8-1984

An Ecological Investigation of Native Grassland in Southern Lower Michigan

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AN ECOLOGICAL INVESTIGATION OF NATIVE GRASSLAND IN SOUTHERN LOWER MICHIGAN

by

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A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Biology

Western Michigan University
Kalamazoo, Michigan
August 1984

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Western Michigan University, 1984

Floristic and soil data from 50 relicts and other sources were analyzed using polar ordination of species presence. Historical and early scientific accounts were interpreted from the results.

The relicts ranged from wet to dry, on either sandy or loamy soil. Alkaline lakeplain sites added a third dimension of variability. Most upland remnants were interpreted as fragments of former savanna.

Floristic composition and distribution of the remnants were determined by these factors:

1. Edaphic: away from the Prairie Peninsula, only very dry or very wet sites support prairie vegetation;
2. Phytogeographic: the farther from the Prairie Peninsula, the fewer characteristic prairie species available;
3. Temporal: most upland prairie fluctuated between grassland and savanna (even forest), causing addition of forest species and loss of prairie species from the local flora;
4. Anthropopyric: Indian-set fires aided by level topography maintained an estimated 480,000 acres of oak savanna.

ACKNOWLEDGMENTS

I dedicate this thesis to Elizabeth Longhurst, there at its start and finish (and beyond).

I thank Robert Pleznac who showed me (in 1976) a relict of native grassland--my first--and the first of many prairies we tramped over. Among others who advanced my understanding of native grasslands I single out Margaret Kohring and Lee Schaddelee who made beginning easier.

I had the help of many who also have studied Michigan prairie, but for the use of their field notes I cite specifically Paul Thompson, Lee Schaddelee, Robert Pleznac, Harvey Ballard, Bertha Daubendiek, Daniel Nepstad, Susan Crispin, and Don Langendoen.

For the mysterious act of computer programming, I thank Rick Stevens. He spent many post-midnight hours at a terminal because the DEC-10 couldn't run the program during normal hours.

The identities of a number of sedges, including some in vegetative condition, were confirmed by Anthony Reznicek, a task only he could have accomplished. Delbert Mokma kindly confirmed the soil textures of 18 samples. Thanks also to Dave Mahan for his help in surveying the Amtrak sites. Larry Brewer has my gratitude for showing me his unpublished presettlement vegetation data.

Field work during summer 1981 was partly funded by a grant from Western Michigan University's Graduate Student Research Fund and

completed in 1982 while under contract to the Michigan Natural Features Inventory.

Finally, I express my gratitude to the members of my graduate committee--Richard Brewer, Richard Pippin, David Cowan--who suffered the reading of a long thesis. In particular I thank Richard Brewer, who taught me a few things about prairie and generously let me use unpublished material from his own studies of native Michigan grassland.

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CHAPMAN, KIM ALAN

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CHAPTER I

INTRODUCTION

The prairies of Michigan disappeared before any scientist was fully able to comprehend them. But today 150 years after settlement of Michigan's prairie regions, relicts of native grassland can be seen at roadsides, in back areas of cemeteries, along railroads, and as larger areas surviving due to special circumstances. Most of these relicts are distinct from the grasslands of Illinois and farther west, products of the unique interaction between grassland and forest at the northeast edge of the Prairie Peninsula. This thesis is an attempt to synthesize the existing knowledge about prairie in Michigan in order to comprehend the nature of Michigan's native grassland, its significance, and the importance--even at this late date--of preserving it.

Historical Accounts

Prairies and Bur Oak Plains

Extent of Michigan Prairie

The historical prairies of Michigan as described by Butler in his noted series (1947-1949) included open, generally mesic blacksoil prairie, large prairies on forest soil, bur oak openings, oak plains, and other open and semi-open uplands. The location of

these features in southern Michigan has been mapped to different degrees of precision using the congressional land survey notes made before settlement (1827-1829). Veatch (1927) was the first to pinpoint some of these upland prairies of southern Michigan using the location of what were then considered prairie soils. Kenoyer (1930, 1934, 1940) added to Veatch's work by mapping the surrounding forest. Brewer (1969) assembled these and other efforts to produce a map depicting the vegetation of southwest Lower Michigan, including the nine counties containing historical prairies. A more ambitious work, delivering accuracy to within a quarter mile, was published for Kalamazoo County (Hodler et al. 1981). Historical prairies, bur oak plains, and oak savanna are clearly delineated and a brief description of each vegetation type accompanies the map. Brewer et al. (1984) used the same techniques for ten southwest Michigan counties.

While Butler was inclusive in his definition of prairie, Veatch (1927) held to a narrow concept of "dry" (i.e., upland) prairie. Except for the Newaygo prairies, Veatch maintained that they were associated with the same suborder of soil as that of the great tallgrass prairies of Illinois and farther west--udic mollisols (U.S. Soil Survey 1960), or udolls (literally, "humid soft soil" for their high organic content that formed in a humid climate). The older name for this soil was Brunizem, or Prairie, soil. Other mollisols are found in Michigan, but these formed in wetlands, not under conditions of good drainage like true prairie soil. Older soil surveys identified nearly 40 areas of mollisol in 9 counties,

totalling about 88,000 acres. Modern soil taxonomy considers about half of those areas to be mollisols and the rest udic alfisols. Udic alfisols (or udalfs--formerly called Gray-Brown Podzols), which are gray to brown forest soils that formed in a humid climate, cover most of southern Lower Michigan. Historical prairies can be divided into those associated with mollisols and those associated with alfisols (Figure 1).

Treeless or Bur Oak Prairie?

Since the historical prairies of Michigan were destroyed within a dozen years of settlement, no scientific study of them was possible. Not even a short list of species, nor the common names of the dominant plants can be found in the settlers' accounts. The prairies disappeared so quickly and had been gone so long that Butler (1947) complained no mention of them was made in even the state gazetteer. Very few Michigan residents know that prairies like those of Illinois and Iowa ever existed in their state. Today ghosts of the biggest prairies are encountered in place names (Youngs Prairie Road, Grand Prairie Cemetery, Prairie River, etc.), and larger prairies may still strike one with their flatness and relatively treeless aspect.

This neglect led to misconceptions about Michigan prairie. Peters (1970a) documented that several times in the literature between 1924 and 1964 students of prairie described Michigan's as grasslands on which stood a scattered growth of bur oak. The first instance of this error was in the Calhoun County soil survey (Rogers

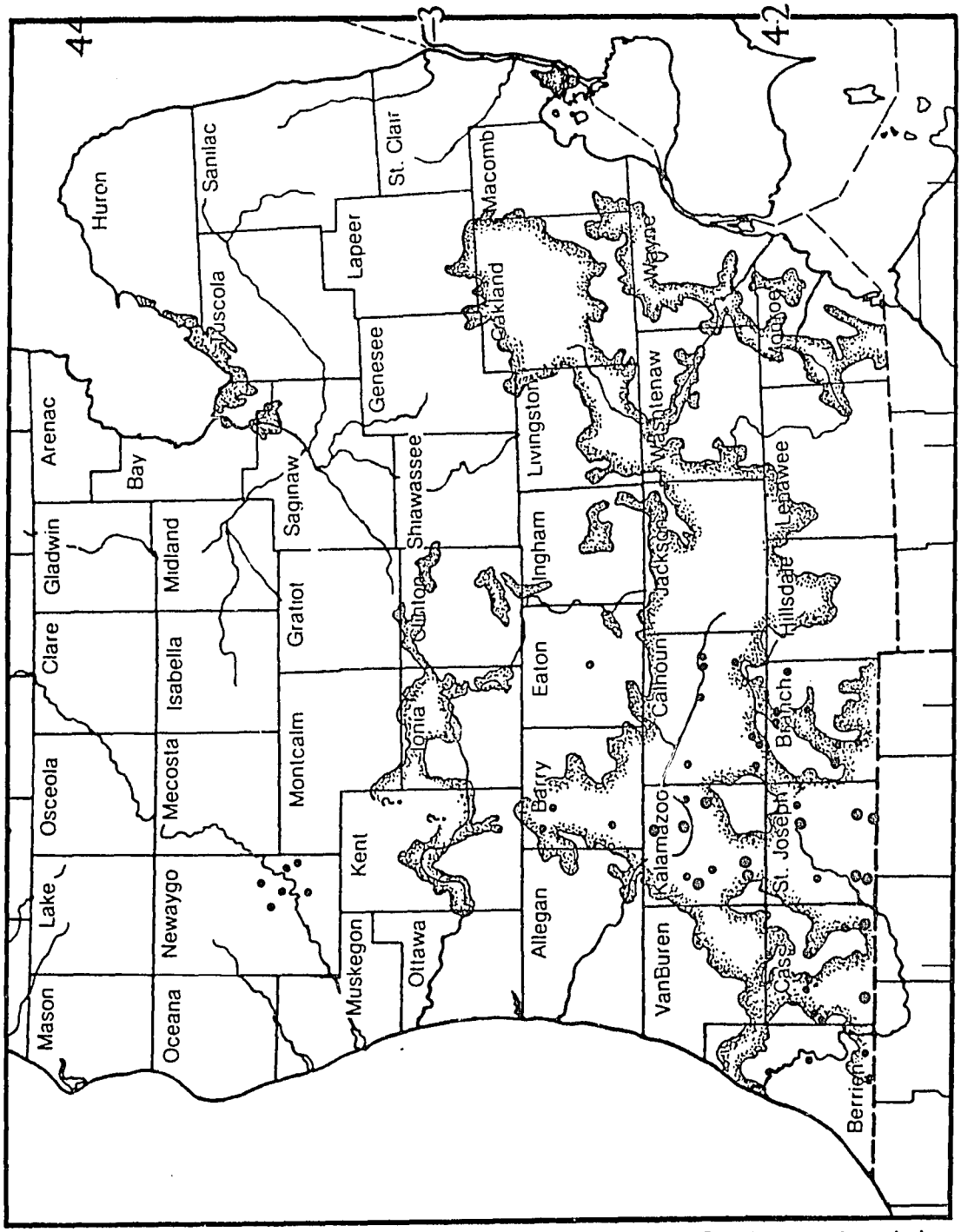

Figure 1. Location of blacksoil (●) and historical upland prairies (•), and limits of lakeplain prairie/savanna and oak savanna at the time of settlement. (After Brewer et al. 1984, Ferrand & Bell 1982, Veatch 1959, Trygg 1964.)

& Smith 1916), in which it was said the grasslands "...formerly were known as prairie, but supported originally a scattering of bur oak." Calhoun County indeed had many bur oak plains (Brewer et al. 1984), which may have had a groundlayer like the treeless prairies, and bur oak also grew in savanna at the edges of blacksoil prairie (Hodler et al. 1981), so confusion is understandable. The distinction between bur oak plains and prairie also blurred because their soils were equated. Bur oak plains were considered not only good, for their more durable soil, but superior cropland to prairie (Peters 1970a, Geib 1907, Higgins 1840).

The earliest soil surveys are most reliable for inquiry into the nature of historical prairie since the scientist could speak with old-timers who were not far removed from the first settlers. In the Cass County survey, one of the oldest in the state, are found discussions of breaking prairie, fire and oak openings, oak grubs, and other lore familiar to the first generation of settlers in southern Michigan.

> A very heavy growth of wild grass originally covered the prairies, and the dark color of the soil and the large amount of vegetable matter is due to the decay of this heavy annual growth. When the first settlers came the greater part of the prairies were [sic] free from all timber growth. On Youngs Prairie, however, there was a series of small maple groves extending from northwest to southeast and reaching the borders of the more densely timbered land [Geib 1907].

Five of the nine prairie county soil surveys aver that there was "a scattering of bur oak" on the prairies. In Kalamazoo County (Perkins & Tyson 1926) the prairie originally supported "a few scattering bur oaks and some hazel brush." The vegetation of Barry

County prairies (Deeter & Trull 1928) consisted of "a heavy growth of grasses with some scattered bur oak."

> The so-called prairies [of Branch County] were not entirely treeless, but supported a scattered growth, consisting principally of bur oak, with smaller numbers of other trees, including elm, but the tree growth was not sufficiently dense to prevent the growth of a heavy grass cover. [Moon et al. 1932]

> On parts of the plains [of Eaton County], the trees were sufficiently scattered to allow more or less grass growth. Such areas were locally referred to as 'prairies' or 'oak openings', an example of which was the Charlotte prairie.... On a number of plains, or fragmentary parts of plains, in southern Michigan the original forest grew sufficiently open to allow a rather heavy grass vegetation... [Moon et al. 1933]

The soils of "bur oak openings" did not merge in the mind of the soil scientist with the soils of prairie, as the vegetation had. In old surveys the prairie soils were classed Warsaw silt loam and sandy loam, or Warsaw, Marshall, and Waukesha loams; bur oak plains, on the other hand, were always on a different soil. In Calhoun County, for instance, prairie was on Waukesha loam and bur oak plains on Fox loam; in Kalamazoo County the two soils were Warsaw loam and Fox silt loam; in Berrien they were Warsaw silt loam and Fox loam. The bur oak plains were on udalfs--forest soils. In modern soil taxonomy, however, about half the bodies of prairie soil noted by early soil surveys now are considered forest soil. Some of the soil surveys recognized the transitional nature of these erstwhile prairie soils (Veatch 1953).

To the pioneers, prairie was distinct from bur oak openings. Besides Peters' (1970a) documentation, other accounts of Prairie Ronde, Michigan's largest prairie, substantiate its treelessness.

> The prairie...seemed wondrously beautiful and grand. It was simply in a state of nature, convered with a pretty rank growth of grass, then [6 November 1831] dry and sere, no tree except the Big Island grove and one or two other small groves... [Brown 1881]

> Ascending slightly from the circumference to the center, yet so as to seem full rather than elevated; surrounded with a noble forest whose sharp-cut and perfect line was nowhere so distant as to be indistinct, yet so remote that the beams of the rising and setting sun seemed to blend in a mist of gold and purple... [Van Buren 1888, describing Prairie Ronde as it appeared at the time of settlement]

Some St. Joseph County prairies appear to have been treeless, too.

> The rich black, open prairies which required no clearing were undoubtedly the choice of the first settlers. The Sturgis prairie and the White Pigeon prairie show evidences of having been the homes of these pioneers. [Wheeting & Bergquist 1923]

> On the one hand stretched bur-oak plains, spread with a verdant carpet, variegated with dazzling wild flowers, without an obstacle to intercept the view for miles, save the sombre trunks of the low oaks, sparsely spreading their shadows across the lawn; on the other hand arose the undulations of the white oak openings, with picturesque outlines of swells and slopes gracefully sweeping and sharply defined in the distance. Then, there lay the majestic prairie, grand in expansive solitude, its fringe of timber, as seen in the distance, resembling a diligently trained and well-trimmed garden parterre. [Coffinberry 1880, describing the area in the vicinity of Nottawa-Sippi Prairie, northeast St. Joseph County, in 1825]

Bur oak plains were readily identified by settlers:

> I remember a place that used to attract my attention; 'twas called Bertram plain...'twas a burr oak plain grown up thick with pea vines and blue joint grass, and columbo root. [Turner 1911, referring to the north side of the Kalamazoo River about two miles west of Marshall]

> There is quite an idea that this village site [Kalamazoo] was a grassy plain with scattering burr oaks; but it was a plain covered with a thick and tall hazel brush, so thick that I have seen a wolf jump up so as to see what caused the row he heard; and the burr oaks were very small, little more than grubs. There stands now on West street [Westnedge Avenue] an oak perhaps two and a half feet through, with a doctor's sign upon it, that when I lived on the spot, several years after I came here, was about the size of a whip stock after I had trimmed it into shape. There was perhaps an acre of clear ground about the mound in the park...[Turner 1911]

> The first actual settlement made in this county [Eaton]...was in the southwest corner of the county, very near the present site of the village of Bellevue.... [An early settler] visited this burr oak plain upon which the village is now located.... "It was to me the most beautiful spot I had ever seen. The wild grass was then about a foot high, and interspersed with it were the most beautiful flowers...." [Foote 1881]

Settlers, then, distinguished treeless prairie and bur oak plain. Circumstantial evidence argues for the existence of discrete treeless areas in southwest Michigan. Nearly all the prairies are associated with long-settled villages or towns, meaning that, in the midst of wilderness, settlers gravitated toward these natural landmarks. Especially where prairies lay near each other, a road nearly always angled between them. The first homesites were on prairies (Peters 1970b, and also several soil surveys), which were prominent enough to serve as an address. Prairie margins were sharply marked so that there was never doubt that one was in a prairie rather than in oak openings. The land surveyors had an easy time indicating when they stepped from a woods into prairie and back again.

While no list of prairie species was made by the settlers, they loved to talk of the beauty of the prairie, likening it again and again to a "garden", but never to "an Englishman's park," which was reserved for oak openings.

> I went out to Gull prairie in the spring of '33 with J.F. Gilkey; the prairie had been burnt over in the fall and the fresh green grass and the thousand wild flowers made it seem like a great garden. [Turner 1911, speaking of Gull Prairie in northern Kalamazoo County]

> ...the whole plain was covered from spring to autumn with a gorgeous array of flowers, whose differing colors followed each other in due succession; at last faded and gone in the autumn winds--"The tall, rank spike grass [Andropogon gerardii?] waved its bristly head." [Van Buren 1888, and a snippet of his poetry]

> ...Beneath, about, and beyond me, as far as the eye could reach, was spread out, in undulating elegance, an emerald carpet of nature's choicest fabric, inlaid profusely with flowers of every imaginable variety of name and tint--gorgeous and fascinating as the most brilliant hues of the rainbow. [Taylor 1855, reflecting upon the beauty of Grand Prairie of Kalamazoo]

> Early in March the rank growth of last year's grass, dried by the sun and wind, was set on fire and the whole prairie burned over, leaving it bare and black as midnight. Then in a few days came the beautiful flowers, covering the whole prairie with one uniform kind and color; first, the blue violet [Viola pedatifida]; then the purple phlox [Phlox pilosa], and this succeeded by some other color. In July and August a tall, yellow flower, the name of which I do not know [Silphium or Ratibida?], mixed profusely with the tall grass, gave yellow as the predominating color. ...But all was wild, with a peculiar, rank, sickening smell, than even now almost brings back the shivers of the ague. [Brown 1881, recalling the aspect of Prairie Ronde and Gourdneck Prairie at the time of settlement]

Origin of True Prairie in Michigan

Curtis (1959) suggested that true (i.e., lacking oak grubs) prairie supplanted mesic hardwoods (sugar maple-beech) rather than oak forest in the Prairie Peninsula. Treeless prairie was likely to derive on a particular spot from hardwoods because maple and beech are killed by catastrophic fire; on the other hand, top-killed oaks resprout from roots, and though subsequent burning knocks them back, they persist as grubs.

Early soil surveyors were impressed by the similarity between prairie soil and those of some adjacent non-prairie soil--they believed that, but for the thickness and organic content of the A horizon, the soils were structurally identical. The Fox loam and silt loam supported not only bur oak plains and some oak openings, but also beech-maple woods. Some of the surveys also noted that

certain tracts of beech-maple forest appeared to be on soil almost indistinguishable from prairie soil except that it looked as if it had recently come under forest cover. Modern soil taxonomy extablishes similar relationships. For instance, in Kalamazoo County Dowagiac and Kalamazoo loam (forest soils) supported prairie, bur oak savanna, and maple-beech forest.

These communities lay adjacent to one another along broad fronts (Brewer et al. 1984). Prairies and bur oak plains were on level or undulating ground; 18 of 49 historic prairies had over half their margins touching bur oak savanna and many several others were adjacent to bur oak savanna. Mesic woods were on more irregular ground; 17 of the historical prairies touched or lay within a mile of mesic forest. Mesic forest was rarely in the "fire tide" which began in prairie and swept into the adjacent forest with prevailing southwesterly winds.

The theory accommodates the pattern in Calhoun County where maple-beech forest was rare. Several small prairies were recorded there, though more and larger bur oak plains were set in the midst of oak forest. In such country, catastrophic fire would not result in true prairie but oak savanna. In St. Joseph County mesic forest was just as rare. Several large bur oak savannas existed, but in addition large true prairies were found. The presence of both might be attributed to a greater frequency of fire in St. Joseph County, which eliminated mesic forest from mesic sites, while in Calhoun County the rarity of mesic forest could be attributed to scarcity of mesic conditions.

Bray (1957) documented the relations of certain forest herbs to prairie in Wisconsin. Certain herbs of high presence in beech-maple and maple-basswood forest, but absent or rare in oak woods, were reported from prairie at the margins of the Prairie Peninsula. This evidence, as well as more particular evidence from a study on a Wisconsin prairie, substantiated Gleason's early opinion that forest herbs in prairie did not invade from surrounding forest but rather existed as relicts from a time of greater forest extent.

Fleckenstein and Pippen (1977) concluded that a Michigan prairie grove (the Big Island Woods of Michigan's largest prairie, Prairie Ronde) was never connected to the nearby beech-maple forest. It was more closely related to an Illinois prairie grove than to Cooper's Glen, a beech-maple woods in Michigan, because four trees (Fagus grandifolia, Liriodendron tulipifera, Quercus borealis, Fraxinus nigra) absent from both prairie groves are present in the beech-maple woods, and four river bottomland trees (Acer nigrum, Fraxinus quadrangulata, Juglans nigra, Ulmus americana) present in the groves are not in the beech-maple woods.

Quantitative data do not support the relationship, perhaps due to severe cutting at the Island. Presence and absence establishes no firm relationship either. Of those trees present at the Island, 52 percent are at the Illinois prairie grove and 42 percent are at Cooper's Glen; 75 percent of the trees at the beech-maple woods are at the Island, but fewer (67 percent) of the Illinois prairie grove trees are at the Island. Of those herbs at the Island, 66 percent are at Cooper's Glen, but only 31 percent are at the Illinois

grove. And of those herbs at Cooper's Glen, 96 percent are at the Island; of those at the prairie grove, 61 percent are at the Island.

The Big Island seems as closely related to Cooper's Glen as to the Illinois prairie grove. What is most intriguing about the four species missing from the Island and present in Cooper's Glen, and the four for which the reverse is true, is that fire is the factor common to both prairie groves and missing from Cooper's Glen. Fire and shade tolerances of the involved species would be the meaningful focus of further research. As a footnote, at the Island sugar maple increases from the upwind (west) side to the east, and black maple reacts in the reverse; such a pattern would result if the fire-intolerant sugar maple were cleared from the side of the Island first struck by fire advancing from the prairie, if black maple is more fire tolerant.

Prairie Outside The Prairie Peninsula

Before settlement, large areas of southeast Lower Michigan and of the southern Saginaw Bay shore were covered by wet to mesic prairie. The prairie occupied considerable portions of Monroe County and here were contiguous with the Oak Openings region of northwest Ohio, but there was also prairie of moderate extent in Wayne County. Prairie was limited, but substantial where it occurred in St. Clair County at the mouth of the St. Clair River, and also in Tuscola and Bay Counties along the southern shore of the Saginaw Bay. It also was found on islands in the Detroit River and on the Canadian side opposite Detroit.

Hubbard (1839) described the wet prairies of Monroe County. Most of the county was more or less level, with sand ridges that ran southwest to northeast and others with no particular orientation. Wet, grassy swales separated the ridges. "Marshes and wet prairie characterize the plains, or whole central portion of the county, comprising nearly one fourth of their surface." The marshes and wet prairies generally were of two kinds: Large wet prairies extended over several miles, with "rank wild grass" over a fibrous peat that overlaid a sandy subsoil; and swales of less than twenty acres lying between sand ridges on which grew trees. The swales either supported a growth of Carex on peat or muck over clay subsoil, or if dark sandy loam over clay, the growth was "a small wiry species...considered of inferior quality [Andropogon scoparius?]." "Small ponds of the lily and other aquatic plants are numerous upon these prairies. A large proportion of the prairies and swales are dry only at mid-summer." These prairies were wetter than would be possible today, drier conditions being the result of plowing and drainage. The wet prairies covered 18 sections of Ida Township, 9 in south Summerfield Township, and 5 in east Whiteford Township. Prairie on "rich black sand loam" covered three-fourths of Milan Township, but it is unclear whether it was lowland or upland.

An early traveler through Monroe County reported extensive prairies west of Monroe and on "Maumee Bay"--actually North Maumee Bay about 12 miles south of Monroe.

> We pass on this route [Tecumseh to Monroe] the great Pararie [sic] which is supposed to Contain about 4 thousand acres, is low & wet, but in places produces fine grass. We have passed many others but none so large...

> The land [12 miles south of Monroe] presents one vast plain as far as the eye can extend wholly destitute of timber except here & there an Iland [sic] of Bushes & few trees. In walking over this land a stranger would believe that these were old cultivated fields & not land in the state of nature. [Everett 1956]

Wayne County also possessed extensive prairies, both lowland and upland. Most of it was lowland prairie associated, as in Monroe, with ridges on which grew trees. Dick (1937) used original land survey notes to map the vegetation of Wayne County. A large, central portion of the county and the northeast part he designated swamp forest, but noted that surveyors set stakes in several places rather than blazed trees, and that such spots likely were wet prairie. Sumpter Township had two large open prairies, apparently upland types, in a region of oak "forest," although Dick wondered if these prairies were associated with oak openings. He also noted prairie, probably wet, along the south shore of the Detroit River and speculated that it extended farther north but went unrecorded because French private claims in the area obviated a land survey.

Hubbard (1839) stated that about a fifth of Wayne County consisted of "wet-grassy prairies" ("wild grasses" being their chief cover,) in oak openings that occupied a third of the county. In the north, about 9 sections of prairie and oak openings existed in Hamtramck Township and 5 sections in adjacent Oakland County, half being actual prairie. Greenfield, Redford, and Royal Oak had 4 sections of the same, which spilled over into 4 sections of Oakland County. In the south of the county, 46 sections of prairie existed--18 in Ecorse (now Taylor), 11 in Brownstown, 10 in Huron, and 7 in Romulus Township, corroborated by an early map (Farmer

1848). These resembled the prairies of Monroe County, being a network of wet prairies in a level plain of sandy ridges on which grew "dry prairie" and thin oak woods. Hubbard was told by Indians that beaver, which disappeared from the region about 1807, were abundant beyond belief and that they had created the wet prairies by damming drainage channels in the level lakeplain, a theory Hubbard thought reasonable.

Cadillac described in flowing hyperbole the area around Detroit in 1701, and another Frenchman the islands of the Detroit River in 1717 (Farmer 1890).

> Its borders [the Detroit River] are so many vast prairies, and the freshness of the beautiful waters keeps the banks always green. The prairies are bordered by long and broad rows of fruit trees...Here, also, orchards, young and old, soften and bend their branches, under the weight and quantity of their fruit...The hand of the pitiless reaper has never mown the luxuriant grass upon which fatten woolly buffaloes, of magnificent size and proportion.... There are ten species of forest trees, among them are the walnut, white oak, red oak, the ash, the pine, white-wood and cottonwood; straight as arrows, without knots, and almost without branches except at the very top, and of prodigious size...
>
> Two leagues [about 6 miles] from Fort Detroit [downstream] is an island called Isle aux Dindes [Turkey Island]. It is so called because Turkeys are always to be found there. It contains only very little timber, only prairie. [There must have been enough oaks for turkeys.]
>
> It [Grosse Isle] is very fine and fertile and extensive, being as is estimated, from six to seven leagues in circumference. There is an extraordinary quantity of apple trees [certainly Crataegus, still abundant in places] on this island, and those who have seen the apples on the ground say that they are more than half a foot deep; the apple trees are planted as if methodically, and the apples are as large as small pippins. Abundance of excellent millstones are found on this island; all around it [i.e. along the shore] are very fine prairies.

An early map (Anderson 1819) shows prairie lying along the length of the military road from Springwells (Dearborn) to the Miami

River, Ohio, via Raisinville (Monroe). Strips of prairie paralleled the Detroit River and ran inland from it so that the road constantly traversed them. Prairie was also indicated along the streams flowing toward the Detroit River. The savanna/wet prairie complex of Wayne County occupied roughly 38,000 acres, and that in Monroe County covered a fourth of the central plains, or about 35,000 acres, with an additional 5,000 acres in the large prairies.

The soil survey of St. Clair County (Deeter et al. 1934) indicates the presence of wet prairie near water. These moderately large prairies were associated with savanna, still present in abundance on Walpole Island, Canada, where Chippewa Indians annually burn them. The prairie and savanna on the American side of the St. Clair River Delta encompassed about 5,000 acres, with additional savanna inland.

The wet prairies of Saginaw Bay were brought into cultivation relatively late, on a large scale in Bay County only after 1860, and later still in Tuscola and Huron County. It was possible to see considerable tracts of this prairie as late as the turn of the century (Davis 1898, 1908). Old soils associated with the open prairie were Thomas, Wisner, and Maumee loams, as well as parts of areas mapped as "Marsh." Savanna existed on sand ridges which paralleled the bayshore, and the soils associated with these features were Granby loamy fine sand and Eastport sandy loam or loamy sand. Davis (1898) likened the region to that at the south end of Lake Michigan. From 10-11,000 acres existed in Tuscola and Huron County, 12-13,000 in Bay, and 1,600 acres and more along the

Saginaw River at the Saginaw County line (Deeter & Matthews 1931, Wonser et al. 1934, Trygg 1964).

> Nearly all this soil [Wisner loam] occurs in one large area near Saginaw Bay. The nearly level relief is broken by only a few small sandy ridges. Drainage is naturally poor, but about 90 percent of the soil is cultivated. The vegetation formerly was various grasses, sedges, rushes, and small willows. Uncultivated areas are mainly in low situations just inside the ridges bordering the bay, where it is difficult to establish drainage.
> The prairie [on Thomas loam] has a grass vegetation, including sedge and bluejoint.... The two largest areas [of Maumee loam] in the northwestern part of the county constitute prairie. Areas which are not cultivated support a growth of aspen...
>
> Marsh occurs in three areas bordering or near Saginaw Bay. They are low and wet and at certain times are covered with water. Sedges and various grasses are the dominant vegetation. This soil [Eastport sand] occupies long narrow ridges in proximity to Saginaw Bay. These ridges have undoubtedly been formed by wave action in recent geologic time. They are now covered with scrub red [i.e. black] oak, a few white pine, and a sparse growth of grass. They extend about 6 or 8 feet above the adjacent coastal beach, and on some underdrainage is imperfect....

The original prairies and marshes in the Bay region mapped from survey notes (Trygg 1964) are shown in Figure 1.

Oak Openings

A Beautiful Forest

> The plains and openings were covered with new and brilliant flowers. After making as full an investigation as their means would allow, having gathered as many flowers and shrubs as they could carry, as evidences of the fertility of the soil, they returned to Detroit, after an absence of three or four days. The report which this party made of the beauty and fertility of the country they had seen after passing the belt of wet timbered lands, and the evidences which they adduced, electrified the hearts of the Americans in Detroit, and utterly astounded the Frenchmen.... [Drake 1872, recounting the 1819 expedition by Detroiters up Woodward Avenue past Pontiac to Waterford where they saw, for the first time, the oak openings]

The settlers had a lot to say about oak openings. The term was coined to describe the general landscape of large areas of northwest Ohio and southern lower Michigan (Peters 1969), and once in place it received wide usage. Travelers and settlers in Michigan who left accounts of the landscape as it first appeared to them referred to or described this unique vegetation type.

Over half of Kalamazoo County was covered by oak openings (Hodler et al. 1981). Peters (1970a) found that settlers called the savannas of this typical oak openings county "barrens," "oak barrens," "bur oak plains", "bur oak openings"--besides the usual "oak openings." Just as they suggest variety to Michigan ecologists, these categories meant different things to the settlers. (Peters 1970b). Peters noted that the openings overlaid the sandy soils of outwash plains or parts of terminal moraines, and that their vegetation consisted of several oak species in a sparse canopy or in small groves, with a scattering of hickories, over a groundlayer of grass. Today a setting on glacial outwash or coarse-textured end moraines, forest soil, and the presence of oaks and hickories--all intercept at most of Michigan's upland grassland relicts.

The extensive oak openings are gone, but relicts remain. The openings themselves--if "captured" by a railroad right-of-way, a cemetery, a field corner--we call prairies; and the oaks, if they survived cutting, today appear as "wolf trees" (see Curtis 1959) in the midst of younger upstarts. Michigan's upland grassland relicts represent pieces of the former oak openings landscape just as

potshards represent vases and amphoras of antiquity. Detailed information on the groundcover of openings and the savannas is missing, but the early work of Cole (1901) and Daniels (1904) came soon enough after settlement to fill in some of this "lost" detail.

A detour into early America fiction is a fitting introduction to a lost part of the early American landscape. After a visit to southwest Lower Michigan, Cooper (1848) penned a surprisingly obscure novel in which he offered an explanation for the name Europeans gave this "new" landscape.

> The country was what is termed "rolling".... Although wooded, it was not as the American forest is wont to grow, with tall straight trees towering toward the light, but with intervals between the low oaks that were scattered profusely over the view.... The trees, with few exceptions, were what is called the "burr-oak," a small variety of a very extensive genus; and the spaces between them, always irregular, and often of singular beauty, have obtained the name of "openings;" the two terms combined giving their appellation to this particular species of native forest, under the name of "Oak Openings."

Though botanically naive, Cooper's impression of the oak openings had two kernels of truth: they were forest and they were beautiful. The settlers' evaluation of them as a type of forest surfaces again and again in historic literature. The beauty of oak openings, as if manicured and tended, drew comparision to parks, though to some the superficial sameness--however beautiful--grew tedious.

> I liked the land [Lenawee County, Town 5 South, Range 3 East, Section 9, West Quarter of Southwest Quarter] and bought 80 acres for 23 £ in a wild state. It is mixt soil partly Timbered and part openings and look [sic] like a gentlemans park. I admire the providence of God in providing such a country for the rescue of the distressed of all Nations. [Tucker 1961, John Fisher describing his new home in America, 1831]

Imagine yourself emerging from a New-Jersey swamp, and coming at one bound upon one of the English parks.... Clumps of the noblest oaks, with not a twig of underwood, extending over a gently undulating grassy surface as far as the eye can reach: here clustered together in a grove of tall stems supporting one broad canopy of interlacing branches, and there rearing their gigantic trunks in solitary grandeur from the plain.... I rode on for hours, unable without an effort to divest myself of the idea that I was in a cultivated country. [Hoffman 1835, depicting the oak openings that began 20 or so miles west of Monroe along the River Raisin]

But at the period I allude to no straight-fenced roads shut in the highway, and travelers might wind at will through the superb natural park, trampling down only the flowers that in many places created glowing parterres.... [Hubbard 1872, recounting his impressions of the landscape near Pontiac during his 1837 expedition with Douglass Houghton through Michigan's new territory]

The ordinary character of the "openings" is that of a majestic orchard of stately oaks, which is frequently varied by small prairies, grassy lawns, and clear lakes. These magnificent groves were, until within a few years, kept free from underbrush by the passage through them of annual fires, allowing successive growths of herbage to spring up luxuriantly, covering the surface with a profusion of wild flowers and verdure....

The variety so essential in a landscape, of woodland, glade and sheets of water, are here combined in a manner which seems the result of art, but which is not less truly inimitable. It is difficult to resist the impression that we are surveying an old abode of civilization and of tasteful husbandry. It resembles those exquisite pictures of park scenery, where the vision roams at will among the clumps of lofty oaks and over open glades, gemmed with flowers; while the distant woodland bounds the horizon, and the velvet-skirted lake gleams upon the eye as it reflects to light from the open prairie, or is faintly visible from the bosom of the glen, reposing in silent loneliness. [Hubbard 1840]

The scenery of Michigan will be far more attractive when cultivation shall have given variety to a landscape which, however beautiful at present, is somewhat monotonous. After visiting nearly a dozen of the transparent ponds of every size which stud the surface of the country...I started...to visit a sheet of water somewhat elevated about twelve miles off. My way, after going a mile or two from the village, led through oak openings of rolling land, called "the Short Hills," which I can best assimilate to a collection of enormous graves...thrown confusedly together upon a perfectly level surface where a

> patch of wild meadow-land, a cranberry marsh, or a bog that looked like the desolated bed of a lake, and frequently, indeed, the shallow lake itself, filled up the intervals. The huge oaks that crowned the summits of these formal mounds were the only objects that relieved the dreariness of the landscape.... [Hoffman 1835, describing the country in the vicinity of Dexter, Washtenaw County]

Fertility and Barrens

An early traveler through the oak openings of southeast Michigan was impressed by the beauty and productivity of the oak openings, though the vegetation and sandy loam at first suggested to him that the land should have been less productive than it was.

> ...we came onto the oak openings. On entering these vast plains a traveller is led to believe that it has been Cleard by the hand of man. These openings are a sandy loom [sic] and are covered with grass & flowers of various descriptions & hues. One would not believe that these plains would be so productive but I never in my life saw better Wheat than grows on these plains. [Everett 1956, Solmon Keeney describing the area near Plymouth, Wayne County, 1831]

Keeney wasn't the only traveler surprised by the productivity of the oak openings. Before anyone saw them, they had a bad reputation. Based on the reports of surveyors who laid down the Michigan meridian and baseline in 1815, the surveyor-general reported that Michigan was a nearly worthless place, half covered by marshes and swamps, the other half "...a poor, barren sandy land on which scarcely any vegetation grows, except very small scrubby oaks. In many places that part which may be called dry land is composed of little, short sand-hills..." (Seeley 1912). The early settlers picked up on this miserable estimation (which also promoted use of "barrens" as a synonym for oak openings, an epithet persisting among settlers even after they reached our fair state.)

> The "openings" were considered poor, and much prejudice existed in the minds of the settlers against this kind of soil, but it has since been demonstrated that this is equal to land that was considered of better quality. [Geib 1907]

> Our road to-day took us through oak openings; timber short, soil sandy. We called it a poor country, and let it go at that. We crossed the Huron River at Milan, and went on the the village of Enterprise [Ohio]. This is on a low prairie, the first I saw. I suppose at that time it was more properly a marsh. It is ten miles long, by six or eight wide.... We started out [the next morning] through a light, sandy country, with scrub oak timber. About ten-o'clock we struck the Black, or Maumee swamp.... [Northrup 1878, recounting his trip through northwestern Ohio's oak openings on his way to Kalamazoo County via Detroit in 1830]

> The plains in Oxford [Oakland County] for many years were passed over by those looking for farms, and places in the far-off forests, less valuable, were settled, under the impression that the Oxford plains were valueless for the purposes of agriculture, and thus one of the best portions of the county remained unoccupied until a late period. [Drake 1872]

Anderson (1971) also reports that the oak openings of Ohio sometimes were avoided because of suspected or actual infertility. In some cases it was justified.

> The timber was not large nor the tree numerous, hence the land was easily cleared.... I cannot in truth and candor say as much in praise of the producing qualities of the land of this dear old farm [Wayne Co., Township 3 South, Range 8 East, Section 18]. It was a very light sandy soil of a reddish color with a stratum of quicksand lying from three to five feet below the surface.... The first one or two seasons after the land was cleared, the crops were fairly good, but after that all the elements that go to produce the usual cereals seem to have been exhausted, and the only thing that would grow to any purpose was the white bean.... [McNath 1890, describing their homestead 4.5 miles southeast of Ypsilanti in 1827]

The tendency to call treeless areas barren, and to consider them unproductive, was popular wisdom among the earliest settlers, but acute observers knew otherwise (e.g. see Baskins & Baskins 1981). The Big Barrens of Kentucky, the barrens of south-central

Indiana (Keith 1983), and many other treeless areas (for a review see DeSelm 1981) received a prejudice which paralleled that against prairie when the settlers first encountered it (Jordan 1964, McManis 1964), but by the time they reached the highlands of southern Michigan, many knew better (Peters 1970a).

Oak Grubs and Fire

Oak grubs were particularly troublesome for the settlers. (For a modern instance of grubs' tenacity under adverse circumstances, see Whitford 1976.) The settlers remembered the grubs long after their eradication. And they clearly understood the relationship oak grubs--and oak openings--had to fire.

> The "openings" presented the appearance of an immense plain. The practice of the Indians was to burn the land over every fall, which had the effect not only of keeping the annual vegetation burned off but the young tree growth also. The "grubs" thus formed grew laterally into stools, the tops of which were hardly perceptible among the prairie grasses. When the land was broken it required a team of from 4 to 9 yoke of oxen and a plow of corresponding strength. [Geib 1907]

> After the very best job of breaking, a live grub would be left upon every square rod of ground. There is nothing now to compare with this pioneer grub. For fifty years or more its yearly growth had been burned off, and had sprouted again in the spring.... The enlargement at the surface about the tap root increased with each year's growth of sprouts, until the cap was formed, a foot or more in width, like an underground toadstool, although not so regular in shape. The whole under-surface of this cap was filled with dormant buds, that awoke into activity at once when the standing ones were cut or were burned away. Nature reasserted itself when the annual burnings had ceased, and the fittest stem survived and became the tree, or young oak, as we see them today, while the cap has rotted away. [Glidden 1892]

> The timber consisted mostly of black oak, white oak, oak bushes, and a species of wooden turnip, which was called oak grubs. These last had above ground a clump of bushes resting upon an immense bulb of the size and shape of a half bushel basket, from

> the under side of which downward, grew a good sized tap root, extending several feet into the earth, and of such vitality was it, that were even the smallest part left, it soon grew and replaced the original grub. These oak grubs gave no little trouble in clearing the land, and their use in the economy of nature, if they ever had any, is a lost art. [McNath 1890]

The settlers had no trouble connecting the original state of oak openings with the occurrence of fire. Fires set by the native inhabitants were witnessed by settlers and nearly all understood that the sudden growth of young oaks from grubs in the oak openings followed the cessation of fire.

> The annual fires burnt up the underwood, decayed trees, vegetation, and debris, in the oak openings, leaving them clear of obstructions. You could see through the trees in any direction, save where the irregularity of the surface intervened, for miles around you, and you could walk, ride on horse-back, or drive in a wagon wherever you pleased in these woods, as freely as you could in a neat and beautiful park. [Van Buren 1884, describing the oak openings settlers saw passing through the southern tiers of counties into Calhoun County]

> To-day, for the first time, I saw the meadows on fire. They are of vast extent, running far into the woods like the friths of a lake; and as the wild grass, which they supply in the greatest profusion, furnishes the new settler with all the hay he uses for his stock, they are burnt over thus annually to make it tender. These fires, traveling far over the country, seize upon the largest prairies, and consuming every tree in the woods, except the hardiest, cause the often-mentioned oak openings, so characteristic of Michigan scenery. It is a beautiful sight to see the fire shooting in every direction over these broad expanses of land.... (Hoffman 1835, recounting his impression of a December fire]

> We left Detroit on a railroad.... Our road lay among the "Openings" much of the way, and we found them undergoing the changes which are incident to the passage of civilized men. As the periodical fires had now ceased for many years, underbrush was growing in lieu of the natural grass, and in so much these groves are less attractive than formerly; but one easily comprehends the reason.... [Cooper 1848]

> The surrounding country seemed to our eyes far enough removed from the gloomy morass [surrounding Detroit] which wild imaginations had depicted it twenty years before. It appeared

> to me the most beautiful the sun ever shone upon. It was of the character then beginning to be classed as "openings," characterized by a gravelly soil [i.e. sandy loam], and a sparse growth of oaks and hickories. I speak in the past tense, because, though the rural beauty of the country is still unrivaled, little remains of the original character of the openings. This is a result partly of the progress of cultivation, and partly of the thick growth of small timber that has covered all the uncultivated portions since the annual fires have ceased, which kept down the underbrush. [Hubbard 1872, recounting his impressions of the landscape near Pontiac during his 1837 expedition with Douglass Houghton through Michigan's new territory]

Some settlers believed grazing eliminated the grass cover in the oak openings. (In the following account it appears oak brush was growing in the prairie grass.)

> There was some brush, but it was covered mostly with what we called "buffalo grass," which grew spontaneously. Cattle loved it very much in the summer, but their grazing seemed to destroy it. It soon died out and mostly disappeared; scrub oak and other brush coming up in its place. [Nowlin 1876, describing his homestead in Wayne County, Township 2 South, Range 10 East, Section 34, Southwest Quarter]

Extent of the Oak Openings

The oak openings brought about their own quick and absolute destruction by permitting rapid settlement. One is impressed by settlers' accounts of how easy it was to travel across the southern Lower Peninsula. It is no coincidence that the earliest and most successful settlements in Michigan's interior, and their connecting roads and railroads were set in the oak openings landscape.

> [The interior of Michigan is] for the most part, a thinly timbered country interspersed with forests and prairie, thereby saving a great part of the immense labor and expense of clearing, which is felt to be a serious obstacle to the English settler in America; whilst at the same time, there is an ample sufficiency of wood for all useful purposes, as building, fuel, etc. [Detroit Northwestern Journal, October 13, 1830, cited in Peters 1970b]

> Though our mode of conveyance for a few years was by ox-team, we could expedite by taking a bee-line (nearly) to the different points, as there was no underbrush (the Indians kept them burned down). Afterward, by chipping the trees, or "blazing," the lines became established roads, until clearing obliged us to turn corners.... In the spring the fire would run through the woods, which warmed up the ground and caused vegetation to spring up, beautiful to behold. The flowers covered the earth and yielded a fragrant perfume. The wild deer would gambol over the plains, and the turkey was also seen. Now and then a massasauger put in an appearance, but the wolves and screech-owls would sometimes make the night hideous. [Clapp 1881, talking of the southern tiers of counties, but especially the area around her home on Moscow Plains, east of Mosherville Station]

> The abundant resources of Michigan are developing so rapidly, that they will shortly require all these outlets (railroad, canal, etc.); and in a country where you may drive a barouche-and-four for hundreds of miles in any direction through the woods, the expense of constructing more artificial ways will be comparatively trivial. [Hoffman 1835]

> In July of the same year [1831], Simeon Mills...made the journey in a lumber wagon drawn by horses, through the unbroken wilderness from Ann Arbor to Gull Prairie [Richland, Kalamazoo County]. They forded the streams; but how they got over the boggy, treacherous ground, or watery marshes, it would be as difficult to tell as it was to do.... This journey was through the oak openings; they did not find one half mile of timbered land on the whole route. [Van Buren 1884]

> The roads in the openings and plains offer to the traveler a variety of routes, with the choice of diverging at pleasure, the scattered oaks leaving sufficient space between for the passage of horses or carriages, while the prairie is one wide unbounded highway, where no obstacle is present for pursuing whichever course curiosity may direct. These roads require the expenditure of little or no labor to keep them in repair. [Higgins 1840]

Douglass (1839) reported on the extent of oak openings in the southern three tiers of counties. Most of the surface area of Kalamazoo, Calhoun, and Jackson County was in openings, and Cass and St. Joseph County probably were similar. Oak openings predominated northwest of a diagonal line bisecting Oakland County, in southeast Livingston, northwest of a diagonal bisecting Washtenaw County, in

parts of Lenawee, Hillsdale and Branch, over two-fifths of Ingham, one-half each of Ionia and Kent, in the far eastern townships of Allegan County and Van Buren County south of the Paw Paw River. Barry and Eaton County also contained oak openings. In southeast Lower Michigan the southern third of Wayne County and a strip eight to fourteen miles wide running northeast to southwest through Monroe County were oak openings and wet prairie, although the pattern of ridge and trough distinguished these lakeplain oak openings from those of the elevated portions of the Lower Peninsula (Hubbard 1839). Oak openings occurred in areas Veatch (1928, 1959) mapped as oak and oak-hickory forest, which in turn parallel the deposits of glacial outwash in southern Lower Michigan (Farrand & Bell 1982).

Soil surveys, used with vegetation maps, give a reasonable estimate of the former acreage of oak openings and bur oak plains. Level areas (0-3 percent slope) of Oshtemo sandy loam (except southeast Lower Michigan), Kalamazoo and Dowagiac loam (bur oak plains), Fox sandy loam and loam, Boyer loamy sand and sandy loam (Jackson, Eaton County), Ockley loam (Berrien County), and Miami loam (Washtenaw County) were included. The fraction of these series estimated to support forest, based on vegetation maps and topography, was excluded. (For instance, Kalamazoo loam and Dowagiac loam support mesic forest one-fourth of the time in Kalamazoo County.) The estimate of 47-480,000 acres excludes the lakeplain oak savanna/wet prairie complex. A crude estimate of the area under oak barrens is 180-190,000 acres, based on level areas of Plainfield, Spinks, Oakville, and Coloma series, plus Oshtemo loamy sand in southeast Lower Michigan.

Trees of the Oak Openings

> Oak is the predominant growth of the peninsula. Among the varieties, the white [Quercus alba] is in the greatest abundance. The shingle or laurel oak [Q. imbricaria, extremely rare today], and the red oak [Q. rubra], are next abundant. And the burr oak [Q. macrocarpa], though not usually found intermixed in common with the varieties, abounds, notwithstanding, over extensive areas, not infrequently to the exclusion of the other kinds. The surest indication of a good soil accompanies the last mentioned, and the finest and largest crops of wheat are there produced, for the reason that the soil contains a larger amount of calcareous matter. [Higgins 1840]

Also according to Higgins (1840), Jackson, Calhoun and Kalamazoo had "black oak, white oak and hickory openings, interspersed with plains of white, black, and burr oak, and hickory;" in Wayne and Monroe County the sandy plains and oak openings were covered with "mostly a yellow [Quercus coccinea?] and white oak, often a thin and scattered growth, upon a meagre soil."

The soil surveyor considered oak openings a type of forest, growing on forest, rather than prairie soil. Trees were the conspicuous growth form and defined the community. From the several soil surveys in the oak openings region come these generalizations: The trees consisted of scarlet, red, black, bur, and white oak (the last predominating) as well as smaller amounts of hickory and other trees. Oak openings on the poorer, drier sands could be called oak barrens in keeping with the spirit of the pioneer vocabulary. Barrens consisted entirely of oaks, mostly black, with white, red, and scarlet--but no bur--oaks. These occurred on nearly level to undulating sand or thin sandy loam of excessive drainage and were cultivated along with the other openings, but quickly abandoned because of the low natural fertility and droughtiness of the soil.

The soil surveys indicate that barrens were found in Berrien, Allegan, Barry, St. Joseph, Ingham, Calhoun, Branch, Jackson, Washtenaw, and probably Kent County, though there, and in Allegan, they were mixed with white pine.

White oak openings and bur oak plains were distinct to some settlers, but many lumped them with barrens and called them "openings" (also termed oak plains, sandy oak plains, or barrens). The white oak openings were on level to undulating sandy loam or loam of good drainage, often as fertile as many forest soils. Bur oak plains were on level to gently sloping loam or silt loam of good to fair drainage and, especially when next to prairies, were thought to have a soil superior to prairie, bringing a slightly higher price for its greater durability--it didn't form "hardpan" as readily as prairie soil. Bur oak formed pure, or nearly pure stands often adjacent to prairie in far southwest Lower Michigan, but as larger isolated stands in Calhoun County and eastward (Brewer et al. 1984). The dry-mesic to mesic oak openings were in Berrien, Van Buren, Allegan, Barry, Kalamazoo, St. Joseph, Ingham, Eaton, Calhoun, Branch, Jackson, Hillsdale, Washtenaw, Livingston, Oakland, and probably Kent County. Bur oak plains were restricted to Berrien, Allegan, Cass, Barry, Kalamazoo, St. Joseph, Calhoun, Branch, Jackson, and Washtenaw County.

The white oak savanna Beal (1904b) described had about 49 trees per acre, the same density calculated for oak savanna in southeast Michigan (Gordon & May 1959) and similar to a settler cemetery savanna in Kalamazoo (Brewer unpubl.). But an area in Blackman Township, Jackson County, supported 4.4 trees per acre (Wing 1937).

Scientific Sources

In this review I restricted myself to those sources which give details about the floristic composition or ecology of Michigan grasslands; consequently, the authors tend to be scientists. Although members of the geological survey were scientists, their descriptions lack detail except in discussions of their geology and soils. Their accounts belong in the realm of anecdote, keen though their powers of observation were. Likewise Butler's (1947-1949), Kenoyer's (1929, 1934, 1940), and Veatch's (1927) contributions to our understanding of Michigan grassland provide not enough botanical or ecological information; for the purposes of this review they are chiefly historical.

Post-settlement Studies

The first list of scientific names from a grassland in the state was inspired by an excursion to Belle Isle in the Detroit River (Foerste 1882). But for the use of scientific names (solely!), the account might have been anecdotal.

> Detroit, the most beautiful city in the West, has the honor of possessing what will some day be one of the most delightful parks. It is the Belle Isle, situated a few miles up the river and connected by constantly going steamers with the wharves of the city. It is still in an almost primitive condition and certainly must be a treasure to the botanists of Detroit, affording a vegetation at once varied and quite free from the introductions that attend the progress of civilization...

Foerste lists species which suggest wet prairie (of a special type): *Lythrum alatum*, *Potentilla anserina*, *Lathyrus palustris*, *Habenaria leucophaea*, *Rosa setigera*, *Lysimachia quadriflora*, *Rubus*

occidentalis, and Lobelia spicata. It is curious that this most obscure of Michigan's grassland types was the first reported. Foerste adds that "Rosa setigera was constantly in demand for the rural bouquets of excursionists, which seemed to have no definite size, but always had room for one more Habenaria [today threatened throughout its range], Lysimachia quadriflora, Lobelia spicata, or Hypericum perforatum..."

Fifteen years later, Davis (1898) noted many prairie species of generally southwestern distribution that had found a slightly disjunct northeastern extension in the region of Saginaw Bay near Fish Point, Akron Township. Davis was struck by the resemblance of this area to the swell and swale region of northwestern Indiana and adjacent Illinois. His visit coincided with the installation of an extensive system of drains, finished in 1902. Fortuitously, he was able to document the undisturbed plant associations and describe subsequent changes due to drainage (Davis 1908).

The prairie stretched from Quanicassee northeastward nearly to Bay Port (about 16 miles) and was three miles across at its widest point, northwest of Unionville. It encompassed around 10-11,000 acres, 5,700 of which were still unplowed in 1926 (Deeter & Matthews 1931), and several thousand additional acres of marsh. By 1926 some of it was covered by brush (aspen generally) because of lowered water tables. The prairie was flat, nearly treeless, and very wet throughout the growing season. Davis believed that saturated conditions hindered development of tree seedlings, an opinion he felt was supported by the very sharp line between the adjacent swamp

forest lying along the south edge of the prairie, and also because when the ditches were finished "...shrubs had appeared in numbers not only on the borders of the woods but were abundantly scattered over the prairies, and considerable tracts of the most open parts had become covered with dense thickets of young poplars and willows..." The Tuscola County wet prairie was the last great expanse of native Michigan grassland to pass from the landscape, 70 years after the large prairies of southwest Lower Michigan had gone.

Davis (1908) detailed the plant associations and their related soils and topographic positions, providing an integrated picture of the structure of pristine grassland, the only such study of a large tract in Michigan, and perhaps Ohio and Indiana (Appendix E). The greatest portion of the prairie was treeless, very wet, covered with a rank growth of grass and forbs, and underlain by a deep alkaline soil--Wisner, Thomas, and Maumee (now Tappan) loams. The vegetation was divided into two broad segments, wet and wet-mesic. Some areas of the wet prairie were dominated by Carex lanuginosa and Carex buxbaumii, and others by Calamagrostis canadensis, Spartina pectinata, and Carex (including C. lanuginosa). Important forbs included Solidago graminifolia, Apocynum sibiricum, Lythrum alatum, and Solidago and Eupatorium species. There were additional grasses, sedges and rushes. Davis did not mention a species of sedge, C. aquatilis, which today is important.

While the wet-mesic association was found on loam, it was more characteristic of slightly raised areas of sandy loam and areas along the edges of sand ridges which ran parallel to the bayshore.

The sandy loam was black, wet and highly alkaline (now Essexville sandy loam). The wet-mesic prairie was more diverse than the wet prairie, and was dominated by Sorghastrum nutans, Panicum virgatum, and Spartina pectinata. Along with these, Andropogon scoparius dominates the wet-mesic segment today, and its exclusion from Davis' notes is a puzzle. Characteristic species included Potentilla fruticosa, Solidago nemoralis, Juncus balticus, and Pycnanthemum virginianum.

The driest portion of the grassland occupied the low sand ridges and sandy islands scattered within the prairie. Because of the sandy soil and high water table, which fell during low lake levels, species of wet and dry situations grew side by side, producing a vegetation that appeared mesic. The ridges and islands were covered with scattered large oaks (60-105 cm dbh) mostly Quercus macrocarpa, but with good numbers of Q. alba, Q. velutina, and several other tree species. The shrub component of this association was high and included Cornus spp., Prunus spp., Potentilla fruticosa, Salix humilis, Gaylussacia baccata, and Vaccinium angustifolium, among others. The herbaceous cover occupied openings in shrubbery and grew along the margins of the oak groves where these descended to the open prairie. Species of the wet-mesic prairie segment grew with species of drier situations, such as Lespedeza capitata, Lechea villosa, Danthonia spicata, and Koeleria macrantha. The oak groves of the islands and ridges were a savanna association in open prairie, supporting trees thanks to drier conditions.

Dodge (1900) botanized extensively near Algonac and adjacent Canada and listed species which occurred in local prairies, similar to those in Tuscola County. No clear picture of the communities materializes since wet prairie was described generally as low or moist meadow, low or damp ground, and marsh; the upland prairie and oak openings he referred to as dry, sandy, or poor ground and dry open woods.

Cole (1901) documented the species of native vascular plants growing near Grand Rapids, Kent County, prefacing her flora with descriptions of favorite collecting sites, including grassland relicts. Two hillside prairies are mentioned (Appendix E): Pine Hill, north of Cascade, a precipitous bluff 150 feet above the Thornapple River, composed chiefly of very dry white sand; and a south-facing bluff that formed a north backdrop to the village of Plainfield, rising 90 feet above Lake Michigan, of a dry sandy loam. Northeast of the village was an area called "the prairie," which was used by Indians as cornfields.

Cole listed species she considered common "...In the 'oak openings' in and near the City...." Cole's concept of oak openings was broad, for she stated that species of oak openings grew on "dry, sandy soil" yet listed plants of, at the least, mesic conditions, such as Silphium terebinthinaceum. She annotated certain species, not included on her oak openings list, as nevertheless growing there. The habitats "dry open woods" and perhaps "dry woods" may have been oak openings, for many other grassland species were annotated as growing in these places (Appendix E).

Beal (1904b), in northwest Ingham County, observed local changes in oak openings between 1870 and 1901. Settlement was about 1840 and no fire passed through the woods in the years Beal studied it. The largest trees were Quercus alba (most 61-107 cm dbh, a few 40-60 cm dbh); their density was 20 trees/ha (49 trees/A). Beneath the white oaks was a layer of Q. velutina, most under 31 cm dbh. Acer rubrum of about the same size were scattered throughout the woods. Beal was struck by the vast numbers of Acer saccharum seedlings and saplings, apparently derived from one old maple on the edge of the woods which "For some reason...was in the act of converting a considerable block of the oak forest into a maple forest...." He concluded that young sugar maples periodically might reach the density he saw only to be killed by fire. Beal credited fire with other structural features of the woods: red maple were bigger than the five sugar maples because they survive fire better and stump-sprout; dying Populus grandidentata stood between the white oaks, having sprouted following cessation of fire, but were being overtopped by black oaks.

Beal (1904a) listed twelve species (Appendix E) "...peculiar to the prairie region of the southwestern portion of the State." One of these is extinct, eight are threatened, and one is of special concern, reflecting the extreme state of grassland in Michigan today. Cole (1901) noted five species extirpated from the Grand Rapids flora, two of which (Habenaria leucophaea, Echinacea purpurea) are from prairie. Of nine species disappearing in Cole's day, two came from fen (Castilleja coccinea, Cypripedium candidum)

and one from prairie, Geum triflorum (since extirpated there).

Daniels (1904) studied the flora of the area around Sturgis, St. Joseph County, during the years 1898 and 1899. He divided his lists of species into several segments (Appendix E), which included prairie, oak openings, hillsides overlooking lakes (Appendix D, Lake Minnewaukon), and barrens. He also mentioned "prairie bogs," meaning "fens" since Daniels clearly distinguished these places from leatherleaf bogs.

> The prairie vegetation is perhaps primary to the region, but has suffered most from the presence of man. It is altogether impossible now to determine accurately what species should be set down as prairie. In fact the presence of this flora is to be detected only from the fact that certain species peculiar to prairies still linger in congenial place.... Some species like Kuhnia eupatorioides and Baptisia leucantha persist by the wayside, and even along the streets of the city, but most find refuge in open bogs, or fringe the railroad tracks. It has two strata, the upland and the lowland. The former tends to coalesce with the flora of the oak openings, while the latter is still well preserved in the prairie bogs [fens] lying south and southwest of the city. It is here that many of the rarest species of the region are found.
>
> The oak openings are of two types, that characterized by the bur oak (Quercus macrocarpa), whence the adjacent village of Burr Oak gets its name, and that in which black oak species predominate. The former lies next to the prairies and has a rich, heavy soil, the latter lies to the north and northwest and is of a lighter and even sandy soil, though the land is seldom pronouncedly barren. The flora of the oak openings is gradually becoming general to the whole upland region. Groves have been planted or encouraged to grow even in the prairie district, and the hardy autumn vegetation springs up in fence corners, and survives in some fashion the frequent pasturings. In fact these little woodlots have developed a flora of their own. It is bur oak overhead and burs all around.

A small flora (Pepoon 1907) of the region where Cass, Berrien, and Van Buren County meet appeared about the time of Daniels', in which several distinct "districts" were described, two of which bear on the subject of native grassland. One consisted of oak and

hickory woods, on the poorest soil and possessing a dull flora, as Pepoon saw it. Trees were oaks, Carya ovalis, Liriodendron and Sassafras. Herbs included those typical of oak woods, but also some of oak openings, such as Swertia caroliniensis (which Pepoon found striking for its explosive blooms followed by dormancy), Aureolaria spp., Desmodium cuspidatum, Cacalia atriplicifolia, Lactuca spp., Hieraceum spp., and Solidago nemoralis. He noted several purported and actual root parasites, as well as many legumes, especially on barren open knolls in the oak region (Lespedeza spp., Lupinus perennis, Tephrosia virginica, Vicia caroliniana, etc. and also Petalostemum purpureum from near Crooked Lake).

Pepoon also noted fen, which he called grass or open bog and, like Daniels, differentiated from Sphagnum-Chamaedaphne bog or tamarack and Vaccinium corymbosum acid swamp. He found fens "here and there, mostly bordering the wooded swamp, and almost invariably with a cold spring rivulet encircling or cutting them." He recognized the local nature of a segment of the fen flora, as exemplified by Tofieldia glutinosa and Zygadenus glauca, and listed many other characteristic species.

A decade later, but still among the early workers, Gleason (1917) discovered a "wet prairie" which today might be called fen. The two-acre site was located just north of a region lying six miles north of Ann Arbor--a place called Northfield Plains, or "the plains" by older inhabitants who affirmed to Gleason its original treelessness.

There were two distinct segments of the fen, one drier than the

other. Sporobolus heterolepis co-dominated in the wet and mesic portions with Sorghastrum nutans and Andropogon gerardii, respectively. Gleason listed 25 species (Appendix E), remarking on the typical affinities of each. He concluded that, despite the bog and marsh species present, the wetland strongly resembled a "hydrophytic prairie of northern Illinois in its paucity of shrubs, level topography, and dominance by grasses." He assumed the area represented a relict colony of prairie plants from an earlier time when southern Michigan had a more prairie-like character, and that the site had been invaded recently by marsh and bog species, a scenario imagined by others (e.g. see Curtis 1959, p. 362) to explain the floristic composition of fen in the Prairie Peninsula.

The work of Davis, Cole, Daniels and Pepoon was completed at the turn of the century and took in large tracts of landscape, though Daniels complained that "...only the bog flora can be considered virgin." After these came Gleason's paper, anecdotal work (Veatch 1927; Kenoyer 1929, 1942, 1940; Hanes 1945; Butler 1947-49), and plant lists (Hebert 1934; Darlington 1941; Bingham 1945; Hall & Thompson 1960). Bingham (1945) briefly described a type of wet prairie which resembles those of southeast Lower Michigan, but seeming drier perhaps due to underlying very sandy soil. Her "dry meadows" are not a native grassland type, for the dominants and several of the commonest species are exotics brought to the continent mostly as forage plants.

Modern Studies

In Michigan, the northernmost historical upland prairies lie in southeast Newaygo County, 45 miles north of Bull's and Scale's Prairies in Barry County. The Newaygo Prairies are considered part of the Prairie Peninsula (Transeau 1935) based on the work of Veatch (1927). However, differences suggest otherwise. Their soil is a forest soil in structure and a dry loamy sand on which oak barrens might be expected to grow. Plants found in sandy ground (like sand dunes) and dry prairie are present, while southern prairies would be expected to support mesic to dry-mesic prairie species. The climate of the Newaygo region is classed as humid continental, with cooler and shorter summers than in the Prairie Peninsula, the biome in which the southern prairies belong.

The settlers treated the Newaygo prairies as they did the southern ones, plowing them before all other land (Mick et al. 1951). But while the southern prairies kept producing, the Newaygo prairies were soon abandoned because of the soil's droughtiness and low natural fertility. The grassland vegetation that survived in a few unplowed tracts, along roadsides, and perhaps in savanna areas adjacent to the open prairies, reclaimed its former domain, creating hundreds of acres of secondary prairies. In the early 1950's, Hauser (1953) studied their vegetation, assuming all had been plowed. Fortunately he was mistaken, for about 66 acres (0.7 percent of the prairies' original extent) survive (Chapman & Crispin 1984). Using the land survey notes, Hauser identified seven historic prairies. He believed 32 actually existed, corresponding

to 32 deposits of Sparta sand which underlay them. Those not recognized by the surveyors were missed because they were small and lay away from survey lines. Restricted to outwash plains, the prairies were surrounded by pine forest, oak forest and savanna, and a little beech-maple-basswood forest. In a virgin condition the land surveyors graded them "2d" or "3d rate", for they supported only sparse grass with scattered oak brush or large oaks and pines. The surveyors were sufficiently impressed by the prickly pear cactus (Opuntia compressa) and "vines" (Rubus flagellaris) on the prairies to mention them several times.

Hauser determined that thirty-nine species had a frequency of 2 percent and above (Appendix E). These common species included not just dry prairie species, but also several species which grow on sand dunes. The sedge Carex pensylvanica was the undisputed dominant of the grasslands, while other significant cover was provided only by Andropogon scoparius, A. gerardii and Rubus flagellaris. He encountered several plots in which Carex and Andropogon reversed roles.

Hauser considered the Newaygo prairies comparable to the "high" and sand prairies of Wisconsin. He believed they lacked a number of characteristic species because of their distant, isolated position in the Prairie Peninsula. Put more directly, they lack "important" prairie plants merely because the ranges of these species stop far west of Michigan. And certain species he thought absent are present (e.g. Bouteloua curtipendula) or not far away (e.g. Amorpha canescens). Hauser believed the weedy nature of the Newaygo

prairies (e.g. Carex pensylvanica dominant; Ambrosia, Rubus, Rumex acetosella very common) was part of their character and not just the result of plowing. But virgin prairie is consistently dominated by Andropogon, and Carex runs a distant third (Chapman & Crispin 1984). Other weedy species show lower frequency in virgin prairie.

Hauser briefly considered the problem of dry sand prairie persisting outside the Prairie Peninsula. He thought exclusion of trees and shrubs by plant competition the most likely cause, but microclimate, edaphic factors, and fire may have helped. Grazing by rabbits and other herbivores was a factor Hauser did not consider.

Once the best remnant of lakeplain wet-mesic prairie in Michigan, 15 acres of unplowed grassland at an original prairie-forest border was discovered from herbarium records by Hayes (1954) on Harsen's Island, near the Middle Channel of the St. Clair River delta (Appendix D). Two to three inches of water stood over the prairie in Spring, 1960. Drainage ditches were dug before the next season, which lowered the water the next year. In 1963 all but 2 acres were plowed to created three fairways for an 18-hole golf course. Hayes studied species frequency and density and prepared a list of species. He concluded that the prairie was like those in Wisconsin, sharing 37 percent of the 82 prevalent species of Wisconsin wet-mesic prairie (Curtis 1959). However, 15 percent of the 117 species found by Hauser in dry prairie also occurred, leading to speculation that the lowland prairies of the St. Clair River delta were not like those of Wisconsin.

Hayes knew the Chippewa Indians at the Walpole Island

Reservation burned the savanna and prairies, which maintained them. The Harsens Island site was burned in 1960, and in 1961 Hayes noted no substantial change in the abundance or frequency of species. However, all woody vegetation was burned except Crataegus crus-galli, which did not fruit. Cornus racemosa and Populus deltoides reappeared near the forest border, but Hayes believed no tree survived longer than three years in the prairie. He examined vegetation along a 100m transect from the woods to the prairie, and he suggested that the microclimate near the wood edge, on slightly higher and drier ground than the prairie, fostered vegetation which resembled that in the wettest parts of the prairie. Species of the wood edge and the wetter prairie were Apocynum sibiricum, Convolulus sepium, Spartina pectinata, Lathyrus palustris, Populus deltoides, Rosa (?palustris), Solidago altissima and Poa pratensis.

A year after Hayes' paper, Brewer (1965) published his study of a prairie now lying beneath the intersection of Stadium Drive and Howard Street in Kalamazoo. The results of a frequency study are included in the stand data for Arcadia Prairie (Appendix D). The prairie was wet-mesic, dominated by Spartina pectinata, and the common forbs (frequency over 50 percent) included four which are common in mesic prairie. On examination of the quadrat data using 2 x 2 contingency tables, little pattern was evident in the prairie, which Brewer considered consistent with the theoretical composition of climax communities.

Just as prairies and savanna in the St. Clair River Delta spanned political boundaries, likewise prairies and savanna lay on

both sides of the Detroit River. An area of 2 mi^2 near Windsor Raceway supported wet to wet-mesic prairie in a savanna setting (Rogers 1966, Langendoen & Maycock 1983). Rogers theorized that early burning by the Indians, and clearing and cultivation or burning by European settlers permitted the establishment and maintenance of grassland species in the area. Certain agricultural practices may have kept the savanna open, and the area's high water table would have slowed the advance of trees and shrubs as well, but savanna was present before European settlement. Before drainage began around 1925 or 1930 the area was wetter (Rogers 1966), and drying probably accelerated woody invasion and perhaps changed species densities.

Slight sand ridges in the generally level grassland perhaps supported Quercus velutina-Q. borealis stands, and in the level parts Q. palustris and clones of Cornus racemosa and Corylus americana were found. The grassy dominants were Calamagrostis canadensis and Spartina pectinata, while the commonest herbs were Baptisia tinctoria, Solidago canadensis, S. graminifolia, Aster ericoides, A. azureus, A. laevis, Desmodium canadense, Pycnanthemum virginianum, Fragaria virginiana, Liatris spicata, Rubus flagellaris, Panicum spp., Amphicarpa bracteata, Carex spp., Pteridium aquilinum, Viola sagittata, and Achillea millefolium. Additional species appear in the stand summary (Appendix 3).

Pokora (1970) studied a railroad relict of oak barrens in Van Buren County. The site was 0.5 miles northeast of Lawton Amtrak Upland Prairie and the two sites are very similar (Appendix D).

Oaks, chiefly Quercus velutina, bordered the site, which was dominated by Andropogon scoparius and A. gerardii. The commonest species included Helianthus occidentalis, Poa compressa, Rosa carolina, Panicum oligosanthes, Tradescantia ohiensis, and Panicum perlongum. Pokora (1968) confirmed in his prairie a known characteristic of grasslands: that flowering follows an orderly seasonal pattern of height.

Thompson (1969) listed the species of a wet prairie in the City of Ann Arbor along the Huron River (Appendix D). Like Pokora and others, Thompson noted seasonal structural change in the grassland and its sequence of flowering. The clones of Rhus glabra and Salix which Thompson mapped are markedly larger today, 14 years later, emphasizing the need to manage grassland in Michigan. Despite dedication as a natural area, some of the prairie was destroyed during the construction of a city park in the late 1970's.

Theories on the origin and persistence of prairie have been debated long and hard, but brief mention needs be made here since the problem was examined exclusively from a Michigan perspective (Robertson 1969). Unfortunately, Robertson drew heavily on data from outside Michigan. He scarcely discussed the role of fire and lack of tree mycorrhizal fungi, and never discussed exclusion of tree seedlings by prairie sod, although his summary included these factors as causal to the persistence of prairie in Michigan.

Despite its shortcomings, Robertson's work is useful for the map he drew of all the more or less open historic prairies in southwest Michigan at the time of settlement, which included both

forest soil and blacksoil prairie. By visiting historic prairies, he confirmed that they are generally level, still nearly treeless, and occupy sites of fertile soils and good drainage. He provided a long list of literature, including reports on pollen profiles from the prairie peninsula. He synthesized profiles from 50 stations and concluded that Michigan indeed experienced a xerothermic interval, that grass pollen in the peat cores peaked in abundance then, and that oak and hickory pollen was associated with these horizons. The studies estimated the xerothermic at between 3500 and 7000 years before present; Robertson settled on 3500 to 5000 years BP. Benninghoff (1966) placed a prairie invasion and an initial xerothermic at the earlier pine maximum and cautioned other palynologists against premature conclusions until more data exist.

In light of Benninghoff's opinion, Robertson may have hit the mark when he hypothesized that immigration of upland prairie into Michigan from the southwest took place at one time, but development of the Newaygo prairies and wet prairie in southeast Michigan proceeded separately. Robertson also pointed out the similarity between forest and prairie soil on outwash plains, as had many soil surveyors previously; and he suggested that oaks and grasses are better suited to the Prairie Peninsula than is maple-beech forest.

Robertson attributed the persistence of Michigan prairie to four factors:

1. Climatic: It lies in a transitional area between a warm and cool humid continental climate which suits both tallgrass prairie and forest but which also suffers from periodic severe drought.

2. Edaphic: Although prairie soils are intermediate in infiltration rate and field capacity (i.e. mesic), they are prone to drought, especially coupled with the region's variable rainfall and temperature. Moreover open prairies were on outwash plains--80 percent of the time near their centers--which promoted good to excessive drainage. When periods of drought are frequent or persist, grasses would have been favored over trees.

3. Biological: The dense root system of prairie grasses prevents tree germination and seedling growth.

4. Pyro-anthropaeic: Fire, both natural and of human origin, and other human activity (Indian farming) "deflected forest succession."

Since site factors are crucial to the persistence of prairie, Robertson considered prairie a post-climax community in Michigan. This was suggested by Transeau (1935).

Scharrer's (1971, 1972) comprehensive treatment of Michigan grassland documented the extent and condition of upland tallgrass prairie in southwest Michigan by surveying railroad crossings in the southern two tiers of counties from western Jackson and northwestern Hillsdale County to Lake Michigan. His chief concerns were to make a list of prairie species, determine their distributions and through the pattern of their occurrence, describe southwest Michigan prairie. He also summarized major papers on the ecology of tallgrass prairie up to the work of Curtis in the late 1950's, and briefly discussed the origin of Michigan prairie.

Scharrer found that within the area surveyed, prairie species

were rare: of the 68 species he considered characteristic of prairie, only nine had a presence above 10 percent, and the commonest, Andropogon gerardii, was found in only 42 percent of the 528 sites. Prairie plants were not just regionally rare, in the relicts themselves most were rare, a pattern noted in dry prairies of Wisconsin (Anderson 1954, cited in Curtis 1959). Not unexpectedly, 9 of the 68 species are legally threatened in Michigan, and one is of special concern (Master et al. 1982). Scharrer also showed that a set of prairie species was associated with sites having many species, another set was less restricted, and the members of a third--the largest by far--could be found growing solitarily or even in non-prairie habitats. (Some species in the first two sets were more widespread than Scharrer realized.) Scharrer's findings suggest that the larger portion of the prairie flora is adapted to the climatic and edaphic conditions of southwest Michigan, for they are not restricted to prairie sites. Perhaps they would not be so rare if fire was not excluded from the landscape. A small part of the prairie flora actually is relict, since it is made of species which are extirpated or threatened with extirpation, or are restricted to habitats of high integrity. Scharrer realized that these would be the first to go extinct in Michigan. Indeed, of the 24 best prairie indicators (ie. present at "good prairies" 70 percent of the time) one-fourth are threatened in Michigan. Although rare, these indicators promise better than other prairie species to lead to good prairie relicts from herbarium records (Appendix E).

Scharrer wanted to establish criteria for judging prairie relicts and to identify the best railroad relicts for preservation. He implied that virgin prairie included both relicts at historic prairies and also unrecorded ones if they lacked surface disturbance and had many prairie species (i.e. over 10 from his list), despite the presence of alien species, even in high frequency. He recognized that not all relicts were "blacksoil" prairies. He speculated that a few of his sites were openings in oak savanna or bur oak plains (the latter produced some of his best remnants, e.g. Thompson Road). However, he considered most of the "good sites" lying outside historic prairies to be tracts of open prairie that were too small to be noticed by the land surveyors, rather than remnants of oak openings.

Unfortunately for prairie, Scharrer's hopes for the preservation of his best sites went unrealized. He found 52 "good prairies", two of which (Thompson and Klumbis Road) and a portion of a third (Sturgis) are protected. Most of the twenty-five in St. Joseph County (the best relicts of blacksoil prairie in the state) were destroyed. The story is the same in other counties because of large-scale track improvements by Conrail, Grand Trunk, and Amtrak during the 1970's, which Scharrer's study preceded. His study is both fortunate and ironic, because he wrote the closing chapter on Michigan's richest reserve of prairie vegetation, yet today there remains too little along the railroads to save his work from anachronism.

The oak openings of Wayne and Monroe County received no

attention from researchers, not the case in adjacent Ohio. Those of northwest Ohio were studied relatively early (Mosely 1928, Sears 1926) and have continued to interest Ohio botanists. One of the most comprehensive treatments (Anderson 1971) examined remnants in Lucas, Fulton, Henry County (which closely resembled adjacent Monroe County) and Wood County. Anderson considered few of the grassland relicts virgin and supposed that most were "undoubtedly quite unnatural in floristic composition," making an understanding of the total vegetation quite difficult.

The structure of the oak openings of Lucas, Henry, and Fulton County was determined by the sand ridge and swale topography of the glacial lakebed. Both prairie and oaks occurred on Ottokee soil associations of sand.

> Associations of dry prairie species occupied the thin oak woods and barrens [these may have been synonymous] of the sand ridges, while in the swales were wet prairies and sedge meadows. Exemplifying the close association between presentday oak woods, which are burned fairly regularly, and the drier prairie is the occurrence of Baptisia tinctoria, Coreopsis tripteris, Lupinus perennis, Monarda fistulosa, and Sisyrinchium albidum both in the woods and in adjacent open prairie. [Anderson 1971]

This general picture of the oak openings is held by Tryon and Easterly (1975), who add that Quercus alba and Q. velutina predominated in the mixed oak community of mesic and xeric situations, and Q. palustris and Acer rubrum dominated lower ground. Interspersed among the oak groves were marshy areas dominated by grasses (including Calamagrostis canadensis) and sedges. Both they and Anderson hesitated to name the marshy areas "prairie", calling them grass or sedge meadows instead.

Anderson, Tryon and Easterly agree that parts of some of the prairies of the oak openings were submerged part of the season. The soil of all prairies in swales was saturated year round. Anderson thought that this high level of soil moisture, as well as fire, kept at least the Wood County prairies open. As mentioned by early settlers, poplar was a natural component of the prairies. Populars and elms invaded them when the region was drained, reminiscent of the decline of Tuscola County prairie (Davis 1908).

Anderson found that the total flora of the oak openings consisted of species with western, southern, northern, and coastal plain affinities, but eastern species and those of widespread distribution made the greatest contribution. Great variety existed between stands, so that numerical similarity was low, reflecting either original diversity of habitats (the consequence of high water table and sandy soil) or the disturbed, isolated nature of the stands. Stand pairs of greatest similarity also had high similarity values with other stands: the most similar wet meadows (Henry and Lucas County--47 percent similarity, the highest in the study) and the most similar dry meadows (Lucas and Fulton County--40 percent similarity) represent the general types (Appendix E).

The grassland communities of the Allegan Pine Plains were altered in that original canopy trees were removed, yet the community that persists may resemble in all but its canopy that which was changed (Schaddelee 1975). The 1831 land survey showed the Plains covered by white pine and white oak in a region of beech-maple forest, the largest southern outlier of pine-oak forest

in Michigan. The stand examined here (Appendix D) actually lay in a strip of white oak forest, with white pine second and black oak distant third (Brewer et al. 1984). Schaddelee estimated the density of white pine as 27 trees/acre, with diameters of 18-76cm. This suggests a savanna setting, though white oak certainly boosted the density. The soil survey (Fippin & Rice 1901) noted that "The original timber was a light growth of a comparatively small pine locally known as 'buckwheat pine'...." Clearing by 1879 left "...shrubby growth of white and red [i.e. black] oak, sassafras, poplar, etc."

Schaddelee surmised that dry prairie vegetation occupied fire-created openings in the forest. In corroboration, the soil survey mapped islands of Kalamazoo gravelly loam (now Oshtemo sandy loam/Chelsea loamy sand) in the Plainfield sand of the Pine Plains. This soil was associated with oak openings in eastern Wayland and Leighton Townships and on river terraces. Schaddelee thought that fires which followed cutting turned the area xeric, promoting the spread of prairie species and dominance by black oak. Given the droughty nature of the soil, however, xeric conditions may have resulted simply by removing the canopy and exposing the soil to the sun and heat of summer. The soil surveyors noticed this tendency: "For grazing this soil has little value, as the sands become so heated during the summer that grasses are badly injured. The natural turf is always light and composed of a variety of grasses."

Schaddelee called the grassland "oak openings," while recognizing that the ground vegetation was that of sand barrens. He

found that primarily black and white oaks, and black cherry and sassafras composed the sparse canopy. The commonest shrubs were Ceanothus americanus, Vaccinium angustifolium, Rubus flagellaris, and Rosa carolina. Grasses and sedges dominated: Carex pensylvanica, Poa pratensis, Koeleria macrantha, Danthonia spicata, Stipa avenacea, Panicum depauperatum, and Andropogon scoparius. Other dry sand prairie species grow in the Pine Plains (Appendix D).

Schaddelee pointed out that the Pine Plains flora resembled that of the Newaygo Prairies (and the jack pine plains of central northern Lower Michigan.) There are differences. While Newaygo and Allegan both enjoy a humid microthermal continental climate, Newaygo actually has cooler summers, while the Pine Plains depends on its position in a frost pocket for cooler summers. Due to its more northern location Newaygo lacks grassland species Allegan has (e.g. Tradescantia ohiensis, Swertia caroliniensis). Despite the loamy appearance of some Plainfield sand, the Pine Plains' soil has much less organic matter than the Sparta sand of Newaygo. The Pine Plains originated in a glacial lake bed (Lake Pullman) put down during the Glenwood Stage of Lake Chicago (17,000 YBP), consisting of 30-60 feet of sand over glacial drift; the substrate beneath the Newaygo Prairies is more recent outwash with a thin mantle of sandy soil.

Thompson (1975, 1983), the most prolific student of Michigan prairie, published floristic inventories of grassland stands in Michigan, Indiana, and Ontario. More detailed studies of some stands can be found elsewhere (e.g. Thompson 1968, 1982, 1983;

Hauser 1953; Rogers 1966; Kron 1982; Bliss and Cox 1966). Thompson's other work on both prairies and fens have appeared as reconnaissance and site reports of the Michigan Natural Areas Council (1979).

Thompson (1975) documented 341 non-adventive native species which fell into the well-known taxonomic pattern of grasslands (e.g. see Curtis 1959) of about one-fourth Asteraceae, and roughly 5 to 10 percent each of Poaceae and Fabaceae. Cyperaceae and Rosaceae contributed between 5 and 10 percent, but in Wisconsin prairies only Rosaceae is so important (in dry prairies). These families account for over half the species of the grassland flora. Only 61 (17.9 percent) of the 341 species in his nine good prairie stands had a constancy over 60 percent, illustrating, as Scharrer did, that most prairie plants are rare. Thompson noticed that southeastern Michigan stands (Algonac, Ann Arbor, Otter Creek, Windsor) had a "typical composition," implying a different flora than other wet prairie stands. The Newaygo prairies, too, were distinct from the rest, 21 (16.4 percent) of the 128 encountered there being absent from other stands.

Grassland Conservation in Michigan

Thompson (1972) summarized the progress Michigan conservationists made in the 1960's toward preservation of Michigan grasslands. Four tracts were protected, all through the efforts of the Michigan Natural Areas Council (MNAC 1979). Ann Arbor Wet Prairie was unplowed. Algonac Wet Prairies, Newaygo Dry Prairies

and Middle Belt Prairie were secondary and disturbed sites, but together preserved a wide range of typical and rare prairie species. Several additional tracts were under consideration for protection: Lawler and Petersburg were treated in recent MNAC reports and presumably are in the management plans for these state lands; 20 acres of fen at Dayton (Thompson 1981) were donated to The Nature Conservancy in 1980. Bertrand (Thompson 1975) is almost destroyed today. A disturbed railroad relict and adjacent wet-mesic prairie near the former Arcadia Prairie in Kalamazoo were mentioned, but remain unpreserved.

Further progress in prairie preservation was catalogued by Chapman and Pleznac (1981). Twenty-three sites were categorized as federal, state, local, or private, and for each were given the owner, location, size, type and dominants, characteristic species, management, and best contact for information. Six prairie reconstructions were described and 27 areas noted as worthy of preservation or further study. Chapman and Pleznac (1982) followed their earlier work with a catalogue of 38 grassland areas, including fens and reconstructions, on land owned by government agencies, private conservation organizations, and institutes of higher education, all of which may be visited if proper arrangements are made. Ownership, location, acreage, descriptions, and maps for each site is given.

The best railroad strip prairies in Michigan (Thompson Road and Lawton Amtrak) are leased from Amtrak by The Nature Conservancy (Kohring 1981), which has improved them through brushing and fire.

Two of the original six sites (Grand Beach, Schwark Road) since have been dropped to consolidate management efforts.

The Michigan Nature Association (MNA), which publishes a guide to their preserves (MNA 1983), has protected 5 upland prairies and several areas of lowland prairie and fen. For the exact status of many preserved grasslands, Crispin (1980) should be consulted.

Fen in Michigan

A concept of fen gaining wide acceptance in North America is that of a wetland on organic soil which receives nutrients by the inflow of groundwater (Heinselman 1968; Jeglum et al. 1974). This is in contrast to bog, which receives most of its nutrients via precipitation. Fens are herb-, shrub-, or tree-dominated communities. First use of the term in North America was applied to an herbaceous community (Anderson 1943). Curtis (1959) defined fen narrowly in the European sense (Tansley 1949), by its calcareous water flow and herbaceous vegetation. Most Midwest ecologists reserve "fen" for chiefly herbaceous, calcareous spring-fed sites in the Prairie Peninsula, using modifiers for other fen communities (e.g. northern fen, Schwintzer 1978; patterned fen, Heinselman 1965). The fen flora of the Prairie Peninsula is surprisingly uniform, varying at sites in the proportion of bog or wet prairie species, or in dominance by Potentilla fruticosa and Carex versus prairie grasses or Cyperaceae. Variations requiring terms like "bog fen", "prairie fen", "sedge fen", and "grass fen" have been documented (Stuckey & Denny 1981, Moran 1981).

Research on Michigan fens is very recent, with the exception of casual studies (Daniels 1904; Pepoon 1907; Gleason 1917) before the concept existed. Cain and Slater (1948) used the term to describe a plant community at Sodon Lake (Appendix D). But neither the term nor the concept is sufficiently accepted or understood in the state.

Mandossian (1965) studied the plant associates of Sarracenia purpurea in neutral and acidic environments of Southern Lower Michigan, mistaking fen habitat as "alkaline bog." Thompson (1981) described the flora of Dayton Fen as a relict of Prairie Terre Coupe, focusing on the absence of the fen indicator, Potentilla fruticosa, and the presence of local small colonies of several lowland prairie species (e.g. Coreopsis tripteris, Silphium terebinthinaceum, Heliopsis helianthoides). This area was near, but not associated with Prairie Terre Coupe; the overall vegetation, the organic soil, and the spring and sheet flow of alkaline groundwater indicate fen.

Kron (1982) likewise noted the absence of Potentilla fruticosa over most of Indian Bowl and the presence of several lowland prairie species (Appendix D), but springs and flow of calcareous groundwater through organic soil (Houghton muck) is typical of fen. The total flora of Indian Bowl is intermediate between fen and wet prairie (Figure 3), but the commonest and dominant species suggest fen. Some recent studies (Sytsma & Pippen 1981a, b, 1982a, b; Hoffhines & Nepstad 1983) show an understanding of Michigan fens. The study of fen--prairie, northern, patterned, and others--is gaining momentum in the Midwest, and doubtless many other papers have appeared recently, or will be written in the near future.

CHAPTER II

METHODS

To accomplish the objectives stated in the Introduction, an analysis of prairie stand data was needed which could be used to interpret historical accounts, scientific reports, and other sources of information about Michigan prairie. For reasons given below, floristic analysis based on polar ordination was chosen as the way to organize stand data. Summaries of physical and floristic characteristics of Michigan prairie types and further interpretation derive from the results of the ordination.

Survey of Prairie Stands

Because undisturbed prairies are so few and small, some latitude was used in stand selection. The requirements were that a stand not be recently extensively or severely disturbed, and be fairly free of adventive North American plants and introduced species, itself an indication of degree and recentness of disturbance.

Shading by woody plants, site history, and site location in the pre-settlement landscape contribute to the number and kind of species at a stand. No attempt was made to reconcile these variables. More easily controlled factors that contribute to species presence were stand size (species-area effects) and length of survey (sampling intensity). Adjustment for the former was not

attempted; adjustment was made for the latter, as described below.

Fifty grassland relicts were visited in 1979 and 1980. Seven additional prairies from the literature or workers' field notes were also used. Five fens (of many to choose from) for which good data exist were included, since in southern Lower Michigan fen and lowland prairie seem closely related. Prairies and fens used in this study were spread across southern Lower Michigan (Figure 2).

At each site physical site characterization required a soil analysis and general notes on aspect, percent slope and topography. Physiognomy, edge communities and other boundaries, and species were also noted.

For later selection of indicators, species frequency was taken in 12 stands, locating 20 quadrats at each by random number table. I used a "cross-quadrat", two 1-m long pieces of chair-rail which I mortised at their centers. The outline of the 1-m^2 quadrat was easily imagined. The advantages of using a cross-quadrat are that it is quickly assembled and taken apart and that it passes into bushes or thickets, permitting strict placement of quadrats. Frequency data for 6 other stands were available in the literature and from other workers.

Soil texture was determined by feel (Thein 1979). Soil pH was tested from a core at about 10-15 cm depth with a LaMotte-Morgan test kit, allowing accuracy to within 0.1 pH units. Soil pH was tested in the field or within 24 hours of sampling, except for several cores which went untested for two weeks. Since the sites were upland ones, there was probably no change in pH, and the

Explanation of Figure 2. Location of study sites (county in parentheses).

1. Bowerman Cemetery (Barry)
2. Newaygo (Newaygo)
3. Allegan (Allegan)
4. Texas Corners (Kalamazoo)
5. 42nd St. & B Ave. (Kalamazoo)
6. Lawton Amtrak Upland (Van Buren)
7. Lawler (Kalamazoo)
8. Mattawan Fruit Belt (Kalamazoo)
9. Fairfax (St. Joseph)
10. Harmonia (Calhoun)
11. Lawton Amtrak Swale (Van Buren)
12. Teeple Lake (Oakland)
13. Bakertown Amtrak Upland (Berrien)
14. Shanghai Ridge (Washtenaw)
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16. Middleville Cemetery (Barry)
17. Vankal (Van Buren)
18. Foster (Washtenaw)
19. Pretty Lake (Kalamazoo)
20. Highland Cemetery (Washtenaw)
21. Long Lake (Barry)
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23. Fay Lake (Jackson)
24. Lake Minnewaukon (St. Joseph)
25. Flowerfield Creek (St. Joseph)
26. Klinger Lake (St. Joseph)
27. Harwood Lake (Barry)
28. Thornapple Bluffs (Kent)
29. Briarcrest (Berrien)
30. XY Avenue (Kalamazoo)
31. Sturgis (St. Joseph)
32. Bertrand (Berrien)
33. State Line (Berrien)
34. Helmer Brook (Calhoun)
35. Roy Road (St. Joseph)
36. Klumbis Road (Cass)
37. Oshtemo Fruit Belt (Kalamazoo)
38. Thompson Road (Cass)
39. Parkville (St. Joseph)
40. Lawton Fruit Belt (Van Buren)
41. Algonac (St. Clair)
42. Petersburg (Monroe)
43. Shanghai Terrace (Washtenaw)
44. Ojibway (Essex, Canada)
45. Cranberry Lake (Oakland)
46. Park Road (Jackson)
47. Arcadia (Kalamazoo)
48. Parma (Jackson)
49. Shaw Lake (Barry)
50. Prairie River Lake (St. Joseph)
51. Ann Arbor (Washtenaw)
52. Concord Swale (Jackson)
53. Bakertown Amtrak Lowland (Berrien)
54. Barry (Barry)
55. Shanghai Slough (Washtenaw)
56. Indian Bowl (Berrien)
57. Sodon Lake (Oakland)
58. Priest Lake (Cass)
59. Whitman Lake (Kalamazoo)
60. Bakertown/Chamberlain Road (Berrien)
61. St. John's (St. Clair)
62. Voakes Road (St. Clair)
63. Middle Channel (St. Clair)
64. Sebewaing Railroad (Tuscola)
65. Sebewaing Bay (Tuscola)
66. Squirrel Island (Lambton, Canada)

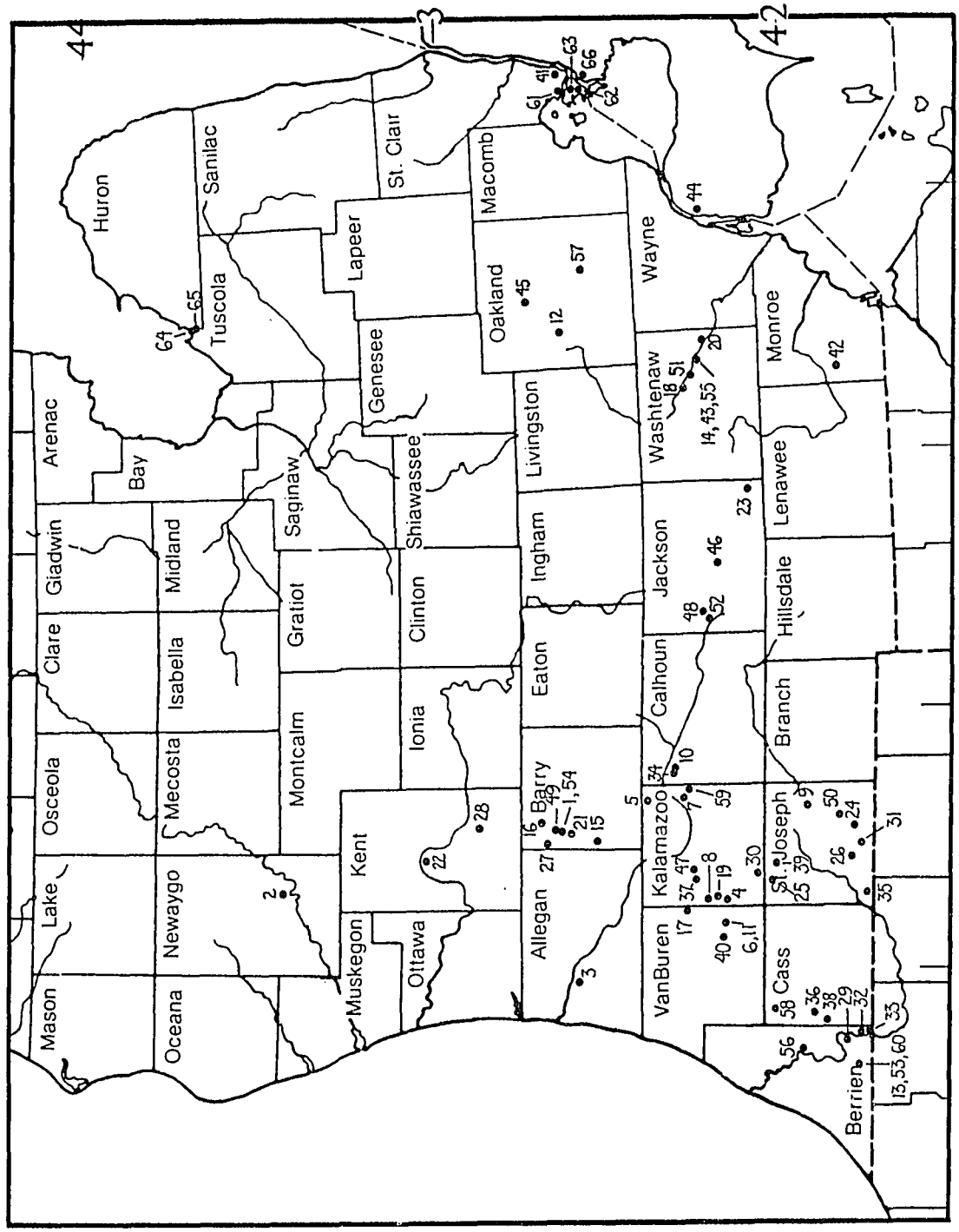

Figure 2. Location of study sites. (See p. 59 for names of study sites.)

results agreed with other similar sites.

Water retaining capacity (wrc) is similar to field capacity and can be related to soil type through available water (or moisture) capacity (wrc = [3.75]awc). Water retaining capacity is constant for a soil type, unlike soil moisture which varies depending on the time of last precipitation and subsequent rate of evaporation. To keep the soil structure intact, cores were taken using cans of 10.75, 15, 16, and 18 ounces. The rims were torn off, leaving a razor sharp edge, and 15 to 20 holes were punched in the bottom from the inside. The cans worked well in all soils except sand (which fell out when the core was lifted) and muck. Its many roots and fibers resist separation of the soil in the can and the soil left behind.

Cores were soaked 24 hours in tap water, then drained 24 hours until water movement due to gravitation ceased. The cores were weighed, dried in an oven at 120° C for 48 hours, weighed again, and the can tared. Expressed as a percent, wrc is calculated as:

$$\text{wrc} = \frac{(\text{wet core} - \text{dry core})\ (100)}{\text{dry core} - \text{tare}}$$

Soil texture, pH, and wrc were compared with soil series at sites as shown by soil surveys of the U.S. Department of Agriculture, Soil Conservation Service. The most likely soil series was chosen as representative of the site. Seven of the 18 counties in which stands occurred lacked modern soil surveys, so old ones were consulted. For three of these, mapping is in progress and advance sheets from county soil survey offices were consulted. Prevailing soils in the area also were noted.

Species Lists

For floristic ordination it was necessary to produce accurate and complete lists of non-adventive North American vascular plants at each stand. A few mosses and lichens were included because they are always present in certain grasslands. Three partially or wholly introduced grasses (Poa pratensis, Poa compressa, Agrostis gigantea) were included because they are so important a component of Michigan's present grassland that it is misleading to ignore them. Andropogon virginicus is adventive in Michigan, but is notable only because it dominates some second-growth grasslands on very sandy soil. Two stands had significant cover of A. virginicus, but it was so rare elsewhere it was ignored.

Species growing in the grassland proper were recorded; adjacent woodland edges were excluded. Species invading the grassland (including trees) were regarded as components of the grassland. Most stands were small and fairly homogeneous, but at some sites I divided a tract into two or three units. The division was always simple: usually between an upland and a lowland area, or between a prairie and a fen. Survey intensity at sites varied. Some were studied previously for a thesis or publication; some I alone saw. Small sites needed only two or three hours to survey, and larger ones took more. For identification I relied on Gleason and Cronquist (1963), Voss (1972) and Mickel (1981). I also used these sources to decide whether a species was native to Michigan. Possible misidentifications often involved two similar species (Appendix F).

The greatest problem posed by other people's lists was that species were recorded from an entire tract without regard for general ecological boundaries. I added to my lists and culled from sites not visited by: 1) eliminating species not native to Michigan grassland; b) eliminating species that, in my experience, cannot live in or invade grassland; c) eliminating very rare species; d) for sites having multiple habitats, adding species restricted to the habitat of interest (e.g. Carex pensylvanica in upland, never lowland, prairies), then adding species of wide ecological amplitude.

Ordination

Choosing the Method

Three general categories of vegetational ordination enjoy currency: multivariate analysis (including principal components analysis), gradient analysis, and floristic analysis. Computer accessibility has put multivariate analysis--once dauntingly laborious in its calculations--at the fingertips of any ecologist. Orloci (1966, 1975), among others, prefers that an ordination actually reflect, in a geometric way, how closely stands or plots are related to each other in nature, and in theory multivariate analysis has this capacity above all other methods. Its greatest recommendation is that it can account for more variance than other ordinations in the same number of axes.

Whittaker (1978), on the other hand, believes that simple mathematics fosters the best ordination method. He prefers gradient analysis, a "direct" approach to ordination whereby stands or plots

are related on the basis of an obvious and simple environmental factor, such a soil moisture or altitude. Brown and Curtis (1952) employed a parallel concept (i.e. subjective weighting of species for ordination) by using "climax adaptation number." Hill (1973) developed an elegant (though arithmetically oppressive) ordination technique, improving a guess about a species' position along an environmental gradient by assigning it a new value which is the average of the ordination scores that stands in which the species occurs receive after an initial run at an ordination axis. These new species values are used to ordinate the stands again. This circular process establishes a matrix that has a unique solution--the solution is the first real axis of the ordination. Because the focus shifts from species to stand to species, etc. Hill called the method "reciprocal averaging." Interpretation of the environmental gradients is predetermined and consequently straight-forward.

Bray and Curtis (1957) presented a geometric method for arranging stands or plots in n-dimensional (typically 3-dimensional) space based on floristic similarity. They considered that organisms "know" more than ecologists why they exist on a particular site and thus accurately reflect its abiotic conditions. Bray and Curtis used Jaccard's cooefficient of community (Sorensen 1948) to produce indexes of similarity between every possible pairing of stands or plots. The similarity index subtracted from unity gives an index of dissimilarity from which an ordination can be constructed using Euclidean geometry--hence the name "polar ordination." The

resulting ordination does not imply that strict distances between points reflect equally strict relationships in nature; but they do reflect relative distances in that simliar stands cluster and dissimilar stands do not. Interpretation of the environmental gradients which correspond to ordination axes is accomplished by attaching values (e.g. pH, light intensity, soil texture) to the stands in the ordination and drawing isolines.

Chief among reasons not to use multivariate analysis is that such ordinations are often ecologically unintelligible; i.e., it is difficult to assign environmental gradients to ordination axes (Robertson 1978). Patterns that emerge are often not different than those revealed by other methods (Beals 1973; Whittaker & Gauch 1973; Robertson 1978). Besides this, it may not be appropriate that such analysis be used to ordinate samples that represent a continuum because stands next to each other are not placed there on the basis of their direct similarity but rather with respect to a hypothetical stand in the center of a hyperellipsoid. Beals (1973) summarizes these objections, which also include that multivariate analysis assumes a normal distribution of the data, including of stands sampled. Studies of relict vegetation usually preclude random selection of stands.

Major problems of gradient analysis are that an environmental factor can be too subtle to detect; an apparent single factor (e.g. soil moisture) is actually a complex of factors (e.g. soil moisture is influenced by wrc in the A-horizon, clay pan in the B-horizon, permeability of the C-horizon); and a single factor (e.g. pH) merely

relects an assortment of counter- and co-acting elements to which it generally, but not necessarily directly, correlates. Accurately detecting environmental variables usually requires additional time and equipment. Partch (1962) concluded that careful measurement of soil moisture in a prairie were no help in predicting the boundaries of homogeneous areas: other microsite variables also influenced species distribution. Plant species may reflect their environment better than humans can judge. Some (Daubenmire 1960; Langford & Buell 1969) criticize gradient analysis because the method itself forces plots into a vegetational continuum.

The Bray-Curtis method is most popular among polar ordinations. Besides satisfying a need for an interpretable floristic ordination, computer algorithms for the coefficient of community are simple to devise. The number of species shared between two stands divided by half the sum of the species in both stands gives an index of similarity. If the stands have 10 species each, all in common, this number divided by half the shared species (20/2 = 10) gives 100 percent. The mathematic expression of the coefficient of community (similarity index, or SI) is:

$$SI = \frac{ab}{.5(a+b)} = \frac{2ab}{a+b}$$

where ab = number of species in common; a+b = total number of species in both stands.

Most ordinations today use quantitative data, such as frequency, dominance, or an index based on more than one measurement. The small size of many remnants may make quantitative data suspect, and more time is needed to sample quantitatively than to make a species

list. Presence is accepted by the Braun-Blanquet school (Mueller-Dombois & Ellenberg 1974) as equal, if not superior, to quantitative data, at least in certain cases. Uncommon (i.e. low to medium frequency) species that are constant from stand to stand and modal within a vegetation type may characterize it as well as, for instance, its 15 to 25 most frequent species. Dominant and frequent species are so because they are very successful, which often means they tend to have broader ecological amplitude. This, by itself, is a convincing reason to use presence in ordinations.

Endpoint Selection and Axis Construction

Dissimilarity, rather than similarity values are used to construct an ordination because the geometric relationship between stands is established by the degree of difference between stands (Dissimilarity Index, DI = 1 - SI.). Two very different stands are chosen as endpoints to an axis that encompasses the spread of stands between them. Stands are "pushed" into place along the axis by both endpoint stands, and the position a stand ultimately occupies in a multidimentional ordination reflects the dissimilarity between it and all the endpoints in the ordination.

The position of non-endpoint stands along each axis is determined geometrically (Bray & Curtis 1959) or algebraically (Beals 1960), the latter being simplest to apply:

$$X_i = \frac{L^2 + L_A^2 - L_B^2}{2L}$$

where L is the axis length (Dissimilarity Index between endpoint stands); L_A is the distance (DI) from endpoint A to stand i; L_B is the distance (DI) from endpoint B to stand i.

There are rules for selecting endpoints which vary according to the aim of the investigator, but central to all are three criteria:

1. Axis endpoints should provide the greatest opportunity for spread among all stands; i.e., they must be the most dissimilar stands on an axis in order to produce the greatest ordination interval. Furthermore, the farther apart endpoint pairs are on previous axes (except on the x-axis), the less the spread.

2. Axis endpoints should have sufficiently high similarity values with some stands to have a decided influence on their ordination position.

3. Endpoints should lie near the center of previous axes. This prevents "damping" of the potential spread of stands because stands close to an endpoint of necessity are more closely related than those at the center of an axis.

A concern when ordinating fragmented relicts of native vegetation is that great dissimilarity between stands results from differences in stand species number, obscuring real dissimilarity between endpoints. It is generally accepted that different sampling sets in the same stand are not over 80 or 85 percent similar (Cox 1980, Curtis 1959). It is reasonable to assume that the greatest sampling similarity between different stands is also 80 to 85 percent. Pairs of stands were used as endpoints only if their maximum SI due to difference in species number was over 85 percent. For instance, the x-axis endpoints of this ordination (with 83 and 74 species) have a maximum similarity index of 94.0 percent:

$$SI = \frac{2w}{a - b} = \frac{2 \times 74}{83 + 74} = 0.94 = 94.0\%$$

Rules to satisfy the other criteria were:

1. For the x-axis choose the stand pair with the greatest interstand distance, or dissimilarity index (DI) (Bray & Curtis 1957). For subsequent axes, again choose the pair with the greatest DI, but subtract from it the previous axis distance(s) between the stands. The pair with the highest resultant value has the greatest ordination interval (OI).

Mueller-Dombois and Ellenberg (1974), following Swan and Dix (1966), first sum the DI's associated with each stand. The stand with the greatest sum is most dissimilar to all other stands and becomes an x-axis endpoint. The stand most dissimilar to it becomes the other. This method provides an "anchor" for the first axis, theoretically promoting the greatest spread of stands by forcing the axis to account for the maximum interstand variance in the first axis. But sometimes the DI between endpoints chosen this way is actually lower than the DI of another pair of stands.

The first y-axis endpoint should be the stand with the poorest fit on the x-axis. Poorness of fit is calculated by:

$$E_X = dA^2 - x^2$$

where dA is the DI between a stand and the first endpoint of the x-axis; x is the distance the stand lies from the endpoint on the x-axis.

(For other axes, the poorness of fit is the sum of poorness of fit values from all previous axes: $E_{X,y\ldots} = E_X + E_y + \ldots.$) The second axis endpoint is again that stand with the greatest DI to the first, with an added requirement that the two endpoints lie within 10 percent of each other on the previous axes.

2. I required that at least three stands be a minimum distance from an endpoint stand. This is a variation on Swan and Dix' (1966) recommendation that an endpoint stand be at least 50 percent similar to three or more stands. That criterion was too rigorous for this study, since only 3 percent of the SI's were over 50 percent. For the x-axis the minimal distance was 25 percent of the DI between endpoints, then 30 percent for the y-axis and 35 percent for all others. Bray and Curtis (1957) asked only that an endpoint stand not have a DI of 100% with any other stand in order to avoid ordinating a stand that the endpoint has no relationship with.

3. I selected endpoints within 15 percent of the previous axis midpoints. Bray and Curtis (1957) suggest 10 percent, Mueller-Dombois and Ellenberg (1974) 25 percent.

Calculation of DI, SI, and axis coordinates was done by a DECsystem-10 computer, using programs written in FORTRAN. Several x-axis pairs were selected which had the greatest DI and met the 85 percent SI test. An x-axis ordination was run using each endpoint pair and each was scored on how it met criterion 2. For subsequent axes I selected stands that had the greatest potential ordination interval (after substracting previous axis separation(s) from DI) and which met the 85 percent SI test. Before ordination, I eliminated those which failed criterion 3. After ordination the pairs were tested for criterion 2. To evaluate potential endpoint pairs, I summed the scores each endpoint pair received for meeting the above criteria. The "winning" endpoints were those which best met all criteria as summed against scores for other stand pairs.

Evaluating the Ordination

An ordination can be tested for effectiveness at expressing relationships between stands by comparing a stand's ordination position (using Ordination Interval, OI) and actual interstand distance (or stand dissimilarity, DI). Each axis can be examined to see how well it placed stands, and the entire ordination can be proofed in the same way. For a single axis, the ordination interval between two stands, OI_X, is the difference between the two stand positions on that axis: $OI_X = x_2 - x_1$. Or for multiple axes:

$$OI_{X,Y,Z\ \ldots} = \sqrt{(x_1 - x_2) + (y_1 = y_2) + (z_1 + z_2) + \ldots}$$

The mean OI of a sample of stand pairs is compared to the mean DI. Over 1 percent of the stand pairs (25 out of 2211) were randomly chosen to test the ordination. Only pairs that passed the 85 percent SI test were used.

Determining Grassland Types

In the simplest example, the continuum theory applied to relict vegetation poses a string of stands from one environmental extreme to another across an ecological gradient (see e.g. Gleason 1926, McIntosh 1967). One would expect the same expression of vegetational pattern in an ordination of the stands. Nevertheless, more stands could end up in certain spots along the continuum than others. Such a spot, or node, would correspond to a place along intersecting ecological gradients (representing the site conditions of a stand) at which certain species reach high presence values.

These species would comprise a repeating assemblage that partly defines, or at least corresponds to, a distinct plant association.

Stands were included in a grassland type if they lay closer to the center of a cluster of stands than they did to more distant unclustered stands. OI was used to determine proximity. Similarity indexes between stands also were consulted. Transitional stands occurred and were not used later to tally presence. Areas of the ordination lacking clusters displayed instead a slurred constellation of points . The elongate array was split into segments to accommodate its range of variation. I decided to let stands contitute a grassland type if an endpoint was near a few to several other stands which lay at the perimeter of the larger array of stands. If OI between such an endpoint and an adjacent stand exceeded that between the adjacent stand and the center of the cluster, the stand belonged to the endpoint grouping. Similarity indexes again were consulted.

Selection of Indicators, Grassland Type Summaries, and Comparison of Types

Presence values in each type were determined using stands with a normal complement of species (over 38 for hillside, 45 for other upland types, and over 50 for lowland). I considered species with presence below 50 percent too rare to be useful as indicators. The species of high presence (equivalent to prevalent species of Curtis, 1959) appear in the lists for the types. I divided the number of high presence species by all species encountered in a type to get

the degree of high presence. The higher the proportion of these species, the more homogeneous the grassland type. This index is artifically inflated when an even number of stands is used to calculate presence in a type.

Presence of all species encountered in the study was calculated separately for upland and lowland stands of normal species number. The master presence list was used in tandem with the lists of high presence species to pick indicators. If a species was present over 80 percent of the time in a grassland type, and not on any other list, it was a good indicator. A good indicator present over 20 percent of the time in the other moisture class was a good indicator only for its own class. Species present 50-79 percent of the time were fair indicators. Consideration for presence in lowland if an upland species (and vice versa) was given here too. Some species of low presence (and excluded from the type species lists) are nevertheless characteristic because they are nearly or wholly restricted to a type. Low presence indicators, but more typically the good and fair indicators are "differential" species (Mueller-Dombois & Ellenberg 1974) that differentiate well between vegetation types because of high presence in a setting for which they have great tolerance and low presence or absence elsewhere. In this study some differential indicators were better--presence in 2 or more stands of another type decreased the value of the others. Modal indicators (Curtis 1959) coupled with frequency were used in two cases to select indicators. Modal indicators can have high presence in other types.

For each grassland type identified, the physiography, surficial geology, soil characteristics and vegetative structure were summarized. Surficial geology was obtained from a map (Ferrand & Bell 1982). Measured soil characteristics (pH, wrc) were averaged; the most frequently encountered soil texture(s) became the soil texture(s) for the type. Soil series and area soils were simply listed from the coarsest to finest soils.

The different growth forms (tree, grass, etc.) in each type were taken from the list of high presence species. Species number for a grassland type was the average of the species number in each stand of the type.

Grassland types were compared by calculating similarity indexes between each pair of types, using the lists of high constancy species. I tabulated the number of indicators at each site described in the literature (Appendix E) and expressed them as a percentage of the total indicators possible for each type. The results reflect the similarity of each site to each grassland type differentiated by this study.

CHAPTER III

RESULTS AND DISCUSSION

Ordination

Only about 3 percent of the stand pair combinations exceeded 50 percent similarity. This can be attributed to the chance events which carved out stands for survival from the once larger prairie matrix, as well as perhaps species-area effects (local extirpations). Despite this drawback, stands clustered in the ordination.

The best endpoint pairs for the ordination axes had dissimilarity indexes (DI) of 97.3 (x-axis), 75.9 (y-axis), and 74.0 (z-axis). Maximum DI's due to differences in species number in each stand were inconsequential at 6.0 (x-axis), 5.6 (y-axis), and 2.0 (z-axis). The x-axis (Figure 3) produced the highest mean ordination interval (31.6) for the sample of 25 stand pairs, which is less than half the mean interstand distance (75.1) for the same pairs. Correlation between the ordination interval (OI) and interstand distance (ID) using Student's t-test showed very significant correlation (99.9%, sd=23.28) for the x-axis. The mean OI of the x-axis exceeded by nearly four times the y-axis sample and by nearly three times the z-axis. Ordination interval for the y- and z-axis did not correlate with DI. This does not mean the y- and

Explanation for Figures 3-6. Stands used in ordination (county in parentheses).

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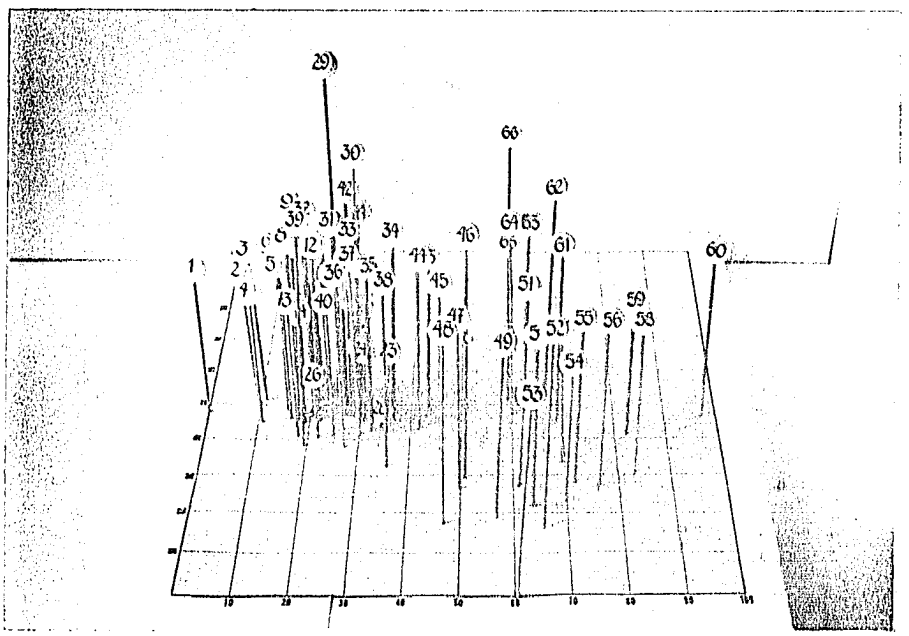
65. Sebewaing Bay (Tuscola)
66. Squirrel Island (Lambton, Canada)



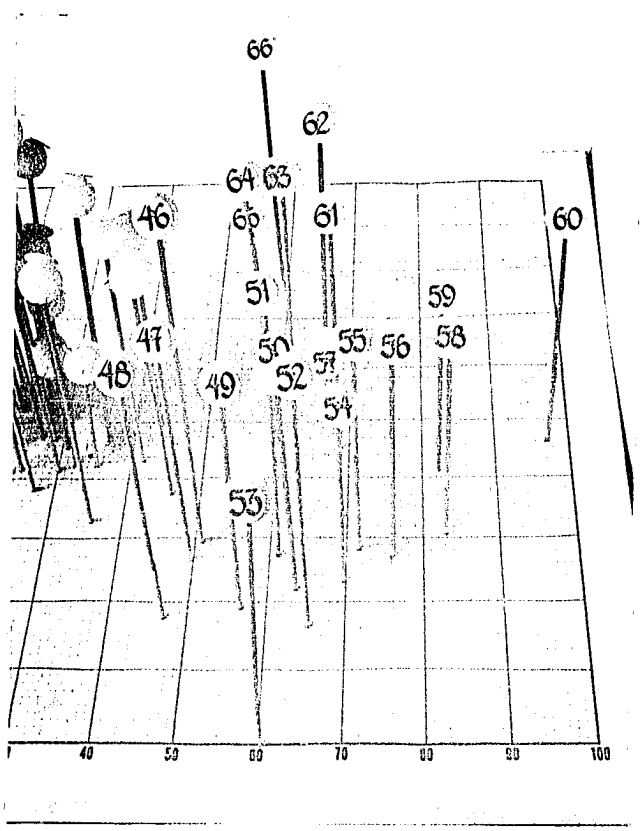


Figure 3 (upper). Ordination model, X and Z axes (front view).

Figure 4 (lower). Ordination model, X and Y axes (lowland sites).

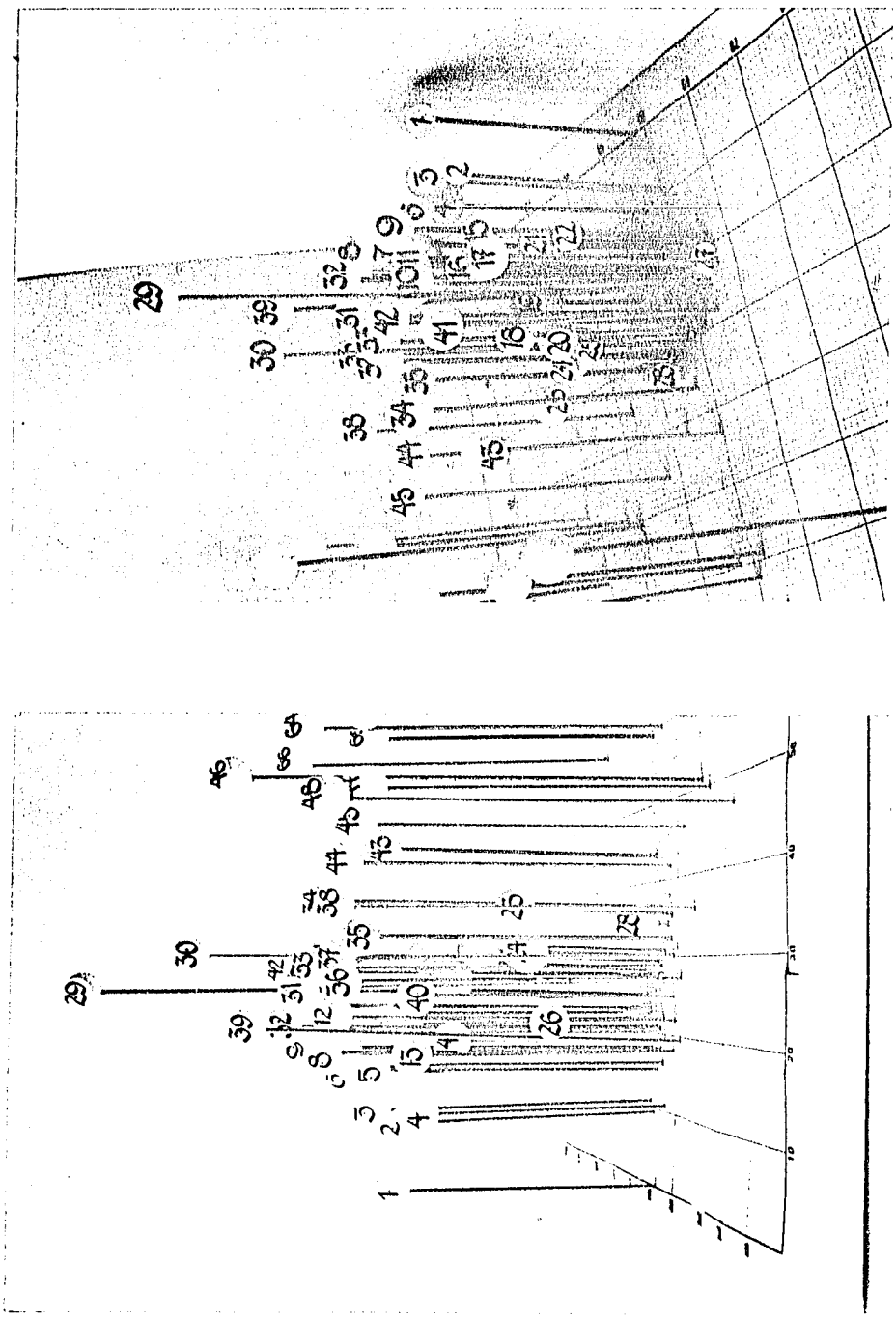


Figure 5 (upper). Ordination model, X and Z axes (upland, front).

Figure 6 (lower). Ordination model, X and Z axes (upland, back).

z-axis were ineffective at discriminating further differences between stands; rather, later axes primarily acted on limited portions of the ordination, but those effects were swamped when unaffected stands also were considered. The y-axis produced good separation in the lowland range (Figure 4) but little in the upland, and since twice as many upland stands exist as lowland, the effectiveness of this separation was underplayed when all stands were considered. Likewise, the z-axis markedly affected only a dozen stands in the upland segment of the ordination (Figure 5, 6), and so appears ineffectual when all stands are examined.

Nevertheless, the ordination improved when axes were considered simultaneously: for both x- and y-axis the mean OI was 34.4 (99.9% correlation, sd=22.46); for the x-, y-, and z-axis the mean OI was 38.7 (99.9% correlation, sd=22.09). Dissimilar stands still lay next to one another after these three axes were constructed. A fourth axis (DI=78.3) showed no significant correlation between OI and DI (again because it affected few stands) but this additional axis improved the ordination further (mean OI 42.4, 99.9% correlation, sd=22.37).

It is widely accepted that tallgrass prairie is divisible into vegetation segments based on soil moisture; soil moisture relates to topographic position, soil texture, subsoil materials, and other factors. The x-axis of the ordination merely confirms this (Figure 3). Stands closest to zero are driest and closest to 100 wettest; stands in the middle are mesic. Three general observations can be made: fens appear wetter than wet prairie in Michigan, probably

because peat holds so much water and, thanks to groundwater flow, there is abundant water to hold. Stands with sandy loam and loamy sand soils can be wet (Figure 3: Stands 44-46, 50, 55, 61-66), suggesting that topographic position overrides soil texture in its effect on soil moisture and, subsequently, vegetation. It is logical to assume that, due to topographic position, mesic conditions also can prevail in sandy loams and loamy sands, and that the vegetation will concomitantly exhibit greater mesophytism. Lastly, among the driest stands are the Newaygo County prairies, long designated a farflung offshoot of the Prairie Peninsula. High SI's (58.0, 64.2, 57.3) ally them with grasslands which formerly existed as a component of dry savannas (Stands 1, 3, 6).

The y-axis worked the lowland end of the x-axis to separate two types of prairie there (Figure 4). Factors that correlate with the y-axis might be soil texture--coarser soils toward zero and finer toward 100--but this trend does not strictly hold. Sapric muck typical of fens (which defies classification by texture) is mostly decomposed organic material and very fine silt-like particles. Nor does the drier segment bear it out, perhaps because differences between loamy sand and sandy loam are insignificant as far as vegetation is concerned. Alternatively, the y-axis may correspond to a geographic cline: sites with greater affinities to true prairie lie nearer zero and sites with lesser lie the other way. This interpretation theoretically relates lakeplain wet prairie to lowland meadows found farther east in the deciduous forest biome.

The z-axis produced greater separation than the y-axis, but did

not resolve distinct types; instead, from the larger bunch of stands, several stands were strung out toward zero (Figure 5 and 6). These were open and semi-open hillsides surrounded by forest, and the axis may indicate the influence exerted by forest on a site, in terms of shading and forest species present, or conversely, to lessened influence by the prairie flora of southern Lower Michigan.

The a-axis (not shown), which performed better than the y- or z-axis, may have detected another variable operating on the species composition of prairie stands. It placed stands 39-45 and 61-66 closer to 100 than other stands in their moisture segment. This axis may represent interlocked factors--sandiness of the soil coupled with topographic position. Moist and wet sandy soils would lie closer to 100 than dry sandy soils, or than moist and wet loamy soils. A geographical interpretation could also be laid on this axis.

Grassland Types

Trends in soil characteristics match patterns in the ordination (Table 1). Mean pH and mean wrc increase along the x-axis, and soil texture gets finer (Dry Sand, Woodland, Mesic, Wet, Fen). The sites toward zero on the z-axis show soil characteristics intermediate between the sites on dry sand and the rest of the drier upland stands. Mesic sites on sandy soil have pH and wrc nearly as low as sites on dry sand, but topographic position causes seasonally wet conditions, these factors coupled in the a-axis. Lakeplain wet prairies are on sandy soil, but surprisingly, mean pH is higher than

Table 1

Soil characteristics of the grassland types.

	pH	wrc	soil texture
Dry Sand	5.1 (4.6-5.7)	38% (28-48%)	loamy sand (sandy loam)
Hillside	5.5 (4.5-7.8)	51% (30-85%)	loamy sand sandy loam
Woodland	5.8 (5.2-6.7)	54% (43-94%)	sandy loam (loamy sand, loam)
Mesic Sand	5.5 (5.4-5.9) [5.9; 5.4-7.3]*	43% (31-62%)	sandy loam (loamy sand, sand)
Mesic	6.2 (4.9-7.5) [5.6(5.1)-7.3]¶	64% (37-106%) [38-90%]¶	loam, sandy loam (silt loam)
Lakeplain Wet	8.0 (7.7-8.2)	60% (50-68%)	sandy loam, loamy fine sand, (loam historically)
Wet	6.9 (5.5-7.7)	100% (43-170%)	loam, (sandy loam, silt loam)
Fen§	7.6 (6.8-8.2)	432% (220-745%)	sapric muck

* Includes Shanghai Terrace
¶ Values from modern soil surveys
§ Data from 18 stands, Chapman unpubl.

in fen and mean wrc approaches mesic loamy sites, probably due to a relatively high organic content and very fine sand. Seasonally wet conditions in sandy soil might suffice as explanation, but the historical occurrence on loam of vast acreages of lakeplain wet prairie suggests a geographic factor also is operating.

The stands at the zero end of the x-axis are typified by dry sand. Stands located near zero on the z-axis mostly occur on

hillsides, with all the consequences that brings. The large clot in the upland segment of the ordination did not separate well on any axis--these stands represent the most widespread prairie type in Michigan, hypothetically derived from oak savanna. Mesic stands are sandwiched between upland and lowland portions of the ordination (so few that no clumping was possible). The a-axis distinguishes mesic stands on sandy soils from drier ones of similar soil texture. At the lowland end, the y-axis separated typical wet prairie from lakeplain wet prairie. Fen lies between these two, but closer to the former. In fact, fen in southern Lower Michigan is related to wet prairie through the possession of typical wet prairie species and to lakeplain wet prairie by some other floristic element. Typical and lakeplain wet-mesic prairie exist, but there are too few stands to produce a pattern. Intermediates between other types, including fen, results from changing the physical variables represented by the different axes.

Indicators and species of high presence are discussed below for each grassland type. Many species of high presence (over 50 percent) in more than one grassland type--poor indicators but prominent species--fall into five categories (Table 2). Members of the first group grow in nearly all upland and lowland types. They could be called weeds, for they are widespread and grow in several habitats besides prairie. These species are the most successful prairie plants in Michigan. This group and the next two are a unifying element that imparts regularity to Michigan grassland. Like the first group, the members of the next two thrive in other

Table 2

Common non-indicator species (exceptions to each category in parentheses).

All Lowland and Upland
Andropogon gerardii, A. scoparius (except Wet), Comandra richardsiana, Fragaria virginiana (except Hillside), Monarda fistulosa, Poa compressa (except Wet), Rudbeckia hirta, Solidago nemoralis (except Wet), Sorghastrum nutans (except Hillside)
All Upland
Anemone cylindrica, Antennaria plantaginifolia, Asclepias tuberosa, Aster azureus, Carex pensylvanica (except Mesic), Ceanothus americanus (except Mesic Sand), Euphorbia corollata, Lactuca canadensis, Lespedeza capitata, Phlox pilosa (except Woodland?), Prunus serotina, Quercus velutina, Rosa carolina (except Mesic Sand), Tradescantia ohiensis (except Mesic Sand)
Only Lowland
Agrostis gigantea, Allium canadense, Anemone canadense, Apocynum sibiricum, Aster novae-angliae, Calamagrostis canadensis, Cicuta maculata, Convolvulus sepium, Cornus stolonifera, Gentiana andrewsii, Iris virginica, Lathyrus palustris, Lycopus americanus, Pycnanthemum virginianum (also in Mesic Sand), Solidago altissima (also in Mesic), Spartina pectinata (also in Mesic), Veronicastrum virginicum (also in Mesic Sand and Mesic), Zizia aurea (also in Mesic)
Dry Sand and Hillside
Juniperus virginiana, Quercus alba, Viola pedata
Mesic Sand and Mesic
Corylus americana, Equisetum laevigatum, Heuchera hirsuticaulis, Luzula multiflora, Solidago graminifolia, Veronicastrum virginicum

habitats besides prairie and figure among the most successful Michigan grassland species. These 42 species comprise 8.5 percent of all species encountered in the study.

Two other groups link grassland types of similar physical

factors. Juniperus virginiana, Quercus alba and Viola pedata commonly grow in the driest grasslands, in dry sand and on hillsides. Q. alba is fairly regular in the next driest type derived from oak openings, but shows a presence there below 50 percent. Mesic conditions in sandy and loamy soil are indicated by six species which (except Luzula multiflora) emphasize tolerance for wetter conditions by entering lowland prairie.

Dry Sand Prairie

Dry Sand Prairie was open prairie at the time of settlement, perhaps sustaining some oak brush (depending on fire frequency). Many remnants today derive from oak barrens, the savanna phase of this type. The barrens Daniels (1904) described are indeed related to Dry Sand Prairie, possessing seven of the type indicators (Table 3). Soil characteristics are similar on sites derived from both (Appendix D, Sites 1-7, 17, 33), but physiography and surficial geography propelled a site toward open prairie or savanna, the flatter and better drained sites going toward open prairie (see Appendix A). Stands 17 and 33 were displaced toward 100 on the x-axis. Due to low species number, stand 33 lacked many species the dry sand endpoint had, which weakened the relationship between them. Local water table was high also, perhaps imparting seasonal dry-mesic conditions. Both stands reflect a geographic variable, stands of Dry Sand Prairie closer to Indiana looking more like dry prairie farther west.

Table 3

Percent of total type indicators in stands from the literature. Number of indicators for each type and in each stand in parentheses.

	Grassland Type						
	DRY SAND (34)	HILL-SIDE (18)	WOOD-LAND (6)	MESIC SAND (20)	MESIC (26)	LKPLAIN WET (26)	WET (24)
Cole: Openings	20.6 (7)	16.7 (3)	16.7 (1)	10.0 (2)	7.7 (2)	(0)	(4.2) (1)
Cole: Hillside	5.9 (2)	16.7 (3)	16.7 (1)	5.0 (1)	3.8 (1)	(0)	(0)
Daniels: Mesic	8.8 (3)	5.5 (1)	16.7 (1)	10.0 (2)	19.2 (5)	(0)	(0)
Daniels: Barrens	20.6 (7)	(0)	33.3 (2)	10.0 (2)	3.8 (1)	(0)	(0)
Daniels: Openings	11.8 (4)	33.3 (6)	16.7 (1)	5.0 (1)	19.2 (5)	(0)	(0)
Davis: Mesic	2.9 (1)	11.1 (2)	16.7 (1)	25.0 (5)	30.8 (8)	15.4 (4)	16.7 (4)
Davis: Wet-mesic	(0)	(0)	16.7 (1)	35.0 (7)	3.8 (1)	46.2 (12)	20.8 (5)
Gleason: Fen	(0)	(0)	(0)	(0)	(0)	12.0 (3)	20.8 (5)
Anderson: Dry	38.2 (13)	5.5 (1)	66.7 (4)	50.0 (10)	7.7 (2)	(0)	(0)
Anderson: Wet	(0)	(0)	(0)	20.0 (4)	3.8 (1)	38.5 (10)	37.5 (9)

Dry Sand Prairie exhibits a distinctness and homogeneity markedly above the other upland grassland types, a trait shared with Wisconsin dry prairie (Curtis 1959). The number of indicators is

the highest in the study, and the proportion of the total flora contributed by species of high presence is also high (Table 4). Further confirmation comes from the high average SI for the type: 45.2 (range 34.3-64.2). The distinctness of Dry Sand Prairie is due partly to several widespread plants of dry sandy situations that are uncommon in or absent from other prairie types, and which serve as indicators of dry sand prairie only outside the context of other dry sandy communities. For instance, the following Dry Sand Prairie indicators are regular components of Michigan sand dunes: Artemisia caudata, Arabis lyrata, Lithospermum caroliniensis, Monarda punctata, and Prunus virginiana. Lest Dry Sand Prairie be seen as less of a grassland for its connection to sand dunes, nine grasses are among the species of high presence, the most in the study.

Dry Sand Prairie in Michigan bears a superficial resemblance to dry prairie in Wisconsin because of shared herbs of dry open situations found throughout the Great Lakes region. Only three Wisconsin dry prairie indicators (Andropogon scoparius, Artemisia caudata, Solidago nemoralis) are useful, the others rare or absent in Michigan grassland. Wisconsin dry prairies developed udolls with much higher pH (mean 7.8) and wrc (mean 60%) than Michigan dry prairies (Table 1). The dry meadows of northwest Ohio, like Michigan's, occur on forest soils (Anderson 1971), and 13 indicators of Dry Sand Prairie (Table 3) detect a similarity to this type; however, the presence of half the possible Mesic Sand Prairie indicators suggests another relationship.

Dry prairie on udolls did not exist in Michigan at the time of

Table 4

Species statistics of the grassland types.

	Species Number	Total Species	Species of High Presence	Degree of High Presence	Number of Indicators
Dry Sand	77	182	76	41.8%	34
Hillside	49	148	41	27.7%	18
Woodland	65	243	41	16.8%	6
Mesic Sand	79	241	59	24.5%	20
Mesic	81	172	81	47.0%	26
Lakeplain Wet	76	157	59	37.6%	26
Wet	69	177	64	36.1%	24

settlement: grassland remnants within historic blacksoil prairies are dry-mesic at the driest. Instead dry prairie was on forest soil, achieved premier expression as open prairie on very dry level sand deposits, such as those in Newaygo County and at Coguaiack Prairie, Kalamazoo County. Because they looked like arable prairies, they were cultivated early, then abandoned when the soil gave out (Chapman & Crispin 1984). Like oak openings, oak barrens also were plowed but the cropland failed as it had in sand prairies. Secondary grasslands developed following relatively early abandonment. Today they resemble natural sites in species composition; some were included in this study.

Hillside Prairie

Hillside Prairie in Michigan little resembles the goat prairies of Illinois and Wisconsin. Shared species with a presence over 50 percent are few: Andropogon scoparius, Bouteloua curtipendula, Euphorbia corollata, Lespedeza capitata, Solidago nemoralis (Evers 1955). Seven other Illinois species with over 22 percent presence are among Michigan's top species as well. Never does a site in Michigan show pH values as high as the Illinois prairie bluffs (7.9-8.4); soil origin, soil group, and organic content also are strikingly different. But the microclimate that exists on steep south- to west-facing slopes in Michigan or Illinois has the same cause. More direct sunlight raises temperature and evaporation rates and provides more light for plants. In Michigan, the sandy soil of the hillsides is well-drained due to outwash in the subsoil (Appendix A), which, compounded by the effect of direct sunlight, creates truly xeric conditions. Prevailing winds from the southwest, passing largely unimpeded across the lakes, broad river valleys, and some streams that the hillsides overlook, add to water stress. Reflecting the dry conditions are two xeric prairie grasses, Bouteloua curtipendula and Stipa spartea, both indicators for the type (the former also an indicator for Illinois hill prairie). Another feature of hillside sites is soil erosion due to steep slopes. The significance to prairie of soil erosion is obscure, but at least one species of Hillside Prairie--Besseya bullii--may require bare ground to establish seedlings.

Hillside Prairie occupies small sites and is more influenced by the surrounding forest than other grassland types. Nine tree species and five species of vine or shrub are among the prevalents. The balance between a swing toward forest or to open conditions hangs on the interaction of factors causing xeric conditions and forest reactions on local evaporation rates and temperature. Nowhere are the occasional droughts of the Prairie Peninsula as crucial to maintenance of open conditions as on hillsides: several historical locations visited during the study were completely overgrown by saplings and shrubs, and others were becoming wooded, suggesting that a microclimatic threshold was crossed and that factors other than those produced by the site itself were needed to keep it open. One factor is fire, though, lying north or east of water, hillsides are in a fire shadow and fire frequency historically was low. Possibly taking advantage of the prospect afforded by high bluffs (and of more wind for relief from biting insects), Indians camped at sites of Hillside Prairie, burning them to maintain the view. If this be true, Indians may be responsible for the occurrence of some of the species at Hillside Prairies.

The average species number per stand and total species encountered in Hillside Prairie were the lowest in the study (49), certainly indicating species-area effects. Evers (1955) found the average species number of Illinois hill prairies to be 49; the minimum size requirement for an average number of species was 0.038 acres, or an area 1655 square feet, comparable to the average size of Michigan Hillside Prairies.

Hillside Prairie is moderately distinct as shown by the number of indicators and degree of high presence. Type indicators identified Cole's (1901) hillside sites as Hillside Prairie (Table 3), though two indicators of Dry Sand Prairie also are present. However, among the stands are two which are not hillsides (Site 21 and 23). Site 23 may occupy its ordination position because of low species number. Site 21 is intermediate between Hillside Prairie and Woodland Prairie, but its proximity to the other hillside sites in the ordination nonetheless is confusing.

Hillsides were difficult to pasture, let alone plow, so many sites should have survived to the present. But since the Great Drought of the 1930's (when historical sites were in good condition judging by the collections of prairie species made at them) the climate seems to have turned against them, and in recent decades the demand for waterside homesites in southern Lower Michigan has contrituted to their demise and present rarity.

Woodland Prairie

Since it represents fragments of the widespread oak savanna, Woodland Prairie is the most widespread and abundant grassland type today. But it is not a homogeneous assemblage. The degree of high presence is low, and the one differential indicator is only fair at distinguishing the type; the other indicators are merely modal and so may be present with fairly high regularity in other types. The heterogeneity of Woodland Prairie may be due principally to variation in the former oak savanna across two hundred miles of

southern Lower Michigan, just as variation exists in sugar maple-beech or oak forest across the same stretch of landscape. In addition, loss of species from sites, as reflected by a low average species number (Table 4), may be more frequent than in other types. On the other hand, diversity in the oak savanna itself may have been lower than in open prairies.

Sites are mostly dry-mesic, as suggested by the ordination position of most stands, but range from slightly drier to nearly mesic in soil moisture. (Oak barrens are drier.) Site 8 is slightly drier than dry-mesic, but shading has increased the mesophytism of the site. Site 34 occupies a slope, at the base of which groundwater seepage enables fen vegetation to thrive. About midway down the slope, water high enough in the soil to support the mesic indicators Panicum leibergii, Silphium terebinthinaceum, and Zizia aurea. Cole (1901) conceived of oak savanna as considerably drier: seven of the type indicators for Dry Sand Prairie appear on her list. Cole was calling oak barrens oak openings for the structural similarity and many prairie species. Oak openings may not have been in Kent County, for away from the Prairie Peninsula's climatic influence, prairie grassland and savanna are sustained only by severe edaphic factors. The Newaygo prairies persist in an unfavorable climate because they occupy xeric sites, moister sites in the north being the domain of forest. Soil surveys indicate that the drier oak barrens lay farther north than oak openings. The mesic bur oak plains were restricted to the prairie counties; similar mesic sites elsewhere were occupied by forest.

On the other hand, Daniels (1904) concept of oak openings was nearly like an oak forest, possessing in fact 17 tree species. The oak openings are related to Hillside Prairie (with six shared indicators) through this forest element (Table 3). The canopy reduced evaporation (five Mesic indicators), but not so much that drier prairie species could not survive (4 Dry Sand indicators). The many oak woods species on his list cast doubt on the concept of oak openings as grassland with scattered trees, as on the African veldt. Rather Daniels data suggest that in the savanna were areas resembling oak woods, though few and small enough so that an impression of oak savanna prevailed.

Woodland Prairie differs fundamentally from western grasslands of equivalent moisture class. In Wisconsin dry-mesic prairie usually occurs on udolls (Curtis 1959); such soils have more organic material, more nutrients and calcium, and much higher pH (7.1) than Michigan udalfs of the same moisture class. Water retaining capacity is the same (55%), as perhaps it should be to attain dry-mesic conditions. Dry-mesic blacksoil prairies in Michigan were nearly eliminated by plowing within 20 years of settlement, and little can be found today (Site 30). Woodland Prairie is a different story. Railroad rights-of-way are the great refuge of this type and most sites in this study are railroad relicts. A decade after settlement, portions of the oak openings which hadn't been cleared and plowed were becoming forest. From 1838 on (Dunbar 1969), railroads were put down across southern Lower Michigan. If one was laid in oak openings, the groundlayer was resurrected by

removing woody plants from the right-of-way and initiating annual burning, management that continued until World War II. Thus oak openings groundlayer was preserved in railroad rights-of-way across much of its former range. Tracts in cemeteries may owe their survival to periodic mowing.

Mesic Sand Prairie

The concept of sandy yet mesic grassland is in use in Illinois (White & Madany 1981). These sites bear some floristic resemblance to Michigan ones in sharing Scleria triglomerata, and Aletris farinosa as indicators. (Other Illinois indicators at lower frequency in Michigan are Calopogon tuberosus and Rubus hispidus.) A high spring water table which falls during summer and culminates in autumn drought puts species of Dry Sand Prairie beside plants of moister sites (Pycnanthemum virginianum, Quercus palustris, Liatris spicata, Spiraea alba, Veronicastrum virginicum, Solidago rugosa [lower presence], etc.). Total composition nevertheless is weighted heavily toward species of dry situations. Straddling the fence between wet and dry produces greater diversity: the average species number per stand is high (partly due to high counts at two stands) and the total species encountered is also high, especially for only six stands. The mesic type in Wisconsin (though not on sand) had the most total species. On the other hand, a high total may reflect heterogeneity; indeed, degree of high presence and number of indicators is about the same as for Hillside Prairie--fair.

Mesic Sand Prairie is found as two subtypes: on glacial

lakeplains, glacial deltas and watercourses in lower elevations; and on outwash in higher southcentral and southwest Lower Michigan. In the latter situation the influence of oak openings vegetation is strongest and stands are transitional to Woodland Prairie (Site 39, 40). On the lakeplains, oak openings of the highlands were replaced by another type of savanna: sand ridges supporting a thin growth of oaks and sand prairie that was mesic due to a seasonally high water table. The larger sand plains of Monroe and Wayne County theoretically supported mesic sand prairie since they were no more elevated above the lake plain than were the sand ridges.

Davis' mesic Saginaw Bay prairie is related to Mesic Sand Prairie by five indicators (Table 3), but eight indicators of Mesic Prairie inexplicably are present. Without an example from the Bay region it can't be known if Mesic Sand Prairie there resembled Mesic Prairie in southwest Lower Michigan. His wet-mesic segment, with seven indicators, is more like Mesic Sand Prairie--Mesic Prairie indicators drop to one. "Dry meadow" of the Ohio oak openings region is strongly related to Mesic Sand Prairie, with ten indicators (Table 3), but as already noted, there are many indicators of Dry Sand Prairie as well.

Mesic Prairie

A strict definition of Mesic Prairie in Michigan demands the presence of a true prairie soil. It is a happy coincidence for this classification that historical prairies in Michigan were overall mesic, regardless of soil texture. There is no clear reason for

this, but a clay pan in the B horizon of Michigan prairie soils may partly account for it. Higher organic content of prairie soils should produce better water economy, but the range of wrc values from modern soil surveys does not bear this out (Table 1). Whether by a coincidence of the data or by nature, pH and wrc for Mesic Prairie approach those in Wisconsin (pH 6.4, wrc 70%). However, none of the mesic stands used in this study are blacksoil prairie remnants, although Stand 37 was at the edge of a blacksoil prairie and 38 is a remnant of bur oak openings, the mesic savanna type. The other two stands (35, 36) are in former oak openings, and their mesophytism results from nearly mesic site conditions coupled with a geographic variable like that proposed for Woodland Prairie.

Mesic Prairie is nearly gone from Michigan, and soon may pass into memory as have bur oak plains and oak openings. One unplowed, fairly undisturbed blacksoil remnant is known--recovered from formerly mowed ground in Harrison Cemetery, Prairie Ronde. Early and thorough plowing by settlers brought about the demise of Mesic Prairie. Even where an early railroad (1838-1860) traverses a prairie, all that remains are some prairie forbs growing among alien grasses and weeds, the ground having been completely cultivated before the railroad was built. Site 37 and 38 survived at the edge of historical prairies--putting the tracks through the prairies themselves would have garnered no prairie remnant, unless by invasion from the prairie edge (the case at Stand 30). The best hope for preserving Mesic Prairie in Michigan is to stop mowing pioneer cemeteries in historical blacksoil prairies and bur oak

savannas and allow prairie plants to regain their former dominance. Prairie grasses dominated Harrison Cemetery two years after mowing stopped, and additional species appear each year, either from the seed bank and dormant rootstocks, or because it takes a while to recover after years spent as a dwarfed plant.

Average species number per stand is the highest in the study (high diversity a consequence of mesic conditions), but perhaps this and the low number of total species is due to using only four stands. The great degree of high presence (Table 4) may be statistical: when few are involved, calculating presence with an even number of stands produces a greater degree of high presence than the next odd number of stands. Still, the many indicators suggest a homogeneous type. Like Mesic Sand Prairie, species of upland sites grow next to species of lowland (Thalictrum dasycarpum, Veronicastrum virginicum, Zizia aurea, Silphium terebinthinaceum, Solidago altissima, Spartina pectinata), but upland species far outweigh the latter. Cacalia atriplicifolia and Swertia caroliniensis--in the common wisdom, indicators of oak savanna--show up as high presence species (but only in oak openings remnants, Stands 35, 36). Nine shrubs and vines have high presence in mesic prairie, suggesting mesic grasslands promote shrubby growth.

Mesic Prairie indicators figured importantly in Daniels' oak openings (which were nearly mesophytic because of semi-forest conditions) and Davis' mesic prairie (Table 3), which had five indicators. Wisconsin mesic prairie indicators are not as useful in Michigan: five of the ten are absent or too rare to be reliable.

Lakeplain Wet Prairie

It may seem overenthusiastic to distinguish two wet prairie types in a state at the edge of North American prairie; but the variability in lowland prairie is there. Wisconsin wet prairie indicators (all ten reliable in Michigan) suggest a difference: Wet Prairie has all ten Wisconsin indicators; Lakeplain Wet Prairie has six, all common lowland prairie species anyway (Table 2). Furthermore, the types had high similarity indexes within them (Lakeplain: 47.8%, range 29.9-61.7, highest in the study), but lower between them (mean 34.4%, range 23.5-48.9). Lakeplain Wet Prairie is homogeneous and distinctive (degree of high presence would be higher if an even number of stands had been used in the calculations); number of type indicators also is high (Table 4). Soil characteristics serve to separate it from Wet Prairie, the former developing in alkaline sandy soil and the latter in circumneutral loamy soil (Table 1). Historically in the Saginaw Bay region the eastern type occurred on loam, but this too was alkaline.

One vegetational feature distinguishing Lakeplain Wet Prairie is the presence of species that are common in interdunal wetlands (pannes) along the Great Lakes shores (Carex buxbaumii, Potentilla anserina), in fens (Asclepias incarnata, Cirsium muticum, Liatris spicata, Lysimachia quadriflora, Prenanthes racemosa, Rosa palustris), and in both (Eleocharis elliptica, Solidago ohioensis). The indicators consist mostly of these species (Appendix A), but there are others (e.g. Parnassia glauca) which may be added after further study. The wet-mesic phase of Lakeplain Wet Prairie is also

distinguished by (besides dominants) species characteristic of fens (Cacalia plantaginea, Cypripedium candidum), interdunal wetlands (Hypericum kalmianum), and both (Potentilla fruticosa). Prairie occupying former lakeshore accounts for interdunal wetland species, but an explanation is not as simple for fen species. Four upland prairie species further differentiate lakeplain prairie.

Davis' wet-mesic segment is undoubtedly Lakeplain Wet Prairie (Table 3), and the high number of Mesic Sand indicators substantiates wet-mesic conditions. Like Ohio "dry meadows", the "wet meadows" are weighted equally toward two Michigan prairie types. A simple explanation is that lowland prairie in the Ohio oak openings is intermediate between the lakeplain and typical wet prairie. The presence of four Mesic Sand Prairie indicators tips the scales slightly toward the lakeplain variety, however.

Wet Prairie

Wet Prairie is a homogeneous and distinctive vegetation type as shown by a large number of high presence species and indicators. Mean similarity index is also high (42.7, range 33.8-52.9). The average number of species per stand is lower than expected (Table 4). Saturated soil conditions in finer-textured soils may lower diversity. Curtis (1959) noticed a sharp decline in species density and total species encountered from wet-mesic to wet prairie; this is the least diverse true prairie type in Illinois (White & Madany 1981). Wisconsin wet prairie differs in a lower pH (6.2) and higher wrc (165%), the latter due to more sites on muck. A higher

Michigan pH may be caused by more alkaline groundwater. Some Wet Prairie in Michigan occurs on mollisols, but these formed under wet conditions and normally support floodplain forest (e.g. Sloan loam).

Despite a short list, among Gleason's fen species are five Wet Prairie indicators and three from the other wet type. Wet Prairie is the lowland prairie of the Prairie Peninsula in Michigan. It bestows a particular floristic component to Michigan fen vegetation and gives fen most of its prairie flavor, leading to a proposed connection between fen and prairie. Many from the list of high presence species are involved (Appendix B), but indicators which best establish the relationship include Apios americana?, Helianthus giganteus?, Oxypolis rigidior, Thelypteris palustris, Angelica atropurpurea, Aster simplex, Bromus ciliatus, Eupatorium maculatum?, Hypoxis hirsuta, Smilacina stellata, Galium boreale, and Thalictrum dasycarpum.

The general land surveys of southern Lower Michigan prompt the opinion that wet prairie abounded, occupied every depression in the outwash plains, fringed every stream and lake, and extended farther north than upland prairie. Some "wet prairies" may have been sedge meadow. Whether sedge meadow or prairie, the low meadows of the region provided hay for the early settler and pasture for cattle and pigs. Today one finds fairly shrub-free meadows that display a peculiar aspect to one familiar with undisturbed wet prairie. Species are missing and the dominants are strange. One explanation for these less-than-prairie wetlands is that long years of mowing kept the meadows (despite watertable changes and fire suppression

after settlement) in a grassy or sedgy state, but selectively removed species, depending on the timing and frequency of mowing. Intact wetlands that were wet prairies may be common, since most were small and not worth the effort of draining, but they suffered change all the same, and natural sites may be as rare as any prairie.

Similarities and Developmental Relationships between Types

Similarity indexes between the grassland types show certain patterns that are, in part, interpretable in terms of developmental trends (Table 5). The lowest values arise when each upland type is paired with each lowland. The highest values are between the lowland pairs, between the mesic pairs, and among certain upland types. The mesic types compared to the lowland are intermediate between the high and low values of the table. For the sake of a model, the mesic types are centered between converging hydrarch and xerarch developmental sequences.

The Wet Prairie and Lakeplain Wet Prairie types are most similar to Mesic Prairie and Mesic Sand Prairie, respectively, which establishes parallel pathways from wet to mesic (Figure 7). At Saginaw Bay, Mesic Sand Prairie could not derive from historical loam wet prairie, so wet-mesic prairie is the terminus of the sequence. Mesic prairie on loam is unlikely anyway because many mesic species are missing from the region and, more importantly, because regional climate strongly favors development of forest on mesic loam. Mesic Sand Prairie probably formed in dune communities

Table 5

Similarity between grassland types. Similarity index is Sorenson's SI, in percent; average species number of type is in parentheses.

	Grassland Type					
Grassland Type	WET (64)	LKPLAIN WET (59)	MESIC (81)	MESIC SAND (59)	WOOD-LAND (41)	HILL-SIDE (41)
DRY SAND (76)	14.2	14.7	45.6	38.2	50.8	42.7
HILLSIDE	11.4	14.0	44.3	36.0	48.8	
WOODLAND	21.0	22.0	54.1	52.0		
MESIC SAND	27.6	28.8	50.0			
MESIC	33.1	25.7				
LAKEPLAIN WET	45.5					

that were augmented by wet-mesic prairie and species of dry sites, such as oak-pine forest. This senario was played out on the lakeplain farther south, but since no loam soils underlaid the lowland prairies there, the jump from wet-mesic to mesic sand prairie is theoretically possible. A sequence from wet to mesic conditions on sand is hypothesized for the interior of Michigan, where pH is acid rather than alkaline, but little data substantiates it. Vegetation of such prairies differs from the analog on the lakeplain. Illinois wet-mesic sand prairie species (Osmunda regalis, Rhexia virginica, Xyris torta, Viola lanceolata) suggest coastal plain marsh in Michigan (White & Madany 1981).

The xerarch sequence presents difficulties since savannas and prairies need accommodation. The greatest similarity indexes are

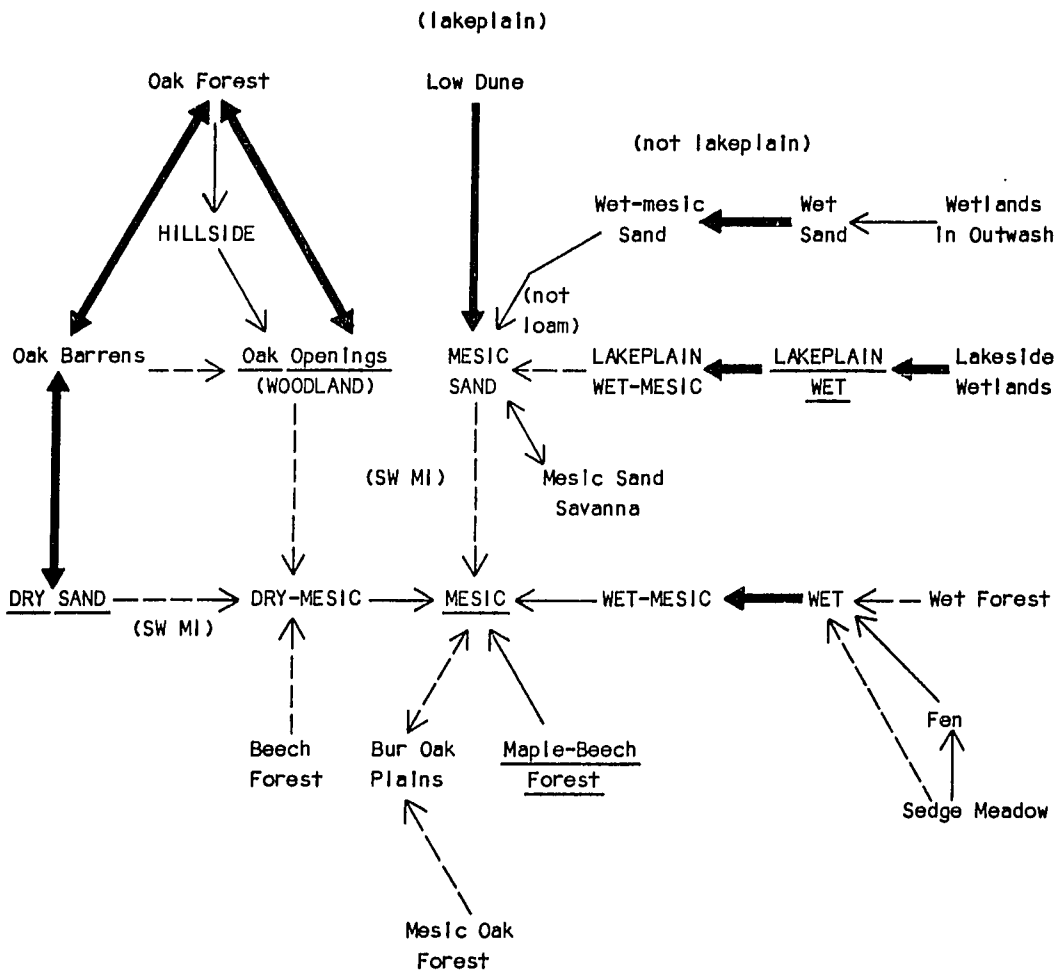


Figure 7. Developmental relationships between grassland associations in Michigan. A heavy line indicates a very likely sequence, a solid line a likely sequence, and a dashed line a possible sequence. Underlined grassland types are long-lived associations (under correct conditions) somewhere in their range.

between all upland types and Woodland Prairie. In such a light, it becomes a "universal donor" by which all upland types are influenced and through which they are related. Hillside is most closely related to Woodland Prairie and, with increased shading or reduction of slope due to erosion, would be expected to become oak savanna (if such species are in the vicinity). Dry Sand Prairie also is most similar to Woodland, but encompasses sites of open sand prairie and oak barrens remnants, necessitating a split in the developmental sequence. Fire frequency tilted a site toward prairie or barrens, but once in place Dry Sand Prairie probably was stable for edaphic and biological reasons. In Newaygo County it topped the developmental sequence, but farther south, in more favorable climate, dry-mesic prairie may have developed (rather than lost out to trees) when conditions headed toward mesophytism due to accumulated organic material and perhaps erosion.

Mesic Sand Prairie most closely resembles Woodland Prairie, but a move from mesic to dry-mesic conditions, or the reverse through a sudden rise in water table, is hard to imagine. It must be remembered that oak openings (i.e., Woodland Prairie) in Michigan's interior were principally dry-mesic, while the ridges and perhaps larger sand plains supporting oak savanna on the lakeplain (i.e., Mesic Sand Prairie) were principally mesic. Although unrelated developmentally, Mesic Sand Prairie may be like Woodland Prairie in representing former savanna. In southwest Lower Michigan, Mesic Sand Prairie could become Mesic Prairie but even this demands a quantum leap of faith, and a move to savanna is easier to picture.

Dry-mesic Prairie is proposed as intermediate in southwest Lower Michigan between either Dry Sand Prairie or Oak Openings, and Mesic Prairie, the former step more likely and resulting from accumulated organic material and erosion. Blacksoil Dry Prairie was not possible in Michigan because of an unfavorable climate.

The hydrarch sequence for Wet Prairie begins either with fen (Kron 1982) or sedge meadow, though meadow probably preceeds fen (Sytsma & Pippen 1982a). Lakeplain Wet Prairie follows lakeshore wetlands, but in Michigan's interior, wetlands on outwash may serve as the starting point for a sequence on sand, as discussed above.

The xerarch succession begins with oak forest, from which, depending on the forest type, all but Mesic Prairie are derived. Mesic Prairie and blacksoil Dry-mesic Prairie may have arisen by catastrophic destruction of non-oak forest (Curtis 1959). True prairie in Michigan may have succeeded a meadow community that first occupied the level outwash plains of southwest Lower Michigan during the pine maximum, or earlier after deglaciation 18,000 years before present (as suggested for dry sand prairies). Primary succession by a long-lived edaphic grassland climax after deglaciation is postulated for the Maxton Plains on Drummond Island (Stephenson 1983). In either case, the meadows would have persisted due to site factors, since the pollen record indicates the region has been forested since the last glaciation. The closely-related bur oak plains may be derived from maple-beech forest or, more likely, a mesic type of oak forest in which bur oak played a prominent role.

CHAPTER IV

CONCLUSIONS

Usefulness of the Study

The grassland types defined in this study describe the present grassland vegetation of Michigan by accommodating the range of vegetation, soil characteristics, physical settings, and geographical locations represented by prairie remnants. But they only serve to describe presettlement grassland associations as a meter stick marked only in decimeters serves to measure length. Too much of the fabric has been gone for too long to be sure of the whole pattern.

This study will be useful for certain applications. Grassland protection in Michigan should be helped by this effort. With the grassland types defined, the total array of botanical diversity found in Michigan grassland can be preserved by strategic selection of types and sites. In a more academic application, Michigan grassland can be compared to the grasslands of other states for similarities and differences. Based on the information gathered here, Transeau's map of the Prairie Peninsula needs revision in Michigan. A more accurate map of the Peninsula's borders will help focus questions regarding its cause and nature--still a matter of lively debate. Most importantly, this effort may increase the

enjoyment of people interested in native Michigan grassland by adding to their understanding of it.

The Nature of Native Michigan Grassland

This discussion pertains to upland grassland. Brief mention will be made of lowland grassland later. Grassland in Michigan goes hand in hand with oak associations. The two ought to be considered components of the same vegetational assemblage--the oak-grassland region. From surveyor's records, historical accounts, and the present distribution of grassland relicts in Michigan, nearly half of southern Lower Michigan belongs to the oak-grassland region (Braun's oak-hickory region), extending southwest into Indiana and Illinois. The rest of southern Lower Michigan belongs to the maple-beech region of Braun (1950). The oak-grassland region might be considered equivalent to the Prairie Peninsula except that true prairie was found in only a limited area--three or four counties in far southwest Lower Michigan. The remainder of the oak-grassland region is actually transitional from the Prairie Peninsula to the Deciduous Forest Biome. Recognizing the transitional nature of Michigan grassland promotes better theoretical understanding of it and its relationship to grassland elsewhere in Eastern North America.

While oak forest may be a site climax in southern Lower Michigan, as determined by subsoil deposits, oak savanna and native grassland are postclimax communities, dependent on fire for persistence. The prevailing view among phytogeographers is that climate sets the approximate boundary of the Prairie Peninsula, a

view held earlier by plant ecologists like Weaver, Transeau, and Curtis. The contact point between grass and tree, however, was on uncertain ground, covered by grasses at one time and trees at another. The deciding factor was fire, but other factors determined the frequency of fires and hence the vegetation. Local conditions, such as topography and natural fire breaks, are widely acknowledged as significant determinants of vegetation in regions where fire is an environmental variable. More recently, the notion of "grassland as a self-fulfilling prophecy" has excited some; that is, grassland has evolved into an excellent fuel type--fine and dense--in order to burn well to the disadvantage of forest. But as determinants of the local prairie-forest border, this and other biological factors (e.g. dense shading at ground level, impenetrability of sod) take a back seat to fire frequency. The oak-grassland region of southern Lower Michigan, while highly dynamic locally, was probably stable overall so long as climate didn't change (or Europeans arrive). Under the correct burning regime, prairie and savanna would have been permanent features of southern Lower Michigan, but changes in the number and distribution of Indians could have changed the regime.

The vegetational composition of native Michigan grassland and savanna is a consequence of complexly interrelating factors. The most important of these factors are the following:

1. Edaphic. The farther away from the Prairie Peninsula--and from its drought-prone climate--the drier a site must be to support open grassland and prairie savanna. Vegetational patterns supporting this principle are discussed under Woodland Prairie

above. Of course, there comes a point when sedges and cool-season grasses, not prairie grasses, dominate--these should not be considered prairie (especially because so many prairie species are missing). Other factors must have kept mesic prairie treeless, but they are too complex to discuss, expecially without any large mesic prairies for reference. Site and biological factors may differ from drier prairies. Prairies underlaid by true prairie soil tended to be the largest of Michigan's prairies, and this trend in conjunction with fire also may be involved in their continuous treelessness.

2. Phytogeographic. The farther from the Prairie Peninsula, the fewer are the characteristic prairie species available. This reflects the extent of the second Xerothermic invasion by prairie into Michigan. When the climate swung the other way, further migration was complicated by discontinuities in native grassland and savanna. The several prairie species restricted to southwest Michigan reinforce this idea.

3. Temporal. Some prairie was continuously under grass for many years--true prairie with mollisols--while other prairie was in rotation, vegetated by forest, then grass, then forest, etc. Or at least microsites in a savanna were occupied by "forest" during the life of a single tree, then by grass when that tree died, and so forth. The duration of occupancy by grass affected species composition in that certain prairie species maybe were restricted to true prairie. Viola pedatifida is the best instance of this. Some of the two dozen or so prairie plants growing just south of Michigan in Indiana (sometimes coming into our state via railroads) or

extirpated from Michigan perhaps were so affected, but certain of them may not be here for phytogeographical reasons. On the other side of the coin, certain plants occur in Michigan grassland because of the surrounding forest. Repeated invasion of prairie edges by forest herbs, and persistence of forest herbs beneath trees--even a single tree--are possible. Savanna demands of its component species not only a tolerance for increased shade but also for greater mesophytism. More mesic conditions result from lessened evaporation, in turn caused by higher relative humidity under greater shading. Fire moderates forest conditions in savanna not only by decreasing shade, but also by increasing xerophytism. Several species (e.g. Swertia caroliniensis, Stipa avenacea, Cacalia atriplicifolia, Helianthus divaricatus) may be ecotonal in tolerance, requiring light intensities and evaporation rates intermediate between grassland and forest.

4. Anthropopyric. Native Michigan grassland and savanna burned. The amount of brush and number and density of trees--and indirectly species composition--probably related to the frequency of fire. Annual fires did not generate stable savanna (Irving & Aksamit 1982) but rather pushed a site toward open--though brushy--grassland (Whitford 1976). Dynamic stability resulted when attrition of trees equalled recruitment into the canopy, a state fostered by frequent, though not yearly, fires. Fire frequency at a site depended on the type and volume of fuel (e.g. more grass on more open sites), topography (chances for wide-ranging fire increasing as the terrain becomes more level), natural firebreaks,

and the numbers and concentrations of American Indians. It is unlikely that lightning caused many fires in southern Lower Michigan since lightning storms nearly always are accompanied by rain, and the light fuel of grassland wets quickly. Indians logically bore the flame that burned savanna and grassland in Michigan, but their efforts were spontaneous and uncoordinated. Given the unlikelihood that Indians set fire yearly to all the savanna and grassland they perceived needed it, levelness of terrain, among the other factors, assumes great importance

The preceeding discussion applies somewhat to lowland grassland, but other considerations are that lowland grassland received an important complement of species from a plant migration out of the southeast and east, and that saturated soil conditions promote treelessness as much as does fire. The geographic variable linking the lowland prairies substantiates the first consideration. The wet-mesic segment of lowland prairie may have depended on fire: today wet-mesic edges are invaded by shrubs before adjacent wet prairies. But historical accounts show that after lakeplain wet prairies were drained, trees sprang up everywhere--the wet prairies may not have needed fire. In addition to this, the floristic separation between wet and wet-mesic is greater than between wet-mesic and mesic. Wet prairie may be in class by itself--more strongly influenced by an eastern flora and less dependent on fire (similar in these regards to dry sand prairie at the other end of the spectrum).

The Future of Native Michigan Grassland

At the edge of North American tallgrass prairie, strongly influenced by forest, native Michigan grassland is worth preserving as a piece of the larger puzzle. The plant species themselves have a right to stay in Michigan...without resorting to a discussion of their potential usefulness to humans. Animals that depend on native grassland have not been mentioned here, but there are some and the loss of native grassland means the loss of them from Michigan. There is a beauty about native grassland missing from old fields and ordinary meadows; it is enhanced by the historical implications of prairie--the settlers' dependence on grassland and savanna and the way this vegetation predetermined the pattern of European settlement. Native grassland is unequalled as a botanical laboratory. Diversity in grassland generally exceeds that of any other native habitat in species numbers and their concentration in small areas.

Conservation of Michigan grassland is underway. About 20 sites with minimally disturbed grassland either are owned by private conservation organizations or formally protected on public land. But the range of types is limited: no unplowed dry sand prairie is protected, only two mesic prairies are set aside, no wet-mesic prairie is preserved, no eastern wet or wet-mesic prairies are formally protected, though they exist on state land...and other gaps could be cited. The management of native grassland is as critical as its protection. Degraded remnants (and most are) demand active

management, mostly involving brush cutting and prescribed burning. Such intensive efforts by The Nature Conservancy restored four prairies, but no other comprehensive, long-term program of prairie restoration has been tried in Michigan.

Many good remnants are on public land, but tight money in the late 1970s and 1980s staunched fledgling attempts by Michigan's public agencies to restore and maintain natural habitat. Education of field personnel and free rein from administrators could turn things around; it could happen that public lands would support the largest, least disturbed examples of certain native grassland types if field personnel believed restoration and maintenance of natural habitat was their mandate. The economic revitalization of railroads (once the richest refuge of upland grassland in Michigan) finished many tracts of prairie in the 1970s. Track improvements continue, and the disappearance, or at least severe disturbance, of railroad relicts is a yearly event. Conservation opportunities along railroads are limited now--the effort needed to survey lines, select, protect, and manage remnants perhaps not worth the returns--unless the railroads themselves be required to take responsibility for threatened prairie species in their rights-of-way.

Conservation of native grassland in Michigan, like habitat conservation anywhere, should proceed along several fronts. Efforts are hampered because prairie is not as familiar in Michigan as "wetlands," sand dunes, and forests. Education is needed, but targeted education--government agencies, railroads--will produce more immediate results than general education. Dedication of public

land and management for native grassland depends on the effectiveness of such education. Beyond education and public lands, limited conservation resources must be directed at the best sites representing the total grassland diversity. Acquisition is one, but not the only, way to preserve. A conservation easement would protect and ensure management of Middle Channel Prairie, for instance. A non-binding agreement between a conservation organization and an individual or company would permit management and prevent destruction of grasslands like Middleville Cemetery, Shanghai Terrace and Slough, Harwood Lake, and New Hope. A lease containing management rights over four Amtrak prairies was obtained by The Nature Conservancy for nomimal cost. Conrail and Grand Trunk railroad relicts could be protected in the same way, although for assured success railroads must assume responsibility for both rare plants and their habitat. Conservation planning, to which this short discussion is but a prelude, can insure that native grassland will not disappear from Michigan, at least not in this generation.

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APPENDIX A

Summaries of Grassland Types

DRY SAND PRAIRIE

Physiography/Surficial Geology: Originally occupied generally level sites (slopes 0-5 degrees), but remnants are more often on slopes (up to 25 degrees) that escaped farming. Principally on sandy glacial outwash plains, but also sandy glacial lakebeds and sand deposits (usually hilly) in ice contact outwash and coarse-textured end and ground moraines.

Soil: Loamy sand (very rarely sandy loam); pH 5.1 (4.6-5.7); wrc 38% (28-48%). Soil series are ?Coloma loamy sand, Oakville fine sand, Plainfield sand (3), Sparta sand, Spinks loamy sand (3); area soils are Chelsea loamy fine sand, Coloma loamy fine sand (5), Oakville fine sand, Plainfield sand (3), Rubicon sand, Rousseau loamy fine sand, Oshtemo sandy loam (6), Fox sandy loam, Spinks sandy loam (2), Kalamazoo loam (3).

Vegetational Structure: Average vegetation low to, less frequently, medium-height (if Carex dominates, vegetation is low); vegetation sparse, bare ground evident. Dominants are Andropogon scoparius, Carex pensylvanica, Andropogon gerardii; Carex pensylvanica subdominant to Andropogon spp. in unplowed prairies. Lichens 1, sedges/rushes 2, grasses 9, forbs 55, shrubs/vines 5, trees 4.

Indicators:

Good: Artemisia caudata, Cyperus filiculmis*, Liatris aspera*, Lupinus perennis*

Fair: Ambrosia artemisiifolia*, A. psilostachya, Arabis glabra, A. lyrata, Aristida purpurascens*, Asclepias amplexicaulis*, A. verticillata, Blephilia ciliata, Cladonia, Gnaphalium obtusifolium, Hieraceum gronovii(*), Krigia virginica, Liatris cylindracea(*), Linaria canadensis, Lithospermum caroliniensis*, Monarda punctata(*), Oenothera rhombipetala, Panicum commonsianum, P. depauperatum*, Polygala polygama(*), Polygonatum biflorum*, P. pubescens, Prunus virginiana*, Senecio plattensis(*), Specularia perfoliata, Tephrosia virginiana(*)

Low presence: Polytrichum piliferum, Rhus copallina, Stipa avenacea, Trichostema dichotomum

* Less reliable indicator
(3) Number of sites associated with this soil series

HILLSIDE PRAIRIE

Physiography/Surficial Geology: Occupies hillsides and crests of hills (maximum slopes 25-45 degrees), generally facing south to west, but northwest and northeast slopes are known. Located always in outwash (mostly glacial, rarely ice contact), either as outwash plain or glacial drainageway (both occasionally near ice contact outwash). Sites overlook kettlehole lakes, streams, or broad river valleys.

Soil: Loamy sand and sandy loam; pH 5.5 (4.5-7.8); wrc 51% (30-85%). Soil series are Oakville loamy fine sand, Plainfield loamy sand, Seward loamy fine sand, Spinks loamy sand (2), Fox sandy loam, Oshtemo sandy loam (2); area soils are Boyer loamy sand, Coloma loamy sand, Plainfield loamy sand, Spinks loamy sand (3), Coloma sandy loam, Fox sandy loam, Oshtemo sandy loam (3), Wasepi sandy loam, Blount loam, Fox loam, Isabella loam, Kalamazoo loam (2), Kent silt loam.

Vegetational Structure: Average vegetation low to medium-height, depending partly on degree of shading; vegetation sparse to moderately dense; bare ground locally due to erosion. Dominants are Andropogon scoparius, Stipa spartea, Andropogon gerardii, Poa compressa; the first two dominate at more open sites, the latter two at shadier ones; dominance by Poa may indicate past heavy grazing or other disturbance. Ferns 1, sedges/rushes 1, grasses 4, forbs 21, shrubs/vines 5, trees 9.

Indicators:

Good: Vitis aestivalis

Fair: Besseya bullii, Campanula rotundifolia, Carya glabra*, Cornus florida, Pinus strobus, Populus grandidentata, Stipa spartea

Low presence: Amelanchier arborea, Bouteloua curtipendula, Hepatica americana, Houstonia longifolia, Phlox bifida, P. subulata

Fair in upland only: Quercus borealis

Modal: Comandra richardsiana, Penstemon hirsutus, Quercus alba

WOODLAND PRAIRIE

Physiography/Surficial Geology: Originally chiefly on level sites (0-5 deg.), but remnants are also on slopes (up to 15, rarely to 30 deg.) because of unsuitability for farming. Either directly on glacial outwash (outwash plains, or near coarse-textured end moraines and till as well as ice contact outwash), or, less commonly, on coarse-textured end moraines (rarely till) within glacial (and rarely ice contact) outwash.

Soil: Sandy loam (occasionally loamy sand, rarely loam); pH 5.8 (5.2-6.7); wrc 54% (43-94%). Soil series are Coloma loamy fine sand, Plainfield sand, Spinks loamy fine sand, Bellafontain sandy loam, Boyer sandy loam, Bronson sandy loam, Martinsville fine sandy loam, Oshtemo sandy loam (3), Plainfield sandy loam (3), Wasepi sandy loam, Sebewa loam; area soils are Coloma loamy fine sand, Plainfield sand, Oshtemo loamy sand, Spinks loamy sand, Spinks-Boyer loamy sand (2), Fox sandy loam (4), Bellafontain sandy loam (2), Oshtemo sandy loam (6), Plainfield sandy loam (3), Riddles sandy loam, Spinks sandy loam, Wasepi sandy loam, Ockley loam (2), Riddles loam (2), Sebewa loam, Houghton muck.

Vegetational Structure: Average vegetation low to medium-height, sometimes high; vegetation moderately dense to dense, little bare ground. Dominants are Andropogon gerardii, A. scoparius--alone, together, or one subdominant to the other; Sorghastrum nutans alone or with A. scoparius; Poa pratensis, various forbs (dominance by Poa and forbs may indicate a secondary site). Sedges/rushes 1, grasses 4, forbs 29, shrubs/vines 5, trees 2.

Indicators:

Good: None

Fair: Aster pilosus

Modal: Amorpha canescens*, Anemone cylindrica, Asclepias tuberosa, Aster laevis, Erigeron strigosus

MESIC SAND PRAIRIE

Physiography/Surficial Geology: Sites always nearly level. Surficial geology variable and includes: glacial outwash (in outwash plain, glacial drainageway), sandy glacial lakeplain, dune sand in silty/clayey glacial lakeplain, and rarely coarse-textured glacial till within glacial and ice contact outwash. In all cases a seasonally high water table creates conditions moister than is typical for sandy upland sites.

Soil: Sandy loam, rarely loamy sand; pH 5.5 (5.9) (5.4-5.9 [7.3]); wrc 43% (31-62%). Soil series are (in SW Lower Michigan) Brems sandy loam, Bronson sandy loam, (in SE Lower Michigan) ?Cohoctah sandy loam, Gilford sandy loam (3/4?), Wainola loamy fine sand; area soils are (in SW Lower Michigan) Plainfield loamy sand, Spinks loamy sand (2), Brady sandy loam, Oshtemo sandy loam (2), (in SE Lower Michigan) Deford fine sand, Granby loamy fine sand (2), Oakville fine sand, Tedrow loamy sand (2), Thetford loamy sand, Spinks-Boyer loamy sand, Wainola fine sand, Wasepi sandy loam.

Vegetational Structure: Average vegetation low to medium-height; vegetation sparse to moderately dense; bare ground evident. Dominant is Andropogon scoparius; Carex spp. can codominate; A. gerardii, Agrostis gigantea, Poa compressa subdominants; Agrostis and Poa may indicate a secondary site. Ferns 3, sedges/rushes 4, grasses 6, forbs 38, shrubs/vines 4, trees 5.

Indicators:

Good: None

Fair: Agrostis hyemalis*, Aster ericoides*, Baptisia tinctoria, Juncus tenuis, Krigia biflora*, Lechea villosa, Lobelia spicata(*), Polygala sanguinea, Spiraea alba

Low presence: Polytrichum juniperinum, Solidago rugosa

Good in upland only: Populus tremuloides(*), Pycnanthemum virginianum

Fair in upland only: Acer rubrum, Aletris farinosa, Equisetum arvense, Liatris spicata, Quercus palustris, Scleria triglomerata, Viola sagittata

MESIC PRAIRIE

Physiography/Surficial Geology: Sites nearly level to slightly undulating. Located nearly exclusively on glacial outwash plains.

Soil: Loam, sandy loam (sometimes silt loam); pH 6.2 (4.9-7.5); wrc 64% (37-106%); [Ranges from soil survey: pH 5.6(5.1)-7.3; wrc 38-90%]. Old soil series are Marshall loam (Cass Co.), Warsaw loam (Barry, Branch, Eaton, Kalamazoo, Van Buren Co.), Warsaw silt loam (Berrien, Kalamazoo Co.), Waukesha sandy loam (St. Joseph Co.), Waukesha loam (Calhoun Co.); modern soil series are Elston and Nottawa sandy loam (St. Joseph Co.), Schoolcraft loam and silt loam (?Calhoun, Kalamazoo, St. Joseph Co.), ?Coupee silt loam (Berrien Co.), ?Dowagiac loam (Cass Co.); area soils are (modern) Kalamazoo loam, Dowagiac loam, Oshtemo sandy loam, Spinks loamy sand, (old) Miami sand, Miami sandy loam, Miami loam, Marshall loam.

Vegetational Structure: Average vegetation medium-height to high; vegetation moderately dense to dense; very little bare ground. Dominant is Andropogon gerardii; A. scoparius is subdominant; Spartina pectinata occasional subdominant. Ferns 2, sedges/rushes 2, grasses 6, forbs 56, shrubs/vines 9, trees 5.

Indicators:

Good: Coreopsis palmata*, Geranium maculatum(*), Helianthus strumosus, Rhus glabra(*), Taenidia integerrima*, Verbena stricta(*)

Fair: Cacalia atriplicifolia*, Carex bicknellii, Gentiana flavida, Kuhnia eupatorioides(*), Quercus macrocarpa*, Swertia caroliniensis, Vicia americana, Viola sororia

Low presence: Viola pedatifida

Good in upland only: Dioscorea villosa, Poa pratensis*, Thalictrum dasycarpum*, Zizia aurea

Fair in upland only: Erigeron annuus*, Eryngium yuccifolium*, Rubus hispidus, Silphium integrifolium, S. terebinthinaceum*, Solidago altissima*, Spartina pectinata*

LAKEPLAIN WET PRAIRIE

Physiography/Surficial Geology: Sites always nearly level. Currently known from sandy, and less commonly silty/clayey, glacial lakeplains.

Soil: Sandy loam, less commonly loamy fine sand [also loam, but none in this study); pH 8.0 (7.7-8.2); wrc 60% (50-68%) [loam would be higher]. Soil series are Essexville loamy fine sand, Sanilac very fine sandy loam, (historically) Tappan, Thomas, and Wisner loam; regional soils are Sanilac and Bach very fine sandy loam, Tappan, Thomas, and Wisner loam.

Vegetational Structure: Average vegetation medium-height to high; vegetation moderately dense to dense; very little bare ground. Dominants are Calamagrostis canadensis, Carex spp. (aquatilis, lanuginosa), less often Andropogon gerardii, A. scoparius, Panicum virgatum; all these except Calamagrostis are also subdominant, but Sorghastrum nutans is most frequent subdominant (also Spartina pectinata); ferns 1, sedges/rushes 4, grasses 9, forbs 40, shrubs/vines 3, trees 2.

Indicators:

Good: Aster dumosus, Eleocharis elliptica, Erigeron philadelphicus*, Galium trifidum, Liatris spicata*, Lysimachia quadriflora, Populus deltoides, Prenanthes racemosa, Solidago ohioensis, Stachys tenuifolia, Vernonia missurica

Fair: Asclepias incarnata, A. sullivantii, Carex buxbaumii, Cirsium muticum, Fraxinus pensylvanica, Habenaria leucophaea, Lythrum alatum, Potentilla anserina, Rosa palustris, Scirpus validus

Good in lowland only: Andropogon scoparius, Aster ericoides, Panicum virgatum, Poa compressa, Solidago nemoralis

WET PRAIRIE

Physiography/Surficial Geology: Sites always nearly level. Located nearly exclusively on glacial outwash (rarely on coarse-textured glacial till), but usually near coarse-textured end moraine, till, or ice contact outwash (rarely near fine and medium textured glacial end moraine). Sites occur along streams and rivers in drainageways, but also along streams that pass through filled kettleholes; sites also occur at the margins of kettlehole lakes and less commonly in outwash depressions.

Soil: Loam, less commonly sandy loam (rarely silt loam; some soils peatlike); pH 6.9 (5.5-7.7); wrc 100% (50-68%). Soil series are Bronson sandy loam, Gilford fine sandy loam, ?Barry loam, Sebewa loam (3), loam (transitional between Fox sandy loam and Rifle peat--old soil survey), Colwood silt loam; area soils are Plainfield loamy sand, Spinks loamy sand, Spinks-Boyer loamy sand, Fox sandy loam, Hillsdale sandy loam (3), Ockley sandy loam, Oshtemo sandy loam, Riddles sandy loam (4), Teasdale fine sandy loam, Wasepi sandy loam, Brady loam, Kalamazoo loam, Schoolcraft loam, mucks

Vegetational Structure: Average vegetation medium-height to high; vegetation moderately dense to dense; very little bare ground. Dominants are Spartina pectinata, Calamagrostis canadensis, Carex spp. (bebbii, stricta); all these are subdominant, Calamagrostis most frequently; also subdominant are Sorghastrum nutans, rarely Andropogon gerardii and A. scoparius, and forbs (Pycnanthemum virginianum, Solidago altissima, Vernonia missurica, etc.); ferns 3, sedges/rushes 2, grasses 8, forbs 44, shrubs/vines 4, trees 2.

Indicators:

Good: Apios americana, Helianthus giganteus*, Oxypolis rigidior, Saxifraga pensylvanica, Thelypteris palustris
Fair: Amphicarpa bracteata, Angelica atropurpurea, Aster simplex, Bromus ciliatus, Carex bebbii, Eupatorium maculatum*, Hypoxis hirsuta, Lysimachia ciliata, Muhlenbergia mexicana, Onoclea sensibilis*, Phalaris arundinacea, Salix interior, Smilacina stellata, Solidago gigantea, S. riddellii
Good in lowland only: Anemone virginiana, Galium boreale, Ratibida pinnata, Thalictrum dasycarpum

APPENDIX B

Prevalent Species of Grassland Types

DRY SAND PRAIRIE

Stands used in analysis: Bowerman Cemetery, Newaygo, Allegan, Texas Corners, 42nd St. & B Ave., Lawton Amtrack Upland
Species number per stand: 77
Total species encountered: 182
Species of high constancy: 76
Degree of high constancy: 41.8%

Species	Presence	Species	Presence
Andropogon scoparius	100.0%	Monarda fistulosa	66.7%
Carex pensylvanica		Monarda punctata	
Ceanothus americanus		Poa compressa	
Cyperus filiculmis		Polygala polygama	
Euphorbia corollata		Prunus serotina	
Fragaria virginiana		Sassafras albidum	
Hieraceum longipilum		Solidago speciosa	
Lactuca canadensis		Specularia perfoliata	
Quercus velutina		Ambrosia psilostachya	50.0%
Solidago nemoralis		Apocynum cannabinum	
Andropogon gerardii	83.3%	Arabis glabra	
Antennaria plantaginifolia		Arabis lyrata	
Artemisia caudata		Aristida purpurascens	
Asclepias tuberosa		Asclepias amplexicaulis	
Aster azureus		Blephilia ciliata	
Danthonia spicata		Cladonia spp.	
Helianthemum canadense		Coreopsis tripteris	
Liatris aspera		Desmodium marilandicum	
Lupinus perennis		Galium pilosum	
Panicum oligosanthes		Helianthus divaricatus	
Rubus flagellaris		Lespedeza hirta	
Rudbeckia hirta		Liatris cylindriacea	
Solidago juncea		Linaria canadensis	
Tradescantia ohiensis		Oenothera rhombipetala	
Ambrosia artemisiifolia	66.7%	Panicum commonsianum	
Anemone cylindrica		Panicum depauperatum	
Apocynum androsaemifolium		Penstemon hirsutus	
Asclepias syriaca		Phlox pilosa	
Asclepias verticillata		Polygonatum biflorum	
Comandra richardsiana		Polygonatum pubescens	
Erigeron strigosus		Prunus virginiana	
Gnaphalium obtusifolium		Quercus alba	
Helianthus occidentalis		Ranunculus fascicularis	
Hieraceum gronovii		Rosa carolina	
Juniperus virginiana		Senecio plattensis	
Krigia virginica		Sorghastrum nutans	
Lespedeza capitata		Tephrosia virginiana	
Lithospermum caroliniense		Viola pedata	

HILLSIDE PRAIRIE

Stands used in analysis: Long Lake, Plainfield Bluffs, Highland Cemetery, Klinger Lake, Thornapple Bluffs, Harwood Lake
Species number per stand: 49
Total species encountered: 148
Species of high presence: 41
Degree of high presence: 27.7%

Species	Presence	Species	Presence
Poa compressa	100.0%	Solidago nemoralis	66.7%
Quercus velutina		Stipa spartea	
Anemone cylindrica	83.3	Tradescantia ohiensis	
Comandra richardsiana		Asclepias tuberosa	50.0
Quercus alba		Aster azureus	
Vitis aestivalis		Besseya bullii	
Andropogon gerardii	66.7	Carex pensylvanica	
A. scoparius		Coreopsis tripteris	
Antennaria plantaginifolia		Cornus florida	
Campanula rotundifolia		Lespedeza capitata	
Carya glabra		L. hirta	
Ceanothus americanus		Monarda fistulosa	
Euphorbia corollata		Pinus strobus	
Galium boreale		Populus grandidentata	
Helianthus divaricatus		Prunus serotina	
Juniperus virginiana		Quercus borealis	
Penstemon hirsutus		Rhus typhina	
Phlox pilosa		Rosa carolina	
Pteridium aquilinum		Sassafras albidum	
Rudbeckia hirta		Viola pedata	
Smilacina racemosa			

WOODLAND PRAIRIE

Stands used in analysis:	Mattawan Fruit Belt, Teeple Lake, Lawton Amtrack Swale, Harmonia, Fairfax, Bertrand, Sturgis, XY Avenue, Briarcrest, Bakertown Amtrack Upland, Shanghai Ridge, Middleville Cemetery, VanKal
Species number per stand:	65
Total species encountered:	237
Species of high presence:	41
Degree of high presence:	16.8%

Species	Presence	Species	Presence
Asclepias tuberosa	100.0%	Ceanothus americanus	69.2%
Andropogon gerardii	92.3%	Helianthus occidentalis	
Anemone cylindrica		Quercus velutina	
Euphorbia corollata		Ratibida pinnata	
Andropogon scoparius	84.6%	Solidago juncea	
Aster laevis		Desmodium marilandicum	61.5%
Erigeron strigosus		Poa compressa	
Fragaria virginiana		Salix humilis	
Rudbeckia hirta		Solidago speciosa	
Solidago nemoralis		Asclepias syriaca	53.8%
Comandra richardsiana	76.9%	Carex pensylvanica	
Lactuca canadensis		Desmodium canadense	
Lespedeza capitata		D. illinoense	
Monarda fistulosa		Hieraceum longipilum	
Rosa carolina		Lithospermum canescens	
Rubus flagellaris		Potentilla simplex	
Tradescantia ohiensis		Prunus serotina	
Achillea millefolium	69.2%	Smilacina racemosa	
Antennaria plantaginifolia		Solidago rigida	
Aster azureus		Sorghastrum nutans	
A. pilosus			

MESIC SAND PRAIRIE

Stands used in analysis:	Parkville, Lawton Fruit Belt, Algonac, Petersburg, Shanghai Trough, Ojibway
Species number per stand:	79
Total species encountered:	241
Species of high presence:	59
Degree of high presence:	24.5%

Species	Presence	Species	Presence
Achillea millefolium	100.0%	Solidago juncea	66.7%
Andropogon scoparius		Solidago nemoralis	
Coreopsis tripteris		Sorghastrum nutans	
Fragaria virginiana		Spiraea alba	
Populus tremuloides		Viola sagittata	
Andropogon gerardii	83.3%	Acer rubrum	50.0%
Apocynum androsaemifolium		Agrostis hyemalis	
Asclepias tuberosa		Antennaria plantaginifolia	
Desmodium canadense		Aster azureus	
Lespedeza capitata		Aster ericoides	
Monarda fistulosa		Aster laevis	
Poa compressa		Baptisia tinctoria	
Polygala sanginea		Carex pensylvanica	
Prunus serotina		Comandra richardsiana	
Pycnanthemum virginianum		Helianthemum canadense	
Rudbeckia hirta		Heuchera hirsuticaulis	
Solidago graminifolia		Krigia biflora	
Aletris farinosa	66.7%	Lactuca canadensis	
Anemone cylindrica		Lechea villosa	
Corylus americana		Lobelia spicata	
Danthonia spicata		Luzula multiflora	
Equisetum arvense		Phlox pilosa	
Equisetum laevigatum		Prunella vulgaris	
Erigeron strigosus		Quercus palustris	
Euphorbia corollata		Quercus velutina	
Juncus tenuis		Rubus flagellaris	
Liatris spicata		Scleria triglomerata	
Potentilla simplex		Solidago rigida	
Pteridium aquilinum		Veronicastrum virginicum	
Salix humilis			

MESIC PRAIRIE

Stands used in analysis: Roy Road, Klumbis Road, Oshtemo Fruit Belt, Thompson Road
Species number per stand: 81
Total species encountered: 172
Species of high presence: 50 (81)
Degree of high presence: 29.1% (47.0%)

Species	Presence	Species	Presence
Andropogon gerardii	100.0%	Ratibida pinnata	75.0%
A. scoparius		Rhus glabra	
Ceanothus americanus		Rudbeckia hirta	
Coreopsis tripteris		Sassafras albidum	
Corylus americana		Smilacina racemosa	
Galium boreale		Solidago graminifolia	
Lactuca canadensis		Taenidia integerrima	
Prunus serotina		Verbena stricta	
Rosa carolina		Zizia aurea	
Salix humilis		Antennaria plantaginifolia	50.0%
Solidago rigida		Asclepias syriaca	
Sorghastrum nutans		Aster azureus	
Thalictrum dasycarpum		Cacalia atriplicifolia	
Tradescantia ohiensis		Carex bicknelli	
Veronicastrum virginicum		Desmodium illinoense	
Achillea millefolium	75.0%	Equisetum laevigatum	
Anemone cylindrica		Erigeron annuus	
Apocynum androsaemifolium		Erigeron strigosus	
Asclepias tuberosa		Eryngium yuccifolium	
Aster laevis		Galium pilosum	
Comandra richardsiana		Gentiana flavida	
Coreopsis palmata		Helianthemum canadense	
Cornus racemosa		Helianthus divaricatus	
Dioscorea villosa		Kuhnia eupatorioides	
Euphorbia corollata		Poa compressa	
Fragaria virginiana		Potentilla simplex	
Geranium maculatum		Pteridium aquilinum	
Helianthus occidentalis		Quercus alba	
H. strumosus		Q. macrocarpa	
Heuchera hirsuticaulis		Rhus typhina	
Lespedeza capitata		Rubus hispidus	
L. hirta		Silphium integrifolium	
Lithospermum canescens		S. terebinthinaceum	
Luzula multiflora		Solidago altissima	
Monarda fistulosa		S. nemoralis	
Panicum oligosanthes		S. speciosa	
Phlox pilosa		Spartina pectinata	
Poa pratensis		Swertia caroliniensis	
Quercus velutina		Vicia americana	
Ranunculus fascicularis		Viola sororia	

LAKEPLAIN WET PRAIRIE

Stands used in analysis:	St. John's, Middle Channel, Sebewaing Railroad, Sebewaing Bay, Squirrel Island
Species number per stand:	76
Total species encountered:	157
Species of high presence:	59
Degree of high presence:	37.6%

Species	Presence	Species	Presence
Andropogon gerardii	100.0%	Prenanthes racemosa	80.0%
Agrostis gigantea		Pycnanthemum virginianum	
Apocynum sibiricum		Solidago nemoralis	
Aster ericoides		Vernonia missurica	
Calamagrostis canadensis		Achillea millefolium	60.0%
Comandra richardsiana		Allium canadense	
Eleocharis elliptica		Anemone canadensis	
Fragaria virginiana		Asclepias incarnata	
Juncus balticus		A. sullivantii	
Liatris spicata		A. syriaca	
Lysimachia quadrifolia		Carex buxbaumii	
Panicum virgatum		Cicuta maculata	
Populus deltoides		Cirsium discolor	
Solidago altissima		C. muticum	
S. ohioensis		Cornus racemosa	
Sorghastrum nutans		Equisetum arvense	
Spartina pectinata		Fraxinus pensylvanica	
Stachys hispida		Gentiana andrewsii	
Andropogon scoparius	80.0%	Habenaria leucophaea	
Aster dumosus		Iris virginica	
A. novae-angliae		Lythrum alatum	
Convolvulus sepium		Poa pratensis	
Cornus stolonifera		Potentilla anserina	
Desmodium canadense		Rosa palustris	
Erigeron philadelphicus		Rudbeckia hirta	
Galium trifidum		Scirpus validus	
Lathyrus palustris		Solidago graminifolia	
Lycopus americanus		Veronicastrum virginicum	
Monarda fistulosa		Zizia aurea	
Poa compressa			

WET PRAIRIE

Stands used in analysis:	Arcadia, Parma, Ann Arbor, Concord Swale, Bakertown Amtrack Lowland, Barry
Species number per stand:	69
Total species encountered:	177
Species of high presence:	64
Degree of high presence:	36.1%

Species	Presence	Species	Presence
Apios americana	100.0%	Solidago riddellii	66.6%
Aster novae-angliae		Sorghastrum nutans	
Gentiana andrewsii		Zizia aurea	
Oxypolis rigidior		Amphicarpa bracteata	50.0%
Solidago graminifolia		Andropogon gerardii	
Thalictrum dasycarpum		Anemone canadensis	
Thelypteris palustris		Angelica atropurpurea	
Allium canadense	83.3%	Apocynum cannabinum	
Anemone virginiana		A. sibiricum	
Calamagrostis canadensis		Aster laevis	
Cicuta maculata		Bromus ciliatus	
Desmodium canadense		Carex stricta	
Fragaria virginiana		Comandra richardsiana	
Galium boreale		Convolvulus sepium	
Helianthus giganteus		Coreopsis tripteris	
Monarda fistulosa		Cornus stolonifera	
Pycnanthemum virginianum		Corylus americana	
Ratibida pinnata		Geranium maculatum	
Saxifraga pensylvanica		Hypoxis hirsuta	
Solidago altissima		Lathyrus palustris	
Spartina pectinata		Lycopus americanus	
Veronicastrum virginicum		Lysimachia ciliata	
Agrostis gigantea	66.6%	Muhlenbergia mexicana	
Apocynum androsaemifolium		Onoclea sensiblis	
Asclepias syriaca		Phalaris arundinacea	
Aster simplex		Populus tremuloides	
Carex bebbii		Quercus macrocarpa	
Cornus racemosa		Rudbeckia hirta	
Equisetum arvense		Salix interior	
Eupatorium maculatum		Smilacina stellata	
Iris virginica		Solidago gigantea	
Silphium terebinthinaceum		S. rigida	

APPENDIX C

Species of Upland and Lowland Prairie in Michigan

Upland stands used in analysis: Bowerman Cemetery, Allegan, Newaygo, Texas Corners, 42nd and B Avenue, Lawton Amtrak Upland, Lawler, Mattawan Fruit Belt, Fairfax, Harmonia, Lawton Amtrak Swale, Teeple Lake, Bakertown Amtrak Upland, Shanghai Ridge, Middleville Cemetery, VanKal, Pretty Lake, Highland Cemetery, Long Lake, Klinger Lake, Harwood Lake, Briarcrest, XY Avenue, Sturgis, Bertrand, Helmer Brook, Roy Road, Klumbis Road, Oshtemo Fruit Belt, Thompson Road, Parkville, Lawton Fruit Belt, Algonac, Petersburg, Shanghai Trough, Ojibway
Species number per upland stand: 67
Total species encountered in upland stands: 382

Lowland stands used in analysis: Ojibway, Park Road, Arcadia, Parma, Ann Arbor, Concord Swale, Bakertown Amtrak Lowland, Barry, St. John's, Middle Channel, Sebewaing Railroad, Sebewaing Bay, Squirrel Island
Species number per lowland stand: 73
Total species encountered in lowland stands: 269

Code	Species	Presence Upland	Presence Lowland	Code	Species	Presence Upland	Presence Lowland
ACE01	Acer rubrum	11.1%	15.4%	AND01	Andropogon gerardii	91.7%	76.9%
ACE02	A. saccharinum		*	AND02	A. scoparius	88.9	61.5
ACH01	Achillea millefolium	63.9	38.5	ANE01	Anemone canadensis	5.6	61.5
AGR01	Agrimonia gryposepala	2.8	15.4	ANE02	A. cylindrica	77.8	7.7
AGR02	A. parviflora	*	*	ANE03	A. quinquefolia	2.8	7.7
AGN02	Agropyron trachycaulum	5.6		ANE04	A. virginiana	19.4	53.8
AGS01	Agrostis gigantea	8.3	76.9	ANG01	Angelica atropurpurea		23.1
AGS02	A. hyemalis	22.2	15.4	ANG02	A. venenosa	*	
ALE01	Aletris farinosa	11.1	61.5	ANT01	Antennaria neglecta	*	
ALL01	Allium canadense	2.8		ANT02	A. plantaginifolia	69.4	
ALL02	A. cernuum	8.3		API01	Apios americana	16.7	61.5
AMB01	Ambrosia artemisiifolia	30.6		APO01	Apocynum androsaemifolium	52.8	46.2
AMB02	A. psilostachya	8.3		APO02	A. cannabinum	27.8	30.8
AME01	Amelanchier arborea	8.3		APO03	A. sibiricum	11.1	61.5
AMO01	Amorpha canescens	11.1	30.8	AQU01	Aquilegia canadensis	2.8	
AMP01	Amphicarpa bracteata	2.8					

Code	Species	Presence Upland	Lowland
ARA01	Arabis glabra	13.9%	
ARA02	A. lyrata	13.9	
ARC01	Arctostaphylos ura-ursi	5.6	
ARE01	Arenaria stricta	5.6	
ARI01	Aristida basiramea	*	
ARI02	A. purpurascens	27.8	
ART01	Artemisia caudata	22.2	
ASC01	Asclepias amplexicaulis	30.6	
ASC02	A. exaltata	2.8	
ASC03	A. hirtella	5.6	7.7%
ASC04	A. incarnata	2.8	46.2
ASC05	A. sullivantii	2.8	30.8
ASC06	A. syriaca	44.4	69.2
ASC07	A. tuberosa	88.9	15.4
ASC08	A. verticillata	22.2	
ASC09	A. viridiflora	22.2	7.7
AST01	Aster azureus	63.9	38.5
AST02	A. cordifolius	2.8	
AST03	Aster dumosus	5.6	38.5
AST04	A. ericoides	36.1	53.8
AST05	A. laevis	63.9	38.5
AST06	A. lucidulus		23.1
AST07	A. macrophyllus	5.3	
AST08	A. novae-angliae	8.3	92.3
AST09	A. pilosus	36.1	
AST10	A. ptarmicoides	2.8	
AST11	A. puniceus		23.1
AST12	A. sagittifolius	25.0	15.4
AST13	A. sericeus	8.3	
AST14	A. simplex		46.2
AST15	A. umbellatus	2.8	30.8
AUR01	Aureolaria flava	8.3	
BAP01	Baptisia leucantha	16.7	
BAP02	B. tinctoria	11.1	7.7

Code	Species	Presence Upland	Lowland
BES01	Besseya bullii	5.6%	
BET01	Betula pumila		7.7%
BID01	Bidens coronata		7.7
BLE01	Blephilia ciliata	13.9	
BOT01	Botrychium multifidum	8.3	
BOU01	Bouteloua curtipendula	8.3	
BRO01	Bromus ciliatus		23.1
BRO02	B. kalmii	13.9	
CAC01	Cacalia atriplicifolia	30.6	7.7
CAC02	C. plantaginea		*
CAL01	Calamagrostis canadensis	8.3	92.3
CLP01	Calopogon tuberosus	2.8	
CTH01	Caltha palustris		7.7
CAM01	Campanula aparinoides		30.8
CAM02	C. rotundifolia	19.4	
CAR01	Carex aquatilis		15.4
CAR02	C. bebbii	2.8	30.8
CAR03	C. bicknellii	22.2	
CAR04	C. brevior	2.8	
CAR05	C. buxbaumii		23.1
CAR06	C. crawei		7.7
CAR07	C. lanuginosa	2.8	23.1
CAR08	C. merritt-fernaldii	2.8	
CAR09	C. muhlenbergii	8.3	
CAR10	C. pensylvanica	55.6	
CAR11	C. sartwellii	2.8	
CAR12	C. scoparia	5.6	
CAR13	C. stipata	2.8	
CAR14	C. tetanica		7.7
CAY01	Carya glabra	27.8	
CAY02	C. ovalis	5.6	
CAS01	Castilleja coccinea	2.8	
CEA01	Ceanothus americanus	63.9	7.7
CEL01	Celastrus scandens	5.6	

Code	Species	Presence Upland	Lowland
CER01	Cerastium arvense	2.8%	
CIC01	Cicuta maculata	2.8	61.5%
CIR01	Cirsium discolor	19.4	38.5
CIR02	C. hillii	2.8	
CIR03	C. muticum		38.5
CLA01	Cladium mariscoides		7.7
CLD01	Cladonia spp.	13.9	
CLY01	Claytonia virginica	11.1	
CLE01	Clematis virginiana	2.8	
COM01	Comandra richardsiana	66.7	69.2
CON01	Convolvulus sepium	2.8	53.8
CON02	C. spithamaeus	11.1	
CNZ01	Conyza canadensis	22.2	
COR01	Coreopsis lanceolata	11.1	
COR02	C. palmata	19.4	
COR03	C. tripteris	66.7	38.5
CRN01	Cornus amomum		*
CRN02	C. florida	16.7	
CRN03	C. purpusi (and amomum)		15.4
CRN04	C. racemosa	25.0	69.2
CRN05	C. stolonifera	5.6	53.8
CRY01	Corylus americana	50.0	30.8
CRA01	Crataegus crus-galli		7.7
CRA02	C. mollis	2.8	
CYS01	Cyperus filiculmis	33.3	
CYS02	C. schweinitzii	2.8	
CYP01	Cypripedium calceolus		15.4
CYP02	C. candidum		7.7
DAN01	Danthonia spicata	38.9	
DES01	Desmodium canadense	47.2	84.6
DES02	D. ciliare	11.1	
DES03	D. dillenii	11.1	
DES04	D. glutinosum	8.3	
DES05	D. illinoense	30.6	
DES06	Desmodium marilandicum	38.9%	
DES07	D. nudiflorum	8.3	
DES08	D. paniculatum	5.6	7.7%
DES09	D. rotundifolium	8.3	
DES10	D. sessilifolium	11.1	
DIO01	Dioscorea villosa	13.9	15.4
DOD01	Dodecatheon meadia		7.7
ECH01	Echinocystis lobata		15.4
ELE01	Eleocharis elliptica	2.8	46.2
ELY01	Elymus canadensis	19.4	15.4
ELY02	E. virginicus		23.1
EPI01	Epilobium spp.		7.7
EQU01	Equisetum arvense	27.8	61.5
EQU02	E. hyemale	8.3	
EQU03	E. laevigatum	44.4	23.1
ERA01	Eragrostis spectabilis	13.9	
ERI01	Erigeron annuus	19.4	7.7
ERI02	E. philadelphicus	2.8	46.2
ERI03	E. strigosus	63.9	15.4
ERY01	Eryngium yuccifolium	16.7	15.4
EUP01	Eupatorium maculatum	2.8	53.8
EUP02	E. perfoliatum	5.6	30.8
EPH01	Euphorbia corollata	86.1	23.1
FRA01	Fragaria virginiana	77.8	92.3
FRX01	Fraxinus americana	2.8	7.7
FRX02	F. pensylvanica		23.1
GAL01	Galium aparine	8.3	
GAL02	G. asprellum		15.4
GAL03	G. boreale	36.1	53.8
GAL04	G. circaezans	5.6	
GAL05	G. lanceolatum	2.8	
GAL06	G. obtusum	2.8	7.7
GAL07	G. pilosum	19.4	
GAL08	G. trifidum	2.8	38.5

Code	Species	Presence Upland	Presence Lowland
GAU01	Gaultheria procumbens	5.6%	
GAY01	Gaylussacia baccata	8.3	
GEN01	Gentiana andrewsii	8.3	76.9%
GEN02	G. flavida	8.3	
GEN03	G. procera	2.8	30.8
GER01	Geranium maculatum	16.7	30.8
GED01	Gerardia purpurea	2.8	23.1
GEU01	Geum triflorum	2.8	
GLY01	Glyceria striata		23.1
GNA01	Gnaphalium obtusifolium	22.2	
HAB01	Habenaria flava	2.8	
HAB02	H. lacera		7.7
HAB03	H. leucophaea		23.1
HAM01	Hamamelis virginiana	*	
HLN01	Helenium autumnale	2.8	30.8
HLM01	Helianthemum canadense	33.3	7.7
HEL01	Helianthus divaricatus	44.4	15.4
HEL02	H. giganteus	5.6	61.5
HEL03	H. grosseserratus		15.1
HEL04	H. hirsutus	5.6	
HEL05	H. mollis	2.8	
HEL06	H. occidentalis	55.6	7.7
HEL07	H. strumosus	13.9	7.7
HEL08	H. tuberosus	2.8	7.7
HPS01	Heliopsis helianthoides	2.8	15.4
HEP01	Hepatica americana	5.6	
HEU01	Heuchera hirsuticaulis	36.1	23.1
HIE01	Hieraceum gronovii	22.6	
HIE02	H. longipilum	44.4	
HCL01	Hierochloe odorata	5.6	30.8
HOU01	Houstonia longifolia	5.6	
HYP01	Hypericum kalmianum	2.8	15.4
HYP02	H. prolificum	5.6	
HYP03	H. punctatum	8.3	7.7
HPX01	Hypoxis hirsuta	2.8%	53.8%
IMP01	Impatiens biflora	7.7	
IRI01	Iris virginica	2.8	53.8
JUG01	Juglans nigra	8.3	
JUN01	Juncus acuminatus	2.8	
JUN02	J. alpinus		7.7
JUN03	J. balticus	2.8	38.5
JUN04	J. canadensis	5.6	15.4
JUN05	J. dudleyi	5.6	38.5
JUN06	J. greenii	11.1	
JUN07	J. tenuis	11.1	
JUN08	J. torreyi	2.8	23.1
JNP01	Juniperus communis	2.8	
JNP02	J. virginiana	25.0	
KOE01	Koeleria macrantha	8.3	
KRI01	Krigia biflora	19.4	7.7
KRI02	K. virginica	13.9	
KUH01	Kuhnia eupatorioides	16.7	
LAC01	Lactuca biennis	2.8	7.7
LAC02	L. canadensis	72.2	15.4
LAR01	Larix laricina		7.7
LAT01	Lathyrus ochroleucus	2.8	
LAT02	L. palustris	5.6	61.5
LAT03	L. venosus	2.8	
LEC01	Lechea villosa	6.7	7.7
LEP01	Lepidium virginicum	11.1	
LPT01	Leptoloma cognatum	11.1	
LES01	Lespedeza capitata	72.2	23.1
LES02	L. hirta	38.9	
LES03	L. intermedia	2.8	
LES04	L. virginica	5.6	
LIA01	Liatris aspera	44.4	
LIA02	L. cylindracea	16.7	
LIA03	L. novae-angliae	22.2	

Code	Species	Presence Upland	Presence Lowland
LIA04	Liatris spicata	11.1%	61.5%
LIL01	Lilium michiganense	11.1	30.8
LIL02	L. philadelphicum	11.1	7.7
LIN01	Linaria canadensis	8.3	
LNM01	Linum sulcatum	2.8	
LIP01	Liparis loeselii		7.7
LTH01	Lithospermum canescens	47.2	15.4
LTH02	L. caroliniensis	25.0	
LOB01	Lobelia kalmii		7.7
LOB02	L. siphilitica		7.7
LOB03	L. spicata	16.7	30.8
LUP01	Lupinus perennis	41.7	
LUZ01	Luzula multiflora	27.8	7.7
LYC01	Lycopus americanus	2.8	53.8
LYC02	L. uniflorus		7.7
LYS01	Lysimachia ciliata		23.1
LYS02	L. lanceolata	25.0	
LYS03	L. quadriflora	5.6	53.8
LYS04	L. quadrifolia	11.1	
LYT01	Lythrum alatum	5.6	38.5
MEN01	Mentha arvensis		7.7
MON01	Monarda fistulosa	72.2	84.6
MON02	M. punctata	22.2	
MUH01	Muhlenbergia glomerata		7.7
MUH02	M. mexicana		23.1
OEN01	Oenothera biennis	27.8	7.7
OEN02	O. parviflora	2.8	
OEN03	O. rhombipetala	8.3	
OEN04	O. tetragona	2.8	
ONO01	Onoclea sensibilis	2.8	30.8
OPU01	Opuntia compressa	5.6	
OSZ01	Osmorhiza claytoni	5.6	
OSM01	Osmunda regalis	2.8	7.7
OST01	Ostrya virginiana	*	
OXY01	Oxypolis rigidior	8.3%	61.5%
PAN01	Panicum capillare	8.3	
PAN02	P. columbianum	8.3	
PAN03	P. commonsianum	8.3	
PAN04	P. commutatum	2.8	15.4
PAN05	P. depauperatum	19.4	
PAN06	P. dichotomum	8.3	7.7
PAN07	P. implicatum	13.9	23.1
PAN08	P. latifolium	13.9	7.7
PAN09	P. leibergii	11.1	30.8
PAN10	P. oligosanthes	36.1	
PAN11	P. precocious	8.3	7.7
PAN12	P. sphaerocarpon	11.1	
PAN13	P. virgatum	25.0	61.5
PAR01	Parnassia glauca		23.1
PTH01	Parthenocissus quinquefolia	13.9	7.7
PAS01	Paspalum ciliatifolium	2.8	
PED01	Pedicularis canadensis	11.1	7.7
PED02	P. lanceolata	2.8	46.2
PEN01	Penstemon digitalis	2.8	7.7
PEN02	P. hirsutus	25.0	15.4
PHA01	Phalaris arundinacea		30.8
PHL01	Phlox bifida	5.6	
PHL02	P. divaricata	2.8	
PHL03	P. maculata		7.7
PHL04	P. pilosa	52.8	23.1
PHL05	P. subulata	5.6	
PHR01	Phragmites australis		7.7
PHY01	Physalis heterophylla	5.6	
PHY02	P. virginiana	27.8	
PIN01	Pinus strobus	13.9	
PLA01	Plantago rugelii	5.6	
POA01	Poa compressa	66.7	38.5
POA02	Poa palustris	2.8	7.7

Code	Species	Presence Upland	Presence Lowland
POA03	Poa pratensis	33.3%	46.2%
POL01	Polemonium reptans	2.8	7.7
PLG01	Polygala polygama	22.2	
PLG02	P. sanguinea	16.7	7.7
PLG03	P. senega	2.8	
PLG04	P. verticillata	8.3	7.7
PGN01	Polygonatum biflorum	25.0	
PGN02	P. pubescens	11.1	
PGL01	Polygonella articulata	2.8	
PGM01	Polygonum douglasii	2.8	
PGM02	Polygonum natans		7.7
PGM03	P. tenue	11.1	7.7
PTR01	Polytrichum juniperinum	13.9	
PTR02	P. piliferum	13.9	
POP01	Populus deltoides	5.6	69.2
POP02	P. grandidentata	13.9	
POP03	P. tremuloides	33.3	46.2
POT01	Potentilla anserina	2.8	23.1
POT02	P. arguta	11.1	7.7
POT03	P. fruticosa		23.1
POT04	P. simplex	41.7	15.4
PRE01	Prenanthes alba	5.6	
PRE02	P. racemosa	2.8	61.5
PRN01	Prunella vulgaris	22.2	38.5
PRU01	Prunus americana	5.6	
PRU02	P. pumila	5.6	
PRU03	P. serotina	66.7	23.1
PRU04	P. virginiana	11.1	
PTE01	Pteridium aquilinum	47.2	15.4
PYC01	Pycnanthemum flexuosum		15.4
PYC02	P. virginianum	19.4	84.6
PYR01	Pyrus coronaria	8.3	7.7
QUE01	Quercus alba	44.4	
QUE02	Q. borealis	8.3	15.4
QUE03	Quercus macrocarpa	22.2%	30.8%
QUE04	Q. palustris	8.3	15.4
QUE05	Q. prinoides	11.1	
QUE06	Q. velutina	77.8	15.4
RAN01	Ranunculus fascicularis	27.8	
RAT01	Ratibida pinnata	50.0	53.8
RHA01	Rhamnus alnifolia		7.7
RHU01	Rhus aromatica	2.8	
RHU02	R. copallina	25.0	
RHU03	R. glabra	22.2	7.7
RHU04	R. radicans	5.6	7.7
RHU05	R. typhina	36.1	7.7
RHU06	R. vernix		7.7
RHY01	Rhynchospora capillacea	2.8	
ROS01	Rosa blanda		7.7
ROS02	R. carolina	55.6	7.7
ROS03	R. palustris	2.8	38.5
ROS04	R. suffulta	5.6	
RUB01	Rubus allegheniensis	16.7	15.4
RUB02	R. flagellaris	55.6	7.7
RUB03	R. hispidus	8.3	7.7
RUB04	R. occidentalis	16.7	
RUB05	R. pubescens	2.8	
RUD01	Rudbeckia hirta	86.1	61.5
SAL01	Salix bebbiana	*	*
SAL02	S. candida		7.7
SAL03	S. discolor	*	15.4
SAL04	S. humilis	55.6	15.4
SAL05	S. interior	2.8	30.8
SAL06	S. petiolaris		15.4
SNC01	Sanicula marilandica	5.6	15.4
SAS01	Sassafras albidum	52.8	
SAX01	Saxifraga pensylvanica	2.8	38.5
SCI01	Scirpus acutus		7.7

Code	Species	Presence Upland	Presence Lowland
SCI02	Scirpus americanus		15.4%
SCI03	S. atrovirens	2.8%	23.1
SCI04	S. validus	5.6	23.1
SCL01	Scleria triglomerata	8.3	15.4
SCR01	Scrophularia lanceolata	5.1	
SEL01	Selaginella rupestris	2.8	
SEN01	Senecio aureus	5.6	38.5
SEN02	S. pauperculus	5.6	15.4
SEN03	S. plattensis	16.7	15.4
SIL01	Silene antirrhina	22.2	
SLP01	Silphium integrifolium	13.9	23.1
SLP02	S. terebinthinaceum	16.7	53.8
SIS01	Sisyrinchium albidum	27.8	7.7
SIS02	S. angustifolium		7.7
SIS03	S. montanum		7.7
SIS04	S. mucronatum	2.8	15.4
SMI01	Smilacina racemosa	38.9	15.4
SMI02	S. stellata	8.3	30.8
SMX01	Smilax ecirrata	*	
SMX02	S. lasioneura	8.3	
SOL01	Solidago altissima	25.0	92.3
SOL02	S. caesia	2.8	
SOL03	S. canadensis		
SOL04	S. gigantea	5.6	46.2
SOL05	S. graminifolia	44.4	84.6
SOL06	S. juncea	55.6	15.4
SOL07	S. nemoralis	77.8	30.8
SOL08	S. ohioensis		38.5
SOL09	S. patula		7.7
SOL10	S. riddellii	5.6	53.8
SOL11	S. rigida	50.0	46.2
SOL12	S. rugosa	5.6	15.4
SOL13	S. speciosa	55.6	15.4
SOL14	S. uliginosa		7.7
SOL15	S. ulmifolia	2.8	
SOR01	Sorghastrum nutans	55.6%	84.6%
SPA01	Spartina pectinata	22.2	92.3
SPE01	Specularia perfoliata	16.7	
SPI01	Spiraea alba	16.7	46.2
SPI02	S. tomentosa	5.6	7.7
SPR01	Spiranthes cernua		7.7
SPR02	S. tuberosa	*	
SPO01	Sporobolus cryptandrus	8.3	7.7
SPO02	S. heterolepis	2.8	
SPO03	S. neglectus	2.8	
SPO04	S. vaginiflorus	5.6	
STA01	Stachys tenuifolia		38.5
STE01	Stellaria longifolia		7.7
STI01	Stipa avenacea	13.9	
STI02	S. spartea	19.4	
SWE01	Swertia caroliniensis	11.1	
TAE01	Taenidia integerrima	19.4	7.7
TEP01	Tephrosia virginiana	22.2	
THA01	Thalictrum dasycarpum	19.4	69.2
THA02	T. dioicum	2.8	
THA03	T. polyganum	?	*
THS01	Thaspium barbinode	8.3	7.7
THS02	T. trifoliatum	2.8	
THE01	Thelypteris palustris	2.8	69.2
TIL01	Tilia americana	2.8	
TOF01	Tofieldia glutinosa		7.7
TRA01	Tradescantia ohiensis	72.2	30.8
TRI01	Trichostema dichotomum	5.6	
TDN01	Tridens flavus	13.9	
TYP01	Typha angustifolia	*	15.4
TYP02	T. latifolia		15.4
ULM01	Ulmus americana	2.8	38.5
URT01	Urtica dioica	2.8	7.7
VAC01	Vaccinium angustifolium	8.3	
VAC02	V. brittonii	5.6	

Code	Species	Presence Upland	Presence Lowland	Code	Species	Presence Upland	Presence Lowland
VAC03	Vaccinium lamarckii	*		VI002	Viola cucullata		7.7%
VAC04	V. myrtilloides	2.8%		VI003	V. fimbriatula	2.8%	
VER01	Verbena hastata		30.8%	VI004	V. papilionacea	2.8	
VER02	Verbena stricta	16.7	7.7	VI005	V. pedata	19.9	
VBS01	Verbesina alternifolia		15.4	VI006	V. pedatifida	5.6	
VRN01	Vernonia altissima	2.8	7.7	VI007	V. sagittata	16.7	15.4
VRN02	V. missurica	11.1	46.2	VI008	V. sororia	13.9	
VCS01	Veronicastrum virginicum	33.3	76.9	VIT01	Vitis aestivalis	25.0	7.7
VIB01	Viburnum acerifolium	2.8		VIT02	V. riparia	2.8	23.1
VIC01	Vicia americana	13.9		ZIZ01	Zizia aurea	22.2	61.5
VIC02	V. caroliniana	*		ZYG01	Zygadenus glaucus		7.7
VI001	Viola affinis	2.8	23.1				

* Present in upland or lowland stands that were not used in this analysis.

APPENDIX D

Stand Summaries

Surveyor noted when other than author. Additions by P.W. Thompson (PWT), L.A. Schaddelee (LAS), H.E. Ballard (HEB), E.M. Scharrer (EMS), M.A. Kohring (MAK), R.J. Pleznac (RJP), D. Langendoen (DL), B. Kilgore (BK). Parentheses enclose pH and wrc from soil survey.

1. BOWERMAN CEMETERY

LOCATION: Barry Co., T3N, R10W, S10, S of SE of SW: 4 miles S of Middleville, 0.3 miles W of Bassett Lake Road and Bowen's Mill Road, N side of road
TYPE: Oak Barrens (Dry Sand Prairie)
COVER: Carex pensylvanica-Andropogon scoparius dominant
SOIL: Plainfield sand, pH 5.2, wrc 39%; area soils Plainfield sand, Fox sandy loam, Coloma loamy fine sand (no modern survey)
SETTING: Slope 0-20°, aspect mainly N; 1.6 acre cemetery prairie (remnant of oak barrens) and adjacent adventive grassland N and W, oak woods (with pine) on S, wet prairie and fen on lower ground to E

Species	Species
Achillea millefolium	Hieraceum gronovii
Agrostis hyemalis	H. longipilum (LAS)
Ambrosia artemisiifolia	Juncus greenii (LAS)
A. psilostachya	Juniperus virginiana (LAS)
Andropogon gerardii	Krigia virginica
A. scoparius	Lactuca canadensis
Anemone cylindrica	Lespedeza capitata
Antennaria neglecta (LAS)	L. virginica
A. plantaginifolia	Liatris aspera
Apocynum androsaemifolium (LAS)	Linaria canadensis
A. cannabinum (LAS)	Lithospermum caroliniensis (LAS)
Arabis lyrata (LAS)	Lupinus perennis
Aristida purpurascens	Lysimachia lanceolata
Artemisia caudata	Monarda punctata
Asclepias syriaca (LAS)	Oenothera rhombipetala (LAS)
A. tuberosa	Panicum columbianum
A. verticillata (LAS)	P. commonsianum (LAS)
A. viridiflora (LAS)	P. depauperatum
Aster azureus	P. oligosanthes
Blephilia ciliata (LAS)	Paspalum ciliatifolium
Botrichium multifidum	Penstemon hirsutus
Carex muhlenbergii	Phlox pilosa
C. pensylvanica	Physalis heterophylla (LAS)
Ceanothus americanus	Poa compressa
Comandra richardsiana	Polygala polygama (LAS)

Species	Species
Conyza canadensis	Polygonum tenue (LAS)
Coreopsis tripteris	Pteridium aquilinum
Corylus americana	Quercus alba
Cyperus filiculmis	Q. velutina
Danthonia spicata	Ratibida pinnata
Desmodium marilandicum	Rubus flagellaris
Equisetum laevigatum (LAS)	Rudbeckia hirta
Erigeron strigosus	Senecio plattensis
Euphorbia corollata	Solidago graminifolia (LAS)
Fragaria virginiana	S. juncea (LAS)
Galium pilosum	S. nemoralis
Gaultheria procumbens	S. speciosa
Gnaphalium obtusifolium (LAS)	Specularia perfoliata (LAS)
Helianthemum canadense	Stipa spartea
Helianthus occidentalis	Tradescantia ohiensis
H. tuberosus (LAS)	Viola pedata
Heuchera hirsuticaulis	

2. NEWAYGO PRAIRIE

LOCATION: Newaygo Co., T12N, R12W, S11, W of NW; 4.5 miles ENE of Newaygo, SE of 56th Street and Poplar Avenue
TYPE: Dry Sand Prairie
COVER: Carex pensylvanica dominant (Andropogon gerardii-A. scoparius dominant in unplowed prairie)
SOIL: Sparta loamy sand, pH 4.8, wrc 45%; area soils Rubicon sand and Rousseau loamy fine sand
SETTING: Slope 0-15 deg., aspect variable (a depression); 23 acre secondary dry sand prairie (originally a native prairie); black oak woods and clearings surround site
CITATION: Hauser 1953; Thompson 1975, 1983a; Chapman and Crispin 1984

Species	Frequency	Species	Frequency
Ambrosia artemisiifolia (LAS)		Leptoloma cognatum	10%
A. psilostachya	65%	Lespedeza capitata (LAS)	
Andropogon gerardii		L. hirta (LAS)	
A. scoparius	5	Liatris aspera	20
Anemone cylindrica	5	L. cylindracea	
Antennaria neglecta		Linaria canadensis (LAS)	
A. plantaginifolia	5	Linum sulcatum	5
Apocynum androsaemifolium (LAS)		Lithospermum canescens (LAS)	
A. cannabinum	5	L. caroliniense	
Arabis glabra		Lupinus perennis (LAS)	
A. lyrata (LAS)		Luzula multiflora	
Arctostaphylos uva-ursi (LAS)		Monarda fistulosa	
Aristida purpurascens	40	M. punctata	
Arenaria stricta		Oenothera rhombipetala	

Species	Frequency	Species	Frequency
Artemisia caudata	5%	Opuntia compressa	20%
Asclepias amplexicaulis (LAS)		Panicum capillare (LAS)	
A. exaltata (LAS)		P. commonsianum*	
A. syriaca (LAS)		P. depauperatum	20
A. tuberosa	5	P. oligosanthes	5
A. viridiflora		P. virgatum (LAS)	
Aster azureus	15	Pedicularis canadensis (LAS)	
A. ericoides	5	Penstemon hirsutus	
A. ptarmicoides (LAS)		Physalis heterophylla (LAS)	
A. sericeus	10	P. virginiana	
Blephilia ciliata	10	Pinus strobus (LAS)	
Botrychium multifidum (LAS)		Poa pratensis	35
Bouteloua curtipendula		Polygala polygama	10
Carex merritt-fernaldii		Polygonatum biflorum (LAS)	
C. pensylvanica	100	Polygonella articulata	
Ceanothus americanus (LAS)		Polygonum douglasii	5
Cerastium arvense	45	Polytrichum piliferum	10
Cladonia spp.	35	Populus tremuloides	
Claytonia virginica (LAS)		Potentilla arguta	5
Comandra richardsiana	5	Prunus americana	15
Convolvulus spithamaeus (LAS)		P. pumila	5
Conyza canadensis		P. serotina*	
Coreopsis lanceolata		P. virginiana (LAS)	
Cyperus filiculmis*		Pteridium aquilinum (LAS)	
Danthonia spicata	30	Pyrus coronaria (LAS)	
Desmodium canadense (LAS)		Quercus alba (LAS)	
D. sessilifolium (LAS)		Q. velutina	5
Equisetum arvense (LAS)		Ranunculus fascicularis (LAS)	
E. hyemale (LAS)		Rosa carolina	5
E. laevigatum	10	Rubus flagellaris	45
Eragrostis spectabilis	5	Salix humilis	
Erigeron strigosus	5	Selaginella rupestris	
Euphorbia corollata	50	Senecio plattensis (LAS)	
Fragaria virginiana (LAS)		Silene antirrhina (LAS)	
Galium pilosum		Sisyrinchium albidum (LAS)	
Geum triflorum	5	Solidago juncea	
Gnaphalium obtusifolium	15	S. nemoralis	30
Helianthemum canadense		S. speciosa	
Helianthus divaricatus (LAS)		Sorghastrum nutans	
H. occidentalis	5	Specularia perfoliata (LAS)	
Hieraceum longipilum	5	Spiraea alba	5
Houstonia longifolia		Sporobolus cryptandrus (LAS)	
Juncus greenii		S. vaginiflorus	5
Juniperus virginiana		Stipa spartea	10
Koeleria macrantha	10	Tephrosia virginiana	10
Krigia virginica		Viola fimbriatula	5
Kuhnia eupatorioides		Viola pedata	
Lactuca canadensis		Xanthoxylum americanum	
Lechea villosa (LAS)			

* Reported as common by LAS

3. ALLEGAN PINE PLAINS

LOCATION: Allegan Co., T3N, R15W, S35, NE and S36, NW; 3 miles E of Fennville, 0.5 miles E of Old Allegan Road, S of 126th Avenue
TYPE: Oak Barrens
COVER: Carex pensylvanica-Andropogon scoparius dominant
SOIL: Oakville fine sand, pH 4.6, wrc 38%; area soils Oakville fine sand, Chelsea loamy fine sand, Oshtemo sandy loam
SETTING: Slope nearly level, aspect N to NE; 125 acre (partly secondary) oak barrens (originally white pine-oak barrens); black oak-white oak woods and clearings surround site
CITATION: Schaddelee 1975, Thompson 1983a

Species	Frequency	Species	Frequency
Ambrosia psilostachya	15%	Lithospermum caroliniensis	20%
Amelanchier arborea	5	Lupinus perennis*	5
Andropogon gerardii	10	Monarda fistulosa (nr. oaks)	5
A. scoparius	70	M. punctata	5
Anemone cylindrica	20	Oenothera biennis (LAS)	
Antennaria plantaginifolia		Opuntia compressa	
Apocynum cannabinum	5	Panicum commonsianum (LAS)	
Arabis glabra	5	P. depauperatum (LAS)	
A. lyrata		P. oligosanthes (LAS)	
Arctostaphylos uva-ursi (LAS)		Pedicularis canadensis (nr. oaks)	
Arenaria stricta		Penstemon hirsutus	
Aristida purpurascens	10	Phlox pilosa	
Artemisia caudata	15	Physalis virginiana	5
Asclepias amplexicaulis (LAS)		Pinus strobus	
A. tuberosa (LAS)		Poa pratensis	35
A. verticillata (LAS)		Polygala polygama	20
Aster azureus	10	Polygonum tenue	5
A. laevis (LAS)		Polygonatum biflorum (LAS)	
Aureolaria flava (nr. oaks)	5	Potentilla simplex (LAS)	
Bromus kalmii (LAS)		Prunus serotina	10
Cacalia atriplicifolia		P. pumila (LAS)	
Carex pensylvanica	95	Quercus alba	10
Ceanothus americanus (nr. oaks)		Q. velutina	25
Claytonia virginica (nr. oaks)		Ranunculus fascicularis*	
Comandra richardsiana	10	Rosa carolina	40
Convolvulus spithamaeus (LAS)		Rubus flagellaris	5
Coreopsis lanceolata	40	Salix humilis (LAS)	
Cyperus filiculmis	5	Sassafras albidum	10
Danthonia spicata	10	Scrophularia lanceolata (LAS)	
Erigeron strigosus	20	Selaginella rupestris (LAS)	
Euphorbia corollata	60	Senecio plattensis (LAS)	
Fragaria virginiana	5	Smilacina racemosa (in oaks)	
Galium pilosum	10	Solidago juncea (LAS)	
Gnaphalium obtusifolium	55	S. nemoralis	10
Helianthemum canadense		S. speciosa (also nr. oaks)	10

Species	Frequency	Species	Frequency
Helianthus divaricatus (nr. oaks)		Sorghastrum nutans	30%
Hieraceum gronovii	5%	Specularia perfoliata (LAS)	
H. longipilum	30	Sporobolus vaginiflorus	55
Juniperus virginiana (LAS)		Stipa avenaea (nr. oaks)	5
Koeleria macrantha	35	Swertia caroliniensis (nr. oaks)	5
Krigia biflora		Tradescantia ohiensis (LAS)	
K. virginica		Vaccinium angustifolium (nr. oaks)	
Lactuca canadensis	15	Viola pedata	15
Liatris aspera	20	Vitis aestivalis (LAS)	
L. cylindracea	5	V. riparia (LAS)	
Linaria canadensis			
Lithospermum canescens (LAS)			

* Commoner (vegetative parts gone at time of sampling)

4. TEXAS CORNERS

LOCATION: Kalamazoo Co., T3S, R12W, S29, NW of NW; 3 miles WSW of Texas Corners, SW of R Avenue and 2nd Street
TYPE: Oak Barrens (Dry Sand Prairie)
COVER: Andropogon scoparius dominant; Cladonia subdominant
SOIL: Spinks loamy sand, (pH 5.1-7.3, wrc 30-38%); area soils Oshtemo sandy loam, Coloma loamy sand, Kalamazoo loam
SETTING: Slope 0-25 deg., aspect variable (kettle-kame topography); 20 acre secondary grassland, remnant of oak barrens; oak-hickory woods, abandoned fields, homesteads surround site

Species	Species
Achillea millefolium	Lespedeza capitata
Agrostis hyemalis	L. hirta
Ambrosia artemisiifolia	Lupinus perennis
Andropogon scoparius	Monarda punctata
Antennaria plantaginifolia	Oenothera biennis
Apocynum androsaemifolium	Panicum columbianum
Artemisia caudata	Poa compressa
Blephilia ciliata	Polygonum tenue (C.R. Hanes 1951)
Carex muhlenbergii	Polytrichum piliferum
C. pensylvanica	Prunella vulgaris
Carya ovalis	Prunus serotina
Ceanothus americanus	Quercus velutina
Cladonia spp.	Rubus flagellaris
Coreopsis tripteris	Rudbeckia hirta
Cyperus filiculmis	Sassafras albidum
Danthonia spicata	Solidago graminifolia
Desmodium marilandicum	S. juncea
Erigeron annuus	S. nemoralis

Euphorbia corollata
Fragaria virginiana
Hieraceum gronovii
H. longipilum
Lactuca canadensis
S. speciosa
Tephrosia virginiana
Tradescantia ohiensis
Trichostema dichotomum (Hanes 1951)
Vitis aestivalis

5. 42nd STREET AND B AVENUE

LOCATION: Kalamazoo Co., T2S, R9W, S4, SW of SE of SE; 5.3 miles ENE of Richland, NE of 42nd Street and B Avenue
TYPE: Oak Barrens (Dry Sand Prairie)
COVER: Andropogon scoparius dominant
SOIL: ?Coloma loamy sand (in mapping unit of Oshtemo sandy loam), pH 4.8, wrc 39%; area soils Kalamazoo loam, Oshtemo sandy loam
SETTING: Slope 25 deg., aspect E to SE; 3 acre grassland, remnant of oak barrens; planted in 1970 to jack and scotch pine; black oak woods, abandoned fields, homesteads surround site
CITATION: Scharrer 1971 (Site No. 96)

Species	Frequency	Species	Frequency
Achillea millefolium		Helianthus strumosus	14%
Ambrosia artemisiifolia		Hieraceum gronovii	
Andropogon gerardii (EMS)		H. longipilum	12
A. scoparius	76%	Juniperus virginiana	
Anemone virginiana		Lactuca canadensis	
Antennaria plantaginifolia	16	Lespedeza intermedia	
Apocynum androsaemifolium		Liatris aspera	
Asclepias syriaca		Monardia fistulosa	
A. tuberosa	4	Oenothera biennis	4
Aster azureus		Panicum capillare	
A. ericoides (EMS)	12	P. dichotomum (EMS)	
A. pilosus	34	P. oligosanthes	
Carex pensylvanica	4	Poa compressa	80
Ceanothus americana (EMS)		Polytrichum piliferum	
Cirsium discolor (EMS)	4	Potentilla simplex (EMS)	8
Cladonia spp.		Prunus serotina	
Cornus racemosa		P. virginiana (EMS)	4
Cyperus filiculmis (EMS)	4	Quercus velutina	
Danthonia spicata		Rhus typhina	
Desmodium marilandicum	12	Rudbeckia hirta	
D. rotundifolium		Sassafras albidum	
Equisetum arvense (EMS)	12	Solidago altissima (low edge)	
Euphorbia corollata	26	S. graminifolia (low edge)	
Fragaria virginiana		S. juncea	
Gnaphalium obtusifolium	10	S. nemoralis	30
Helianthemum canadense (EMS)	2	Tradescantia ohiensis	
Helianthus mollis (EMS)			

6. LAWTON AMTRAK UPLAND

LOCATION: Van Buren Co., T3S, R13W, S22, SW & S27, NW; 2 miles NE of Lawton, S side of Amtrak line between Drape Road and 28th Street
TYPE: Oak Barrens
COVER: Andropogon gerardii-A. scoparius dominant; Carex pensylvanica dominant under oaks and codominant with Rubus flagellaris in thickets
SOIL: Plainfield sand, pH 5.2, (wrc 34-45%); area soils Oshtemo sandy loam, Plainfield sandy loam, Spinks sandy loam
SETTING: Slope 0-5 deg. (steeper on railroad cuts), aspect NW; 0.5 mile-long railroad prairie, remnant of oak barrens (interrupted by 0.1 mile-long Lawton Amtrak Swale); black oak woodlots, abandoned fields (invaded by native grassland species), cultivated fields surround site
CITATION: Pokora 1968, 1970, Kohring 1981

Species	Species
Andropogon gerardii	Lespedeza hirta (under oaks)
A. scoparius	Liatris aspera
Anemone cylindrica	L. cylindracea
Arabis glabra	Lithospermum caroliniensis
Artemisia caudata (dist'd. ground)	Lupinus perennis
Asclepias amplexicaulis	Monarda fistulosa
A. syriaca	Panicum oligosanthes
A. tuberosa	P. virgatum
A. verticillata	Penstemon hirsutus
Aster azureus	Phlox pilosa
A. laevis	Physalis heterophylla
Carex pensylvanica	Poa pratensis
Ceanothus americanus	Polygala polygama
Comandra richardsiana	Polygonatum biflorum (under oaks)
Conyza canadensis (dist'd. ground)	Polytrichum piliferum
Coreopsis tripteris	Quercus velutina
Corylus americana	Ranunculus fascicularis
Cyperus filiculmis (dist'd. ground)	Ratibida pinnata
C. schweinitzii (dist'd. ground)	Rhus copallina
Desmodium marilandicum	R. typhina
Eragrostis spectabilis	Rosa carolina
Erigeron annuus	Rubus flagellaris
E. strigosus	Rudbeckia hirta
Euphorbia corollata	Sassafras albidum
Fragaria virginiana	Silene antirrhina (dist'd. ground)
Helianthemum canadense	Solidago nemoralis
Helianthus divaricatus (under oaks)	S. rigida
H. occidentalis	Sorghastrum nutans
Heuchera hirsuticaulis	Specularia perfoliata
Hieraceum longipilum	Stipa avenacea (under oaks)
Krigia virginica	Swertia caroliniensis (under oaks)
Lactuca canadensis	Tephrosia virginiana

Species	Species
Lechea intermedia	Tradescantia ohiensis
Lepidium virginicum (dist'd. ground)	Vaccinium brittoniii
Leptoloma cognatum	Vitis aestivalis
Lespedeza capitata	

7. LAWLER

LOCATION: Kalamazoo Co., T2S, R9W, S10, NW of SE; 1.6 miles S of Augusta, NE of Territorial Road at Lawler Cemetery, W of Augusta-Climax Road
TYPE: Dry Sand Prairie
COVER: Andropogon virginicus-Danthonia spicata dominant; Carex rugosperma-Cladonia spp. subdominant (Andropogon scoparius dominant on nearby remnants)
SOIL: Spinks loamy sand, pH 5.7, wrc 28%; area soils Oshtemo sandy loam, Coloma loamy sand, Kalamazoo loam
SETTING: Slope 0-5 deg., aspect NE; 25-30 acre secondary dry sand prairie, remnant of Coguaiack Prairie; abandoned fields, thickets, abandoned homesteads, and scattered old oaks (bur, black, white) surround site

Species	Species
Achillea millefolium	Juglans nigra
Andropogon gerardii	Lactuca canadensis
A. scoparius	Lechea villosa (PWT)
Antennaria plantaginifolia	Leptoloma cognatum
Asclepias amplexicaulis (PWT)	Lespedeza capitata
(A. hirtella PWT)	L. hirta
A. tuberosa	Liatris aspera
A. viridiflora (PWT)	Monarda fistulosa
Aster pilosus	Physalis heterophylla (PWT)
Carex pensylvanica	Polygala polygama (PWT)
Carya glabra	Potentilla arguta (PWT)
Coreopsis lanceolata (PWT)	Prunus serotina
C. tripteris	Quercus alba
Cyperus filiculmis	Q. macrocarpa
Danthonia spicata	Q. velutina
Desmodium canadense (PWT)	Ratibida pinnata (PWT)
D. dillenii (PWT)	Rudbeckia hirta
D. illinoense (PWT)	Sassafras albidum
D. marilandicum	Solidago juncea
Erigeron strigosus	S. nemoralis
Euphorbia corollata	S. rigida
Gnaphalium obtusifolium	S. speciosa
Hieraceum longipilum	Verbena stricta (PWT)

8. MATTAWAN FRUIT BELT

LOCATION: Kalamazoo Co., T3S, R12W, S5, SE; 2.7 miles NE of Mattawan, along abandoned Fruit Belt Railroad (original Michigan Central line) between 4th Street and O Avenue
TYPE: Oak Barrens/Oak Openings
COVER: Andropogon gerardii dominant; Carex pensylvanica subdominant, especially under trees
SOIL: Spinks loamy sand, pH 5.4, wrc 48%; area soils Oshtemo sandy loam, Coloma and Spinks loamy sand
SETTING: Slope 0-5 deg., aspect variable (kettle-kame topography); 0.25 mile-long railroad strip prairie, remnant of oak barrens; black oak woods, cultivated field, homesteads surround site; Spartina dominant, moist prairie species present, in some kettleholes
CITATION: Thompson 1983a

Species	Species
Achillea millefolium (common)	Lespedeza capitata (rare)
Amorpha canescens (common)	L. hirta (PWT)
Andropogon gerardii (abundant)	Liatris aspera (rare)
A. scoparius (loc. common)	Lupinus perennis (PWT)
Anemone cylindrica (uncommon)	Monarda fistulosa (common)
Antennaria plantaginifolia (PWT)	Oenothera biennis (PWT)
Apocynum androsaemifolium (rare)	Populus tremuloides (uncommon)
A. sibiricum (PWT)	Potentilla simplex (common)
Aristida purpurascens (PWT)	Prunus serotina (common)
Asclepias amplexicaulis (rare)	Pteridium aquilinum (loc. common)
A. syriaca (common)	Quercus macrocarpa (uncommon)
A. tuberosa (rare)	Q. prinoides (abundant)
Aster azureus (PWT)	Q. velutina (common)
A. laevis (abundant)	Ratibida pinnata (rare)
A. pilosus (PWT)	Rhus copallina (abundant)
A. sagittifolius (PWT)	Rosa carolina (common)
Cacalia atriplicifolia (PWT)	Rubus flagellaris (abundant)
Carex pensylvanica (abundant)	R. occidentalis (abundant)
Carya glabra (rare)	Rudbeckia hirta (PWT)
Ceanothus americanus (common)	Salix humilis (uncommon)
Comandra richardsiana (PWT)	Sassafras albidum (common)
Coreopsis palmata (PWT)	Solidago altissima (abundant)
C. tripteris (rare)	S. graminifolia (uncommon)
Corylus americana (common)	S. juncea (common)
Desmodium canadense (rare)	S. nemoralis (PWT)
D. marilandicum (PWT)	S. rigida (loc. common)
Elymus canadensis (PWT)	S. speciosa (PWT)
Erigeron strigosus (PWT)	Sorghastrum nutans (rare)
Eryngium yuccifolium (local, rare)	Stipa spartea (rare)
Euphorbia corollata (abundant)	Taenidia integerrima (uncommon)
Fragaria virginiana (common)	Tephrosia virginiana (PWT)
Helianthus occidentalis (abundant)	Tradescantia ohiensis (common)
Lactuca canadensis (common)	

9. FAIRFAX

LOCATION: St. Joseph Co., T6S, R9W, S17; between M-89 and Conrail line, from Fairfax village limits W to Lepley Road
TYPE: Woodland Prairie (Oak Openings)
COVER: Andropogon gerardii-A. scoparius dominant
SOIL: Oshtemo sandy loam, pH 5.4, wrc 44%; area soils Oshtemo and Hillsdale sandy loam
SETTING: Slope 0-5 deg., aspect N; 1.25 mile-long railroad prairie, remnant of oak openings; cultivated fields, homesteads surround site; sloughs at site dominated by Spartina pectinata, or by Calamagrostis canadensis (also with Spartina), or by Carex stricta and prairie composites (Populus deltoides is present)
CITATION: Scharrer 1971 (Site No. 524), Thompson 1975, 1983a

Species	Species
Achillea millefolium	Lespedeza capitata
Andropogon gerardii	L. hirta
A. scoparius	Lilium philadelphicum
Anemone cylindrica (PWT)	Lithospermum canescens
Antennaria plantaginifolia	Luzula multiflora (PWT)
Apocynum cannabinum	Monarda fistulosa
Asclepias syriaca (PWT)	Panicum commutatum
A. tuberosa	Physalis heterophylla
Aster azureus	Poa compressa (PWT)
A. ericoides	Polytrichum juniperinum
A. laevis	Populus tremuloides
A. pilosus	Prunus serotina
A. sagittifolius (PWT)	Pteridium aquilinum
Baptisia leucantha	Quercus velutina
Carex pensylvanica (PWT)	Ratibida pinnata (PWT)
Cirsium discolor	Rosa suffulta
Comandra richardsiana (PWT)	Rubus flagellaris
Coreopsis tripteris	Rudbeckia hirta (PWT)
Cornus racemosa	Salix humilis
Desmodium canadense (PWT)	Senecio pauperculus (PWT)
D. illinoense (PWT)	Smilacina racemosa
D. marilandicum	Solidago graminifolia
Equisetum laevigatum	S. juncea
Erigeron strigosus	S. nemoralis (PWT)
Eryngium yuccifolium (PWT)	Sorghastrum nutans
Euphorbia corollata	Spiraea alba
Fragaria virginiana	Thaspium barbinode (PWT)
Helianthemum canadense (PWT)	Tradescantia ohiensis
Helianthus occidentalis	Tridens flavus
Hieraceum longipilum	Vernonia missurica
Lactuca canadensis	
Lathyrus ochroleucus (PWT)	

10. HARMONIA

LOCATION: Calhoun Co., T1S, R8W, S33, SE of SE; 4 miles NW of Battle Creek, between Harmonia Road and Conrail line
TYPE: Woodland Prairie
COVER: Andropogon scoparius dominant; Carex pensylvanica subdominant
SOIL: Plainfield sandy loam, pH 5.5, wrc 65%; area soils Plainfield and Fox sandy loam (no modern soil survey)
SETTING: Slope 0-5 deg., aspect NNE; 1 acre railroad prairie, remnant of oak openings; wet-mesic prairie on adjacent slightly lower ground; thickets, abandoned fields, disturbed ground surround site

Species	Frequency	Species	Frequency
Achillea millefolium	45%	Heuchera hirsuticaulis	
Agrostis gigantea	5	Hieraceum longipilum	
Andropogon gerardii	10	Liatris novae-angliae	15%
Andropogon scoparius	95	Lithospermum canescens	15
Anemone cylindrica	15	Luzula multiflora	10
Antennaria plantaginifolia	45	Monarda fistulosa	15
Asclepias tuberosa		Panicum depauperatum	20
Aster azureus	95	Panicum implicatum	20
Aster laevis	20	Phlox pilosa	10
Cacalia atriplicifolia		Poa compressa	80
Carex bicknellii	10	Poa pratensis	15
Carex brevior	5	Polygala sanguinea	5
Carex pensylvanica	40	Populus grandidentata	
Ceanothus americanus	15	Populus tremuloides	
Comandra richardsiana		Prunella vulgaris	35
Coreopsis tripteris	10	Ratibida pinnata	45
Cornus racemosa	10	Rosa carolina	5
Danthonia spicata	10	Rudbeckia hirta	10
Desmodium canadense		Sisyrinchium albidum	15
Desmodium marilandicum	15	Solidago gigantea	5
Equisetum arvense		Solidago nemoralis	20
Equisetum laevigatum	40	Solidago rigida	50
Erigeron strigosus	25	Solidago speciosa	15
Euphorbia corollata	60	Spartina pectinata	
Fragaria virginiana	20	Tradescantia ohiensis	40
Helianthus occidentalis	50	Zizia aurea	35

11. LAWTON AMTRAK SWALE

LOCATION: Van Buren Co., T3S, R13W, S22, SW & S27, NW; 2 miles NE of Lawton, S side of Amtrak line between Drape Road and 28th Street
TYPE: Woodland Prairie
COVER: Andropogon scoparius-A. gerardii dominant; Carex pensylvanica dominant under oaks and codominant with Rubus flagellaris in thickets
SOIL: Plainfield sand, pH 5.4, wrc 47%; area soils Oshtemo sandy loam, Plainfield sandy loam, Spinks sandy loam
SETTING: Slope 0-5 deg., aspect none (a depression); 0.1 mile-long railroad prairie, remnant of oak openings; grades into sedge meadow around pond; oak barrens, black oak woodlots, abandoned fields (invaded by native grassland species), cultivated fields surround site
CITATION: Kohring 1981

Species	Frequency	Species	Frequency
Achillea millefolium	5%	Lupinus perennis	15%
Agrostis hyemalis		Luzula multiflora	
Andropogon gerardii	55	Lysimachia lanceolata	10
A. scoparius	75	Monarda fistulosa	20
Anemone cylindrica	10	Panicum praecocius	15
Apios americana	5	P. sphaerocarpon	5
Apocynum androsaemifolium		P. virgatum	
Arabis glabra		Pedicularis canadensis	55
Asclepias tuberosa		Phlox pilosa	25
A. verticillata		Poa pratensis	20
Aster azureus	60	Polytrichum juniperinum	5
A. laevis	5	Populus tremuloides	10
Bromus kalmii	5	Potentilla arguta	10
Carex pensylvanica	5	P. simplex	25
C. bicknellii	60*	Prunella vulgaris	10
C. lanuginosa		Prunus serotina	
C. scoparia		Pteridium aquilinum	85
C. stricta		Quercus alba	
Ceanothus americanus	15	Q. velutina	5
Cirsium discolor	10	Ranunculus fascicularis	
Comandra richardsiana	15	Ratibida pinnata	
Coreopsis tripteris	30	Rosa carolina	55
Desmodium marilandicum		R. palustris	5
D. paniculatum	10	Rubus hispidus	55
Equisetum laevigatum	10	Rudbeckia hirta	20
Erigeron strigosus		Salix humilis	30
Eryngium yuccifolium	30	Sassafras albidum	5
Eupatorium perfoliatum	5	Senecio aureus	5
Euphorbia corollata	80	Silene antirrhina (dist'd. ground)	
Fragaria virginiana	75	Smilacina racemosa (nr. oaks)	
Galium circaezans		Solidago graminifolia	5
Geranium maculatum (nr. oaks)	5	S. juncea	

Species	Frequency	Species	Frequency
Habenaria flava	5%	Solidago nemoralis	
Helianthus divaricatus	5	S. rigida	
H. occidentalis	45	S. speciosa	55%
Heuchera hirsuticaulis	5	Sorghastrum nutans	20**
Hieraceum longipilum	5	Spartina pectinata	10
Hypericum punctatum		Stipa avenacea (nr. oaks)	
Krigia biflora		Tephrosia virginiana	10
Lactuca canadensis	30	Tradescantia ohiensis	55
Lespedeza capitata		Vaccinium brittonii	20
Liatris aspera		Viola pedata	10
L. cylindracea	35	V. sagittata	30
Lilium philadelphicum		Zizia aurea	5
Lithospermum canescens	20		

12. TEEPLE LAKE

LOCATION: Oakland Co., T3N, R8E, S30, SW of NW of SW; 3.5 miles NE of Milford, NW of Teeple Lake at SW base of Teeple Hill
TYPE: Woodland Prairie
COVER: not known
SOIL: Wasepi sandy loam, (pH 5.6-7.3, wrc 49-56%); area soils Oshtemo and Spinks loamy sand, Riddles sandy loam, Houghton muck
SETTING: Slope 5-10 deg., aspect SW; 3-5 acre secondary prairie, remnant of oak openings; abandoned field at N edge, oak-hickory woods on hill to E, fen, thicket, and wet meadow at S edge
CITATION: Thompson 1983a (chiefly for fen)

Species	Species
Achillea millefolium	Erigeron strigosus
Agrimonia gryposepala	Euphorbia corollata
Ambrosia artemisiifolia	Fragaria virginiana
Andropogon gerardii	Gaylussacia baccata
A. scoparius	Helianthus divaricatus
Anemone cylindrica	Hieraceum longipilum
Antennaria plantaginifolia	Lactuca canadensis
Apocynum androsaemifolium	Lespedeza capitata
Aristida purpurascens	L. virginica
Asclepias syriaca	Oenothera biennis
A. tuberosa	Parthenocissus quinquefolia
Aster azureus	Physalis heterophylla
A. ericoides	Plantago rugelii
A. laevis	Polygonatum pubescens
A. macrophyllus	Potentilla simplex
A. pilosus	Quercus alba
A. sagittifolius	Q. borealis
Baptisia tinctoria	Q. velutina
Campanula rotundifolia	Rhus radicans
Carya glabra	R. typhina
C. ovalis	Rosa carolina
Conyza canadensis	Rubus allegheniensis
Cornus florida	R. flagellaris
Corylus americana	R. occidentalis
Crataegus mollis	Silene antirrhina
Desmodium canadense	Sisyrinchium albidum
D. dillenii	Smilacina racemosa
D. glutinosum	Solidago juncea
D. illinoense	S. nemoralis
D. nudiflorum	S. speciosa
D. sessilifolium	
Eragrostis spectabilis	

Surveyed by P.W. Thompson, 1980

13. BAKERTOWN AMTRAK UPLAND

LOCATION: Berrien Co., T7S, R18W, S34, SW of SE; 1.8 miles SW of Buchanan, E of Bakertown Road in Amtrak line right-of-way
TYPE: Woodland Prairie
COVER: Andropogon gerardii dominant; A. scoparius subdominant
SOIL: Spinks loamy fine sand, pH 5.2, wrc 30-38%*; area soils Oshtemo sandy loam, Ockley and Riddles loam
SETTING: Slope 0-5 deg., aspect NW; 0.33 mile-long railroad prairie, remnant of oak openings; grades into wet prairie at W edge; cultivated fields, oak woodlots surround site
CITATION: Kohring 1981, 1982

Species	Species
Achillea millefolium	Lactuca canadensis
Ambrosia artemisiifolia	Liatris aspera
Andropogon gerardii	Lupinus perennis
A. scoparius	Monarda fistulosa
Anemone cylindrica	Oenothera biennis
Apocynum androsaemifolium	Osmorhiza claytoni
A. sibiricum	Panicum capillare (MAK)
Arabis lyrata (MAK)	P. virgatum
Asclepias syriaca	Parthenocissus quinquefolia
A. tuberosa	Phlox pilosa
A. verticillata	Physalis heterophylla (MAK)
Aster azureus	Poa compressa
A. laevis	Prunus serotina
A. pilosus	Pteridium aquilinum
Cacalia atriplicifolia	Quercus macrocarpa (MAK)
Ceanothus americanus	Q. velutina
Comandra richardsiana	Ranunculus fascicularis
Conyza canadensis	Ratibida pinnata
Coreopsis tripteris	Rhus typhina
Corylus americana	Rosa carolina
Desmodium illinoense	Rubus allegheniensis
Elymus canadensis	R. flagellaris
Equisetum arvense (MAK)	Rudbeckia hirta
E. hyemale	Salix humilis
E. laevigatum	Sassafras albidum
Erigeron strigosus	Sisyrinchium albidum (MAK)
Euphorbia corollata	Solidago graminifolia
Fragaria virginiana	S. juncea
Galium aparine	Tradescantia ohiensis
G. boreale (MAK)	Tridens flavus
Helianthus divaricatus	Veronicastrum virginicum
H. occidentalis	

14. SHANGHAI RIDGE

LOCATION: Washtenaw Co., T2S, R7E, S31, NE; 2.5 miles NW of Ypsilanti, in a large oxbow of the Huron River, N side of Conrail line
TYPE: Woodland Prairie
COVER: Andropogon gerardii dominant; Poa pratensis dominant on disturbed ground
SOIL: Boyer sandy loam, (pH 5.6-6.5, wrc 38-45%); area soils (in floodplain) Spinks-Boyer loamy sand, Wasepi sandy loam; (on uplands) Hoytville, Nappanee silt clay loam, St. Clair clay loam
SETTING: Slope 0-10 deg. (steeper on railroad cut), aspect SE; 0.25 mile-long railroad prairie (remnant of oak openings) on sand deposit of glacial Huron River; oak woods and abandoned cropland on N; mesic sand prairie on terrace to S
CITATION: Walpole 1924, Thompson 1983a

Species

Ambrosia artemisiifolia (PWT)
Andropogon gerardii
A. scoparius
Anemone cylindrica (PWT)
Antennaria plantaginifolia
Apocynum androsaemifolium
Asclepias syriaca
A. tuberosa
Aster ericoides
A. macrophyllus (PWT)
A. pilosus (PWT)
Blephilia ciliata (PWT)
Carex bicknellii
C. pensylvanica
Ceanothus americanus
Celastrus scandens (PWT)
Comandra richardsiana (PWT)
Conyza canadensis (PWT)
Coreopsis tripteris (PWT)
Cornus florida (PWT)
Corylus americana
Cyperus filiculmis (PWT)
Desmodium dillenii (PWT)
D. glutinosum (PWT)
D. illinoense (PWT)
D. marilandicum (PWT)
Dioscorea villosa (PWT)
Elymus canadensis (PWT)
Equisetum arvense
Erigeron strigosus
Euphorbia corollata
Gentiana flavida

Species

Liatris novae-angliae (PWT)
Lithospermum canescens
Lysimachia quadrifolia (PWT)
Oenothera biennis (PWT)
Panicum latifolium
P. leibergii
Parthenocissus quinquefolia (PWT)
Penstemon hirsutus (PWT)
Phlox pilosa (PWT)
Physalis heterophylla (PWT)
Poa pratensis
Polygala verticillata
Polygonatum biflorum
Populus grandifentata
Prenanthes alba (PWT)
Prunella vulgaris
Prunus serotina
P. virginiana (PWT)
Pteridium aquilinum
Pyrus coronaria (PWT)
Quercus alba
Q. macrocarpa
Q. velutina
Rhus glabra (PWT)
R. typhina (PWT)
Rosa carolina
Rubus allegheniensis (PWT)
R. flagellaris
R. occidentalis (PWT)
Rudbeckia hirta
Salix humilis
Sassafras albidum (PWT)

Species	Species
Helianthus divaricatus (PWT)	Silene antirrhina
H. occidentalis	Smilacina racemosa
Lactuca canadensis (PWT)	Smilax lasioneura
Lechea villosa (PWT)	Solidago nemoralis
Lepidium virginicum (PWT)	Smilax lasioneura
Lespedeza capitata	S. speciosa
Liatris aspera	Vitis aestivalis

15. OAK HILL CEMETERY

LOCATION: Barry Co., T2N, R10W, S17, SW of SW of SE; E edge of Orangeville, E of Marsh Road
TYPE: Woodland Prairie
COVER: Andropogon scoparius (A. gerardii near woods) dominant
SOIL: Coloma loamy fine sand, pH 6.3, wrc 52%; area soils Coloma loamy fine sand, Plainfield sand, Bellafontaine sandy loam (no modern soil survey)
SETTING: Slope 30 deg., aspect NNE; less than 1 acre cemetery prairie, remnant of oak openings; black oak-white oak woods (with pignut hickory, black cherry, etc.) surround site

Species	Species
Achillea millefolium	Euphorbia corollata
Andropogon gerardii	Helianthemum canadense
A. scoparius	Helianthus divaricatus
Anemone cylindrica	Hieraceum gronovii
Antennaria plantaginifolia	Kuhnia eupatorioides
Artemisia caudata	Lespedeza virginica
Asclepias syriaca	Panicum oligosanthes
A. verticillata	Poa pratensis
Aster azureus	Quercus velutina
Carex muhlenbergii	Rhus typhina
Carya glabra	Rosa suffulta
Ceanothus americanus	Rubus flagellaris
Conyza canadensis	Rudbeckia hirta
Cyperus filiculmis	Sassafras albidum
Desmodium rotundifolium	Solidago nemoralis
Erigeron strigosus	Tradescantia ohiensis
Eragrostis spectabilis	

16. MIDDLEVILLE CEMETERY

LOCATION: Barry Co., T4N, R10W, S23, NE of SW of SE; E edge of Middleville, N of State Street
TYPE: Woodland Prairie
COVER: Andropogon gerardii dominant
SOIL: Bellafontaine sandy loam; area soils Bellafontain sandy loam, Fox sandy loam, Bellafontaine sandy loam (no modern soil survey)
SETTING: Slope 30 deg., aspect W; 6-7 acre prairie (remnant of oak openings) in back of cemetery; oak woods (with white pine), cemetery, homesteads surround site

Species	Species
Andropogon gerardii	Lysimachia lanceolata
A. scoparius	Monarda fistulosa
Anemone cylindrica	Panicum latifolium
Antennaria plantaginifolia	P. oligosanthes
Apocynum cannabinum	P. virgatum
Artemisia caudata	Phlox pilosa
Asclepias tuberosa	Physalis heterophylla
Aster laevis	Pinus strobus
A. sagittifolius	Poa compressa
Cacalia atriplicifolia	Polygonatum biflorum
Ceanothus americana	Potentilla simplex
Comandra richardsiana	Quercus velutina
Cornus florida	Rhus copallina
Corylus americana	Rosa carolina
Cyperus filiculmis	Rudbeckia hirta
Desmodium marilandicum	Salix humilis
D. paniculatum	Sassafras albidum
Dioscorea villosa	Smilacina racemosa
Fragaria virginiana	Solidago juncea
Galium boreale	S. nemoralis
Helianthus divaricatus	S. speciosa
Hieraceum longipilum	S. ulmifolia
Lactuca canadensis	Tradescantia ohiensis
Lespedeza hirta	Veronicastrum virginicum
Liatris aspera	Vicia americana
L. novae-angliae	Viola sororia

17. VANKAL

LOCATION: Van Buren Co., T2S, R13W, S12, SE of SE; 7 miles N of Mattawan, W side of Vankal Avenue (22nd Street) S of Fish Hatchery Road
TYPE: Dry Sand Prairie (Oak Barrens)
COVER: Andropogon virginicus dominant; Rubus flagellaris-Poa compressa subdominant; natural dominant probably Andropogon scoparius
SOIL: Coloma loamy sand, (pH 5.1-6.0, wrc 34-45%); area soils Plainfield and Spinks loamy sand, Oshtemo sandy loam
SETTING: Slope 5-10 deg., aspect S to SE; less than 1 acre secondary grassland, remnant of oak barrens; cultivated fields, young oak woods surround site

Species	Species
Andropogon scoparius	Krigia virginica (LAS)
Anemone cylindrica (LAS)	Kuhnia eupatorioides (LAS)
Aristida purpurascens	Lepidium densiflorum
Artemisia caudata	Lespedeza capitata
Asclepias amplexicaulis (LAS)	L. hirta (LAS)
A. tuberosa	Lupinus perennis
A. viridiflora (LAS)	Monarda punctata
Aster pilosus (HEB)	Panicum columbianum (HEB)
Aureolaria flava (HEB)	P. dichotomum (HEB)
Cladonia spp.	Poa compressa
Comandra richardsiana	Polygala polygama (LAS)
Conyza canadensis (LAS)	Polytrichum piliferum
Cyperus filiculmis	Potentilla simplex
Danthonia spicata	Quercus velutina
Desmodium canadense (LAS)	Rhus copallina
D. ciliare	R. typhina
D. rotundifolium (LAS)	Rubus flagellaris
Eragrostis spectabilis	Rudbeckia hirta
Euphorbia corollata	Sassafras albidum
Gnaphalium obtusifolium	Solidago nemoralis
Hieraceum gronovii (LAS)	S. rigida
Juniperus virginianum (HEB)	Trichostema dichotomum

18. FOSTER

LOCATION: Washtenaw Co., T2S, R6E, S18, NE of NE of NE; 0.6 miles E of Foster on Huron River Drive, between Conrail line and Huron River
TYPE: Woodland Prairie
COVER: Sorghastrum nutans dominant; Andropogon scoparius-Poa compressa locally subdominant
SOIL: Sebewa loam, pH 5.3, wrc 94%, (Fox sandy loam on ridges?); area soils (floodplain) Boyer loamy sandy, Fox sandy loam, Sebewa loam; (uplands) Miami, Conover, Brookston loam
SETTING: Slope 0-25 deg., aspect variable (railroad cut and river banks); 1-2 acre remnant of oak openings on a river terrace; black oak-white oak woods, railroad right-of-way, homesteads surround site

Species	Species
Andropogon gerardii	Phlox pilosa
A. scoparius	Poa compressa
Antennaria plantaginifolia	P. pratensis
Apocynum androsaemifolium	Populus grandidentata
Asclepias tuberosa	Quercus alba
Aster laevis	Q. macrocarpa
A. sagittifolius	Q. velutina
Carex pensylvanica	Rhus glabra
Cornus racemosa	Rosa carolina
Corylus americana	Rudbeckia hirta
Desmodium canadense	Salix humilis
Equisetum laevigatum	Silphium terebinthinaceum
Euphorbia corollata	Smilacina racemosa
Gentiana flavida (E.G. Voss 1962)	S. nemoralis
Helianthemum canadense	S. rigida
H. divaricatus	S. speciosa
Lespedeza capitata	Sorghastrum nutans
Liatris novae-angliae	

19. PRETTY LAKE

LOCATION: Kalamazoo Co., T3S, R12W, S21; 2 miles W of Texas Corners, E side of Pretty Lake
TYPE: Hillside/Woodland Prairie
COVER: Poa compressa dominant
SOIL: Spinks loamy sandy, pH 4.5, wrc 46%; area soils Oshtemo sandy loam, Coloma loamy sand, Kalamazoo loam
SETTING: Slope 45 deg., aspect W; less than 1 acre of prairie in patches on steep slope overlooking lake; homesteads surround and break up site, black oak woods on higher ground to E

Species	Species
Ambrosia artemisiifolia	Euphorbia corollata
Amelanchier arborea	Galium lanceolatum
Andropogon gerardii	Helianthus divaricatus
Anemone cylindrica	Lactuca canadensis
A. virginiana	Lespedeza capitata
Antennaria plantaginifolia	Liatris aspera
Apios americana	Phlox subulata
Apocynum cannabinum	Poa compressa
Aquilegia canadensis	Prunus serotina
Asclepias tuberosa	Quercus alba
Aster azureus	Q. velutina
A. laevis	Rhus radicans
A. sericeus (C.R. Hanes 1935)	R. typhina
Campanula rotundifolia	Rubus occidentalis
Claytonia virginica	Rudbeckia hirta
Convolvulus spithamaeus	Sassafras albidum
Cornus florida	Solidago altissima
Desmodium canadense	S. nemoralis
D. glutinosum	S. speciosa
D. nudicaulis	Tradescantia ohiensis
Elymus canadensis	Viburnum acerifolium
Equisetum laevigatum	Viola pedata
Erigeron annuus	V. sororia

20. HIGHLAND CEMETERY

LOCATION: Washtenaw Co., T3S, R7E, S4, SE of SE of NE; north side of Ypsilanti, west of River St. and Holmes St., on bluff above Huron River
TYPE: Hillside/Woodland Prairie
COVER: Andropogon gerardii-A. scoparius-Stipa spartea dominant
SOIL: Seward loamy fine sand (in a mapping unit of Spinks loamy sand), pH 6.8, wrc 39%; area soils Spinks and Boyer loamy sands and Wasepi sandy loam
SETTING: Slope 35-40 deg., aspect W to SW; 1-2 acre hillside prairie in former oak openings; transitional lowland prairie at base of slope, sedge fen beyond; oak woods on less-exposed slopes and old oak "savanna" in cemetery
CITATION: Brown 1905, Walpole 1924, Thompson 1983a

Species	Frequency	Species	Frequency
Allium cernuum		Koeleria macrantha (PWT)	
Andropogon gerardii	60%	Lespedeza hirta	
Andropogon scoparius	65	Liatris cylindracea	5%
Anemone cylindrica	15	Lithospermum canescens	5
Antennaria plantaginifolia	35	Monarda fistulosa	5
Asclepias tuberosa		Panicum implicatum	
Asclepias viridiflora	5	Panicum leibergii	20
Aster ericoides	30	Penstemon hirsutus	20
Aster laevis	15	Phlox pilosa	
Bouteloua curtipendula		Physalis heterophylla	5
Bromus kalmii		Poa compressa	55
Campanula rotundifolia		Poa pratensis	20
Carex pensylvanica	10	Prunus serotina	5
Carya glabra		Quercus alba	5
Ceanothus americanus	5	Quercus prinoides	15
Comandra richardsiana	5	Quercus velutina	5
Convolvulus spithamaeus	50	Rhus aromatica	5
Coreopsis tripteris	5	Rhus typhina	15
Corylus americana	15	Rosa carolina	20
Crataegus sp.	5	Rubus sp.	10
Desmodium canadense	10	Rudbeckia hirta	5
Desmodium sp.	5	Salix humilis	5
Equisetum laevigatum	25	Silphium terebinthinaceum	20
Erigeron strigosus	5	Solidago nemoralis	
Euphorbia corollata	60	Solidago rigida	15
Galium boreale		Sorghastrum nutans	20
Helianthemum canadense	5	Stipa spartea	80
Helianthus divaricatus	15	Taenidia integerrima	
Helianthus occidentalis	20	Vitis aestivalis	
Houstonia longifolia			

Brown (1905): Angelica venenosa, Gaultheria procumbens, Gaylussacia baccata, Lespedeza capitata, L. violacea, Lupinus perennis, Quercus muhlenbergii, Solidago caesia, S. speciosa, Vaccinium vacillans, Viola pedata

21. LONG LAKE

LOCATION: Barry Co., T3N, R10W, S28, NE; E of Long Lake, N of Gun Lake Road
TYPE: Woodland/Dry Sand Prairie (Oak Barrens)
COVER: Andropogon scoparius dominant
SOIL: Plainfield sand, pH 4.8, wrc 32%; area soils Coloma loamy fine sand, Plainfield sand (no modern soil survey)
SETTING: Slope 0-30 deg., aspect W to SW; 5 acres of secondary grassland (some disturbed), remnant of oak barrens; black oak woods, black locust thickets surround site

Species	Species
Agrostis hyemalis	Lespedeza capitata
Ambrosia artemisiifolia	L. hirta
Andropogon gerardii	Liatris aspera
A. scoparius	Monarda fistulosa
Anemone cylindrica	M. punctata
Artemisia caudata	Panicum depauperatum
Asclepias amplexicaulis	P. oligosanthes
A. syriaca	Pinus strobus
A. tuberosa	Poa compressa
Aster azureus	Polytrichum piliferum
Carya glabra	Populus grandidentata
Ceanothus americanus	Prunus serotina
Cladonia spp.	Pteridium aquilinum
Comandra richardsiana	Quercus alba
Conyza canadensis	Q. velutina
Coreopsis tripteris	Rhus copallina
Cornus florida	Rubus flagellaris
Cyperus filiculmis	Rudbeckia hirta
Danthonia spicata	Sassafras albidum
Desmodium nudiflorum	Solidago altissima
Erigeron annuus	S. nemoralis
Helianthus hirsutus	S. speciosa
Hieraceum gronovii	Spartina pectinata
H. longipilum	Tephrosia virginiana
Juglans nigra	Tradescantia ohiensis
Juniperus viginicus	

22. PLAINFIELD BLUFFS

LOCATION: Kent Co., T8N, R11W, S26, S of NW & N of SW; 2.6 miles NE of Plainfield Heights, W of M-44
TYPE: Hillside/Woodland Prairie
COVER: Andropogon scoparius-Stipa spartea codominant where sod remains; Poa compressa dominant under oaks
SOIL: Plainfield loamy sand, pH 5.0, wrc 47%; area soils Plainfield loamy sand, Chelsea loamy fine sand
SETTING: Slope 0-45 deg., aspect NE (5 deg. slope to SW was formerly prairie but now severely disturbed); 1-2 acres of grassland in patches, remnant of oak openings; oak woods on slopes toward river, apartments and abandoned disturbed fields on level ground

Species	Species
Andropogon scoparius	Penstemon hirsutus
Anemone cylindrica	Phlox pilosa
Antennaria neglecta	Poa compressa
Artemisia caudata	Polygonatum biflorum
Asclepias amplexicaulis	Polytrichum piliferum
Aster azureus	Populus grandidentata
Carex pensylvanica	Prunus serotina
Ceanothus americanus	Pteridium aquilinum
Cornus florida	Quercus borealis
C. racemosa	Q. velutina
Euphorbia corollata	Rubus flagellaris
Geum triflorum (C.W. Bazuin 1941)	R. occidentalis
Helianthemum canadense	Sassafras albidum
Lespedeza capitata	Smilacina racemosa
Liatris aspera	S. stellata
Lithospermum caroliniense	Stipa spartea
Lupinus perennis	Tradescantia ohiensis
Monarda fistulosa	Vaccinium angustifolium
Panicum columbianum	Viola pedata
P. commonsianum	Vitis aestivalis
P. oligosanthes	

23. FAY LAKE

LOCATION: Jackson Co., T4S, R2E, S14, NE of SW; 4.5 miles WNW of Brooklyn, at intersection of Fay Lake Road and abandoned railroad
TYPE: Woodland Prairie
COVER: Andropogon scoparius-Stipa spartea dominant
SOIL: Boyer sandy loam (in mapping unit of Houghton muck), pH 7.4, wrc 41%; area soils Hillsdale, Riddles sandy loam
SETTING: Slope 0-15 deg., aspect none (site is domed); less than 1 acre railroad prairie, remnant of oak openings; bur oak woods (with hickory and other oaks) on uplands, Spartina-Calamagrostis prairie and sedge meadow on lower ground (mostly grazed)

Species	Species
Allium cernuum	Lithospermum canescens
Andropogon gerardii	Monarda fistulosa
A. scoparius	Panicum leibergii
Anemone virginiana	Phlox pilosa
Apocynum androsaemifolium	Poa compressa
Asclepias hirtella	Pteridium aquilinum
A. tuberosa	Ratibida pinnata
Aster sagittifolius	Quercus macrocarpa
Campanula rotundifolia	Rosa carolina
Comandra richardsiana	Silphium terebinthinaceum
Coreopsis tripteris	Smilacina stellata
Corylus americana	Solidago rigida
Equisetum laevigatum	Sorghastrum nutans
Euphorbia corollata	Spartina pectinata
Galium boreale	Stipa spartea
Juniperus virginiana	Taenidia integerrima
Lactuca canadensis	Zizia aurea

LAKE MINNEWAUKON

LOCATION: St. Joseph Co., T7S, R10W, S34, SE; 2 miles WNW of Sturgis, at SE shore of Lake Minnewaukon
TYPE: Hillside Prairie
COVER: Andropogon scoparius dominant; Poa compressa subdominant
SOIL: Oshtemo sandy loam, pH 5.0, wrc 30%; area soils Oshtemo sandy loam, Spinks loamy sand
SETTING: Slope 0-25 deg., aspect NW; less than 1 acre hillside prairie remnant; homesteads bisect and surround site, overtopped by oaks in places; abandoned fields to E
CITATION: Daniels 1904

Species	Species
Achillea millefolium	Lespedeza virginica
Andropogon gerardii	Oenothera parviflora
A. scoparius	Panicum oligosanthes
Antennaria plantaginifolia	Phlox subulata (also by Daniels)
Aster laevis	Poa compressa
A. pilosus	Polygonatum biflorum
Besseya bullii	Populus tremuloides
Bouteloua curtipendula (Daniels)	Quercus alba
Campanula rotundifolia (Daniels)	Q. borealis
Carya glabra	Q. velutina
C. ovalis	Ranunculus fascicularis (Daniels)
Cornus florida	Rosa suffulta
Heuchera hirsuticaulis	Solidago speciosa
Lespedeza hirta	Viola pedata

25. FLOWERFIELD CREEK

LOCATION: St. Joseph Co., T5S, R12W, S12, NW; 1 mile S of Flowerfield, N of Pulver Road on E side of Flowerfield Creek
TYPE: Hillside Prairie
COVER: Poa compressa dominant
SOIL: Oshtemo loam, (pH 5.1-6.5, wrc 38-56%); area soils Oshtemo sandy loam, Spinks loamy sand, Kalamazoo loam
SETTING: Slope 0-45 deg., aspect W; less than 1 acre hillside prairie overlooking creek; oak woods surround site, cultivated fields surround woods

Species	Species
Amelanchier arborea	Lathyrus ochroleucus (LAS)
Andropogon gerardii	Lespedeza hirta
Antennaria plantaginifolia	Luzula multiflora
Arenaria stricta	Poa compressa
Besseya bullii	Polytrichum piliferum
Cacalia atriplicifolia	Quercus alba
Ceanothus americanus	Q. velutina
Cornus florida	Rosa carolina
Equisetum arvense	Sassafras albidum
E. laevigatum	Senecio plattensis
Galium pilosum (LAS)	Taenidia integerrima
Hamamelis virginiana	Tradescantia ohiensis
Heuchera hirsticaulis (LAS)	Vicia americana (LAS)
Krigia biflora (LAS)	Viola pedata

26. KLINGER LAKE

LOCATION: St. Joseph Co., T7S, R11W, S36, S of NW; 5.3 miles ENE of White Pigeon, N shore of Klinger Lake
TYPE: Hillside Prairie
COVER: no clear dominants; Equisetum laevigatum locally dominant
SOIL: Spinks loamy sand, pH 5.7, wrc 43%; area soils Spinks loamy sand, Oshtemo sandy loam
SETTING: Slope 45 deg., aspect S; scattered patches of prairie vegetation between homesteads; black oak woods at top of bluff, red oak-hickory woods at base of slope

Species	Species
Achillea millefolium	Heuchera hirsticaulis
Ambrosia artemisiifolia	Juniperus virginiana
Andropogon gerardii	Lactuca canadensis
Anemone cylindrica	Lithospermum canescens
A. virginiana	Osmorhiza claytoni
Antennaria plantaginifolia	Parthenocissus quinquefolia
Apios americana	Phlox bifida (C.F. Wheeler 1890)
Arabis lyrata	P. divaricata
Asclepias tuberosa	P. pilosa
Aster cordifolius	Poa compressa
A. laevis	Polygonatum biflorum
A. sagittifolius	Populus grandidentata
Aureolaria flava	Pteridium aquilinum
Besseya bullii (H.W. Trudell 1926)	Quercus alba
Blephilia ciliata	Q. borealis
Campanula rotundifolia	Q. velutina
Carex pensylvanica	Rosa carolina
Carya glabra	Rudbeckia hirta
Claytonia virginica	Sanicula marilandica
Comandra richardsiana	Senecio plattensis
Coreopsis tripteris	Smilacina racemosa
Cornus florida	Solidago caesia
Equisetum laevigatum	Tilia americana
Euphorbia corollata	Tradescantia ohiensis
Fragaria virginiana	Viola pedata
Galium boreale	Vitis aestivalis
Helianthus divaricatus	

27. HARWOOD LAKE

LOCATION: Barry Co., T4N, R10W, S32, NW of NW; 6.3 miles ENE of Wayland, E shore of Harwood Lake
TYPE: Hillside Prairie
COVER: Andropogon gerardii-Stipa spartea dominant
SOIL: Fox sandy loam (in mapping unit of Plainfield loamy sand), pH 7.8, wrc 59% (on slope), pH 6.4, wrc 85% (at crest); area soils Fox sandy loam, Fox loam, Plainfield loamy sand (no modern soil survey)
SETTING: Slope 40 deg., aspect W; 0.5 acre hillside prairie overlooking lake; young black oak-white oak woods at top of slope, thickets at base of slope along lakeshore

Species	Species
Acer rubrum	Lithospermum canescens
Amelanchier arborea	Monarda punctata
Andropogon gerardii	Panicum latifolium
A. scoparius	Penstemon hirsutus
Anemone cylindrica	Phlox pilosa
Antennaria plantaginifolia	Pinus strobus
Apocynum androsaemifolium	Poa compressa
Asclepias viridiflora	Polygonatum pubescens
Aster azureus	Populus tremuloides
Besseya bullii	Pteridium aquilinum
Bouteloua curtipendula	Quercus alba
Campanula rotundifolia	Q. velutina
Carya glabra	Ratibida pinnata
Ceanothus americanus	Rhus typhina
Comandra richardsiana	Rosa carolina
Danthonia spicata	Rudbeckia hirta
Elymus canadensis	Salix humilis
Equisetum laevigatum	Sassafras albidum
Euphorbia corollata	Smilacina racemosa
Galium boreale	Solidago nemoralis
Helianthus divaricatus	Stipa spartea
Hepatica americana	Tradescantia ohiensis
Juniperus virginiana	Vicia americana
Lespedeza hirta	Viola pedata
Liatris cylindricea	Vitis aestivalis
L. novae-angliae	

28. THORNAPPLE BLUFFS

LOCATION: Kent Co., T6N, R10W, S27, center of W of NE, and S22, SW of SE; 0.25 miles W of Whitneyville, on N bank of Thornapple River
TYPE: Hillside Prairie
COVER: Poa compressa dominant (S27); Andropogon gerardii dominant (S22)
SOIL: Oakville loamy fine sand, pH 5.4, (wrc 23-? %); area soils Blount loam, Coloma loamy sand, Isabella loam, Kent silt loam
SETTING: Slope 20-35 deg., aspect S to NW; 9 acre hillside prairie in two parts, on 0.5 mile of river bluff; oak woods surround site

Species	Species
Apocynum androsaemifolium (rare)	Pinus strobus (canopy dominant)
Aureolaria flava (occasional)	Poa compressa (dominant herb)
Besseya bullii (local, uncommon)	Prunus virginiana (common)
Cacalia atriplicifolia (occasional)	Quercus alba (common in canopy)
Campanula rotundifolia (occasional)	Q. borealis (frequent in canopy)
Celastrus scandens (rare)	Q. velutina (occasional in canopy)
Comandra richardsiana (common)	Ratibida pinnata (rare)
Fraxinus americana (occas. in canopy)	Rhus radicans (occasional)
Galium boreale (common)	R. typhina (occasional)
Gaylussacia baccata (occasional)	Rosa suffulta (occasional)
Helianthus divaricatus (common)	Scrophularia lanceolata (rare)
Hepatica americana (common)	Smilacina racemosa (rare)
Heuchera hirsuticaulis (frequent)	S. stellata (common)
Houstonia longifolia (local, rare)	Smilax lasioneura (occasional)
Juniperus virginiana (common)	Solidago nemoralis
Lathyrus ochroleucus (occasional)	S. rigida (occasional)
Lespedeza capitata (local, rare)	Stipa spartea (local, rare)
Ostrya virginiana (occas. in canopy)	Tilia americana (occas. in canopy)
Penstemon hirsutus (rare)	Vitis aestivalis (frequent)

Surveyed by S.R. Crispin, 1981

29. BRIARCREST

LOCATION: Berrien Co., T7S, R17W, S27, NE of SE; NW edge of City of Niles, W of Lincoln St., N side of Amtrak line
TYPE: Woodland Prairie
COVER: Andropogon gerardii dominant; Poa pratensis subdominant
SOIL: Martinsville fine sandy loam, (pH 5.6-7.3, wrc 60-68%); area soils Ockley and Riddles loam, Oshtemo sandy loam
SETTING: Slope 0-10 deg., aspect SE; 2 acre woodland prairie in a natural amphitheater (remnant of oak openings) and adjacent railroad prairie (bulldozed 1982); thicket, disturbed secondary woods, abandoned fields, and apartment buildings surround site

Species	Frequency	Species	Frequency
Achillea millefolium	22%	Lithospermum canescens	8%
Andropogon gerardii	88*	Lysimachia lanceolata	6
Anemone cylindrica	2	Monarda fistulosa	6
Antennaria neglecta	20	Panicum oligosanthes	18
Aristida purpurascens		P. virgatum	
Asclepias tuberosa		Poa pratensis	48
A. viridiflora	2	Potentilla arguta	2
Aster azureus	10	P. simplex	4
A. ericoides	6	Ranunculus fascicularis (common)	
A. laevis	56	Ratibida pinnata	18
Baptisia leucantha	2	Rhus copallina (rare)	
Carex bicknellii¶	24	R. glabra (common)	
Desmodium canadense	4	Rubus flagellaris	76
D. ciliare	20	Salix humilis (local)	
D. marilandicum	26	Silphium integrifolium (nearby)	
Elymus canadensis		Sisyrinchium albidum (rare)	
Erigeron strigosus	2	Solidago juncea	44§
Euphorbia corollata	82	S. nemoralis (common)	
Fragaria virginiana	6	S. rigida	14
Galium pilosum	2	Sorghastrum nutans (uncommon?)	
Helianthus occidentalis	46	Tradescantia ohiensis	30
H. subtuberosus	4	Veronicastrum virginicum	
Hieraceum gronovii	2	Vicia americana	2
Lactuca canadensis	10	Viola papilionacea	2
Lespedeza capitata	2		

* includes some Sorghastrum nutans
¶ includes some Carex cephalophora
§ includes some Solidago nemoralis

Surveyed by L.A. Schaddelee, 1978

30. XY AVENUE

LOCATION: Kalamazoo Co., T4S, R11W, S31, SE; 2 miles S of Schoolcraft, S of XY Avenue along Conrail line
TYPE: Dry-mesic Prairie
COVER: Poa compressa-Rubus flagellaris dominant; Aster laevis subdominant; (Stipa spartea-Andropogon gerardii natural dominant?)
SOIL: Schoolcraft loam, pH 4.9 (5.6-7.3), wrc 37% (68-90%); area soils Schoolcraft loam
SETTING: Slope 0-5 deg., aspect SE; 0.5 mile-long secondary railroad prairie, remnant of Prairie Ronde (top layer of soil removed); undulating to level former prairie (now cornfields) surrounds site; black cherry thickets at south end have entered prairie since settlement

Species	Species
Achillea millefolium	Lithospermum canescens
Agropyron trachycaulum	Lysimachia lanceolata
Amorpha canescens	Monarda fistulosa
Andropogon gerardii	Panicum depauperatum
Antennaria neglecta	P. oligosanthes
Apocynum cannabinum	P. virgatum
Asclepias amplexicaulis	Phlox bifida
A. syriaca	Poa compressa
A. tuberosa	P. pratensis
Aster ericoides	Prunus americana
A. laevis	P. serotina
A. pilosus	Ratibida pinnata
A. sericeus (R. Brewer 1963)	Rhus glabra
Baptisia leucantha	Rosa carolina
Carex bicknellii	Rubus flagellaris
Ceanothus americanus	R. occidentalis
Cirsium hillii (C.R. Hanes 1936)	Rudbeckia hirta
Coreopsis palmata	Silene antirrhina
Desmodium illinoense	Silphium integrifolium
Erigeron strigosus	Solidago graminifolia
Euphorbia corollata	S. nemoralis
Fragaria virginiana	Sorghastrum nutans
Helianthus occidentalis	Stipa spartea
Hieraceum longipilum	Tradescantia ohiensis
Hypericum punctatum	Tridens flavus
Kuhnia eupatorioides	Veronicastrum virginicum
Lactuca canadensis	Viola pedatifida
Leptoloma cognatum	Vitis aestivalis
Lespedeza capitata	

Surveyed by H.E. Ballard, 1979

31. STURGIS

LOCATION: St. Joseph Co., T8S, R10W, S7, N of NE of NE; 4 miles W of Sturgis, NW of Shimmel Road and US-12, along Conrail line
TYPE: Woodland Prairie
COVER: Poa pratensis-Aster laevis-other forbs dominant; Andropogon gerardii-A. scoparius subdominant
SOIL: Oshtemo sandy loam, pH 6.7, wrc 43%; area soils Oshtemo sandy loam
SETTING: Slope 0-5 deg., aspect S; 4.2 acre railroad prairie, remnant of oak plains; cultivated fields, homesteads surround site
CITATION Scharrer 1971 (Site No. 17), Thompson 1975, 1983a

Species	Species
Achillea millefolium	Lithospermum canescens
Agrostis gigantea (PWT)	Lupinus perennis (PWT)
Ambrosia artemisiifolia (PWT)	Monarda fistulosa
Amorpha canescens	Oenothera biennis
Andropogon gerardii	Panicum oligosanthes
A. scoparius	Phlox pilosa (PWT)
Anemone cylindrica	Poa compressa (PWT)
Antennaria plantaginifolia (PWT)	P. pratensis
Apocynum androsaemifolium	Polygonatum biflorum
A. cannabinum (PWT)	Prunus serotina
Asclepias amplexicaulis (PWT)	Quercus macrocarpa
A. purpurascens (PWT)	Q. prinoides
A. syriaca	Q. velutina
A. tuberosa	Ranunculus fascicularis
A. verticillata	Ratibida pinnata
Aster azureus (LAS)	Rhus glabra
A. ericoides	Rosa carolina
A. laevis	Rubus flagellaris (PWT)
A. pilosus (PWT)	Rudbeckia hirta
Carex pensylvanica (PWT)	Salix humilis
Carya glabra	Sanicula marilandica
Ceanothus americanus	Silphium integrifolium (PWT)
Comandra richardsiana	Smilacina racemosa
Coreopsis palmata	S. stellata
Corylus americana	Solidago altissima
Desmodium illinoense	S. graminifolia
D. sessilifolium	S. juncea
Erigeron annuus	S. rigida
E. strigosus	S. speciosa
Euphorbia corollata	Sorghastrum nutans
Fragaria virginiana	Taenidia integerrima
Geranium maculatum (PWT)	Thalictrum dasycarpum (PWT)
Helianthus hirsutus (LAS)	Thaspium barbinode (PWT)
H. occidentalis	Tradescantia ohiensis
H. strumosus	Tridens flavus
Heuchera hirsuticaulis	Vernonia missurica (PWT)
Lactuca canadensis (PWT)	Veronicastrum virginicum

Species	Species
Leptoloma cognatum	Vitis aestivalis
Lespedeza capitata	Zizia aurea (PWT)
Lilium michiganense (PWT)	

32. BERTRAND

LOCATION: Berrien Co., T8S, R17W, S14; 0.4 miles NE of Bertrand, along Conrail line between Fulkerson Road and Bertrand road
TYPE: Woodland Prairie
COVER: Andropogon gerardii-A. scoparius dominant
SOIL: Oshtemo sandy loam, pH 6.5, wrc 41%; area soils Oshtemo sandy loam (some Riddles and Ockley loam, Spinks loamy fine sand, Oakville fine sand)
SETTING: Slope 0-10 deg., aspect generally W; 0.5 mile-long railroad prairie, remnant of oak openings; black oak woods, homesteads, light industry, etc. surround site
CITATION Thompson 1975

Species	Species
Achillea millefolium	Liatris aspera
Andropogon gerardii	Lithospermum canescens
A. scoparius	L. caroliniensis
Anemone cylindrica	Lupinus perennis
Aristida purpurascens	Lysimachia lanceolata
Asclepias amplexicaulis	Monarda fistulosa
A. syriaca	M. punctata
A. tuberosa	Penstemon hirsutus
A. verticillata (PWT)	Phlox pilosa (PWT)
A. viridiflora	Physalis heterophylla (PWT)
Aster azureus	Poa compressa
A. laevis	Polygonatum biflorum
A. pilosus (PWT)	P. pubescens
A. sagittifolius (PWT)	Potentilla simplex (PWT)
Cacalia atriplicifolia	Pteridium aquilinum
Carex pensylvanica	Ranunculus fascicularis
Ceanothus americanus	Ratibida pinnata
Celastrus scandens (PWT)	Rhus glabra
Cirsium discolor	Rosa carolina
Comandra richardsiana	Rubus flagellaris
Conyza canadensis (PWT)	Rudbeckia hirta
Coreopsis lanceolata	Scrophularia lanceolata (PWT)
C. palmata	Senecio plattensis
Desmodium canadense (PWT)	Silene antirrhina (PWT)
D. dillenii (PWT)	Sisyrinchium albidum
D. illinoense (PWT)	Smilacina racemosa
D. marilandicum (PWT)	S. stellata (PWT)
Eragrostis spectabilis (PWT)	Smilax ecirrata (PWT)
Erigeron strigosus	Solidago altissima (PWT)

Species	Species
Euphorbia corollata	S. canadensis (PWT)
Fragaria virginiana	S. juncea
Galium aparine (PWT)	S. nemoralis
G. boreale (PWT)	S. rigida
G. circaezans (PWT)	S. speciosa
G. pilosum (PWT)	Sorghastrum nutans
Geranium maculatum (PWT)	Specularia perfoliata (PWT)
Helianthus divaricatus	Thalictrum dasycarpum (PWT)
H. occidentalis	Thaspium barbinode (PWT)
Kuhnia eupatorioides (PWT)	Tradescantia ohiensis
Krigia biflora (PWT)	Tridens flavus
Lactuca biennis (PWT)	Verbena stricta
L. canadensis (PWT)	Viola sororia (PWT)
Lespedeza capitata	Zizia aurea
L. procumbens (PWT)	

Surveyed by L.A. Schaddelee, 1981

33. STATE LINE

LOCATION: Berrien Co., T8S, R17W, S24, NW of NE; 1.5 mile ESE of Bertrand, E of 13th Street and S of Redfield Street (Ontario Road)
TYPE: Dry Sand Prairie (Oak Barrens)/Woodland Prairie
COVER: Andropogon scoparius dominant
SOIL: Plainfield loamy sand, pH 4.8, (wrc 15-34%); area soils Plainfield loamy sand, Oshtemo sandy loam (some Spinks loamy fine sand and Oakville fine sand)
SETTING: Slope 0-5 deg., aspect S; 20 acre secondary sand prairie, remnant of oak barrens (transitional to oak openings); black oak woods, trailer park, abandoned fields, homesteads surround site

Species	Species
Achillea millefolium	Leptoloma cognatum
Ambrosia artemisiifolia	Lespedeza capitata
Andropogon gerardii	Linaria canadensis (HEB)
A. scoparius	Lupinus perennis
Arabis glabra	Panicum oligosanthes
Aristida purpurascens	Poa pratensis
Asclepias amplexicaulis (HEB)	Polytrichum piliferum
Aster pilosus	Potentilla simplex (HEB)
Carya glabra	Prunus serotina
Cladonia spp.	Quercus velutina
Conyza canadensis	Rhus copallina
Coreopsis lanceolata	R. typhina
C. palmata (HEB)	Rosa carolina
Eragrostis spectabilis	Rubus flagellaris

Species	Species
Euphorbia corollata	Sassafras albidum
Gnaphalium obtusifolium	Tridens flavus
Hieraceum gronovii	Viola fimbriatula (HEB)
Lactuca canadensis	V. pedata (HEB)
Lepidium virginicum	

34. HELMER BROOK

LOCATION: Calhoun Co., T1S, R8W, S33, SE; 4 miles WNW of Battle Creek, N of the Amtrak line at Helmer Brook
TYPE: Woodland Prairie
COVER: Andropogon scoparius-Sorghastrum nutans dominant; A. gerardii subdominant at top of slope
SOIL: Plainfield sandy loam, pH 5.9, wrc 49%; area soils Plainfield sandy loam, Fox sandy loam (no modern soil survey)
SETTING: Slope 15 deg., aspect N; less than 1 acre prairie, remnant of oak openings; narrow strip of Spartina pectinata-Sorghastrum nutans wet-mesic prairie at base of slope, sedge fen beyond; black oak woods, landfill, abandoned gravel pits, shrubby wetlands surround rest of site
CITATION: Thompson 1983a

Species	Species
Achillea millefolium	Lilium philadelphicum
Andropogon gerardii	Lithospermum canescens
A. scoparius	Lobelia spicata
Anemone cylindrica	Lupinus perennis
Antennaria plantaginifolia	Monarda fistulosa
Asclepias tuberosa	Oenothera tetragona
Aster azureus	Panicum leibergii
A. laevis	P. praecocious
A. novae-angliae	Phlox pilosa
Cacalia atriplicifolia	Pycnanthemum virginianum
Coreopsis tripteris	Quercus macrocarpa
Corylus americana	Q. velutina
Desmodium canadense	Ratibida pinnata
D. illinoense	Rhus typhina
Equisetum laevigatum	Rosa suffulta
Euphorbia corollata	Rudbeckia hirta
Fragaria virginiana	Silphium terebinthinaceum
Galium boreale	Sisyrinchium albidum
Helianthus occidentalis (LAS)	Solidago rigida
Heuchera hirsuticaulis	S. speciosa
Krigia biflora	Sorghastrum nutans
Lathyrus palustris	Spartina pectinata
Lespedeza capitata	Tradescantia ohiensis
Liatris novae-angliae	Zizia aurea

35. ROY ROAD

LOCATION: St. Joseph Co., T8S, R12W, S22, NW of NW; 3.5 miles SW of White Pigeon, in Conrail line N and S of Roy Road, and just W of railroad along Roy Road
TYPE: Woodland Prairie/Mesic Prairie
COVER: Andropogon scoparius-A. gerardii dominant (not evident now)
SOIL: Spinks loamy sand, Bronson sandy loam, (pH 5.1-7.3, wrc 38-56%); area soils Spinks loamy sand, Oshtemo sandy loam
SETTING: Slope 0-5 deg., aspect W; former railroad prairie and adjacent land (now largely destroyed), remnant of oak openings; 5-6 acre black oak-white oak woods NW of crossing still harbors some prairie species; cultivated fields E and N, mostly secondary marsh on W, oak and homesteads S
CITATION: Scharrer 1971 (Site No. 345, 346)

Species	Species
Amorpha canescens	Lupinus perennis
Andropogon gerardii	Lysimachia lanceolata
A. scoparius	Panicum oligosanthes (EMS)
Anemone cylindrica	Phlox pilosa
Asclepias amplexicaulis	Poa pratensis
Aster ericoides (EMS)	Polygala polygama
Baptisia leucantha	Potentilla arguta
Cacalia atriplicifolia	Prunus serotina
Campanula rotundifolia	Quercus alba
Ceanothus americanus	Q. velutina
Comandra richardsiana	Ratibida pinnata
Coreopsis palmata	Rhus glabra
C. tripteris	Rosa carolina
Corylus americana	Rudbeckia hirta
Desmodium illinoense (EMS)	Salix humilis
D. sessilifolium (EMS)	Sassafras albidum
Elymus canadensis	Silphium terebinthinaceum
Eryngium yuccifolium (EMS)	Smilacina stellata
Galium boreale	Solidago graminifolia (EMS)
G. pilosum	S. rigida
Helianthemum canadense	Sorghastrum nutans (EMS)
Helianthus divaricatus	Spartina pectinata
H. occidentalis	Stipa spartea
H. strumosus	Swertia caroliniensis
Heuchera hirsuticaulis	Tephrosia virginiana
Kuhnia eupatorioides (EMS)	Thalictrum dasycarpum
Lactuca canadensis	Tradescantia ohiensis
Lespedeza capitata	Verbena stricta
Liatris aspera	Veronicastrum virginicum
Lithospermum canescens	Zizia aurea
Lobelia spicata	

Surveyed by L.A. Schaddelee, 1981

36. KLUMBIS ROAD

LOCATION: Cass Co., T6S, R16W, S22, SE of SW; 1.5 miles NW of Pokagon, between Amtrak line and Klumbis Road
TYPE: Woodland Prairie/Mesic Prairie
COVER: Andropogon gerardii dominant; Andropogon scoparius local dominant
SOIL: Miami sandy loam, pH 5.7 (trough), 7.5 (slope); area soils Miami sandy loam, Miami sand (no modern soil survey)
SETTING: Slope 0-50 deg., aspect WNW (site is a trough between the railroad embankment and the higher natural level of the road; natural slope and aspect 0-5 deg., SW); 0.4 mile long railroad prairie, remnant of oak openings; abandoned gravel quarry across railroad; cultivated fields, black oak woodlots, occasional homesteads occupy surrounding land
CITATION: Scharrer 1971 (Site No. 245), Kohring 1981, Thompson 1983a

Species	Species
Achillea millefolium	Liatris aspera
Agrostis hyemalis	L. novae-angliae (LAS)
Andropogon gerardii	Lithospermum canescens
A. scoparius	Luzula multiflora
Anemone cylindrica	Monarda fistulosa
A. virginiana	Oenothera biennis
Antennaria plantaginifolia	Panicum depauperatum
Apocynum androsaemifolium	P. implicatum
A. sibiricum	P. latifolium
Asclepias purpurascens	P. leibergii
A. syriaca	P. oligosanthes
A. tuberosa	Parthenocissus quinquefolia
Aster azureus (MAK)	Phlox pilosa
A. laevis	Populus grandidentata
Bromus kalmii	Prunus serotina
Cacalia atriplicifolia	Pteridium aquilinum
Carex bicknellii	Quercus alba
Carya glabra	Q. prinoides
Ceanothus americanus	Q. velutina
Cirsium discolor	Ranunculus fascicularis
Clematis virginiana	Ratibida pinnata
Comandra richardsiana	Rhus copallina
Coreopsis palmata	R. glabra
C. tripteris	R. typhina
Cornus racemosa	Rosa carolina
Corylus americana	Rubus hispidus (MAK)
Desmodium marilandicum	Salix humilis
Dioscorea villosa	S. interior
Eragrostis spectabilis (MAK)	Sassafras albidum
Equisetum hyemale	Senecio plattensis (MAK)
E. laevigatum	Silene antirrhina
Erigeron annuus	Silphium integrifolium
E. strigosus	Smilacina racemosa

Species	Species
Euphorbia corollata	Solidago graminifolia (EMS)
Fragaria virginiana	Solidago nemoralis
Galium boreale	S. rigida (LAS)
G. pilosum	S. speciosa (LAS)
Gentiana flavida	Sorghastrum nutans (MAK)
Geranium maculatum	Sporobolus cryptandrus
Helianthus divaricatus	Swertia caroliniensis
H. occidentalis	Taenidia integerrima
H. strumosus	Thalictrum dasycarpum
Hieraceum longipilum	Thaspium trifoliatum
Kuhnia eupatorioides (MAK)	Tradescantia ohiensis
Lactuca canadensis	Verbena stricta
Leptoloma cognatum (LAS)	Veronicastrum virginicum
Lespedeza capitata	Zizia aurea
L. hirta	

37. OSHTEMO FRUIT BELT

LOCATION: Kalamazoo Co., T2S, R12W, S25, NW of SE; 1.5 miles NE of Oshtemo, in right-of-way of former Fruit Belt Railroad (original Michigan Central line) between 11th Street and 12th Street (Drake Road)
TYPE: Mesic Prairie
COVER: Andropogon gerardii dominant; Andropogon scoparius subdominant
SOIL: Kalamazoo loam, pH 7.0 (mid- to lower slope), wrc 60-83%*; area soils Kalamazoo and Schoolcraft loam
SETTING: Slope 37 deg., aspect N (a railroad cut); 0.3 mile-long railroad prairie, on north edge of Genessee Prairie; site destroyed by contruction of US-131 and a restaurant
CITATION: Brewer unpubl.

Species	Frequency	Species	Frequency
Achillea millefolium	32.3%	Monarda fistulosa	40.0%
Agropyron trachycaulum	10.8	Phlox pilosa	20.0
Andropogon gerardii	83.1	Poa compressa	40.5
A. scoparius	35.4	P. pratensis	7.1
Anemone quinquefolia	3.1 (25.0*)	Polygonatum biflorum	2.5*
A. virginiana	47.7	Potentilla simplex	4.5
Angelica venenosa	3.1	Prunella vulgaris	1.5
Antennaria plantaginifolia	30.8	Prunus serotina	3.1
Apocynum androsaemifolium	16.9	Pteridium aquilinum	35.4
Arenaria stricta	2.5*	Quercus macrocarpa	
Asclepias tuberosa	1.5	Q. velutina	1.5
Aster laevis	23.1	Ranunculus fascicularis	12.5*
A. pilosus	3.1	Rhus glabra	4.8
A. sagittifolius	47.7	Rosa carolina	38.5

Species	Frequency	Species	Frequency
Botrychium multifidum	1.5%	Rubus allegheniensis	13.3%¶
Carex pensylvanica	16.9 (92.5*)	Rubus flagellaris	
Ceanothus americanus	13.8	Rudbeckia hirta	12.3
Cicuta maculata	3.1	Salix humilis	9.2
Coreopsis tripteris	1.5	Smilacina racemosa	12.3
Cornus racemosa	16.9	Solidago canadensis	3.1
Corylus americana	10.8	S. gigantea	3.1
Dioscorea villosa	7.7	S. rigida	1.5
Euphorbia corollata	72.3	Sorghastrum nutans	9.2
Fragaria virginiana	13.8	Symphoricarpos orbiculatus	1.5
Galium boreale	52.3 (65.0*)	Taenidia integerrima	24.6
Geranium maculatum	40.0*	Thalictrum dasycarpum	9.2
Hepatica americana	7.7	T. dioicum	22.5*
Heuchera hirsuticaulis	10.8	Tradescantia ohiensis	32.3
Lathyrus venosus	9.2	Veronicastrum virginicum	10.8
Lactuca canadensis	16.9	Vicia americana	16.9
Lysimachia quadrifolia	1.5	Viola sororia	7.5*

Sampled by R. Brewer, 1961-1963
* Spring sample only
¶ Includes Rubus flagellaris

38. THOMPSON ROAD

LOCATION: Cass Co., T7S, R16W, S5, NE; 1.5 miles SW of Pokagon, between Thompson Rd. and railroad tracks
TYPE: Mesic Prairie (Bur Oak Openings)
COVER: Andropogon gerardii dominant; Spartina pectinata, Andropogon scoparius locally dominant
SOIL: Miami loam, pH 6.8, wrc 106%; area soils Miami and Marshall loam (no modern soil survey)
SETTING: Slope 0-5 deg., aspect WNW; 0.4 mile-long railroad prairie, remnant of bur oak openings on edge of Sand Prairie (S part of Pokagon Prairie); Carex-Typha marsh in adjacent low ground, oak-cherry thickets or canopies (over pasture or homesteads) of old-growth Quercus velutina-Quercus macrocarpa on surrounding uncultivated uplands
CITATION: Scharrer 1971 (Site No. 247), Thompson 1983a

Species	Frequency	Species	Frequency
Achillea millefolium	5%	Monarda fistulosa	5%
Allium canadense	5	Oxypolis rigidior	
Allium cernuum	40	Panicum oligosanthes	
Andropogon gerardii	50	Panicum praecocius	15
Andropogon scoparius	35	Panicum sphaerocarpon	20
Anemone canadensis	5	Panicum virgatum	

Species	Frequency	Species	Frequency
Anemone cylindrica	5%	Poa compressa	10%
Anemone virginiana	5	Poa pratensis	5
Apios americana		Polemonium reptans	
Apocynum androsaemifolium	25	Polygala senega	
Asclepias syriaca	15	Potentilla simplex	15
Asclepias tuberosa		Prunus serotina	
Aster azureus	30	Pycnanthemum virginianum	
Aster laevis	5	Quercus macrocarpa	
Calamagrostis canadensis	15	Quercus velutina	
Carex bebbii	90*	Ranunculus fascicularis	
Carex bicknellii		Ratibida pinnata	50
Carex sp.		Rhus typhina	
Ceanothus americanus		Rosa carolina	35
Comandra richardsiana	5	Rosa palustris	
Coreopsis palmata	5	Rubus hispidus	50
Coreopsis tripteris	10	Rubus occidentalis	10
Cornus racemosa	15	Rudbeckia hirta	
Cornus stolonifera	5	Salix humilis	5
Corylus americana	5	Sassafras albidum	10
Desmodium illinoense	5	Senecio aureus	5
Dioscorea villosa	10	Silphium integrifolium	5
Equisetum laevigatum	10	Silphium terebinthinaceum	10
Erigeron annuus	5	Sisyrinchium albidum	
Erigeron strigosus	10	Smilacina racemosa	
Eryngium yuccifolium		Solidago altissima	20
Euphorbia corollata	80	Solidago graminifolia	10
Fragaria virginiana	50	Solidago juncea	
Galium aparine	10	Solidago nemoralis	10
Galium boreale	15	Solidago rigida	25
Gentiana andrewsii	5	Solidago speciosa	15
Gentiana flavida		Sorghastrum nutans	
Geranium maculatum	20	Spartina pectinata	50
Helianthemum canadense	10	Stipa avenacea	
Helianthus occidentalis	10	Taenidia integerrima	5
Helianthus strumosus	35	Thalictrum dasycarpum	25
Heliopsis helianthoides		Tradescantia ohiensis	95
Heuchera hirsuticaulis	5	Urtica dioica	
Hierochloe odorata		Vernonia missurica	20
Juglans nigra	5	Veronicastrum virginicum	40
Juncus dudleyi		Vicia americana	5
Lactuca canadensis	10	Viola affinis	20
Lespedeza capitata		Viola pedatifida	15
Lespedeza hirta		Viola sagittata	
Lilium michiganense		Viola sororia	15
Lithospermum canescens	5	Vitis aestivalis	5
Luzula multiflora		Zizia aurea	

* Includes all sedges, but C. bicknellii is by far the commonest

39. PARKVILLE

LOCATION: St. Joseph Co., T5S, R11W, S15, NW of NW; 2.5 miles NW of Parkville, SE of Michigan Avenue and Hutchinson Road
TYPE: Mesic Sand Prairie
COVER: Andropogon virginicus-Poa compressa-Polytrichum juniperinum dominant; Aster-Solidago subdominant; (natural dominant Andropogon scoparius-Carex spp.?)
SOIL: Bronson sandy loam, pH 5.4, wrc 31%; area soils Oshtemo sandy loam, Spinks loamy sand, Brady sandy loam
SETTING: Slope 0-5 deg., aspect W; 7 acre secondary mesic sand prairie (with aspen, cherry), remnant of mesic sand savanna; marsh or wetter prairie-like areas on slightly lower ground, black oak woods (with aspen), homesteads, cultivated and abandoned fields surround site

Species	Species
Achillea millefolium	Lactuca canadensis
Andropogon gerardii	Lespedeza capitata
A. scoparius	Lysimachia lanceolata
Apocynum cannabinum	Oenothera biennis
Aristida purpurascens	Poa compressa
Asclepias hirtella	Polygala polygama
A. tuberosa	P. sanguinea
Aster laevis	Polytrichum juniperinum
A. pilosus	Populus tremuloides
Baptisia leucantha	Prunus serotina
Cacalia atriplicifolia	Pteridium aquilinum
Carex bicknellii	Quercus velutina
Coreopsis tripteris	Rhus typhina
Corylus americana	Rubus flagellaris
Danthonia spicata	Sassafras albidum
Desmodium canadense	Solidago graminifolia
D. ciliare	S. juncea
Eryngium yuccifolium	S. nemoralis
Fragaria virginiana	Spartina pectinata
Gnaphalium obtusifolium	Spiraea tomentosa
Hieraceum gronovii	Vernonia altissima
Juncus greenii	Veronicastrum virginicum
J. tenuis	Viola sagittata

40. LAWTON FRUIT BELT

LOCATION: Van Buren Co., T3S, R13W, S19, SW of SE and NE of SW; 2 miles NW of Lawton, in right-of-way of former Fruit Belt Railroad, N of 64th Street
TYPE: Woodland Prairie/Mesic Sand Prairie
COVER: Andropogon gerardii-A. scoparius dominant; Sorghastrum nutans subdominant
SOIL: Brems sandy loam, (pH 5.1-6.5, wrc 38-45%); area soils Plainfield and Spinks loamy sand, Oshtemo sandy loam
SETTING: Slope 0-5 deg., aspect NW; 0.4 mile-long railroad prairie and adjacent land, remnant of mesic sand savanna; white oak woods with numerous openings, cultivated fields, pine plantation surround site

Species	Species
Acer rubrum	Liatris spicata
Achillea millefolium	Lilium michiganense
Agrostis hyemalis	L. philadelphicum
Aletris farinosa	Lithospermum caroliniensis
Andropogon gerardii	Lupinus perennis
A. scoparius	Luzula multiflora
Anemone cylindrica	Lysimachia lanceolata
A. virginiana	L. quadrifolia
Antennaria plantaginifolia	Monarda fistulosa
Apocynum androsaemifolium	Oenothera biennis
Arabis glabra	Osmunda regalis
Artemisia caudata	Oxypolis rigidior
Asclepias syriaca	Panicum latifolium
A. tuberosa	Pedicularis canadensis
Aster azureus	Phlox pilosa
A. sagittifolius	Plantago rugelii
Baptisia leucantha	Poa compressa
Bromus kalmii	P. palustris
Cacalia atriplicifolia	Polygala sanguinea
Calamagrostis canadensis	Polygonatum biflorum
Carex pensylvanica	Populus tremuloides
C. stipata	Potentilla simplex
Carya ovata	Prenanthes racemosa
Castilleja coccinea	Prunella vulgaris
Ceanothus americanus	Prunus serotina
Comandra richardsiana	Pteridium aquilinum
Coreopsis tripteris	Pycnanthemum virginianum
Cornus stolonifera	Quercus alba
Corylus americana	Q. velutina
Danthonia spicata	Rhus copallina
Desmodium marilandicum	Rubus allegheniensis
Equisetum hyemale	R. flagellaris
E. laevigatum	R. pubescens
Erigeron strigosus	Rudbeckia hirta
Eryngium yuccifolium	Salix humilis

Species	Species
Euphorbia corollata	Sassafras albidum
Fragaria virginiana	Saxifraga pensylvanica
Galium boreale	Smilacina racemosa
G. obtusum	Smilax lasioneura
Gaultheria procumbens	Solidago graminifolia
Gaylussacia baccata	S. juncea
Helianthemum canadense	S. rigida
Helianthus divaricatus	S. speciosa
H. occidentalis	Sorghastrum nutans
Heuchera hirsuticaulis	Specularia perfoliata
Hypericum kalmianum	Spiraea alba
Iris virginica	Sporobolus heterolepis
Juncus tenuis	Stipa avenacea
Krigia biflora	Tephrosia virginiana
Lactuca canadensis	Tradescantia ohiensis
Lechea villosa	Vaccinium angustifolium
Lespedeza capitata	Vernonia missurica
Liatris aspera	Viola sagittata
L. novae-angliae	

41. ALGONAC

LOCATION: St. Clair Co., T3S, R16W, S27, N of SW; 2.5 miles N of Algonac, E of Marsh Road between Swartout Road and Benoit Road
TYPE: Mesic Sand Prairie
COVER: Andropogon scoparius dominant
SOIL: Wainola loamy fine sand (in mapping unit of Rosseau fine sand), pH 5.4, wrc 42%; area soils Wainola and Deford fine sands
SETTING: Slope 0-5 deg., aspect NE to E; 6 acres of mesic sand prairie in 4 areas (partly secondary), remnant of mesic sand savanna; black oak woods (with white oak, black cherry) on adjacent ground, homesteads, sand pits, abandoned fields surround site

Species	Frequency	Species	Frequency
Acer rubrum	5%	Lechea villosa	15%
Achillea millefolium	30	Lespedeza capitata	20
Agrostis gigantea	20	Liatris spicata	
A. hyemalis	25	Luzula multiflora	15
Aletris farinosa	80	Lycopus americanus	5
Andropogon scoparius	100	Lysimachia quadriflora	
Antennaria plantaginifolia	30	Lythrum alatum	
Apios americana	5	Monarda fistulosa	20
Apocynum androsaemifolium	10	Onoclea sensibilis	
A. sibiricum	5	Panicum sphaerocarpon	80

Species	Frequency	Species	Frequency
Asclepias tuberosa		Panicum virgatum	
Aster dumosus	25%	Poa compressa	50%
A. ericoides	10	Polygala sanguinea	25
Baptisia tinctoria	5	Polytrichum juniperinum	35
Calopogon tuberosus		Populus tremuloides	15
Carex aurea	10	Potentilla simplex	75
C. muhlenbergii	10	Prunella vulgaris	50
C. pensylvanica	5	Prunus serotina	
C. scoparia		Pteridium aquilinum	20
Coreopsis tripteris		Pycnanthemum virginianum	15
Corylus americana	5	Quercus alba	
Danthonia spicata	30	Q. velutina	20
Desmodium canadense	5	Rhynchospora capitellata	10
Eleocharis elliptica	15	Rudbeckia hirta	20
Equisetum arvense	50	Salix humilis	65
E. laevigatum	15	Scirpus atrovirens	
Erigeron strigosus	10	S. validus	5
Eupatorium perfoliatum		Scleria triglomerata	20
Fragaria virginiana	15	Sisyrinchium mucronatum	5
Helianthemum canadense	45	Solidago graminifolia	10
Helianthus occidentalis	5	S. juncea	5
Hypericum kalmianum (common nearby)		S. nemoralis	45
H. prolificum	10	S. rugosa	40
Juncus acuminatus	10	Spiraea alba	
J. canadensis		Vaccinium lamarckii	10
J. tenuis			
Lactuca canadensis	10		

42. PETERSBURG

LOCATION: Monroe Co., T7S, R6E, S15, SE; 2.5 miles SE of Petersburg, S of Teal Road and Stacy Drain
TYPE: Mesic Sand Prairie
COVER: Andropogon scoparius dominant; A. gerardii locally dominant or codominant
SOIL: Gilford sandy loam, pH 5.4, wrc 62%; area soils Oakville fine sand, Tedrow loamy sand, Granby loamy fine sand
SETTING: Slope 0-5 deg., aspect S to SW; 9 acres of mesic sand prairie in 7 areas (some secondary), remnant of mesic sand savanna; black oak-white oak woods (with bur oak, black cherry, sassafras, witch hazel, red maple) on slightly higher ground; cottonwood, pin oak, black willow, red maple on same level as prairie; slightly lower ground supports rush and sedge communities with forbs of wet prairie and fen
CITATION: Thompson 1983a

Species
Achillea millefolium
Aletris farinosa
Andropogon gerardii
A. scoparius
Anemone cylindrica
Antennaria plantaginifolia
Apocynum androsaemifolium
Aristida purpurascens
Asclepias hirtella
A. tuberosa
Aster azureus
A. dumosus
A. laevis
Baptisia tinctoria
Carex sartwellii
Cirsium discolor
Comandra richardsiana
Coreopsis tripteris
Cornus racemosa
Danthonia spicata
Desmodium canadense
D. ciliare
Equisetum laevigatum
Erigeron strigosus
Euphorbia corollata
Fragaria virginiana
Gaylussacia baccata
Gnaphalium obtusifolium
Heuchera hirsuticaulis
Hypericum prolificum (PWT)
H. punctatum
Juncus greenii
Lespedeza capitata
Liatris novae-angliae
L. spicata
Lilium michiganense

Species
Lithospermum caroliniense
Lobelia spicata
Lupinus perennis
Luzula multiflora
Monarda fistulosa
Oenothera parviflora
Panicum implicatum
P. sphaerocarpon
Penstemon hirsutus
Poa compressa
Polygala sanguinea
Polytrichum juniperinum
Populus deltoides
P. tremuloides
Potentilla simplex
Prunella vulgaris
Prunus serotina
Pycnanthemum virginianum
Quercus palustris
Rhus copallina
Rubus flagellaris
Rudbeckia hirta
Salix humilis
Scleria triglomerata
Sisyrinchium albidum
Solidago graminifolia
S. juncea
S. nemoralis
S. rugosa
S. speciosa
Sorghastrum nutans
Spiraea alba
Vaccinium brittonii
Veronicastrum virginicum
Viola sagittata

43. SHANGHAI TERRACE

LOCATION: Washtenaw Co., T2S, R7E, S31, NE; 2.5 miles NW of Ypsilanti, in a large oxbow of the Huron River, between the Conrail line and the base of the high river bluff
TYPE: Mesic Sand Prairie
COVER: Andropogon scoparius dominant; Agrostis gigantea, Poa compressa subdominant
SOIL: Gilford (Cohoctah?) sandy loam; pH 7.3, 8.1; wrc 37%; area soils (in floodplain) Spinks-Boyer loamy sand, Wasepi sandy loam, (uplands) Hoytville, Nappanee silt clay loam, St. Clair clay loam
SETTING: Slope 0-5 deg., aspect E; 7-9 acre probably secondary mesic sand prairie on river terrace; ridge (former river bar) to N supports drier prairie; wet prairie and elm-ash-cottonwood-sycamore thicket/forest in slough along S edge
CITATION: Thompson 1983a

Species	Species
Achillea millefolium	Juncus dudleyi
Agrostis gigantea	J. tenuis
Allium cernuum (PWT)	Juniperus communis
Andropogon gerardii	J. virginiana
A. scoparius	Krigia biflora
Anemone cylindrica (PWT)	Lobelia spicata
Apocynum androsaemifolium	Monarda fistulosa
Aster ericoides	Panicum implicatum
A. novae-angliae	Phlox pilosa
A. sagittifolius	Poa compressa
Campanula rotundifolia	Polygala verticillata
Carex granularis	Populus tremuloides
C. pensylvanica	Potentilla simplex
Cirsium discolor (PWT)	Pycnanthemum flexuosum
Coreopsis tripteris (PWT)	Rudbeckia hirta
Desmodium canadense	Scirpus validus
Equisetum arvense	Senecio pauperculus (PWT)
E. laevigatum	Silene antirrhina
Erigeron philadelphicus	Silphium terebinthinaceum
Euphorbia corollata	Sisyrinchium albidum
Fragaria virginiana	Solidago altissima
Galium boreale (PWT)	S. nemoralis
Gentiana andrewsii	S. rigida
Helianthus giganteus	Sorghastrum nutans
Heuchera hirsuticaulis	Sporobolus neglectus
Juncus balticus	Vernonia missurica
J. canadensis	

44. OJIBWAY

LOCATION: Essex Co. (Ontario, Canada); 5.5 miles SSW of Windsor, N of Langlois Road between Malden Road and Matchette Road
TYPE: Lakeplain Wet-Mesic Prairie (including areas Mesic Sand Prairie)
COVER: Calamagrostis canadensis-Solidago canadensis-Rubus flagellaris-Pycnanthemum virginianum-Spartina pectinata dominant
SOIL: Gilford? sandy loam, pH 5.9, (wrc 45-53%); area soils Thetford loamy sand, Granby and Tedrow loamy fine sand
SETTING: Slope 0-5 deg., aspect W to SW; 6 acre secondary wet-mesic prairie and savanna on sandy soil; homesteads, abandoned fields, black oak-red oak woods surround site
CITATION: Rogers 1966, Langendoen and Maycock 1983, Thompson 1983a

Species	Frequency	Species	Frequency
Acer rubrum		Lobelia spicata	
Achillea millefolium*		Lycopus americanus	
Agrimonia parviflora	7%	Lysimachia quadriflora	
Agrostis gigantea	1	Lythrum alatum	
Aletris farinosa		Monarda fistulosa	40%
Amphicarpa bracteata*		Muhlenbergia glomerata	
Andropogon gerardii	1	Oenothera biennis	1
A. scoparius	1	Onoclea sensibilis	27
Anemone canadensis		Osmunda regalis	7
A. cylindrica		Oxypolis rigidior	
A. virginiana	7	Panicum virgatum	1
Apios americana	7	P. sphaerocarpon*	20
Apocynum androsaemifolium		Pedicularis lanceolata	
A. cannabinum	13	Penstemon hirsutus	
Asclepias sullivantii		Phlox pilosa	
A. syriaca		Poa pratensis	7
A. tuberosa		Polygala sanguinea	
A. viridiflora		P. verticillata	
Aster azureus*		Polygonum tenue	
A. ericoides*		Populus deltoides	1
A. laevis*		P. tremuloides	1
A. novae-angliae		Potentilla simplex	40
A. simplex	1	Prenanthes racemosa	
A. umbellatus	13	Prunus serotina	
Baptisia tinctoria*		Pteridium aquilinum*	
Calamagrostis canadensis*	73	Pycnanthemum virginianum*	93
Carex lanuginosa*	33	Pyrus coronaria	
C. tenera	13	Quercus borealis	
Cirsium discolor	20	Q. palustris	1
Comandra richardsiana	1	Q. velutina	
Convolvulus sepium	20	Ratibida pinnata	
Coreopsis tripteris	1	Rubus allegheniensis*	
Cornus amomum	7	R. flagellaris	87
C. racemosa	53	R. hispidus	1

Species	Frequency	Species	Frequency
Corylus americana	1%	Rudbeckia hirta	
Crataegus pedicellata	1	Salix bebbiana	13%
Desmodium canadense*	7	S. discolor	1
Equisetum arvense	7	S. humilis	
Erigeron strigosus		Scleria triglomerata	
Eupatorium maculatum		Silphium terebinthinaceum	
E. purpureum	7	Sisyrinchium albidum	13
Euphorbia corollata	1	Solidago canadensis*	93
Fragaria virginiana*	67	S. graminifolia*	13
Fraxinus pensylvanica	1	S. juncea	1
Galium obtusum	1	S. riddellii	
G. trifidum		S. rigida	
Gentiana andrewsii		S. rugosa	7
G. crinita		Sorghastrum nutans	
Gerardia purpurea		Spartina pectinata*	60
Helenium autumnale		Spiraea alba	
Helianthemum canadense		S. tomentosa	
Helianthus gigantea	1	Sporobolus cryptandrus	
Hierochloe odorata		Taenidia integerrima	
Hyposix hirsuta	1	Thalictrum polyganum	7
Juncus torreyi		Thelypteris palustris	27
Krigia biflora	1	Tradescantia ohiensis	
Lathyrus palustris	7	Ulmus americana	
Lechea villosa		Verbena stricta	
Lespedeza capitata		Vernonia altissima	27
Liatris spicata*	7	Veronicastrum virginicum	20
Lithospermum canescens		Viola pensylvanica	7
		V. sagittata*	
Surveyed by D. Langendoen, 1981		Vitis riparia	33

45. CRANBERRY LAKE

LOCATION: Oakland Co., T4N, R9E, S17, NE; 1.5 miles N of Clarkston, N shore of Cranberry Lake
TYPE: Wet-mesic Sand Prairie
COVER: Andropogon gerardii-A. scoparius-Carex stricta dominant
SOIL: Capac sandy loam (mapping unit of Marlette sandy loam), pH 7.5, wrc 49%; area soils Oshtemo and Fox sandy loam, Spinks loamy sand, Houghton muck
SETTING: Slope 0-5 deg., aspect S; less than 1 acre wet-mesic sand prairie at a lakeshore; black oak-white oak forest on upland slopes; cottonwood and black willow at lake shore

Species	Species
Achillea millefolium	Fragaria virginiana
Agrimonia parviflorum	Lathyrus palustris
Agrostis gigantea	Monarda fistulosa
Andropogon gerardii	Onoclea sensibilis
A. scoparius	Poa compressa
Anemone cylindrica	Populus deltoides
Aster azureus	Potentilla fruticosa
A. dumosus	Prunella vulgaris
A. laevis	Pycnanthemum virginianum
A. novae-angliae	Rudbeckia hirta
Carex stricta	Salix bebbiana
Cornus racemosa	S. discolor
Desmodium canadensis	S. interior
Equisetum arvense	Solidago graminifolia
E. laevigatum	Thelypteris palustris
Erigeron philadelphicus	Typha angustifolia

46. PARK ROAD

LOCATION: Jackson Co., T3S, R1W, S16, center of SE of NW; 2.2 miles SW of Jackson, S side of Conrail line 0.25 miles E of Park Street crossing
TYPE: Wet-mesic Sand Prairie/Wet-mesic Prairie
COVER: Sorghastrum nutans-Carex ?bebbii dominant; Agrostis gigantea-Solidago altissima subdominant
SOIL: Gilford fine sandy loam (in mapping unit of Palms muck), pH 5.2, wrc 32%; area soils Oshtemo and Riddles sandy loam, Brady loam
SETTING: Slope 5 deg., aspect S; 2-5 acre, partly secondary, wet-mesic prairie (transitional to wet-mesic sand prairie); higher ground supports big bluestem-Indian grass prairie and black oak-white oak (with red oak, shagbark hickory); shrubs, thicket/young woods, marsh, subdivisions surround site
CITATION: Scharrer 1971 (Site No. 55), Thompson 1975, 1983a

Species
Agrimonia gryposepala
Agrostis gigantea
Andropogon gerardii
A. scoparius
Anemone canadensis
A. virginiana
Apocynum androsaemifolium
Asclepias incarnata
A. syriaca
Aster azureus
A. ericoides
A. laevis
A. lucidulus
A. novae-angliae
A. puniceus
A. sagittifolius
A. simplex
A. umbellatus
Calamagrostis canadensis
Carex ?bebbii
Cirsium discolor
Coreopsis tripteris
Cornus racemosa
Cypripedium calceolus
Desmodium canadense
Dioscorea villosa
Eleocharis erythropoda
Elymus virginicus
Eupatorium maculatum
E. perfoliatum
Fragaria virginiana
Geranium maculatum
Helianthus giganteus
H. grosseserratus
Heuchera hirsuticaulis
Hypoxis hirsuta
Juncus dudleyi
Lactuca canadensis
Lobelia spicata
Luzula multiflora
Lythrum alatum
Monarda fistulosa
Oenothera biennis
Onoclea sensiblis
Oxypolis rigidior
Panicum implicatum
P. leibergii
Panicum virgatum
Pedicularis lanceolata
Phlox pilosa
Poa compressa
P. pratensis
Populus deltoides
Potentilla arguta
P. simplex
Prenanthes racemosa
Prunella vulgaris
Prunus serotina
Pycnanthemum virginianum
Quercus velutina
Ratibida pinnata
Rhus glabra
Rubus allegheniensis
R. flagellaris
R. hispidus
Rudbeckia hirta
Salix humilis
Scirpus atrovirens
Senecio aureus
S. pauperculus
Silphium integrifolium
S. terebinthinaceum
Sisyrinchium albidum
S. angustifolium
Solidago altissima
S. gigantea
S. graminifolia
S. juncea
S. riddellii
S. rigida
S. speciosa
Sorghastrum nutans
Spartina pectinata
Spiraea alba
Stellaria longifolia
Thalictrum dasycarpum
Tradescantia ohiensis
Typha latifolia
Ulmus americana
Verbena hastata
Veronicastrum virginicum
Vitis riparia
Zizia aurea

47. ARCADIA PRAIRIE

LOCATION: Kalamazoo Co., T2S, R11W, S20, SW of SE; City of Kalamazoo, at the intersection of Howard St. and Stadium Drive
TYPE: Wet-mesic Prairie
COVER: Spartina pectinata dominant; Pycnanthemum virginianum -Carex bebbii subdominant
SOIL: Sebewa loam (in a mapping unit of Glendora sandy loam), pH 6.8-7.0, (wrc 68-73); area soils Kalamazoo and Schoolcraft loams
SETTING: Slope 0-5 deg., aspect E; 1-2 acre wet-mesic prairie (now destroyed) along Arcadia Creek; the valley formerly supported oak savanna and wetlands; old bur oaks, degraded railroad and roadside prairie, and sedge meadow still persist
CITATION: Brewer 1965

Species	Frequency	Species	Frequency
Achillea millefolium	3.4%	Liatris spicata	24.1%
Allium canadense	38.5	Monarda fistulosa	38.0
Andropogon gerardii	31.0	Onoclea sensibilis	27.6
Anemone quinquefolia	3.4	Oxypolis rigidior	3.4
Apios americana	3.4	Panicum leibergii*	27.6
Apocynum sibiricum	27.6	Populus deltoides	6.8
Aster azureus	13.8	Populus tremuloides	3.4
Aster novae-angliae	6.8	Prunus serotina	3.4
Aster sagittifolius	6.8	Pycnanthemum virginianum	65.6
Carex bebbii	46.2	Quercus macrocarpa	
Cicuta maculata	69.0	Ratibida pinnata	6.8
Comandra richardsiana	15.4	Rosa palustris	31.0
Coreopsis tripteris	48.3	Salix interior	
Cornus racemosa	38.0	Saxifraga pensylvanica	7.6
Crataegus sp.	6.8	Senecio aureus	
Desmodium canadense*	46.2	Silphium integrifolium	13.8
Equisetum arvense		Smilacina racemosa	27.6
Equisetum laevigatum	46.2	Solidago altissima	41.4
Erigeron sp.		Solidago graminifolia	3.4
Eryngium yuccifolium	51.8	Solidago riddellii	6.8
Euphorbia corollata		Solidago rigida	48.3
Fragaria virginiana	53.8	Solidago speciosa	
Galium boreale	69.2	Sorghastrum nutans	3.4
Gentiana andrewsii	6.8	Spartina pectinata	100.0
Geranium maculatum	76.9	Thalictrum dasycarpum	24.1
Helianthus decapetalus		Thelypteris palustris	3.4
Helianthus divaricatus	6.8	Tradescantia ohiensis	13.8
Helianthus giganteus	6.8	Vernonia missurica	3.4
Heuchera hirsuticaulis	10.3	Veronicastrum virginicum	10.3
Iris virginica	20.7	Viola sp.	3.4

* May include other species

48. PARMA

LOCATION: Jackson Co., T2S, R3W, S36 and T3S, R3W, S2; 0.5 miles SW of Parma to Concord Road, S of Conrail line
TYPE: Wet-mesic Prairie
COVER: Calamagrostis canadensis-Carex bebbii-Sorghastrum nutans dominant; Andropogon gerardii-A. scoparius-C. canadensis dominant on slightly higher ground
SOIL: ?Barry loam (in mapping units of Henrietta and Palms muck), pH 5.5 (6.1-7.8), wrc 150%; area soils Hillsdale, Riddles sandy loam, Teasdale fine sandy loam
SETTING: Slope 0-10 deg., aspect variable; 2 miles of overall wet-mesic railroad prairie interrupted by drier rises; low areas are Phalaris-Carex meadow; black oak woods, farmed fields, Am. elm-trembling aspen thickets off right-of-way
CITATION: Thompson 1983a

Species	Species
Agrostis gigantea	Helianthus occidentalis
Aletris farinosa	Heuchera hirsuticaulis
Allium canadense (PWT)	Iris virginica
Andropogon gerardii	Lespedeza capitata
A. scoparius	Lysimachia ciliata
Anemone canadensis (PWT)	Monarda fistulosa
A. virginiana	Muhlenbergia mexicana
Apios americana	Oxypolis rigidior
Apocynum androsaemifolium (PWT)	Panicum leibergii
A. sibiricum (PWT)	P. virgatum
Asclepias syriaca	Pedicularis canadensis
Aster laevis	Populus tremuloides
A. novae-angliae	Potentilla simplex
A. simplex	Pteridium aquilinum
A. umbellatus	Pycnanthemum virginianum
Calamagrostis canadensis	Quercus macrocarpa
Carex bebbii	Ratibida pinnata
Cicuta maculata	Rudbeckia hirta
Comandra richardsiana	Salix discolor
Coreopsis tripteris	S. interior
Cornus purpusi (PWT)	Saxifraga pensylvanica (PWT)
C. racemosa	Silphium terebinthinaceum
Corylus americana	Solidago altissima
Desmodium canadense	S. graminifolia
Elymus canadensis (PWT)	S. riddellii
Equisetum arvense (PWT)	S. rigida
E. laevigatum	Sorghastrum nutans
Erigeron philadelphicus (PWT)	Spiraea alba
Euphorbia corollata	Thalictrum dasycarpum
Fragaria virginiana	Thelypteris palustris
Galium boreale	Ulmus americana
Gentiana andrewsii	Veronicastrum virginicum
Geranium maculatum (PWT)	Zizia aurea
Helianthus giganteus	

49. SHAW LAKE

LOCATION: Barry Co., T3N, R10W, S3, NW of SE; 2.4 miles S of Middleville, along Shaw Lake Road at creek
TYPE: Wet Prairie
COVER: Spartina pectinata dominant; Calamagrostis canadensis-Carex sp. subdominant
SOIL: Fox sandy loam (transitional to Rifle Peat), pH 7.2, wrc 81%; area soils Fox sandy loam, Plainfield loamy sand (no modern soil survey)
SETTING: Slope 5 deg., aspect SE; 1-2 acre wet prairie along a stream; sedge meadow, willow thickets along stream as well; black oak woods on upland

Species	Species
Andropogon gerardii	Onoclea sensiblis
Aster lucidulus	Oxypolis rigidior
A. puniceus	Pycnanthemum virginianum
Calamagrostis canadensis	Rudbeckia hirta
Cirsium muticum	Salix interior
Coreopsis tripteris	Solidago altissima
Corylus americana	S. graminifolia
Desmodium canadense	Spartina pectinata
Eupatorium maculatum	Spiraea alba
Euphorbia corollata	Vernonia missurica
Fragaria virginiana	Viola cucullata
Helianthus giganteus	

50. PRAIRIE RIVER LAKE

LOCATION: St. Joseph Co., T7S, R9W, S18, NW of SW; 4 miles N of Sturgis, both side of M-66 at Prairie River Lake
TYPE: Wet Prairie (tending toward Fen)
COVER: Spartina pectinata-Carex spp. dominant; Calamagrostis canadensis local subdominant
SOIL: Bronson sandy loam, pH 7.7, wrc 43%; area soils Spinks loamy sand, Hillsdale sandy loam
SETTING: Slope 0-5 deg., aspect generally E; less than 1 acre wet prairie on former lakebed; pin oak-green ash-silver maple woods adjacent; Carex-Calamagrostis meadow (with Typha, Aster lucidulus, Rhus vernix) on wetter ground

Species	Species
Acer saccharinum	Onoclea sensibilis
Agrostis gigantea	Oxypolis rigidior
Aster lucidulus	Populus deltoides
A. novae-angliae	Pycnanthemum virginianum
A. sagittifolius	Rudbeckia hirta

Species	Species
A. umbellatus	Salix discolor
Calamagrostis canadensis	Silphium terebinthinaceum
Cirsium muticum	Solidago altissima
Coreopsis tripteris	S. graminifolia
Cornus racemosa	Spartina pectinata
C. stolonifera	Spiraea alba
Cypripedium reginae	Thelypteris palustris
Equisetum arvense	Typha latifolia
Fraxinus pensylvanica	Ulmus americana
Gentiana andrewsii	Vernonia altissima
Lathyrus palustris	Veronicastrum virginicum
Monarda fistulosa	Zizia aurea

51. ANN ARBOR

LOCATION: Washtenaw Co., T2S, R6E, S27, SE of NW; E edge of Ann Arbor, 0.5 miles NW of Gallup Park bridge (formerly Geddes Road bridge), between the Conrail line and Huron River
TYPE: Wet Prairie
COVER: Carex stricta-Calamagrostis canadensis-Pycnanthemum virginianum dominant; Solidago altissima-Spartina pectinata-Vernonia missurica subdominant
SOIL: Sebewa loam (in a mapping unit of Sloan loam), pH 7.2, wrc 67%; area soils (floodplain) Spinks and Boyer loamy sands, Wasepi sandy loam, (uplands) Miami, Conover and Brookston loams
SETTING: Slope 0-5 deg., aspect WNW; 5 acre wet prairie (containing sedge meadow, cattail marsh, willow-dogwood thickets); oak savanna (formerly) and, where undeveloped, oak forest on uplands; degraded grassland along adjacent railroad
CITATION: Thompson 1968, 1975, 1983a

Species	Frequency	Species	Frequency
Agrimonia gryposepala	5%	Impatiens biflora	15%
Agrostis gigantea	10	Iris virginica (PWT)	
Allium canadense	30	Juncus dudleyi	25
Amphicarpa bracteata	5	Lactuca biennis	5
Anemone canadensis	45	Lathyrus palustris	30
Anemone virginiana	10	Lilium michiganense	
Apios americana	75	Lycopus americanus	55
Apocynum androsaemifolium	5	Lysimachia ciliata	50
Apocynum sibiricum	10	Lysimachia quadriflora (PWT)	
Asclepias syriaca (PWT)		Mentha arvensis	10
Aster lucidulus		Monarda fistulosa	35
Aster novae-angliae	10	Onoclea sensibilis	
Bromus ciliatus	35	Oxypolis rigidior	25
Calamagrostis canadensis	75	Parnassia glauca (PWT)	

Species	Frequency	Species	Frequency
Carex lanuginosa		Pedicularis lanceolata	10%
Carex stricta*	70%	Phlox pilosa	5
Cicuta maculata (PWT)		Poa palustris	
Cirsium discolor	5	Poa pratensis¶	80
Cirsium muticum (PWT)		Prenanthes racemosa (PWT)	
Convolvulus sepium	10	Prunella vulgaris (PWT)	
Desmodium canadense	5	Pycnanthemum virginianum	90
Eleocharis elliptica	5	Ratibida pinnata	15
Elymus virginicus	10	Rhus typhina	15
Equisetum arvense	25	Rudbeckia hirta	
Erigeron philadelphicus	20	Saxifraga pensylvanica	10
Erigeron strigosus	5	Silphium terebinthinaceum	75
Eupatorium maculatum	50	Solidago altissima	95
Eupatorium perfoliatum	5	Solidago gigantea	15
Fragaria virginiana (PWT)		Solidago graminifolia (PWT)	
Galium asprellum (PWT)		Solidago juncea	10
Galium boreale	40	Solidago riddellii (PWT)	
Gentiana andrewsii		Sorghastrum nutans (PWT)	
Geranium maculatum	15	Spartina pectinata	65
Glyceria striata		Thalictrum dasycarpum	50
Helenium autumnale (PWT)		Thelypteris palustris (PWT)	
Helianthus giganteus (PWT)		Typha latifolia	
Helianthus grosseserratus (PWT)		Vernonia missurica	40
Helianthus strumosus		Veronicastrum virginicum	35
Helianthus tuberosus (PWT)		Viola cucullata	20
Heliopsis helianthoides	5	Zizia aurea	30

* Frequency of all sedges 90%
¶ May include P. palustris

52. CONCORD SWALE

LOCATION: Jackson Co., T3S, R3W, S10; 0.4 miles W of Concord Road, S side of Conrail line
TYPE: Wet Prairie
COVER: Calamagrostis canadensis-Carex bebbii dominant
SOIL: Colwood silt loam (in mapping unit of Henrietta muck); pH 7.1; wrc 170%; area soils Riddles and Hillsdale sandy loam
SETTING: Slope 0-5 deg., aspect SSE; less than 1 acre wet prairie next to large grazed wet prairie (now sedge meadow); dogwood thickets at edges of site; bur oaks grow at edges of lowland, black and white oaks on higher ground
CITATION: Thompson 1983a

Species	Species
Agrostis gigantea	Hypoxis hirsuta (PWT)
Allium canadense (PWT)	Lycopus americanus
Anemone virginiana	Monarda fistulosa
Angelica atropurpurea	Muhlenbergia mexicana
Apios americana	Oxypolis rigidior
Aster laevis	Panicum leibergii
A. lucidulus	Phalaris arundinacea
A. novae-angliae	Prenanthes racemosa (PWT)
A. simplex	Pycnanthemum virginianum
A. umbellatus	Quercus macrocarpa
Bromus ciliatus	Ratibida pinnata
Calamagrostis canadensis	Rudbeckia hirta
Caltha palustris (PWT)	Sambucus canadensis
Carex bebbii	Saxifraga pensylvanica (PWT)
Cicuta maculata	Silphium terebinthinaceum
Convolvulus sepium	Smilacina stellata
Cornus racemosa	Solidago gigantea
C. stolonifera	S. graminifolia
Cypripedium calceolus	S. riddellii
Echinocystis lobata	S. rigida
Eupatorium maculatum	S. rugosa (PWT)
Fragaria virginiana	Spartina pectinata
Gentiana andrewsii	Thalictrum dasycarpum
G. procera (PWT)	Thelypteris palustris (PWT)
Helianthus giganteus	Veronicastrum virginicum
Hierochloe odorata (PWT)	Zizia aurea

53. BAKERTOWN AMTRAK LOWLAND

LOCATION: Berrien Co., T7S, R18W, S34, SE of SW and SW of SE; 1.8 miles SW of Buchanan, E and W of Bakertown Road along Amtrak line
TYPE: Wet Prairie
COVER: Spartina pectinata-Carex stricta dominant; Calamagrostis canadensis locally dominant
SOIL: Sebewa loam transitional to Gilford sandy loam (in mapping unit of Morocco loamy sand and Sebewa loam)); pH 6.5 (fall), 7.3 (spring), wrc 88%; area soils Oshtemo sandy loam, Ockley and Riddles loam
SETTING: Slope 5 deg., aspect E; 0.2 mile-long railroad prairie (in 2 sections) in floodplain of McCoy Creek; grades into maple-elm thicket, then oak woods on W (NW right-of-way disturbed in 1982); sedge meadow (grazed prairie) at NW edge; grades into fen at NE edge, upland prairie at E edge; Salix-Cornus thickets and farmed/disturbed ground along S border
CITATION: Kohring 1981

Species	Species
Agrostis gigantea	Lathyrus palustris (uncommon)
Allium canadense (uncom./loc. common)	Lilium michiganense (rare)
Amphicarpa bracteata (rare)	Monarda fistulosa
Andropogon gerardii (uncommon)	Onoclea sensibilis (common, loc. abundant)
Anemone canadensis (common)	Oxypolis rigidior
A. virginiana (uncommon)	Poa pratensis (uncommon)
Angelica atropurpurea (rare)	Phalaris arundinacea (loc. common)
Apios americana (common)	Phlox maculata (loc., uncommon)
Apocynum androsaemifolium	Polemonium reptans (uncommon/loc. common)
A. sibiricum (rare)	Prunella vulgaris
Asclepias incarnata (wet ditch)	Pycnanthemum virginianum (common)
A. syriaca (rare)	Ranunculus septentrionalis
Aster laevis	Ratibida pinnata (at drier edge)
A. novae-angliae (uncommon)	Rosa palustris (rare)
A. puniceus	Salix discolor (rare)
A. simplex	S. interior (rare)
Calamagrostis canadensis	Sambucus canadensis (rare)
Carex bebbii (common)	Saxifraga pensylvanica
C. stricta	Senecio aureus (common)
Coreopsis tripteris (uncommon)	Silphium integrifolium (uncommon)
Cornus stolonifera (rare)	S. terebinthinaceum (at fen edge)
Corylus americana (drier edge, rare)	Smilacina stellata (common)
Desmodium canadense (uncommon)	Solidago altissima (common)
Dodecatheon meadia (local, uncommon)	S. graminifolia
Equisetum arvense (common)	Spartina pectinata
Eryngium yuccifolium (local, uncom.)	Thalictrum dasycarpum (common)
Eupatorium maculatum	Thaspium trifoliatum (at fen edge)
Fragaria virginiana (common)	
Galium boreale	

Species	Species
Gentiana andrewsii	Thelypteris palustris (common)
Helianthus giganteus (uncommon)	Vernonia altissima (uncommon)
Heliopsis helianthoides (drier edge)	Veronicastrum virginicum (uncommon)
Hypoxis hirsuta	Viola affinis
Iris virginica	Vitis riparia (at ballast edge)
Juncus dudleyi	Zizia aurea (common/loc. abundant)

54. BARRY

LOCATION: Barry Co., T3N, R10W, S10, SW of SE, S15, NW of NE; 4 miles S of Middleville, W of Bassett Lake Road, both sides of Bowen's Mill Road at S, E, and NW edges of fen
TYPE: Wet Prairie/Fen
COVER: Carex stricta-Solidago altissima-Eupatorium maculatum dominant; Calamagrostis canadensis subdominant; Spartina pectinata-C. stricta-C. canadensis dominant S of road
SOIL: Rifle Peat (sand evident), pH 7.0, wrc 439% (in Spartina), 205% (in SE wet-mesic prairie); area soils Plainfield loamy sandy, Fox sandy loam, Coloma loamy fine sand (no modern soil survey)
SETTING: Slope 0-5 deg., aspect S; 6.8 acre wet prairie/fen in kettlehole depression, stream at S edge; 2.4 acres of Andropogon gerardii-dominated wet-mesic prairie at SE, NE, and NW edges; cultivated fields, oak woods, abandoned fields, pine plantations surround site
CITATION: Thompson 1983a

Species	Species
Amphicarpa bracteata	Lathyrus palustris
Andropogon gerardii	Liatris spicata
Anemone virginiana (LAS)	Lobelia siphilitica
Angelica atropurpurea	Lycopus americanus
Apios americana	L. uniflorus (LAS)
Apocynum androsaemifolium (LAS)	Lysimachia ciliata (LAS)
A. cannabinum	Muhlenbergia glomerata
Asclepias incarnata (LAS)	M. mexicana
A. syriaca (LAS)	Onoclea sensibilis
Aster dumosus (LAS)	Osmunda regalis
A. lucidulus	Oxypolis rigidior
A. novae-angliae (LAS)	Pedicularis lanceolata
A. puniceus	Phalaris arundinacea
A. simplex (LAS)	Phragmites australis
Betula pumila (LAS)	Populus deltoides
Bromus ciliatus	P. tremuloides
Calamagrostis canadensis	Potentilla fruticosa
Campanula aparinoides	Pycnanthemum virginianum
Carex stricta	Rhamnus alnifolia

Species	Species
Cicuta maculata (LAS)	Rhus vernix
Cirsium muticum	Salix candida (LAS)
Convolvulus sepium	Scirpus atrovirens
Cornus racemosa	Smilacina stellata
C. stolonifera (LAS)	Solidago altissima
Desmodium canadense	S. gigantea
D. paniculatum (LAS)	S. graminifolia
Dioscorea villosa (LAS)	S. patula
Elymus virginicus	S. riddellii (LAS)
Epilobium coloratum	S. rugosa
Erigeron annuus (LAS)	S. uliginosa (LAS)
Eupatorium maculatum	Sorghastrum nutans (LAS)
E. perfoliatum	Spartina pectinata
Galium boreale	Spiraea alba
G. asprellum	Thalictrum dasycarpum
Gentiana andrewsii	Thelypteris palustris
Glyceria striata	Tofieldia glutinosa (LAS)
Habenaria lacera (LAS)	Ulmus americana
Helianthus divaricatus (LAS)	Urtica dioica (LAS)
Hypoxis hirsuta (LAS)	Verbena hastata
Lactuca canadensis (LAS)	Zizia aurea
Larix laricina	Zygadenus glaucus

55. SHANGHAI SLOUGH

LOCATION: Washtenaw Co., T2S, R7E, S31, NE; 2.5 miles NW of Ypsilanti, in a large oxbow of the Huron River, S of the Conrail line
TYPE: Wet Prairie (transitional to Lakeplain Wet Prairie)
COVER: Carex stricta dominant; Calamagrostis canadensis-Juncus spp.-Scirpus atrovirens-Carex hystericina subdominant
SOIL: Gilford (Cohoctah?) sandy loam; (pH 6.1-7.3; wrc 49-56%); area soils (in floodplain) Spinks-Boyer loamy sand, Wasepi sandy loam, (uplands) Hoytville, Nappanee silt clay loam, St. Clair clay loam
SETTING: Slope 0-5 deg., aspect SE; 8-10 acre probably secondary wet prairie in old channel of Huron River at base of steep unforested river bluff; thicket, then elm-ash-cottonwood-sycamore forest at W end of channel, 2 acre pond at E; mesic sand prairie on terrace along N edge
CITATION: Walpole 1924, Thompson 1983a

Species	Species
Agrimonia parviflora	Juncus balticus
Allium cernuum	J. canadensis
Amphicarpa bracteata	J. dudleyi

Species	Species
Anemone virginiana	Juniperus virginiana
Apios americana	Lilium michiganense
Apocynum sibiricum	Lycopus americanus
Asclepias incarnata	L. uniflorus
Aster junciformis	Lysimachia quadriflora
A. lucidulus	Muhlenbergia glomerata
A. novae-angliae	Onoclea sensiblis
Calamagrostis canadensis	Panicum virgatum
Campanula aparinoides	Parnassia glauca
Carex hystericina	Pedicularis lanceolata
C. stricta	Populus deltoides
Chelone glabra	P. tremuloides
Cicuta maculata	Pycnanthemum flexuosum
Cirsium discolor	Rubus hispidus
C. muticum	Salix interior
Clematis virginiana	Sambucus canadensis
Cornus purpusi	Scirpus atrovirens
C. racemosa	Solidago gigantea
C. stolonifera	S. graminifolia
Crataegus crus-gallii	S. riddellii
C. mollis	Spiraea alba
Elymus virginicus	Spiranthes cernua
Eupatorium maculatum	Thalictrum dasycarpum
E. perfoliatum	Thelypteris palustris
Fraxinus americana	Typha latifolia
F. pensylvanica	Ulmus americana
Gentiana procera	Verbena hastata
Glyceria striata	Vernonia missurica
(Habenaria leucophaea)*	Veronicastrum virginicum
Helianthus giganteus	Vitis riparia
H. grosseserratus	Zizia aurea
Iris virginica	

* B.A. Walpole, 1924)
Surveyed by P.W. Thompson, 1980

56. INDIAN BOWL

LOCATION: Berrien Co., T6S, R17W, S8, SW and S17, W of NW; 1.5 miles NE of Berrien Springs, between St. Joseph River and Hochberger Road, N of Love Creek
TYPE: Sedge Fen (transitional to Wet Prairie)
COVER: Carex aquatilis-Eupatorium maculatum-Solidago altissima dominant
SOIL: Houghton muck, pH 6.8; area soils Oshtemo sandy loam, Ockley and Riddles loam, Spinks loamy fine sand
SETTING: Slope 0-5 deg., aspect SW; 66 acre sedge fen in the floodplain of the St. Joseph River; floodplain forest edges the river on one side of the fen, tamarack and swamp forest separate the fen from oak-covered river bluffs to the E; cultivated field on SW
CITATION: Kron 1983; Thompson 1975, 1983a

Species	Species
Agrimonia parviflora	Iris virginica
Allium canadense	Larix laricina
A. cernuum	Liatris spicata
Amphicarpa bracteata	Lilium michiganense
Andropogon gerardii	Lobelia kalmii
Angelica atropurpurea	L. siphilitica
Anemone canadensis	Lycopus americanus
A. virginiana	Lysimachia ciliata
Apios americana	L. quadriflora
Apocynum cannabinum	Muhlenbergia glomerata
A. sibiricum	Onoclea sensibilis
Asclepias exaltata	Osmunda regalis
A. incarnata	Oxypolis rigidior
Aster junciformis	Parnassia glauca
A. lucidulus	Pedicularis lanceolata
A. novae-angliae	Phalaris arundinacea
A. puniceus	Phragmites australis
A. simplex	Polemonium reptans
A. umbellatus	Polygala senega
Betula pumila	Potentilla fruticosa
Boehmeria cylindrica	Prunella vulgaris
Bromus ciliatus	Prenanthes racemosa
Calamagrostis canadensis	Pycnanthemum virginianum
Calopogon tuberosus	Ranunculus septentrionalis
Caltha palustris	Rhamnus alnifolia
Campanula aparinoides	Rhus vernix
Cardamine bulbosa	Rhynchospora capillacea
Carex aquatilis	Ribes hirtellum
C. lanuginosa	Rudbeckia hirta
C. prairea	R. sullivantii
C. sterilis	Rumex orbiculatus
C. tetanica	Salix candida
Castilleja coccinea	Saxifraga pensylvanica

Species

Chelone glabra
Cicuta bulbifera
C. maculata
Cirsium muticum
Comandra richardsiana
Convolvulus sepium
Cornus purpusi
C. racemosa
C. stolonifera
Cypripedium calceolus
C. candidum
Desmodium canadense
Eleocharis elliptica
Elymus virginicus
Equisetum laevigatum
Erigeron philadelphicus
Eupatorium maculatum
E. perfoliatum
Filipendula rubra
Fragaria virginiana
Galium asprellum
Gentiana andrewsii
G. procera
Gerardia purpurea
Habenaria psycodes
Helenium autumnale
Helianthus giganteus
Heliopsis helianthoides
Hierochloe odorata
Hypoxis hirsuta
Impatiens biflora

Surveyed by M. Medley, 1972

Species

Selaginella eclipes
Senecio aureus
Silphium integrifolium
Sisyrinchium angustifolium
Smilacina stellata
Solidago altissima
S. graminifolia
S. patula
S. ohioensis
S. riddellii
S. rugosa
S. uliginosa
Sorghastrum nutans
Spartina pectinata
Spiraea alba
Spiranthes cernua
Stellaria longifolia
Thalictrum dasycarpum
Thaspium trifoliatum
Thelypteris palustris
Thaspium trifoliatum
Triglochin palustre
Typha angustifolia
T. latifolia
Verbena hastata
Verbesina alternifolia
Vernonia altissima
Veronicastrum virginicum
Viburnum lentago
Viola cucullata
Zizia aurea
Zygadenus glaucus

57. SODON LAKE

LOCATION: Oakland Co., T2S, R10E, S20, NE of NW; 3.5 miles N of Franklin, SE of Long Lake Road and Franklin Road
TYPE: Fen
COVER: Potentilla fruticosa-Carex laxiflora-Thelypteris palustris dominant; Betula pumila subdominant
SOIL: Houghton-Adrian muck, (pH 6.5-7.8); area soils Marlette and Capac sandy loam, Spinks loamy sand
SETTING: Slope 0-5 deg., aspect E; less than 1 acre shrub-herb fen at the W side of a lake; dense shrub fen, then tamarack swamp away from lake, sedge and Lythrum salicaria islands at lake edge; lake surrounded by subdivision
CITATION: Cain & Slater 1948

Species	Frequency*	Species	Frequency
Acer rubrum	4%	Parnassia glauca	16%
Agropyron trachycaulum	8	Parthenocissus quinquefolia	4
Apios americana	16	Potentilla fruticosa	72
Apocynum cannabinum	28	Pycnanthemum virginianum	36
Asclepias incarnata		Rhamnus alnifolia	36
Aster novae-angliae	8	Rhus radicans	8
Betula pumila	60	R. vernix	4
Boehmeria cylindrica	36	Rubus pubescens	28
Bromus ciliatus	32	R. strigosus	12
Calamagrostis canadensis	28	Rudbeckia hirta	4
Campanula aparinoides	24	Rumex orbiculatus	4
Carex laxiflora	80	Salix bebbiana	4
Cicuta maculata	4	S. candida	20
Cirsium muticum	32	S. discolor	16
Cornus racemosa	32	Sanicula marilandica	4
C. stolonifera	8	Scirpus validus	40
Eleocharis smallii	40	Scutellaria galericulata	24
Equisetum arvense	20	Solidago altissima	32
Erigeron philadelphicus	4	S. graminifolia	24
Eupatorium maculatum	40	S. ohioensis	32
E. perfoliatum	4	S. uliginosa	4
Fragaria virginiana	4	Thalictrum dasycarpum	4
Fraxinus pensylvanica	16	Thelypteris palustris	80
Galium boreale	8	Tofieldia glutinosa	4
Glyceria striata		Triadenum fraseri	12
Impatiens biflora	20	Typha latifolia	16
Larix laricina	4	Ulmus rubra	8
Lathyrus palustris	32	Urtica dioica	
Lilium michiganense	4	Valeriana uliginosa	4
Liparis loeselii		Vernonia ?missuruca	24
Lycopus americanus	68	Viola cucullata	20
Panicum implicatum	4		

* Determined in 25 quadrats from two zones: shrub and herb fen

58. PRIEST LAKE

LOCATION: Cass Co, T5S, R16W, S11, center of SW; 4.5 miles NNW of Dowagiac, both sides of Priest Street N of Priest Lake
TYPE: Fen
COVER: Carex stricta-Andropogon scoparius-Sorghastrum nutans dominant
SOIL: Houghton muck, pH 7.3, wrc 538%; area soils Miami sand, Miami sandy loam (no modern soil survey)
SETTING: Slope 0-5 deg., aspect S; 2 acre grass fen in former lakebed; cultivated fields N, homesteads E and W of site; oak woods on slopes south of road; tamarack swamp between lake and fen

Species

Agrimonia parviflora
Allium cernuum (LAS)
Andropogon gerardii
A. scoparius
Anemone virginiana (LAS)
Angelica atropurpurea
Asclepias incarnata
A. lucidulus
A. novae-angliae
A. puniceus
A. simplex
A. umbellatus
Bidens cernua
B. frondosa (LAS)
Bromus ciliatus
Cacalia plantaginea
Calamagrostis canadensis
Calopogon tuberosus (LAS)
Caltha palustris
Carex hystericina
C. sterilis
C. stipata
C. stricta
Castilleja coccinea (LAS)
Chara spp. (LAS)
Cicuta bulbifera (MAK)
C. maculata
Cirsium muticum
Cladium mariscoides
Cornus racemosa
C. stolonifera
Cypripedium candidum
C. reginae (LAS)
Decodon verticillata (LAS)
Drosera rotundifolia
Erigeron philadelphicus (LAS)

Species

Lycopus americanus
Lysimachia quadriflora
Monarda fistulosa
Muhlenbergia glomerata
Osmunda regalis
Oxypolis rigidior
Parnassia glauca
Pedicularis lanceolata
Phalaris arundinacea
Phlox pilosa
Pogonia ophioglossoides (LAS)
Polemonium reptans
Populus tremuloides
Potentilla fruticosa
Prenanthes racemosa
Pycnanthemum virginianum
Rhamnus alnifolia
Rhus vernix
Rhynchospora alba (MAK)
Rhynchospora capillacea (LAS)
Ribes hirtellum (MAK)
Rosa palustris
Rubus pubescens (MAK)
Rudbeckia hirta
Salix discolor
Saxifraga pensylvanica
Scirpus acutus
S. americanus
S. atrovirens
Scutellaria galericulata
Selaginella eclipes (MAK)
Senecio aureus
Silphium integrifolium
Sisyrinchium angustifolium
Smilacina stellata
Solidago graminifolia

Species	Species
Eriophorum viridi-carinatum	Solidago ohioensis
Eupatorium maculatum	S. patula
E. perfoliatum	S. riddellii
Galium boreale	S. rugosa
G. trifidum	S. uliginosa (LAS)
Gentiana procera	Sorghastrum nutans
Glyceria striata	Sphagnum spp.
Helianthus giganteus	Sphenopholis intermedia (MAK)
Hierochloe odorata	Spiraea alba (LAS)
Hypoxis hirsuta	Spiranthes cernua
Iris virginica	Stellaria longifolia
Juncus brachycephalus	Symplocarpus foetidus (MAK)
J. canadensis	Thalictrum dasycarpum
Larix laricina	Thelypteris palustris
Lathyrus palustris	Typha latifolia
Leersia oryzoides	Utricularia intermedia
Liatris spicata	Valeriana ciliata
Lilium michiganense (LAS)	Vernonia missurica
Lobelia kalmii	Viola cucullata
Ludwigia palustris (LAS)	Zizia aurea

59. WHITMAN LAKE

LOCATION: Kalamazoo Co., T2S, R9W, NW of SE; 3.5 miles SE of Augusta, SW side of Whitman Lake
TYPE: Fen
COVER: Potentilla fruticosa-Carex stricta dominant; Sporobolus heterolepis-Andropogon scoparius-Sorghastrum nutans locally dominant
SOIL: Houghton muck, pH 8.1, wrc 286%; area soils Oshtemo sandy loam, Coloma loamy sand, Kalamazoo loam
SETTING: Slope 5 deg., aspect SE; 5 acre sedge fen encircling a lake on three sides, with an area of grass fen at the S end of the lake; dogwood thickets and sedge meadow cover some of the lowland, medium-aged oak woods grow on the steep slopes surrounding the wetland and lake

Species	Frequency	Species	Frequency
Acer rubrum		Monarda fistulosa	10%
Agropyron trachycaulum	5%	Muhlenbergia glomerata	10
Andropogon gerardii	10	M. mexicana	25
A. scoparius	15	Oxypolis rigidior	5
Apocynum sibiricum	5	Panicum implicatum	
Asclepias incarnata		Parnassia glauca	
Aster lucidulus	10	Phalaris arundinacea	5
A. novae-angliae		Phlox pilosa	
A. simplex	40	Populus tremuloides	

Species	Frequency	Species	Frequency
Bromus ciliatus	5%	Potentilla fruticosa	60%
Calamagrostis canadensis	25	Prunus serotina	
Campanula aparinoides		Pteridium aquilinum	
Carex stricta	85	Pycnanthemum virginianum	25
Cicuta maculata		Rhus copallina	
Cirsium muticum	55	R. vernix	5
Cladium mariscoides	10	Ribes missouriense	
Convolvulus sepium		Rudbeckia hirta	15
Cornus racemosa	10	Salix sericea	
C. stolonifera	5	Scirpus acutus	15
Deschampsia caespitosa	25	S. americanus	10
Dryopteris cristata		Selaginella apoda	15
Equisetum laevigatum	15	Senecio aureus	5
Eleocharis rostellata	10	Solidago altissima	45
Eupatorium maculatum	20	S. gigantea	20
E. perfoliatum	10	S. ohioensis	
Filipendula rubra		S. patula	40
Galium boreale	20	S. riddellii	5
Glyceria striata	5	S. uliginosa	10
Helianthus giganteus	5	Sorghastrum nutans	5
Hypoxis hirsuta		Spartina pectinata	10
Juncus brachycephalus		Sphagnum	
Lactuca canadensis		Sporobolus heterolepis	
Liatris spicata	5	Thalictrum dasycarpum	
Lobelia kalmii		Thelypteris palustris	55
L. siphilitica		Valeriana uliginosa	5
Lycopus americanus	20	Zizia aurea	10
Lysimachia quadriflora			

60. BAKERTOWN/CHAMBERLAIN ROAD

LOCATION: Berrien Co., T8S, R18W, S3, NW of NE; 1.8 miles SW of Buchanan, SE of Bakertown Road and Chamberlain Road
TYPE: Fen
COVER: Carex aquatilis dominant
SOIL: Houghton muck, pH 6.8, wrc 339%; area soils Oshtemo sandy loam, Ockley and Riddles loam
SETTING: Slope 0 deg., aspect none; less than 2 acre sedge fen bounded by a moat and cattails, roads and farmland; natural edge once was willows, wet prairie, and oak woods
CITATION: Kohring 1982

Species	Species
Allium cernuum	Lobelia kalmii
Andropogon gerardii	L. spicata
Asclepias incarnata	Lycopus americanus
Aster junciformis	L. uniflorus
A. lucidulus	Lysimachia ciliata
A. novae-angliae	L. quadriflora
A. puniceus	Muhlenbergia glomerata
A. simplex	Oxypolis rigidior
A. vimineus	Panicum implicatum
Bromus ciliatus	Parnassia glauca
Cacalia tuberosa	Pedicularis lanceolata
Calamagrostis canadensis	Poa pratensis
Caltha palustris	Potentilla fruticosa
Campanula aparinoides	Pycnanthemum virginianum
Cardamine bulbosa	Rhynchospora capillacea
Carex aquatilis	Rudbeckia hirta
C. hystericina	Rumex orbiculatus
Cirsium muticum	Sarracenia purpurea
Cladium mariscoides	Scirpus acutus
Deschampsia caespitosa	S. americanus
Drosera rotundifolia	Silphium integrifolium
Eleocharis rostellata	Smilacina stellata
Equisetum hyemale	Solidago canadensis
Eriophorum angustifolium	S. ohioensis
Eupatorium maculatum	S. riddellii
E. perfoliatum	S. rugosa
Galium boreale	S. uliginosa
Gentiana procera	Sorghastrum nutans
Glyceria striata	Sphenopholis intermedia
Hierochloe odorata	Spiranthes cernua
Hypericum kalmianum	Thelypteris palustris
Hypoxis hirsuta	Triglochin maritima
Impatiens biflora	Utricularia intermedia
Juncus acuminatus	Valeriana ciliata
J. brachycarpus	Vernonia missurica
Lathyrus palustris	Viola cucullata
Liatris spicata	Zizia aurea

61. ST. JOHN'S

LOCATION: St. Clair Co., T2N, R16E, S6, NW; 0.25 miles N of Pearl Beach, SE corner of St. John's Marsh Recreation Area
TYPE: Lakeplain Wet-Mesic Prairie
COVER: Andropogon gerardii dominant; Sorghastrum nutans-Carex lanuginosa subdominant
SOIL: Sanilac very fine sandy loam, pH 7.7, wrc 50%; area soils Sanilac and Bach very fine sandy loam
SETTING: Slope 0-2 deg., aspect WSW; 14-16 acre secondary wet-mesic prairie (in 2 parts) on upland margin of large delta formation; subdivision to E; homesteads, cultivated and abandoned fields, woodlots on upland to N; Calamagrostis, Carex, and Juncus meadows interrupted by Cornus-Salix thickets occupy wetter ground; Phragmites, Cephalanthus, and Typha are natural dominants on even wetter ground
CITATION: Thompson 1983a, 1983b

Species	Species
Acer rubrum	Juncus torreyi (PWT)
Agrostis gigantea	Lathyrus palustris
Andropogon gerardii	Liatris spicata
Anemone virginiana (PWT)	Lilium michiganense
Apocynum sibiricum	Liparis loeselii
Asclepias incarnata	Lycopus americanus
A. syriaca	Lysimachia quadriflora
A. ericoides	Lythrum alatum (PWT)
A. novae-angliae	Monarda fistulosa
A. simplex (PWT)	Panicum implicatum
Calamagrostis canadensis	P. virgatum
Carex lanuginosa	Pedicularis lanceolata
Cicuta maculata (PWT)	Poa compressa
Cirsium discolor	Populus deltoides
C. muticum	P. tremuloides
Comandra richardsiana (PWT)	Potentilla anserina (PWT)
Cornus amomum	Prenanthes racemosa
C. racemosa	Prunella vulgaris
C. stolonifera	Pycnanthemum virginianum
Cypripedium candidum (PWT)	Rosa palustris (PWT)
Desmodium canadense	Sanicula marilandica
Eleocharis elliptica	Scutellaria galericulata (PWT)
Equisetum arvense	Senecio pauperculus (PWT)
Eupatorium maculatum (PWT)	Solidago altissima
E. perfoliatum (PWT)	S. gigantea
Fragaria virginiana	S. ohioensis
Galium boreale	S. riddellii (PWT)
Gentiana andrewsii (PWT)	Sorghastrum nutans
Gerardia purpurea (PWT)	Spartina pectinata
Glyceria striata	Spiranthes cernua
Helenium autumnale (PWT)	Stachys tenuifolia
Hypoxis hirsuta (PWT)	Vernonia missurica

Species	Species
Iris virginica (PWT)	Veronicastrum virginicum
Juncus balticus	Vitis riparia
J. canadensis	Zizia aurea
J. dudleyi	

62. VOAKES ROAD

LOCATION: St. Clair Co., T2N, R16E, private claim; center of Harsens Island (exact location is not given because of threat of orchid poaching)
TYPE: Lakeplain Wet Prairie
COVER: Carex lanuginosa-Calamagrostis canadensis dominant
SOIL: Sanilac very fine sandy loam, (pH 7.4-7.8, wrc 60%); area soils Sanilac and Bach very fine sandy loam
SETTING: Slope 0-2 deg., aspect SW; less than 1 acre perhaps secondary wet prairie on upland margin of large delta formation; cultivated and abandoned fields, small woodlots cover uplands; Cornus-Fraxinus thicket at margin; wetter ground dominated by Typha or diked and farmed

Species	Species
Agrostis gigantea	Panicum virgatum
Apocynum sibiricum	Penstemon digitalis
Asclepias sullivantii	Populus deltoides
Calamagrostis canadensis	Pycnanthemum virginianum
Campanula aparinoides	Rudbeckia hirta
Carex lanuginosa	Scirpus validus
Cornus racemosa	Scutellaria galericulata
C. stolonifera	Solidago altissima
Desmodium canadense	S. gigantea
Fraxinus pensylvanica	S. graminifolia
Habenaria leucophaea	S. ohioensis
Juncus balticus	Sorghastrum nutans
J. canadensis	Spartina pectinata
Lathyrus palustris	Stachys tenuifolia
Liatris spicata	Vernonia missurica
Lycopus americanus	Veronicastrum virginicum
Lysimachia quadriflora	Vitis riparia
Monarda fistulosa	Zizia aurea

63. MIDDLE CHANNEL

LOCATION: St. Clair Co., T2N, R16E, private claim; NW edge of Harsens Island (exact location is not given because of threat of orchid poaching)
TYPE: Lakeplain Wet-mesic Prairie
COVER: Andropogon scoparius-Calamagrostis canadensis-Sorghastrum nutans-A. gerardii dominant
SOIL: Sanilac very fine sandy loam, pH 7.9, wrc 68%; area soils Sanilac and Bach very fine sandy loam
SETTING: Slope 0-2 deg., aspect SW; 2.5 acre wet-mesic prairie; golf course fairways and ditches surround site; oak (pin, bur, swamp white) woods, once continuous with prairie, lie on slightly higher ground; homesteads, abandoned fields surround golf course
CITATION: Hayes 1964

Species	Frequency	Species	Frequency
Achillea millefolium	35%	Juncus torreyi	
Agrostis gigantea	5	Lathyrus palustris	15%
Andropogon gerardii	70	Liatris spicata	15
A. scoparius	60	Lobelia spicata	
Anemone canadensis		Lycopus americanus	35
Apocynum sibiricum	30	Lysimachia quadriflora	45
Asclepias incarnata		Lythrum alatum	5
A. sullivantii		Monarda fistulosa	
A. syriaca		Panicum commutatum	
Aster dumosus	40	P. leibergii	
A. ericoides	55	P. praecocius	40
A. novae-angliae		P. virgatum	20
Calamagrostis canadensis	60	Penstemon digitalis	
Carex buxbaumii	70*	P. hirsutus	
C. crawei		Poa pratensis	5
C. lanuginosa		Populus deltoides	
C. tetanica		Potentilla anserina	20
Cicuta maculata		Prenanthes racemosa	
Cirsium discolor		Prunella vulgaris	25
C. muticum	10	Pycnanthemum virginianum	75
Comandra richardsiana	10	Quercus macrocarpa	
Convolvulus sepium	20	Q. palustris	
Cornus racemosa	30	Rosa blanda	15
C. stolonifera	20	R. carolina	5
Crataegus crus-galli		R. palustris	30
Desmodium canadense		Rudbeckia hirta	5
Eleocharis elliptica	5	Scirpus validus	
Equisetum arvense	5	Senecio aureus	15
Erigeron philadelphicus	50	Sisyrinchium mucronatum	15
Eupatorium maculatum	10	Solidago altissima	35
E. perfoliatum		S. graminifolia	10
Fragaria virginiana	75	S. nemoralis	
Fraxinus pensylvanica		S. ohioensis	

Species	Frequency	Species	Frequency
Galium boreale		S. riddellii	
G. obtusum	35%	Sorghastrum nutans	80%
G. trifidum		Spartina pectinata	
Gentiana andrewsii		Spiraea alba	10
G. procera		Spiranthes cernua	
Gerardia purpurea		Stachys tenuifolia	5
Glyceria striata		Ulmus americana	
Habenaria leucophaea		Verbena hastata	
Helenium autumnale		Verbesina alternifolia	35
Helianthus giganteus		Vernonia missurica	
Hypoxis hirsuta		Veronicastrum virginicum	
Iris virginica	5	Viola affinis	40
Juncus balticus	35	Zizia aurea	
J. dudleyi			

64. SEBEWAING RAILROAD

LOCATION: Huron Co., T15N, R9E and Tuscola Co., T15N, R8E; (exact location is not given because of threat of orchid poaching)
TYPE: Lakeplain Wet Prairie
COVER: Carex aquatilis-Calamagrostis canadensis dominant; Sorghastrum nutans-Andropogon gerardii-A. scoparius subdominant
SOIL: Essexville loamy fine sand (mapping unit of Tappan loam), pH 7.9, wrc 59%; area soils Wisner and Thomas loam
SETTING: Slope 0-2 deg., aspect WNW; 1.1 mile-long railroad prairie in former historic wet prairie; ditches, cultivated fields edge railroad line, bur oak woodlot present in adjacent field

Species	Frequency	Species	Frequency
Achillea millefolium	5%	Lycopus americanus	10%
Agrostis gigantea	20	Lysimachia quadriflora	15
Allium canadense	5	Lythrum alatum	
Andropogon gerardii	25	Monarda fistulosa	
A. scoparius	30	Panicum virgatum	
Anemone canadensis		Parnassia glauca	5
Apocynum sibiricum	35	Parthenocissus quinquefolia	
Asclepias hirtella		Phalaris arundinacea	5
A. incarnata		Poa compressa	25
A. syriaca	5	P. pratensis	
Aster azureus	10	Populus deltoides	
A. dumosus	20	Potentilla anserina	15
A. ericoides	15	P. fruticosa	5
A. simplex	5	Prenanthes racemosa	10
Calamagrostis canadensis	65	Pycnanthemum virginianum	50
Campanula aparinoides	15	Quercus macrocarpa	

Species	Frequency	Species	Frequency
Carex aquatilis	70%	Rhus radicans	10%
C. buxbaumii	10	Rosa palustris	
Cicuta maculata		Rudbeckia hirta	
Cirsium discolor		Salix discolor	
Comandra richardsiana	15	Sanicula marilandica	
Convolvulus sepium	15	Scirpus atrovirens	
Cornus stolonifera	50	S. validus	
Desmodium canadense	5	Senecio plattensis	
Eleocharis elliptica	10	Silphium terebinthinaceum	
Equisetum arvense	15	Solidago altissima	30
Erigeron philadelphicus		S. gigantea	
Fragaria virginiana	40	S. graminifolia	20
Fraxinus pensylvanica		S. nemoralis	
Galium trifidum	45	S. ohioensis	5
Gentiana andrewsii		Sorghastrum nutans	60
Glyceria striata	5	Spartina pectinata	50
Habenaria leucophaea		Spiraea alba	
Helianthus giganteus		Stachys tenuifolia	5
Hierochloe odorata	5	Thalictrum dasycarpum	
Hypericum kalmianum	15	Thelypteris palustris	
Iris virginica	15	Typha angustifolia	
Juncus balticus	15	Verbena hastata	
Lathyrus palustris	5	Vernonia missurica	5
Liatris spicata	10	Vitis aestivalis	
Lilium michiganense			

65. SEBEWAING BAY

LOCATION: Tuscola Co., T15N, R8E, S13 and S14; (exact location is not given because of threat of orchid poaching)
TYPE: Lakeplain Wet Prairie
COVER: Carex aquatilis-Calamagrostis canadensis dominant; Sorghastrum nutans-Andropogon scoparius-Spartina pectinata subdominant
SOIL: Essexville loamy fine sand, pH 8.1, wrc 62%; area soils Wisner and Thomas loam
SETTING: Slope 0-3 deg., aspect NW; 13-14 acre wet prairie at the lakeshore; sand ridges support wet-mesic and mesic prairie, succeeding to Cornus stolonifera then Populus tremuloides/P. deltoides-Fraxinus pensylvanica; toward lake Carex aquatilis, Scirpus acutus, Typha angustifolia, etc. dominate in patches or together
CITATION: Davis 1898, 1908

Species	Species
Agrostis gigantea	Liatris spicata
Allium canadense	Lysimachia quadriflora
Andropogon gerardii	Panicum virgatum
A. scoparius	Poa compressa
Anemone canadensis	Polygonum natans
Apocynum sibiricum	Populus deltoides
Aster dumosus	P. tremuloides
A. ericoides	Potentilla anserina
A. novae-angliae	P. fruticosa
Bidens coronata	Pycnanthemum virginianum
Calamagrostis canadensis	Rosa palustris
Campanula aparinoides	Rudbeckia hirta
Carex aquatilis	Salix discolor
Cicuta maculata	S. interior
Cladium mariscoides	Scirpus americanus
Comandra richardsiana	Senecio aureus
Convolvulus sepium	S. plattensis
Cornus racemosa	Sisyrinchium montanum
C. stolonifera	Smilacina stellata
Eleocharis elliptica	Solidago altissima
Erigeron philadelphicus	S. graminifolia
Fragaria virginiana	S. nemoralis
Fraxinus pensylvanica	S. ohioensis
Galium trifidum	Sorghastrum nutans
Habenaria leucophaea	Spartina pectinata
Hypericum kalmianum	Stachys tenuifolia
Iris virginica	Thelypteris palustris
Juncus alpinus	Typha angustifolia
J. balticus	Verbesina alternifolia
J. canadensis	

66. SQUIRREL ISLAND

LOCATION: Lambton Co. (Ontario, Canada); N tip of Squirrel Island, lying between Walpole Island and Harsens Island in the St. Clair River Delta

TYPE: Lakeplain Wet-mesic Prairie

COVER: Panicum virgatum-Andropogon scoparius dominant; A. gerardii subdominant

SOIL: Sanilac very fine sandy loam, pH 8.2, wrc 59%; area soils Sanilac and Bach very fine sandy loam

SETTING: Slope 3 deg., aspect W; 3-4 acre wet-mesic prairie along the St. Clair River; cultivated fields, spoil bank, cattail marsh surround site; cottonwood groves on slightly higher ground, oak woods in center of island; towards river Spartina, Panicum, Phragmites, Calamagrostis dominate alone or together

Species	Frequency	Species	Frequency
Achillea millefolium	5%	Lithospermum canescens	5%
Agrostis gigantea	65	Lobelia kalmii	5
Allium canadense (BK)		L. spicata	40
Andropogon gerardii	60	Lycopus americanus	15
A. scoparius	50	Lysimachia quadriflora	70
Apios americana	5	Lythrum alatum	5
Apocynum sibiricum	15	Monarda fistulosa	25
Asclepias tuberosa		Panicum commutatum	20
Aster azureus	30	P. implicatum	20
A. dumosus	35	P. virgatum	80
A. ericoides	24	Parnassia glauca	20
A. novae-angliae	15	Pedicularis lanceolata	20
Calamagrostis canadensis	35	Poa compressa	5
Carex buxbaumii	20	P. pratensis	10
C. stricta	25	Populus deltoides	
Carex tetanica	10	Prenanthes racemosa	30
Ceanothus americanus		Pycnanthemum virginianum	40
Cirsium muticum	5	Rudbeckia hirta	40
Comandra richardsiana	40	Scirpus acutus	
Convolvulus sepium	5	S. americanus	
Cypripedium candidum	30	S. validus	5
Desmodium canadense	15	Scleria triglomerata	10
Eleocharis elliptica	20	Sisyrinchium mucronatum	10
Elymus canadensis	15	Smilacina stellata	10
Equisetum laevigatum	35	Solidago altissima	10
Erigeron philadelphicus	25	S. nemoralis	35
Fragaria virginiana	10	S. ohioensis	70
Galium trifidum	10	S. rigida	10
Gentiana procera (BK)		Sorghastrum nutans*	
Gerardia purpurea	5	Spartina pectinata	30
Helenium autumnale (BK)		Stachys tenuifolia	15
Hypericum punctatum (BK)		Tradescantia ohiensis	5
Hierochloe odorata (BK)		Vernonia missurica	5
Juncus balticus	40	Veronicastrum virginicum	40
J. canadensis	5	Viola affinis	55
Lathyrus palustris	70	V. sagittata	5
Lespedeza capitata	10	Zizia aurea	50
Liatris spicata	50		
Lilium philadelphicum	5		

* Commoner than indicated

APPENDIX E

Species Lists from Accounts in Literature.

Species of the oak openings in the vicinity of Grand Rapids, Kent County (after Cole 1901). This list is Cole's "oak openings" list plus species noted as occurring in "oak openings" or "dry open woods." If species of "dry woods" were included, this list would be doubled.

Agropyron trachycaulum (freq.)
Andropogon gerardii (common)
A. scoparius (common)
Arabis canadensis (well-distributed, but solitary)
A. lyrata (common)
Asclepias verticillata (occas.)
Aster laevis (common)
A. macrophyllus (common)
Aureolaria pedicularis (freq.)
Aureolaria virginica (frequent)
Besseya bullii (occasional)
Cacalia atriplicifolia (freq. on margins [of openings?])
Carex pensylvanica (common)
Ceanothus americanus (common)
Comandra umbellata (common)
Coreopsis tripteris (occas.)
Cornus racemosa (common)
Danthonia spicata (common)
Desmodium nudiflorum (common)
D. paniculatum (common)
D. rotundifolium (frequent)
Galium boreale (common)
Helianthus divaricatus (com.)
H. occidentalis (frequent and well-distributed)
Hepatica americana (common)
Koeleria macrantha (frequent)
Krigia biflora (frequent)
K. virginica (frequent)
Lechea villosa (common)
Lespedeza capitata (common)
L. hirta (common)
Lithospermum caroliniensis (freq.)
Monarda fistulosa (common)
Orobanche uniflorus (scarce)
Panicum depauperatum (common)
Panicum dichotomum (common)
Phlox pilosa (frequent)
Potentilla simplex (common)
Pteridium aquilinum (common)
Pyrola elliptica (common)
Rubus flagellaris (common)
Salix humilis (common)
Sassafras albidum (common)
Silphium terebinthinaceum (local)
Solidago nemoralis (common)
S. speciosa (common)
S. speciosa var. angustata (frequent)
Stipa avenacea (abundant)
Swertia caroliniensis (frequent)
Tephrosia virginiana (frequent)
Viburnum pubescens (common)
Vicia americana (common)
Viola pedata (common)

Cole listed species of two hillside prairies: Pine Hill north of Cascade Springs, and a south-facing bluff (forming a backdrop for Plainfield Village) near the Grand River. Species restricted to either Pine Hill or Plainfield Village are followed by (P) or (PV).

Amorpha canescens (PV)
Asclepias amplexicaulis
A. viridiflora
Aster ericoides (PV)
A. sericeus (P)
Besseya bullii (P)
Bouteloua curtipendula
Coreopsis lanceolata (P)
Cornus rugosa (P)
Desmodium illinoense (PV)
D. sessilifolium (PV)
Eragrostis spectabilis
Juniperus virginiana (P)
Kuhnia eupatorioides (PV)
Linum sulcatum (PV)
Monarda punctata
Penstemon hirsutus
Polygonum tenue (P)
Quercus muhlenbergii
Q. prinoides (P)
Selaginella rupestris (P)
Solidago rigida
S. speciosa var. angustata (P)
Sporobolus cryptandrus (P)
Zizia aptera (P)

Beal (1904b) listed the following plants as "peculiar to the prairie region of the southwestern portion of the State." It is remarkable that eight of them are legally threatened (THR), one is of special concern (SC), and one believed to be extirpated (EXT).

Amorpha canescens (SC)
Asclepias verticillata
Aster sericeus (THR)
Bouteloua curtipendula (THR)
Baptisia leucantha (THR)
Coreopsis palmata (THR)
Echinacea purpurea (EXT)
Helianthus laetiflorum var. scabra
Phlox bifida (THR)
Silphium integrifolium (THR)
S. laciniatum (THR)
S. perfoliatum (THR)

Daniels (1904) describing the flora in the vicinity of Sturgis, made lists for certain habitats, those of prairie affinities roughly corresponding to mesic prairie, barrens, and oak openings.

Mesic Prairie

Amorpha canescens
Asclepias amplexicaulis
Astragalus canadensis (rare)
Baptisia leucantha
Coreopsis palmata (rare, along railroads)
Corydalis aurea
Desmodium canadense
D. canescens
D. sessilifolium
Equisetum laevigatum (railroads)
Eryngium yuccifolium
Festuca octoflora (roadsides)
Hedeoma pulegioides (common)
Kuhnia eupatorioides
Liatris aspera
Polygala sanguinea (railroads, especially near "bogs")
Potentilla arguta
Rudbeckia hirta (becoming a weed)
Silphium terebinthinaceum
Solidago juncea
Stipa spartea (very rare)
Tephrosia virginiana
Viola sagittata (railroads)

Barrens

Agrostis hyemalis
Andropogon gerardii (open areas)
A. scoparius
Anemone cylindrica
A. virginiana
Antennaria plantaginifolia
Aristida purpurascens (very rare)
Asclepias tuberosa
Aster sagittifolius
Aureolaria pedicularia
Carex cephalophora
C. cephaloidea [wrong habitat; C. muhlenbergii?]
Ceanothus americanus
Cyperus filiculmis
Danthonia spicata
Diervilla lonicera
Euphorbia corollata (also a weed)
Gaylussacia baccata
Gnaphaium obtusifolium
G. macounii
Helianthemum canadense
Helianthus occidentalis
H. strumosus (railroads)
Koeleria macrantha (rare)
Lactuca canadensis (very rare, rr.'s)
Lathyrus ochroleucus (railroads)
Lechea villosa
Lespedeza capitata
L. hirta
Lithospermum caroliniense
Lupinus perennis (railroads)
Panicum depauperatum
P. dichotomum
Polygala polygama
Polygonum tenue (hills)
Pteridium aquilinum
Ratibida pinnata
Rhus copallina
Salix humilis
Senecio plattensis
Solidago nemoralis
S. rigida
S. speciosa
Sorghastrum nutans
Swertia caroliniensis (rare)
Taenidia integerrima
Tradescantia ohiensis
Vaccinium angustifolium
Viola pedata

Oak Openings

Adiantum pedatum
Agrimonia gryposepala (open places in woods)
Agropyron trachycaulum
Agrostis perennans
Amelanchier laevis (uncommon)
Amphicarpa bracteata
Anemone quinquefolia
Anemonella thalictroides
Aquilegia canadensis
Aralia racemosa
Aristolochia serpentaria (rare; Tyler's woods)
Asclepias exaltata
A. purpurascens
Aster azureus
A. cordifolius
A. laevis
A. macrophyllus
A. undulatus (fields)
Aureolaria flava
A. virginica
Blephilia ciliata
Botrychium virginianum
Bromus ciliatus (Tyler's woods)
B. latiglumis
B. pubescens
Cacalia atriplicifolia (also open places, roadsides)
Carex pensylvanica
C. artitecta
Carpinus caroliniana
Carya cordiformis
C. ovalis
C. tomentosa
Celastrus scandens
Chimaphila umbellata
Claytonia virginica (also bottoms)
Collinsonia canadensis (Tyler's woods)
Comandra umbellata
Coreopsis tripteris
Cornus florida
Corylus americana
Cypripedium pubescens (rare)
Desmodium cuspidatum
D. dillenii

Desmodium glutinosum
D. nudiflorum
D. paniculatum
D. rotundifolium
Dioscorea villosa
Dryopteris spinulosa
Elymus canadensis
E. striatus
E. virginicus
Erigeron pulchellus
Eupatorium rugosum (Tyler's woods)
Festuca nutans (Tyler's woods)
Fragaria virginiana
Galium boreale
G. circaezans
G. pilosum
G. triflorum
Gaultheria procumbens (rare)
Geranium maculatum
Hackelia virginiana
Hamamelis virginiana
Helianthus divaricatus
Hepatica americana
Hieraceum scabrum
H. venosum
Hypoxis hirsuta
Hystrix patula
Juglans cinerea
J. nigra
Juniperus communis (rare on hillsides)
Krigia biflora (Tyler's woods)
Lactuca canadensis (common)
Lonicera dioica
Melampyrum lineare
Monarda fistulosa
Muhlenbergia shreberi (common also in yards)
M. sylvatica
M. tenuifolia (Tyler's woods)
Ostrya virginiana
Panicum latifolium
Parthenocissus quinquefolius
Pedicularis canadensis
Phegopteris hexagonoptera (Tyler's woods)
Phlox pilosa (Tyler's woods)
Poa debilis (Tyler's woods)
Podophyllum peltatum
Polygonatum biflorum
P. pubescens
Polystichum acrostichoides
Potentilla canadensis
Prenanthes alba (Tyler's woods)
P. altissima (Tyler's woods)
Prunella vulgaris
Prunus americana
P. serotina
P. virginiana
Pyrola secunda
Pyrus coronaria
Quercus alba
Q. borealis
Q. imbricaria
Q. macrocarpa
Q. prinoides
Q. velutina
Ranunculus abortivus
Rhus glabra
R. typhina
Ribes cynosbati
Rosa carolina
Rubus canadensis (thickets, fields)
R. flagellaris
R. occidentalis
Sambucus canadensis
Sanguinaria canadensis
Sanicula marilandica
Sassafras albidum
Scrophularia marilandica
Smilacina racemosa
S. stellata
Smilax herbacea
Solidago caesia
S. canadensis
S. flexicaulis
S. gigantea
Thalictrum dioicum
Triosteum perfoliatum
Trillium grandiflorum
Veronicastrum virginianum
Viburnum acerifolium
V. pubescens
Viola palmata
V. papilionacea
V. pubescens
Vitis aestivalis (fence rows)
Vitis riparia (fence rows, thickets)

Species of Tuscola County grasslands, by habitat (Davis 1908). Presence in habitat is denoted by "x".

Species	Mesic Savanna	Wet-mesic	Prairie Wet
Acer rubrum		x	
Achillea millefolium	x		
Agrimonia gryposepala	x		
A. parviflora	x		
Agrostis gigantea		x	
A. hyemalis	x	x	
Amelanchier laevis	x		
Amphicarpa bracteata	x		
Andropogon gerardii	x	x	
Anaphalis margaritacea	x		
Anemone virginiana	x		
Antennaria plantaginifolia	x		
Apocynum sibiricum			x
Aquilegia canadensis	x		
Asclepias hirtella		x	
A. purpurascens		x	
A. sullivantii		x	
A. syriaca		x	
Aster ericoides		x	
A. laevis	x	x	
A. novae-angliae	x	x	
A. puniceus		x	
A. sagittifolius		x	
A. junciformis	x	x	
Betula papyrifera	young		
Cacalia plantaginea		x	
Calamagrostis canadensis	x		codominant
Carex lanuginosa			codominant
C. buxbaumii			x
C. flava		x	
Carex spp.		x	x
Castilleja coccinea		x	
Convolvulus sepium		x	
C. amomum	x		
Cornus racemosa	x	x	
C. stolonifera	x	x	
Corylus americana	x		
Crataegus crus-gallii	x	x	
Danthonia spicata		x	
Desmodium canadense	x		
Eleocharis spp.		x	x
Eupatorium perfoliatum		x	
Fragaria virginiana	x	x	
Fraxinus americana	young		
Gaylussacia baccata	x		
Gentiana andrewsii	x		
G. procera		x	

Species	Mesic Savanna	Wet-mesic Prairie	Wet
Geranium maculatum	x		
Gerardia purpurea	x	x	
Helenium autumnale		x	
Helianthemum canadense	x	x	
Helianthus giganteus	x	x	
Hieraceum canadense	x		
Iris virginica		x	
Juncus balticus	x	x	
J. canadensis			x
J. nodosus		x	x
Juncus sp.		x	
Koeleria macrantha		x	
Lactuca hirsuta	x		
Lechea villosa		x	
Lespedeza capitata	x		
Liatris spicata	x	x	
Lobelia kalmii		x	
L. spicata		x	
Ludwigia polycarpa		x	
Lycopus americanus		x	
Lysimachia quadriflora		x	
Lythrum alatum		x	x
Monarda fistulosa	x	x	
Panicum lanuginosum		x	
P. virgatum	x	x	
Parnassia glauca		x	
Parthenocissus quinquefolius		x	
Pedicularis lanceolata	x		
Phragmites australis			x
Poa compressa	x	x	
P. pratensis	x	x	
Populus deltoides	x		
P. balsamifera	x		
P. tremuloides	x		
Potentilla anserina		x	
P. fruticosa	x	x	
Prunella vulgaris		x	
Prunus pumila	x		
P. virginiana	x		
Pteridiumn aquilinum	x		
Pycnanthemum virginianum	x	x	
Quercus alba	x		
Q. bicolor	x		
Q. borealis	x		
Q. macrocarpa	x		
Q. velutina	x		
Rhus aromatica	x		
R. glabra	x		
R. typhina	x	x	

Species	Mesic Savanna	Prairie Wet-mesic	Prairie Wet
Rosa carolina	x	x	
R. blanda	x		
Rubus canadensis	x		
R. flagellaris	x		
Rudbeckia hirta	x	x	
Salix humilis	x		
S. nigra	x		
Salix spp.	x	x	
Scleria verticillata		x	
Senecio pauperculus		x	
Silphium terebinthinaceum	x	x	
Solidago canadensis	x	x	
S. gigantea		x	
S. graminifolia	x	x	x
S. nemoralis	x	x	
S. ohioensis		x	x
S. riddellii		x	x
Sorghastrum nutans	x	x	
Spartina pectinata	x	x	x
Spiranthes cernua		x	
Taenidia integerrima	x		
Thalictrum dasycarpum	x	x	
Tilia americana	x		
Ulmus americana	young		
Vaccinium angustifolium	x		
Vernonia altissima	x	x	
Vibernum lentago	x		
Vitis riparia	x	x	

"The original land survey of Washtenaw County...describes a tract of land [Town 1 South, Range 6 East, Section 21, 27, 28] about six miles north of Ann Arbor as 'plains'.... [They] occupy an area of rolling topography, so that their name was probably suggested by the vegetation. [Still persisting were Andropogon gerardii, Coreopsis tripteris, Desmodium illinoense, Heliopsis helianthoides, and Silphium integrifolium.] The older inhabitants of the region verify this idea, and state that it was originally completely treeless. At the present time it is almost completely under cultivation, and several small groves of native trees occur (Gleason 1917)."

"Just north of this area there is still preserved a small tract of grassy marsh, about two acres in extent and in almost original condition. This marsh resembles a hydrophytic prairie closely in general appearance, and includes a number of prairie species in its floristic composition." What was probably a fen was divisible into a mesic and wet portion, and most plants grew in only one or the other.

Amphicarpa bracteata (mesic)
Andropogon gerardii (codominant in mesic portion)
A. scoparius (mesic)
Aster novae-angliae (mesic)
Cypripedium candidum (wet)
Desmodium illinoense (wet)
Eupatorium maculatum (wet)
Gentiana procera (wet)
Helianthus grosseserratus (mesic)
Liatris spicata (mesic and wet)
Lilium philadelphicum (mesic)
Muhlenbergia mexicana (mesic)
Oxypolis rigidior (wet)
Parnassia glauca (wet)
Phlox pilosa (mesic)
Phragmites australis (wet)
Potentilla fruticosa (mesic)
Sarracenia purpurea (wet)
Silphium terebinthinaceum (mesic)
Solidago ohioensis (wet, mesic)
Sorghastrum nutans (mesic, and codominant in wet portion)
Sporobolus heterolepis (codom. in wet and mesic portions)
Thaspium trifoliatum (mesic)
Thelypteris palustris (mesic)
Tofieldia glutinosa (wet)

Commonest species of the Newaygo Dry Sand Prairies (Hauser 1953). (Frequency expressed as percent in 500 $1m^2$-quadrats.)

Species	Freq.	Species	Freq.
Ambrosia psilostachya	58.4%	Koeleria macrantha	43.8%
Andropogon gerardii	27.4	Krigia virginica	5.0
A. scoparius	45.6	Liatris aspera	22.8
Anemone cylindrica	3.2	Linaria canadensis	8.8
Arenaria stricta	8.2	Linum sulcatum	9.0
Aristida purpurascens	12.4	Monarda punctata	6.8
Artemisia caudata	6.2	Panicum commonsianum	13.2
Aster azureus	2.6	P. depauperatum	15.4
A. ericoides	2.2	Poa compressa	4.4
Carex pensylvanica	89.0	P. pratensis	8.2
Coreopsis lanceolata	5.2	Polygala polygama	25.8
Cyperus filiculmis	11.2	Polygonella articulata	4.4
Danthonia spicata	9.4	Rosa carolina	5.4
Eragrostis spectabilis	8.8	Rubus flagellaris	24.6
Euphorbia corollata	23.8	Solidago nemoralis	17.4
Geum triflorum	2.0	Sorghastrum nutans	9.2
Gnaphalium obtusifolium	2.2	Sporobolus cryptandrus	2.0
Helianthemum canadense	3.8	Tephrosia virginiana	10.2
Helianthus occidentalis	14.6	Viola pedata	11.0
Hieraceum longipilum	8.2		

Best indicators of mesic and dry-mesic prairie in southwest Michigan (from Scharrer 1971). Species first listed are those that occur most frequently at sites having many other prairie species. The numbers in parentheses are the total sites (out of 52 "good prairies") at which the species grew.

Coreopsis palmata (10)
Lithospermum canescens (10)
Ruellia humilis (5)
Viola pedata (5)
Carex bicknellii (3)
Asclepias viridiflora (2)
Eryngium yuccifolium (2)
Allium cernuum (1)
Aster sericeus (1)
Helianthus mollis (1)
Sisyrinchium albidum (1)
Viola pedatifida (1)
Viola sagittata (1)
Potentilla arguta (16)
Salix humilis (20)
Desmodium sessilifolium (18)
Aster azureus (11)
A. ericoides (11)
Stipa spartea (10)
Comandra richardsiana (10)
Verbena stricta (13)
Helianthus occidentalis (39)
Aster laevis (17)
Kuhnia eupatorioides (20)

Species of dry and wet meadow in the Oak Openings of northwest Ohio (after Anderson 1971). The dry meadow sites were in Fulton County and Lucas County (Nebraska Road); the wet meadows in Henry County (Maumee State Forest) and Lucas County (Irwin Prairie). Asterisked species were found in over half of all dry meadows studied by Anderson and are hence highly characteristic.

Species	Dry	Wet	Species	Dry	Wet
Acer rubrum	x	x	Leersia oryzoides		x
Achillea millefolium*	x		Leucosporum multifidum		x
Agrimonia parviflora		x	Lepidium densiflorum*	x	
Agrostis hyemalis*	x	x	L. virginicum*	x	
Aletris farinosa*	x		Leptoloma cognatum*	x	
Alisma subcordata		x	Lespedeza capitata*	x	
Ambrosia artemisiifolia*	x	x	Liatris aspera*	x	
Andropogon gerardii*	x	x	L. spicata		x
A. scoparius*	x	x	Lilium michiganense		x
Anemone cylindrica	x		Lithospermum caroliniensis	x	
A. virginiana*	x	x	Lobelia spicata		x
Angelica venenosa	x	x	Lupinus perennis*	x	
Antennaria plantaginifolia*	x		Ludwigia alternifolia		x
Apios americana*	x		L. palustris		x
Apocynum androsaemifolium	x		L. polycarpa		x
A. cannabinum	x		Lycopus americanus		x
Arabis glabra	x		L. uniflorus		x
A. lyrata	x		Lysimachia quadrifolia*	x	
Aristida purpurascens*	x		Lythrum alatum		x
Asclepias hirtella	x		Monarda fistulosa*	x	x
A. incarnata		x	Myrica asplenifolia*		
A. syriaca	x		Oenothera biennis*		
A. tuberosa*	x		Onoclea sensibilis		x
Aster azureus	x		Oxalis dillenii*		
A. novae-angliae*	x	x	Oxypolis rigidior		x
A. pilosus*	x		Panicum agrostoides		x
A. praealtus		x	P. depauperatum*		
A. simplex		x	P. dichotomum*		
A. umbellatus	x		P. lanuginosum*	x	x
Baptisia tinctoria*	x		P. oligosanthes*	x	
Calamagrostis canadensis		x	Paspalum ciliatifolium*	x	x
Carex aurea		x	Penstemon digitalis		x
C. bicknellii	x		Penthorum sedoides		x
C. buxbaumii		x	Phalaris arundinacea		x
C. communis*			Physalis heterophylla	x	
C. granularis		x	Physocarpus opulifolius		x
C. lasiocarpa		x	Poa compressa*	x	
C. muhlenbergii	x		P. pratensis*	x	
C. pensylvanica*	x		Polygala polygama	x	
C. sartwellii		x	P. sanguinea*	x	
C. stricta		x	P. verticillata	x	
C. vulpinoidea		x	Polygonatum biflorum	x	
Ceanothus americanus*	x		Populus deltoides		x

Species	Dry	Wet	Species	Dry	Wet
Cicuta maculata		x	Populus tremuloides*	x	x
Cirsium discolor*	x	x	Potentilla simplex*	x	x
Comandra richardsiana*	x		Proserpinaca palustris		x
Conyza canadensis	x		Prunella vulgaris	x	x
Coreopsis tripteris*	x	x	Prunus serotina	x	
Cornus purpusi		x	Pteridium aquilinum*	x	
C. racemosa		x	Pycnanthemum virginianum	x	x
Cyperus filiculmis*	x		Rhus copallina*	x	
C. strigosus		x	Rosa carolina*	x	x
Desmodium canadense*	x	x	R. palustris		x
D. ciliare*	x		R. setigera		x
D. marilandicum*	x		Rubus allegheniensis	x	
D. paniculatum	x		R. flagellaris*	x	x
D. sessilifolium*	x		R. hispidus*	x	
Eleocharis elliptica		x	Rudbeckia hirta*	x	x
E. erythropoda		x	Salix amygdaloides		x
Elymus virginicus	x		S. bebbii		x
Equisetum arvense*	x		S. discolor*	x	
Eragrostis spectabilis*	x		S. humilis*	x	
Erigeron philadelphicus		x	S. interior		x
E. strigosus*	x	x	S. rigida		x
Eupatorium maculatum		x	Sassafras albidum	x	
E. perfoliatum		x	Scirpus atrovirens		x
Euphorbia corollata*	x		S. pendulus		x
Fimbristylis autumnalis		x	S. validus		x
Fragaria virginiana*	x	x	Scleria triglomerata	x	
Gentiana andrewsii		x	Scrophularia lanceolata	x	
G. crinita		x	Sisyrinchium albidum*	x	
Gerardia purpurea	x	x	Smilacina racemosa	x	
Glyceria striata		x	Smilax glauca*		
Gnaphalium obtusifolium*	x		Solidago canadensis	x	
Habenaria flava	x		S. graminifolia	x	x
Helenium autumnale		x	S. juncea*	x	
Helianthemum canadense*	x		S. nemoralis*	x	
Helianthus divaricatus*	x		S. riddellii		x
Hypericum punctatum*	x		S. rugosa	x	x
Iris virginicus		x	Sorghastrum nutans	x	
Juncus biflorus		x	Spiraea alba		x
J. brachycarpus		x	Spiranthes cernua		x
J. canadensis		x	Sporobolus cryptandrus	x	
J. dudleyi		x	S. vaginiflorus	x	
J. greenii*	x		Thalictrum dasycarpum		x
J. marginatus		x	Tridenum fraseri		x
J. torreyi		x	Typha latifolia		x
Juniperus virginiana*	x		Tridens flavus	x	
Krigia biflora	x		Vernonia altissima	x	
K. virginica*	x		Viola sagittata*	x	
Lactuca canadensis*	x				

APPENDIX F

Possible Misidentifications of Species in the Study

Antennaria neglecta, *A. plantaginifolia*: Nearly every plant I saw looked like the latter, even at places where *A. neglecta* was reported. It may be that *A. neglecta* is an environmental morph of the other, existing in its purest form under xeric conditions.

Apocynum cannabinum, *A. sibiricum*: Intermediates exist, so I'm not convinced my determinations are all correct.

Comandra richardsiana: It is this phase of *C. umbellata* which grows in Michigan prairies.

Cornus racemosa, *C. purpusi*, *C. amomum*: *C. racemosa* is the commonest and when I examined a plant I found only it. I may have overlooked the other two--*C. amomum* in southeast Michigan and *C. purpusi* in southwest Michigan.

Galium trifidum var. *tinctorium*, *G. obtusum*: I regularly encountered a bedstraw in vegetative condition which looked like flowering *G. trifidum* I had identified in 1980. They didn't resemble vegetative parts of *G. obtusum* as well (and even less so *G. boreale* var. *intermedium*.) But without flowers, I can't be sure.

Gerardia (Agalinus) purpurea: The variety I saw in fens and certain wet prairies was *G. purpurea* var. *parviflora* = *G. paupercula*.

Helianthus divaricatus, *H. strumosus*: All *H. strumosus* were identified correctly, but it may have been missed when I assumed that sunflowers on the wood edges (with ostensibly sessile leaves) were *H. divaricatus*. *H. divaricatus* does fringe on the open grassland, but *H. strumosus* grows more often in direct sunlight.

Helianthus grosseserratus, *H. giganteus*: *H. giganteus* is correctly identified. Some sites may have had *H. grosseserratus*, which I probably overlooked if *H. giganteus* was present. The species intergrade, but I found only *H. giganteus* when I checked. *H. giganteus* seems a plant of wet prairie and fen and the other of slightly drier situations.

Heuchera hirsuticaulis: I never determined if this was the eastern *H. americana*, western *H. richardsonii*, or the hybrid swarm, *H. hirsuticaulis*. According to Gleason & Cronquist, Michigan has the hybrid.

Oenothera biennis, *O. parviflora*: The former is always correct and certainly the commoner, but their similarity on casual inspection means I may have missed the latter.

Pycnanthemum flexuosum, *P. virginianum*: *P. virginianum* is far and away the commoner, and therefore I certainly missed the former where it occurred unless I knew beforehand to expect it.

Rhus glabra, R. typhina: Intermediates occur. All R. glabra are correct, but at sites of the commoner R. typhina I may have missed R. glabra, which appeared more often at sites less influenced by surrounding woodland.

Rosa carolina, R. blanda, R. suffulta: The commonest by far is the first, but sites may have had the others since, after R. carolina was found I didn't notice roses unless they were very different. All R. suffulta are correct.

Senecio plattensis, S. pauperculus: A decision on species was arbitrary when intermediates of this intergrading pair were found. The former seems typical of upland prairie, the latter of fens (also interdunal wetlands, etc.).

Smilax ecchirata, S. lasioneura: I saw only S. lasioneura, usually in woodland prairie. The former is reported, but I've never seen it outside woods, especially in floodplains.

Solidago altissima (S. canadensis var. scabra), S. canadensis: Nearly everything I saw was the former. When I saw S. canadensis, it was strikingly distinct. It was reported at many places I saw only the variety. S. canadensis was quite rare in my observation, and often solitary, whereas the variety was abundant and formed large clones.

Thalictrum dasycarpum, T. polygamum: The expected species in wet prairie is the former, but T. polygamum--which I only recently learned exists--should be anticipated at least in southeast Lower Michigan.

Thaspium barbinode, T. trifoliatum: Both barely make it into Michigan, and T. trifoliatum is overwhelmingly the commoner. I only saw this one, but the other is reported.

Vaccinium brittonii, V. lamarckii, V. angustifolium: These once were considered varieties of the same species, V. pensylvanicum. They never keyed satisfactorily, always seeming intermediate with something else. I don't know which is commonest--actually, they're all uncommon in Michigan prairie.

Vernonia missurica, V. altissima: Most of what I saw was closest to V. missurica, but intermediates between these intergrading species occur in Berrien County. We have no V. fasciculata, the ironweed of western prairie.

Viola fimbriatula, V. sagittata: Like the two Antennaria's, these may be ecological morphs, the former in very dry places and the latter in moister ones. I saw mostly the latter, in both dry and moist sites, but it was intermediate in characters. I saw V. fimbriatula only in the driest places, and its form was pure.

Vitis aestivalis, V. riparia: Some confusion, but mostly correct; however, plants rarely fit key characters satisfactorily. Both were in prairie, the former in upland sites and the latter in lowland ones.

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