areas	Oak-hickory forest
Obliquely shaded area	Oak-pine forest
Vertically shaded area	Swamp associations

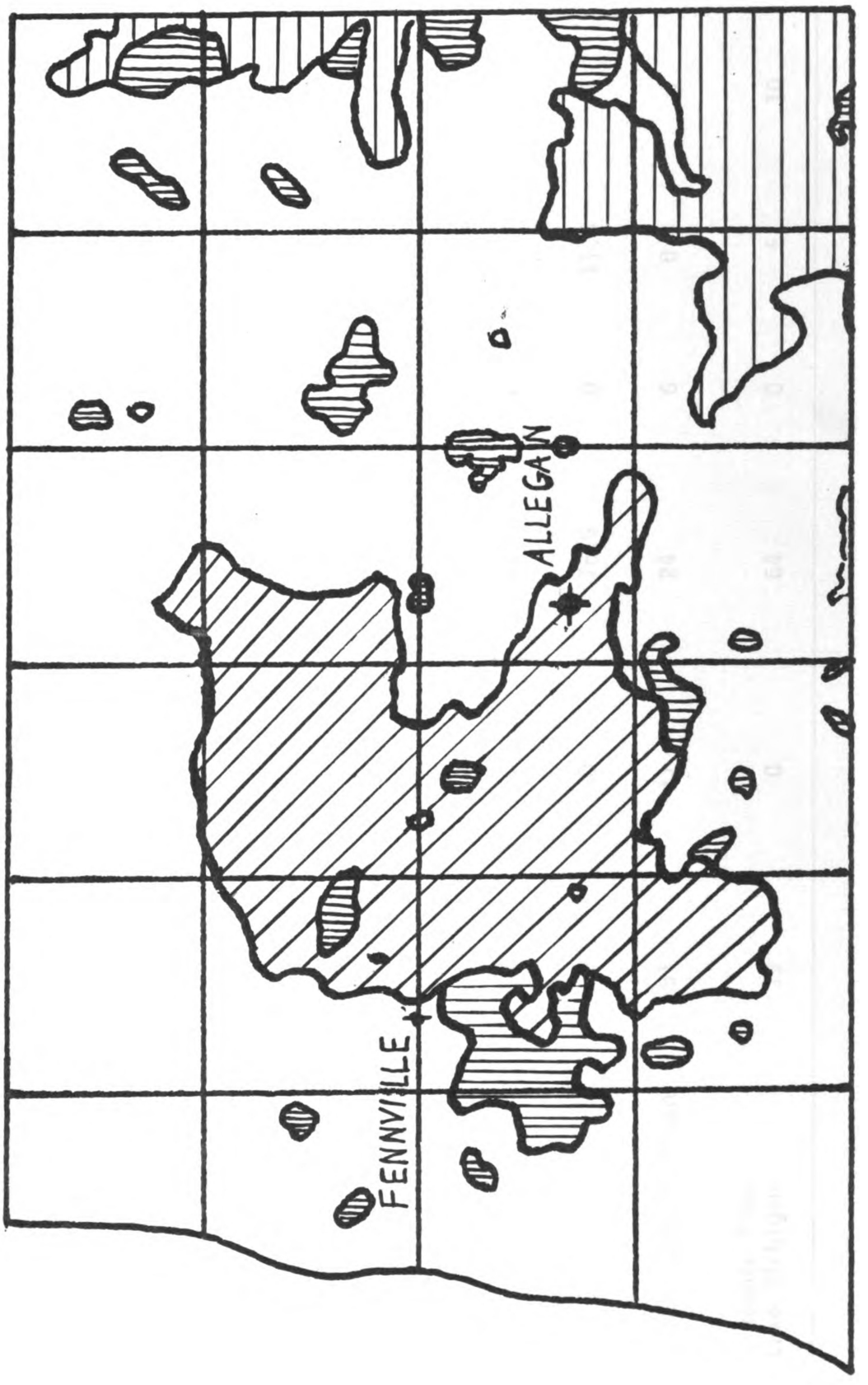

ALLEGAN
FENNVILLE

TABLE 2.--Percentage Distribution of Plant Communities for Six Southwest Michigan Counties.

County	Beech-Maple	Beech-Maple with Hemlock	Oak-Hickory	Oak-Pine	Dry Prairie	Lake and Swamp
Allegan	51	18	8	16	0	7
Van Buren	40	15	33	3	0.2	9
Berrien	62	0	32	0	1	5
Cass	28	0	59	0	4	9
Kalamazoo	23	0	56	0	8	13
St. Joseph	5	0	76.5	0	11.5	7
3 Near Lake Michigan	51	11	24	6	0.4	7
3 Remote from Lake Michigan	19	0	64	0	6	10

forest is northern in character, the prairie is southwestern, although most of the elements present are well-suited to a cold climate and also occur in the northern Lower Peninsula.

Ill-fated attempts at farming, following the removal of the pines, resulted in large tracts of cleared land which, upon the retreat of the farmers, grew up to sand prairie vegetation. Man has thus been influential in extending the acreage of this interesting plant association. Examples of both natural oak opening and "man-made" prairie* occur in the Savanna Unit. The planting of red pine plantations and protection from fire are now reducing the amount of prairie land; without periodic burning, it can be expected to entirely disappear.

E. Lucy Braun (1950) comments on the presence of such unusual vegetation types within the general boundaries of the Beech-Maple Association:

> . . . numerous inclusions of oak forest lie within the Beech-Maple region. . . . A variety of xeric oak and oak-hickory communities are normally associated with sandy or gravelly deposits where pervious subsoils result in rapid drying. The area is in a tension zone, where soils and microclimatic factors are determinative. . . . Black oak predominates in the drier sites. . . . Evidence remains of former oak openings . . . and of prairie communities . . . (p. 323).
>
> The oak forest and prairie inclusions are stages of a clisere initiated by a dry post-glacial period. . . . Like

---

*Even the "natural" openings probably owed much to man's influence. Before the coming of the white man, Indians no doubt set the woods on fire to drive out game, thus creating an environment suitable to prairie vegetation.

> the inclusions of northern conifers on bog borders, they are remnants of previous climaxes now completely surrounded by a vegetation more in accord with recent climatic influences.
>
> These transitions and inclusions add to the vegetational diversity of the region without, however, detracting from the essential uniformity of the region as a whole (p. 324).

Many kinds of wetland occur in the Pine Plains, the most interesting being the various types of bog. Four are found in the Miner Lake area. Their flora is largely boreal, and several species are found here very near their southern limit. Other wetland communities, such as bottomland hardwood forest, occur nearby.

One of the most intriguing features of the Miner Lake area is the close proximity of all these diverse vegetation types. Thus a short walk enables one to go from hot, dry sand prairie, with its cactus and butterfly weed and blazing star, to cool, moist cedar swamp where hemlock and showy lady's slipper and purple avens grow. Such dramatic contrasts provide exciting prospects for the nature trail.

Major Plant Communities. Descriptions of each of the major plant communities found in the Miner Lake area follow. See Figure 6 for locations.

1. Oak Forest. Using the plant community classification scheme developed by Curtis (1959), the original forest can be classified as Northern Dry Forest. The removal of the pine produced a modification in which trees of Southern Dry Forest--oaks and cherry--exercise a much more important role. Curtis notes that ground fires are frequent in such forest types because of low

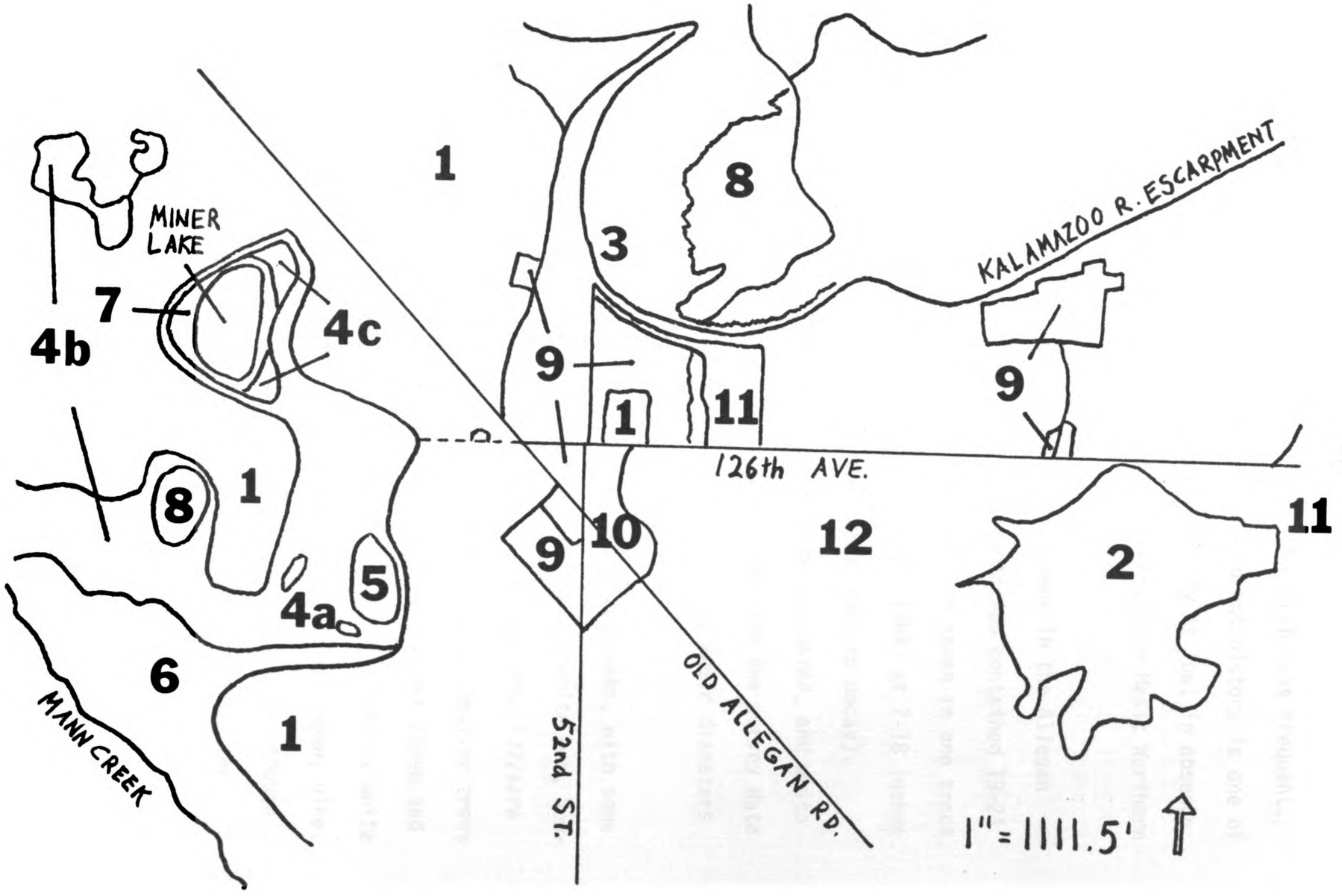
Figure 6.--Miner Lake Area Vegetation Pattern.

Major Plant Communities

1. Oak Forest
2. Oak Openings
3. Cedar-Hemlock Swamp
4. Sedge Bog
   a. Mostly bog
   b. Mostly meadow
   c. Floating mats
5. Tamarack Bog Forest
6. Red Maple Swamp

Minor Plant Habitats

7. Waterlilies
8. Wet Thicket
9. Old Field
10. Pine Plantation
11. Turkey Pasture
12. Slash


MINER LAKE
KALAMAZOO R. ESCARPMENT
126th AVE.
52nd ST.
OLD ALLEGAN RD.
MANN CREEK
1
8
3
7
4b
4c
9
1
11
9
8
1
5
4a
6
1
9
10
12
2
11
1" = 1111.5'

moisture content in the soil; crown fires are much less frequent. All species show high fire tolerance. The forest history is one of succession and retrogression cycles. Stability is low; in absence of fire, the forest readily succeeds to Dry-Mesic or Mesic Northern Forest.

Brewer et al. (1973) counted pine stumps in the Allegan Pine Plains and found that the original vegetation contained 19-24 pine trees per acre in three tracts studied, and seven in one tract. They estimated their diameter at breast height (dbh) at 7-18 inches. (Some stumps, it was noted, can be considered lost to decay). According to the 1831 land survey, white pine dominated, and white oak was second in importance. It is estimated from the survey data that the pine density was about 27 trees per acre; their diameters ranged from 7 to 30 inches.

Today, the larger trees are white and black oaks, with some white pine. Black oak is predominant in most areas; white oak, however, is a close second. Canopy tree density ranges from 122/acre to 225/acre in the tracts studied by the Brewer team. Smaller trees are also white and black oaks, especially white; bigtooth aspen and black cherry occur in much lesser numbers. In the understory, white oak is by far the dominant species; black oak, bigtooth aspen, pine, black cherry, and flowering dogwood are much less frequent, though all are conspicuous. In some places red maple is common in the understory. To these species noted by the Brewer team can be added sassafras, witch hazel, and two species of shadbush.

We found that in the Miner Lake and Kalamazoo River Escarpment Units, conspicuous plants in the low shrub and herb levels were bracken, Pennsylvania sedge, black oatgrass, wintergreen, black huckleberry, and low blueberry. Species of special interest were pink lady's slipper, pipsissewa, roundleaf pyrola, trailing arbutus, downy false foxglove, and cow-wheat.

Future succession, according to Brewer et al., will emphasize the white oak more. Red maple, present as small trees, could develop increasing importance, as it apparently has in northern Michigan and elsewhere (see references in Brewer et al.). A forest dominated by red maple and oaks could be transitional from dry oak forest to mesic beech-maple. White pine probably will never return to dominate the forest as it once did, although Brewer et al. note that the late leafing out of the oaks, resulting in late closing of the canopy (early June) may give young pines the light they need to continue growth. Presumably they could once again become important in the canopy.

Oak Forest Phenology

Based on Wenger (1970) and on personal observation. Information on bird movements is provided here for convenience.

Mid April--red maple flowers

Late April--smooth shadbush flowers; trailing arbutus

Early May--downy shadbush flowers; low blueberry, plantain-leaved pussytoes, and northern downy violet; ovenbird, great crested flycatcher, scarlet tanager, and rose-breasted grosbeak arrive; spring azure and mourning cloak butterflies

Mid May--smooth shadbush out of bloom, leaves unfolding (red in color); downy shadbush still in peak bloom; dogwood begins; wood betony; bracken fiddleheads up; canopy trees begin leafing out; wood pewee, yellow-throated vireo, wood thrush, least flycatcher arrive; migrating warblers pass through

Late May--pink lady's slipper and bastard toadflax; whip-poor-will, red-eyed vireo, and cuckoos (two species) arrive

Early June--black cherry flowers; dewberry, mapleleaf viburnum, black oatgrass; leafing out of canopy completed; leaf-rollers conspicuous in witch hazel

Mid June--bracken full-grown; lepidopteran larvae and carabid beetles abundant

Late June--pasture rose flowers

Early July--New Jersey tea flowers; pipsissewa; smooth shad-bush berries ripening; blueberries ripe

Mid July--roundleaf pyrola and flowering spurge bloom; downy false foxglove; deer flies abundant

Late July--wintergreen blooms; ovenbirds leave (first summer residents to do so)

Mid August--woodland sunflower and bluestem goldenrod bloom

Late August--dogwood fruits turning red

Early September--white oak acorns drop

Mid September--flowering dogwood starting to turn color

Late September--wood pewees leave (last summer residents to do so)

Early October--sassafras (gold-yellow) and dogwood (pale yellow to pale red) turn color

Mid October--bracken brown, shriveling; leaf shed of shadbush completed; oaks turn color (russet to purple-brown); black cherry leaves yellow; huckleberry red, low blueberry dark red to purplish (both very attractive); pink lady's slipper leaves wilted, yellow with brown edges; trailing arbutus in bud

Late October--cherry, shadbush, maple, sassafras, and dog-wood completely shed; two-thirds oak leaf loss

Early November--witch hazel flowers

Mid November--most oak leaves gone

2. Oak Openings. This association is made up of Curtis' Savanna and Sand Barrens. It constitutes one of the most beautiful vegetation types in Michigan, a natural park of grassland broken by individual trees and clumps of trees. Savanna occurs where the soil is least disturbed and a thin sod covers the sand. Sand barrens represents an earlier successional stage; sod gives way to exposed sand on which the pioneer mosses (Polytrichum) and lichens (Cladonia) grow, with panic grasses and purple needlegrass. The sand barren type dominates abandoned fields.

Both associations are dependent on fire for their maintenance. Without fire, savanna grows up to brush within 10 years, to forest in 25-30 years. Conversion from sand barrens is much slower. The last fire in this area occurred in 1967 or 1968. Effects of fire other than control of brush are documented by Smith and Owensby (1973) and by Anderson (1973).

Curtis observes that the sand barrens presents "an extremely severe and exacting environment," characterized by high soil temperatures (140-155°F in summer), high evaporation rate, low surface moisture, and the "almost total lack of available nutrients." Not surprisingly, many plants survive only by special adaptations. These include:

--an annual lifestyle, permitting plants to bloom in the cool, moist spring and then die back and survive the summer as seeds (blue toadflax, false dandelion, Venus looking-glass)

--water storage (prickly pear, racemed milkwort, which produces swollen, white, cleistogamous flowers on underground branches; these do not set seeds and are used for water storage)

--small, hard, tough leaves to reduce transpiration (bearberry, slender knotweed)

--hairy covering to reduce transpiration (sweet everlasting, long-bearded hawkweed)

--deep tap roots (butterfly weed, wild lupine)

Some species, notes Curtis, seem not to have any such adaptations and yet survive splendidly (birdfoot violet).

Trees of the oak openings are black and white oaks, black cherry, and sassafras. Common shrubs are New Jersey tea, early low blueberry, common dewberry, and pasture rose; less common ones include shadbushes of four species, eastern dwarf cherry, bearberry, black huckleberry, and late low blueberry. A large variety of herbs is present, dominated by Pennsylvania sedge and the following grasses: Kentucky bluegrass (an alien), junegrass, poverty oatgrass, black oatgrass, starved panic grass, and little bluestem. The abundance of several kinds of wildflowers is responsible for impressive floral displays in the spring. The summer aspect is totally different. The lush, flower-spangled green of spring gives way to a seered yellow-brown look; the dessicated lichens crunch underfoot, fruiting lupine and coreopsis are brown and shriveled, and flower color is sparse. I have observed in years past, however, that if rain has been plentiful during the summer, several species are capable of putting on a minor show about the end of August.

Oak savanna was a common vegetation type in the Great Lakes region at one time. Braun (1950) describes the Kankakee sand plains as "an area of some 3,000 square miles partly in Illinois and partly in Indiana. Low ridges in the sand plains are forested; black oak (of small stature) is usually the dominant tree. In open stands, prairie species are abundant in the undergrowth" (p. 189). Good examples of this area are apparently now rare--at least no parts of it have been preserved or identified as being worthy of preservation (Lindsey et al., 1969; Illinois Nature Preserves Two-Year Report, 1973). In southern Wisconsin, probably the most important vegetation type at the time of settlement was oak savanna, dominated by bur oak, white oak, and bluestem. Writes Curtis: "Beyond question, an oak savanna with an intact ground layer is the rarest plant community in Wisconsin today." So it would seem that this vegetation type--or at least good examples of it--are rare not only in Michigan but in adjacent states as well.

Two of the dominant grasses (three including the alien bluegrass) are dominants in true tallgrass prairie; two others, less common but conspicuous, are big bluestem and Indian grass. The strong affinity of this grassland flora with true prairie is interesting and significant enough to warrant extensive discussion.

Out of a list of 68 Michigan prairie species compiled by Scharrer (1971), 27 occur in the Savanna Unit; three additional species have been found outside the Unit. Betz's list (1965) for

Chicago-area prairie contributes another six.* It is interesting that the best prairie remnant discovered by Scharrer (in Cass County) had 28 prairie species, only one more than the number for the Savanna Unit.

The comparison between the Allegan oak opening flora and the Newaygo County sand prairie flora shows much greater similarity than dissimilarity. By far the majority of prairie species (35) are had in common; 16 more occur only at Newaygo (including porcupine grass, tall cinquefoil, prairie avens, round-headed bush-clover, downy phlox, hoary vervain, hardleaved goldenrod, western silvery aster, and heath aster--Hauser, 1953, and personal observation). Only one prairie plant, Ohio spiderwort, seems to occur in Allegan but not in Newaygo.

Curtis and Greene (1949) recognized sand prairie as one of four prairie types in Wisconsin. They found it to be the "least distinct . . . and subject to greatest disturbance. Vegetation seems to be at subclimax level, rarely reaching stability." Of the 10 most typical Wisconsin species, five occur in the Pine Plains, six in Newaygo. Of the five species they listed as being preferential for sand prairie, four are found in the Pine Plains (rough blazingstar, little bluestem, junegrass, and long-bearded hawkweed); all five occur in the Newaygo sites (the fifth being round-headed bush-clover). See Figure 7 for an interesting comparison based on their data.

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*Kenoyer (1934) notes that a seventh, the prairie avens (Geum triflorum) is found here. If so, it must be very local, as we failed to find it anywhere in the Pine Plains.

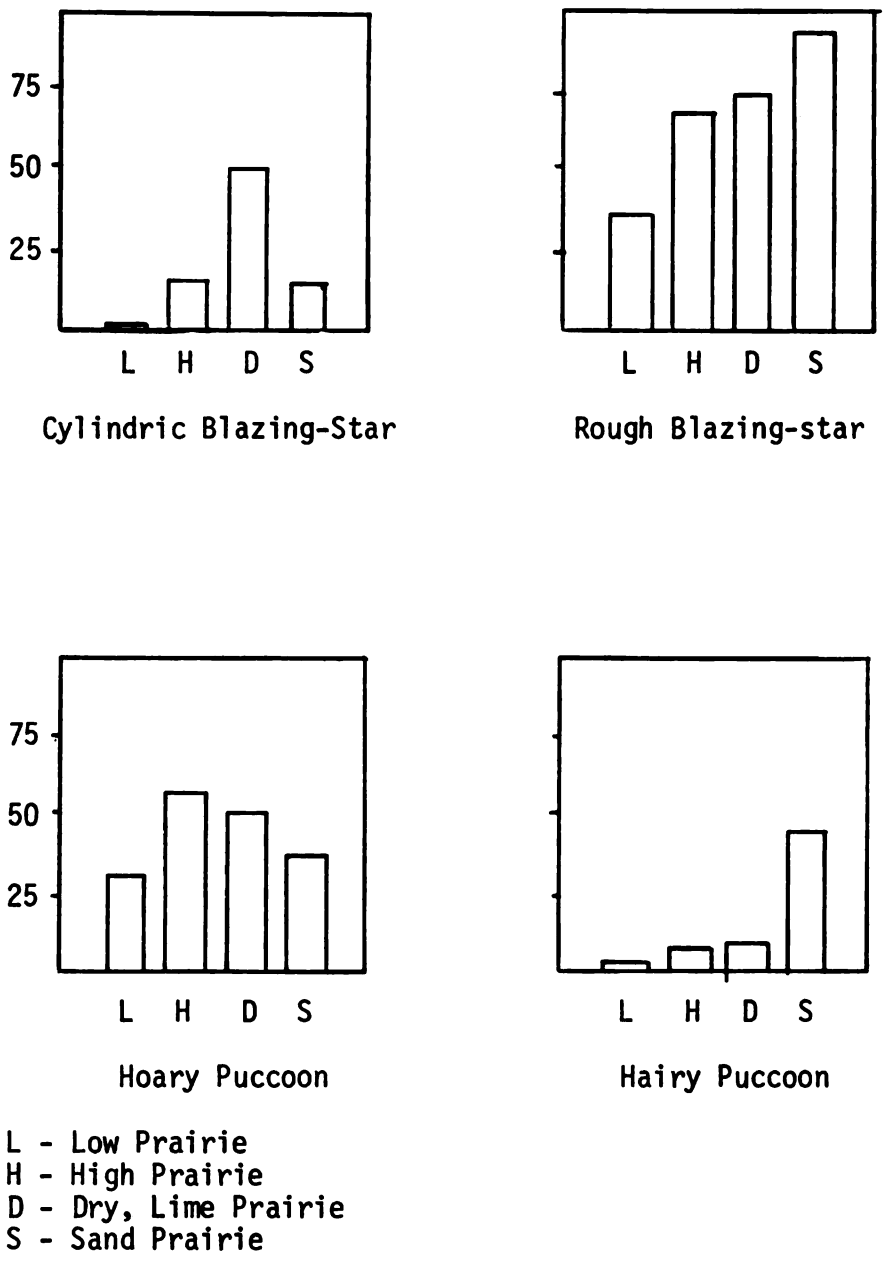

Figure 7.--Presence Percentages for Four Prairie Species in Each of Four Prairie Types.

In closing this section, a comparison between the Allegan savanna flora and the vegetation of the jack pine plains of northern Michigan is appropriate. Beal (1904) lists most of the plants to be found there. The list is reproduced here, the nomenclature updated to conform with the Eighth Edition of Gray's Manual (Fernald, 1950). Species common both to the Pine Plains (but not necessarily to the Savanna Unit) and to the jack pine plains are noted with an asterisk.

Most Common Species

*Amelanchier arborea
*Andropogon gerardi
*Andropogon scoparius
*Arctostaphylos uva-ursi
*Aster laevis
*Carex pensylvanica
*Comptonia peregrina
*Danthonia spicata
*Epigaea repens
*Erigeron canadensis
*Gaultheria procumbens
Oryzopsis canadensis
*Pinus banksiana
*Populus tremuloides
*Prunus pensylvanica
*Prunus pumila
*Prunus virginiana
*Pteridium aquilinum
Quercus coccinea
*Quercus velutina
*Rumex acetosella
*Salix humilis
*Solidago nemoralis
Vaccinium myrtilloides
*Vaccinium angustifolium
*Vaccinium vacillans

Less Frequent Species

Agrostis scabra
*Antennaria plantaginifolia
*Apocynum androsaemifolium
Aralia hispida
*Campanula rotundifolia
*Ceanothus americanus
Cirsium pumilum
*Comandra umbellata
*Convolvulus spithamaeus
Diervilla lonicera
*Erigeron strigosus
Festuca ovina
*Fragaria virginiana
*Gaylussacia baccata
*Liatris cylindracea
*Lithospermum croceum
*Lycopodium complanatum
*Maianthemum canadense
*Melampyrum lineare
*Monarda fistulosa
*Oenothera biennis
*Panicum depauperatum
*Panicum dichotomum
Pinus resinosa
*Pinus strobus
*Polygala polygama
*Populus grandidentata
*Potentilla canadensis

Gnaphalium macounii
*Helianthemum canadense
*Helianthus divaricatus
*Helianthus occidentalis
*Hieracium venosum
*Houstonia longifolia
*Koeleria cristata
*Krigia virginica
Potentilla tridentata
*Quercus alba
Rubus canadensis
*Rubus hispidus
*Rudbeckia hirta
*Solidago juncea
Viola adunca
*Viola pedata

Oak Opening Phenology

Late April--big bluestem renews growth

Early May--Pennsylvania sedge, early buttercup, spring beauty bloom; olympia butterflies common

Mid May--birdfoot violet, hoary puccoon bloom; big leafy rosettes of columbo conspicuous

Late May--wild lupine blooms (great blue patches), with rock sandwort, hairy puccoon, prairie ragwort; columbo begins growth of stalk; Karner blue butterflies abundant

Early June--crickets singing; orange hawkweed (alien) blooms; foliage of big bluestem conspicuous

Mid June--columbo stalk five feet high; junegrass, black oatgrass, Ohio spiderwort, hairy beardtongue, and lanceleaf coreopsis (much yellow) bloom; little wood satyr butterflies abundant

Late June--pasture rose and columbo (only in certain years) bloom

Early July--poverty oatgrass, flowering spurge, prickly pear bloom; black oatgrass seeds picked up in clothing

Mid July--New Jersey tea, goat's-rue, butterfly weed, racemed milkwort bloom; deer flies abundant

Late July--long-bearded hawkweed, whorled milkweed, cylindric blazingstar, woodland sunflower bloom; black oatgrass seeds completely shed; tawny-yellow aspect; Karner blue butterflies commonly seen on butterfly weed

Early August--showy goldenrod (var. angustata) and western sunflower bloom; flower stems of big and little bluestem conspicuous

Late August--rough blazingstar, azure aster, sweet everlasting, gray goldenrod, big and little bluestem, Indian grass bloom; black cherry fruits ripening; leaves of columbo died back

Early September--showy goldenrod (typical variety) blooming, angustata fruiting

Mid September--only gray and showy goldenrods and azure aster still in full bloom

Mid October--attractive yellow (cherry) and purple-brown (oak) aspect; pale brown patches of big bluestem; pasture rose bright red; columbo pods still retaining seeds; a few azure aster flowers

3. Cedar-Hemlock Swamp. At the base of the Kalamazoo River escarpment, over 40 feet below the oak forest, is a swamp of northern conifers dominated by northern white cedar and hemlock. Curtis calls the type Northern Wet-Mesic Forest. It is very stable, but is succeeded eventually by Northern Mesic Forest. White pine occurs in the drier and tamarack in the wetter parts. Associated hardwoods are black ash, yellow birch, and red maple. Spicebush is predominant in the tall shrub layer, which offers quite a variety of species. Dominant herbs are cinnamon fern, skunk cabbage, Canada mayflower, marsh marigold, goldthread, and wild sarsaparilla. Of special interest are over 30 species of distinctively northern plants (see Appendix A, Section 3) and nine species of orchids, of which the showy lady's slipper is visually the most impressive. As a southern plant growing in a northern forest type, lizard's-tail is noteworthy. Seepage springs with water high in calcium are responsible for the presence of several calcicolous species. Twinflower is known to occur in the same habitat at a location about 40 miles south (Grande Mere, Berrien County) and is to be expected here as well, although the inventory did not turn it up.

The swamp represents a relict plant association, persisting in response to favorable microclimatic conditions, and later invaded by a more southern element. One of the most conspicuous plant communities in northern Michigan, cedar swamps are rare this far south.

The forest presents a mature aspect. The trees create a gloomy environment of deep, cool shade. While not especially large, they are good-sized relative to what is normally seen. Four of the largest cedars were 15.6, 16.4, 17.8, and 17.9 inches dbh. While hemlock, cedar, and pine seedlings occur (rather sparsely), trees of intermediate size appear to be absent. The forest floor is cut by numerous small creeks and pitted by pools of water or muck.

Bryophytes are especially conspicuous in such a forest. Sphagnum occurs in the wettest areas, associated with tamarack, poison sumac, showy lady's slipper, and pitcher plant. In the higher, drier parts, beds of an attractive, large-leaved moss, probably Mnium, are common, especially on dead wood. Other species include fern moss (Thuidium) and tree moss (Climacium dendroides); liverworts are also common. Fungi are noteworthy for their variety; a discussion on the fungi found here is reserved till a later section.

Cedar-Hemlock Swamp Phenology

Early April--skunk cabbage blooming

Mid May--goldthread and naked miterwort (on logs)

Late May--pink and yellow lady's slippers, large-flowered trillium, swamp saxifrage blooming

Early June--purple avens

Mid June--showy lady's-slipper and pink pyrola

Late June--bog twayblade

Early July--northern green orchid and white adder's-mouth, small enchanter's nightshade; dwarf raspberry fruit ripe

Late July--lizard's-tail and green-headed coneflower

Early August--clubspur orchid and purple fringed orchid; red baneberry in fruit; painted boletinus conspicuous

Late August--hemlock-parsley blooming; spikenard in fruit

Mid October--strongly contrasting dark green overstory and yellow (spicebush) understory; leaves of birch already shed; no sign of skunk cabbage (!); much pine needle shed

4. Sedge Bog. Sedge or Open Bog (Curtis' term) is found just south of Miner Lake. Merging with it are two associated communities, Northern Sedge Meadow and Emergent Aquatic Community. Parts of the association seem to fit Curtis' description of an open bog-sedge meadow hybrid, produced by natural or artificial drainage lowering the water table, allowing fire to destroy surface peat layers. The dominant plant is probably water sedge (more associated with sedge meadow); slender sedge is also abundant (more associated with sedge bog). Other common sedges are tawny cottongrass, white beakrush, and twigrush. Other common herbs include royal and marsh ferns, cattail, and bluejoint. Common shrubs are meadowsweet, steeplebush, bog rosemary, leatherleaf, and large cranberry. Bog wildflowers include orchids (four spp.), pitcherplant, sundews (two spp.), buckbean, and bladderworts (four spp.); sedge meadow flowers include marsh cinquefoil, common skullcap, marsh bellflower,

spotted joe-pye-weed, goldenrods (four spp.), and asters (three spp.).

Emergent aquatics include three-way sedge, great bulrush, white waterlily, spatterdock, mermaid-weed, and purple bladderwort. Along the east shore of the lake basin, these give way to a fringe of sloughgrass, or prairie cordgrass, on slightly higher, drier ground. This is a prairie species also characteristic of Southern Sedge Meadow. A narrow shrub zone surrounds this part of the lake basin, made up of autumn willow, meadowsweet, swamp rose, and some buttonbush. An outstanding late summer feature of these shores is the spectacle of masses of bright yellow tickseed-sunflower.

Two floating bog mats are found, separated from the rest of the sedge bog by emergent aquatic vegetation and from each other by Miner Lake itself. Located on private property, their future is uncertain and they will probably not be available to interpretation. However, as part of the Miner Lake basin complex--and a very fascinating part--they certainly deserve comment. The vegetation offers a few elements not found in the sedge bog proper, including Carolina yellow-eyed grass, pickerelweed, dwarf St. Johnswort, and humped bladderwort. Rose pogonia occurs in abundance on both mats, grasspink is found only on the southern mat. The chief interpretive value of these mats, of course, is the fact that they are floating islands which, when walked upon, can be made to shiver and roll and ripple not unlike a mound of jello.

On the shore opposite the southern mat grows a colony of Rhynchospora macrostachya, a sedge found only on the Atlantic

Coastal Plain and around the southeast corner of Lake Michigan. Voss (1972) says that because of its large size, it serves well as an indicator plant for smaller, less conspicuous sedges which share its oddly disjunct range. My field studies were terminated before I had a chance to search for these lesser associates, which--if they occur at all--would probably include Psilocarya scirpoides and Scleria reticularis. Ely and Crooked Lakes, six miles away, are known to harbor a large selection of these Coastal Plain disjuncts (Pierce, 1974). In fact, Crooked Lake probably has more kinds than any other location in Michigan. Pierce observes that three conditions must be met for these plants to be present: 1) a shoreline consisting of sedge peat grading into acid sand; 2) soft water (neutral to moderately acid); and 3) a lake level that fluctuates greatly from season to season and year to year, due to absence of inlet or outlet ("seepage lake"). Miner Lake seems to meet these conditions. Seasonal lake level fluctuation is very pronounced; in spring the lake is two to three times its late summer size. The only indication we have, however, that the level changes from year to year is the presence of the sedge. Pierce states that the seeds of these plants were no doubt introduced from the northern Coastal Plain by waterbirds, and that their "distribution in the Midwest is related not so closely to geologic history [as was long theorized] as to present distribution of a suitable habitat."

Much of the research done by Crow (1969) at Pennfield Bog near Battle Creek (Calhoun County) is applicable to Miner Lake Bog.

He concluded that 10% of the species were widespread, 26% were typical of the Eastern U.S., 8% of the unglaciated Coastal Plain, 28% of the glaciated Northeast, and 28% were northern and circumboreal. Judging by the similarity between the species lists for the two bogs, these percentages would be very roughly comparable to Miner Lake.

Curtis (1959) stresses the extreme limiting factors present in open bogs, which prevent other plants from moving in and competing and which therefore contribute heavily to the unusual longevity of this successional stage. These factors are: water saturation, high surface temperature coupled with low root-level temperature, high acidity (all three of which prevent or retard decay), low nutrient level (a function of poor decay), and possibly the production of toxic substances by sphagnum and other bog plants. Crow (1969a) measured average pH values in the various bog zones and found that open water was neutral; the sedge-cranberry zone was 6.03 but ranged from 4.7 in sphagnum hummocks to 6.8 in depressions; leatherleaf areas were 4.76; areas of highbush blueberry growing under tamarack were 4.5, of sphagnum under tamarack, 4.18; and the red maple zone was 4.81 (6.42 in openings at the outer edge).

The depressions in the sedge-cranberry zone, with their near-neutral pH, present an interesting microhabitat. In late summer, notes Crow, the low acidity, higher temperatures, and lower water table permit some decay to take place. Growing here but nowhere else in the bog are spoon-leaved sundew and flat-leaved

bladderwort. Both of these are also found at Miner Lake, under apparently the same circumstances.

Sedge Bog Phenology

Based on Brewer (1966) and on personal observation.

Late April--leatherleaf blooms

Early May--northern bog violet; spring peepers calling

Mid May--buckbean in bloom; bog rosemary begins

Late May--pitcher plant begins; arethusa begins (through mid June)

Early June--spatterdock and white waterlily begin; cranberry begins; marsh cinquefoil, flat-leaved bladderwort; buckbean in fruit; green frogs calling; spotted turtles seen

Late June--rose pogonia begins

Early July--grasspink begins (through late July); ragged fringed orchid, purple bladderwort, white beakrush; leaves of cordgrass very conspicuous; bog copper butterflies abundant

Mid July--spoon-leaved sundew and yellow-eyed grass; scattered cranberry blossoms, many yellow cranberries

Late July--tawny cottongrass blooms

Early August--steeplebush begins; cordgrass and bog goldenrod

Mid August--tawny cottongrass in fruit; new growth of leatherleaf noticeable, and flower buds present

Late August--cranberries begin to redden; tickseed-sunflower and rush aster begin

Mid October--cottongrass still in fruit, shedding seeds; leatherleaf mostly green, some orange leaves; poison sumac mostly leafless, hanging clusters of white berries conspicuous (yellow-rumped warblers feeding on them)

5. Tamarack Bog Forest. In southwest Michigan sedge bog succeeds to tamarack thicket which yields to tamarack forest (Brewer, 1966), called Northern Wet Forest by Curtis. It is very stable but given certain conditions will succeed to mixed forest (pine-maple-birch). In northern Michigan it succeeds to black spruce, which succeeds to white cedar. Brewer (1966) observes that changing water levels, fire, and insect damage usually prevent this sequence from being carried to completion. As with sedge bog, the environment is very acid and very wet, hence very low in oxygen. The anaerobic conditions inhibit decay, so that mineral nutrients are essentially unavailable. Curtis notes that since bogs are lower than the surrounding land, cool air collects there and causes dense night fog, which encourages a heavy growth of moss and lichens on the twigs.

About six acres of tamarack forest exist in the southeast corner of the Miner Lake basin, surrounded by sedge bog. (On the east, only a very narrow strip of bog-meadow separates it from the oak forest). White pine joins the tamarack in making up the overstory; highbush blueberry creates a very dense understory. Several shrubs are associated with it: speckled alder, two species of chokeberry, poison sumac, winterberry, and mountain-holly. Virginia chainfern and several sedges are common, but wildflowers are scarce. Canada mayflower, goldthread, pitcher plant, bristly dewberry, and wintergreen are probably the most common. In the clearings, where sunlight permits, pink lady's slipper, grasspink, and white fringed and yellow fringed orchids are common. The grasspink

is exceptionally large and showy here. Hybrids between the two fringed orchids are more common than either species. Deep cushions of bright green sphagnum moss everywhere cover the ground.

Tamarack Bog Forest Phenology

Based on Brewer (1966) and on personal observation

Late April--tamarack begins to leaf out

Mid May--tamarack in flower (male and female on same twig); blueberry begins to bloom; pick lady's slipper (to mid June)

Late May--pitcher plant begins; chokeberry in flower

Early June--new cones on tamarack; green developing fruits on blueberry

Mid June--poison sumac begins

Early July--new growth of tamarack noticeable; wintergreen with new growth; grasspink, Indian pipe, dewberry begin

Mid July--blueberries ripening (some remain green to end of month)

Late July--white fringed and yellow fringed orchids begin; wintergreen

Mid August--cottongrass fruiting; 10-14" of new growth on young tamaracks

Late August--blueberries almost all gone; chokeberries beginning to ripen; dewberries ripening

Mid October--tamaracks still mostly green, just beginning to turn color; winterberry leaves a blackened green, bushes loaded with red berries; blueberry dull orangy mass beneath tamaracks, well into shedding (some bushes already done); cottongrass still in fruit, shedding seeds; chokeberry dark purple, mostly shed; fringed orchid stalks brown, dried-out

Late October--tamaracks golden-yellow

Late November--tamarack leaf-shed completed

6. Red Maple Swamp. Red maple swamp occupies the low land south and southwest of the sedge bog. As the highest part of the Miner Lake basin, this area has been free of water the longest, affording time for the final stage of bog succession to develop. It is currently drained by Mann Creek, which runs from southeast to northwest on its way to the Kalamazoo River. The creek is inaccessible except to those willing to wade through deep muck and thick brush. Many small pools pit the forest floor.

The red maple swamp found here is the same as Brewer's "mixed forest" and is classified by Curtis as a type of Northern Wet-Mesic Forest, though quite different from cedar swamp. At its upland edge, where it merges with oak forest, the mesic quality is quite evident and here the boreal element is most pronounced.

The common tree is red maple; lesser numbers of white pine, American elm, ironwood, and ashes (at least two species) occur. The yellow birch is rather uncommon but is noteworthy because of its northen range and its unique habit of enveloping old stumps with prop roots. The white pines are quite large; three of them we measured were 22.6, 25.5, and 29.6 inches dbh.

Common shrubs are spicebush, gray dogwood, and speckled alder. Dominant herbs include cinnamon fern, royal fern, several grasses, jack-in-the-pulpit, Indian cucumber-root, Canada mayflower, goldthread, bristly dewberry, four species of violet, and partridgeberry. A small colony of nodding trillium is found on the northern border.

The upper edge is an ecotone where oak forest species merge with swamp species. Here are large beds of tree club moss, much goldthread, some bunchberry, shinleaf, roundleaf pyrola, starflower, and mountain honeysuckle. Most of these are especially characteristic of the mounds which were once the root systems of fallen trees. Nearby, but in wetter soil, are small colonies of beadlily occurring rarely, and clubspur orchids, also quite local.

Red Maple Swamp Phenology

Early April--red maple and American elm flowers

Early May--marsh marigold, sweet white violet, and goldthread; clubspur orchid leaves up

Late May--Canada mayflower, starflower, beadlily, bunchberry begin

Early June--Indian cucumber-root begins

Late June--partridgeberry flowers

Early July--dewberry in bloom; pyrola beginning

Late July--beadlily in fruit

Early August--clubspur orchid in full bloom

Late August--great lobelia begins; cinnamon fern starting to die back; dewberries ripening

Mid September--red maple and sourgum starting to turn color

Mid October--red maples yellow (not red); sourgum nearly all shed; cinnamon fern brown and shriveled; gray dogwood still green, spicebush mostly green; low blueberry dull yellow; many spring peepers observed in woods

Rare Plants. Probably none of the plants in the Miner Lake area are rare in an absolute sense; i.e., probably all are common

in some part of their range. They are rare only for this part of the country. Most of these plants are northerners found here very near or even at the southern limit of their distributions. They don't normally begin to get common until the latitude of Clare, Michigan is reached, about 90 miles north. This is considered the point at which the North Woods begins.

The extreme southern limit for many of these plants is reached in northern Illinois and northern Indiana. A few bogs in these states still harbor most of the northerners found at Miner Lake; some are extremely rare, and others are extinct in the Illinois-Indiana area. Man's destruction of bog habitat there has contributed much to the rarity and has significantly enhanced the value of such places as Miner Lake, where a large selection of boreal species can still be found close to their southern limit. (As "the only bog in Illinois that contains a well developed tamarack forest and all prior stages of bog succession,") Volo Bog in Lake County is the only bog in Illinois that is comparable to Miner Lake (Illinois Nature Preserves Two-Year Report, 1973).

Another pattern of rarity, one which accounts for only a few species in the Miner Lake area, involves southerners found as far north as southwest Michigan. These include several dry prairie plants, now limited in Michigan (except for a few hundred acres in Newaygo County) to a few railroad strips and undisturbed roadsides. Though they have always been local, man's alteration of the environment is the major cause of their rarity. All are (or were) common

and widespread in Illinois and Indiana--the time is rapidly approaching when one will have to go to a natural area preserve to find them. For some, that time has already come. Tallgrass prairie is the most decimated major vegetation type in the United States.

Allegan County thus falls within a tension zone where north and south meet. Not all northerners and southerners within this zone are rare. Some, in fact, are abundant both in and outside of the Pine Plains, including such southerners as flowering dogwood, black oak, and sassafras; northerners like white pine and hemlock, while more local, are hardly rare in southern Michigan.

Berrien County, 12 miles south of Allegan County and 26 miles south of Miner Lake, is one of 22 counties included by Swink (1969) in the Chicago region. Since Miner Lake can thus be considered as situated on the fringe of the Chicago region, some indication of the rarities among its plants can be gathered from Swink's comments. A list of 35 species follows, with notes from Swink and from the Illinois Nature Preserves Two-Year Report. All quotes, unless otherwise noted, are from Swink.

Tree Clubmoss (Lycopodium obscurum) "Rare"

Virginia Chainfern (Woodwardia virginica) Antioch Bog, Lake County, is "the only known Illinois station" (Preserves Report). "Locally frequent" in Indiana (Swink).

Canada Yew (Taxus canadensis) "In our area known only from Berrien and Kankakee Counties." ("undoubtedly extinct" in Kankakee County)

Hemlock (Tsuga canadensis) "In our area known only from Berrien County"

Carolina Yellow-eyed Grass (Xyris caroliniana) "very local"

Nodding Trillium (Trillium cernuum) "Very rare; . . . by now it is undoubtedly extinct in Indiana."

Showy Lady's slipper (Cypripedium reginae) "This plant grew by the thousands in Lake County, Indiana, where downtown Gary now stands. It is now very rare in our region, and probably extinct in most of the [Chicago region]."

White Fringed Orchid (Habenaria blephariglottis) "Booth Lake, Berrien County"

Yellow Fringed Orchid (Habenaria ciliaris) "Very rare"

Clubspur Orchid (Habenaria clavellata) "Rare"

Arethusa (Arethusa bulbosa) "Now almost certainly extinct in the Chicago region; known to have occurred in Lake County, Indiana," the location of "probably the last specimens of the Indiana dune region, and possibly for the entire state."

White Adder's-mouth (Malaxis brachypoda) Not listed by Swink; apparently not found in the Chicago region.

Autumn Willow (Salix serrisima) "Rare"

Rock Sandwort (Arenaria stricta) "by no means common"

Naked Miterwort (Mitella nuda) "In [the Chicago area] known only from Berrien and Racine Counties."

Smooth Gooseberry (Ribes hirtellum) "Very rare"

Low Juneberry (Amelanchier humilis) "Very rare"

Running Juneberry (Amelanchier stolonifera) Not listed by Swink; apparently not known from the Chicago area.

Smooth Shadbush (Amelanchier laevis) "Outside of the [Lake Michigan] dune area, it is rather scarce."

Purple Avens (Geum rivale) "Very rare" Trout Park Nature Preserve, Kane County, is the only known Illinois station (Preserves Report).

Small Enchanter's Nightshade (Circaea alpina) "Very rare"

Hemlock Parsley (Conioselinum chinense) "exceedingly rare" Trout Park Nature Preserve, Kane County, is the only known Illinois station (Preserves Report).

Bunchberry (Cornus canadensis) "Now extremely rare"

Roundleaf Pyrola (Pyrola rotundifolia) "Very rare"

Pink Pyrola (Pyrola asarifolia purpurea) "In [the Chicago] area known only from Berrien and Racine Counties."

Pipsissewa (Chimaphila umbellata) "Although collected in ten counties in [the Chicago] area, it has now become extremely rare."

Trailing Arbutus (Epigaea repens) "Now reduced to a very few stations in [the Chicago] area. . . . A specimen exists collected by Vasey in 'Illinois'; apparently there is no other evidence of the presence of Trailing Arbutus as a wild plant in Illinois."

American Columbo (Swertia caroliniensis) "Rare and local"

Downy False Foxglove (Gerardia virginica) "Rare"

Flat-leaved Bladderwort (Utricularia intermedia) "Very rare, and possibly even extinct"

Humped Bladderwort (Utricularia gibba) "Rare"

Purple Bladderwort (Utricularia purpurea) "known only from Lake and Porter Counties in Indiana, where it is very rare." I have also seen it at Grande Mere, Berrien County.

Partridgeberry (Mitchella repens) "Exceedingly rare in our Illinois and Wisconsin sectors"

Twinflower (Linnaea borealis) Not yet known from Miner Lake area, but presence is likely. "now very rare . . . being extinct in Illinois and almost certainly so in Lake County, Indiana. From this latter county Pepoon reported a station at Miller (east part of Gary) which had thousands of plants extending for one-fourth mile, but which apparently was eventually covered by a moving dune."

Northern Wild Raisin (Viburnum cassinoides) "One of the rarest shrubs of the Chicago region, known in our area only from Berrien and LaPorte Counties."

Non-vascular Plants. No systematic attempt was made to identify bryophytes and lichens. Reference is made to the mosses of the cedar-hemlock swamp in the section which discusses this community. Mosses and lichens are conspicuous in the sand barrens and probably include most of those listed by Duncan (1973) as occurring in early successional stages on dry, sandy soil in northern Michigan. He records that Ceratodon purpureus came in very early and in 20 years had covered 94.5% of the plot studied. Twenty-one years later the Ceratodon had been almost totally replaced by two species of Polytrichum, juniperinum and piliferum. Lichens came in sometime between 20 and 40 years after succession began, only after the mosses had stabilized the site by their sod-like growth habit. The nine lichens found on the site were:

Cladonia rangiferina
C. mitis
C. uncialis
C. cornuta
C. cristatella
C. gracilis
C. verticillata
C. fimbriata
C. chlorophaea

One noteworthy moss seen by myself was the elfcap (Buxbaumia aphylla), the capsules of which were evident on May 11 and June 8. It was found along the jeep trail which runs from the intersection of 126th Ave. and Old Allegan Rd. to Miner Lake.

A greater effort was made to understand the fungi. The larger and more noticeable species were collected and later

identified if possible. Those species to which definite or tentative names were assigned are listed below, according to the community in which they were found. They represent perhaps half of the species actually seen.

Oak Forest

Narrow-head Morel (Morchella angusticeps) probably; May 11
Emetic Russula (Russula emetica) probably; July 26

Red Maple Swamp (especially ecotone)

Microglossum rufum, or Clavaria sp. August 3
Earth Tongue (Trichoglossum velutipes) probably; August 31
Spring Amanita (Amanita verna) August 31, October 13
Honey Armillaria (Armillaria mellea) local: many clusters on one or two stumps, October 13. This is the species responsible for foxfire.
Tricholoma sp. May 31
Broad-gilled Collybia (Collybia platyphylla) probably; May 31
Vermilion Hygrophorus (Hygrophorus miniatus cantherellus) August 31
Pleurotus sp. on trees, May 31
Chameleon (Russula chamaeleontina) October 13

Cedar-Hemlock Swamp

Coral Fungus (Clavaria sp.) August 31
Yellowish Chanterelle (Craterellus lutescens) August 31
Painted Boletinus (Boletinus pictus) August 3, 31
Funnel-shaped [Clitocybe] (Clitocybe infundibuliformis) August 31
Waxy Laccaria (Laccaria Clitocybe laccata) August 31
Vermilion Hygrophorus (Hygrophorus miniatus subsp.) August 3
Tufted Yellow Hypholoma (Hypholoma fasiculare) August 31

A list given me by Agnes Hess of Niles, Michigan presents some of the mid-summer mushrooms found by her in the Allegan State Game Area. Habitat data is from Graham (1944) unless otherwise stated.

Scientific Name	Common Name	Habitat
Boletus edulis	Edible Bolete	savanna (Hess)
B. castaneus		
B. aurantiacus		

Strobilomyces strobilaceus	Cone-like Bolete	
Boletinus pictus	Painted Boletinus	mossy coniferous swamp
Amanita verna	Spring Amanita	
A. muscaria	Fly Amanita	open woods
A. virosa	Destroying Angel	deciduous woods
A. brunnescens	Browning Amanita	
A. citrina	Napkin Amanita	
A. caesarea	Caesar's Amanita	oak woods
Armillaria mellea	Honey Mushroom	around stumps (Hess)
Clitocybe aurantiaca	Yellow Clitocybe	
C. infundibuliformis	Funnel Clitocybe	leafy ground in woods
Lactarius chrysorheus		sphagnum bogs
L. camphoratus	Aromatic Lactarius	swamps
L. hygrophoroides		open woods
L. scrobiculatus		mossy coniferous swamps
L. volemus	Orange-Brown Lactarius	oak woods esp.
L. piperatus	Peppery Lactarius	woods
Russula emetica	Emetic Russula	acid soil, woods, on moss or decayed wood
R. vesca		
R. decolorans		
R. delica	Whitish Russula	sandy soil, birch-conifer
Cantharellus cibarius	Chanterelle	savanna (Hess)
Clitopilus orcella	Sweetbread Mushroom	savanna (Hess)
Leucoagaricus procerus	Parasol Mushroom	open scrub oak (Hess)

Animals

Mammals

1. Oak Forest. Hodgson (1959), in a mammal study conducted in the Allegan County oak forest, found the white-footed mouse to be by far the most abundant mammal, with a peak density of 13.8 animals per acre for August. They were found throughout the oak and oak-pine areas. During this study 334 specimens were trapped. The next most

common, with 60 specimens trapped, was the chipmunk. It had a maximum estimated density of 2.02 per acre. The southern flying squirrel (49 animals trapped) had a maximum estimated density of 2.93 per acre but was found to be more local than the preceding two. The red squirrel (34 animals trapped) had a maximum estimated density of 3.42 per acre and was found only where pine is part of the understory.

Other mammals caught were:

Meadow Vole--1
Short-tailed Shrew--1
House Mouse--1
Masked Shrew--2
Long-tailed Weasel--3
Woodchuck--3
Opossum--5
Raccoon--16

Hodgson believes the first four are rare in oak woods because they require more moisture than is available here. Other species, observed only, were:

Fox Squirrel
Red Fox
Skunk
Mink
Prairie Mole
White-tail Deer

Ostenson and Orwoll (n. d.) studied eight quadrats along a transect just south of M-89, in the area of Palmer Bayou, where the Kalamazoo River and Sand Creek meet. Two were in dry oak uplands, where 11 white-footed mice were trapped, one pine vole, and two red squirrels; raccoon and opossum were seen. A pine-beech-oak forest yielded five white-footed mice, one short-tailed shrew, one woodchuck, three chipmunks, four opossums, and two flying squirrels;

fox squirrels were seen. A moist beech-maple forest yielded seven white-footed mice, three short-tailed shrews, and two masked shrews.

Maya Hamady, at my suggestion, set 50 mouse traps twice a day from August 17 to August 20, in Miner Lake Bog, on the edge of the bog, and in the adjacent oak forest. One deer mouse was obtained from the edge of the bog, and one white-footed mouse from the forest. Prairie mole tunnels were observed where they crossed the jeep trail.

2. Oak Openings. Two areas of abandoned farm, grown up to grass, were observed by Ostenson and Orwoll. These yielded 10 white-footed mice, 19 prairie deer mice, and one pine vole. The thirteen-lined ground squirrel, a prairie species, was common here. This animal was sighted on only one occassion at the Savanna Unit. Woodchuck holes were seen here, but what animals were occupying them is not known.

3. Cedar-Hemlock Swamp. No mammals were observed here, and no data is available on which would be most likely to occur. It is well-known that white cedar is a favorite food of deer. Medley (in Grande Mere, A Very Special Place, 1973) lists red squirrel and southern flying squirrel as also being typical of this habitat.

4. Sedge Bog. Ostenson and Orwoll surveyed two areas of wet sedge meadow in the Kalamazoo River floodplain and came up with 10 meadow voles, 21 meadow jumping mice, and one pine vole. Maya Hamady trapped two meadow jumping mice in the sedge bog at Miner Lake. We had hoped to obtain evidence for the presence of the

southern bog lemming, a species of grassy bogs (Burt, 1948) found very locally in Michigan (Dr. Baker, Michigan State University, in a personal communication to Miss Hamady).

5. Tamarack Bog Forest. The red squirrel was observed here. This is a species considered endangered in Illinois and possibly already extirpated there (Nature Preserves Two-Year Report, 1973).

6. Red Maple Swamp. No mammals were observed here, and no data is available on what would be most likely to occur. From Hodgson's material, we can assume that certain species which are rare in the oak forest are probably more common here because of the more mesic conditions. Medley includes starnose mole, mink, and cottontail for this habitat.

The following list of Allegan County mammals is based on Burt (1948). Those marked with an asterisk are those definitely known to occur within the Pine Plains, according to Hodgson, Ostenson and Orwoll, and the collection of skins assembled at the Swan Creek Highbanks Unit of the State Game Area.

*Opossum (Didelphis virginiana)
*Prairie Mole (Scalopus aquaticus)
*Starnose Mole (Condylura cristata)
*Masked Shrew (Sorex cinereus)
*Least Shrew (Cryptotis parva)
*Short-tailed Shrew (Blarina brevicauda)
*Big Brown Bat (Eptesicus fuscus)
*Red Bat (Lasiurus borealis)
*Raccoon (Procyon lotor)
*Long-tailed Weasel (Mustela frenata)
*Least Weasel (Mustela rixosa)
A rarity collected in Sec. 5 of Valley Twp. (Allen, 1940)
*Mink (Mustela vison)
*Striped Skunk (Mephitis mephitis)

*Badger (Taxidea taxus)
*Red Fox (Vulpes fulva)
Gray Fox (Urocyon cinereoargenteus)
Very rare in southern Michigan; last reported in 1922 from Charlevoix County until found in Allegan County, east of the Pine Plains, in 1939 (Allen, 1940)
Coyote (Canis latrans)
*Woodchuck (Marmota monax)
*Thirteen-lined Ground Squirrel (Citellus tridecemlineatus)
*Eastern Chipmunk (Tamias striatus)
*Red Squirrel (Tamiasciurus hudsonicus)
Gray Squirrel (Sciurus carolinensis)
*Fox Squirrel (Sciurus niger)
*Southern Flying Squirrel (Glaucomys volans)
*Prairie Deer Mouse (Peromyscus maniculatus)
*White-footed Mouse (Peromyscus leucopus)
*Southern Bog Lemming (Synaptomys cooperi)
*Meadow Vole (Microtus pennsylvanicus)
*Pine Vole (Pitymys pinetorum)
*Muskrat (Ondatra zibethica)
*Meadow Jumping Mouse (Zapus hudsonius)
*Cottontail (Sylvilagus floridanus)
*White-tail Deer (Odocoileus virginianus)

Several mammals have become extinct in Allegan County within historic time:

Black Bear (Ursus americanus)
Marten (Martes americana)
River Otter (Lutra canadensis)
Timber Wolf (Canis lupus)
Cougar (Felis concolor)
Lynx (Lynx canadensis)
Bobcat (Lynx rufus)
Beaver (Castor canadensis)
Porcupine (Erethizon dorsatum)
Snowshoe Hare (Lepus americanus)
Elk (Cervus canadensis)

At least the wolf, cougar, lynx, and beaver were still found in 1840 (Cook, 1889). Though not known historically from Allegan County, moose (Alces americana) and caribou (Rangifer caribou) probably occurred at one time.

The following six extinct mammals, all of which have left fossils in southwest Michigan, probably also occurred. Fossil records from Allegan County exist only for the mastodon (Dorr and Eschman, 1970).

Giant Beaver (Castoroides ohioensis)
American Mastodon (Mammut americanum)
Jefferson Mammoth (Mammuthus jeffersoni)
Peccary (Platygonus compressus)
Scott's Moose (Cervalces scotti)
Woodland Muskox (Symbos cavifrons)

Birds

1. Oak Forest. Wenger (1970) studied the birds of an 18.4 acre tract in Section 30 of Valley Township, from 1966 to 1968. The list of breeding birds, with number of territorial males for each of the three years, follows:

Species	1966	1967	1968
Wood Duck	0	+	+
Yellow-billed Cuckoo	1.5	2.1	1.4
Whip-poor-will	nc	0.2	0
Yellow-shafted Flicker	0.7	0.8	1.0
Downy Woodpecker	+	1.4	1.0
Hairy Woodpecker	0.8	1.0	0.7
Red-bellied Woodpecker	0.8	0.5	+
Great Crested Flycatcher	1.9	2.0	1.1
Eastern Wood Pewee	2.8	3.8	2.8
Blue Jay	1.8	1.0	1.0
Black-capped Chickadee	4.0	4.0	0.8
Tufted Titmouse	1.2	2.0	0.6
White-breasted Nuthatch	2.1	2.4	1.8
Robin	+	1.5	0.7
Wood Thrush	+	0.4	+
Blue-gray Gnatcatcher	0	0	0.7
Yellow-throated Vireo	0	1.0	0.1
Red-eyed Vireo	2.7	4.6	3.5
Ovenbird	1.4	2.5	0.9

Brown-headed Cowbird	1.3	1.0	1.0
Baltimore Oriole	1.7	2.2	1.0
Scarlet Tanager	4.6	7.4	3.8
Rose-breasted Grosbeak	4.1	7.5	4.4

nc -- not censused
\+ -- present on tract

Note that the most abundant birds here were the scarlet tanager and rose-breasted grosbeak; other common species were eastern wood pewee and red-eyed vireo. Species with large stable numbers tend to find xeric oak woods optimal for breeding purposes, while such forest tends to offer only marginal habitat for those with small, fluctuating numbers. The scarlet tanager, for example, favors forest in which the canopy closes late (i.e., oak forest), because enough light must remain available for the female in the canopy to observe the male near the ground as he displays his red back in courtship (Prescott, 1965, as reported in Brewer, 1967).

Visitors seen during the breeding season were:

Swainson's Thrush	late migrant
Cedar Waxwing	late migrant
Red-headed Woodpecker	early spring visitor
Chipping Sparrow	edge species
Field Sparrow	edge species
Catbird	edge species
Cardinal	edge species
Redwing Blackbird	nearby bog
American Redstart	nearby mesic forest
Warbling Vireo	nearby mesic forest
Acadian Flycatcher	nearby mesic forest
Least Flycatcher	nearby mesic forest

Wenger concludes that bird density is lower in xeric oak forest than it is in other forest types, probably because the open canopy and sparse understory make good visibility possible, thus

increasing size of territories. Wenger admits that inadequate censusing technique could also be responsible for the low figures. In 1966, there were an estimated 178 territorial males/100 acres; in 1967, 266/100 acres; and in 1968, 153/100 acres. Deciduous forests on the whole average about 200 pairs/100 acres (for woods with 21 breeding species). Spruce-fir forest, because of the much greater cover, has 323-370 pairs/100 acres. It is interesting to note that Warren Woods, a virgin beech-maple forest in Berrien County, had 45 red-eyed vireo singing males per 100 acres compared to only 15 in the Allegan oak forest.

According to Wenger, bird activity in the oak forest decreases dramatically towards the end of the breeding season--by August the forest is silent. This is not true of nearby mesic forest. Birds leave soon after nesting. Ovenbirds, gone by late July, are the first to go. The last is the wood pewee, gone by late September.

Only nine species of birds were found on the tract in winter. There were 21 individuals per 100 acres during the winter of 1966-67, and 45 per 100 acres during the winter of 1967-68. The white-breasted nuthatch was most abundant and stable in its numbers; second to it was the black-capped chickadee. Blue jay, titmouse, and robin populations are limited by snow cover; the two former species depend largely on acorns, while the latter forages on the ground for worms and insects. Foraging mixed flocks of chickadees, nuthatches, titmice, and sometimes brown creepers are typical. A list of the nine species follows:

Red-bellied Woodpecker
Hairy Woodpecker
Downy Woodpecker
Black-capped Chickadee
Tufted Titmouse
White-breasted Nuthatch
Brown Creeper
Blue Jay
Robin

Gottshall (1969) observed the birds on three different tracts in Clyde and Valley Townships during spring and early summer of 1966. Area 1 (16.5 acres) was a "relatively mature oak forest with a poorly developed shrub and brush layer." Area 2 (14.5 acres) was an "oak forest with an understory of white pines." Area 3 (18.4 acres) ranged from "mature oaks and a closed canopy to disturbed areas that hosted a tangle of greenbrier." Species observed and number of males per 100 acres for the three areas are presented below:

Species	Area 1	Area 2	Area 3
Ovenbird	13	24	18
Red-eyed Vireo	10	18	21
Black-capped Chickadee	21	13	4
Scarlet Tanager	16	12	16
*Blue Jay	(13)	(21)	(13.5)
White-breasted Nuthatch	12	13	8
Tufted Titmouse	10	12	10
Great Crested Flycatcher	7	19	5
Eastern Wood Pewee	10	3	8
Downy Woodpecker	2	3	10
Baltimore Oriole	13	+	5
Cuckoo (Black-billed & Yellow-billed)	13	-	12.5
Wood Thrush	13	-	5
Yellow-throated Vireo	-	7	12.5
Rufus-sided Towhee	-	7	15
Least Flycatcher	-	7	+
Cardinal	-	7	-

Robin	-	3	-
Catbird	-	-	2
Brown-headed Cowbird	++	++	++
Ruffed Grouse	+	++	+
Rose-breasted Grosbeak	+	-	+
Yellow-Shafted Flicker	+	+	-
Brown Thrasher	-	+	-
Whip-poor-will	-	-	+
Total number of males	140	148	152.5
Total number of species	17	18	21

* -- estimated number of blue jay males not included
+ -- species observed on site, but no territory estimate was possible

Our own casual observations in the oak forest near Miner Lake produced the following list of species seen and/or heard during the breeding season:

Ruffed Grouse
Cuckoo (species?)
Great Crested Flycatcher
Blue Jay
White-breasted Nuthatch
Blue-headed Vireo
A pair seen by Ken VanderKamp on August 3, on jeep trail leading to lake. This is a species considered rare in Illinois.
Ovenbird
Northern (Baltimore) Oriole
Rose-breasted Grosbeak

The following migrants were observed on May 11:

Nashville Warbler
Yellow-rumped (Myrtle) Warbler
Black-throated Green Warbler
Blackburnian Warbler
Palm Warbler
Dark-eyed (Slate-colored) Junco
White-throated Sparrow

Gottshall observed the following on May 16 and 17:

Blue-gray Gnatcatcher
Present in Wenger's study area in 1968; may breed here

Black-and-white Warbler
Magnolia Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Blackburnian Warbler
Chestnut-sided Warbler

2. Oak Openings. No studies are available. The following species were recorded by us during the breeding season:

Wild Turkey
Once native, this bird was hunted to extinction in Michigan; was reintroduced here in 1954. Two turkey pastures have been planted in the Miner Lake area: one in the Kalamazoo River Escarpment Unit and one adjoining the east border of the Savanna Unit.
Mourning Dove
Nighthawk
Common (Yellow-shafted) Flicker
Pileated Woodpecker
Seen flying over on August 3; no doubt breeds in the oak forest and only visits here.
Red-headed Woodpecker
Kingbird
Eastern Wood Pewee
Black-capped Chickadee
Brown Thrasher
Robin
Eastern Bluebird
Northern Oriole
Goldfinch
Towhee
Vesper Sparrow
Chipping Sparrow
Field Sparrow

Other species of clearings and edges no doubt occur as well.

One bird that should definitely be looked for here is the lark sparrow, a species that, in Wisconsin and southeast Michigan, is restricted to sand barrens for nesting (Curtis, 1959 and Bent, 1968). Apparently rather local this far north, its presence in southwest Michigan is unknown to me. Certainly, however, the oak openings provide ideal habitat.

3. Cedar-Hemlock Swamp. No studies are available, and our own observations produced very little. Some discussion on cedar swamp avifauna is provided by Brewer (1967). He notes that certain species seem to be more characteristic of cedar or cedar-mixed forest than of pure deciduous or pure spruce-fir. These are: red-breasted nuthatch (the species most characteristic of cedar forest), black-throated green warbler (with hemlock), parula warbler (with hemlock), black-and-white warbler, and veery. Species most characteristic of the hemlock-white pine-northern hardwoods association are, according to Brewer: black-and-white warbler, black-throated green warbler, black-throated blue warbler, yellow-bellied sapsucker, and possibly veery. Some breeding birds of the northern cedar swamp are: winter wren, yellow-bellied flycatcher, junco, purple finch, hairy woodpecker, wood pewee, red-eyed vireo, and white-breasted nuthatch.

In the cedar-hemlock swamp found at Grande Mere, the Canada warbler is known to breed regularly (Medley, in Grande Mere, A Very Special Place, 1973). On June 8 Medley, in company with myself, found a pair of Canada warblers at the Miner Lake cedar site. This boreal species is unknown as a breeder in Illinois and Indiana.

Nesting with this bird at Grande Mere is a southern species, the hooded warbler. It is known to nest as far north as Kent and Kalamazoo Counties (Bent, 1963) and should be looked for here also. Another southerner found commonly along the Kalamazoo River in Calhoun County (Bent, 1963) is the prothonotary. There is a good chance

that both species breed in the floodplain forest along the Kalamazoo River here in the Pine Plains, and may enter the cedar-hemlock association as well, though probably not to breed.

From an examination of the relevant literature, I have compiled the following list of northern species which might be found nesting in the cedar-hemlock community here:

Saw-whet Owl
Yellow-bellied Sapsucker
Red-breasted Nuthatch
Brown Creeper
   Has nested in Calhoun County
Winter Wren
   Has nested in East Lansing area
Veery
Black-throated Green Warbler
Canada Warbler
Purple Finch

4. Sedge Bog. In his discussion of Portage Bog in Kalamazoo County, Brewer (1967) deals with both open bog and tamarack bog breeding species. He found the avifauna essentially undistinguished, with nearly all species being those which could be found in any moist thicket situation. In fact, all species found are more likely to occur in non-bog vegetation. Density was about 170 pairs per 100 acres. His findings are presented here:

Species	Number of males/100 acres
Song Sparrow	57
Yellowthroat	27
Field Sparrow	14
Towhee	14
Brown-headed Cowbird	14
Catbird	9
Goldfinch	6
Traill's Flycatcher	5
Yellow Warbler	3
Black-capped Chickadee	3
Mourning Dove	3

Cedar Waxwing	3
Flicker	2
Cardinal	2
Brown Thrasher	2
Hummingbird	1
Nashville Warbler	1
Mallard	+
Marsh Hawk	+
Bluebird	+
Tree Swallow	+
Robin	+
Whip-poor-will	+
Veery	+

+ -- present on tract

The tree swallow, black-capped chickadee, and Traill's flycatcher are typical boreal species but are widely distributed in non-bog vegetation in southern Michigan and further south as well. The most interesting species in his list is the Nashville warbler, considered rare in southern Michigan and Illinois. Brewer concludes that, although bogs in southwest Michigan may be boreal islands with respect to plants, with respect to birds they are not.

Brewer found a post-breeding emigration from Portage Bog into other vegetation types--he doesn't know why. Also, winter populations were very low, probably due to poor food supply (tamarack seeds are shed in autumn) and possibly also to wind exposure in the flat open areas.

A partial list of open-bog birds is provided by Brewer, arranged according to habitat as follows:

Open wet bog	Rails
	American Bittern
	Redwing Blackbird
	Swamp Sparrow

Open dry bog	Song Sparrow
	Yellowthroat
Thickets	Yellow Warbler
	Traill's Flycatcher
	Towhee
	Downy Woodpecker
	Hairy Woodpecker
	Hermit Thrush
	several Warblers

Ostenson and Orwoll (n. d.) record the following for two areas of wet sedge meadow:

Great Blue Heron
American Bittern
Turkey Vulture
Marsh Hawk
Yellowthroat
Crow
Cardinal
Indigo Bunting
Field Sparrow

Our own observations produced very little data. From bird song heard, we might assume the yellowthroat to be the most common bird in the sedge bog at Miner Lake. One species of special interest heard singing near the edge of the tamarack forest during the breeding season was the golden-winged warbler. A red-tailed hawk was seen flying over, and green herons and great blue herons were typical of areas of emergent aquatic vegetation. A couple of years ago Ken VanderKamp flushed a turkey from a nest here. Interestingly, no redwing blackbirds seem to occur, despite the presence of cattail area. Note that this species is also absent from Brewer's list for Portage Bog.

5. Tamarack Bog Forest. Brewer's general notes on Portage Bog apply to the tamarack areas as well as to sedge areas. The

avifauna is basically forest edge rather than forest. Our own observations produced the following:

Green Heron
Sharp-shinned Hawk
Woodcock
  Flying over
Hairy Woodpecker
Blue Jay
Catbird
Robin
Cedar Waxwing
Yellow Warbler
Yellowthroat
Northern Oriole
Towhee

On June 8 a small flock of red crossbills was identified by Max Medley. The presence of this strictly boreal species this far south during the breeding season is baffling.

6. Red Maple Swamp. Brewer (1967) studied the breeding avifauna at Sugarloaf Bog, a red maple-yellow birch-white pine area in Kalamazoo County. He found the bird density to be about 270 males per 100 acres, 100 more than at Portage Bog. The list is presented below:

Species	Number of males/100 acres
Black-capped Chickadee	40
Ovenbird	38
Eastern Wood Pewee	26
Blue Jay	22
Cardinal	20
Scarlet Tanager	18
Downy Woodpecker	16
Red-eyed Vireo	16
Great Crested Flycatcher	15
Song Sparrow	13
Tufted Titmouse	8
Towhee	8
Wood Thrush	6
Yellow-throated Vireo	6

Hairy Woodpecker	4
Flicker	4
White-breasted Nuthatch	3
Black-throated Green Warbler	3
Catbird	2
Grackle	+
Veery	+
Ruffed Grouse	+
Yellowthroat	+
Owl (Barred?)	+
Wood Duck	+
Cowbird	+

+ -- present on tract

Note that the avifauna is decidedly more forest than forest edge. The birds represent deciduous forest species rather than mixed conifer-deciduous or conifer. In fact, not counting the chickadee, only the black-throated green warbler is considered a boreal species. It is a rare nester in southern Michigan, occurring in both bog and non-bog habitats where conifers occur. I believe it is absent from Indiana and Illinois.

Extinct Birds. Finally, a note on extinct birds, using information from Greenway, 1958. The passenger pigeon certainly utilized the Pine Plains, though whether it nested is uncertain. Forest in which beech was abundant was the favorite habitat, but oak areas were also important; beech and oak mast were perhaps the most important food.

The Carolina parakeet may have been present as a visitor in the Kalamazoo River floodplain forest.

Reptiles and Amphibians

1. Oak Forest. Ostenson and Orwoll (n. d.) found, in two dry oak areas, the box turtle, blue racer, and American toad. In a pine-beech-oak forest, the box turtle, blue racer, Fowler's toad, and Jefferson salamander (under logs) were found. A moist beech-maple forest produced the blue racer, redback salamander, and wood frog. We observed the blue racer and box turtle in the Miner Lake Unit oak forest.

2. Oak Openings. While the vegetation here strongly suggests prairie, the herpetofauna does not. Sand prairies of northwest Indiana apparently represent the eastern limit of the distinctively prairie element (western smooth green snake, western fox snake, bull snake, western ribbon snake, plains garter snake, ornate box turtle, six-lined racerunner, and western slender glass lizard--Minton, 1972).

The blue racer was found in two areas of abandoned farm (grassland) by Ostenson and Orwoll. The box turtle was seen by us in the Savanna Unit. If my memory serves me well, I have heard gray treefrogs calling in this type of community, along M-89, in years past; I have no notes to confirm this. According to Dr. Hensley of Michigan State University (1975, personal communication), the hognose snake is a characteristic species of the Allegan Pine Plains forest and I would expect it to occur in the openings as well. I have seen it in open sand dunes bordering Lake Michigan in Allegan County.

3. Cedar-Hemlock Swamp. The only herptiles seen here were the box turtle, American toad, and a frog that eluded us before we could identify it. The four-toed salamander should be looked for--in Indiana, where it is local and rather rare, it is considered a boreal relict (Minton, 1972).

4. Sedge Bog. Four turtles observed here were the box, spotted, snapping, and painted. The spotted is considered endangered in Indiana (Minton) and in Illinois it may now be extinct (Illinois Nature Preserves Two-Year Report, 1973). Snakes observed were the massasauga rattlesnake, northern water snake, and ribbon snake. The common frog here is the green; the spring peeper, western chorus frog, gray treefrog, and bullfrog were heard. The mudpuppy was seen in Miner Lake by Ken VanderKamp. I could find no literature on bog herpetofauna; personal observation at two bogs in Osceola County produced gray treefrog, wood frog, and ribbon snake, and a bog in Kent County yielded cricket frog and ribbon snake.

5. Tamarack Bog Forest. No herptiles were observed here. A gray treefrog was found in the tamarack area of a bog in Kent County.

6. Red Maple Swamp. Spring peepers were abundant on October 13. I would expect the mesic conditions at the upland edge to be productive of salamanders, but none were seen (partly, perhaps, due to my refusal to tear apart the rotten logs where they spend most of their time). In northern Indiana, Minton found the four-toed salamander in "moist and thoroughly rotted logs" in

"undisturbed swamp forest where there were numerous shallow pools heavily shaded and surrounded by ferns and mosses." This description fits both the red maple and cedar-hemlock swamp communities here.

Following is a list of Allegan County reptiles and amphibians, based on information provided by Conant (1958) and Hensley (1975, personal communication). Those definitely known from the Pine Plains, according to Ostenson and Orwoll and my own notes, are marked with an asterisk. Habitat information (from Minton) is provided in those cases where it seems important.

*Common Snapping Turtle (Chelydra s. serpentina)
*Spotted Turtle (Clemmys guttata)
"quiet, clean, shallow water with much aquatic vegetation surrounded by a zone of relatively undisturbed meadow or undergrowth"
Wood Turtle (Clemmys insculpta)
apparently rare this far south; seen by Hensley in Allegan County in 1968
*Stinkpot (Sterno thaerus odoratus)
northern Indiana: "small marl lakes" especially (not peat bogs)
*Map Turtle (Graptemys geographica)
"rivers and large creeks that have sluggish to moderate current, a soft bottom, and some aquatic vegetation"
*Midland Painted Turtle (Chrysemys picta marginata)
*Eastern Box Turtle (Terrapene c. carolina)
northern Indiana: "sandy areas such as the beaches of extinct glacial lakes" Tinkle and Hensley (n. d.) consider this a threatened species in Michigan.
*Blanding's Turtle (Emydoidea blandingi)
"shallow, quiet, warm water surrounded by grassland" especially
*Eastern Spiny Softshell Turtle (Trionyx s. spinifer)
"rivers, creeks, large ditches and lakes, especially those with sand or silt bottom"--aquatic vegetation not necessary
Five-lined Skink (Eumeces fasciatus)
rare or absent in northern Indiana; local in the Allegan State Game Area (Hensley)
Northern Red-bellied Snake (Storeria o. occipitomaculata)
"dry, forested upland" Hensley doubts its presence in the county

Northern Brown Snake (Storeria d. dekayi)
Midland Brown Snake (Storeria decayi wrightorum)
*Northern Water Snake (Natrix s. sipedon)
Queen Snake (Natrix septemvittata)
uncommon in northern Indiana
Eastern Garter Snake (Thamnophis s. sirtalis)
*Eastern Ribbon Snake (Thamnophis s. sauritus)
"abundant sunlight and low, dense vegetation in the vicinity of quiet, shallow water"
*Eastern Hognose Snake (Heterodon platyrhinos)
"rather dry, open situations"
Northern Ring-necked Snake (Diadophis punctatus edwardsi)
"damp, heavily shaded forest" northern Indiana: "largely restricted to sandy areas"
*Blue Racer (Coluber constrictor foxi)
"dry, open or forest edge habitats where there is considerable undergrowth" northern Indiana: old dunes, sparse woods, sand prairies
Eastern Smooth Green Snake (Opheodryas v. vernalis)
Black Rat Snake (Elaphe o. obsoleta)
habitat includes tamarack bogs; Tinkle and Hensley consider this a threatened species in Michigan
*Eastern Milk Snake (Lampropeltis doliata triangulum)
habitat includes sandy oak woods ("a fairly high degree of moisture seems to be essential")
*Eastern Massasauga (Sistrurus c. catenatus)
*Mudpuppy (Necturus m. maculosus)
"rare or absent in small ponds"
Western Lesser Siren (Siren intermedia nettingi)
known in Michigan only from Allegan and Van Buren Counties (Hensley)
Central Newt (Diemictylus viridescens louisianensis)
"woodland with reasonably permanent ponds or marshes"
Blue-spotted Salamander (Ambystoma laterale)
"moist woodland with sandy soil"
*Jefferson Salamander (Ambystoma jeffersonianum)
"well-drained, undisturbed woodland"
Spotted Salamander (Ambystoma maculatum)
"mixed hardwood forest . . . that has been spared from grazing and severe fires and is not subject to spring floods"
Eastern Tiger Salamander (Ambystoma t. tigrinum)
"near ponds or in bogs and marshes"
*Redbacked Salamander (Plethodon c. cinereus)
beech-maple "woodland where soil is moist and the ground cover undisturbed"
Four-toed Salamander (Hemidactylium scutatum)
see text
*American Toad (Bufo americanus)
"decidedly less partial to sandy situations than is Fowler's toad"

*Fowler's Toad (Bufo woodhousei fowleri)
"sand or loose soil and open or sparsely wooded country"
*Northern Spring Peeper (Hyla c. crucifer).
*Eastern Gray Treefrog (Hyla v. versicolor)
*Blanchard's Cricket Frog (Acris crepitans blanchardi)
*Western Chorus Frog (Pseudacris t. triseriata)
*Pickerel Frog (Rana palustris)
northern Indiana: "near small, clear streams, wet meadows, and sphagnum bogs"
*Northern Leopard Frog (Rana p. pipiens)
"wet meadows, marshes, bogs, and shallow ponds in open situations"
*Green Frog (Rana clamitans melanota)
"Cool, relatively clear, permanent bodies of water are highly favorable . . . very warm, muddy, transient waters are avoided"
*Wood Frog (Rana sylvatica)
northern Indiana: "moist woods and near lakes and swamps. It disappears from farmland and in most suburban areas."
*Bullfrog (Rana catesbeiana)
"permanent water is essential"

Insects

Insects are presented here in terms of three patterns: 1) butterflies; 2) night-sounding insects; and 3) defoliators.

Butterflies. Only butterflies of the open areas, i.e. the oak openings and sedge bog, were collected, due to their conspicuous presence there and to the ease of collecting. An annotated list of species identified, according to the community in which they were found follows:

1. Oak Openings

Little Wood Satyr (Euptychia c. cymela)
Abundant on June 15 (also in oak woods); lesser numbers on July 6 and 21. Larvae feed on grasses.
Wood Nymph (Cercyonis pegala nephele)
August 31, not common. Feed on grasses.
Monarch (Danaus plexippus)
Feed on various milkweeds.
Aphrodite (Speyeria aphrodite)
Feed on violets.

American Painted Lady (Vanessa virginiensis)
Feed on many composites, esp. (here) sweet everlasting and pussytoes.
Coral Hairstreak (Strymon t. titus)
Feed on black cherry here.
American Copper (Lycaena phlaeas americana)
Feed on sheep sorrel here; species also found in Europe.
Eastern Tailed Blue (Everes c. comyntas)
Feed on legumes.
Karner Blue (Lycaeides melissa samuelis)
Feed on wild lupine; abundant on May 31; also (second brood) on July 21, clustered on butterflyweed.
Spring Azure (Lycaenopsis argiolus)
Many foods. Common on May 10, mostly in woods.
Tiger Swallowtail (Papilio glaucus)
Feeds on many trees; here, mostly black cherry.
Spicebush Swallowtail (Papilio troilus)
Feed on sassafras here (spicebush in the swamps).
Olympia (Euchloe olympia)
Several on May 10 and 31. Feed on tower mustard here.
Orange Sulphur (Colias eurytheme)
Feed on legumes.
Indian Skipper (Hesperia sassacus)
June 15; feeds on grasses.
Crossline Skipper (Polites manataaqua)
Feed on grasses.

2. Sedge Bog

Silver-bordered Fritillary (Boloria selene subsp.)
Several on July 6. Feed esp. on violets.
Baltimore (Euphydryas phaeton)
Normally feeds on turtlehead, which may grow in red maple swamp (where we failed to find it); may feed on ash and/or viburnum here.
Bog Copper (Lycaena epixanthe michiganensis)
Abundant on July 6, a few on July 15. Feed on cranberry, so found only in sphagnum bogs. Survives winter as egg, which can stand being submerged.
Orange Sulphur (Colias eurytheme)

Two of the above deserve special comment.

The Karner blue is regarded by Shapiro as "the most local butterfly of the northeastern states" (Irwin and Downey, 1973). It is known from at least seven counties in Michigan, all but one

in the west-central part of the state where wild lupine is abundant on sand areas (Moore, 1960). There is only one record from Illinois, where it is probably extinct due to habitat destruction. A very small colony (a few hundred square yards in size) survives near Hessville, Indiana (Irwin and Downey).

The bog copper is not definitely known to occur in Illinois or Indiana (Irwin and Downey). In Michigan, where its distribution seems to be local, it has been recorded as far south as Jackson and Washtenaw Counties (Moore).

A butterfly that should be looked for in the oak openings is the Ottoe skipper (Hesperia ottoe), a prairie species not supposed to be found east of those states which border the Great Plains (Klots, 1951). However, it has been recorded from Newaygo, Allegan, Barry, Kent, and Montcalm Counties in Michigan, where it apparently flies from about mid-June through July (Moore). It is rare and local in Illinois (Irwin and Downey). Klots states that it "is to be found in (now rare) undisturbed prairie areas . . ." In Michigan and Illinois it occurs in sand areas characterized by scattered clumps of grass; it seems to favor cactus blossoms (Nielsen, 1975, personal communication).

A fourth species which should be mentioned is Reakirt's blue (Hemiargus isolus), collected on July 18, 1938 at Round Lake, four miles from Miner Lake (Moore). Normally found west of the Mississippi River (Klots), this is the only record (as of 1960) of a fresh specimen (too fresh to be wind-blown) from the state. If a

colony really existed at Round Lake, I'm surprised that other specimens haven't been reported between 1938 and 1960. However, if the species does occur here, it should be looked for in the Miner Lake area as well.

The following spring butterflies should, according to Nielsen, be found in the Allegan Pine Plains. All are encountered seldom enough to be considered collector's items.

Mid to Late May

Brown Elfin (Incisalia augustinus)
Hoary Elfin (I. polios) Possibly.
Henry's Elfin (I. henrici) Possibly.
Frosted Elfin (I. irus)
Pine Elfin (I. niphon)
Olympia (Euchloe olympia)
Sleepy Duskywing (Erynnis brizo)
Juvenal's Duskywing (E. juvenalis)
Persius Duskywing (E. persius)
Cobweb Skipper (Hesperia metea)
On birdfoot violet.

June

Indian Skipper (Hesperia sassacus)
Roadside Skipper (Amblyscirtes vialis)
Dusted Skipper (Atrytonopsis hianna)
Possibly--not yet recorded from Allegan County.

Night-sounding Insects. On the night of August 2, three insects were caught after stalking them by their sounds. These were: 1) bush katydid (Scudderia), a one-and-a-half inch green creature which made a sound consisting of several soft ticks followed by a soft pulsating buzz; this was very commonly heard in the oak forest adjacent to the Miner Lake basin; 2) coneheaded grasshopper (Neoconocephalus), a one-and-three-quarters to two-inch

green or brown insect which made a loud continuous rasping zit-zit-zit; this was the most noticeable sound of open, sand barren areas, where it emanated from scattered small oaks; 3) shield-backed grasshopper (Atlanticus), a seven-eighthsinch brown, thick, stubby creature that produced a high-pitched buzzy trill, heard rather uncommonly in the oak forest. These are all members of the long-horned grasshopper family, Tettigoniidae. Three other sounds heard that night include that of the common field cricket (Gryllus). I would expect that later in the season the true katydid (Pterophylla) fills the woods with its distinctive clatter.

Defoliators. The data supplied here is from Faulkner, 1970. In studying frass (insect fecal matter) production in an Allegan County oak forest, he found that the larvae of five species were responsible for most of the foliage consumption. All are moths (though he mistakenly calls one a beetle). They are:

Ribbed Cocoon-maker (Bucculatrix ainsliella)
The one-quarter inch larvae are leaf-miners which normally feed on black oak and hibernate in slender white cocoons attached to twigs and bark.
Spring Cankerworm (Paleacrita vernata)
An inchworm with a preference for elm and basswood.
Eastern Tent Caterpillar (Malacosoma americanum)
Feeds on black cherry, where the larvae build their communal silken tents.
Apple Leafroller (Archips argyrospilus)
Linden (Maple) Leafroller (Sparaganothis [Cenopis] pettitiana)

The Deerfly: It would be an inexcusable omission to close the section on insects without mention of the deerfly (Chrysops).

It is abundant and an all too conspicuous feature of the oak forest and savanna during most of July and August. Larvae live in Miner Lake, from which they emerge as adults to attack the heads and necks of deer and other creatures, not the least of which are human. Actually, only the females suck blood; the males feed on flowers. The genus is typical of broken woodland in the north temperate zone, tropical Africa, the Far East, and the north tip of Australia. The deerfly constitutes a significant drawback to any interpretive plans for this area. I suggest that an effective repellent (one containing diethyltoluamide) be found and a supply of it be carried by the interpreter, who will make it available to visitors he is guiding.

Archeology

Since it is the natural features that so distinguish the Pine Plains, archeological and historical investigations were underemphasized. Still, any interpretation of an area which purports to be complete cannot omit these minor features which are interesting in their own right and are bound to appeal strongly to some visitors. Some knowledge of the Pine Plains Indians is, therefore, desirable.

Background information providing the context for the remarks which follow can be obtained from Kinietz (1940) and Fitting (1970).

Peru (1965) reported on three fluted points discovered in Allegan County, two near the shore of Glacial Lake Pullman and one in Lee Township, well within the area covered by the lake. This latter was found at an elevation of 660 feet; Peru believes the lake was still extant but at a level near that of Lake Chicago

(640 feet) into which it drained. He thinks all three points are at least 14,000 years old, although Fitting regards that as the very maximum and believes them to be younger.

Indians must have occupied Allegan County continuously from the time the ice left. The Pine Plains, however, was no doubt always sparsely populated and never by any permanent villages. Because of the abundance of white oak, the carrying capacity of the forest was no doubt greater than that of the northern pine forests, yet Hinsdale's comment on these north woods probably applies somewhat to the Allegan Pine Plains too:

> The Indian procured very little, if any kind of food from conifers. . . . Animals whose flesh made human food could not subsist upon resinoid kinds of trees; whereas fruits, nuts, berries, sugars, building barks, and browse for some of the animals came from the other types of vegetable growth. The gloomy recesses of the pine woods, monotonous and scant in nutritional plants, were not often frequented by animal and bird life in appreciable numbers. That part of the state is so non-productive that, since it has been denuded of pine, it has not offered congenial conditions for people who subsist upon what they can force the soil to produce. (quoted in Fitting, 1966)

In 1968 a team sponsored by Western Michigan University and the Kalamazoo Valley Chapter of the Michigan Archeological Society excavated a site on the south bank of the Kalamazoo River in Section 30 of Heath Township. Fragments of simple pottery, usually marked by pressing cord into wet clay, clay pipe fragments, and various stone tools were recovered from what appeared to be two hearths and two storage pits. Charcoal found with them was dated at A.D. 1230±100 and 1180±100. Only a small number of people--men

and women probably in equal numbers--used the site, and perhaps for only one season. Activities carried on were "cooking food, food storage, hide preparation, tool making, and probably fishing." The conclusion of the team was that this was a winter camp of a band of Chippewa (Rogers, 1972). The site is well-situated: on the one side is upland pine-oak woods which supported populations of deer and turkey with its mast, and on the other side is the river, where fish and clams could be caught.

Another site was uncovered three miles north of Fennville, where the lake plain and the moraine meet. It is estimated that the find here is early Late Woodland (probably 700-900 A.D.) with some carry-over from Middle Woodland (Rogers).

The only evidence I found that anyone had recently lived in the Miner Lake area was a clearing along 126th Avenue on the north edge of the Savanna Unit (see Figure 12), where some tell-tale depressions together with some scrubby lilac and rose bushes testified to the former presence of a homestead. No doubt it dates from the late 1800's or early 1900's. This certainly deserves interpretation and additional research is warranted.

INTERPRETATION OF THE SITE

Introduction

Now comes the task of selecting what, of all this material, will be presented to the public, and how it will be done.

The guiding principle here is that the interpretation should emphasize the uniqueness of the site, and the way it contrasts with the usual landscape types in southern Michigan. The program would be essentially site-centered, geared to interpreting a very special place, as opposed to interpretation which uses any natural or semi-natural area to explain general scientific or environmental concepts which could just as well be explicated elsewhere. It would thus resemble national park interpretation more than the nature center type used by most school districts, cities, counties, and private foundations. The national park model begins with the land and demands that people come to it, while the nature center model begins with where people are, and builds a facility on land which, however inferior in natural qualities, is close and available--perhaps for free. The national park model, while stressing the recreational approach (as opposed to the educational), need not neglect the "teaching" of important concepts of environmental conservation education. At Miner Lake, interpretation would certainly embrace such generalities, but within, as much as possible, the context of the special features offered by this particular site.

The interpretive objective can thus be stated as follows: to acquaint the visitor with the features which make this place unique and for which it was preserved (i.e., the diverse relict vegetation), so that his understanding and appreciation will be deepened. People should come away knowing they've been shown an extraordinary public treasure, and they ought to know why it's a treasure.

Land Zoning

To achieve this objective without impairing the valuable features in the process, certain precautions must be taken. To begin, the precise locations of these features must be delineated. Less valuable areas within the preserve should also be noted, as well as those which are too disturbed to have any value at all in terms of features to be protected. These lands need to be identified because this is where parking and other facilities will be placed. A land classification system not unlike that developed by the Outdoor Recreation Resources Review Commission (ORRRC) of the Bureau of Outdoor Recreation should be used to label the parts of the preserve.

The following system is presented for use in the Miner Lake area (see Figure 8):

Zone 1. Most valuable areas; no facilities but trails permitted; off-trail use forbidden or tightly controlled.

Zone 2. Less valuable; contains some elements worth preserving, also valuable as buffer zone to protect Zone 1 land.

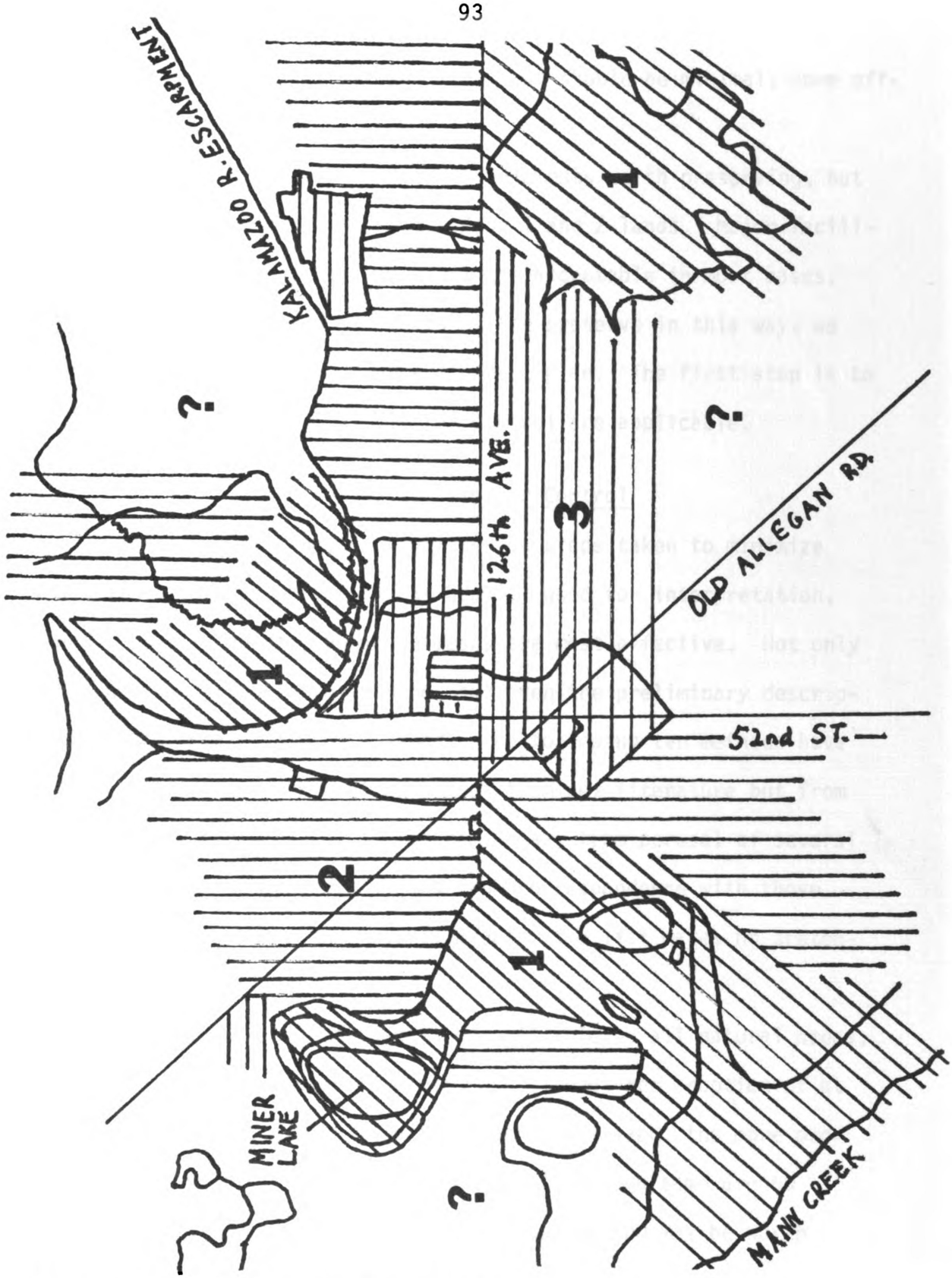

Figure 8.--Land Zoning for Miner Lake Area.

Facilities besides trails permitted, but should be minimal; some off-trail use acceptable.

Zone 3. Least valuable; no elements worth preserving, but useful as buffer zone to protect Zone 1 and 2 lands. Major facilities to be located here; off-trail use acceptable in most cases.

Having defined the parts of the preserve in this way, we are ready to move on to the development plan. The first step is to determine what methods of visitor control are applicable.

Methods of Visitor Control

Very little has been written on steps taken to minimize damage to the resource in areas heavily used for interpretation, and virtually nothing on which means are most effective. Not only has no quantification been done, but even the preliminary descriptive work remains unaccomplished. The following ten methods have been gleaned, for the most part, not from any literature but from personal observation within natural areas, from perusal of several master and management plans, and from correspondence with those responsible for managing natural areas. The list makes no pretension to being complete.

While not all of these are applicable to all natural areas, no area should be opened to public use without the adoption of at least some of them. The more that can be utilized, the more protection, generally, is afforded an area (although some are no doubt more effective than others; one good method may be worth two or three inferior ones). Since eight of the ten can be

employed in the Miner Lake area, chances are good that visitor control will be adequate to insure preservation of the resource.

1. Supervision by official personnel. Any interpreters present will, of course, function as supervisors too, if only incidentally; all they have to do is be there for visitors to feel somewhat supervised. Or a more formal supervision can be instituted by assigning a ranger to the preserve. At the Markham sanctuary, an excellent virgin prairie in the Chicago area, supervision constitutes the only visitor control (except for use of a wide trail). This consists of one caretaker working five days a week, including the weekend, from May through October. Besides patrolling the area and cutting brush, his duties include some casual interpretation. Nonconforming use by neighborhood residents when the caretaker is off-duty has prompted plans for a fence.

2. Use of the "people filter." Lindsey et al. (1969) recommend that no other uses be permitted in the vicinity of a natural area, and that parking be provided some distance from the trailhead, so that people have to walk to get there.

> With all vehicular traffic prohibited on the trails and with no picnic tables provided, the segment of the population which does not vandalize or appreciably damage the outdoors should be willing to walk some distance. Walking is generally unpopular with those who are likely to harm natural areas. If parking places are to be specially provided near state-owned natural areas, a long foot trail to the main feature had best be provided as a people-filter. The smaller and more vulnerable areas should not be developed by having parking areas provided. (p. 12).

3. Use of such trail modifications as:

a. the elevated boardwalk. According to Tans (1975, personal communication) this method has been used "with a great deal of success" in Wisconsin natural areas, and more are planned. It is used, for example, at The Ridges Sanctuary on the Door Peninsula, famous for its many rare plants (among the 25 orchids are the calypso and ram's-head lady's slipper). Its visitation rate of upwards of 30,000 a year would not be possible without the boardwalk trail.

Any trail serves to direct traffic through an area, but a boardwalk trail even more so; the mere fact that it is raised above the surrounding terrain no doubt provides a subtle but decided incentive to stay on it, especially when the area is wet and noted for the presence of poison sumac and rattlesnakes. Handrails probably help.

Boardwalk trails can beaesthetically designed so as to complement and not detract from the natural beauty of the site.

It has been pointed out to me that, despite signs explaining the evils of flower-picking, no flower of any appeal within arm's reach of a trail is safe--a fact to consider when laying out a trail through an area of rare plants. It would be interesting to do a study on which flowers are most likely to be picked, in terms of color, size, density of blossoms, reputation, etc. The results might help us know what we can and can't get away with in trail layout.

b. use of paving, without which soil compaction and erosion can become serious problems. Paving is especially valuable for use on slopes and such unstable soils as sands. Again, paving is available which is aesthetically acceptable.

c. use of wide trails. This is a must if groups led by a guide will be using the trail. There must be enough trail-room for people to bunch up around the guide when he stops to explain something, without overflowing into the surrounding vegetation and trampling the plants. I would say there is no place for the single-file path in a natural area where interpretation is going on.

4. Use of alternate trails. The trail system can be designed in such a way that parts of it can be closed to give the land a "rest"--a chance to recover from erosion and soil compaction--every other year or so. A trail, for example, could have two loops instead of one, although only one would be in use in any given year. Some sites lend themselves to this kind of thing much better than others. At Miner Lake the unique areas are too small to permit development of double-loop trails, and the heavy use of boardwalk and paving largely eliminates their desirability.

5. Use of the bypass. The trail can be routed to pass close to the unique area without actually entering it; visitors would have the opportunity to look into it while the area itself remains closed to public use. Observation platforms can be erected along the way. The interpretive prospectus for the Indiana Dunes

National Lakeshore recommends such a trail for use on the periphery of Pinhook Bog. A fragile area containing a plant community rare in the South Dakota Badlands is interpreted via a trail which encircles it. Such trails are especially useful in areas in which a shy, rare bird or other animal breeds and the objective is to expose people to a glimpse of it without disturbing the breeding grounds.

6. Generally avoid pointing out specific rare plants. This goes especially for non-personal methods of interpretation. The visitor should be made aware what rare plants grow in the area, and that they can be observed from the trails. That's as far as the responsibility of the interpretation need go in acquainting the visitor with rare plants. Interpreters should be allowed to exercise their own judgment on whether or not to point out rarities on guided walks.

7. Education. It has been pointed out by some authors that much "vandalism" is not vandalism at all because it was perpetrated in ignorance, not out of malice. Interpretation should be conducted in such a way that the visitor can't get far before he knows about the rarities and his responsibility to respect their continued presence. This information can be presented with taste, style, and discretion; it need not be a blunt command accompanied by a warning, which tends to offend and elicit a counter-productive response. Visitors may be subjected to a more or less formal orientation at the interpretive center before being allowed to walk the trails by themselves. However, in cases where the physical set-up precludes

control of trail access (such as at Miner Lake), this course of action is unfeasible.

8. Use of quality facilities. Other authors have noted that "patron response to quality equipment, color, and good design appears to be effective" (Wilson, 1958) in reducing vandalism. Signs and other interpretive media should be professionally designed and made and should be well-maintained.

9. Restricted use. It is difficult to predict the carrying capacity of a site in terms of number of people it can support without environmental degradation. In most cases, restrictions are imposed only after damage has become visible. Recently, however, guidelines have begun to appear which, for all their weaknesses, help move planning away from an arbitrary basis for decision-making towards one that is more objective and reliable. (The biggest inadequacy of any attempt to quantify carrying capacity is, of course, that type of use cannot be considered as a factor. A carrying capacity of one person per acre may be too high if that person is a vandal).

A paper done for the National Park Service (Sudia et al., n. d.) points out that carrying capacity depends not on the total acreage of the park, or on its natural characteristics, but on the amount and kind of developed land within the park (roads, trails, campgrounds), since the great bulk of park use occurs in the developments. The paper suggests that no development should operate at full (100% capacity; in fact, levels of occupancy greater than 65%

probably cause a facility to deteriorate faster than it can be maintained. Full capacity for a ten foot wide trail is considered to be 311 people/acre; (very roughly, two acres equal one mile of trail). How they arrive at this figure is not explained.

One place where this kind of use occurs is Muir Woods National Monument, near San Francisco. It embraces 500 acres and has about six miles of trail (about 11 acres of development). Because of its size and the nature of its main feature (the redwood-dominated flora, which, because of its intolerance to soil compaction, can be considered fragile), it invites comparison with the Miner Lake area.

Muir Woods is heavily over-used, with up to 5,000 people present on the 11 acres in one day. While that many people surely constitutes a threat to the resource, apparently the recommended maximum of 2,000/day does not. This use level would occur at 65% of total capacity, or 202 people/acre.

This sounds much too high for an outstanding natural area (Class IV land, using ORRRC-BOR classification). Even at 202/acre, Muir Woods receives high density (Class I) use; Disney World is less crowded! Sudia et al. suggest 10% of total capacity is probably right for natural areas (presumably Class IV lands) and 20% for recreation areas (presumably Class III lands). Again, we are not told how they arrive at these figures, but they sound fairly reasonable.

If we accept these figures,* we can arrive at a rough estimate of an acceptable use level at Miner Lake. At Miner Lake the

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*With effective visitor control, we may feel comfortable with 20% or even slightly more.

trails would be no more than five feet wide, so we should halve the 311/acre figure to get total capacity. Rounding off, we have 150 people/acre, or (assuming one mile of five foot trail equals one acre) 150 people/mile at Miner Lake. At 10-20% of total capacity, we'd have 15-30 people/acre. About three miles (acres) of trail, including over three-quarters mile of road used as trail, are anticipated. Multiplying 15-30 by three, we get the maximum number of people--45-90--which can be permitted on the preserve at any given time. If an average of 45-90 people used the preserve each day all 365 days of the year, annual visitation would be 16,425-32,850. Bad weather will reduce the figure to less than 45-90/day, while good weather may boost the actual figure to perhaps twice that number (remember, this is the maximum permitted at any given moment, not the daily maximum).

How do you keep visitation down to the recommended figure?

School classes and other groups should be scheduled according to a reservation system; certain blocks of time should be devoted especially to serving such groups, while other blocks are reserved for visitation by the general public, which is encouraged to utilize the preserve at such times by the publicized activities scheduled then. These are heavily weekend-oriented.

When the parking lot is full, a gate is closed and visitors are turned away. It may be necessary to initiate a reservation system for the general public as well as groups. Visitors traveling some distance especially should be encouraged to notify the staff so that

a parking space can be reserved for the time they plan to be visiting.

Visiting school classes should be accompanied by adults at the ratio of one per 15 children, a procedure insisted upon by the Hennepin County, Minnesota Park Reserve District, well-known for its excellent interpretive services. Teachers and other supervising adults should be well-coached before time on the importance of staying on the trails, etc.

Fencing may be deemed necessary, although I would turn to it only as a last resort, to keep out off-the-road vehicles, beer parties, and the like. As a permanent intrusion of human technology on the natural scene, trails are bad enough; fences are going too far.

These are only examples of the kind of controls which should be used; others may be necessary. Interpreters must carefully monitor the area at frequent intervals to determine what vandalism or other damage is occurring; the results of these inventories should determine ensuing use policy.

10. Supervised off-trail use by special interest groups. This is really a special type of restricted use and, but for the length of treatment I want to give it, could have been discussed under point #9. I am not aware, incidentally, of any preserve where this is now being practiced in the way described here.

The biggest offenders in natural areas are often nature-lovers and photographers who seem to think their passion for the

subject gives them the right to leave the trail at will to pursue their hobby in more detail. They are correct in assuming that there is a place for leaving the trail; even a bog can take a certain amount of trampling. The problem comes when too many people leave the trail in the wrong place at the wrong time, with motives that are sometimes not altogether suitable to dedicated natural areas.

Therefore, special excursions can be arranged, weekly or bi-weekly perhaps, for those who want to get closer to some of the flowers. These groups should be limited to six or seven persons, and an interpreter should always be present to supervise (i.e., guard against the more zealous carrying away trophies for their collections, etc.). Hopefully, providing such special opportunities for the nature devotee will help to discourage his taking matters into his own hands.

Non-personal Interpretation

Self-guiding Trails

It was decided that each of the three units in the preserve should have its own theme trail, designed to interpret the story or theme its features best illustrate. According to National Forest Service Miscellaneous Publication 968 (1964), "this is the most effective type of self-guiding trail; unity, coherence, and a story theme increase the visitor's understanding and help him remember more of the interpretation." Each trail would have several stops, each marked by a numbered post; a printed guidebook would explain the feature at each stop, building on what was said at previous

stops to develop the story. These would be available from a box with a lift-up lid, located next to the entrance sign (or it can be attached to the sign as shown in Figure 9).

This sign will give only the name of the trail and the name of the administering agency (see Figure 9). It will be two by three feet in size, of rough, weathered-gray oak to match the siding of the interpretive center. Letters are routed out and painted yellow or orange in the case of the Savanna Trail and green in the case of the Tamarack and North Woods Trails; color is thus coordinated with that of the trail guidebooks. Smaller directional signs, the same except that only the name of the trail is given, along with an arrow, shall be used as well.

The three trails and their themes:

1. Tamarack Trail (Miner Lake Unit). Three-quarter mile; bog plant succession, from lake to bog forest. See Figure 10.

2. North Woods Trail (Kalamazoo River Escarpment Unit). One-half mile (half above escarpment, half below). The what and why of a North Woods remnant isolated in the midst of a more southern flora, with related phytogeographical considerations. See Figure 11.

3. Savanna Trail (Savanna Unit). One-half mile. The importance of fire in creating and maintaining the oak opening community. See Figure 12.

The existence of a fourth (Floating Island Trail: one-quarter mile) depends on whether or not Miner Lake itself can be

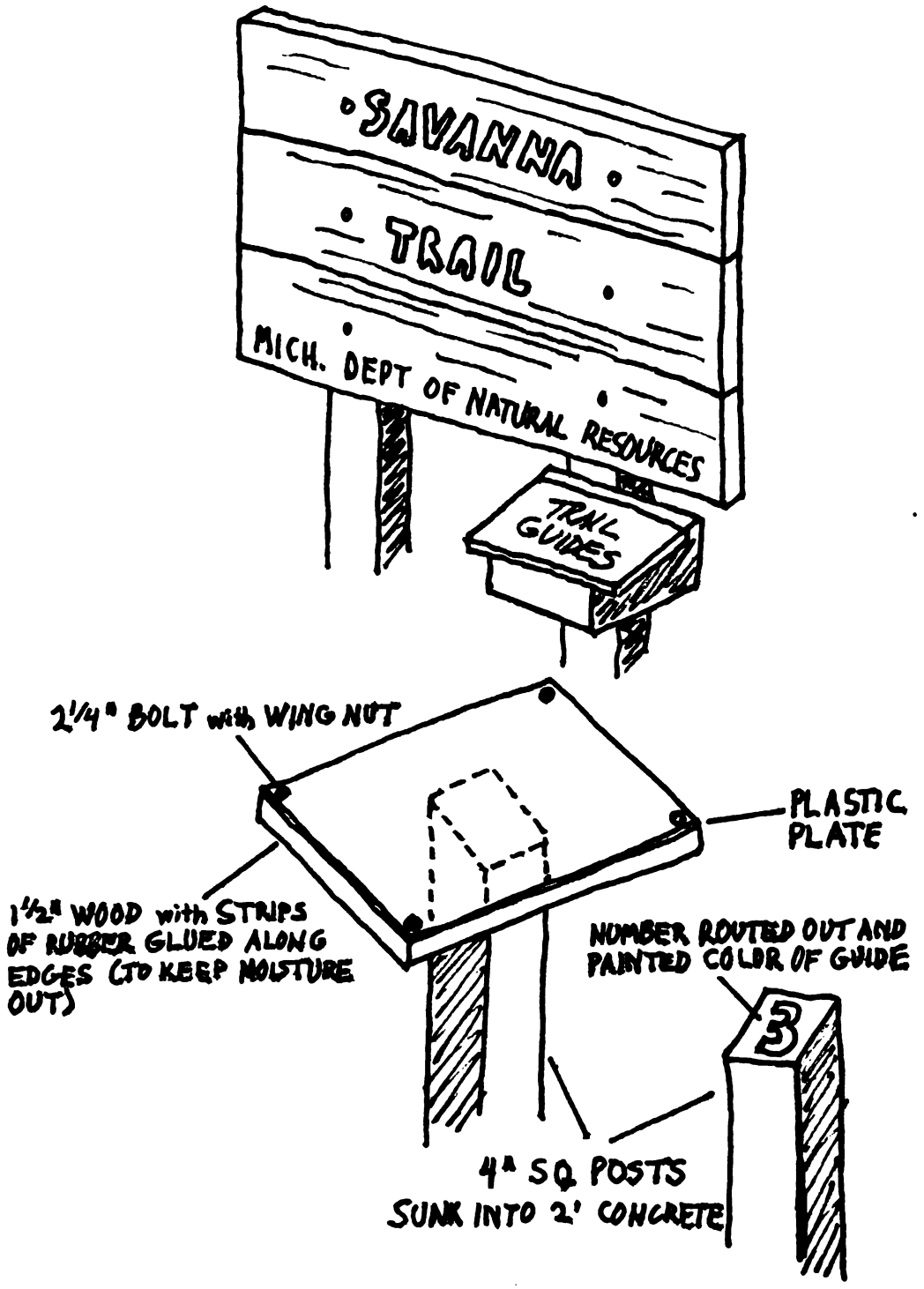
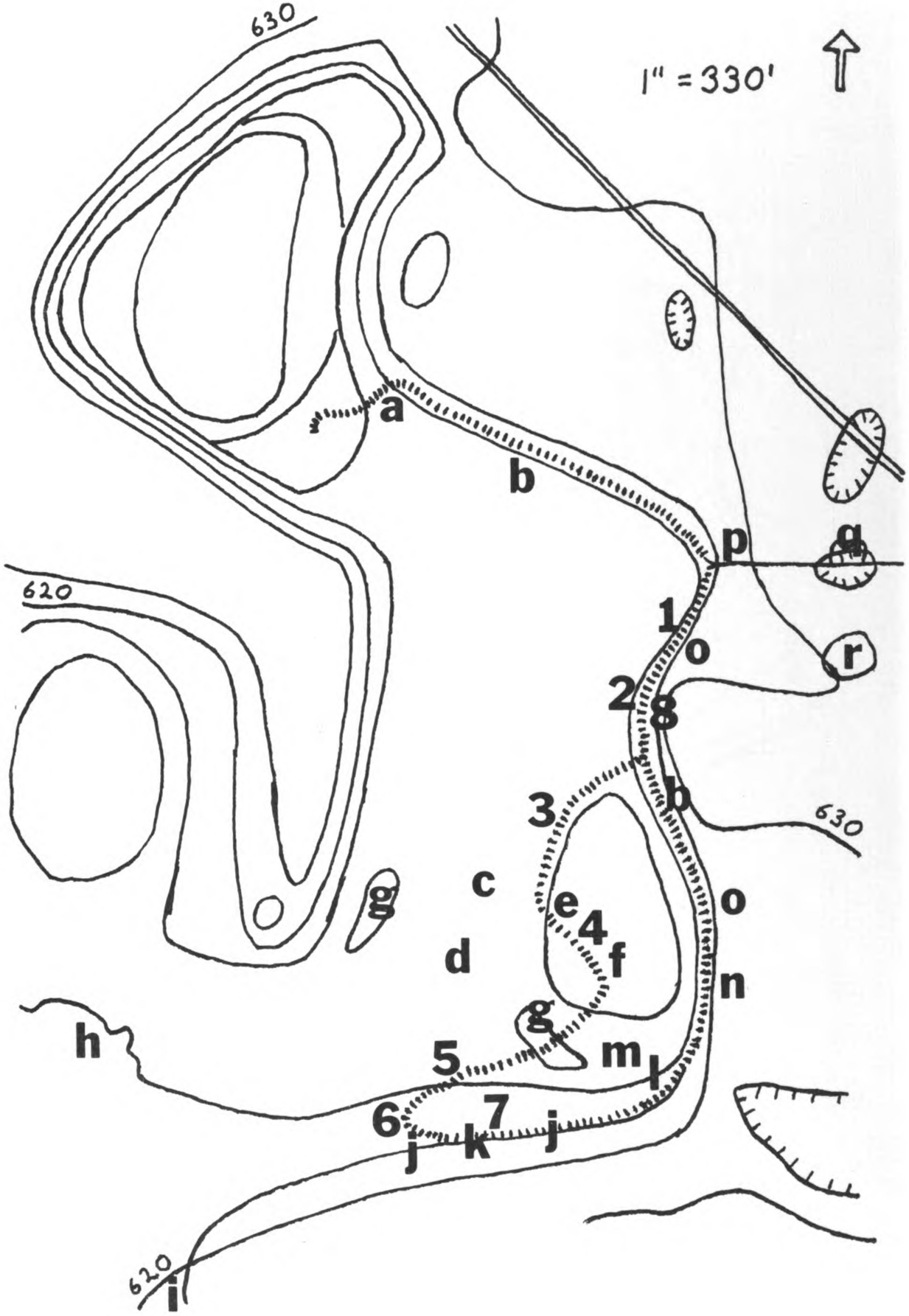


Figure 9.--Interpretive Signing.

Figure 10.--Tamarack Trail and Floating Island Trail.

Outstanding botanical features:

a. Horned-rush
b. Sour gum and pin oak
c. Cattail area
d. Arethusa
e. Grasspink
f. White fringed and yellow fringed orchids
g. Tamarack thicket
h. Nodding trillium
i. Beadlily and clubspur orchid
j. Beds of tree clubmoss
k. Bunchberry and pyrola
l. Stump with honey mushrooms
m. Area being invaded by white pine
n. Pyrola
o. Trailing arbutus
p. Elfcap moss
q. Clearing with lupine, birdfoot violet, and running shadbush
r. Clearing with lupine, spring beauty, and low shadbush


630
1" = 330'
a
b
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q
620
1
o
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2
8
3
b
630
c
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m
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620
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Figure 11.--North Woods Trail.

A. Visitors' Center and parking (first choice)

B. Visitors' Center (second choice)

C. Parking (second choice)

D. Sand roads

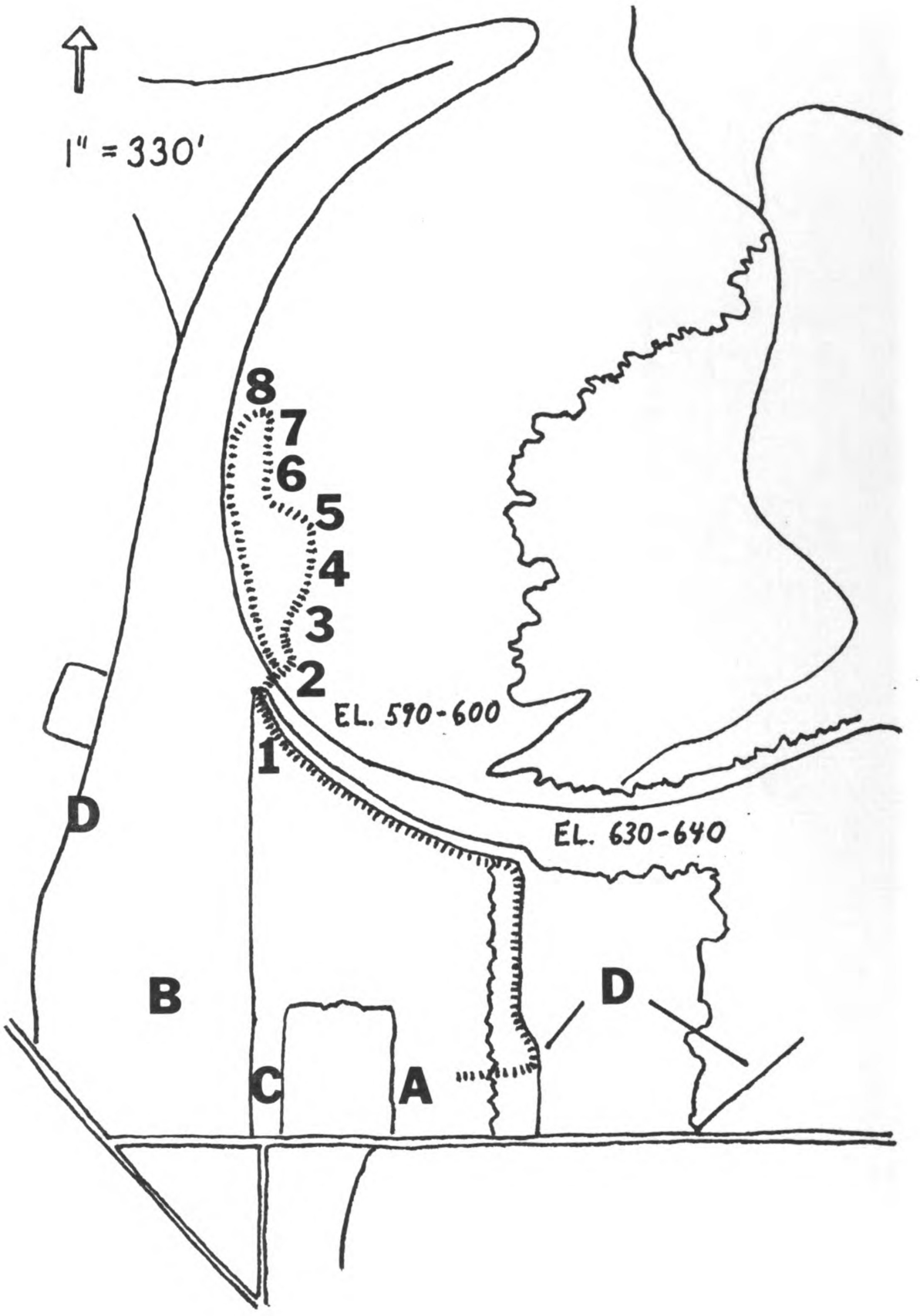
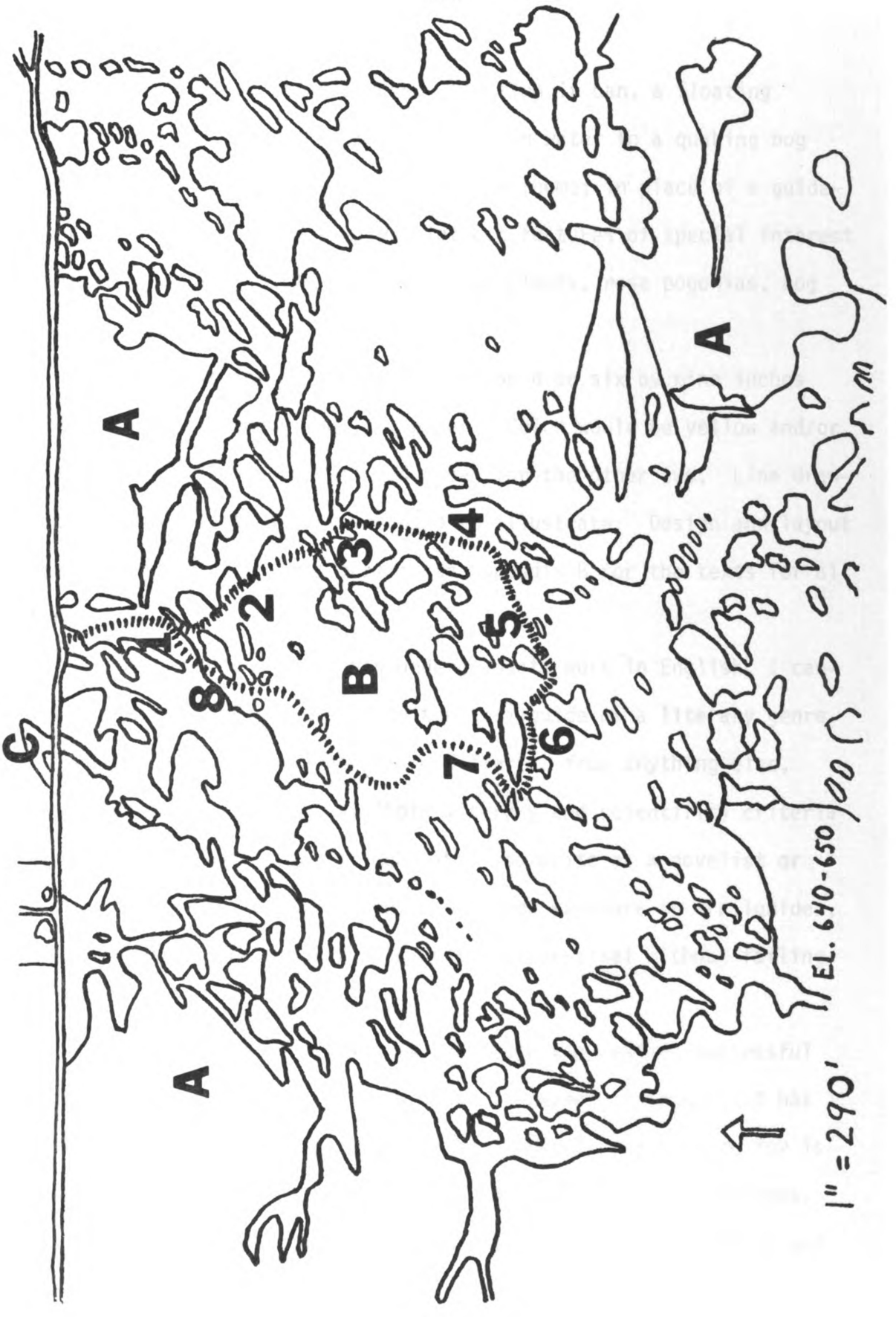

1" = 330'
8
7
6
5
4
3
2
1
EL. 590-600
EL. 630-640
D
B
C
A
D

Figure 12.--Savanna Trail.

A. Mostly woodland

B. Mostly grassland

C. Site of former homestead


A
A
A
B
C
1
2
3
4
5
6
7
8
EL. 640-650
1" = 290'

acquired as part of the preserve. Assuming it can, a floating boardwalk would be constructed across open water to a quaking bog mat. It would be too short to develop a theme; in place of a guidebook, a few signs would simply point out features of special interest (the floating mat itself, insectivorous plants, rose pogonias, bog coppers, etc.).

Booklets for all three trails would be six by nine inches and use a fairly heavy, quality paper. Color would be yellow and/or orange for the Savanna Trail and green for the other two. Line drawings executed by an artist are used to illustrate. Design and layout are not presented in this paper; see Appendix B for the texts for all three trails.

As someone who did his undergraduate work in English, I cannot resist a brief discussion on the trailguide as a literary genre. It is just that, a whole new genre different from anything else, requiring a whole new set of (both literary and scientific) criteria by which to judge it, and as much skill to write as a novelist or poet. As far as I can tell from my limited exposure to trailguides, not too many can be subjected to critical appraisal without failing badly.

There is no formula to my knowledge for writing successful trailguides, and I'm not sure the work I present in Appendix B has achieved what a trailguide ought to be. What I have strived for is balance, which I think is the crucial factor in achieving success. The text must be not too long and not too short, not too simple and

not too technical. It must say something new and memorable both to the expert and to the person who knows absolutely nothing about the subject, and should appeal both to the junior high school kid and the college graduate. Using everyday language to convey non-everyday ideas, the text should be sophisticated without seeming pretentious. It must be folksy and personal in style without going too far in that direction, i.e., it should strike a balance between the intimacy of friendly banter and the distance of a scientific treatise. Elements of any good writing, of course, should come into play, including, especially, use of metaphor, which can make just about anything relevant and interesting.

In short, writing trailguides should not be approached lightly. If the interpreter responsible for the text is not a man of letters himself, let him work with a man of letters (and an artist when it comes to design and illustration). A good poet can do much for the state of interpretation!

Wildflower Trail

The Savanna Trail would also function as a wildflower trail. Six permanent posts are mounted by nine by eleven-and-a-half inch signs consisting of heavy wood backing and a clear plastic plate, between which is an eight-and-a-half by eleven inch paper insert (see Figure 9). The insert pictures one or two kinds of flowers (in color), each of which is interpreted via a short (two or three sentence) text. These are changed as plants come into flower and fade.

The main advantage of doing it this way is that a lot of trailside clutter and irrelevance is avoided. Instead of a large number of permanent signs, all of which are interpreting flowers visible only for a small fraction of the year, you have only six signs, each with a timely message. The method contributes relevance to the visit and invites return trips, since the visitor has no way of knowing what will be present to look at next month, and his curiosity is aroused. Furthermore, the paper inserts are cheap and easily reproduced; they can be run-off on a copying machine and quickly hand-colored.

Of course, there is no interpretation of the plant when not in flower, or when just beginning or fading. The objective is simply to interpret wildflowers at or near full bloom. This is a real limitation, since some plants, though not in bloom, may be very conspicuous and likely to elicit questions. This problem may be somewhat settled by presenting inserts for such species, i.e., columbo, lupine, and coreopsis.

During the seasons when nothing is in bloom, the sign posts will of course remain. Rather than go unused, inserts can be presented to interpret other features in the vicinity (trees and shrubs in fall or winter aspect, dead but standing remains of herbs, winter rosettes, etc.), noting coming attractions, asking arresting questions, explaining where summer residents are now, and why, etc. The idea is to <u>use</u> the plates regardless of season, making a point with a short verbal and/or pictorial message.

Flowers to be interpreted follow, according to the month when they bloom:

May	1.	Birdfoot Violet
	2.	Spring Beauty and Pennsylvania Sedge
	3.	Early Buttercup and Pussytoes
	4.	Hairy Puccoon and Prairie Ragwort
	5.	Wild Lupine and Rock Sandwort*
	6.	Rosettes of American Columbo
June	1.	Orange and Field Hawkweeds
	2.	Ohio Spiderwort
	3.	Junegrass and Black Oatgrass
	4.	Hairy Puccoon and Wild Lupine
	5.	Lanceleaf Coreopsis
	6.	Hairy Beardtongue and Pasture Rose
July	1.	Flowering Spurge
	2.	Butterflyweed (pictured with butterflies that use it)
	3.	Wild Bergamot and New Jersey Tea
	4.	Goat's-rue
	5.	American Columbo
	6.	Racemed Milkwort
August	1.	Woodland Sunflower
	2.	Long-bearded Hawkweed and Flowering Spurge
	3.	Cylindric Blazingstar and Whorled Milkweed
	4.	Showy Goldenrod (var. angustata)
	5.	Sweet Everlasting
	6.	Western Sunflower
September	1.	Azure Aster and Gray Goldenrod
	2.	Rough Blazingstar
	3.	Little Bluestem
	4.	Big Bluestem and Indian Grass
	5.	Showy Goldenrod (typical var.)
	6.	Sweet Everlasting

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*A quote now and then from a famous author would not be inappropriate. For example, the following is applicable here: "Sometimes in June, when I see unearned dividends of dew hung on every lupine, I have doubts about the real poverty of the sands. On solvent farmlands lupines do not even grow, much less collect a daily rainbow of jewels." Aldo Leopold

Trail Construction

Trail design and construction in a unique natural area requires great care. The locations of all unusual plants must be painstakingly noted and marked so that the construction crew can avoid damaging them. Probably the person responsible for the inventory--in this case, myself--should not only design but mark the course of the trail, perhaps with lime, the way athletic fields are laid-out.

The crew which follows must be careful not to trample unique vegetation, and all earth removed must be carted away immediately rather than be allowed to pile up beside the trail. Anything outside the lines is not to be touched. Trails should be dug in summer when most of the valuable plant material is visible.

The trail should be five feet wide, and dug to a depth of about five inches. The upland segment of the Tamarack Trail should be filled with woodchips, the wetland segment will consist of boardwalk. The entire Savanna Trail should be paved, preferably with soil cement made with the native Plainfield Sand. This should be four-five inches thick, with a slight crown for run-off of rain water. The first part of the North Woods Trail, in the sand barrens, could also be paved. Wooden steps should take the visitor down the escarpment, at the base of which a boardwalk trail takes over.

The boardwalk segments should also be five feet wide. They should consist of decking overlying sections of telephone pole

arranged crosswise and/or lengthwise. Height should be about 18 inches above ground. During the dry summer and autumn, these logs will rest on (or more likely, in) the ground, except for the Floating Island Trail, which will be permanently floating. Wooden parts below decking not already treated with a preservative should be penta-treated. Decking should consist of two inch by six inch by five foot boards nailed side by side, left unpainted but treated by the Wohlman salt pressure process. There will be no handrails.

The Interpretive Center

Location. A number of sites were considered for the location of the interpretive center, none of which met all the conditions specified as desirable. As the place where the trails would begin, it should be located some distance from the main natural features, in compliance with the people-filter idea. This ruled out a site overlooking the lake, which would have provided an excellent sweeping view of the Miner Lake basin. The fact that this site is now on private land and may not be available, as well as its being on Zone 2 land, adds to its undesirability.

A second alternative would situate the center in the triangle formed by 126th Avenue, 54th Street, and Old Allegan Road. This is Zone 3 land, unexceptional from a botanical standpoint except for the presence of some prickly pear cactus; disturbance due to construction would have less effect here than in any of the other sites considered. The interpretive center would be highly

visible in such a setting, although intensive plantings could be used to help screen the building and parking lot.

A third alternative would avoid the necessity of plantings by placing the center in the woods just north of the triangle. The vegetation, in addition to providing an attractive setting, would effectively screen it from view and give it a low profile, which I think is desirable: an interpretive building should be subordinated to the landscape. The chief disagreeable feature is that a fine woodland would have to be disturbed, although no impairment of rarities is involved. With trees crowding the building on all sides, the lack of any view might also be considered an undesirable feature.

Parking would be provided in an 80 by 300 foot clearing between the forest on the west and a small woodlot on the east. Cars would be enclosed by the "walls" formed by the foliage, effectively lowering their visibility.

Finally, a fourth possibility has the center located in the Zone 3 area to the east of the woodlot. Again, the building and parking lot would be in the open, although they wouldn't be as conspicuous as in the triangle because of the greater amount of brush here. The building could be set back against the woodlot so that it would face both trees and clearing. Since the site is already disturbed, the environmental impact of construction would be less here than in the forest. Another advantage is that the adjacent sand road could be readily converted into the first half of the North Woods Trail, making it unnecessary to build it from scratch. Here

is a beautiful opportunity to use an existing man-made feature, adapting it to our purpose.

Although I find the forest idea quite attractive, I think this fourth alternative has the most going for it.

Parking. Limiting parking space to 30 cars contributes to use control. At 3.5 people per car, which in the national parks is average (Sudia et al.), parking would be provided for 105 people, which represents about the maximum for carrying capacity in the Miner Lake area.

Despite the distance of the Savanna Trail from the Visitors' Center, no parking would be provided for Savanna Trail users. A sign near the entrance of the trail would direct visitors to park at the interpretive center three-quarters mile down the road. A second alternative--some would say somewhat more humane!--was considered but rejected; it would provide space for six cars on the north side of 126th Avenue, across from the trail entrance. The primary goal of the sanctuary, after all, is to preserve the natural qualities of the site, not to serve people. Providing for the convenience of the public comes at the expense of the people-filter. Someone willing to walk three-quarters mile to get to a nature trail must want to visit that trail pretty badly, and isn't likely to abuse it. The infirm, of course, can be dropped off at the trail entrance. (The paving and flat terrain, by the way, make this trail ideal for wheelchair use).

The Building. The interpretive building should be modern in design without being ostentatious; it must fit into and complement its environment. I envisage a single-story building with five or six walls and a good deal of glass. Should its location be determined according to the third alternative, each large window, while letting in as much of the scant forest light as possible, would also provide a pleasing green framed picture of forest, even more delightful in May when the dogwood blooms. Only an open porch or veranda would separate the rest of the building from the trees; in fact, the porch could be built around three or four of the trees, in order to enhance the effect of the building blending into the forest. In the case of both third and fourth alternatives, no landscaping would be required. The building should be made of native oak wood, the boards left rough and unfinished and allowed to weather into a low-key gray.

The Interior. The same rough oak theme is carried out on the walls of the interior. The single large public room would be partially partitioned. Part of it would be devoted to permanent exhibits, part to informal, temporary displays especially directed to children. This dual approach is used very effectively, for example, at Badlands National Monument. Though child-oriented, the "feely-room," as it's nick-named, is very popular among people of all ages and incurs no vandalism, while the formal, permanent display area (in contradiction of visitor control method #8!) receives more than its share.

Permanent exhibits would include:

--a panel picturing geological stages (shallow sea of Early Mississippian time, Carboniferous swamp with large amphibians, savanna with dinosaurs, glaciers of Ice Age, glacial lake, boreal forest with mastodon)

--a panel showing history (Indian campsite, logging, farming, with a few implements to illustrate the technology used during each era)

--a large, colorful map showing post-glacial plant migration streams (see Figure 13 for map based on data provided by Crow, 1969b)

--a panel with photographs and equipment demonstrating how bogs are drilled and pollen is analyzed to determine former climate-vegetation of area

--wall map and panels showing southwest Michigan vegetation types, and biotic communities present in the immediate area, each with a few of its most characteristic plants and animals (some pictured, others as specimens mounted or cast in latex)

--a panel interpreting Michigan's other pine plains, the jack pine plains of the north, with special reference to the Kirtland's warbler

--a panel on endangered plants, explaining why they're endangered and what can be done about it

Quality technique, of course, in the preparation of these exhibits is essential. All the principles of good design in terms of form, color, and texture must come into play, as well as meticulous craftsmanship in their execution.

Figure 13. Post-glacial Plant Migration Streams.

A. From the Rocky Mountains: Bog Willow, Red Osier Dogwood

B. Wild Lupine, Prickly Pear, Blazingstar, Puccoon, Butterflyweed

C. Goldthread, Buckbean, Roundleaf Sundew

D. Pink Lady's-slipper, Starflower, Cranberry

E. Trillium, Lizard's-tail, Skunkcabbage

F. White Fringed Orchid, Rose Pogonia, Pitcherplant, Purple Bladderwort, Spoonleaf Sundew

G. From Europe: Sheep Sorrel, Orange Hawkweed

The informal display area consists of tables and walls upon which are scattered objects that can be touched and smelled and tasted. Information is on hand-lettered cards; no attempt is made to be neat or "professional." Displays are haphazard and cluttered, creating an exciting environment to be explored. A sign can tell visitors to "Touch if you wish," or it can list the rules for this area: "1. You must touch to enjoy displays. 2. To be announced." Interpretation here is less site-oriented, offering objects common to most any natural area: galls, a snakeskin, a wasp nest, dried grasses, mammal skins, deer antlers, kingbird nest, samples of Cold-water Shale (some with fossils in them), mosses and lichens, hawk pellets, rose hips, tea made from sassafras or cherry bark, dried herbs, incubating grouse eggs, a terrarium with a snake in it or an aquarium with fish or a mudpuppy from Miner Lake, etc.

Audio-visual Possibilities. No audio-visual methods are anticipated, except for a slide program, "Moods of the Pine Plains," which can be shown in a basement viewing room or be loaned out to schools and groups for viewing in preparation for their visit. Using the lap-dissolve technique and music instead of narration, it would provide a season by season introduction to the area's charms. A program that is visually and musically exciting and lacking in narration should make it unnecessary to produce two versions, one for lower elementary children and another for upper elementary through adult.

A very effective film could also be made available showing the stages through which the area has gone from the Ice Age to the

present. Again, music would carry the theme, with narration avoided or kept to a bare minimum. It would begin with scenes of wind-swept ice reminiscent of Antarctica then show glaciers calving into the sea (Glacial Lake Pullman), glacial torrents, pioneer vegetation of the north, scenes of spruce-fir and muskeg, northern wildflowers and wildlife; move on to pine forest complete with shots of pine plains fire, then prairie; and close with contemporary scenes filmed in the immediate area.

Personal Interpretation

Guided Walks

The staff should consist of one interpreter and one assistant interpreter. They would accommodate visiting school classes via a guided walk along one of the trails and, optionally, a slide program.

Guided walks would be offered to the general public especially during the weekends. These should supplement and complement the self-guided theme and wildflower trails; there should be little duplication or competition. While certain walks could be set up with no other theme or purpose than to experience what happens to be there along a particular trail at a particular time, others can be specialized. The variety encourages repeated visits while making the interpreter's job more interesting and helping him to be more enthusiastic. They might include walks designed to interpret:

--grasses: "From Bluestem to Wheat--How Grass Made the Midwest." A walk east along 126th Avenue, taking in turkey pasture

(wheat) and prairie grasses in the savanna, and emphasizing the importance of grass both to certain natural communities and to civilization.

--butterflies: "Insect Jewels." Savanna Trail.

--microhabitats: "A World of Little Things." An examination of rotten logs and stumps, pitcher plant vases, galls, tree holes, etc. Tamarack Trail.

--useful plants: "The Fat of the Land." Savanna Trail, to find and talk about acorns, sheep sorrel, wild lettuce, goat's-beard, prickly pear, mullein, black cherry, blueberry, and tea plants (New Jersey tea, bergamot, wintergreen, rose hips, sassafras). Or Tamarack Trail, for cattail, swamp milkweed, blueberry, cranberry, sphagnum, brachen, cinnamon and royal ferns, shadbush, dewberry.

--pond life: "Midget Monsters of Miner Lake." Jars of pond water can be collected and the contents examined with microscopes back at the center.

--mushrooms: "Destroying Angels, Stinkhorns, and Chanterelles." Tamarack or North Woods Trail.

--night experiences: "Those Mysterious Night Noises." Visitors can be issued flashlights to look for frogs in spring and insects in late summer and early autumn. Stars can also be interpreted. Look for foxfire along Tamarack Trail. Blacklights can be used to attract moths, and owl recordings to attract owls.

Off-site Activities

Two kinds of off-site activities can be planned:

1. Visits by the interpreter to schools and clubs to show the slides or film, talk about a milksnake or baby fox he has brought along, and mostly to leave the message that natural areas are important, for some very good reasons.

2. Guided tours within the Allegan State Game Area but not in the Miner Lake area. These would include an auto caravan to the Farm Unit south of Fennville, in October and November, to see the 13,000+ Canada geese which stop here on their way south, and a canoe trip down the Kalamazoo River from M-89 to New Richmond.

SUMMARY AND CONCLUSIONS

Instead of presenting an abstract series of principles to follow in interpretive planning for the quality natural area, an actual plan was presented to illustrate the type of thing required. What we end up with is a model in the sense of something "serving as an example to be imitated or compared" (American Heritage Dictionary). The practicality of this procedure is another of its advantages. Admittedly sketchy in some places, it nevertheless provides an adequate basis upon which the Department of Natural Resources can make a real-life decision. The groundwork has been laid; now it's up to them.

Several ideas for future research were generated in the course of writing this paper, of which the following five seem to me worth stating:

1. A study of the "quality" of the cheap, informal non-professional-looking interpretive exhibit: how effective is it? How popular? Why is it popular? Perhaps a comparison of the effect of such an exhibit with that of an expensive, formal, professional-looking display would prove enlightening.

2. A study into the likelihood of wildflower picking within the dedicated natural area: what kinds of flowers by what kinds of persons?

3. A study of the trailguide as a literary genre: what are the criteria by which trailguides should be judged? What makes them work? How do you write the ones that do?

4. A study of the relative effectiveness of two or more visitor control methods: how to measure, how to get data for a quantitative comparison.

5. A survey of the managers of selected quality natural areas (perhaps 50) offering interpretation. Each would be sent a questionnaire designed to get at which methods of visitor control are employed, which ones are judged most effective, what problems are encountered, etc. Unlike proposal #4, which uses observation to objectively measure effectiveness, this would deal with (experience-informed) attitudes and would thus constitute a subjective approach.

The chief points or guidelines in the model presented in the thesis are summarized here:

1. Research. Field research coordinated by one individual, who will conduct the natural resource inventory with help from specialists; site must be visited at least once a month for at least the duration of the growing season. Coupled with intensive library research.

2. Establishment of the primary features in the area, those that make it unique and worth preserving. Of course, if the site is already a dedicated natural area, these will have already been determined. These are the features which, naturally, will receive top

billing in the interpretive program. They should be described in some detail.

3. Land zoning, i.e., identification of most valuable and least valuable areas within the preserve as a guide in the planning of facility development.

4. Determination of methods of visitor control to help insure the preservation of the unique features. Ten are discussed. The more that can be utilized in a particular area, the safer, theoretically, will be the resource. No quality natural area should be opened to public use without such controls.*

5. Methods of interpretation are established within the broad categories of personal and non-personal. Interpretation is heavily site-centered, geared to explicating the unique features, but is not limited to this function. Rather than attempting to present everything known about the area, interpretation is selective, stressing the most important features and under-emphasizing or ignoring the insignificant.

6. Throughout, maintenance of quality standards is essential. A quality environment demands quality treatment. It means that the program will be relatively expensive; it also means success. When it comes to the quality natural area, we should probably accept the National Park Service dictum that "poorly done interpretation is worse than none at all."

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*And some areas now in use should be closed for lack of such controls!

By following steps such as these, a quality natural area can be preserved while relatively large numbers of people are given an outstanding recreational-educational experience. Careful planning makes it possible to develop almost any site, no matter how fragile, for interpretive use.

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APPENDICES

APPENDIX A

SPECIES PRESENCE LISTS FOR VASCULAR PLANTS FOR THE SIX MAJOR COMMUNITIES

(Nomenclature is according to Fernald, 1950)

APPENDIX A--SECTION 1

Oak Forest

Common Name	Scientific Name	Abundance Status
Ebony Spleenwort Found locally on the escarpment	Asplenium platyneuron	uncommon
Maidenhair Fern Found locally on the escarpment	Adiantum pedatum	uncommon
Brachen	Pteridium aquilinum	abundant
White Pine	Pinus strobus	loc. common
Hairgrass On jeep trail going down to Miner Lake	Deschampsia flexuosa	loc. common
Black Oatgrass	Stipa avenacea	com./abun.
Forked Panicgrass	Panicum dichotomum	uncommon
Broadleaved Panicgrass	Panicum latifolium	uncommon
Pennsylvania Sedge	Carex pensylvanica	abundant
False Soloman's-seal	Smilacina racemosa	uncommon
Solomon's-seal	Polygonatum biflorum	uncommon
Canada Mayflower	Maianthemum canadense	local
Pink Lady's slipper	Cypripedium acaule	uncommon
Spotted Coralroot On the escarpment	Corallorhiza maculata	uncommon
Trembling Aspen	Populus tremuloides	common
Bigtooth Aspen	Populus grandidentata	
Beech	Fagus grandifolia	rare
White Oak	Quercus alba	abundant
Black Oak	Quercus velutina	abundant
Pin Oak On shore	Quercus palustris	local
Bastard Toadflax	Comandra umbellata	common
Roundlobe Hepaticia Locally on the escarpment	Hepatica americana	uncommon
Thimbleweed	Anemone virginiana	rare/unc.
Columbine	Aquilegia canadensis	rare
Sassafras	Sassafras albidum	abundant
Witch Hazel	Hamamelis virginiana	common

Downy Shadbush	Amelanchier arborea	common
Smooth Shadbush	Amelanchier laevis	common
Black Cherry	Prunus serotina	abundant
Chokecherry	Prunus virginiana	
Naked-flowered Tick-trefoil	Desmodium nudiflorum	
Hoary Tick-trefoil	Desmodium canescens	unc., loc.
Panicled Tick-trefoil	Desmodium paniculatum	rare
Wandlike Bushclover	Lespedeza intermedia	unc., loc.
Hairy Bush-clover	Lespedeza hirta	loc. common
Herb-robert One small station near bottom of jeep trail leading to Miner Lake (with Sweet Cicely)	Geranium robertianum	local
Red Maple	Acer rubrum	common
New Jersey Tea	Ceanothus americanus	loc. common
Frost Grape	Vitis riparia	local
Birdfoot Violet Especially on jeep trail leading to Miner Lake	Viola pedata	local
Northern Downy Violet	Viola fimbriatula	local
Sourgum On shore	Nyssa sylvatica	local
Sweet Cicely One small station near bottom of jeep trail leading to Miner Lake (with Herb-Robert)	Osmorhiza claytoni	local
Flowering Dogwood	Cornus florida	abundant
Pipsissewa	Chimaphila umbellata	rare-unc.
Roundleaf Pyrola	Pyrola rotundifolia	uncommon
Indian Pipe	Monotropa uniflora	uncommon
Pinesap	Monotropa hypopithys	rare
Trailing Arbutus Especially in wood along edge of Miner Lake	Epigaea repens	uncommon
Wintergreen	Gaultheria procumbens	abundant
Black Huckleberry	Gaylusaccia baccata	abundant
Early Low Blueberry	Vaccinium vacillans	abundant
Late Low Blueberry	Vaccinium angustifolium	common
Black Highbush Blueberry In wood along edge of Miner Lake	Vaccinium atrococcum	local

Highbush Blueberry	Vaccinium corymbosum	local
In woods along edge of Miner Lake		
Whorled Loosestrife	Lysimachia quadrifolia	loc. common
Poke Milkweed	Asclepias exaltata	rare
Downy False Foxglove	Gerardia virginica	local
Cow-wheat	Melampyrum lineare	loc. common
Especially along jeep trail going to Miner Lake		
Wood Betony	Pedicularis canadensis	uncommon
Squawroot	Conopholis americana	local
Mapleleaf Viburnum	Viburnum acerifolium	common
Harebell	Campanula rotundifolia	uncommon
Bluestem Goldenrod	Solidago caesia	
Largeleaf Aster	Aster macrophylla	uncommon
Smooth Aster	Aster laevis	common
Woodland Sunflower	Helianthus divaricatus	common
White Rattlesnake-root	Prenanthes alba	rare

APPENDIX A--SECTION 2

Oak Openings

' - mainly in woods
* - prairie species (Betz & Scharrer)
A - alien

Common Name	Scientific Name	Abundance Status
Sand Spikemoss	Selaginella rupestris	?
'Brachen	Pteridium aquilinum	com./abun.
White Pine	Pinus strobus	uncommon
Red Cedar	Juniperus virginiana	rare
*Kalm's Chess	Bromus kalmii	unc., local
A Canada Bluegrass	Poa compressa	uncommon ?
A Kentucky Bluegrass	Poa pratense	abundant
A Quackgrass	Agropyron repens	uncommon
*Junegrass	Koeleria cristata	abundant
Poverty Oatgrass	Danthonia spicata	abundant
Ticklegrass	Agrostis hyemalis	unc., local
Black Oatgrass	Stipa avenacea	abundant
Purple Needlegrass	Aristida purpurascens	uncommon
Starved Panicgrass	Panicum depauperatum	abundant
Long-stalked Panicgrass	Panicum perlongum	uncommon ?
'Forked Panicgrass	Panicum dichotomum	uncommon
Commons' Panicgrass	Panicum commonsianum	common
*Few-flowered Panicgrass	Panicum oligosanthes	uncommon
'Broadleaved Panicgrass	Panicum latifolium	uncommon
*Little Bluestem	Andropogon scoparius	abundant
*Big Bluestem	Andropogon gerardii	common
*Indian Grass	Sorghastrum nutans	common
Slender Cyperus	Cyperus filiculmis	uncommon
Pennsylvania Sedge	Carex pensylvanica	abundant
*Ohio Spiderwort	Tradescantia ohiensis	common
A Asparagus	Asparagus officinale	rare
'False Solomon's-seal	Smilacina racemosa	uncommon
Solomon's-seal	Polygonatum biflorum	uncommon
'Catbrier	Smilax rotundifolia	rare
'Spotted Coralroot	Corallorhiza maculata	rare
*Prairie Willow	Salix humilis	rare
'Trembling Aspen	Populus tremuloides	rare
White Oak	Quercus alba	common
Black Oak	Quercus velutina	common
*Bastard Toadflax	Comandra umbellata	common/abun.

A Sheep Sorrel	Rumex acetosella	abundant
Slender Knotweed	Polygonum tenue	rare/unc.
Spring Beauty	Claytonia virginica	abundant
*Rock Sandwort	Arenaria stricta	abundant
A Evening Lychnis	Lychnis alba	rare
Early Buttercup	Ranunculus fascicularis	com./abun.
*Long-headed Thimbleweed	Anemone cylindrica	common
'Thimbleweed	Anemone virginiana	rare/unc.
Tower Mustard	Arabis glabra	common
Sassafras	Sassafras albidum	common
Low Juneberry	Amelanchier humilis	unc., local
Running Juneberry	Amelanchier stolonifera	unc., local
Downy Shadbush	Amelanchier arborea	uncommon
Smooth Shadbush	Amelanchier laevis	uncommon
Wild Strawberry	Fragaria virginiana	common
A Rough-fruited Cinquefoil	Potentilla recta	uncommon
Common Cinquefoil	Potentilla simplex	common
Northern Dewberry	Rubus flagellaris	common
*Pasture Rose	Rosa carolina	common
Eastern Dwarf Cherry	Prunus susquehanae	uncommon
Pin Cherry	Prunus pensylvanica	rare ?
Black Cherry	Prunus serotina	common
Chokecherry	Prunus virginiana	uncommon
Wild Lupine	Lupinus perennis	abundant
*Goat's-rue	Tephrosia virginiana	common
'Hoary Tick-trefoil	Desmodium canescens	unc., local
'Panicled Tick-trefoil	Desmodium paniculatum	rare
'Wandlike Bush-clover	Lespedeza intermedia	unc., local
'Hairy Bush-clover	Lespedeza hirta	com., local
A Hairy Vetch	Vicia villosa	rare
Racemed Milkwort	Polygala polygama	common
*Flowering Spurge	Euphorbia corallata	common
'*New Jersey Tea	Ceanothus americanus	common
Summer Grape	Vitis aestivalis	rare
Frost Grape	Vitis riparia	rare
A Common St. Johnswort	Hypericum perforatum	uncommon
Frostweed	Helianthemum canadense	common
*Birdfoot Violet	Viola pedata	common
Prickly Pear	Opuntia humifusa	rare
Common Evening-primrose	Oenothera biennis	uncommon
Sand Evening-primrose	Oenothera rhombipetala	rare
'Flowering Dogwood	Cornus florida	uncommon
'Gray Dogwood	Cornus racemosa	com., local
'Wintergreen	Gaultheria procumbens	common
Bearberry	Arctostaphylas uva-ursi	unc., local
'Black Huckleberry	Gaylussacia baccata	unc., local
Early Low Blueberry	Vaccinium vacillans	unc., local
Late Low Blueberry	Vaccinium angustifolium	com., local
American Columbo Blooms only in certain years	Swertia caroliniensis	common

Spreading Dogbane	Apocynum androsaemiifolium	uncommon
*Butterflyweed	Asclepias tuberosa	uncommon
'Purple Milkweed	Asclepias purpurascens	rare
'Poke Milkweed	Asclepias exaltata	rare
*Blunt-leaved Milkweed	Asclepias amplexicaulis	rare/unc.
*Whorled Milkweed	Asclepias verticillata	uncommon
*Upright Bindweed	Convolvulus spithameus	rare/unc., loc.
Hairy Puccoon	Lithospermum croceum	common
*Hoary Puccoon	Lithospermum canescens	rare
'Heal-all	Prunella vulgaris lanceolata	rare
*Wild Bergamot	Monarda fistulosa	uncommon
Horsemint	Monarda punctata	common
Glammy Ground-cherry	Physalis heterophylla	rare ?
Blue Toadflax	Linaria canadensis	uncommon
Figwort	Scrophularia lanceolata	rare
Hairy Beardtongue	Penstemon hirsutus	rare/unc.
'Yellow False Foxglove	Gerardia flava	com., local
'Fern-leaved False Foxglove	Gerardia pedicularia	unc., local
'Cow-wheat	Melampyrum lineare	unc., local
'*Wood Betony	Pedicularis canadensis	unc., local
Hairy Bedstraw	Galium pilosum	uncommon
Mountain Honeysuckle	Lonicera dioica	rare
Venus Looking-glass	Specularia perfoliata	uncommon
'Harebell	Campanula rotundifolia	rare
*Rough Blazing-star	Liatris aspera	common
*Cylindric Blazing-star	Liatris cylindracea	common
*Showy Goldenrod	Solidago speciosa & var. angustata	uncommon
Angustata blooms about a month earlier than speciosa.		
Early Goldenrod	Solidago juncea	uncommon
*Gray Goldenrod	Solidago nemoralis	common
'Late Goldenrod	Solidago gigantea	rare
'Largeleaf Aster	Aster macrophyllus	uncommon
*Azure Aster	Aster azureus	common
'Arrowleaf Aster	Aster sagittifolius	uncommon
'*Smooth Aster	Aster laevis	com./abun.
Narrowleaf Fleabane	Erigeron strigosus	common
Plantain-leaved Pussytoes	Antennaria plantaginifolia	unc./com.
Sweet Everlasting	Gnaphalium obtusifolium	common
Western Ragweed	Ambrosia psilostachya	common
*Black-eyed Susan	Rudbeckia hirta	unc./com.
*Western Sunflower	Helianthus occidentalis	com./abun.
'Woodland Sunflower	Helianthus divaricatus	common
Lanceleaf Coreopsis	Coreopsis lanceolata & var. villosa	abundant
A Yarrow	Achillea millefolium	uncommon
Wormwood	Artemesia caudata	common
'*Pale Indian Plantain	Cacalia atriplicifolia	loc. common
Prairie Ragwort	Senecio plattensis	loc. common
Dwarf Dandelion	Krigia virginica	uncommon

A Goat's-beard	Tragopogon major	uncommon
Wild Lettuce	Lactuca canadensis	common
'White Rattlesnake-root	Prenanthes alba	uncommon
A Orange Hawkweed	Hieracium aurantiacum	common
A Field Hawkweed	Hieracium pratense	common
Hairy Hawkweed	Hieracium gronovii	common
*Long-bearded Hawkweed	Hieracium longipilum	common

Other (Native) Oak Opening Species Seen Elsewhere in the Pine Plains

Four-o'clock	Mirabilis nyctaginea
Lyreleaf Rockcress	Arabis lyrata
Green Rockcress	Arabis missouriensis
Hawthorn	Crataegus sp.
*Showy Tick-trefoil	Desmodium canadense
*Grooved Yellow Flax	Linum sulcatum
Dwarf Sumac	Rhus copallina
Lanceleaf Loosestrife	Lysimachia lanceolata
Indian Hemp	Apocynum sibiricum
Common Milkweed	Asclepias syriaca
*Green Milkweed	Asclepias viridiflora
Large-bracted Vervain	Verbena bracteata
Horse Nettle	Solanum carolinense
Virginia Ground-cherry	Physalis virginiana
*False Boneset	Kuhnia eupatorioides
Horseweed	Erigeron canadensis
'Rattlesnake-weed	Hieracium venosum

APPENDIX A--SECTION 3

Cedar-Hemlock Swamp

* - northern species
' - southern species

Common Name	Scientific Name	Abundance Status
Field Horsetail	Equisetum arvense	uncommon
Swamp Horsetail	Equisetum fluviatile	uncommon
*Shining Clubmoss	Lycopodium lucidulum	unc., local
Rattlesnake-fern	Botrychium virginianum	uncommon
Royal Fern	Osmunda regalis	abundant
Cinnamon Fern	Osmunda cinnamomea	abundant
Marsh Fern	Dryopteris thelypteris	common
*Oak Fern	Dryopteris disjuncta	rare ?
Crested Fern	Dryopteris cristata	common ?
Lady Fern	Athyrium felix-femina	uncommon ?
*Canada Yew	Taxus canadensis	uncommon
*Hemlock	Tsuga canadensis	com., local
*Tamarack	Larix laricina	common
*White Pine	Pinus strobus	common
*White Cedar	Thuja occidentalis	common
Fringed Brome	Bromus ciliatus	common
Autumn Bent	Agrostis perennans	uncommon
Wood Reedgrass	Cinna arundinacea	common
Long-awned Woodgrass	Brachyelytrum erectum septentrionale	uncommon
Rice Cutgrass	Leersia oryzoides	uncommon
Jack-in-the-pulpit	Arisaema atrorubens	uncommon
Arrow Arum	Peltandra virginica	rare
Skunk Cabbage	Symplocarpus foetidus	abundant
Duckweed	Lemna sp.	local
Large-flowered Bellwort	Uvularia grandiflora	rare
Michigan Lily	Lilium michiganense	uncommon
*Canada Mayflower	Maianthemum canadense	abundant
Large-flowered Trillium	Trillium grandiflorum	uncommon
Bristly Catbrier	Smilax tamnoides hispida	rare
'Wild Yam	Dioscorea villosa	uncommon
Yellow Lady's slipper	Cypripedium calceolus parviflorum	uncommon
*Showy Lady's slipper	Cypripedium reginae	uncommon
*Pink Lady's slipper	Cypripedium acaule	uncommon

Clubspur Orchid	Habenaria clavellata	rare/unc.
*Northern Green Orchid	Habenaria hyperborea	uncommon
*Purple-fringed Orchid	Habenaria psychodes	rare
*White Adder's mouth	Malaxis brachypoda	uncommon
?Lily-leaved Twayblade	Liparis lilifolia	rare
*Bog Twayblade	Liparis loeselii	rare
'Lizard's-tail	Saururus cernuus	unc., local
Abundant elsewhere at the base of the escarpment in this community.		
*Hoary Willow	Salix candida	rare ?
*Yellow Birch	Betula lutea	uncommon
*Bog Birch	Betula pumila	uncommon
*Speckled Alder	Alnus rugosa	common
False Nettle	Boehmeria cylindrica	uncommon
Arrow-leaved Tearthumb	Polygonum sagittatum	uncommon
Long-leaved Chickweed	Stellaria longifolia	uncommon
Hooked Buttercup	Ranunculus recurvatus	
Purple Meadow-rue	Thalictrum dasycarpum	
Marsh Marigold	Caltha palustris	
*Goldthread	Coptis groenlandica	abundant
*Red Baneberry	Actaea rubra	rare
May Apple	Podophyllum peltatum	rare
Canada Moonseed	Menispermum canadense	rare
Spicebush	Lindera benzoin	abundant
Spring Cress	Cardamine bulbosa	
Pennsylvania Bittercress	Cardamine pensylvanica	
*Pitcher plant	Sarracenia purpurea	uncommon
Swamp Saxifrage	Saxifraga pensylvanica	uncommon
Bishop's-cap	Mitella diphylla	uncommon
*Naked Miterwort	Mitella nuda	uncommon
*Golden Saxifrage	Chrysosplenium americanum	common
*Smooth Gooseberry	Ribes hirtellum	common
*Chokeberry	Pyrus sp.	
Smooth Shadbush	Amelanchier laevis	
?Swamp Shadbush	Amelanchier intermedia	
*Purple Avens	Geum rivale	uncommon
*Dwarf Raspberry	Rubus pubescens	common
Agrimony	Agrimonia gryposepala	rare
Ground-nut	Apios americana	common
Hog-peanut	Amphicarpa bracteata	common
Poison Sumac	Rhus vernix	uncommon
Poison Ivy	Rhus radicans	common
*Winterberry	Ilex verticillata	uncommon
Red Maple	Acer rubrum	common
Spotted Jewelweed	Impatiens capensis	abundant
Virginia Creeper	Parthenocissus quinquefolia	
Marsh Violet	Viola cucullata	common
*Northern Willow-herb	Epilobium glandulosum	uncommon
Large Enchanter's-night-shade	Circaea quadrisulcata	common

*Small Enchanter's-nightshade	Circaea alpina	common
Spikenard	Aralia racemosa	rare
*Wild Sarsaparilla	Aralia nudicaulis	common
Water-parsnip	Sium suave	uncommon
*Hemlock-parsley	Conioselinum chinense	common
Cowbane	Oxypolis rigidior	rare
Gray Dogwood	Cornus racemosa	
*Pink Pyrola	Pyrola asarifolia	uncommon
Indian Pipe	Monotropa uniflora	rare
Black Highbush Blueberry	Vaccinium atrococcum	uncommon
*Tufted Loosestrife	Lysimachia thyrsiflora	uncommon
Fringed Loosestrife	Lysimachia ciliata	uncommon
*Starflower	Trientalis borealis	
White Ash	Fraxinus americana	uncommon
Green Ash	Fraxinus pensylvanica subintegerrima	
Black Ash	Fraxinus nigra	common
Bartonia	Bartonia virginica	uncommon
*Buckbean	Menyanthes trifoliata	uncommon
Mad-dog Skullcap	Scutellaria lateriflora	common
Self-heal	Prunella vulgaris lanceolata	common
Turtlehead	Chelone glabra	uncommon
Swamp Lousewort	Pedicularis lanceolata	uncommon
Sweet-scented Bedstraw	Galium triflorum	
Partridgeberry	Mitchella repens	
Great Lobelia	Lobelia siphiltica	uncommon
Sweet Joe-pye-weed	Eupatorium purpureum	rare
Rough-leaved Goldenrod	Solidago patula	common
Rough-stemmed Goldenrod	Solidago rugosa	common
Purple-stem Aster	Aster puniceus	common
Calico Aster	Aster lateriflorus	common
*Flat-topped White Aster	Aster umbellatus	rare
Green-headed Coneflower	Rudbeckia laciniata	unc., local
Tall Sunflower	Helianthus gigantea	uncommon
Tickseed-sunflower	Bidens aristosa	common
Golden Ragwort	Senecio aureus	rare
Swamp Thistle	Cirsium muticum	uncommon
Blue Lettuce	Lactuca biennis	rare
White Rattlesnake-root	Prenanthes alba	rare
Tall Rattlesnake-root	Prenanthes altissima	uncommon

APPENDIX A--SECTION 4

Sedge Bog

* - floating mat
\+ - shore

Common Name	Scientific Name	Abundance Status
Royal Fern	Osmunda regalis	abundant
Cinnamon Fern	Osmunda cinnamomea	rare
Sensitive Fern	Onoclea sensibilis	rare/unc. ?
Marsh Fern	Dryopteris thelypteris	abundant
Tamarack	Larix laricina	uncommon
Cattail	Typha latifolia	loc. abun.
Seaside Arrowgrass	Triglochin maritima	rare
Bluejoint Grass	Calamagrostis canadensis	abundant
Satingrass	Muhlenbergia glomerata	common
+Sloughgrass	Spartina pectinata	abundant
Reed Canary Grass	Phalaris arundinaceum	rare
Threeway Sedge	Dulichium arundinaceum	loc. abun.
Spikerush	Eleocharis elliptica	common ?
+Threesquare Bulrush	Scirpus americanus	unc., loc.
Great Bulrush	Scirpus acutus	abundant
Sheathed Cottongrass	Eriophorum spissum	rare
Slender Cottongrass	Eriophorum gracile	rare
Tall Cottongrass	Eriophorum angustifolium	rare
Tawny Cottongrass	Eriophorum virginicum	common
+Horned-rush	Rhynchospora macrostachya	unc., loc.
+Clustered Beakrush	Rhynchospora capitellata	loc. com.
White Beakrush	Rhynchospora alba	abundant
Twigrush	Cladium mariscoides	abundant
Water Sedge	Carex aquatilis	abundant
Brown Sedge	Carex buxbaumii	loc. com.
Slender Sedge	Carex lasiocarpa	common
Sedge	Carex sp.	
Sedge	Carex sp.	
*Broad-leaved Arrowhead	Sagittaria latifolia	common
+*Carolina Yellow-eyed Grass	Xyris caroliniana	common
*Pickerelweed	Pontederia cordata	unc., loc.
Blue Flag	Iris versicolor	uncommon
Ragged Fringed Orchid	Habenaria lacera	rare
Rose Pogonia	Pogonia ophioglossoides	common
Grasspink	Calopogon pulchellus	uncommon
Arethusa	Arethusa bulbosa	uncommon

Nodding Ladies'-tresses	Spiranthes cernua	unc., loc.
+Autumn Willow	Salix serissima	loc. com.
Bog Willow	Salix pedicellaris	uncommon
+Slender Willow	Salix gracilis	uncommon
Bog Birch	Betula pumila	common
Speckled Alder	Alnus rugosa	uncommon
False Nettle	Boehmeria cylindrica	common
Water Smartweed	Polygonum amphibium	common
Swamp Smartweed	Polygonum coccineum	uncommon
*Bullhead-Lily	Nuphar variegatum	common
Fragrant Waterlily	Nymphaea odorata	abundant
Water-shield	Brassenia schreberi	common
Purple Meadow-rue	Thalictrum dasycarpum	loc. unc.
Pitcher plant	Sarracenia purpurea	common
*Spoonleaf Sundew	Drosera intermedia	abundant
Roundleaf Sundew	Drosera rotundifolia	abundant
Narrowleaf Meadowsweet	Spiraea alba	common
Steeplebush	Spiraea tomentosa	common
Marsh Cinquefoil	Potentilla palustris	common
Bristly Dewberry	Rubus hispidus	common
+Swamp Rose	Rosa palustris	common
Vetchling	Lathyrus palustris	uncommon
Poison Sumac	Rhus vernix	common
Red Maple	Acer rubrum	uncommon
Kalm St. Johnswort	Hypericum kalmianum	loc. unc.
+*Dwarf St. Johnswort	Hypericum mutilum	loc. unc.
Marsh St. Johnswort	Hypericum virginianum	common
Bog Violet	Viola nephrophylla	common
Swamp Loosestrife	Decodon verticillata	rare/unc.
*Narrow-leaved Willowherb	Epilobium leptophyllum	rare
+Mermaid-weed	Proserpinaca palustris	abundant
Red Osier Dogwood	Cornus stolonifera	uncommon
Gray Dogwood	Cornus racemosa	loc. unc.
Bog Rosemary	Andromeda glaucophylla	abundant
Leatherleaf	Chamaedaphne calyculata	abundant
Large Cranberry	Vaccinium macrocarpon	abundant
Yellow Loosestrife	Lysimachia terrestris	uncommon
Tufted Loosestrife	Lysimachia thyrsiflora	uncommon
Bartonia	Bartonia virginica	uncommon
Buckbean	Menyanthes trifoliata	common
*Swamp Milkweed	Asclepias incarnata	rare/unc.
Common Skullcap	Scutellaria epilobiifolia	common
Northern Bugleweed	Lycopus uniflora	uncommon
*Small-flowered Gerardia	Gerardia paupercula	common
Purple Bladderwort	Utricularia purpurea	abundant
Greater Bladderwort	Utricularia vulgaris	common
*Humped Bladderwort	Utricularia gibba	common
Flat-leaved Bladderwort	Utricularia intermedia	common
Labrador Bedstraw	Galium labradoricum	common
*Stiff Marsh Bedstraw	Galium tinctorium	rare

+Buttonbush	Cephalanthus occidentalis	uncommon
Marsh Bellflower	Campanula aparinoides	loc. unc.
Spotted Joe-pye-weed	Eupatorium maculatum	uncommon
*Boneset	Eupatorium perfoliatum	loc. unc.
Bog Goldenrod	Solidago uliginosa	common
Roughleaf Goldenrod	Solidago patula	common
Roughstem Goldenrod	Solidago rugosa	common
Grassleaf Goldenrod	Solidago graminifolia	uncommon
Calico Aster	Aster lateriflorus	rare
Rush Aster	Aster junciformis	common
Flat-topped White Aster	Aster umbellatus	uncommon
+Tickseed-sunflower	Bidens aristosa	abundant
Wild Lettuce	Lactuca canadensis	rare

APPENDIX A--SECTION 5

Tamarack Bog

Common Name	Scientific Name	Abundance Status
Virginia Chainfern	Woodwardia virginica	loc. abundant
Tamarack	Larix laricina	abundant
White Pine	Pinus strobus	common
Woolgrass	Scirpus cyperinus	unc., local
Tawny Cottongrass	Eriophorum virginicum	common
Three-fruited Sedge	Carex trisperma	abundant
Canada Mayflower	Maianthemum canadense	rare
Pink Lady's slipper	Cypripedium acaule	common
Yellow Fringed Orchid	Habenaria ciliaris	common
White Fringed Orchid	Habenaria blephariglottis	common
Grasspink	Calopogon pulchellus	uncommon
Trembling Aspen	Populus tremuloides	rare
Speckled Alder	Alnus rugosa	common
Black Oak	Quercus velutina	rare/unc. seed.
Goldthread	Coptis groenlandica	uncommon
Pitcher plant	Sarracenia purpurea	common
Red Chokeberry	Pyrus arbutifolia	common
Black Chokeberry	Pyrus melanocarpa	common
Downy Shadbush	Amelanchier arborea	unc., local
Wild Strawberry	Fragaria virginiana	rare
Bristly Dewberry	Rubus hispidus	abundant
Swamp Rose	Rosa palustris	common (edges)
Pin Cherry	Prunus pensylvanica	rare
Poison Sumac	Rhus vernix	common
Winterberry	Ilex verticillata	common
Mountain Holly	Nemopanthus mucronata	unc., local
Red Maple	Acer rubrum	common
Indian Pipe	Monotropa uniflora	uncommon
Bog Rosemary	Andromeda glaucophylla	uncommon
Leatherleaf	Chamaedaphne calyculata	uncommon
Wintergreen	Gaultheria procumbens	common
Highbush Blueberry	Vaccinium corymbosum	abundant
Black Highbush Blueberry	Vaccinium atrococcum	common
Starflower	Trientalis borealis	unc., local
Buckbean	Menyanthes trifoliata	uncommon

APPENDIX A--SECTION 6

Red Maple Swamp

* - n. species

Common Name	Scientific Name	Abundance Status
*Shining Clubmoss	Lycopodium lucidulum	uncommon
*Wolf's-claw Clubmoss	Lycopodium clavatum	rare
*Tree Clubmoss	Lycopodium obscurum	loc. abund.
Rattlesnake-fern	Botrychium virginianum	uncommon
Royal Fern	Osmunda regalis	common
Cinnamon Fern	Osmunda cinnamomea	abundant
Sensitive Fern	Onoclea sensibilis	common
Marsh Fern	Dryopteris thelypteris	common
Spinulose Woodfern	Dryopteris spinulosa and var. intermedia	common ?
Crested Woodfern	Dryopteris cristata	uncommon
Lady Fern	Athyrium filix-femina	common ?
Virginia Chainfern	Woodwardia virginica	uncommon
*Tamarack	Larix laricina	uncommon (seed.)
*White Pine	Pinus strobus	uncommon
Fowl Manna-grass	Glyceria striata	
Autumn Bent	Agrostis perennans	common
Wood Reedgrass	Cinna arundinacea	common
Long-awned Woodgrass	Brachyelytrum erectum septentrionale	common
*Tall Millet Grass	Milium effusum	uncommon
Rice Cutgrass	Leersia oryzoides	common
Jack-in-the-pulpit	Arisaema atrorubens	uncommon
Skunk Cabbage	Symplocarpus foetidus	uncommon
Michigan Lily	Lilium michiganense	uncommon
*Beadlily	Clintonia borealis	unc., local
False Solomon's-seal	Smilacina racemosa	uncommon
*Canada Mayflower	Maianthemum canadense	common ?
Indian Cucumber-root	Medeola virginiana	common
Nodding Trillium	Trillium cernuum	rare/unc., local
Large-flowered Trillium	Trillium grandiflorum	rare
Pink Lady's slipper	Cypripedium acaule	rare/unc.
Clubspur Orchid	Habenaria clavellata	loc. unc.
Ragged Fringed Orchid	Habenaria lacera	rare
*Purple Fringed Orchid	Habenaria psychodes	rare
Spotted Coralroot	Corallorhiza maculata	rare

Ironwood	Carpinus caroliniana	common
*Yellow Birch	Betula lutea	rare/unc.
*Speckled Alder	Alnus rugosa	common
Beech	Fagus grandifolia	rare ?
American Elm	Ulmus americana	common
False Nettle	Boehmeria cylindrica	uncommon
Virginia Knotweed	Tovara virginiana	uncommon
Halberd-leaved Tearthumb	Polygonum arifolium	uncommon
Kidneyleaf Buttercup	Ranunculus abortivus	uncommon
Hooked Buttercup	Ranunculus recurvatus	
Clematis	Clematis virginiana	common
Marsh Marigold	Caltha palustris	uncommon ?
*Goldthread	Coptis groenlandica	abundant
Spicebush	Lindera benzoin	com./abun.
Spring Cress	Cardamine bulbosa	uncommon
Pennsylvania Bittercress	Cardamine pensylvanica	uncommon
*Golden Saxifrage	Chrysosplenium americanum	uncommon ?
Gooseberry	Ribes sp.	uncommon
*Chokeberry	Pyrus sp.	
Bristly Dewberry	Rubus hispidus	com./abun.
Swamp Rose	Rosa palustris	
Black Cherry	Prunus serotina	uncommon
Poison Ivy	Rhus radicans	
Red Maple	Acer rubrum	abundant
Spotted Jewelweed	Impatiens capensis	uncommon ?
Virginia Creeper	Parthenocissus quinquefolia	
Frost Grape	Vitis riparia	
Common Blue Violet	Viola papilionacea	common
Sweet While Violet	Viola blanda	abundant
Smooth Yellow Violet	Viola pensylvanica	common
Dog Violet	Viola conspersa	common
Sourgum	Nyssa sylvatica	rare
*Wild Sarsaparilla	Aralia nudicaulis	
*Bunchberry	Cornus canadensis	uncommon
Red Osier Dogwood	Cornus stolonifera	uncommon
Gray Dogwood	Cornus racemosa	com./abun.
*Shinleaf	Pyrola elliptica	uncommon
*Roundleaf Pyrola	Pyrola rotundifolia	uncommon
Indian Pipe	Monotropa uniflora	
Late Low Blueberry	Vaccinium angustifolium	uncommon ?
Highbush Blueberry	Vaccinium corymbosum	uncommon
*Starflower	Trientalis borealis	common
White Ash	Fraxinus americana	uncommon
Black Ash	Fraxinus nigra	uncommon
Bartonia	Bartonia virginica	uncommon
Wood Betony	Pedicularis canadensis	rare
Squawroot	Conopholis americana	uncommon
Sweet-scented Bedstraw	Galium triflorum	
Partridgeberry	Mitchella repens	uncommon

Mountain Honeysuckle	Lonicera dioica	uncommon
*Witch Hobble	Viburnum alnifolium	rare
*Northern Wild Raisin	Viburnum cassinoides	loc. unc.
Mapleleaf Viburnum	Viburnum acerifolium	uncommon
Common Elderberry	Sambucus canadensis	uncommon
Great Lobelia	Lobelia siphilitica	uncommon
Bluestem Goldenrod	Solidago caesia	rare
Roughleaf Goldenrod	Solidago patula	common
Routhstem Goldenrod	Solidago rugosa	common
Calico Aster	Aster lateriflorus	common
Golden Ragwort	Senecio aureus	rare
Swamp Thistle	Cirsium muticum	uncommon
White Rattlesnake-root	Prenanthes alba	uncommon

APPENDIX B

TEXTS FOR SELF-GUIDING TRAILS

APPENDIX B--SECTION 1

Tamarack Trail

Length: 3/4 mile. Walking time: 1 hour.

How do you get from the middle of a lake to a forest without moving so much as an inch? Follow the trail, read this booklet, and find out. If you already know, take the trail anyway and learn something else.

1. Please stay on the trail, and don't pick the flowers!

   Why?

   You are about to enter a very fragile environment, one that requires more-than-usual respect. Many rare and delicate plants grow along the trail. You can see to it that they continue to grow there, simply by not walking off the trail and trampling them.

   And, of course, by not picking the flowers.

   Picking flowers not only deprives people who come after you of the chance to enjoy them, but may actually hurt or even kill the plants. This is especially true of the orchids that grow along the trail. Some kinds have the leaves arranged in such a way that when you pick the flower, you pick the leaves too. Without them the plant can't make the food it needs, and it starves to death. Other plants are so loosely rooted in the soft moss that picking the flower usually results in pulling up the whole plant! You can see how easy it would be for someone to wipe out an entire colony.

   Besides protecting the bog and its flowers, staying on the trail protects the people who use it--from rattlesnakes and poison sumac!

   Important! Parents, please watch your children!

2. Emergent Aquatic Community

   You can't see it but straight ahead of you, as you stand facing the numbered post, is a small body of open water

that is all that's left of Miner Lake. Miner Lake is nearly dead, killed not by man's pollution but by Nature itself, by the natural process of filling-in until a lake has become land.

The very first stages of this filling-in process occur underwater, as pondweeds and other totally aquatic plants build up the bottom with their dead remains.

Over there where the waterlilies are growing is the first above-water stage. Ecologists call this the emergent aquatic community: the plants that make it up, although water-loving, have emerged at least part way into air. Their dead leaves and stems build up the bottom of the lake until at last it's no longer wet enough for them and they must give way to plants that prefer less water and more air. The plants in a particular community change their environment, making it less fit for themselves and more fit for others.

Before we move on to examine this next community, take some time to get better acquainted with the emergent aquatics. Animals, of course, are members of the community too. Which ones do you think can be classified as emergent aquatics?

[pictures of spatterdock, bulrush, mermaidweed, three-way sedge, and bladderwort]

3. Sedge Bog

Waterlilies and bulrushes once grew where you're standing now. Certain kinds of sedges gradually crept out among them from the shore, held up by their floating root systems. The tightly intertwined roots formed a seedbed on which sphagnum moss could grow. Together the sedges and moss created a gradually-thickening mat that floated on the water. Pieces of it fell off and drifted to the bottom, continuing to build it up, until at last top and bottom met and the floating mat turned into solid land.

[pictures of slender sedge, cottongrass, and twig-rush]

(Examples of the floating mat stage are still found at Miner Lake and can be seen along the "Floating Island Trail").

Composed entirely of plant remains, this land is hardly solid in the sense that on-shore land is. Called peat, these

remains are only partly rotted. Acids made by the moss, plus low air content in the water, discourage the bacteria that break down dead things into the chemicals that make them up--which is all that rotting (or decomposing) really is.

[pictures of bluejoint, poison sumac, marsh fern]

Because decomposition is retarded, chemicals in the remains of previous moss and sedge generations are not available to the living generation. Plants that grow in peat must get along somehow without the chemical nutrients most other plants need--or get them from some other source.

Some bog plants get their nitrogen from insects they catch and digest, others have roots inhabited by fungi that change free nitrogen into a form usable by the plant.

[pictures of pitcher plant and sundew]

Acid not only creates a nutrient-poor environment; along with cold temperatures at root level, it keeps plants from absorbing water as well as they might. Strangely enough, bog plants suffer drought conditions even with their roots in water! Actually the plants are hardly suffering. Every one you see is well adapted to life with a minimum of water. Look around you and observe some of these adaptations: small leaf size, leaf margins curled inward beneath, leaves tough and leathery. These are characteristics of desert plants. A bog is really a sort of wet desert!

[pictures of leatherleaf, bog rosemary, cranberry]

See if you can find all the plants shown in the accompanying pictures.

4. Tamarack Bog Forest

The filling-in of the lake is completed when the sedge mat eventually covers the open water and packs the watery space between it and the bottom with peat. But the changes don't stop here. Sedges and moss prepare the way for bog shrubs, and shrubs prepare the way for trees. After a while forest grows where bass and bluegills swam.

The first tree to come in is the tamarack, which you see here. Sedges and moss still grow among the trees, though the species are usually different from those that made the sedge mat. The sun-loving shrubs of the sedge mat tend to

disappear in the shade of the tamaracks, their place being taken by highbush blueberry. You can see how well the blueberry does. Its dense thickets create a shade in which little else but moss can grow.

[pictures of tamarack, highbush blueberry]

Notice there are no young tamaracks coming along to replace their elders. Tamaracks need lots of sun to grow and cannot survive in the shade of older, larger trees. The shade, incidentally, occurs only for a part of the year. Like broad-leaved trees, tamaracks shed all their needles in autumn, a trait unusual among members of the pine family.

Tamarack creates conditions suitable for white pine and red maple, which can take more shade and need drier soil. The scattered white pines you see have a much longer future ahead of them than the tamaracks do. Further north, black spruce joins the tamarack and takes over where tamarack leaves off, creating a different kind of bog forest.

[pictures of winterberry, mountain-holly, and chokeberry]

Why don't we have the black spruce here at Miner Lake?

Spruce is only one of several bog plants that are very rare this far south. Although we don't have the spruce here, we do have a good variety of these other rarities. Following the Ice Age, when the climate was much cooler, these plants were more widespread in southern Michigan. As the climate warmed, they retreated northward except here and there where conditions to their liking prevailed. Ecologists call these left-over communities relicts.

5. An Interlude: Sedge Meadow.

Before we enter the next stage, let's take a look at a community that looks much like the sedge bog, to which it's closely related. This is the sedge meadow. It's drier, less acid, and many of the plants are different, although sedges are still the most important species. It was probably formed during a period of low water when the surface layers of peat dried out enough to be burned by a fire sweeping down from the upland. The fire changed conditions so that they were somewhat more favorable to wet meadow plants than to bog plants.

6. Red Maple Swamp

After the tamaracks disappear, this is the kind of forest we get. Less acid and more exposure to oxygen have allowed bacteria to rot the peat and turn it to muck. The environment is not nearly so hostile as the tamarack bog, and the number of plants that can grow here is much greater.

[pictures of red maple, white pine, spicebush, cinnamon fern]

This is the final bog stage in the series of changes we call succession. More and more dry-land plants will now be coming in as generation after generation of pine needles and maple leaves and fern fronds build up the forest floor, raising it above the water level.

[pictures of elm, gray dogwood, jack-in-the-pulpit, dewberry, Indian cucumber-root]

Notice that some parts of the forest floor are wetter than others. Can you imagine how these small, water-filled depressions were formed? And the dry mounds next to them? The mounds are all that's left of the huge root systems of fallen trees that once stood where the depressions are now. Their trunks for the most part have rotted into the ground.

7. Transition Zone.

Most of the rest of this trail will follow the edge of the bog, keeping to a narrow transition zone. Here the mucky swamp soil meets the dry sand soil of the upland, and plants of the oak forest grow side by side with plants of the swamp. Notice that it's dry enough here for oaks and black cherry to have joined the red maples. This was actually the bank of Miner Lake at one time, a place where bulrushes and cattails grew.

[pictures of goldthread, tree clubmoss, bunchberry]

Certain plants are found neither in the oak forest nor in the swamp, but only in this narrow in-between area. As you walk along, look for some of the northern wildflowers that seem to prefer growing here. Most are rare this far south, and are very near the southern limit of their ranges. The soil of the mounds which are the rotted roots of fallen pine trees must be especially favorable to these northerners, since that's where most of them are growing.

[pictures of pyrola, trailing arbutus, starflower]

8. Here we are back where we started, back at the emergent aquatic stage where all we've seen had its beginning. By this time you must know the answer to the question at the beginning of this booklet. All you have to do to get from lake to forest is wait a few thousand years. It helps to have a lot of patience!

Before we leave the subject of succession altogether, take a look at the oak forest to your right. Just as the plant and animal communities we've seen so far are adapted to a wet environment, the oak woods is adapted to a dry one. The plants for the most part are very different from the ones we've been looking at, yet if you look hard enough, you may be able to find some that grow in both areas.

[pictures of pink lady's slipper and Indian pipe]

The oak forest is the final stage in a series of dry-land changes, just as the red maple swamp is the end product of bog change. Actually, even with these final products, very slow, minor changes are still going on. As we saw in the transition zone, the oaks and cherries are moving out among the pines and maples--or is it the other way around? In places, the oaks seem to be invading the swamp, while in other places, the maples and pines (both quite able to thrive in dry conditions) are invading the oaks. Eventually, large parts of the forest around here may consist of a mix of all these species.

[pictures of blueberry, brachen, wintergreen]

The original upland forest was mostly white oak and white pine, and this may well be what it will become in the future. Come back in 50 or a hundred years and find out.

Meanwhile, come back often just to enjoy the passing of the seasons here where constant change keeps on offering new experiences to grow on.

Thanks for letting us guide you.

APPENDIX B--SECTION 2

North Woods Trail

Length: 1/2 mile. Walking time: 3/4 hour.

> This is the forest primeval.
> The murmuring pines and the hemlocks,
> Bearded with moss,
> and in garments green,
> indistinct in the twilight,
> Stand like Druids of eld . . .
>
> --Longfellow

This guide is meant to enhance your enjoyment of a very special place. It's got a lot of writing, but we think the effort you spend in reading it will be well worth your while. It tells you what's around you and why it's there and why it's so special. And if it can be the means to your finding out more--because there's really so much more--it will have served its purpose well. The thrill of discovery awaits you. Walk on, read on, observe, and enjoy!

1. Take a good look around you. Not much like the cool evergreen North Woods, is it. We'd say it's more like desert. Yet just a few feet ahead--200, to be exact--you'll find yourself in a northern swamp-forest that's about as different from what you see here as northern Michigan is different from Oklahoma. As you descend the stairs ahead of you and enter the North Woods, try to think of a good reason why what you see there is so different from what you're seeing here.

   The slope, by the way, used to be the bank of the Kalamazoo River, which now lies a mile to the north.

2. Forest like this can only grow where it's cool enough. It's actually cooler here than it is in the desert-like area you were just looking at. Why might that be?

One reason is that this area gets much less sun. The slope is facing north and east, which, if you're big on keeping houseplants, you probably know are the two directions which get the least amount of sun. As you move away from the bottom of the slope, the northern forest peters out in response to increasing light and warmth.

The swamp is about 40 feet lower than the top of the slope. That gives us a clue to another reason for the greater coolness here, if we remember that cold air builds up in low-lying areas and, without any wind, tends to stay put. Such pools of cold air are called frost pockets.

Another reason it's cooler here is because of the water which seeps out of the slope and keeps the ground so wet. Coming from deep in the ground, the water is cold to begin with, and it tends to stay cold because of the shade provided by the slope and the evergreen trees.

These trees are the fourth reason for the northern vegetation here: their dense shade not only helps keep the water cool, it protects small, cold-loving plants from the overhead sun.

What are these trees, and if they're normally found in northern Michigan, how did they get way down here?

3. Four kinds of evergreen trees are found in this swamp--the accompanying pictures will help you identify them. All of them are quite uncommon this far south. The further north you go, the more the forest changes from deciduous trees (the kind that lose their leaves in the fall) to coniferous (the kind that stay green the year round). Most of the common trees in the Canadian forests are evergreens.

   Why?

   [pictures of hemlock, white cedar]

   The answer is simply because they're better adapted to a rigorous climate than deciduous trees are. The needles being smaller than regular leaves, and covered with a protective layer of hard, waxy cells, they can take more cold and wind. The trees are cone-shaped to shed snow better, and they rely on wind for pollination, an advantage in cold climates where pollinating insects are scarce. Plus, the large amount of resin in the wood keeps the sap from freezing and splitting the tree.

   [pictures of white pine, tamarack]

So well adapted are the conifers to all sorts of climates that they have survived almost unchanged for 300 million years. Before the rise of deciduous trees, conifers ruled the earth. Successful as they were, deciduous trees were more successful yet, and took over the most favorable climates for themselves, letting the conifers dominate the places where the living was hard.

The Ice Age was just what the conifers needed to push back the deciduous trees and recover their old territory. However, with the passing of the glaciers and the warming of the climate, the deciduous trees marched up out of the Southern Appalachians where they had taken refuge, and took over southern Michigan once more. The conifers retreated to the north, except in places like this, where local conditions allowed them to stay. What you are looking at is something of how all of southern Michigan looked 13,000 years ago, shortly after the ice had gone.

4. Actually, this forest isn't as northern as it first appears. After all, we're not really in the far north, and many of the plants here you wouldn't find there. For example, the shrub you're looking at--the most common shrub in the swamp and very typical of moist woodlands all over southern Michigan. It's spicebush, which gets its name from the spicy aroma of its crushed leaves.

    [pictures of spicebush, skunk cabbage]

    One of the common herbs* here is the skunk cabbage, another plant named for the smell of its leaves. It's not as southern as spicebush, but neither is it a true northerner. It's found in a broad belt from southern Canada to Virginia, Indiana, and Iowa. In Michigan it's widespread only in the southern counties.

    Some of the truly northern herbs are pictured below. See if you can find them.

    [pictures of goldthread, shining clubmoss, purple avens, wild sarsaparilla, starflower, hemlock parsley]

5. If you're willing to take the time and look hard, you might find two little herbs that aren't much to look at but are interesting enough to have their story told. They're miterwort and enchanter's nightshade--two kinds of each actually, one northern and one southern. Common miterwort and large enchanter's nightshade are typical of deciduous forests,

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*"Herb" means one thing to the botanist and another to the gardener. To the botanist, any plant without woody stem is an herb.

while naked miterwort and small enchanter's nightshade are characteristic of the cool, mossy coniferous woods of the north. Yet here they are together, side by side.

[pictures of common and naked miterwort, large and small enchanter's nightshade]

Both miterwort and enchanter's nightshade, by the way, are found in eastern Asia as well as North America. So are spicebush and skunk cabbage, and many other plants you see here, for that matter. Most of the plants found both in eastern America and eastern Asia are found nowhere else. How come so many plants are found on opposite sides of the globe but not in-between?

Millions of years ago a land bridge connected North America and Asia. Plants were able to migrate from one continent to another, so that the same kind of forest was found throughout the Northern Hemisphere. Then came the ice, bearing down out of the north like some monster bulldozer, pushing the warm climate south, and the plants that were adapted to it. When they ran up against the Alps, and the deserts of western America and western Asia, they could go no further, and literally froze to death. But in eastern America and eastern Asia, where the mountains run north and south, the plants were able to find refuge in sheltered mountain valleys. After the Ice Age they emerged along with the rest of the deciduous forest (remember?!) to recover as much of their old territory as they could.

And that's why we can feel so at home in a Chinese forest--its jack-in-the-pulpits and may apples and trilliums are familiar to all of us who like to tramp our Michigan woods.

6. Something else you should notice as you walk along are the little, humble plants that don't bear flowers and so are usually overlooked. These are the mosses and fungi, both of which are especially well represented here.

Mosses and their relatives, the liverworts, are among the very oldest land plants, and have survived little-changed for 400 million years. Their transition from water to dry land seems never to have been completed, for they still depend on an abundant supply of moisture--hence their luxuriance in swamps like this. North American mosses reach their greatest size and most spectacular growth forms in the coniferous forests of the Pacific Northwest, which also happen to get more rain than any other part of the

continent. Water is soaked up not through roots, as with other plants (mosses don't have any), but through the leaves which are usually only one cell thick. Without adaptations to dryness, mosses are not especially cut out for survival in deserts or prairies. Not surprisingly, you don't find them there.

[pictures of Mnium, Thuidium, Climacium]

Fungi are thin threads that lace dead wood and soil (up to 2 miles of them per ounce of soil). At the right time of year they push up reproductive structures called mushrooms. Unlike mosses, which make their own food, fungi live on dead leaves and wood. In the process, this dead stuff is broken down into elements like phosphorus and potassium, so necessary to plant growth. Along with bacteria, fungi are the chief decomposers--if it weren't for them, forests couldn't last more than a generation. When trees would die, they'd fall over and just lie there on top of each other, and never disappear.

[pictures of painted boletinus, vermilion hygrophorus, yellowish chanterelle]

Fungi are even more important to a coniferous forest like this, since bacteria can't decompose evergreen needles but fungi can. Soil under coniferous trees is very poor in those tiny plants and animals that swarm through the soil of deciduous forest. Their absence, however, is well made up for by the numbers and variety of fungi. It's this variety that gives the North Woods its characteristic seasonal parade of colorful mushrooms. A few of them are pictured on these pages--see if you can find them.

[pictures of tufted yellow hypholoma, waxy laccaria]

7. See any orchids?

Some people may be surprised to learn that orchids grow in the North Woods. They may be interested to know that orchids grow just about everywhere. Orchids are almost our largest plant family, with possibly as many as 35,000 species. Most are found in the tropics, where most of them live in trees as "air plants." While many have spectacular blossoms, others do not. The range of showiness is well illustrated right here, where we have the showy lady's slipper, with a flower to rival any of the great tropical beauties, and the white adder's-mouth, with a blossom so small you need a magnifying glass to really see what it looks like.

[pictures of showy lady's slipper, white adder's-mouth]

Orchids are among the many kinds of plants (including these conifers) that have fungi living in or around their roots. We don't know exactly what they do, but somehow they seem to be necessary to the survival of the host plant (which, in turn, benefits the fungi). Each kind of orchid--and there are at least 9 in this swamp--has its own special kind of fungus, which works only for it. One more way in which this kind of forest is dependent on the lowly fungi!

Delicate is a word you often hear when orchids are being described. The word is appropriate. Many orchids are so highly specialized that if just the right set of very specific conditions isn't provided, they can't survive. Not only must just the right fungus be present, but just the right insect to pollinate the flowers, and just the right shade, and soil temperature and humidity and competition. The damp, mossy North Woods seems to offer a set of conditions that suits many species just fine--better, in fact, than conditions in southern deciduous forests, where orchids aren't nearly as common. Like the fungi, orchids do a lot to give the North Woods its distinctive character--and some of its more interesting color.

[pictures of yellow lady's slipper, clubspur orchid, northern green orchid]

8. What about animals? Do we have any northerners here to go along with the plants?

The black-capped chickadee is so familiar to so many people that we scarcely think of it as a bird of the North Woods. Yet the great bulk of its range <u>is</u> in the evergreen country. South of Michigan, its place is taken by the Carolina chickadee. The black-cap is the bird you'll be most likely to see in this swamp, any month of the year.

One you would be much luckier to see is the Canada warbler, which breeds here and then leaves for South America to spend the winter. Like so many of our warblers, its year is divided between cool evergreen woods and hot, steaming jungles. Unlike the chickadee, nesting Canada warblers are pretty much restricted to the true North Woods; exceptions like this swamp are rare. The bird is a living gem: only 5 inches long, with a necklace of jet black streaks on a bright yellow breast.

[picture of Canada warbler]

If you're really lucky, you might find one of the other northern birds that sometimes nest this far south. Birds like the black-throated green warbler, red-breasted nuthatch, brown creeper, veery, and purple finch. Get a field guide to the birds and look for them the next time you're here--which we hope will be soon.

APPENDIX B--SECTION 3

Savanna Trail

Savanna Trail gives you the chance to experience one of Michigan's rarest and most interesting natural communities. The trail is about half a mile long and takes from half an hour to half a day to walk, depending on how much time and curiosity you have. This guide is meant to help you enjoy your visit more, in the belief that deeper understanding leads to deeper pleasure. Take it with you for future reference or return it to the box when you're through.

1. Savanna. Take a while to look around you. What kind of vegetation do you see? Forest? Prairie? It's neither, and yet it's both. Such mixtures are called parkland, or savanna, and they're especially common in dry tropical regions. You may recall seeing pictures of East African elephant and antelope and giraffe, or Australian kangaroos, moving about in an environment that looks much like this. Personally, we think country like this is prettier than either pure forest or pure grassland.

   How was this type of vegetation formed? Move on to the next stop to find out.

2. Fire. The most important cause of savanna is fire. A devastating crown fire opened up the forest that once grew here and subsequent ground fires kept it open. Without a fire every few years, the grassland grows up to brush, and eventually forest. The change is rapid as such things go: it is completed in 25-30 years. In this part of the country forest is the stronger and will always win out over the grass if given the chance. That's because the rainfall here is heavy enough to favor trees. Further west, in the prairie states, rainfall is much less, and grass has the advantage.

   Fire counteracts the effect of heavy rainfall and gives grasslands a chance. But what gives fire a chance? What keeps it coming along often enough to keep the grassland going?

3. Sand--Fire's Partner. When lightening strikes around here, chances are better that it will set off a fire than if it struck in most other places in Michigan. Why? Beneath where you stand is 30-60 feet of sand. When it rains, the water sinks down through it, leaving the surface tinder dry. There's not enough humus in the thin soil to absorb and hold moisture, because previous fires have burned up any dead plant remains and kept humus from forming. With so little ground moisture, ground fires stand a very good chance.

   But how can the plants here go on living when they're being burned every few years?

4. Plants that just make it. . . . Most plants wouldn't be able to survive being burned every few years. But the ones you see here are well adapted both to dry soil and frequent fire.

   Least tolerant are the trees. A ground fire will kill the seedlings, but older trees are usually protected by their thick bark. No tree here is safe when the fire leaves the ground and climbs into the branches. Such crown fires are rare in savannas. Can you think of a reason why? How can you tell it's been quite a while since a crown fire swept through here?

   Non-woody plants that die back to the roots every fall and send up new greenery in the spring are called perennials. Since they can survive as roots, fire can't hurt them. It might set certain kinds of perennials back a year or two if the fire occurs at the peak of the growing season, but recovery is almost always certain with true grassland plants. Of course, if the fire comes before or after the growing season, no harm is done at all since all of the above-ground parts of the plant are dead anyway.

   Certain trees share this ability of the perennials to sprout from the roots. Small oaks and cherries are often burned right down to the ground. Instead of being killed like most other trees, they just send up a clump of sprouts, each one of which turns into a trunk. Such multi-trunked trees are called grubs. See if you can find one.

   Common trees and shrubs are pictured on the next page.

   [pictures of early low blueberry, pasture rose, New Jersey tea, black oak, white oak, black cherry]

5. . . . and plants that wouldn't make it at all--except for fire! Even out west, where the grasses and prairie flowers don't have to worry about being crowded out by trees, fire does them a lot of good. It keeps dead leaves and stems from building up and smothering seedlings and early spring growth. Its black ash absorbs the heat of the spring sun, so that the ground can warm faster and plants can get an earlier start. And it injects the soil with a healthy dose of ash fertilizer to make the plants grow bigger and better and more beautiful.

   A few of the plants that thrive after a fire are pictured on the next page. Nearly all are sun-loving prairie species much more common in states west of us. Except for fire, we probably wouldn't have them here in Michigan.

   [pictures of little bluestem, black oatgrass, junegrass, Ohio spiderwort, rough blazingstar, gray goldenrod, western sunflower, azure aster, wild lupine]

6. Fire helps keep the savanna from turning into a lawn! Grasses out west may not be threatened by trees, but they can be crowded out by other kinds of grass, foreign ones that don't belong there. The same problem exists here.

   If you have a house with a lawn, you probably have Kentucky bluegrass growing in it. That's where bluegrass belongs, not here in the savanna. Originally from Europe (not Kentucky!), it followed wherever the white man led, including here.

   Kentucky bluegrass develops early in the spring and thus has an advantage over the still-dormant native grasses. Slowly but surely, the natives are being crowded out. An early spring fire, when bluegrass is greening up, sets it back and gives the native grasses a better chance. So fire can be a means of keeping the grassland natural, the way it was before the white man came with his weeds.

7. A Climax of Pioneers! In this part of the world, forest is the climax community--the final, self-sustaining stage in plant community development (succession), towards which all other stages build. Ordinarily, grassland is an early stage, and lasts only a short time.

   Parts of this grassland, in fact, belong to the very earliest stage. Where there is scarcely any soil at all--like right here--the "pioneer" mosses and lichens can be found, doing

their work of soil-building, preparing the way for later plants. Their work is largely in vain, since fire destroys the soil as fast as it is formed. We call these sterile areas "sand barrens," and the fact that cactus grows in some of them indicates how close they are to true desert.

[pictures of haircap moss, British soldiers lichen, panic grass, purple needlegrass, goat's-rue]

The fire cycle allows the grassland and even the sand barrens to endure, and become a kind of climax just like the forest. Forest and sand barrens--the last and the first stage in plant succession--exist together in an uneasy, constantly shifting balance. Whether the land is dominated by forest plants or prairie plants at any given time depends on how often fires occur and how severe they are.

8. Fire--Nature's Friend, and Ours. With all our buildings and roads and farms, we can no longer allow lightning to set fires that run uncontrolled over the countryside. Yet if we want to keep this rare and interesting vegetation type, with its beautiful prairie flowers, we can't afford to keep fire out either. Ecologists have found that many plant communities need fire every once in awhile in order to survive. To protect them from fire is unnatural, and would mean their destruction. The discoveries of these ecologists have led to the new field of fire management, which uses carefully controlled prescribed burning to achieve the effects of nature. We've learned that the right kind of fire in the right place at the right time is not Nature's enemy, but her friend and helper.

And if it's Nature's friend, it's our friend too.

Any questions? Feel free to ask the ranger at the Visitors' Center.