THE OAK UPLAND CONTINUUM IN SOUTHERN MICHIGAN

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George Wyman Parmelee

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This is to certify that the

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By

George Wyman Parmelee

A DISSERTATION

Submitted to the School of Graduate Studies of Michigan

State College of Agriculture and Applied Science

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THESIS

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AN ABSTRACT

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Although oak upland forest occupies more aggregate acreage than any other natural community in southern Michigan (Gysel and Arend 1953), this element currently ranks as the least known plant community of the region. Accordingly, a primary objective of this study has been to record by phytosociological methods the vascular components of a regional series of stands representative of the oak upland type. In all, quadrat data for trees, shrubs and herbs from 36 stands distributed through 17 counties are presented.

The extremely diverse species representation indicated by these data suggested that the continuum concept as elaborated by Curtis and McIntosh (1951) would provide the most realistic orientation of stands for purposes of comparison and contrast. Importance values were therefore computed for each tree species and these values were weighted by climax adaptation numbers to yield continuum index numbers ranging from 751 to 1999.

Data representing individual components of the various synusiae of each stand were charted in a sequence determined by these continuum index numbers. The resulting curves were interpreted as graphical expressions of tolerance ranges. No tendency for such ranges to occur in patterns suggesting discrete combinations of species was evident in any synusia. (Rather, the charts based on tree data indicated that even the most contrasting stands differed less by kind of dominants than by proportion of dominants.) The majority of shrub and herb species were found to show definite correlation with continuum index sequence. Among those which do not are certain of the more ubiquitous subdominants and those which occur so sporadically that trends are inconclusive. Species of either of these categories are held to have no utility as indicators of site.

The leading pairs and trios of dominants in each stand were correlated with continuum index sequence in order to determine the validity of each as bases for empirical classification of oak upland stands. For this purpose two leading dominants are held to be superior to three because of the fewer number of unduplicated combinations and the narrower overlapping in scale position of the stand groupings characterized by the same leading dominants. The scale sector between index values of 1350 and 1400 was tentatively recognized as a boundary separating stands having black oak as one of the two leading dominants from those in which red oak has a similar position.

Few "natural laboratories" of the type envisioned by Major (1951), in which the influence of one-factor environmental variation on continuum index number could be noted, were found. Stands developed on slopes of southern exposure had significantly lower continuum index numbers than those developed on slopes of northern aspect. Except on north slopes, severe disturbance was likewise reflected by a significant lowering in continuum index number. Despite effective variation of other environmental factors, a general correlation was noted between continuum index number and soil texture.

Data obtained in this study were combined with information from other sources in an effort to test the validity of the various climax hypotheses as applied to the oak upland continuum in southern Michigan. The climax pattern hypothesis of Whittaker (1953) was found to agree most closely with observable facts.

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INTRODUCTION

Oak upland forest was an extensive and distinctive element of the primary vegetation of southern Michigan. Today, though probably more nearly obliterated than any other forest community, this type still occupies a greater aggregate acreage than any other natural plant community. Despite its obvious importance in the original and present vegetation mosaic, the oak upland element currently ranks as the least known plant community of the region. No phytosociological papers dealing specifically with the oak upland community of southern Michigan have been published and the only maps in which the element has been segregated are that of Veatch (1928b) based on soil maps and those of Kenoyer (1930, 1934, 1940, 1943) based on land survey notes for eleven southwestern counties.

The study reported herein was undertaken to obtain data that might be used in describing the oak upland community. The objectives, scope and procedure were in large measure determined by the relationship between available information and the great areal extent of this community. Thus, in concordance with the views of Yapp (1922), it was felt that the greatest initial contribution would accrue from emphasis on extensive, rather than locally intensive investigation. If, for example, extensive phytosociological investigation should reveal the existence of repetitive aggregations of species, then subsequent autecological and environmental studies would obviously be facilitated, as emphasized by Curtis and McIntosh (1951: 476). Moreover, though detailed attempts to

demonstrate community interrelationships would obviously be precluded by the time factor, advantage could be taken of such fortuitous opportunities for pointing out coincidences and correlations as chanced to occur. Such observations might be expected to serve as suggestions for future intensive investigation.

Specifically, the primary objectives of this study were twofold: first, to record by phytosociological techniques the vascular components of a regional series of oak upland stands; and second, to organize the data thus obtained to demonstrate or refute the existence of discrete arrays of dominant as well as subdominant components. Secondary objectives were (1) to make such inferences relative to oak upland community dynamics as were possible within the limits of a short period of study; and (2) to note, wherever evident, coincidences and correlations involving stand composition and environmental factors or factor complexes.

LITERATURE REVIEW

Darlington (1946) has supplemented a review of the history of botanical exploration in Michigan with an extensive bibliography of well over 300 citations concerning taxonomic or ecological studies on the higher plants of the state.

The first reference to plant communities in southern Michigan was made by Lanman (1839). He mentioned (p. 251) heavily timbered land, barrens, white oak openings, bur oak plains and prairies. The heavily timbered land was described as composed of a variety of species, including the combination of sugar maple and beech. The barrens were depicted as "but thinly covered with stunted oaks." The white oak openings comprised a great proportion of the area of the state and were described (p. 323) as composed of "white oaks interspersed with black and yellow oaks as well as hickory." They were repeatedly referred to as park-like in aspect, and lacking undergrowth except where they adjoined heavily timbered land. Lanman also provided generalized descriptions (pp. 282--291) of the natural vegetation of 22 southern counties. Numerous references to oak openings, bur oak plains and prairies occur in these descriptions. Such emphasis doubtless reflects the tendency of the early road builders to establish routes through these types which were at once easiest to traverse and which occupied types of land most in demand by the settlers.

In the preface to their catalog of the Michigan flora, Wheeler and Smith (1881) depicted the upland forests of southern Michigan as consisting

of beech-maple and oak communities, with one type locally shading into the other in response to textural variations of the glacial drift.

Other early references to forest communities were based on relatively localized observations. In his classical report on the dune vegetation along the southern Lake Michigan shore, Cowles (1889: 384--385) recognized three types of dune forest. These were held to be determined primarily by slope aspect and distance from the shore. In a study of the forests of Kent County, Livingston (1903: 39) recognized five upland communities which he regarded as comprising a gradational series determined primarily by moisture relationships. These communities in order from most mesic to most xeric were: beech-maple, maple-elm-agrimony, oak-hickory, oak-hazel and oak-pine-sassafras. Concerning the problems of delimiting these types Livingston (p. 39) states that they "often merge gradually into one another so that in some localities it appears that there is a mixture of several of them." His report also includes a list of accessory species which are classified as to relative abundance in the different communities. Additional early observations were published concerning the upland forests of the Huron River valley (Brown 1905; Transeau 1905) and Wayne County (Brown 1917). More recent observational accounts concerning the forests of the general region are included in the contributions of Bingham (1945), Braun (1950) and Veatch (1953).

A number of workers have mapped pre-settlement vegetation for all or parts of Michigan. Utilizing soil-vegetation correlations, Veatch (1928b) delimited generalized types of vegetation for the state as a whole. The maps of others were based on field notes compiled during the original land survey. These reconstructions include (1) small scale maps of the

Lower Peninsula which show the distribution of original swamp areas (Davis 1907) and gross vegetation types (Marshner 1946), and (2) large scale maps showing the pre-settlement vegetation in considerable detail for 11 southwestern counties (Kenoyer 1930, 1934, 1940, 1943).

Wheeler and Smith (1881) regarded the flora of the Lower Peninsula as relatively homogeneous, stating that "probably three-fourths of our species are common to all sectors." Soon after, however, two areas comparable to the tension zones of Griggs (1914: 47) were recognized and species reaching northern or southern limits in them were listed. These comprised the Grand Haven area along the Lake Michigan shore (Bailey 1882) and the valley of the Grand River (Beal and Wheeler 1892). Veatch (1932) recognized a transition zone, based on pedologic evidence but characterized also by transitional vegetation, centered to the north of these areas along a line from Saginaw Bay in the east, to Muskegon in the west. The northern boundary of the oak hickory forest was depicted as being reached in this zone, as were the southern limits of white spruce, and jack, red and white pines. This zone would thus seem to constitute an ecotone separating natural regions of a scope comparable to the biotic provinces of Dice (1931, 1943), the natural areas of Cain (1947), the floristic areas of Raup (1947) and Egler (1947) and the floristic provinces of Curtis and McIntosh (1951). The boundary between the Alleghenian and Carolinian biotic provinces (Dice 1931) falls entirely within the transition zone, as does the boundary between the beech-maple and hemlock-white pine-northern hardwood regions recognized by Braun (1950).

The first report incorporating quantitative data on actual composition of upland forest in southern Michigan was that of Quick (1924) who presented frequency data for 10 stands of the beech-maple type. Quick regarded the beech-maple community as an "ecological species" of "definite biotic composition." Moreover, he was evidently determined to depict "typical" composition as indicated by his statement (p. 221) that some species "were so typical of a preceding association as to warrant their exclusion" from the data. The tree species accepted by him as components of the beech-maple association were:

Acer saccharum	Carya ovata
Fagus grandifolia	Prunus serotina
Tilia americana	Carya cordiformis
Ulmus americana	Juglans cinerea
Fraxinus americana	Quercus alba
Ostrya virginiana	Tsuga canadensis
Quercus rubra	Liriodendron tulipifera
	Betula lutea

Concerning the 15 species included in this list Quick stated (p. 221) that "a few such as the white oak were scarcely typical, but occur so often that they were included as indices of the forest type."

The first quantitative account concerned specifically with oak upland stands was that of Wood (1930) who studied five grazed woodlots on the W. K. Kellogg tract in Kalamazoo County. Black and white oaks and pignut hickory were the leading dominants of these stands but were poorly represented in the reproduction classes, comprising only 10 per cent of the total. In an inventory of 45 oak stands in Livingston and Genesee Counties, Monroe (1943) found the proportion of trees over 15 inches at d.b.h. so low that the basal area of this class was exceeded by that of the 2- to 6-inch group. Young and Sholz (1949) found reproduction of the predominant oaks and hickories in a Washtenaw County stand to be "almost negligible in amount." The most recent and comprehensive paper on the oak upland is by Gysel and Arend (1953), who obtained tree data from a total of 118 sample plots in 61 oak stands. The plots were grouped into five site classes based on varying combinations of soil texture, position of moist layers in the substrata, general topography and position on slope. The proportion of oak in the reproduction class (less than 0.6 inch at d.b.h.) was found to decrease with improving site quality from a maximum of 50 percent on very poor sites to only 4 percent on very good sites. In general, reproduction of black and white oaks was most abundant on both "very poor" and "poor" sites while that of red oak was confined mainly to "medium" to "very good" sites.

Studies of upland forests in contiguous regions indicate the occurrence of oak upland types similar in composition and site characteristics to those of southern Michigan. Kittredge and Chittenden (1929) recognized a gradational sequence of oak types on the sandy scrub oak lands north of the tension zone across lower Michigan. These appear to be correlated primarily with edaphic influences. They range from the jack oak type, on the most xeric and sterile soils, through jack oak-white oak and white oak-black oak mixtures on intermediate sites, to the red oak type on the most mesic and fertile sandy soils. In a study of 98 woodlots in Missaukee County, likewise north of the tension zone, Elliott (1952) found stands dominated by red and white oaks to be restricted to xeric sands of the Roselawn series.

In the glaciated region of northern Ohio, the general descriptions of Sears (1925), Sampson (1927, 1930) and Shanks (1942) indicate a gradational series of upland oak types determined primarily by available moisture. Of the species dominating these types, post and bur oaks occur on the most xeric forest sites, with a sequence from black to white to red oaks indicative of progressively more mesic conditions. The two charts included in Sampson's second paper (1930: 360, 362) are most useful in indicating the ranges in site tolerance and abundance of the various tree components. A similar chart of site range for the trees of southern Ontario has been provided by Hills (1952).

Gordon (1936) recognizes four types of upland oak forest in Indiana. Although he does not attempt to arrange these in a series as regards site requirements, from his descriptions the white oak-black oak type would definitely appear to be the more xeric and the oak-maple type the more mesic. Oak and oak-hickory comprise the intermediate types.

Potzger (1935, 1939) and Potzger and Friesner (1940b) present quantitative data which indicate that topographic climate exerts sharp control on forest types in central Indiana. All three sets of quadrat data included with these papers seem inherently consistent except Potzger's data of 1935 which indicate that Quercus borealis maxima (= Q. rubra) is restricted to a south slope and Q. velutina to a north slope. Such results are at such marked variance with the other two sets of data, as well as with observational experience in general, as to suggest that the two names may have been interchanged in setting up the table.

Potzger and Friesner (1940a) and Jones (1952) have compared the herb synusiae of oak upland stands in central Indiana with those of more mesic types in the same region. With one exception, their data indicate oak upland forest to be richer in species than other types.

Comprehensive phytosociological reports on the forests of southern Wisconsin have been presented by Whitford (1951) and Curtis and McIntosh (1951). Whitford classified the 26 stands included in his study on the

basis of shade tolerance of the tree components. He arbitrarily assigned each tree species to one of three tolerance classes and then determined the proportion of all trees in a stand which belonged to each class. This permitted the ranking of stands in accordance with the percentage of intolerant components. The importance of black oak, bur oak, shagbark hickory and black cherry were found to decline sharply in stands composed of less than 75 percent intolerant species. White oak remained high in importance in the intermediate stands composed of 25 to 45 percent intolerant species, while red oak reached its peak importance in such stands.

Curtis and McIntosh (1951) presented data from 96 upland stands which were ranked according to the more inclusive concept of "climax adaptation," encompassing the entire assemblage of attributes which collectively determine the range of environmental tolerance of a given species. Their method of stand analysis represents an admirable example of the inductive approach. First, relative measures of density, frequency and dominance (all expressed as percentages) were added to yield a summation index termed importance value. Next, the importance value for each species of a stand was recorded to scale, and in color code, on a strip of celluloid. Similar strips were prepared for all 96 stands after which the strips were arranged in such order as to yield the smoothest possible trends in importance value for four key species.[1] Such a sequence of strips was found to indicate independent, although broadly overlapping, curves of importance value for the various stand components. It was possible, therefore, to rank each species as to

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[1]*Quercus velutina*, *Q. alba*, *Q. rubra* and *Acer saccharum*.

climax adaptation by assigning it a number ranging from 1 to 10 depending upon the position of its importance value-maximum relative to the other species. These climax adaptation numbers were used to weight the importance values. The resulting weighted importance values were then summed to obtain the continuum index number for each stand. For any given stand this number has a possible range from 300 to 3,000,[2] so a vegetational continuum index of 2700 scale divisions is available for classifying upland forest vegetation. Beginning at the xeric (low) end of the scale, the importance value-maxima of the principal oak upland species of southern Wisconsin occurred in the following order: *Quercus macrocarpa*, *Q. velutina*, *Carya ovata*, *Q. alba*, *Q. rubra*.

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[2]Since the importance value index has a constant total value of 300 units per stand.

THE REGION AND ITS HISTORY

Physiography

Except for a few extremely local outcroppings of bedrock, the whole of southern Michigan is mantled with glacial drift of Wisconsin age. The genetic types of this drift -- morainal, fluvial, lacustrine -- have been differentiated and mapped in considerable detail by Leverett (1924).

Primary Configuration Features

The brief interval of geologic time during which the unconsolidated deposition in southern Michigan has been subjected to gradational forces is nearly everywhere reflected in the constructional character of the land surface. Gross constructional variations in the drift mantle permit the recognition of major physiographic and land divisions (Veatch 1953: Fig. A). In a general way these divisions are correlated with the genetic types of drift which comprise the primary configuration features of the region.

In the southern half of the Lower Peninsula, the prevailingly flat lacustrine plains adjoining Lakes Michigan, Huron and Erie are delimited toward the interior by old shorelines marking the highest stages of glacial lakes. Such shoreline traces are located at elevations ranging from about 150 to 200 feet above present Great Lake levels. The interior highland reaches elevations of approximately 400 to 600 feet above present

Great Lake waters and includes three major land types: (1) rolling clay plains; (2) dry sandy plains; (3) sandy hills.

The rolling clay plains, consisting of scarcely undulating to gently rolling terrain are closely correlated in distribution with clay till plains; because of the relatively low perviousness of the drift, surface runoff is of common occurrence and, in consequence, even very slight local relief may strongly influence moisture relationships. The dry sandy plains are most typical of outwash plains, but also include some valley train and terrace deposits; because of the pervious sandy drift, surface runoff is of restricted occurrence and dry depressions, often of a pit nature, are a common feature. The sandy hills conform closely in distribution to the belts of recessional and interlobate moraines. Although an abundance of lakes is a characteristic feature of this land type, the presence of innumerable dry hollows which lack surface drainage, implies a prevailingly pervious substratum.

Secondary Configuration Features

The secondary configuration features, which collectively determine the local landscape aspect, are largely an expression of minor constructional variations in the drift mantle. Though varying greatly in abundance, size and shape in the different landscapes, depressions which lack surface drainage are perhaps the most characteristic secondary configuration features of the region as a whole. Such depressions are, of course, a corollary of the youthful drainage pattern; these range from mere sags or pits, dry or only intermittently containing water, to permanent swamps, marshes and lakes, often of considerable extent.

Though likewise having a multitude of variant forms, the elevated configuration features of secondary rank are in nearly all instances characterized by rounded contours and a complexity of slopes. In combination such land forms result in a landscape of typically softened aspect.

Slope gradient varies through wide limits. Occasionally, a prominence will be found with an abrupt incline approaching the angle of repose; more commonly, however, gradients are of much lower order and frequently are scarcely perceptible. Local relief tends to be of relatively low magnitude; generally, it does not exceed 50 or 75 feet, and even in the more rugged morainal belts is very seldom more than 150 or 200 feet. A map of generalized slope and relief is provided by Veatch (1953: Fig. 13).

In the light of the above generalizations it would appear that influences correlated with aspect or exposure may be considered minor sources of vegetational diversity in southern Michigan. However, in company with variations in the lithologic composition of the drift, secondary configuration features are of primary significance in determining moisture relationships on a local basis, and, accordingly, may be expected to play an important role in determining the local patterns which collectively comprise the regional mosaic of natural vegetation.

Although the multiplicity of detail evident in a given landscape defies complete cartographic expression, Veatch (1953), by recognizing pattern continuity as regards minor variations in configuration and lithologic composition of the drift, has succeeded in delineating minor land divisions which are most helpful in visualizing the more or less characteristic landscape aspects prevailing over extensive aggregate areas.

Climate

The regional climate of southern Michigan alternates between continental and semimarine. The intervals of the latter type coincide with periods of strong onshore winds during which the equalizing effects of the windward Great Lakes waters are manifested far inland. Because of prevailing westerly winds, the waters of Lake Michigan are more influential in this regard than those of Lakes Huron and Erie. Continental climate, with its characteristic pronounced fluctuation in temperature, prevails during periods of atmospheric calm, as well as during those rare intervals when the Lakes are entirely frozen over.

A narrow belt extending along the Lake Michigan shore is characterized by relatively continuous semimarine climate. The transition from this zone of more equable climate to that of the interior is not well defined and, over the interior, differences in topographic climate are even less marked, as may be inferred from the rather narrow range in elevation and local relief characterizing the area. Spatially, therefore, the climate of southern Michigan may be regarded as essentially uniform. Such effective variations as occur appear to be of a regional nature, and thus not correlated with the rather abrupt transitions in natural vegetation that characterize the area.

The mean annual precipitation ranges from less than 28 inches in the Thumb Area to more than 36 inches in the extreme south-central portion. Precipitation is fairly well distributed through the year, though the monthly totals in winter average about one inch less than in summer. An average of 16 to 20 inches falls during the warm season between April 1 and September 30. The number of days with snow cover of one inch or more in depth ranges from about 70 in the south to around 110 in the north. The average annual temperature ranges between 45 and 50 degrees, with a July average of about 72 degrees as opposed to a January average of around 24 degrees. The growing season ranges from more than 180 days in the extreme southwest to about 140 days in the Thumb region.

According to the Köppen classification of climates as modified by Ackerman (1941), the area lies well within the Df boundary, which delimits a cold forest climate with humid, snowy winters. The a/b boundary between the subdivisions marked by hot and cool summers passes through the southern tier of counties. A more genetic classification by Borchert (1950) indicates the area to lie largely in the transition zone between his climatic regions I and IV. Its climate is thus held to be intermediate between that of the northeastern forest region of deep winter snows and reliable summer rains and that of the prairies with relatively dry winters and occasional low summer rainfall. The inclusion of the southern tier of counties in region IV is not well supported by the natural vegetation, although some restricted areas of prairie do occur in the southwestern counties (see subsequent section, General Vegetation).

Soils

Authoritative treatments of the soils and land of Michigan are provided by Veatch (1941, 1953). His latest monograph largely furnishes the basis for the resume below.

The mineral soils of the southern half of the Lower Peninsula are derived from gray and yellowish drifts showing a strong influence of shales and limestone from the local geologic formations. In the highland physiographic division of the region there is an additional strong influence of local sandstones. The zonal soils of the region — those associated with upland forest vegetation — are representative of the gray-brown podzolic group and probably comprise about half the total area.

Profiles from southern Michigan referable to this great soil group show certain features in common. The organic accumulation on the surface is relatively thin, varying mostly within the limits of one to three inches; calcium and magnesium carbonates have been almost completely leached from the solum; sesquioxides have been removed from the sola, or upper gray horizon immediately below the mull humus layer.

Depending primarily upon the proportions of the different soil separates, three principal variants of the idealized zonal profile may be recognized. These are: (1) profiles characterized by predominant influence of clay; (2) profiles developed from drift of intermediate texture; (3) profiles developed on prevailingly sand drift.

The zonal soils of southern Michigan strongly reflect the extreme diversity in surface configuration and lithologic composition of the parent materials from which they were developed. Accordingly, it is most difficult to generalize concerning the landscape aspects and principal soil types of such areas as are characterized by predominance of any one of these profile variants. Nevertheless, catenary sequences involving principal soil types and showing a gross correlation with configuration features may be recognized. Such gradational sequences are determined primarily by variations in moisture and texture (see Veatch 1953: Fig. 10). Thus, clay profiles prevail on the rolling clay plains of ground moraine origin where the St. Clair and Napanee types are representative of the less pervious soils of the relatively flat land, and the more pervious Miami type characterizes much of the elevated terrain. As the topography becomes more rolling, and the clay influence less predominant, the Hillsdale type becomes increasingly important and forms a transition to the intermediate profile variant. This soil also plays a transitional role as regards topography, occurring typically on the more rolling terrain of both till plains and recessional moraines.

On the higher, complex ridges of recessional and interlobate moraines the Hillsdale soils are largely replaced by the Bellefontaine and Coloma types. The Bellefontaine and Hillsdale types are roughly equivalent texturally, but the former tends to be somewhat more xeric because of configuration characteristics. Coloma soils are representative of the sand profile variant and thus constitute the most xeric type of the sequence.

A more abbreviated catena is characteristically developed on drift of glacio-fluvial origin, such as outwash plains, valley trains and terraces. In this gradational sequence the Oshtemo type, characterized by a very weak clay B-horizon, is transitional from the Fox soil, representative of the profile variant of intermediate texture, to the xeric sand profile of the Plainfield type.

It must be emphasized that the above soils, comprising the principal upland types of southern Michigan, do not occur in extensive continuous bodies but, on the contrary, are to be found in intimate association with one another and with a large number of other types as well. Moreover, such soil associations in turn comprise a pattern of marked complexity, as is strikingly shown by the detailed map of soil associations compiled by Veatch (1953) to accompany his monograph. Finally, even the soil within the boundaries of a single type must be envisioned as of a gradational nature, for as Veatch states (1953: 27) "no unit small or large, possesses absolute uniformity or homogeneity throughout the space given to it on a map. It usually happens that the divisions shown on a soil map are more often an association of units rather than a single unit."

General Vegetation

Postglacial History

Gleason (1923) has presented a detailed, and in many respects speculative, account of the vegetational history of the general region. Subsequent reports have been based on, or at least tempered by, the evidence of pollen analysis.

Sears (1942b) has charted the migration routes of five important tree genera. In general terms, Quercus and Fagus advanced from the south; Carya and Tilia entered from the west; Tsuga migrated from the northeast. Pollen profiles depicting the postglacial clisere in southern Michigan have been presented by Potzger and Wilson (1941), Sears (1942a), Parmelee (1947) and Potzger (1948). In general, these profiles support the regional sequences recognized by Sears (1948) and Flint and Deevey (1951), which involve five main phases from deglaciation to the present:

1. Spruce-fir
2. Pine
3. Mesophytic deciduous
4. Xerophytic deciduous
5. Mesophytic deciduous

All three deciduous phases of this clisere were evidently characterized by a predominance of oaks, with beech assuming increasing importance in the last two stages.

The method of radiocarbon dating devised by Libby, Anderson and Arnold (1949) has provided evidence that the Mankato maximum, which marks the approximate time of initiation of this clisere, occurred only 11,000 years ago. (Flint and Deevey 1951: 261--263). Additional radiocarbon datings indicate further that, depending on latitude, the pine phase of North American profiles occurred from 6,000 to 9,000 years ago (ibid.: 272). No consistent chronology for the deciduous phases of the regional sequences is yet available. The latest estimate regarding the dating of the thermal maximum (phase 4, above) in North America is from 3,000 to 6,000 years ago (ibid.: 258).

There is increasing support for the view that once local climates determined by proximity to vast continental ice sheets ceased to exist, subsequent major climatic shifts were contemporaneous throughout the world (Raup 1937; Deevey 1939; Willett 1949, 1951). In his two papers Willett presents a great amount of evidence in support of the theory that geological, postglacial and secular trends in climate are all determined by the same astronomic control.[3] In the northern hemisphere he regards such control as reflected by long period expansion and contraction of the pattern of zonal circumpolar weather. According to this theory, phase five of the above sequence, indicative of increased moisture, could be correlated with the sub-Atlantic period of Europe initiated about 2,800

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[3]Most probably ultraviolet radiation of the sort correlated with sunspot activity (see Willett 1949: 46).

years ago.

On the basis of widespread and well documented evidence in the northern hemisphere, Willett (1949: 49) notes the occurrence of a second thermal maximum during the period from 400 to 1,000 A.D. He states that "this period was similar in nearly all respects to the Climatic Optimum except that it did not develop quite as far, nor last nearly so long." Evidently this thermal maximum corresponds to the retreat phase of the Cochrane episode of post-Mankato time reported by Sears (1948), and the late thermal maximum postulated by Transeau (1935). Sears describes this period as "marked by the northernmost advance of deciduous trees, notably oak, and by the prevalence of oak-hickory and prairie in Ohio." It would seem likely that the pre-settlement prairies in southern Michigan represented relics dating from this period.

Willett (1949) describes the last 950 years as a period of climatic stress, reaching peak severity during the 13th and 14th centuries when the thriving Viking colonies in Greenland were exterminated. Subsequent to that time he states (pp. 49—50) that "only minor climatic changes have occurred although conditions have remained definitely on the cool and stormy side compared with the milder periods, in both Europe and North America. The 17th and 18th centuries were rather mild, the 19th somewhat colder and stormier... but the recent oscillations of climate have been relatively small." Judging from this general characterization, recent cliseral shifts of vegetation might be safely considered of very small moment.

Pre-settlement Vegetational Pattern

Prior to the period of intensive settlement beginning about 1820--1830, Veatch (1953: 196) estimates that forests covered probably no less than 95 percent[4] of the area of the state. The vegetation map compiled from land office field notes by Marshner (1946) indicates dry prairies and marshes were concentrated mainly in southern Michigan. However, the aggregate area of such dominant vegetation would seem scarcely sufficient to be reflected in a proportion of forested area in southern Michigan significantly less than that for the state as a whole.

Marshner's map shows the original forests to have consisted largely of hardwoods, with areas of swamp conifers scattered throughout, and with conifers[5] codominant with hardwoods over extensive areas in the Thumb Region, in the interior north of the southern four tiers of counties and in Ottawa, Allegan and Van Buren counties bordering Lake Michigan. Veatch's (1928b) reconstruction of the original forests, based on soil-vegetation correlations, is in essential agreement with Marshner's maps as regards the areas of hardwood-conifer dominance and, in addition, delimits tentative, generalized types of hardwood forest.

In general, the more local variations in forest composition appear to be strongly correlated with moisture relations, which in turn are conditioned mainly by surface configuration and lithologic composition of the weathered glacial drift. Veatch (1953: 39) estimates that possibly as much as 40 percent of the area included in the gray-brown soil region

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[4]The remaining five percent is described by Veatch as comprised of "lakes, marshes, bogs, natural prairies, lake beaches, shifting dunes and garden sized clearings made by Indian tribes."

[5]Presumably white pine and hemlock.

of southern Michigan is characterized by azonal or intrazonal soils. Of these, wet types -- hydromorphic, organic, recent alluvium -- comprise all but a minor fraction of the aggregate area. As a group, such wet soils originally supported some expression of swamp or bottomland forest.

Of the organic soils, peats were characterized by swamp conifers[6] with an admixture of hardwoods such as aspen, red maple, elm and black ash. Muck soils, representing an advanced stage of decomposition and alteration of the organic parent material, supported a hardwood swamp forest in which american and rock elms, red and silver maples, black ash, swamp white oak and cottonwood were common components.

Swamp forests of hardwoods also were characteristic of hydromorphic soils. For the most part these were similar to the types developed on muck. In forests developed on heavy textured hydromorphics such as the Brookston type, bitternut and shagbark hickories, white ash, sycamore and basswood were additional common components; likewise, the diversity of the swamp forests developed on wet sandy soils were increased by pin and bur oaks, black gum and aspen.

Not all the zonal soils supported typical upland forests. On the less undulating portions of the interior clay plains what might be regarded as types transitional from swamp to upland forest occurred on the less pervious Napanee and St. Clair types. Except for the occurrence of sugar maple, beech and white and red oaks — usually in slightly elevated sites — these forests were reminiscent of the swamp type developed on Brookston soils.

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[6]Typically tamarack but occasionally black spruce or northern white cedar.

On the more rolling portions of the interior clay plains, as typified by the Miami-Hillsdale-Conover Association (Veatch 1953: 61) the forest assumed a more definite upland character. Regarding this soil association, Veatch writes (p. 62):

> The original forest cover on the upland probably contained more sugar maple and beech than elsewhere in Michigan, but it is doubtful whether these species were universally present on all the upland, or in greater numbers than white, red, and black oaks, elms, white ash, hickories and basswood.

With increasing local relief and soil perviousness, as typified by the catenary sequence of soil types from Miami through Hillsdale to Bellefontaine, the original forests increasingly assumed the character of oak-hickory uplands with red, white and black oaks and pignut hickory comprising the major dominants.

On the soils developed from drift of glacio-fluvial origin, oak-hickory forests of composition similar to the above, or forests dominated largely by oaks alone, were of widespread occurrence. The latter type was composed largely of black and white oaks, except in the environs of prairies where bur oak was the leading dominant. The latter areas occur as relatively small tracts aggregating some 85,000 acres in the southwestern part of the state, where they lie in close proximity to the central prairie region. The absence of any indications of local edaphic, topographic, or climatic compensation (Veatch 1953: 44) suggests that these areas represented relics of a once more extensive prairie region and that they persisted up to the time of settlement through the influence of fire coupled with the capacity of grass vegetation to compete with tree reproduction.

Post-settlement History

The pre-settlement pattern of natural vegetation in southern Michigan has been profoundly modified by the activities of Caucasian man. It may be assumed that a very small proportion of the change dates back more than 150 years since as late as 1817 there were no roads leading to the interior (Tuttle 1873). By 1830, however, heavy immigration was in progress and during the brief interval from 1830 to 1838 the population of the territory increased from 32,000 to 175,000 (Lanman 1839). Hotchkiss (1898) states that by 1837 at least 433 sawmills were in operation in the southern part of the state. The product of these mills was predominantly whitewood and basswood lumber which seemed to meet best the needs of the settlers.

From the accounts of Lanman (1839), Hotchkiss (1898) and Watkins (1900) it is evident, however, that only a small part of the old growth timber was converted into lumber. Much oak and black walnut was used for rail fencing and great quantities of timber of all species was burned to provide ashes for glass and soap manufacture. To make way for agriculture, girdling or "windrowing" preparatory to burning was practiced on an extensive scale. Watkins observed that:

> One of the worst obstacles in clearing off the timber preparatory to opening up the land for agricultural purposes was the great whitewood trees ... These trees when fallen and green positively refused to burn ... Other trees were felled across then and a fire started and kept burning sometimes for weeks until the great logs finally yielded.

Clearing for agricultural purposes in southern Michigan has progressed to the point where in 1950 woodlands were estimated to comprise only about 10 percent of the farm land (Cunningham 1950). In addition approximately two-thirds of these remnant woodlands were reported to be grazed (Anonymous 1950).

The pattern of forests and cropland in southern Michigan has been and continues to be strongly influenced by the pattern of natural drainage. In the early period of settlement the well-drained oak uplands were particularly sought out because of the ease with which roads could be constructed and the land prepared for agriculture (Veatch 1928b, 1953). In consequence, there is little doubt that the proportion of cleared land is greater in the oak upland areas than in any other forest type in the state.

In addition to being greatly reduced in area, the oak upland type in southern Michigan has been greatly modified by past utilization. Many tracts are perhaps better classed as wooded pastures than woodlots; stands containing any large proportion of old growth are uncommon. Gysel and Arend (1953: 14) have called attention to the selective cutting of white oak in the last half of the nineteenth century. They further express the belief that heavy cutting on moist sites where oak was originally associated with other hardwoods has increased the present proportion of oak.

Further modification of the oak type in southern Michigan may be expected to result from the ravages of oak wilt. In Michigan this disease was first discovered in 1951 in seven southern counties (Strong 1951). In some locations the initial infection was judged to have occurred about five years earlier. The disease has since been found in additional counties (Foster 1953). A sanitation program designed to control oak wilt by voluntary destruction of infected trees was initiated in 1952 (Smith

1953). It is at present too early to evaluate the effectiveness of the measure, though Foster (1953) does express cautious optimism that the disease can be suppressed in lightly infected areas such as southern Michigan.

METHODS

Reconnaissance

General reconnaissance, to attain working familiarity with the vascular components of the oak upland community and to locate representative stands suitable for sociological analysis, occupied most of the summers of 1948 and 1949. Exploratory field trips were made to districts considered promising on the basis of vegetation maps prepared by Kenoyer (1930, 1934, 1940, 1943) and Veatch (1928b). In addition information regarding the location of specific stands was sought from local sources including farm foresters, lumbermen, district conservation personnel and local botanists. In all, well over 300 stands, distributed through thirty-five counties, were critically appraised as to suitability for sociological analysis.

Stand Selection

As originally conceived, the criteria of stand acceptability for this study closely approximated those of the relic method expounded by Weaver and Clements (1938: 48). It was hoped that ungrazed stands, essentially primary in character, or at least of advanced second growth, could be located in replicate on each of the major soil types and natural land divisions (Veatch 1931) which were found to support the oak upland community in southern Michigan. However, as extensive reconnaissance revealed the full magnitude of disturbance and fragmentation of the oak upland community, it became evident that a drastic lowering of the initial

criteria of acceptability would be mandatory. Thus, at the end of the second season of reconnaissance, an oak upland stand, wherever its location, was regarded as suitable if (a) it showed no evidence of recent pasturing, (b) was reasonably well stocked with class 5 dominants, and (c) occupied enough area, either in a single block or in fragments, to permit the establishment of ten quadrats within the zones of border effect.

On the basis of these revised standards a total of 36 stands were selected for sociological analysis. The approximate location of each stand is shown in Fig. 1, and a detailed description of location -- by township, range and section -- is included in the captions of Appendix Tables I to XXXVI. Of the nearly 300 stands rejected, the most common defect was evidence of recent pasturing. In view of the urgent need for a large and representative set of stands, no ungrazed stand was rejected without thorough appraisal of its minimum possibilities. Obviously, no clear cut boundary separated stands rejected as too small from those finally selected for detailed study. In several borderline cases tracts consisting of two or more apparently homogeneous fragments of older growth, interspersed in a matrix of younger timber, were included in the study with the aggregate area of the older growth considered as a single stand.

Of the stands selected, only three contained any large proportion of old growth individuals, and only one -- since logged -- was regarded as a true primary remnant.

While it is clearly evident that the shift in emphasis from primary to secondary stands in this study was a practical expedient, this shift is not difficult to defend. Today, an overwhelming and constantly

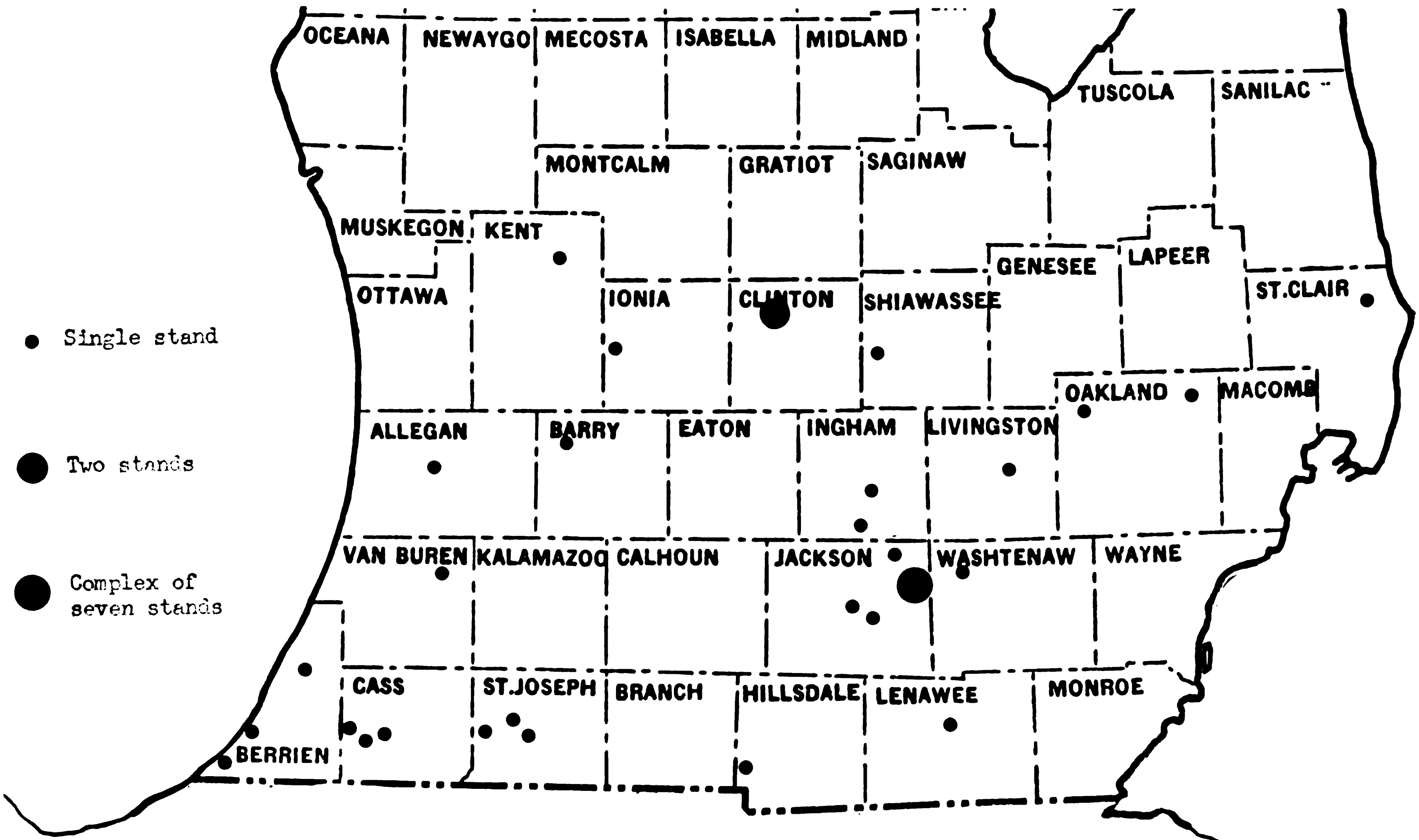

FIG. 1. Map of southern Michigan showing location of stands studied.

increasing majority of stands representing the oak upland community in southern Michigan are secondary. From the practical viewpoint such stands comprise our oak forests of the present and future. As Tansley (1935: 304) emphasizes, we cannot afford to "ignore the processes and expressions of vegetation now so abundantly provided us by the activities of man."

Quadrat Location

The task of obtaining quantitative data in this study was almost constantly complicated by situations which necessitated the maintenance of a clear distinction between the terms "tract" and "stand." Attention has already been directed to fragmented stands. Other tracts, appearing well stocked from a distance, were found on closer inspection to display fragmentation of a more covert type, characterized by abundant small openings clearly the result of past cutting practices. A further complication, especially prevalent in the more rolling tracts, was the occurrence of "internal edge effect" in consequence of poorly drained depressions. The peripheral vegetation of such sites constituted a clear departure from the prevailing type, and often extended radially for a considerable distance from the source. Finally, vigilance had to be maintained at all times to detect possible vegetation changes correlated with macro-variations in relief or soil, or even with line fences in tracts which chanced to straddle property lines (see Fig. 36).

Under such circumstances, the usual methods for assuring regular or random dispersion of quadrats within a tract could only becloud the compositional picture by combining data from two or more adjacent stand elements. Therefore, after much deliberation, the added subjective burden of arbitrarily locating quadrats was undertaken as the only feasible alternative.

Accordingly, once intensive reconnaissance revealed a stand to be apparently homogeneous, quadrats were laid out along lines approximately paralleling the long axis of the area, with the interval between successive quadrats so adjusted that each fell within a site reasonably well stocked with class 5 individuals. In the interest of uniformity this method was followed in laying out 350 of the four hundred quadrats temporarily established. The remaining fifty quadrats were located within a single forty-acre tract, according to a grid pattern established by a previous survey.

Collection of Field Data

Qualitative Data

Though primary emphasis throughout the study was on the assembling of quantitative data, qualitative observations were recorded throughout all phases of field activity. During reconnaissance, records as to major components of each synusia, stocking of each synusia, and degree of past disturbance from the standpoints of grazing and cutting were made for each stand visited. In those stands finally selected for detailed studies, intensive efforts to obtain a complete presence list were made at the time quadrat data were collected.

Other qualitative data included (a) estimates of herb coverage in quadrats, (b) observations concerning the herb and shrub flora of openings and their contiguous border zones, (c) observations of the tree reproduction of openings and adjacent abandoned fields, and (d) tolerance data as indicated by ability of advanced reproduction to withstand suppression.

Quantitative Data

Data in this category were based on a minimum of ten sets of "nested" quadrats per stand, a number considered adequate by Oosting (1942: 4) to portray the composition of a forest community.

Density-list counts for tree representatives above 0.9 ft. tall were obtained from 10 x 10 m. quadrats and recorded according to the arbitrary size-class designations of Weaver and Clements (1938: 35).

Density-list counts for seedlings 0.9 ft. tall or less and for shrubs were based on 2 x 2 m. quadrats. In addition, shrub species-lists were compiled for the 10 x 10 m. quadrats.

Requisite to a really adequate quantitative representation of forest herbs is the establishment of permanent quadrats which could be visited at least twice in the course of a season. The impracticability of such a program as part of the present study, however, was evident from the time and distance aspects involved. It was therefore decided that the maximum yield in herb data, commensurate with expenditure of time, could be obtained by quadrat species-lists.

Initially, herb species-lists were compiled for both the 2 x 2 m. and 10 x 10 m. quadrats. However, as early compilations showed that only a few species attained frequencies of 100 percent even in the 10 x 10 m. quadrats, listing for the smaller size was abandoned. This policy was later reversed, and a third list (for 1 x 1 m. quadrats) added, in consequence of the clear demonstration by Curtis and McIntosh (1950: 452) of the importance of correlating quadrat size with mean area, even when frequency is the only index sought. Of the 670 species lists compiled, 400 were based on the 10 x 10 m. size, 150 on the 2 x 2 m. size, and 120 on the 1 x 1 m. size. In all cases the smaller size quadrats were nested in the same corner of each 10 x 10 m. quadrat.

Voucher Plant Collections

During the course of this investigation, somewhat in excess of 2,500 plant vouchers were collected, of which a large proportion were taken within stands selected for sociological analysis. A minor fraction of the specimens consist of immature herbs which could not be assigned to species categories at the time they were recorded in quadrats. Wherever later critical study of such individuals revealed the existence of distinctive vegetative characters, they have been arranged in developmental sequences and thereby correlated with identifiable specimens. All specimens have been deposited in the Beal-Darlington Herbarium of Michigan State College. Such documentation would seem adequate to satisfy the requirements advanced by Fosberg (1950), and perhaps even to echo the more rigorous challenge of Davidson (1952: 229): "This is the particular plant studied in this work, call it what you will."

With the exception of the subfamily Panicoideae and the genus *Vaccinium*, the nomenclature used in this study follows that of Gray's Manual of Botany, 8th edition (Fernald 1950). Representatives of the Panicoideae are named in accordance with Hitchcock's Manual of the Grasses (Hitchcock and Chase 1950). The nomenclature used in the genus *Vaccinium* follows Camp (1945).

Treatment of Data

The continuum concept, as elaborated by Curtis and McIntosh (1951), would appear to be of such sweeping scope as to be wholly independent of the sampling methods used to obtain the necessary supporting data. Accordingly, it seems incumbent upon the investigator desirous of employing this classification device to maintain the original conceptual terminology, even though his data might have different origin or limits. Such a view has been adhered to in the present investigation.

Further, employment of the continuum concept demands tacit acceptance of the obsolescence, except for restricted purposes, of synthetic methods of vegetational analysis. Required also is a full recognition of the greatly increased significance of analytical indices. In this study, the major efforts supplemental to establishment of a continuum index sequence have therefore been directed toward the compilation of analytical indices whereby the various vascular components of the oak upland community may be viewed against the perspective provided by the continuum index scale.

Analytical Indices

Importance value. This summation index expressing the relative importance of the stand dominants has been considered in the Literature Review. The quadrat data used in compilation of importance values in this study differ in three respects from the random pairs data used by Curtis and McIntosh (1951: 482): (1) relative frequency is based on quadrat frequency as opposed to random pairs frequency; (2) density is compiled on a unit area basis instead of through use of a statistical concept based on average distance between trees; (3) purely for reasons of convenience, the lower limit of trees used for computation of importance value is set at 3.6 inches at d.b.h. rather than 4.0 inches.

The significance of such differences in origin and limits of data would appear to be small. Quadrat frequencies tend somewhat to reduce the weighting toward density as opposed to dominance, since frequency values smaller than half the density values are possible in the case of quadrat — but not of random pair — frequency numbers. However, such a shift could not be of very great magnitude and, in any event, would tend to be counter-balanced by the lower size limits here employed.

Significance value. Compiled in the same manner as importance value, the summation index herein referred to as significance value provides a measure of class 3 reproduction. It thus differs from importance value in that it is based on a "closed" class interval from 1.0 to 3.5 in. at d.b.h., as opposed to an "open-end" class of 3.6 in. and over at d.b.h.

DF_r value. Density and frequency data for tree reproduction of classes 1 and 2, as well as of shrub representation, may be combined to yield a summation index herein termed DF_r value. Like importance value and significance value, this index is determinate inasmuch as simple frequency is converted to relative frequency. However, for a given DF_r value, the absence of a measure of basal area results in a constant sum for all species of only 200 index points per stand instead of 300.

DF_r values for class 2 reproduction are based on data from 10 x 10 m. quadrats. For both class 1 reproduction and shrub representation they are based on data from 2 x 2 m. quadrats.

<u>Simple frequency</u>. In view of the obvious subjectivity involved in assigning coverage values, the frequency data and optical estimates of coverage class compiled for herb and shrub representation in 10 x 10 m. quadrats may not legitimately be combined to yield a summation index. Accordingly, for such representation no need exists for conversion of simple frequency values to relative frequency.

Synthetic Indices

In the light of the continuum concept, synthetic indices are revealed to be of limited applicability and utility. It would seem necessary to restrict their use in this study to those vegetational components, the representation of which shows no obvious correlation with progressive change in continuum index number. For such components four indices involving syntheses of stand data have been used.

<u>Presence</u>. This index in the present study is based on presence lists compiled in the course of at least two reconnaissance surveys of each stand. Regardless of stand size, all species recorded within stand boundaries except those correlated with peripheral or internal edge effect are included.

<u>Aggregate constance</u>. To eliminate discrepancies in representation attributable to size of stand the index herein termed <u>aggregate constance</u> has been used. It differs from presence in that only data from quadrats are admissable. It differs from true constance in that the total sample area of 1000 square meters is an aggregate of ten 10 x 10 m. areas rather than a single plot.

Relative to the latter index, aggregate constance is thus weighted in favor of contagious species, since occurrence in one quadrat is accorded the same significance as occurrence in all ten. Moreover, because a sample area of 100 square meters is patently less than the minimal area of a forest community, it does not permit expression of all possible plant interactions as pointed out by Clapham (1936) and re-emphasized by Curtis and McIntosh (1950: 450).

Summation frequency. Providing a means for integrating inter- and intra-stand dispersion, the index referred to herein as summation frequency expresses the total number of quadrats in which a given species was recorded as a percentage of the total number of quadrats established in all stands. It is based on the premise that the species concerned is as likely to occur in one stand as another, and thus may be expected to show greatest accuracy in representing the more ubiquitous species not correlated with continuum sequence. Used in conjunction with presence and aggregate constance, it provides a more detailed measure of dispersion for such species.

Relative DF_r value. Devised to provide a means for ranking the vegetational importance of the shrub species not correlated with continuum sequence is the index referred to herein as relative DF_r value. For a given species this index value represents the sum of stand DF_r values, expressed as a percentage of the total stand DF_r values for all shrub species in the non-correlated group.

Graphical Presentation

Whenever warranted by a sufficient number of index values to permit recognition of trends, graphical means of presentation of data have been employed. In evaluating such trends, for reasons elaborated in the Discussion, considerably greater significance has been accorded high index values than total absence of representation. Such interpretation may be regarded as controversial, and has necessitated dispensing with statistical methods for smoothing curves on the premise that the full range of index variation should be retained for the reader's personal evaluation.

It has been found impractical, however, to chart the data for each stand in exact continuum index position. As shown in Fig. 4, several of the continuum index intervals are so narrow as to preclude adequate separation of graph elements. To obviate this difficulty, each stand has been assigned a number determined by its relative position on the continuum index scale; this number has then been used instead of the actual continuum index number for identifying the stand data in all graphical and -- in the interest of uniformity -- tabular presentations.

The reader must be cautioned that the regular positioning of graph elements fails to indicate magnitude of the scale intervals separating points on the curve and, more importantly, actually tends to impart the misleading impression that the intervals are constant. This fact is obvious from a glance at Fig. 4.

RESULTS AND OBSERVATIONS

As the study of the oak upland community progressed, observational and quantitative data contributed constant and cumulative evidence attesting to the great diversity of plant aggregations referable to this broad and loosely delimited category. Highlighted, as a consequence, was the prime necessity for an orderly and inherently natural classification of stands to assure the most efficient presentation of results and the most productive evaluation of their significance. Of the various possible means to this end, the principle of the vegetative continuum index appeared to be based on the most realistic premises, and hence most likely to yield the desired natural orientation of data.

Provisional Climax Adaptation Numbers for Southern Michigan

In general, few serious difficulties were experienced in performing the operations necessary to establish a continuum index for the oak uplands of southern Michigan. Most of these were encountered in the process of setting up the scale of climax adaptation numbers shown in Table I. The key role played by this scale in establishing the sequence of stands demanded that every effort be made to assure its accuracy. In the case of infrequently encountered species such as *Carya cordiformis*, *Juglans nigra*, *J. cinerea* and *Ulmus rubra*, tentative estimates pending more extensive studies in southern Michigan were based on the climax adaptation numbers for Wisconsin and the charts of tolerance ranges for the trees of Ohio

TABLE I. Provisional climax adaptation numbers for tree species occurring on upland sites in southern Michigan

Scientific Name	Common Name	Climax Adaptation Number
Populus tremuloides Michx.	Trembling aspen	1.0
Populus grandidentata Michx.	Large-tooth aspen	1.5
Quercus velutina Lam.	Black oak	2.0
Sassafras albidum (Nutt.) Nees	Sassafras	3.0
Carya ovalis (Wang.) Sarg.	Pignut hickory	3.0
Prunus avium L.	Sweet cherry	3.5
Prunus nigra Ait.	Canada plum	3.5
Prunus serotina Ehrh.	Wild black cherry	3.5
Amelanchier sp.	Service-berry	4.0
Cornus florida L.	Flowering dogwood	4.5
Quercus macrocarpa Michx.	Bur oak	5.0
Quercus alba L.	White oak	5.0
Quercus bicolor Willd.	Swamp white oak	5.0
Liriodendron tulipifera L.	Tulip-tree	5.0
Pinus strobus L.	White pine	5.0
Juglans nigra L.	Black walnut	5.0
Fraxinus nigra Marsh.	Black ash	5.0
Fraxinus americana L.	White ash	6.0
Quercus rubra L.	Northern red oak	6.5
Carya ovata (Mill.) K. Koch	Shagbark hickory	6.5
Juglans cinerea L.	Butternut	7.0
Ulmus americana L.	American elm	7.0
Ulmus thomasii Sarg.	Rock elm	7.0
Acer rubrum L.	Red maple	7.5
Nyssa sylvatica Marsh.	Black gum	8.0
Celtis occidentalis L.	Hackberry	8.0
Ostrya virginiana (Mill.) K. Koch	Hop hornbeam	8.0
Carya cordiformis (Wang.) K. Koch	Bitternut hickory	8.5
Carpinus caroliniana Walt.	American hornbeam	8.5
Tilia americana L.	Basswood	9.0
Fagus grandifolia Ehrh.	Beech	10.0
Tsuga canadensis (L.) Carr.	Hemlock	10.0
Acer saccharum Marsh.	Sugar maple	10.0

(Sampson 1930) and Ontario (Hills 1952).

The adaptation numbers for most species, however, were determined according to the procedure proposed by Curtis and McIntosh (1951), with the result that several departures from the Wisconsin values — some of minor, others of major, import — were indicated. In the former category are higher positions on the scale for Carpinus caroliniana, Carya ovata and Tilia americana, as well as lower rank for Fraxinus americana and Ostrya virginiana. Of greater significance, in consequence of the higher range in importance values of the species involved are the higher positions on the scale for Quercus alba, Q. rubra and Acer rubrum.

Carya ovata and Quercus macrocarpa each definitely appear to be represented in southern Michigan by two ecotypes. The less common upland form of shagbark hickory, evidently comparable to the shagbark of the prairie-forest border, was occasionally encountered in stands visited during the reconnaissance phase of the study. All shagbark hickories recorded in quadrats, however, were of the more common lowland form which is associated typically with heavier textured soils (see Fig. 2). The climax adaptation number for shagbark hickory is thus based on this form. Similarly, the adaptation number for bur oak is based on the form which for the most part is confined to lowlands where it is associated with red maple, american elm, swamp white oak and other moderately tolerant trees. The highly intolerant form, which once formed park-like stands on xeric outwash plains in the southern counties, now occurs chiefly as isolated individuals in cultivated fields (see Fig. 3).

FIG. 2. Lowland form of shagbark hickory growing in association with red oak and swamp white oak.

FIG. 3. Old growth bur oak of the type which, in open stands, once characterized the bur oak plains and prairie environs in southern Michigan.

The Continuum Index Scale

Included as the final element of Appendix Tables XXXVIII through LXXIV are weighted importance values, whose sum for each stand comprises its continuum index number and thus determines its position on the continuum index scale. The resulting overall pattern of scale representation is indicated in Fig. 4, in which the stand symbols are spotted in actual continuum index position. In general, the low index numbers on the scale, to the left in this and subsequent figures, reflect xeric conditions; high index numbers, to the right, indicate more mesic conditions. The magnitude of scale interval between contiguous symbols ranges from a maximum of 121 points (between stands 35 and 36) to a minimum of two points (between stands 31 and 32). Moreover, the latter interval is part of an especially heavily represented segment of the index scale in which the indices for five stands (28 through 32) fall within a 20-point range.

The overall representation of the oak upland community as measured by the vegetative continuum index is thus shown to have zones of comparative weakness and strength. Nevertheless, the gaps would appear sufficiently narrow and few to justify the frequent allusions made here that the data are, as a whole, representative of the oak upland community of southern Michigan.

Components of the Oak Upland Community

While rightly emphasizing the role of closely spaced individuals of large stature in characterizing and dominating the multistratal plant community, the continuum concept does not necessarily deny recognition

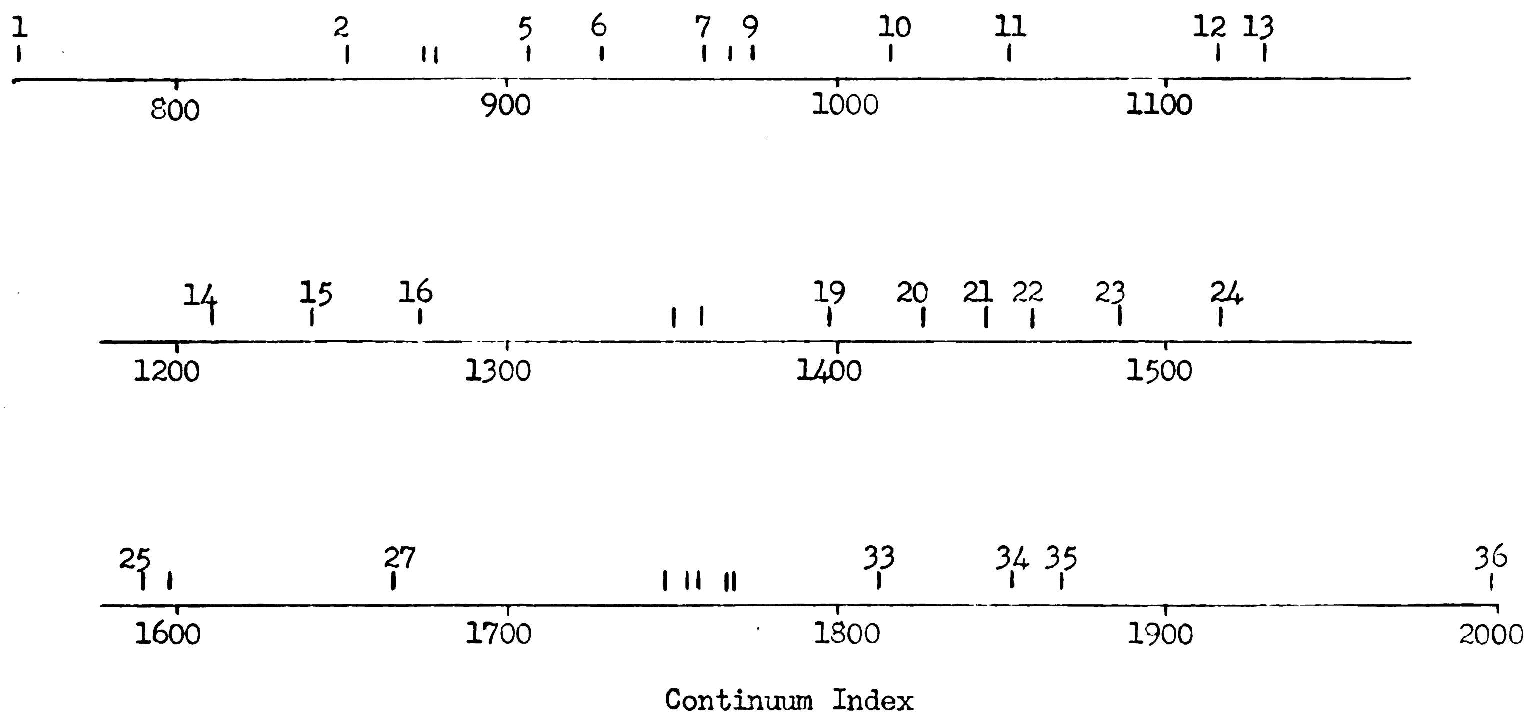

FIG. 4. **Continuum index scale for the oak upland community in southern Michigan showing scale position of the stands studied.**

to the lesser strata. Rather, as Curtis and McIntosh (1951: 493--4) have implied, it may be regarded as a detailed background against which the significance of any phenomenon known or suspected to be mutually related to the dominant vegetation may be evaluated. The only limit to the number of such correlations which might be made would appear to be the amount of significant data obtainable.

In this study, the collection of quantitative data was restricted to the vascular components of the oak upland community. For convenience in presentation of results these components have been segregated in habit categories.

Tree Components

In consideration of the preeminent importance of trees in a forest community, not only in characterizing stands, but also in providing bases for deductions concerning future trends in their development, an attempt has been maintained consistently to assemble and preserve for possible future use the largest feasible amount of data concerning this habit category. Toward attainment of this end, free use has been made of appendix tables. Thus, complete summaries of data on species of trees for classes 2 through 5 for the thirty-six stands included in this study are to be found in Appendix Tables I to XXXVII inclusive. Likewise, complete data for size class 1 are included in Appendix Tables XXXVIII through LXXIV, in which are also found summation indices for classes 2 and 3 and composite summation indices (importance values) for class 4-5. Tree frequency on a species basis is shown in Appendix Table LXXV. It has seemed inadvisable to average, or otherwise group, stand data which show definite correlation with the continuum sequence. As evidenced by curves obtained and, where indicated, by computation of correlation coefficients, most tree data obtained in this study clearly exhibit such correlation. Notable exceptions appear to be the mean areas occupied in a given stand by the total representation in each size class, as well as the mean area occupied by the one most numerous species in each size class. For these data, the only correlation coefficient exceeding 0.2 is the 0.37 figure for total size class 1 representation, a value obviously over-enlarged due to the anomalous totals of size class 1 for stands 25 and 33 (Appendix Tables LXII and LXX). It is evident, therefore, that averages based on such data have meaning within their limits of variability irrespective of the species or species complements involved.

Mean Area Relationships

Because of the distinct value of mean area relationships in evaluating sampling efficiency (see below) as well as in elucidating certain patterns of species representation (see below in sections devoted to class 1 and 2 DF_r values) mean area data are summarized in Tables II and III.

Despite the omissions of extreme values indicated in footnotes to both tables, these data are observed to be highly variable, and, therefore of limited utility. Moreover, as might be expected, the mean area measures summarizing data of single species (Table III) are shown without exception to exhibit such variability in considerably greater degree than those summarizing data for total species.

Even so, in the light of findings by Curtis and McIntosh (1950: 453), a case of obvious maladjustment in sample area is disclosed by the

TABLE II. Mean area relationships by size class for total tree representation

Size class	Mean area in square meters: Range	Mean area in square meters: Average[a]	Quadrat-mean area ratio	Coefficient of variation
1	0.2 — 2.7	1.1 ± 0.2	3.6 ± 0.7	18.2
2	0.7 — 7.0	2.3 ± 1.1	43.5 ± 20.8	47.8
3	5.9 — 34.5[b]	15.1 ± 6.5	6.6 ± 2.7	43.1
4-5	8.5 — 19.2	12.8 ± 2.5	7.9 ± 1.5	19.5

[a]For classes 1, 2, and 4-5 based on individual mean area computations for 36 stands; for class 3 based on 34 stands.

[b]Class 3 mean area values for stand 2 (125.0 m^2) and stand 25 (167.0 m^2) were omitted as anomalous.

TABLE III. Mean area relationships by size class for the single most numerous species in each stand

Size class	Mean area in square meters: Range	Mean area in square meters: Average[a]	Quadrat-mean area ratio	Coefficient of variation
1	0.8 — 8.0[b]	3.1 ± 1.7	1.3 ± 0.7	54.8
2	1.7 — 14.9[c]	5.4 ± 2.9	18.5 ± 9.9	53.7
3	8.1 — 83.3[d]	32.5 ± 22.5	3.1 ± 2.1	69.2
4-5	15.9 — 50.0[e]	29.6 ± 9.6	3.4 ± 1.1	32.4

[a]For class 1 and class 4-5 based on 35 stands; for class 2 based on 34 stands; for class 3 based on 33 stands.

[b]The class 1 mean area value for stand 25 (0.3) was omitted as anomalous.

[c]Class 2 mean area values for stand 26 (23.3) and stand 28 (22.7) were omitted as anomalous.

[d]Class 3 mean area values for stands 4 (250.0), 16 (125.0), and 25 (250.0) were omitted as anomalous.

[e]The class 4-5 mean area value for stand 33 (77.0) was omitted as anomalous.

quadrat-mean-area-ratio[7] for size class 2 in Table III. This ratio is about nine times the value proposed by the above mentioned investigators and, in view of the strong positive correlation between Q/MA ratio and frequency, a significantly greater proportion of high frequencies could be expected than where other ratios were involved in this study. Although Curtis and McIntosh's specific criticism (1950: 452) of frequency values in the 80 to 100 percent class is not applicable here, inasmuch as density values were determined by actual count, it would nevertheless appear undeniable that the occurrence of more than a few 100 percent frequency values would tend to diminish the intrinsic acuity of frequency as an index. As shown in Table IV, the incidence of such values reaches a striking maximum in class 2.

Table V provides a basis for evaluating ratios of size class occurrences on a species basis. While it is obvious that these ratios are correlated with many other factors to be considered later, the overall impress of Q/MA ratio on frequency is evident, especially in the 3 reproduction classes.

Importance Value

The necessary condensation of data for graphical portrayal of tree representation over 3.5 inches at d.b.h. was achieved through use of the importance value index. Integrated from quantitative measures of frequency, density and dominance, this index would appear to provide the most concise and balanced means yet devised for depicting the overall participation of a given species in the control of a given stand. As

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[7]Hereafter referred to as Q/MA ratio.

TABLE IV. Stand occurrences of 100 percent frequencies by size classes

Size class	Number of 100 percent frequencies per stand				
	0	1	2	3	4
1	34	2	--	--	--
2	9	9	12	5	1
3	28	8	--	--	--
4-5	19	13	4	--	--

TABLE V. Stand occurrence[1] for tree components[2] of the oak upland community by size class

Species	Size class			
	4-5	3	2	1
Acer rubrum	26	32	35	26
Acer saccharum	11	12	19	7
Amelanchier sp.	3	25	32	10
Carpinus caroliniana	—	7	10	1
Carya cordiformis	3	3	6	3
Carya ovalis	30	24	35	28
Carya ovata	8	5	8	5
Cornus florida	17	26	29	15
Crataegus sp.	—	5	20	6
Fagus grandifolia	9	11	9	1
Fraxinus americana	14	15	24	16
Juglans cinerea	1	1	1	1
Juglans nigra	1	1	4	—
Ostrya virginiana	9	15	18	8
Prunus serotina	27	29	35	33
Quercus alba	35	19	26	20
Quercus rubra	28	12	28	26
Quercus velutina	31	1	14	19
Sassafras albidum	17	21	32	19
Tilia americana	9	9	16	5
Ulmus americana	4	14	27	9
Ulmus rubra	3	4	14	5
Totals	286	291	442	263

[1]For classes 2 through 4-5 based on representation in one or more of ten 10 x 10 m. quadrats; for class 1 based on representation in one or more of ten 2 x 2 m. quadrats.

[2]Includes only those species represented in the data by 3 or more size classes.

such, its potential contribution to the success of any objective scheme for stand classification needs no further emphasis.

As indicated by data in Table VI, relatively few species are endowed with the biological potential to attain high importance values in the oak upland environment of southern Michigan. In this characteristic, the oak upland of southern Michigan resembles the environment of the Prairie-Forest Province of Wisconsin, as indicated by a comparable table of importance values compiled by Curtis and McIntosh (1951: 483). For reasons to be considered later, however, Table VI sheds little additional light on matters of vegetative or floristic significance in the oak upland community.

Yet when, as in Fig. 5, importance values for the four leading dominants indicated in Table VI are charted on a stand basis and in continuum index order, an overall pattern of vastly enhanced significance emerges. Furthermore, when this pattern is compared with the oak dominated portion of the Wisconsin sequence (Curtis and McIntosh 1951: Figs. 4 and 5), the three oak species common to both regions show the same rise and ebb in representation, the same reciprocity of trend, the same divergence of maxima and, as a consequence, the same progressive permutation. The curves for Quercus alba and Carya ovalis are seen to be clearly less definite than those for the other two leading dominants. Nevertheless, poorly defined maxima for these species are indicated in the median range of the index scale with the maximum for Q. alba in a somewhat higher sector than that for C. ovalis.

Curves for species of lesser rank, but nevertheless sufficiently well represented to permit recognition of trends, are shown in Fig. 6.

TABLE VI. Tree species most frequently sharing in control of the oak upland community of southern Michigan

Species	No. of stands of occurrence	Average importance value	Maximum importance value
Quercus velutina	31	79.4	218
Quercus rubra	28	66.7	179
Quercus alba	35	56.5	133
Carya ovalis	30	32.2	93
Acer rubrum	26	14.8	72
Prunus serotina	27	13.4	80
Sassafras albidum	22	7.2	27
Cornus florida	17	4.5	32
Acer saccharum	11	4.4	34
Fraxinus americana	14	3.8	25
Ostrya virginiana	10	2.8	30
Fagus grandifolia	9	2.4	23

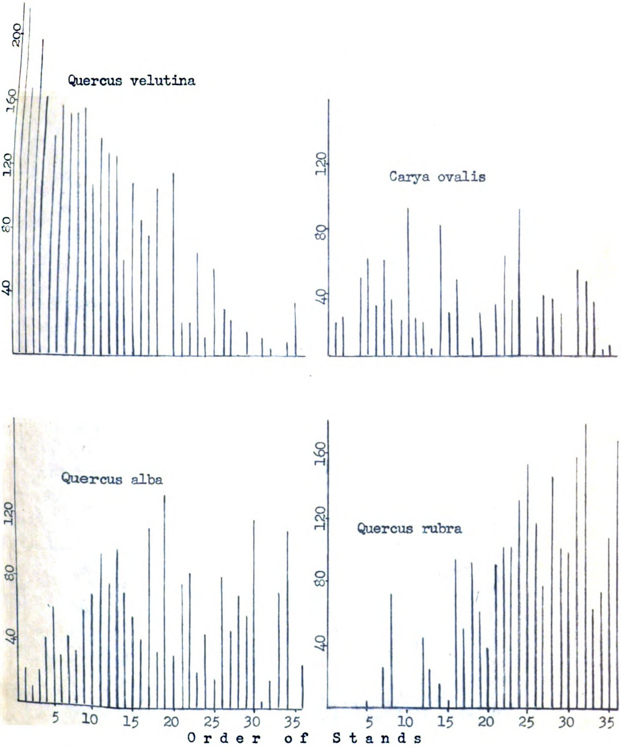

FIG. 5. Importance values of four major dominants in individual stands arranged according to continuum index number.

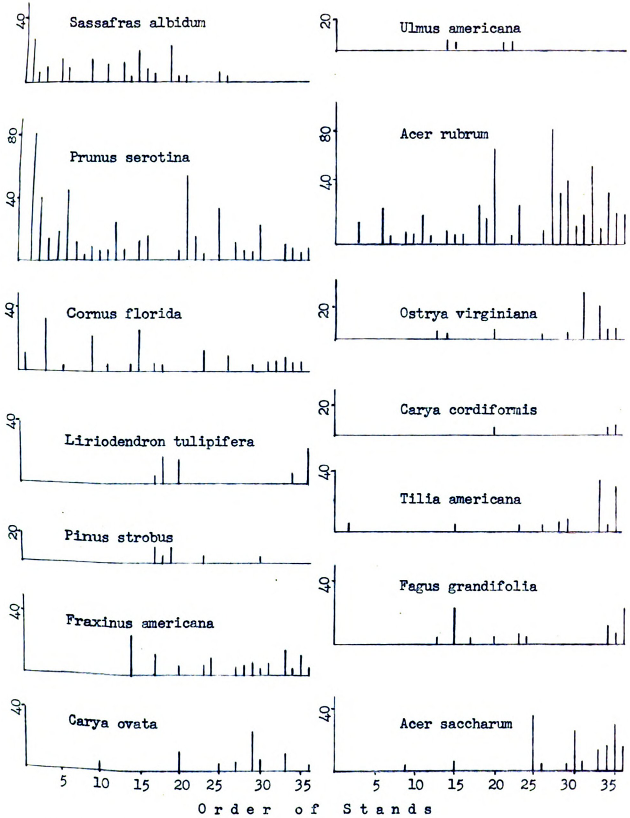

FIG. 6. Importance values of 14 accessory dominants occurring in individual stands arranged according to continuum index number.

Importance values in this group are seen to be generally of low magnitude. Moreover, the highest values are concentrated in the curves for Acer rubrum and Prunus serotina. For these two species only seven values exceed 40, and only two are over 70. For all of these curves, such relatively high importance values as occur are of sporadic distribution; hence, they generally fail to display definite maxima. Illustrative of this tendency are the curves for Sassafras albidum, Acer rubrum, Prunus serotina, Fraxinus americana and Cornus florida. However, the above species, in common with most of the others charted in Fig. 6, do exhibit trends toward greater overall magnitude of representation in one part of the scale than in another. Sassafras albidum and Fraxinus americana, in common with Acer saccharum, Carya ovata, Tilia americana, Ulmus americana, and Pinus strobus are absent -- except for sporadic occurrences -- from one or both ends of the scale and hence manifest this tendency to a maximum degree. Of the three species which range throughout the scale, Cornus florida and Prunus serotina appear more important toward the xeric end, while Acer rubrum shows an opposing trend. A puzzling suggestion of trend discontinuity characterizes the curves for Fagus grandifolia and Liriodendron tulipifera. These and other trend irregularities are considered further in a section of the Discussion devoted to the concept of climax adaptation number.

Summation Indices for Tree Reproduction

In the present study, summation indices were compiled for reproduction up to the arbitrary limit of 3.5 inches at d.b.h. Curtis and McIntosh (1951: 490) have indicated the possible utility of such indices in further weighting stand position on the continuum index scale. However, no attempt to so employ them was made in this study for the following reasons: (1) The index range for class 1 and 2 reproduction is only two-thirds as wide as that for the larger size classes and thus could not readily be combined with the latter; (2) the Q/MA ratio for class 2 representation is in decided disharmony with the ratios for all other size classes; (3) great temporal variation in class 1 reproduction is to be anticipated, and thus a single season's data for this size class would seem to have much less significance than similar data for the larger size classes. As a consequence, the three classes of tree reproduction here recognized fall in the general category of community components which may be correlated with the framework established by weighted importance values. To facilitate such correlation, summation index values for each reproduction class were charted in the same manner as were the importance values.

Significance values. Curves for species sufficiently well represented by class 3 reproduction to establish trends are shown in Figs. 7, 8 and 9. As might be anticipated, comparison of these curves with those of Figs. 5 and 6 reveal for most species a general correspondence in trend between importance value and significance value. Notable exceptions to this generalization, however, are the significance value curves for the three leading dominants of the oak upland community. Actually, because class 3 reproduction of *Quercus velutina* was recorded in only one stand, no curve of significance value could even be established for this, the principal dominant. Although the class 3 occurrences of *Q. alba* and *Q. rubra* were also considerably reduced in relation to occurrences for

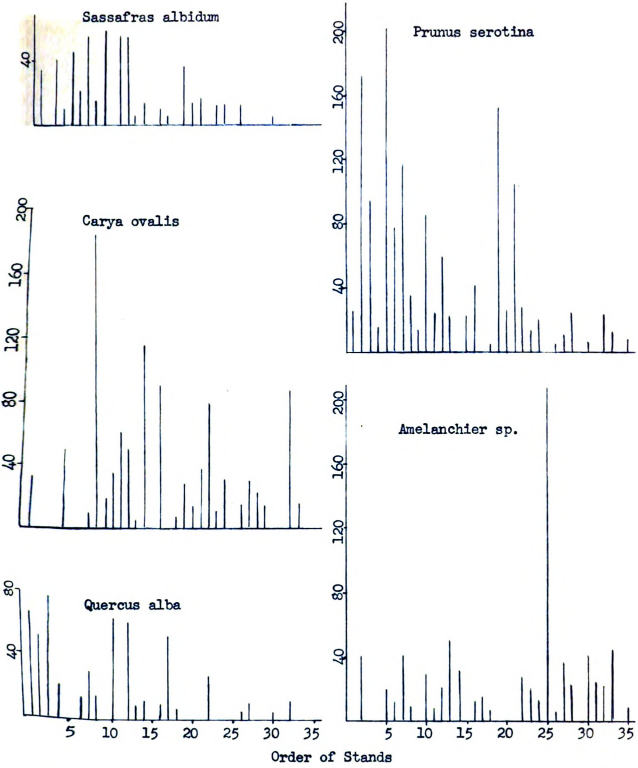

FIG. 7. Significance values for five species of low climax adaptation number occurring in individual stands arranged according to continuum index number.

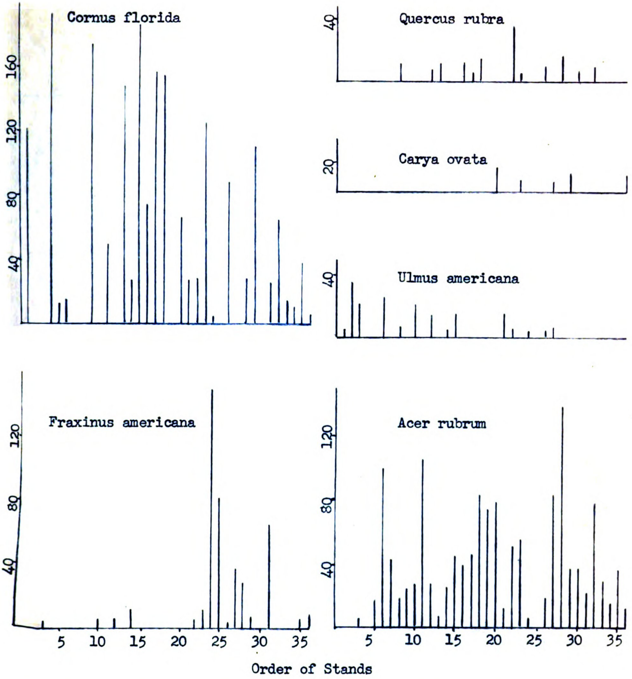

FIG. 8. Significance values for six species of intermediate climax adaptation number occurring in individual stands arranged according to continuum index number.

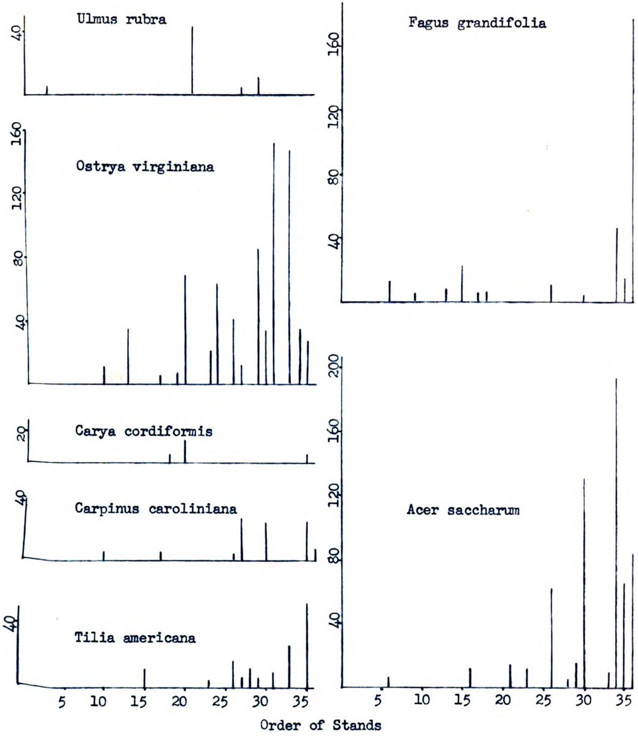

FIG. 9. Significance values for seven species of high climax adaptation number occurring in individual stands arranged according to continuum index number.

the larger size classes of these species, significance value curves were established and appear to be valid indicators of trend. It is therefore worthy of note that the curve of significance value for Q. rubra, in contrast with the curve of importance value for this species, shows little evidence of a peak in any part of the scale. More remarkable, in view of the poorly defined and centrally located importance value "plateau" for Q. alba, is the decisive maximum in the xeric portion of the significance value curve for this species.

But even more striking than such anomalies is the restricted occurrence and magnitude of the class 3 representation of these leading dominants. Of all the species listed in Table V, only Carya ovalis and C. ovata join the oaks in showing lower stand occurrence in class 3 than in class 4-5. This decrease, moreover, is decisive only in the data for the oaks. Furthermore, only in the latter group is there an equally decisive restriction in magnitude of class 3 representation. Reference to Fig. 7 reveals that in thirteen of the nineteen stands in which Q. alba was recorded the significance values attained did not exceed 50. The restriction was much more marked in the case of class 3 representation of Q. rubra where only one of twelve significance values exceeded 20. Representation of class 3 Q. velutina was recorded only in stand twenty where its significance value was 6.9.

Taken as a group, one or more of these oak species were recorded as class 3 reproduction in 21 of the 36 stands. In but seven of these did their combined significance values exceed 50; such values in no stand surpassed 80. As a result of the low representation of the dominant oaks, the greater proportion of the significance value index (varying from 223 to 300 units per stand) is distributed among the other species present. The resulting overall pattern is in striking contrast to that observed for importance values, wherein the oaks collectively comprised so large a portion of the importance value index.

In this overall pattern of significance value, a large proportion of the species attain high rank in one or more stands. Thus, examination of Figs. 7, 8 and 9 reveals that significance values in excess of 130 are reached by nine species. However, for any given species, such high significance values are rarely in scale juxtaposition; as a result, no single species clearly predominates in any sector of the continuum index scale. Nevertheless, sector predominance may be shared by relatively few species, especially at the scale extremes. Thus, with one exception, *Prunus serotina* or *Cornus florida* attains the highest significance value in each of the 7 stands at the xeric end of the continuum index scale. Again, in six of the seven stands at the mesic end of the continuum index scale, the peak significance value is distributed among *Ostrya virginiana*, *Acer saccharum* and *Fagus grandifolia*.

As manifested particularly by the curves for *Cornus florida*, *Prunus serotina*, *Carya ovalis*, *Acer saccharum* and *Ostrya virginiana*, significance values may fluctuate enormously, even over narrow ranges of the continuum index scale. Moreover, in the majority of such curves, the conspicuously high values tend to be too inherently consistent to be considered mere chance "irruptions." For example, in the curves for *Cornus florida* and *Carya ovalis*, the widely dispersed high values show a quite consistent trend toward a maximum in the xeric half of the continuum index scale. Again, a converse trend is exhibited by the curves for Acer saccharum and Ostrya virginiana. The reader attempting to envision trends in the unsmoothed data is thus confronted with the necessity for considering two general magnitudes of importance values. Fortunately, in most cases, the high and low values tend to reinforce each other in indicating a common trend. However, in the curve for Cornus florida there is at least a suggestion of two trends with considerably displaced maxima. This puzzling phenomenon will receive further attention in the Discussion.

The prime utility of the significance value index would appear to reside in the basis it provides for deductions concerning future stand composition. However, in the present study, failure to segregate class 3 data for those species genetically limited as to stature, considerably lowers its efficiency for this purpose. As might be anticipated, class 3 representation of such species tends to be heavy, as illustrated by the curves for Cornus florida, Ostrya virginiana, Sassafras albidum, Carpinus caroliniana and Amelanchier spp. Although from the standpoints of coaction and reaction the significance of this group is obviously of a high magnitude, it is equally manifest that the curves for its member species cannot be considered as directly indicative of future stand composition. Thus, their inclusion as components of the index introduces a variable element into the data which hinders inter-stand evaluation of the representation for those species capable of regularly attaining and participating in the overstory. Even though thus deprived of its fullest meaning and efficiency, the overall pattern of significance value nevertheless seems clearly to prophecy changes in the oak upland community. As measured by the significance value index, Acer rubrum, Prunus serotina and *Carya ovalis* would appear to be the chief instruments of such change. The validity of this, and other evidence bearing on the dynamics of the oak upland community will be considered in the Discussion.

DF_r indices for class 2 reproduction. Curves for class 2 reproduction sufficiently well represented to establish trends are shown in Figs. 10 and 11. Only seven indices exceed 70, and the highest, a value of 109 for *Cornus florida* in stand nine, falls far below the peak values attained in the other three size groupings.

In part, such reduction in magnitude is a consequence of the DF_r index range, which is narrower by one-third than the importance value and significance value scales. However, even when compensation is made for this reduction in available scale units, the trend toward sameness in index values is still apparent. The conclusion inevitably follows that, quadrat by quadrat, a greater number of species are more frequently represented in the data by this class than by any other. The same relationship obtains on a stand basis, as shown by Table V, where, for a given species, class 2 stand occurrence is seen to be exceeded by that of another size class in only 2 instances. There seems little reason to doubt that such high frequency of representation is primarily a manifestation of the high Q/MA ratio used for class 2 (see Table III). Moreover, the numerous similar DF_r values for class 2 would appear to bear out the forecast of diminished utility of the relative frequency of class 2 as a measure of dispersion.

Yet, most surprisingly, the curves for class 2 representation do not appear to be less clearly marked than those for the other classes. On the contrary, the curves of size class 2 for such species as *Acer saccharum*,

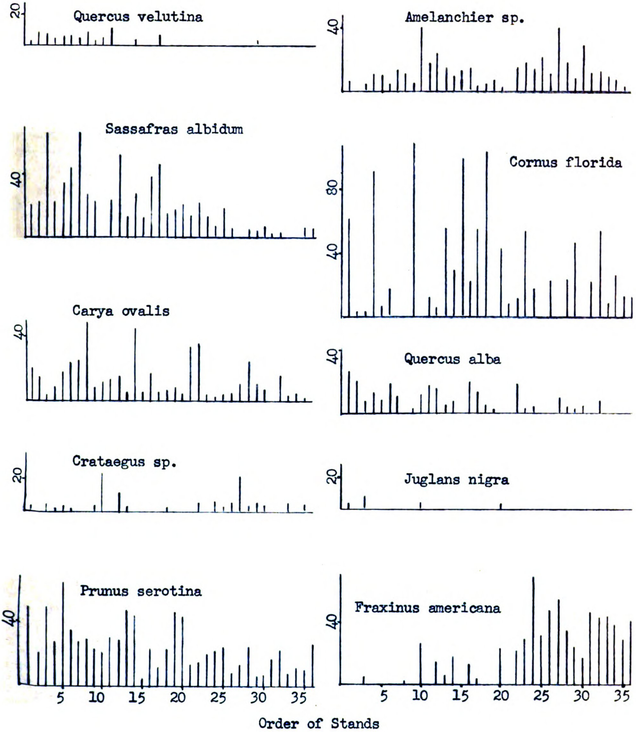

FIG. 10. Class 2 DF_r values for ten species of low to intermediate climax adaptation number occurring in individual stands arranged according to continuum index number.

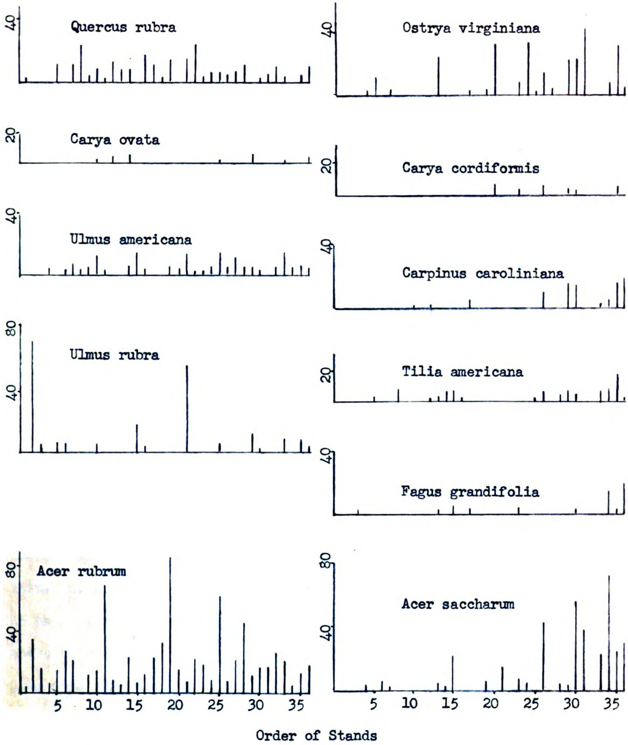

FIG. 11. Class 2 DF_r values for 11 species of intermediate to high climax adaptation number occurring in stands arranged according to continuum index number.

Fraxinus americana, *Carpinus caroliniana*, and *Tilia americana*, in relation to the curves for other size classes, display peak definiteness in consequence of the combination of a greater number of stand indices and their prevailingly less erratic fluctuation.

Though in many respects unique, the overall pattern of class 2 representation bears closest resemblance to the pattern of significance value. Particularly, the class 2 curves for *Quercus alba* and *Q. rubra*, by their similarity in trend and magnitude of representation, add to the credibility of the significance value curves for those leading dominants. Moreover, the class 2 curve for *Cornus florida* continues to emphasize strongly the tendency, strikingly exhibited in the significance value curve, for heavy representation of this species to be confined to a relatively few stands. Furthermore, comparison of Figs. 8 and 10 reveals the peak values are reached in the same stands.

In tallying class 2 representation of flowering dogwood, separate lists for seedling and vegetative reproduction were not maintained, and hence no ratio as to type of reproduction can be presented here. However, observational data indicate there can be little doubt that the latter category was in the great majority. This was particularly true in those stands supporting heavy representation of flowering dogwood, where this species was disposed in typical clonal fashion with the various size classes commingling and often forming thickets of considerable extent. Although the origin of the large individuals of course could not be determined, there seems little reason to challenge the obvious inference that they too were in large part of vegetative origin.

The limits of significance to be accorded class 2 representation are difficult to fix. The enormous disparity in mean area between classes 2 and 3 (see Table II) provides a clear indication of the fate of most class 2 individuals. Moreover, the very high Q/MA ratio used for this class, while evidently not seriously affecting the capacity of the class 2 DF_r index to indicate dispersion, nevertheless is in decided unbalance with the ratios for the other classes. The distinct possibility thus arises that certain of the unique features of the class 2 curves may be attributable less to ecological phenomena than to disparity in sample area. In view of the many intangibles involved, there would thus appear to be every reason to exercise considerable caution in interpreting the class 2 curves.

Yet, however temporary the status of most individual class 2 elements, it must be acknowledged that those of seed origin have survived one of the most critical stages of ecesis. Moreover, irrespective of mean area relationships for the several classes, the class 2 records after all were obtained from the identical areas used for sampling the larger size classes. That data so obtained should, when oriented in a sequence determined by weighted importance values, form intelligible and relatively consistent trends, adds valuable support to the sequence. That such trends do not in all cases parallel the importance value trends, in no way detracts from such support, but rather heightens it by emphasizing the intrinsic significance of the class 2 data.

<u>Class 1 DF_r values</u>. Curves for species represented in three or more stands by class 1 reproduction are shown in Figs. 12 and 13. From the general pattern of these curves it is evident that, in trend and magnitude

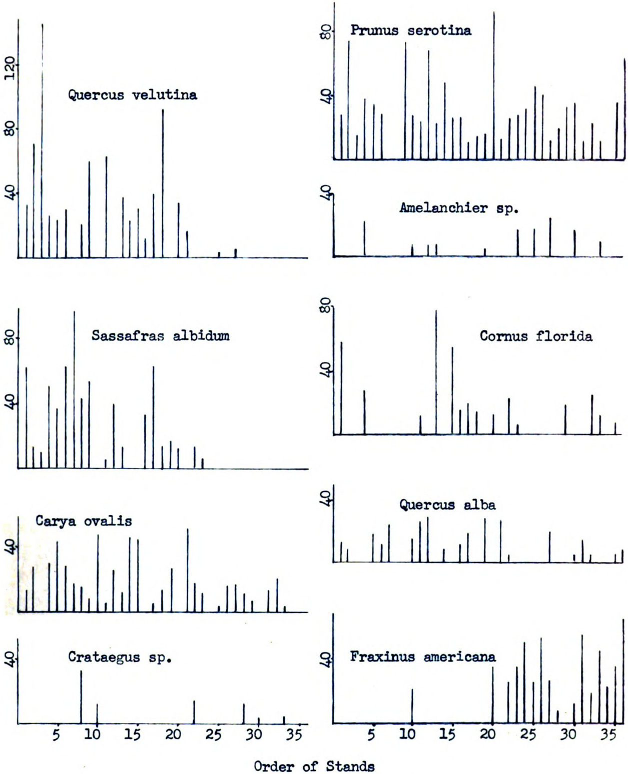

FIG. 12. Class 1 DF_r values for nine species of low to intermediate climax adaptation number occurring in individual stands arranged according to continuum index number.

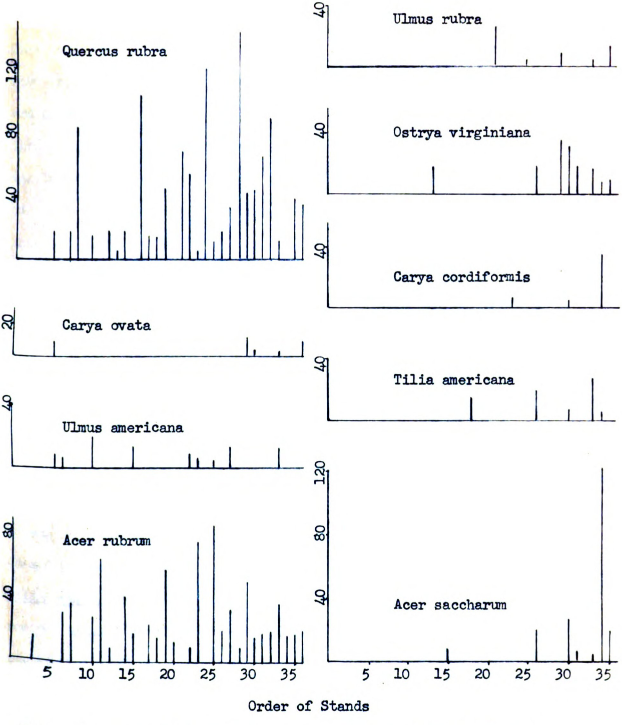

FIG. 13. Class 1 DF_r values for nine species of intermediate to high climax adaptation number occurring in individual stands arranged according to continuum index number.

of index values, class 1 reproduction corresponds much more closely to representation of class 4-5 than do the other two classes of reproduction. That such correlation is far short of a cause and effect relationship, however, is evident from a stand by stand comparison of importance values and class 1 DF_r values. High values on the respective curves seldom coincide; with few exceptions neither do gaps in representation. Most of the latter exceptions are concentrated in the curves for the oaks and hickories which display only three instances of class 1 reproduction unaccompanied by records of class 4-5 reproduction.

Tables IV and V indicate a low overall frequency of class 1 reproduction. For those species shown in Table VI to most frequently share in control of the stands studied, such low frequency is reflected in the curves primarily by a tendency toward reduction in the number and index range of stand occurrences.

Thus, compared to the class 4-5 representation of the 12 species in the above category, class 1 individuals of only Fraxinus americana, Prunus serotina and Sassafras albidum were recorded in more stands, and only the first two species were recorded over a wider sequence range. Moreover, as manifested by the curves for Acer saccharum, Fagus grandifolia and Tilia americana, the reduction in both number and range of stand occurrences is most pronounced in those species identified with extreme climax adaptation numbers.

Any observations as to the ecological significance of the comparatively abbreviated curves for class 1 representation must be weighed against the unique Q/MA ratio used for this class. Of the ratios shown in Table III, it alone is of lower magnitude than the theoretical optimum of 2.0 set by Curtis and McIntosh (1950: 453). Although this deficiency of the class 1 ratio would appear to be small, there is no assurance that its effect on the data should be correspondingly small, particularly with reference to data for the less commonly represented species. Moreover, one must be cognizant of the fact that the differential in ratio between class 1 and each of the other size classes is considerably greater. The maximum such differential is between classes 1 and 2, the ratio of the latter exceeding that of class 1 by about 14 times. In view of so great a disparity, the utility of any detailed comparison of the DF_r curves for these 2 classes is patently subject to serious question.

There is a need also to appraise critically the significance to be accorded the magnitude of class 1 representation. As a class, this is shown by the ratio of mean areas in Table II to be about twice as abundant as the class 2 representation. However, in view of the sensitivity of class 1 reproduction to the various influences affecting seed production and establishment of seedlings, comparisons of even so general a character would seem to have little justification. Just as a single year of weather observations cannot adequately characterize a climate, a single season's data from temporary quadrats cannot yield a dependable index of class 1 reproduction.

Shrubs and Woody Vines

The stand by stand occurrence of the 53 shrubby species encountered in the course of this study is indicated in Appendix Table LXXVI. The large number of species involved and the wide range in their stand occurrence indicated the desirability of restricting detailed consideration to those entities which, on the basis of quantitative data and field observations could be considered as more or less typical of the oak upland community. A critical appraisal was therefore made to determine which of those species listed in Appendix Table LXXVI should be regarded only as strangers or accidental species in the oak upland community. The decisions in this regard were based primarily on number of stand occurrences and supplemented by considerations as to prevalence in other habitats.

Shrub Species Accidental in the Oak Upland Community

Inspection of Appendix Table LXXVI reveals that a total of 13 species, comprising approximately 25 percent of the total, were recorded in not more than two stands each. These species, together with their stands of occurrence, are listed below:

Species	Stand No.
Asimina triloba	36
Berberis vulgaris	13, 14
Epigaea repens	17, 30
Euonymus atropurpureus	3
Ilex verticillata	27
Lonicera canadensis	36
Lonicera sp.	23
Pyrus melanocarpa	11
Rhus aromatica	21
Rubus idaeus	6, 13
Salix humilis	8
Viburnum cassinoides	11
Vitis aestivalis	12, 13

The accidental status of the members of this group, as suggested by their sporadic occurrence, is confirmed by a consideration of their usual habitats (Deam 1940; Bingham 1945). Among the more incongruous of these elements in the oak upland community are Ilex verticillata, Pyrus melanocarpa, Viburnum cassinoides, Euonymus atropurpureus and Salix humilis.

Nevertheless, the occurrences of each of the species in this group were in sites representative of the stands involved; each species must thus be regarded as a legitimate, though obviously atypical, element contributing to the great diversity of the oak upland community.

The More Common Shrub Components

The remaining 40 species were recorded in more than ten percent of the stands studied. Their representation, as measured by three indices — DF_r values based on data from 2 x 2 m. quadrats, frequency values based on the same 10 x 10 m. quadrats from which tree data were obtained, and presence in the stand at large — is graphically shown in Figs. 14 through 21. A realistic decision as to the relative degree of significance to be accorded the first two of these indices would seem to demand the perspective gained from a consideration of mean area relationships.

Mean area-frequency correlations. As was previously found true of tree densities, no significant correlation linking density of the most abundant shrub species with position on the continuum index scale could be demonstrated. Accordingly, there appeared to be no valid objection to the use of measures of central tendency in an attempt to express mean area relationships for shrubs on a community wide basis. However, in apparent consequence of the clonal character and corollary contagious distribution of almost all shrub elements recorded, the total density of the most abundant single species was found to vary enormously from stand

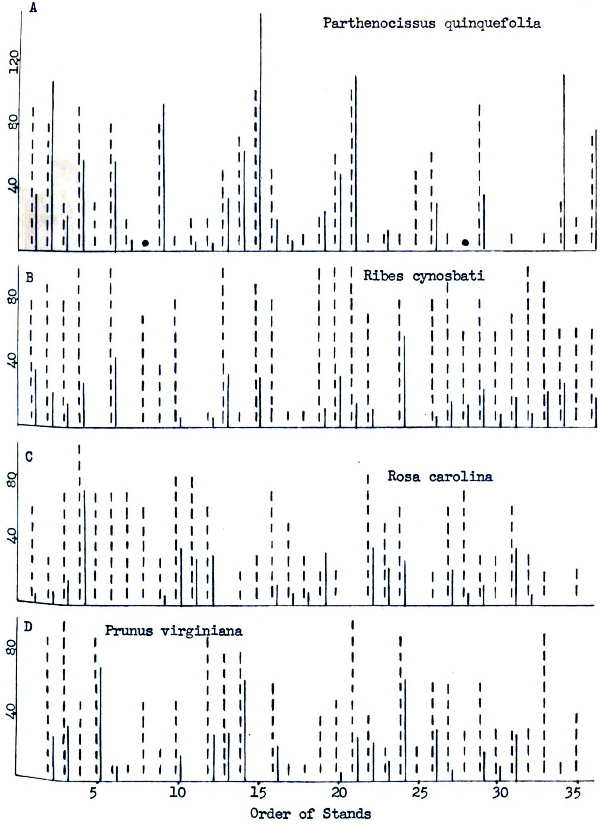

FIG. 14. Index values for four more ubiquitous shrub species showing no evident correlation with a stand sequence determined by continuum index numbers. Dashed bars indicate frequency percentages obtained from 100 m^2 quadrats; solid bars indicate DF_r values obtained from 4 m^2 quadrats; dots indicate presence. The charts are arranged in order of decreasing relative DF_r value.

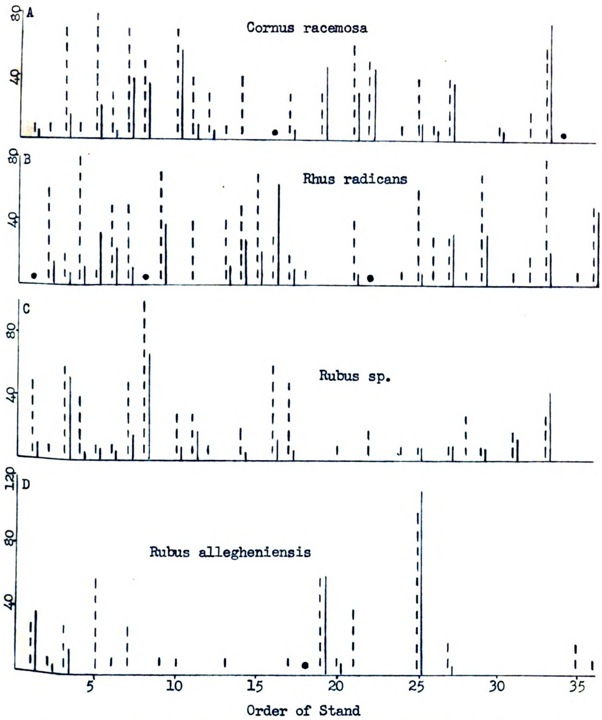

FIG. 15. Index values for four shrub species showing no evident correlation with a stand sequence determined by continuum index numbers. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_r values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of decreasing relative DF_r value.

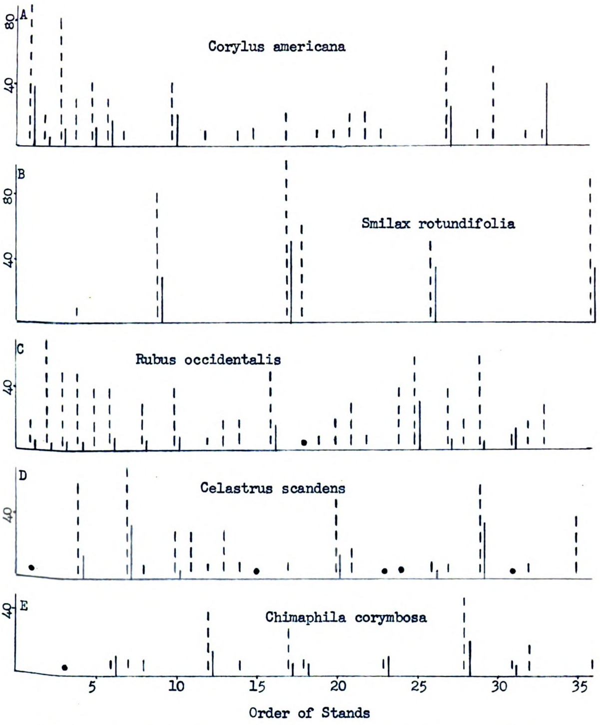

FIG. 16. Index values for five shrub species showing no evident correlation with a stand sequence determined by continuum index numbers. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_r values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of decreasing relative DF_r value.

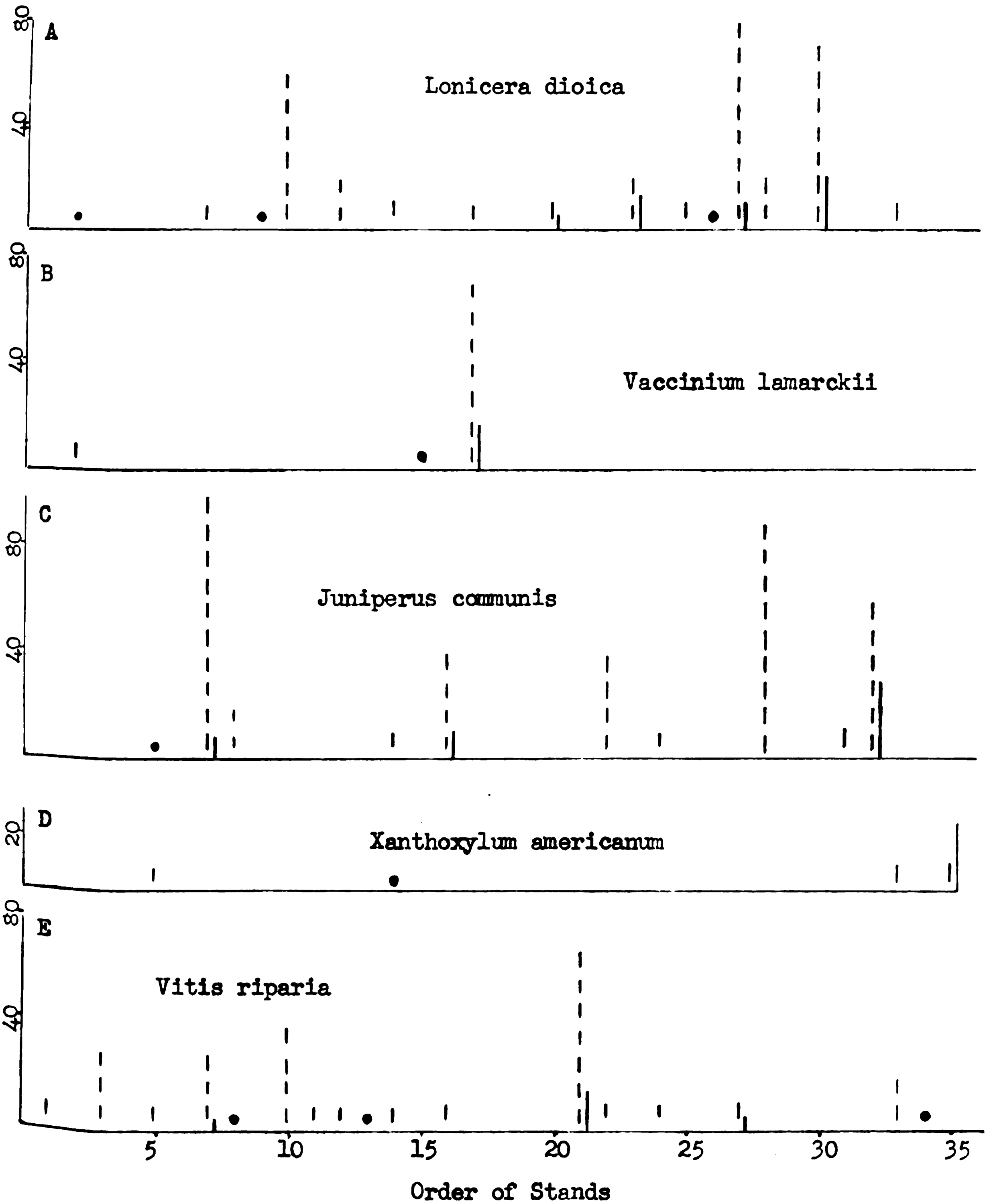

FIG. 17. Index values for five less common shrub species showing no evident correlation with a stand sequence determined by continuum index numbers. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_r values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of decreasing relative DF_r value.

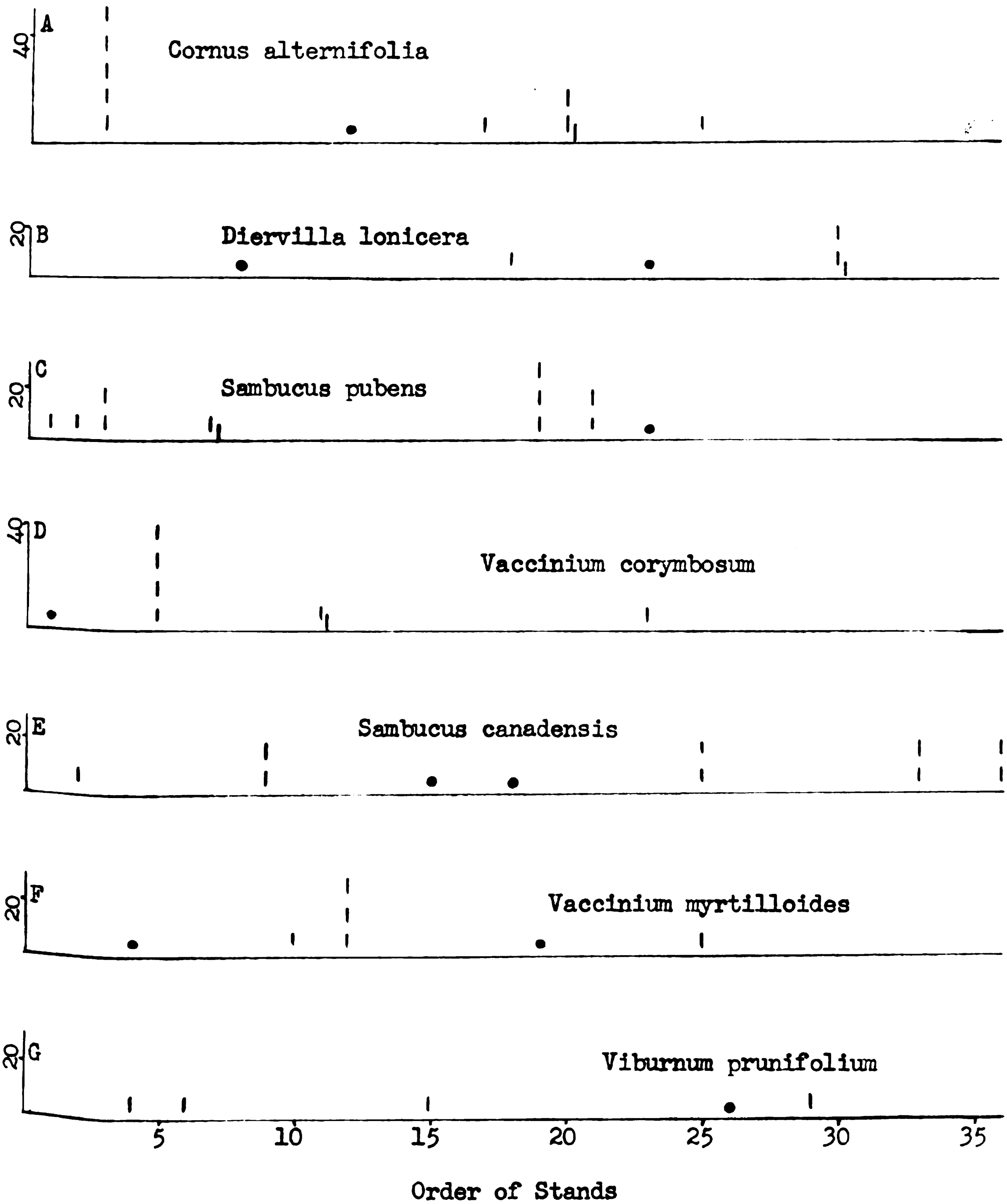

FIG. 18. Index values for seven uncommon shrub species showing no evident correlation with a stand sequence determined by continuum index numbers. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_r values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of decreasing relative DF_r value.

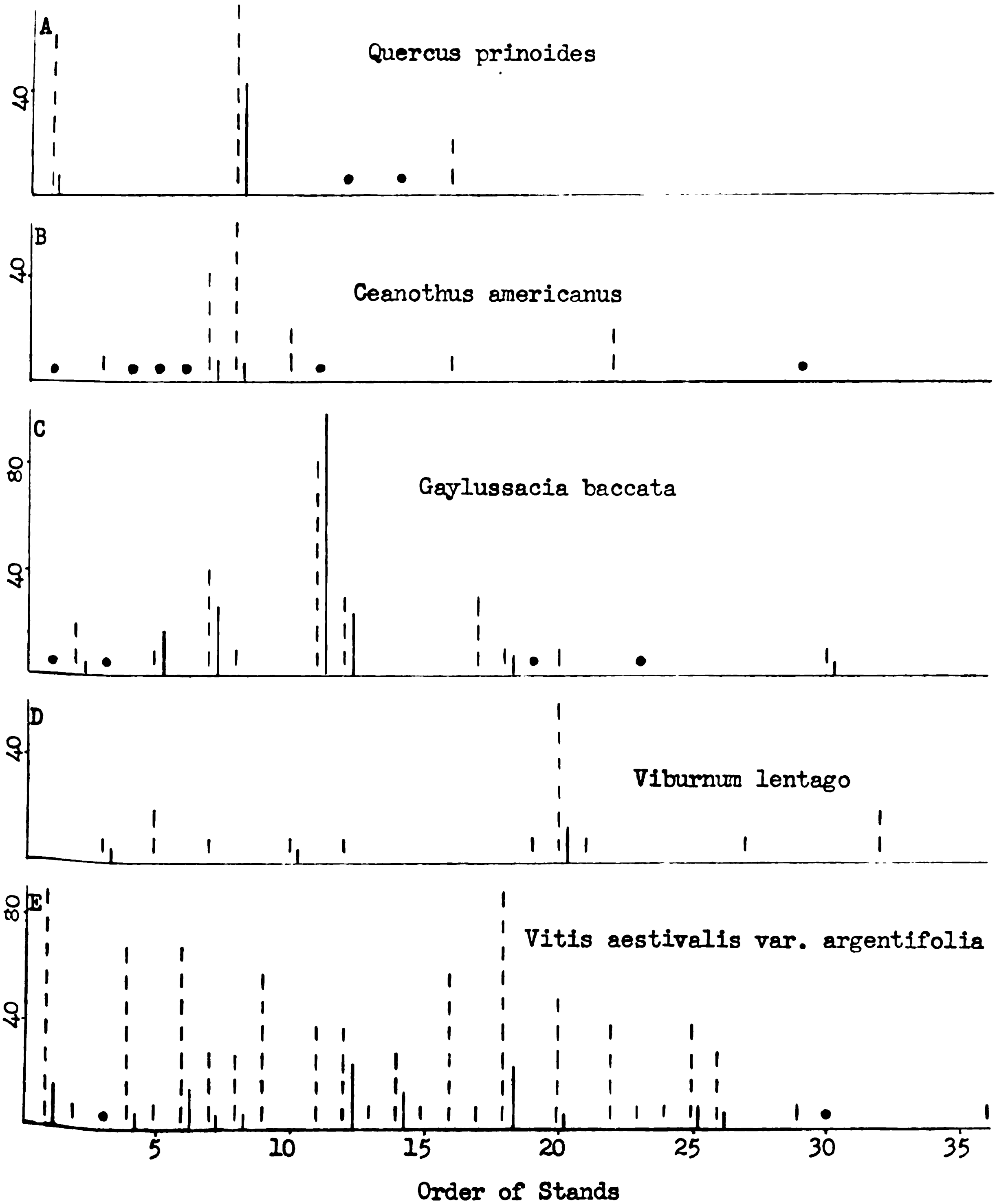

FIG. 19. Index values for five shrub species evidently most abundantly represented in the more xeric stands of a sequence determined by continuum index number. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_T values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

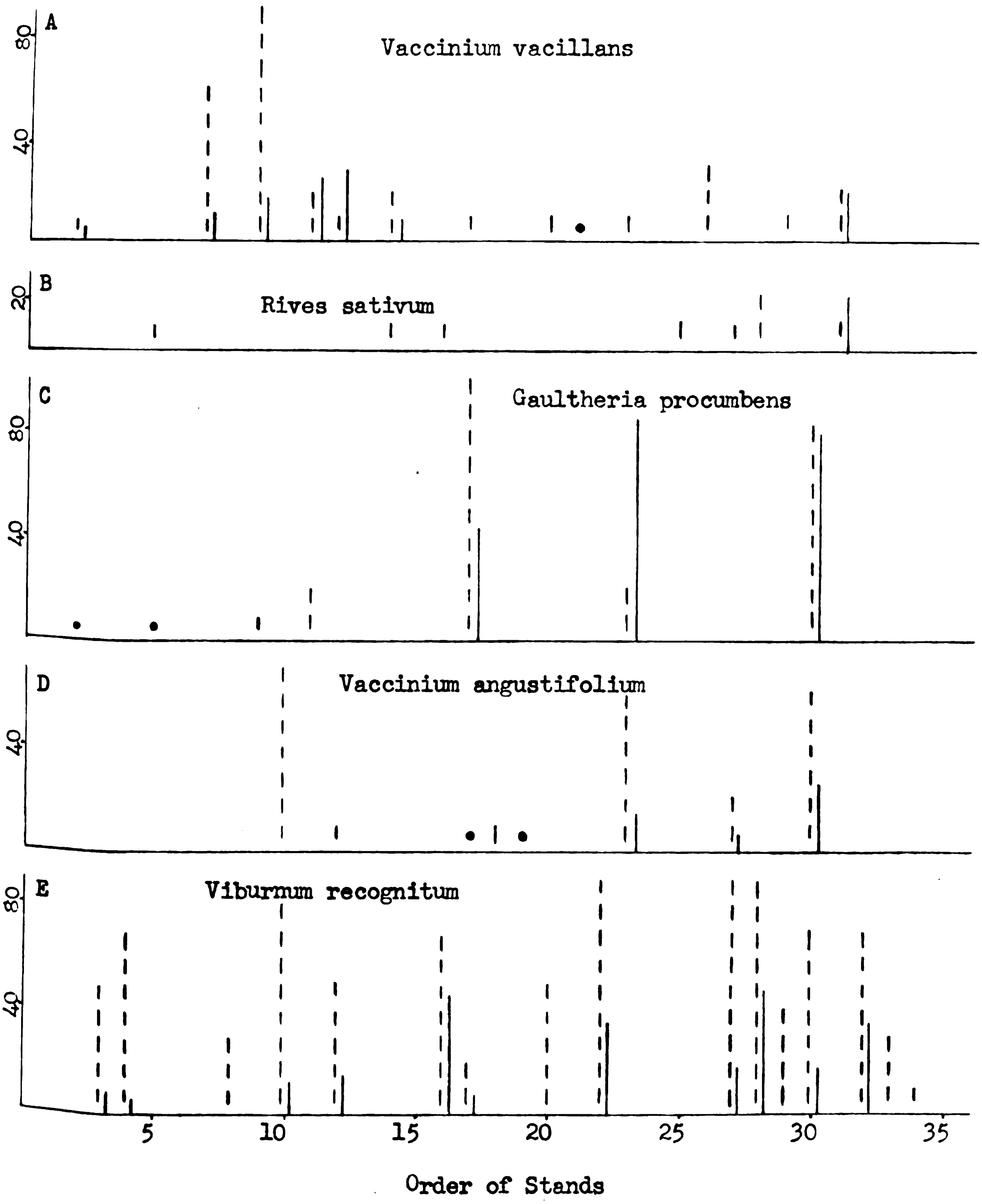

FIG. 20. Index values for five shrub species evidently correlated with a stand sequence determined by continuum index number. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_r values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

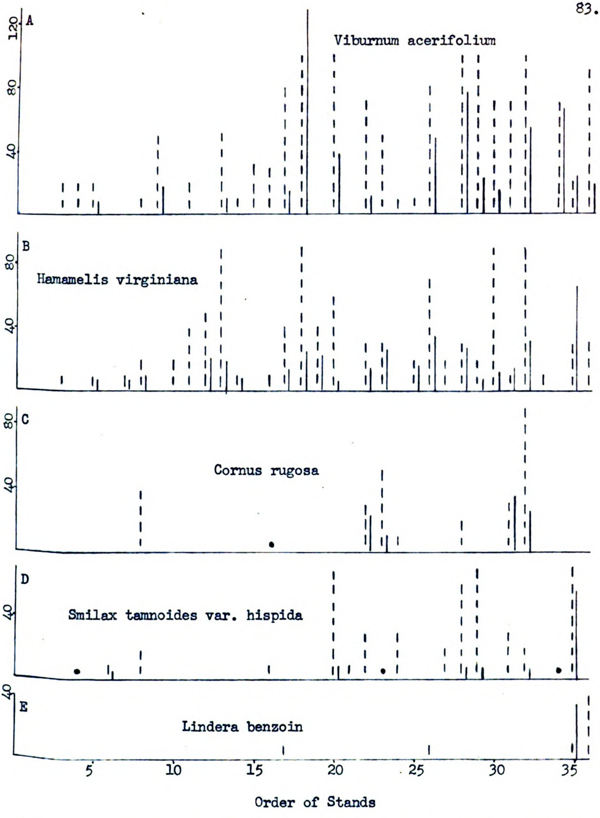

FIG. 21. Index values for five shrub species evidently most abundantly represented in the more mesic stands of a sequence determined by continuum index number. Dashed bars indicate frequency percentages obtained from 10 x 10 m. quadrats; solid bars indicate DF_I values obtained from 2 x 2 m. quadrats; dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

to stand. The range in such values was from 4 to 227, with only seven densities exceeding a value of 94. Obviously, no meaningful averages could be based on such variable data. However, total density for the most abundant species in twenty-nine stands was found to fall within a fairly continuous range from 4 to 69, with ten such densities in the 31--40 class. Converted to mean area, these twenty-nine values yield an averaged mean area of 1.2 ± 0.6 m^2. Expressed as a Q/MA ratio this value becomes 3.3 ± 1.7. The distribution of frequency magnitudes correlated with this ratio is shown in the first line of Table VII. The 90 and 100 percent frequency magnitudes were recorded for species with

TABLE VII. Relation of quadrat size to number and magnitude of frequency records

Quadrat size	Frequency (percent)										Total frequency records
	100	90	80	70	60	50	40	30	20	10	
2 x 2 m.	1	1	2	5	5	22	24	35	62	153	310
10 x 10 m.	23	23	27	37	41	33	37	61	78	172	532

Q/MA ratios of 17.8 and 18.3 respectively -- values which, it should be noted, are far above the averaged Q/MA ratio of 3.3. The second line of Table VII shows the pattern of frequency magnitudes correlated with the unknown, but manifestly very high, Q/MA ratio for 10 x 10 m. quadrats. The frequency distributions shown in Table VII are graphed in Fig. 22. The orientation of the two curves reveal that, for frequency magnitudes above 30 percent, the increment in number of quadrat occurrences

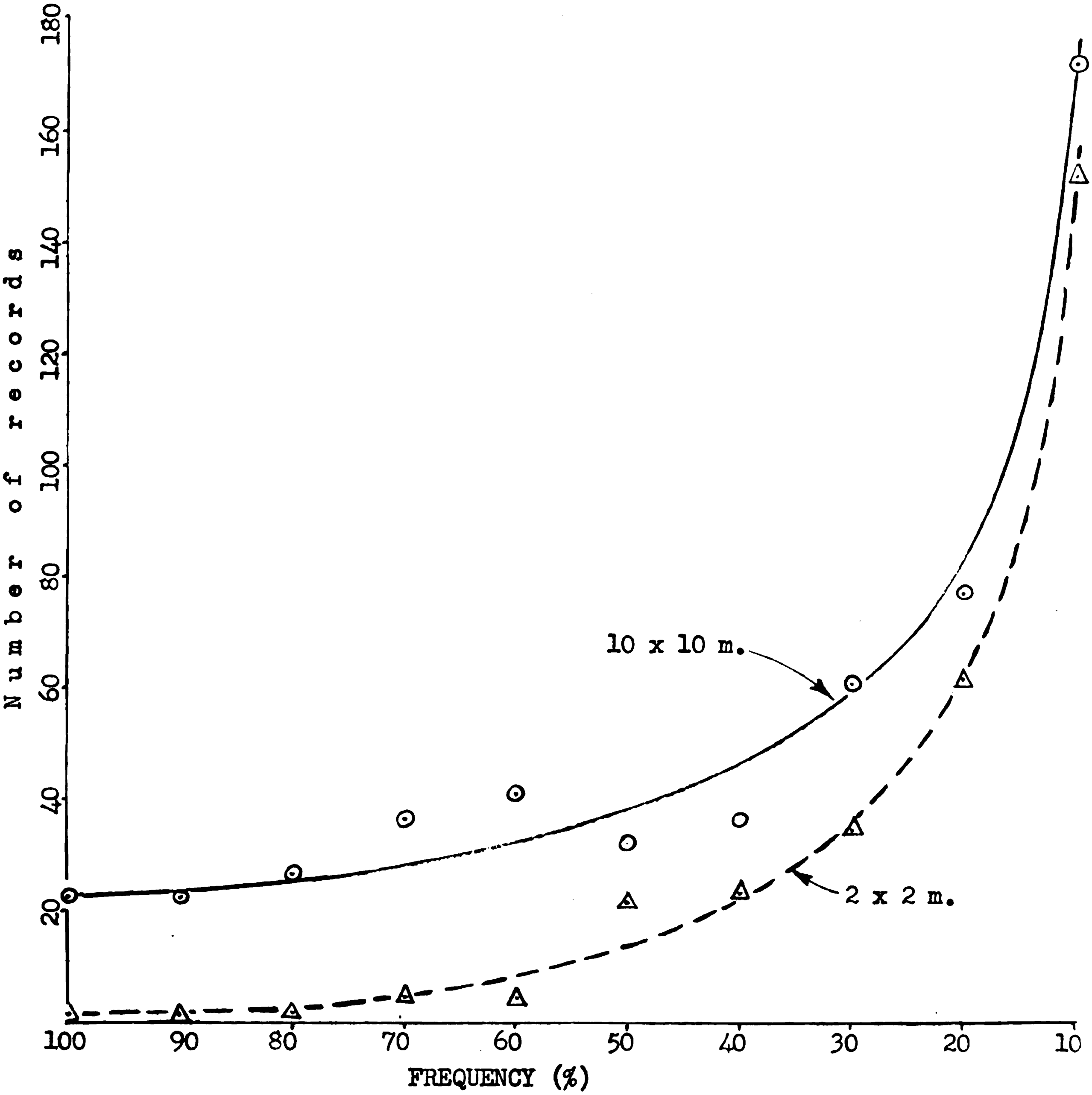

FIG. 22. Relation between number and magnitude of frequency records obtained from two sample areas of different size.

correlated with the 96 square meter increase in sample area appears to be relatively constant.

Relative significance of the indices of shrub representation. Highlighting the need for an objective appraisal of the frequency and DF_r values charted in Figs. 14--21 are the 222 instances where the representation of a given species in a given stand is based solely on frequency data. Such unilateral representation is clearly attributable to an increase in sample area from 4 to 100 square meters. The significance to be accorded these 222 frequency records must therefore be governed by a consideration of which of these two quadrat sizes can more often be expected to yield the most reliable measure of synusial composition and species dispersion.

It must be acknowledged at the outset that the enormous variation from stand to stand in mean area for the most abundant shrub species precludes high sampling efficiency when inflexible sample areas of any size are used in all stands. Under such circumstances, the most that can confidently be expected of such uniform sample areas is that they yield reasonably accurate and representative data for a maximum number of stands.

The evidence as to whether the sample area of 4 square meters meets these limited requirements is subject to question. The average Q/MA ratio based on data from 29 stands considerably exceeds the value considered optimum by Curtis and McIntosh (1950: 453) and would thus indicate that a sample area of such size is even larger than necessary to assure representation of all the ecologically important shrub components. Nevertheless, the occurrence of only four frequency values above 70 percent, out of the total of 310 frequencies of all magnitudes recorded in Table VII, would indicate that the quadrat area could be increased substantially without impairing the efficiency of the frequency index. Added support for this contention is supplied by the previously mentioned occurrence of only two frequencies exceeding 70 percent in the seven stands in which the Q/MA ratio for the single leading species varied from 9.5 to 22.7. Finally, Curtis and McIntosh (1950: 453), recognizing the need for standardized sample sizes, have suggested a compromise sample area of 16 square meters for shrubs of the eastern deciduous forest. Applied to the present mean-area data, such a size would yield an average Q/MA ratio in excess of 13 for the single leading shrub species. In the light of these various indications, it would appear reasonable to consider that a significant proportion of the shrub representation based only on frequency data may in fact reflect under-representation of DF_r values rather than over-representation of frequency values (F).

Over-representation of frequency values from 10 x 10 m. quadrats is suggested by the data in Table VII. That such a tendency is greatly removed from the point where relative frequencies begin to converge toward a common value,[8] however, is clearly demonstrated by the absence of any marked divergence of the high-frequency sectors of the curves shown in Fig. 22. Nevertheless, the 23 records of 100 percent frequency each indicate the potentiality of a disproportionate increase of lesser frequency values. This follows because once a quadrat size is reached which yields a 100 percent frequency for a given species, any further increase in sample area obviously can elevate only lesser frequency magnitudes.

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[8]See Curtis and McIntosh 1950: Fig. 8.

The shrub data for stands 15 and 21, listed below, illustrate this effect with particular clarity.

Stand 15

	Quadrat size 100 m^2	4 m^2
Corylus americana	10	--
Parthenocissus quinquef.	100	100
Rhus radicans	70	20
Ribes cynosbati	90	40
Ribes sativum	10	--
Rosa carolina	70	--
Rubus occidentalis	50	--
Rubus sp.	60	--
Smilax tamnoides	10	--
Viburnum acerifolium	30	--
Viburnum prunifolium	10	--
Vitis aestivalis	10	--

Stand 21

	Quadrat size 100 m^2	4 m^2
Celastrus scandens	20	--
Cornus racemosa	60	50
Corylus americana	20	--
Parthenocissus quinquef.	100	90
Prunus virginiana	100	50
Rhus aromatica	10	--
Rhus radicans	40	10
Ribes cynosbati	100	30
Rubus allegheniensis	40	--
Rubus occidentalis	30	--
Sambucus pubens	20	--
Smilax tamnoides	10	--
Viburnum lentago	10	--
Vitis riparia	70	30

In stand 15, the total increase in representation, amounting to 9 species and 36 quadrat occurrences, is referable in its entirety to the increase of 96 square meters in sample area. In stand 21, the multiple occurrence of 100 percent frequencies for species with quite different degree of dispersion on the basis of data obtained from 4 square meters indicates even greater over-representation. It would thus seem clear that in the above stands the smaller area, though yielding records of 73 fewer quadrat occurrences, and only about a third as many species, nevertheless provides a quantitatively more accurate picture of the ecologically most significant elements.

The evidence is much less conclusive, however, for the 20 stands in which even the 10 x 10 m. sample area yielded no 100 percent frequencies. Nevertheless, even in these stands the larger quadrat size, in consequence of its greater disparity in area from the mean for the most abundant shrub species, would seem likely to display the greater potential for exaggeration of frequency magnitudes.

The preceding observations indicate the desirability of placing primary emphasis on DF_r values in the interpretation of shrub representation. However, as inspection of Figs. 14--21 will show, DF_r reference points are frequently so widely separated for any given curve, or sector thereof, as to render recognition of trends difficult, if not impossible. In such instances data based on 10 x 10 m. quadrats are of decided value in indicating whether the gap reflects actual absence, or only sparse dispersion of the species concerned. Moreover, presence records contribute in similar fashion to trend clarification, as illustrated by the curves for Ceanothus americanus (Fig. 19, B) and Gaultheria procumbens (Fig. 20, C). In critically appraising a given curve it has therefore been found frequently necessary to use all three measures together.

Such analyses of the curves of each of the 40 less infrequent oak upland shrubs has led to their classification in two arbitrary categories based on the degree to which they correlate with the continuum index scale.

Species exhibiting no obvious correlation with stand sequence. Graphs of representation for the 25 species placed in this category are shown in Figs. 14 through 18. As evidenced particularly by the numerous gaps in representation -- even by data from 10 x 10 m. quadrats -- for all but a very few of these curves, lack of evident correlation with stand sequence brings no diminution in the tendency for changes in grouping so characteristic of the tree components of the oak upland community. Rather, such permutations in the shrub synusia appear even more pronounced and varied in consequence of the larger complement of species and their evident ability to substitute for one another over the whole range of the stand sequence.

In the resulting intricate pattern of overall group representation, the role of the individual species is relatively obscure. The possibility must be acknowledged that the representation of selected small groups of species with closely similar habitat requirements may show similar patterns of representation, as shown in Fig. 23. However, the demonstration or refutation of all such relationships would require the use of elaborate computing equipment and other resources not available for the present study. By necessity, therefore, consideration of individual species representation in this group is restricted to the inter-stand viewpoint.

Regarded thus, the individual species representation would appear adaptable to, and more efficiently summarized by, methods of synthetic analysis. Accordingly, in Table VIII relative DF_r values and indices of summation frequency, aggregate constance and presence are provided for each of the species in this category. It should be pointed out that relative DF_r values are influenced to a certain extent by shrub representation correlated with the continuum sequence. This follows because relative DF_r values are based on stand DF_r values which have a percentage basis and are thus influenced by all shrub elements recorded. However, in view of the rather low total magnitude of such correlated representation, and the compensatory effect of the xeric and mesic elements, the residual error from this source would not appear to be serious. It would be unlikely, therefore, to disrupt seriously the order of species in Table VIII based on relative DF_r values.

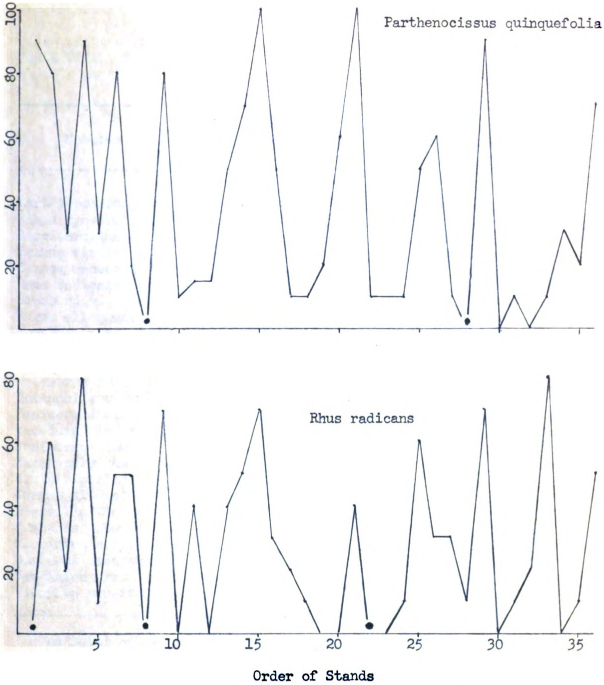

FIG. 23. Curves of frequency for two species of similar habitat requirement showing similar trends of representation; dots indicate presence.

TABLE VIII. Synthetic indices for those shrub species showing no clearly evident correlation with continuum index sequence

Species	Relative DF_r value[1] %	Summation frequency[2] %	Aggregate constance[3] %	Presence %
Parthenocissus quinquef.	22.0	40.5	89.0	94.5
Ribes cynosbati	10.5	61.7	86.2	86.2
Rosa carolina	10.5	43.1	86.2	86.2
Prunus virginiana	10.1	44.4	89.0	89.0
Cornus racemosa	9.4	24.4	66.7	72.3
Rhus radicans	8.5	27.4	72.3	80.6
Rubus sp.[4]	6.2	18.9	66.7	72.3
Rubus allegheniensis	4.9	13.9	50.0	52.8
Corylus americana	3.1	16.7	61.2	61.2
Smilax rotundifolia	3.1	10.6	16.7	16.7
Rubus occidentalis	2.4	21.9	66.7	69.5
Celastrus scandens	2.3	12.8	44.5	58.4
Chimaphila umbellata	1.7	6.1	33.3	36.1
Lonicera dioica	1.5	9.4	36.1	44.5
Vaccinium lamarckii	1.5	3.1	8.3	10.1
Juniperus communis	1.0	10.1	25.0	27.8
Xanthoxylum americanum	0.8	1.4	10.1	13.9
Vitis riparia	0.4	7.8	38.9	47.2
Cornus alternifolia	0.1	2.5	10.1	13.9
Diervilla lonicera	0.1	0.8	5.6	10.1
Sambucus pubens	0.1	2.8	16.7	19.4
Vaccinium corymbosum	0.1	1.7	8.3	10.1
Sambucus canadensis	--	2.5	13.9	19.4
Vaccinium myrtilloides	--	1.4	8.3	13.9
Viburnum prunifolium	--	1.1	10.1	13.9

[1]The total of all stand DF_r values for a given species expressed as a percentage of the sum of stand DF_r values for all species included in this list.

[2]Total quadrat occurrences in all stands expressed as a percentage of the 360 possible quadrat occurrences.

[3]Total stand occurrences based on representation in one or more 10 x 10 m. quadrats per stand and expressed as a percentage of the 36 possible stand occurrences.

[4]Section Flagellares.

Inspection of Table VIII reveals a general correlation in the index values for any given species. Such lack of correlation as occurs appears readily attributable to the type of distribution of the species involved. Thus, the high summation-frequency value for Ribes cynosbati emphasizes the non-contagious pattern of distribution for this species. In contrast, the comparatively high relative DF_r value for Smilax rotundifolia attests to a strongly contagious distribution correlated with the vigorous vegetative reproduction noted for this species in four of its six stations. The comparatively low relative DF_r value for Vitis riparia substantiates field observations indicating this species to be of scattered occurrence and apparently relic status under closed canopy conditions.

With the exception of Vitis riparia and possibly Juniperus communis, the last 11 species listed in Table VIII can scarcely be regarded as normal components of oak upland stands. All attain considerably greater importance in other habitats in which greater insolation is a prevailing characteristic. Their inclusion here, therefore, rests on the arbitrary criterion of presence in more than 10 percent of the stands.

Shrub representation displaying correlation with stand sequence. Graphs of representation for the 15 species held to exhibit linear or curvilinear correlation with stand sequence are shown in Figs. 19--21. As might be anticipated of a habit category which in such large part displays no obvious correlation with stand sequence, the degree of correlation exhibited by members of this minority group is of variable magnitude and is never clearly defined. The greatest correlation is exhibited by the surprisingly parallel trends in DF_r and frequency values for the more frequently recurring species such as Hamamelis virginiana, Viburnum acerifolium, V. recognitum and Vitis aestivalis var. argentifolia. The degree of agreement in DF_r and frequency trends for the above species suggests that Lindera benzoin, Ceanothus americanus, Gaultheria procumbens and Smilax tamnoides var. hispida also belong in this category, although the data do not permit wholly adequate evaluation by DF_r values.

In certain curves, presence records have been regarded as contributing to the evidence for correlation. Thus, in the curves for Ceanothus americanus and Quercus prinoides the concentration of presence records at the xeric end of the scale reinforce the otherwise meager evidence for a maximum in that sector. An entirely different interpretation would appear justifiable with respect to the two presence records at the xeric end of the curve for Gaultheria procumbens. The magnitude and number of DF_r values for this species suggest such sporadic distribution as to raise the question of whether or not chance played a determinative role in the absence of DF_r records from the xeric portion of the sequence. However, the two presence records and the intervening pair of frequency values lend credence to the view that the environment toward the xeric end of the sequence may become progressively more rigorous for this species. A similar use of presence records for qualifying absence of DF_r and frequency values was made in interpreting the curve for Gaylussacia baccata. Here, the two pairs of presence values flanking the definite maxima of DF_r and frequency values are of aid in delimiting the sector of the index scale seemingly most favorable for this species.

Of the six species with representation confined wholly or mainly to the xeric half of the continuum index scale (Fig. 19) none display a definite maximum at the extreme xeric end. The representation of Quercus prinoides and Viburnum lentago is of too sporadic occurrence to permit designation of a maximum in any sector; that of Vitis aestivalis is perhaps best interpreted as indicative of a maximum extending over the whole xeric half of the sequence. The curves for Ceanothus americanus, Vaccinium vacillans and Gaylussacia baccata, however, appear to manifest distinct curvilinear correlation with maxima for all three in approximately the same sector of the index scale.

Of the nine species with representation by DF_r values confined to, or reaching a peak in the mesic half of the sequence (Fig. 20, B--E, and Fig. 21), only the curves for Smilax tamnoides var. hispida, Lindera benzoin and possibly Hamamelis virginiana suggest trends toward maxima at or beyond the arbitrary limits recognized here for the oak upland community. Nevertheless, with the exception of the curve for Viburnum recognitum and possibly that of V. acerifolium, there are few indications of curvilinear correlation to be seen in the curves for these mesic species. In part such lack of definiteness results from a representation too sporadic to reveal the true pattern of representation, as typified by the curves for Gaultheria procumbens, Vaccinium angustifolium, Cornus rugosa and Ribes sativum. In part it is also a consequence of the lack of continuum data for such species as Hamamelis virginiana and Viburnum acerifolium from stands still more mesic in character.

As the general tone of the above observations suggest, many of the interpretations relative to the 15 species whose representation is held to exhibit correlation with stand sequence must be regarded as provisional; their validation and refinement must await more intensive and extensive application of the continuum principle to the upland forests of southern Michigan.

Herbs

As previously mentioned, the herb data consist of species lists compiled from varying numbers of three different sample sizes. The 10 x 10 m. quadrat size was universally employed and thus data yielded by this quadrat area comprise the standard of comparison for all stands. Data obtained from such quadrats established in the 36 stands selected for intensive study are recorded in Appendix Table LXXVII.

Comparison of Data from Different Sizes of Quadrats

Some conception of the reliability of the three quadrat sizes used in yielding information relative to the floristic and vegetational composition of the herb synusia is provided by data from a complex of seven stands located in northeastern Jackson County (see Fig. 1). These stands are developed on a single soil type and are so nearly contiguous as virtually to nullify distance and isolation influences on community composition. In consequence, as measured by 10 x 10 m. quadrats, the complement of herbaceous species for the complex appears to exhibit scarcely less uniformity from stand to stand than one would expect to find among the several sectors of a single stand (Table IX). That such uniformity is unique for the complex, and not merely a manifestation of the predominance of certain herb elements throughout the oak upland community, may be readily demonstrated by comparing the herb records for the seven stands as a group with those of the other 29 stands included in the study. Such comparison reveals that the seven stands of this complex possess a group individuality equivalent to that of a single stand. Thus, there

TABLE IX. Frequency data for the 42 most common herbs recorded in sets of 10 quadrats of three different sizes established in each of seven stands located within a circle of one-half mile radius.

Species	Stand Number																					Frequency Totals		
	8			16			22			24			28			31			32					
	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²	100m²	4m²	1m²
Hepatica-americana	10	6	4	9	6	4	10	8	4	10	2	1	10	8	6	10	7	3	10	7	5	69	44	27
Solidago caesia	9	3	3	10	7	4	9	6	3	10	7	3	10	-	-	10	7	2	9	2	-	67	32	15
Carex pensylvanica	10	9	8	8	4	2	10	7	3	-	-	-	9	4	2	4	2	2	10	2	1	51	28	18
Galium circaezans	10	4	2	9	3	-	9	3	2	6	1	-	9	3	-	4	1	-	3	-	-	50	14	4
Desmodium glutinosum	7	1	-	8	6	4	10	6	4	5	-	-	5	1	-	8	2	-	5	1	-	48	17	8
Aster macrophyllus	3	1	-	4	2	1	6	-	-	9	3	1	3	1	-	9	6	3	6	2	-	40	15	5
Galium boreale	4	1	1	5	2	1	9	3	3	4	2	1	8	1	-	4	1	1	6	1	-	40	11	7
Thalictrum dioicum	2	-	-	2	1	-	6	2	2	9	-	-	9	5	-	6	1	-	5	-	-	39	9	2
Smilacina racemosa	6	1	-	9	4	2	8	2	-	5	1	1	4	1	-	4	1	-	1	-	-	37	10	3
Aster cordifolius	10	7	2	1	1	-	9	2	1	2	-	-	7	-	-	3	-	-	4	-	-	35	10	3
Helianthus divaricatus	9	1	1	7	1	-	8	2	2	1	-	-	6	-	-	1	-	-	3	-	-	35	4	3
Polygonatum pubescens	3	1	-	1	-	-	1	-	-	4	1	-	10	4	-	6	3	2	9	3	2	34	11	4
Amphicarpa bracteata	9	4	1	3	-	-	10	7	3	3	-	-	5	3	1	1	-	-	X	-	-	31	14	5
Aster sagittifolius	1	-	-	6	3	2	8	4	3	4	-	-	2	-	-	4	-	-	3	-	-	28	7	5
Uvularia grandiflora	2	-	-	-	-	-	1	-	-	6	1	-	6	-	-	6	3	-	7	2	1	28	6	1
Desmodium nudiflorum	5	2	1	5	2	2	8	4	2	1	-	-	4	2	2	X	-	-	4	-	-	27	10	7
Sanicula marilandica	3	-	-	2	-	-	3	1	-	-	-	-	9	3	2	5	-	-	5	-	-	27	4	2
Geranium maculatum	X*	-	-	5	1	-	7	-	-	2	2	1	4	-	-	3	2	-	4	-	-	25	5	1
Festuca obtusa	5	-	-	4	1	-	5	1	-	3	-	-	3	-	-	2	-	-	-	-	-	22	2	-
Monarda fistulosa	7	5	1	5	-	-	3	-	-	1	-	-	2	-	-	-	-	-	-	-	-	18	5	1
Antennaria sp.	7	2	-	-	-	-	7	4	2	-	-	-	4	-	-	1	-	-	-	-	-	18	6	2
Pteridium aquilinum var.	4	2	-	5	-	-	4	1	-	-	-	-	2	1	1	-	-	-	-	-	-	15	4	1
Aralia nudicaulis	X	-	-	-	-	-	2	1	-	1	-	-	3	1	-	2	2	1	6	-	-	14	4	1
Carex convoluta	X	-	-	X	-	-	2	1	-	5	1	-	X	-	-	6	1	-	1	1	1	14	4	1
Pyrola elliptica	1	-	-	-	-	-	1	-	-	-	-	-	4	1	1	1	-	-	6	1	-	13	2	1
Anemone virginiana	7	1	-	2	-	-	3	-	-	-	-	-	1	-	-	-	-	-	-	-	-	13	1	-
Collinsonia canadensis	-	-	-	1	-	-	2	1	-	-	-	-	X	-	-	5	-	-	4	1	1	12	2	1
Aster laevis	3	1	1	3	-	-	3	-	-	-	-	-	1	-	-	1	-	-	1	-	-	12	1	1
Adiantum pedatum	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	6	3	-	4	1	1	12	5	1
Agrimonia gryposepala	4	-	-	X	-	-	3	-	-	-	-	-	3	-	-	1	1	-	1	-	-	12	1	-
Solidago hispida	4	-	-	X	-	-	-	-	-	4	-	-	4	-	-	-	-	-	-	-	-	12	-	-
Viola pubescens	1	-	-	X	-	-	2	1	1	2	-	-	2	-	-	2	2	-	2	-	-	11	3	-
Carex albursina	-	-	-	-	-	-	-	-	-	2	1	-	2	1	1	4	-	-	3	-	-	11	2	1
Dioscorea villosa	1	-	-	1	-	-	4	-	-	4	-	-	X	-	-	1	-	-	X	-	-	11	-	-
Potentilla simplex	3	1	1	1	1	1	2	-	-	-	-	-	1	-	-	2	-	-	-	-	-	9	2	1
Desmodium rotundifolium	X	-	-	5	1	1	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	9	2	2
Polygonatum biflorum	3	1	-	4	-	-	1	1	1	-	-	-	-	-	-	1	-	-	-	-	-	9	2	1
Osmorhiza claytonii	X	-	-	5	2	2	1	-	-	1	-	-	X	-	-	2	-	-	X	-	-	9	2	2
Lespedeza intermedia	2	-	-	1	1	1	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	2	1
Poa compressa	1	-	-	4	2	2	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	8	2	2
Veronicastrum virginicum	X	-	-	1	-	-	-	-	-	2	-	-	2	-	-	-	-	-	3	-	-	8	-	-
Vicia caroliniana	4	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-

*The symbol 'X' indicates presence in stand.

would seem to be considerable justification for regarding the averaged data yielded by each of the quadrat sets used in the complex as representative of a single large stand.

Species-area relationships. Table X was prepared to demonstrate the relation of quadrat size to number of species, and to supply a basis for some estimate of the number of smaller quadrats needed to match the species total obtained by a single set of 10 x 10 m. quadrats. The seventy 1 x 1 m. quadrats established in the complex, as shown in Table X, contained a total of 44 species, only 2 more than the average for each of the seven sets of ten 10 x 10 m. quadrats, and only slightly more than one-half the cumulative total found in the latter size. Although Table X indicates that 2 x 2 m. quadrats contain about half as many species per set of ten as do the 10 x 10 m. quadrats, the declining trend of the species-area curve would indicate that considerably more than twenty 2 x 2 m. quadrats would be required to equal the species total provided by ten quadrats of the largest size.

Frequency-area relationships. The approximately 7:3:1 ratio of average species densities indicated in Table XI provides a basis for interpreting the frequency pattern correlated with each quadrat size. Because of the intermediate size of the 2 x 2 m. quadrat, frequency totals obtained from such sample areas would seem to provide a logical point of reference for measuring the relative degree of deviation from the 7:3:1 ratio. Thus, for the first 24 species listed in Table IX, two-thirds of the frequency totals obtained from 2 x 2 m. sample areas show closer agreement with totals from the 10 x 10 m. quadrats than with

TABLE X. Relation of quadrat size to number of herb species recorded in seven stands encompassed by a radius of one-half mile.

Quadrat size	Stand number 8	16	22	24	28	31	32	Ave. species no.	Cumulative species total
100 m^2	51	46	58	31	33	41	35	42.1	85
4 m^2	24	24	28	12	18	21	13	21.7	53
1 m^2	12	16	18	7	8	11	7	11.3	44

TABLE XI. Relation of quadrat size to average species density of herbs recorded in seven stands encompassed by a radius of one-half mile

Quadrat size	Stand number 8	16	22	24	28	31	32	Ave. species density all stands
100 m^2	18.1	14.2	21.9	10.3	10.3	13.9	13.7	14.6
4 m^2	5.8	5.7	7.4	2.3	4.2	5.0	2.5	4.7
1 m^2	2.6	3.1	3.8	0.9	1.6	1.8	1.2	2.1

those from the 1 x 1 m. size. The frequency pattern associated with the smallest sample area is thus revealed to be relatively unique. The question therefore arises as to whether the sample area of 1 square meter provides a more or a less reliable measure of overall herb frequency than do the other two quadrat sizes.

Only one-third of the deviations from the 7:3:1 ratio by frequency totals from 1 x 1 m. quadrats are positive. However, those positive values for the first three species listed in Table IX reach extreme magnitudes. The concentration represented by the 60 frequency records for these three species comprises 40 percent of the frequency total obtained from all 1 x 1 m. quadrats.

Negative deviation from the 7:3:1 ratio by frequency records from 1 x 1 m. quadrats are particularly evident in the totals for Galium circaezans, Thalictrum dioicum, Smilacina racemosa, Aster cordifolius, Uvularia grandiflora, Sanicula marilandica, Geranium maculatum and Festuca obtusa. As shown in Table IX, no member of this group was recorded in less than six of the seven stands; five of these species were recorded in all stands. Thus, the failure of any species of this group to be registered in more than four of the 70 quadrats of 1 square meter size would appear strongly suggestive of a Q/MA ratio too low to allow its regular representation.

In providing a measure of the degree of regularity of dispersion, the sample area of one square meter is evidently unreliable. With an average species density seven times greater, the 10 x 10 m. quadrat patently is much more effective in supplying such a measure. Moreover, that the latter size of sample area performs this function without an excessive upward shift in frequency magnitudes[9] of less abundant species, may be confirmed through a species by species comparison of the frequency totals in Table IX for the two larger quadrat sizes. Finally, use of the same quadrat area to obtain quantitative data for all vascular components of the community would seem to assure maximum opportunity for detection of such inter-synusial relationships as may exist. In view of these considerations the sample area of 100 square meters was regarded as the most suitable size for use in a regional study where primary emphasis was directed toward the disclosure of inter-stand and inter-synusial correlations.

Ecologically Significant Herb Species

Of the some 250 herb species listed in Appendix Table LXXVII, only 74 species were recorded in more than twenty percent of the stands studied. The remainder, except for a group of 26 species whose occurrence records are restricted to relatively narrow segments of the continuum index scale, would appear to have little ecological significance in the oak upland community of southern Michigan. Their representation is regarded, therefore, to be adequately treated by Appendix Table LXXVII.

The frequency curves for the 74 herb species recorded in eight or more stands were critically studied to determine the degree to which they correlate with stand sequence. Unless the evidences of correlation in the frequency trend for a given species were definite and reasonably consistent, such a species was not included in the correlated group. Therefore, additional data, including index values of density and coverage,

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[9]See p. 88 for an example of such shift in frequency representation of shrubs.

would probably increase the number of species in the correlated group.

In the absence of such density and coverage data, it would seem necessary to qualify, as provisional, the status of those species interpreted here as correlated with stand sequence. Nevertheless, the frequency trends for these species seem sufficiently definite and consistent with field observations as to merit considerable confidence in their reliability.

Species exhibiting no obvious correlation with stand sequence. Frequency graphs for the 40 species included in this category are shown in Figs. 24—27. The order in which the graphs are arranged in these figures is determined by the total number of frequency records for each species. This number constitutes a gross measure of community-wide frequency, here termed summation frequency; it is given numerical expression in Table XII, wherein are listed two other synthetic indices for this group.

With three exceptions[10] this category includes all herbs recorded in more than 70 percent of the stands studied. With a single exception[11] it includes all species attaining summation frequencies in excess of 30 percent. This group is thus seen to include a very great proportion of the leading herb species occurring in the oak upland community. However, such leading species, together with most of the other herbs, should in no case be regarded as exclusives of the oak upland community. Rather, with few exceptions, the members of this group will be recognized as wide ranging species of upland forests in general.

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[10] Desmodium nudiflorum, Helianthus divaricatus, Festuca obtusa.

[11] Desmodium nudiflorum.

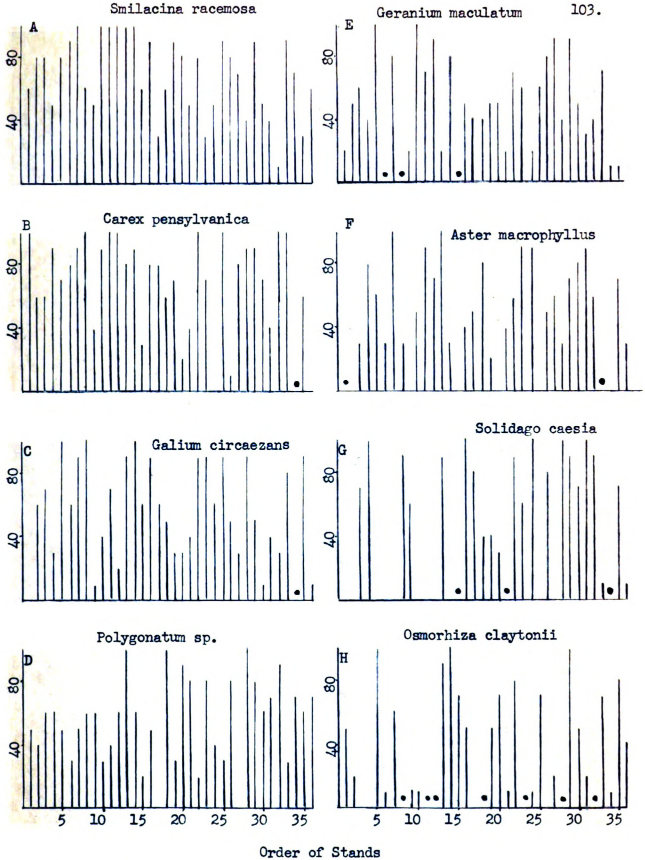

FIG. 24. Frequency values for eight more ubiquitous herbs showing no evident correlation with a stand sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of decreasing summation frequency.

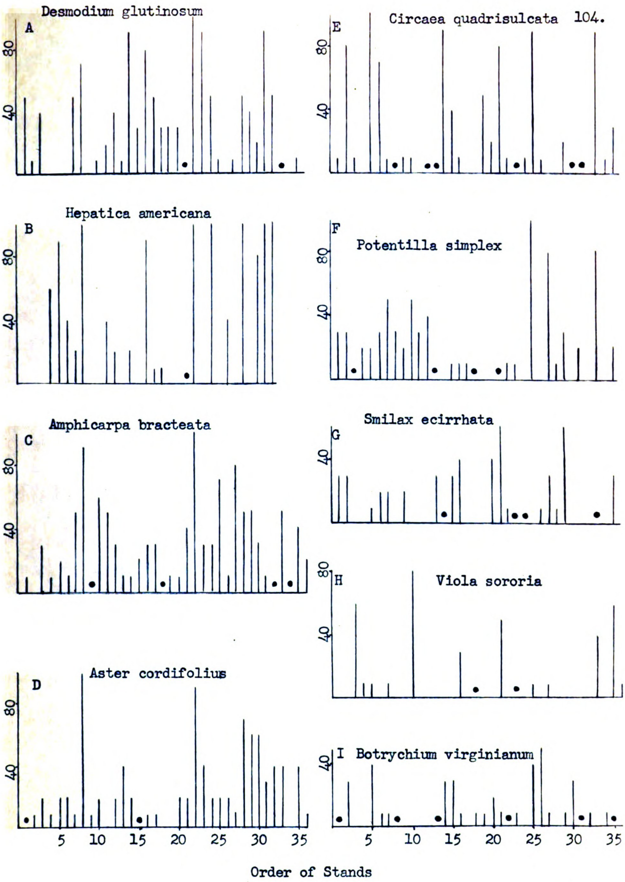

FIG. 25. Frequency values for nine common herbs showing no evident correlation with a stand sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of decreasing summation frequency.

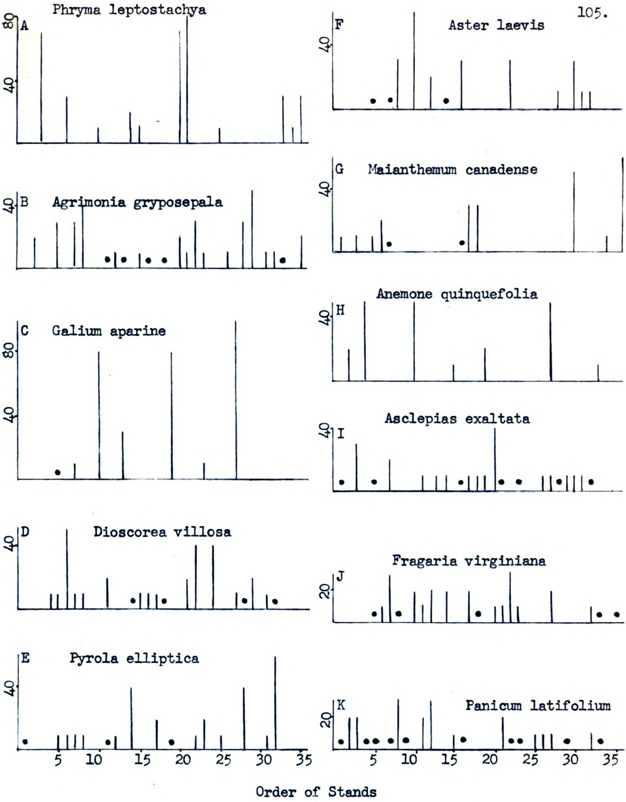

FIG. 26. Frequency values for 11 less common herbs showing no evident correlation with a stand sequence determined by continuum index numbers. Dots indicate presence. The charts are arranged in order of decreasing summation frequency.

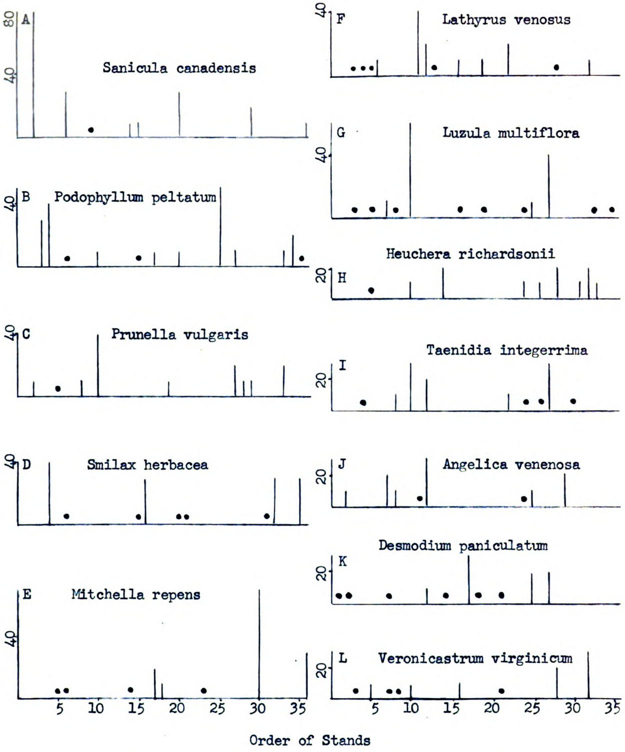

FIG. 27. Frequency values for 12 uncommon herb species showing no evident correlation with a stand sequence determined by continuum index numbers. Dots indicate presence. The charts are arranged in order of decreasing summation frequency.

TABLE XII. Synthetic indices for the more common herb species showing no clearly evident correlation with stand sequence

Species	Summation frequency[1] %	Aggregate constance[2] %	Presence %
Smilacina racemosa	69.8	100.0	100.0
Carex pensylvanica	67.8	91.7	94.5
Galium circaezans	56.1	94.5	97.2
Polygonatum sp.	55.6	94.5	94.5
Geranium maculatum	48.1	91.7	100.0
Aster macrophyllus	46.7	77.8	83.3
Solidago caesia	43.9	63.9	72.2
Osmorhiza claytonii	34.7	69.5	88.9
Desmodium glutinosum	32.0	75.0	80.6
Hepatica americana	30.8	50.0	52.8
Amphicarpa bracteata	30.3	86.1	97.2
Aster cordifolius	25.3	83.3	88.9
Circaea quadrisulcata	23.9	61.1	77.8
Potentilla simplex	21.1	63.9	75.0
Smilax ecirrhata	13.3	47.2	58.4
Viola sororia	11.1	33.3	38.9
Botrychium virginianum	10.6	52.8	69.5
Phryma leptostachya	10.3	30.6	30.6
Agrimonia gryposepala	9.4	44.5	58.4
Galium aparine	8.6	16.7	22.2
Dioscorea villosa	7.8	41.7	52.8
Pyrola elliptica	7.2	36.1	44.5
Aster laevis	6.4	25.0	33.3
Maianthemum canadense	6.1	25.0	30.6
Anemone quinquefolia	6.1	22.2	22.2
Asclepias exaltata	5.6	38.9	58.4
Fragaria virginiana	5.8	36.1	56.8
Panicum latifolium	5.3	30.6	58.4
Sanicula canadensis	5.3	19.4	22.2
Podophyllum peltatum	3.9	25.0	33.3
Prunella vulgaris	3.6	22.2	25.0
Smilax herbacea	3.6	11.1	25.0
Mitchella repens	3.6	11.1	22.2
Lathyrus venosus	3.3	19.4	33.3
Luzula multiflora	3.3	11.1	36.1
Heuchera richardsonii	3.1	22.2	25.0
Taenidia integerrima	3.1	13.9	25.0
Angelica venenosa	2.8	16.7	22.2
Desmodium paniculatum	2.2	11.1	27.8
Veronicastrum virginicum	2.2	13.9	25.0

[1]Total quadrat occurrences in all stands expressed as a percentage of the 360 possible occurrences.

[2]Total stand occurrences based on at least one quadrat tally per stand and expressed as a percentage of the 36 possible occurrences.

Most of the species with relatively high presence values (Table XII) also attain high quadrat, and summation frequencies. Notable exceptions to this generalization, however, are seen in the data for Botrychium virginianum, Agrimonia gryposepala, Dioscorea villosa, Asclepias exaltata, Fragaria virginiana and Panicum latifolium. All of these species were recorded in at least half of the stands studied, but none attained a quadrat frequency of more than 50 percent, or a summation frequency greater than 11 percent. In consequence, the synthetic data for these six species show a relatively high ratio of presence to summation frequency of from more than 6:1, to more than 10:1.

A contrasting value of less than 3:1 for the above ratio is evident from the synthetic data for Hepatica americana, Phryma leptostachya and Galium aparine. Reference to Figs. 25 and 26 reveal these species to attain higher quadrat frequencies than other species of comparable presence.

The apparent low presence value of G. aparine is attributable probably in an important degree to completion of the life cycle and disappearance of this annual by the time many of the stands were studied. On the other hand, the low presence value of H. americana relative to the prevailingly high level of quadrat frequencies for this species, attests to some decisive environmental control. Deam (1940: 462) has noted a similar puzzling absence of this species in evidently suitable habitats, and has suggested a possible correlation of such absence with low soil acidity.

With decreasing presence, interpretation of frequency curves based on records distributed over much of the continuum index scale become increasingly subject to error. Moreover, despite such broad scale distribution, species of low presence would seem less likely to be adapted to the full range of habitat conditions existing in the oak uplands than would more regularly recurring species. It is probable, therefore, that frequency curves based on a very large number of stands would reveal some of the species charted in Figs. 26 and 27 to be correlated with stand sequence. On the basis of present suggestive, but inconclusive, frequency trends, species most likely to exhibit such correlation include _Aster laevis_, _Maianthemum canadense_, _Sanicula canadensis_, _Lathyrus venosus_, _Angelica venenosa_ and _Taenidia integerrima_.

Inadequate data also prevent conclusive evaluation of the frequency trends for _Polygonatum biflorum_ and _P. pubescens_. Prior to the publication of edition eight of Gray's Manual (Fernald 1950), both of these entities were recorded as _P. biflorum_. Subsequent records suggest that _P. biflorum_ may be more xeric than _P. pubescens_ (see Appendix Table LXXVII).

Herb species correlated with stand sequence. Curves for the 60 species indicated by stand occurrence and/or quadrat frequency to be correlated with stand sequence are charted in Figs. 28 through 32. The graphs are arranged in an order which approximates, insofar as the often restricted data permit, a progression from species recorded only in xeric stands, through those most prominent in intermediate sectors of the scale, to those evidently restricted to the mesic extreme of the oak upland community.

As was found true of the non-correlated group of herbs, low frequency values tend to be concentrated among the species of limited stand occurrences. Thus, of the 32 species for which no frequency values in excess

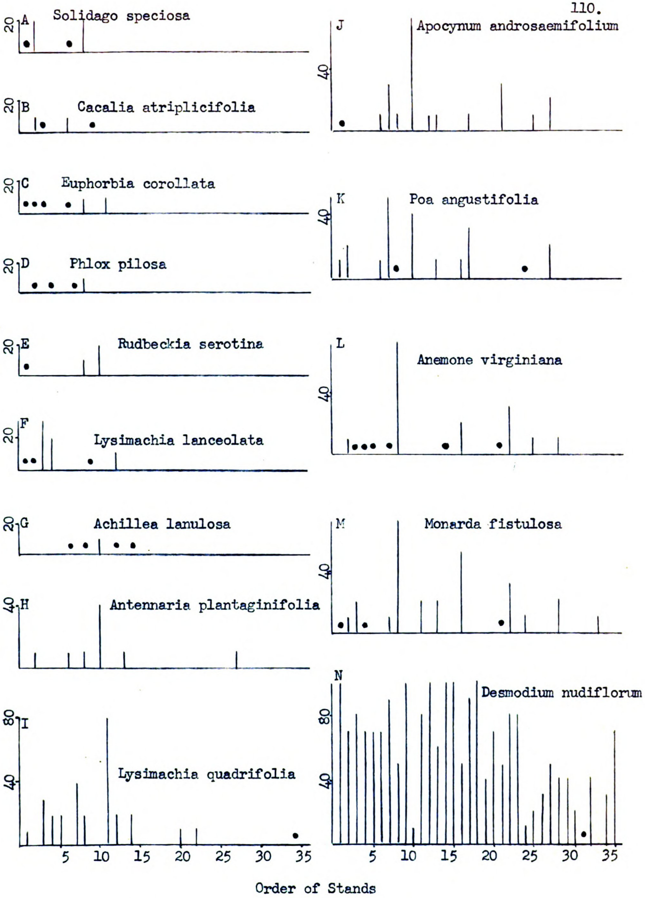

FIG. 28. Frequency values for 14 herbs evidently most abundantly represented in the more xeric stands of a sequence determined by continuum index number. Dots indicate presence. The chart arrangement is in order of apparent increasing moisture requirement.

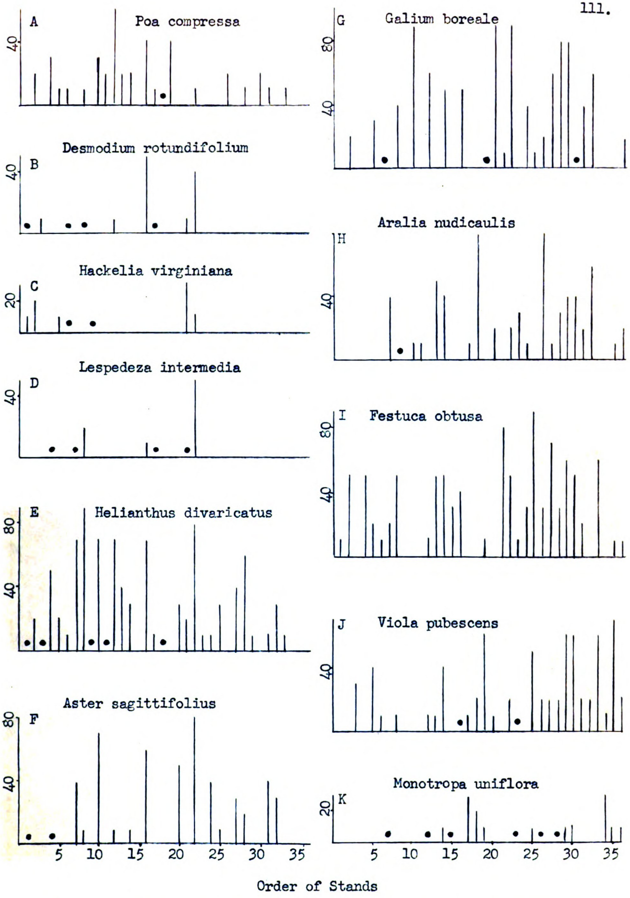

FIG. 29. Frequency values for 11 herbs evidently correlated with a stand sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

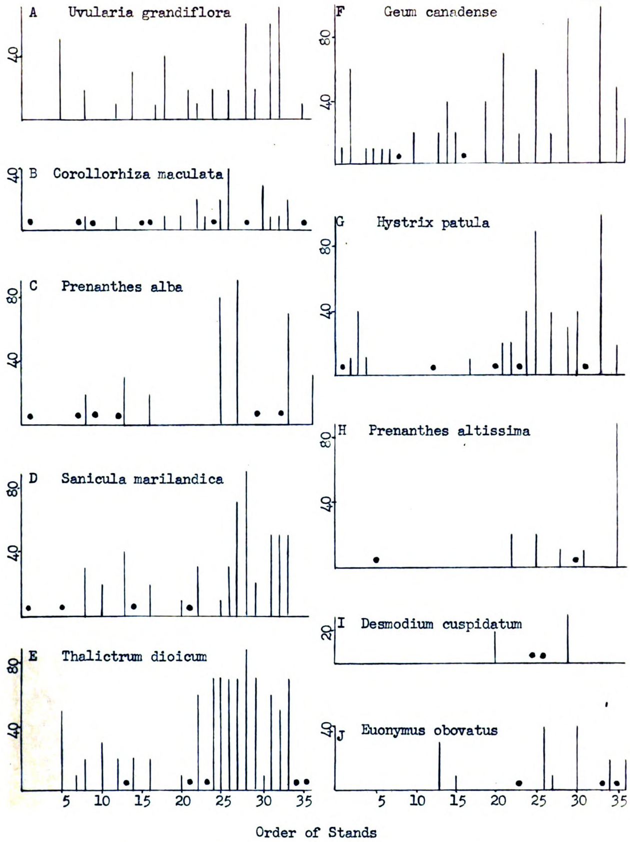

FIG. 30. Frequency values for ten herbs evidently most abundantly represented in the more mesic stands of a sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

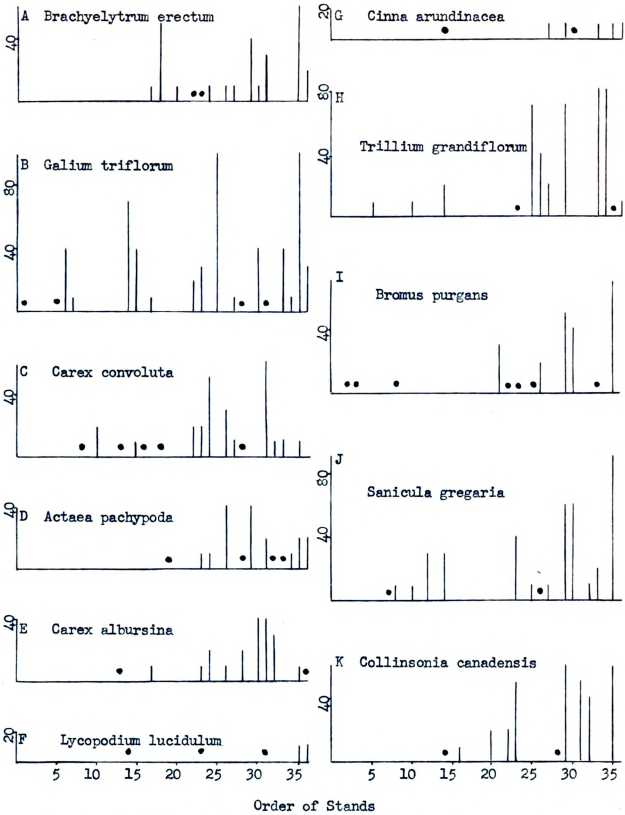

FIG. 31. Frequency values for 11 herbs evidently most abundantly represented in the more mesic stands of a sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

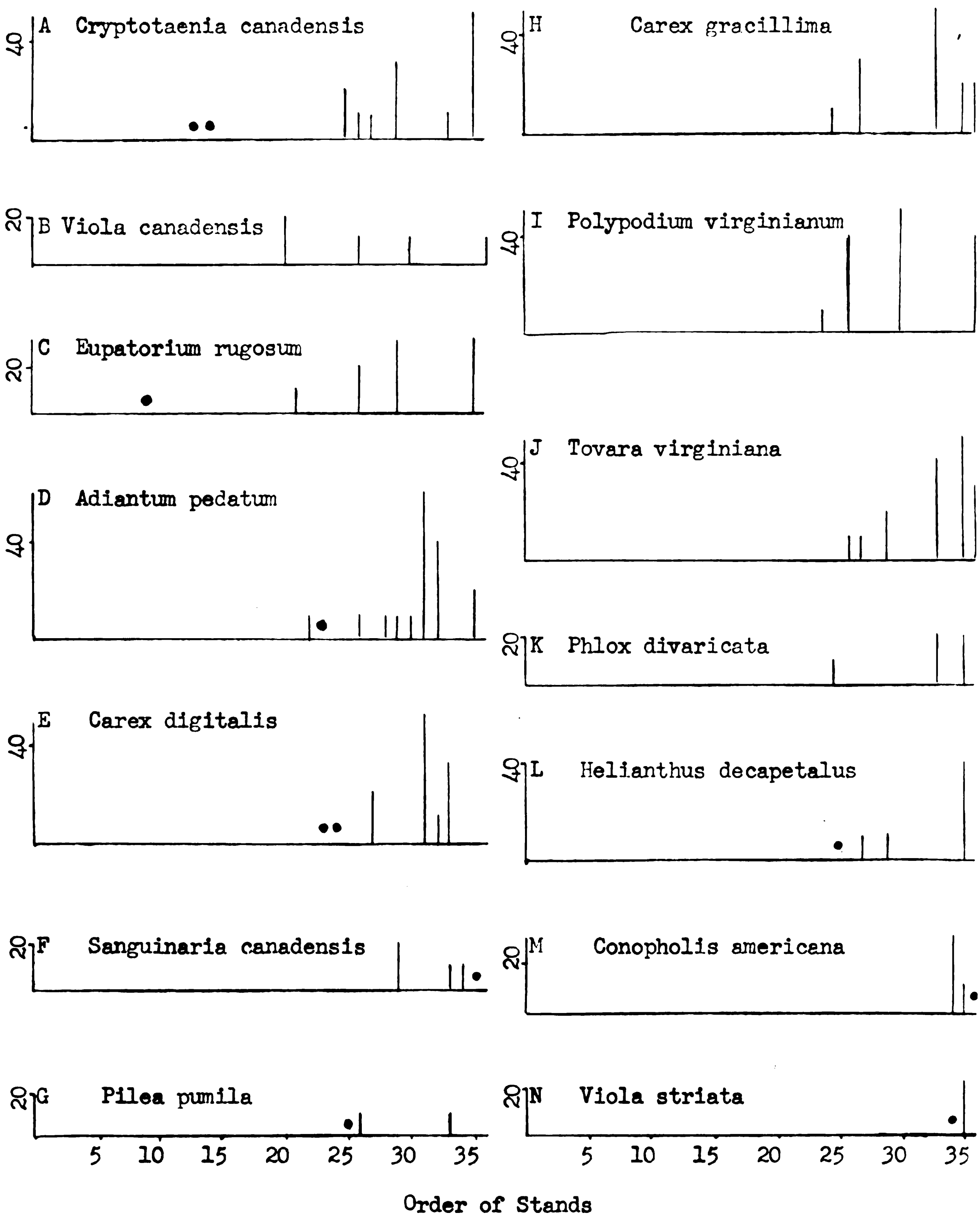

FIG. 32. Frequency values for fourteen herbs evidently most abundantly represented in the more mesic stands of a sequence determined by continuum index number. Dots indicate presence. The charts are arranged in order of apparent increasing moisture requirement.

of 50 percent were obtained, only Monotropa uniflora and Corallorhiza maculata were recorded in more than one-third of the stands.

The only member of the group of 26 species recorded in less than eight of the stands to exceed a 50 percent frequency value is Prenanthes altissima. The stand occurrence indicated for this species, however, is doubtless far too restricted, since at the time data were collected in 15 stands, the stage of development of Prenanthes did not permit specific determination (see Appendix Table LXXVII).

Most of the other 25 species recorded in less than 20 percent of the stands attain much greater importance in other communities. Of the ten species restricted to the xeric portion of the stand sequence, Solidago hispida, Cacalia atriplicifolia, Phlox pilosa, Euphorbia corollata, Rudbeckia serotina, Achillea lanulosa and Antennaria plantaginifolia are recognized as plants of old fields, woodland borders or prairies. Although the remaining members of this restricted xeric group, consisting of Desmodium rotundifolium, Lespedeza intermedia, Lysimachia lanceolata and Hackelia virginiana are to be regarded as woodland forms, D. rotundifolium and L. intermedia appear to be markedly intolerant, in that they are restricted almost wholly to well insolated openings. The relatively high frequency for both these species in stand 22, and for D. rotundifolium in stand 16, in all probability is correlated with the rather abrupt south slopes on which both these stands were developed (see Table XIII).

The remaining 16 species occurring in less than eight of the stands, are included among the curves charted in Figs. 30, 31 and 32. With the exception of Conopholis americana and Cinna arundinacea, all the members of this group exhibit far greater ecological importance in the beech-maple community. A root parasite, Conopholis americana is described by Deam (1940: 860) as occurring typically in oak woods with a deep leaf litter. It was observed in such surroundings in stands 34, 35 and 36. Cinna arundinacea attains greatest importance in poorly drained, heavy textured soils supporting a bottomland, or even swamp type of forest.

Of the group of 34 species occurring in more than 20 percent of the stands, a total of 26 species included in the portion of the graph sequence beginning with Aster sagittifolius (Fig. 29, F) and ending with Adiantum pedatum (Fig. 32, D) attain maximum frequency values in the mesic portion of the index scale. Moreover, with the exceptions of Aster sagittifolius, Galium boreale and Corallorhiza maculata, this group is identified with the beech-maple community in scarcely less degree than the more restricted group toward the mesic end of the graph progression (Billington 1925; Deam 1940; Bingham 1945).

Frequency curves for the remaining eight members of the group of 34 species occurring in more than 20 percent of the stands are included in the portion of the graph sequence beginning with Lysimachia quadrifolia (Fig. 28, I) and ending with Helianthus divaricatus (Fig. 29, E). These curves are seen to be marked by relatively low magnitude — or absence — of frequency records over most of the mesic sector of the sequence. Only Desmodium nudiflorum and Helianthus divaricatus appear well represented over the whole range of the stand sequence.

Considering all 60 species included in Figs. 28 through 32, 41 species, or almost 70 percent of the total, are shown to reach maximum stand occurrence and frequency magnitudes toward the mesic end of the index scale. This group tendency is responsible in large part for the rising trends shown in the curves for total species complement and average species density of the herb synusia (see Fig. 36).

Correlation between Leading Dominants and Continuum Index Sequence

Abundant evidence emphasizing the great heterogeniety of the oak upland community has been presented in preceding sections. The inclusion of so many and widely dissimilar vegetational elements under this single community name suggests the practical desirability of some empirical means for designating stands in terms of leading dominants. The importance value index has previously been described as the most comprehensive measure of dominance available. Accordingly, designation of stands by the two or three leading dominants as determined by importance values would seem to provide a convenient means of reference which could supplement, or substitute, for continuum index number.

Bearing upon the significance and utility of such an empirical system of classification is a consideration of: (1) What combinations of leading dominants recur with greatest regularity? (2) What relation do the various combinations bear to the continuum index sequence? (3) How harmonious, from the standpoint of the concept of climax adaptation, do such combinations appear to be?

In an attempt to provide answers for these questions, Figs. 33 and 34, showing scale positions of stands designated by two, and three leading dominants, respectively, have been prepared. As indicated in Fig. 33 only four leading dominant pairs are not duplicated; yet only five such pairs recur more than twice. Of the latter, the combinations of black oak-pignut

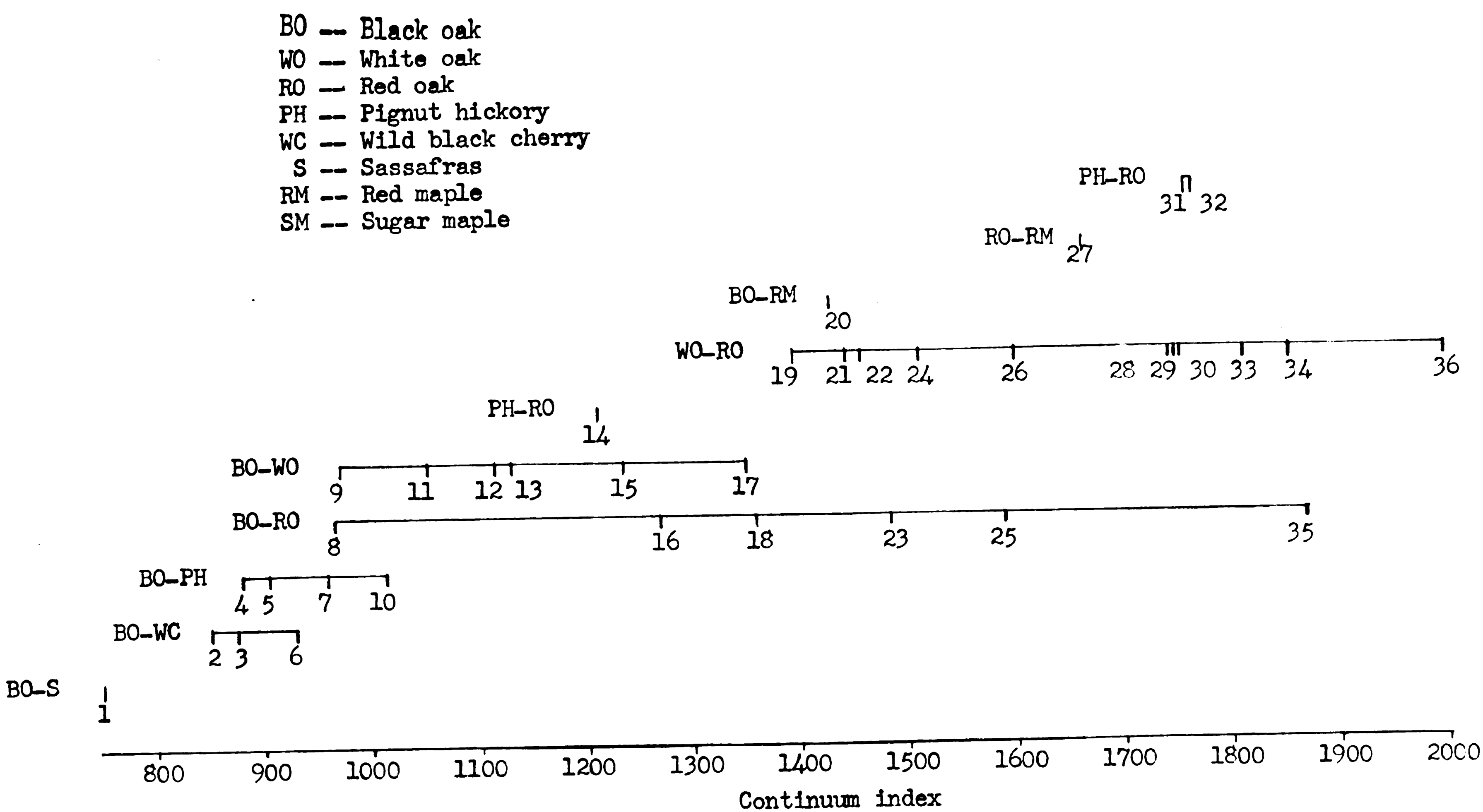

FIG. 33. Relation between index position and the two leading stand dominants.

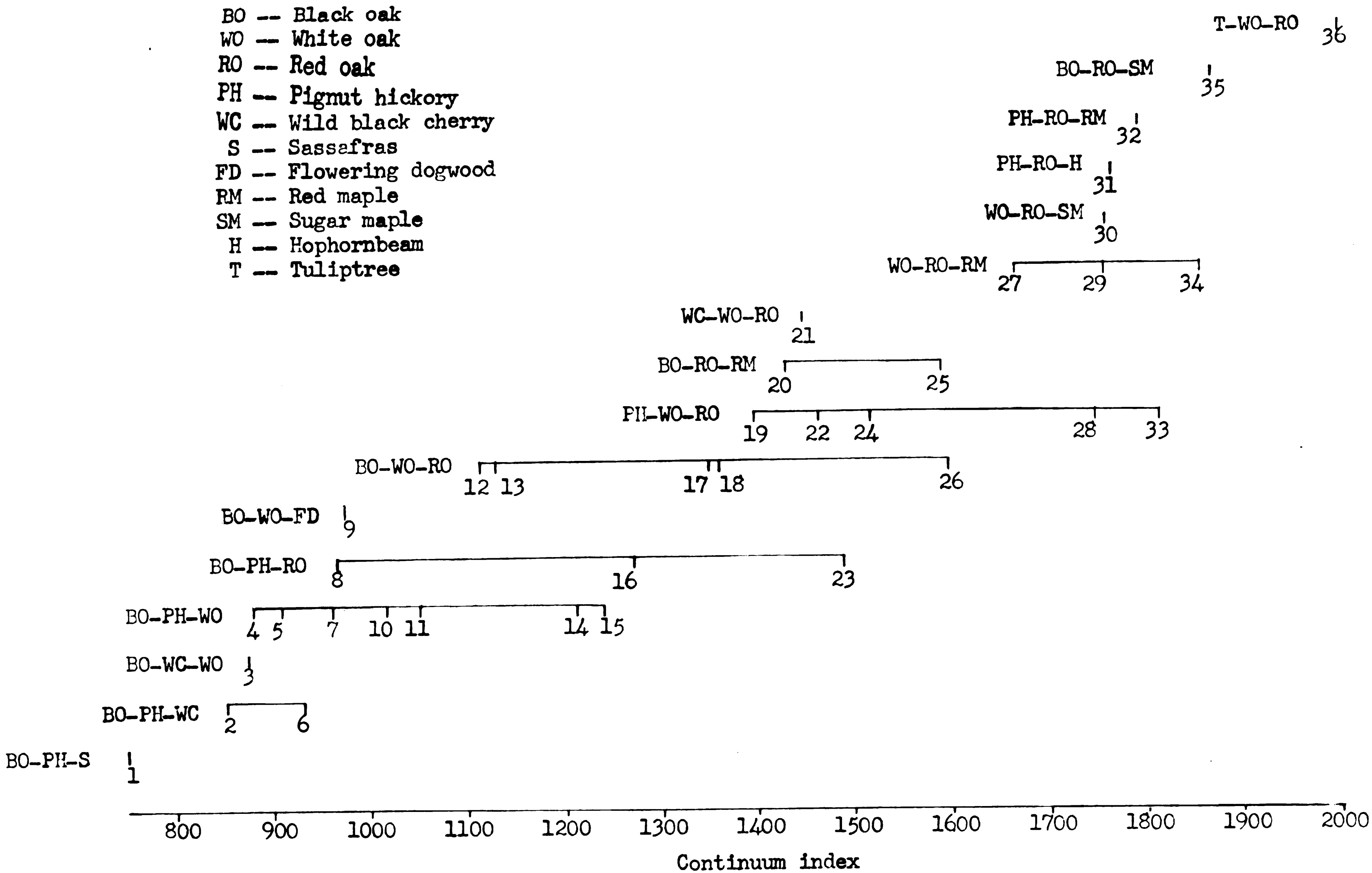

FIG. 34. Relation between continuum index position and the three leading stand dominants.

hickory and black oak-black cherry are restricted to surprisingly narrow segments of the index scale. Moreover, the black oak-red oak combination is responsible for the only overlap exceeding 75 scale divisions.

Considering all pairs, only those of black oak-red oak, black oak-red maple, and red oak-pignut hickory appear not in accord with the principle of climax adaptation. The black oak-red oak combination seems particularly anomalous in view of the very wide range of the continuum index scale over which stands with this pair of leading dominants are distributed. Evidence is available suggesting that all three of these seemingly incongruous combinations may reflect modifications resulting from heavy disturbance in the past. Indications that stands 8, 16, 31 and 32, prior to modification, may have been dominated by red and white oak will be presented later. The owner of stand 25 revealed in conversation that selective removal of white oak occurred in 1889, and that the hickory was taken out about twenty years ago.

Evidence that black oak may comprise an abnormal leading dominant in stands 18, 20, 23 and 35 is provided by other tree components, particularly Carya cordiformis and Fagus grandifolia which occur in all four stands, and Tilia americana which was recorded in all except stand 20. Such evidence is strongest in stand 35, where the combined importance values of Acer saccharum, Fagus grandifolia and Tilia americana reach a total almost double that of black oak. It is weakest in stand 20, where the importance value of black oak is double that of any other species. Nevertheless, that disturbance might conceivably result in such a great preponderance of black oak is demonstrated by the composition of stand 8 as compared to other stands of the complex of which it is a part.

Interpretation of the combinations of black oak-red oak and black oak-red maple as anomalies correlated with unusual past disturbance, permits recognition of a continuum index boundary in the scale sector between 1350 and 1400 which serves to separate stands characterized by black oak as one of the two leading dominants from those similarly distinguished by red oak. Should further investigation demonstrate this boundary to remain reasonably distinct, it would obviously prove useful as a basis for delimiting two relatively homogeneous subdivisions of the oak upland community.

Fig. 34 shows 16 combinations of three dominants of which nine are unduplicated, and five are repeated more than twice. Moreover, a conspicuous overlapping in index position is characteristic of all recurring combinations. With the single exception of stand 18, all stands with leading pairs of dominants (see Fig. 33) interpreted as anomalous show similarly abnormal combinations of three leading dominants.

From the standpoint of suitability as a basis for empirical classification, combinations of three leading dominants would appear to have few advantages to compensate for the greater number of combinations, the many unrepeated combinations, and the broad overlapping in scale position of stands representing recurring groupings of dominants.

Continuum Index Numbers as Measures of Environmental Influences

In providing a quantitative means for representing the dominant elements of an entire stand by a single number, the concept of the vegetational continuum index would seem notably complementary to the functional, factorial approach to environment-vegetation relationship advanced by Major (1951). It must be acknowledged that the imperfect correlation indicated in previous sections between the representation of tree dominants and lesser synusiae necessitates that the continuum index number be regarded as only an approximate representation of the entire stand. Nevertheless, such an approximation would appear comparable in accuracy to any value which could be assigned to any one of the five gross variables recognized by Major (1951: 393). Therefore, once comparable stands have been located which effectively differ as to environment by only one of the five factors, the field investigator needs only to establish continuum index numbers for each stand in order to obtain a gross evaluation of the influence of that environmental factor in terms of vegetation response. While such evaluation is comparative and obviously only approximate, it nevertheless would seem to provide a worthwhile standard of comparison against which the vegetational response to effective variation of other environmental influences may be weighed. By such comparison some estimate may be made as to the relative degree to which the various environmental factors, or factor complexes, influence stand composition within a natural area.

In southern Michigan the scarcity of suitable "natural laboratories" markedly restrict the joint use of these two procedures to measure the influence of single environmental variables on the composition of oak upland stands. In part such scarcity is a function of micro-diversity in the surface configuration and composition of the drift mantle, which still is strongly reflected in local land forms and soil profiles. Slopes seldom are of sufficient length to allow evaluation of topographic influence. On a stand basis, edaphic influence is rendered difficult to interpret by the common occurrence, even within a few feet, of marked variations in soil profile.

By far the most important reason for the rare occurrence of suitable experimental areas, however, is the pronounced fragmentation and modification of the oak upland community resulting from the activities of man. Mention has previously been made (in the section on post-settlement history) that in southern Michigan only about ten percent of the land remains in forest. Moreover, an overwhelming proportion of the remaining forest in all areas has been profoundly modified by past utilization practices.

The major share of modifications induced by such practices appear to be of long standing, or at least tend to antedate the periods of residence of the local populace. As a result, relatively little reliable information concerning past history can be gained from local residents. In advanced second growth stands, contrasts coinciding with property lines usually comprise the only tangible evidence of compositional changes induced by past utilization (see Fig. 36). Such evidence, however, merely reflects the influence of two differing patterns of utilization on a common prototype. In no way does it provide a measure of the absolute nature and degree of modification of that prototype. It is thus evident that the influence of past utilization may not be expressed quantitatively in a manner comparable to that of soil type or slope class, which may be assigned a definite value on the basis of intrinsic properties of the factor involved.

In the absence of a reliable means to measure the influence of past utilization, it would appear necessary to restrict any attempts to evaluate topographic or edaphic influences to single tracts wherein careful reconnaissance reveals no pattern of differential past disturbance to exist. In the various sectors of such tracts it would then seem justifiable to regard the influence of past utilization as constant, or varying ineffectively, even though the actual magnitude of such influence be unknown. As might be anticipated, relatively few tracts were found which, in their various portions, provided opportunity to evaluate influence of soil or topography, while showing, at the same time, no evidence of differential past utilization.

Influence of Slope

In Table XIII are shown the past land use and topographic contrasts which serve to distinguish seven individual stands in an otherwise closely similar complex made up of four contiguous tracts. Pairs of these stands occurring in each of three different tracts provide an opportunity for evaluating the influence of: (1) slope exposure in a tract containing some old growth remnants (stands 22 and 28); (2) slope exposure in a completely second growth tract (stands 16 and 32); (3) relative position on a slope of northern exposure (stands 24 and 31). The first two pairs of stands mentioned above occur on slopes of comparable length and incline, ranging from 200 to 400 feet in length, and averaging close to 20 percent in gradient. The third pair of stands is located on a longer and more abrupt slope exceeding 500 feet in length and approaching a 30 percent gradient.

Influence of Slope on Tree Dominants

The differentials in continuum index number evidently referable to slope influence are indicated in the bottom column of Table XIV. The

TABLE XIII. Variations in topography and past land use of seven stands of a complex[1] for which soil type[2], macroclimate and species complement[3] may be considered constant or to vary ineffectively

Stand no.	Topography			Past land use				Continuum index no.
	Undulating or level	Southern exposure	Northern exposure	Old growth timber removal		Past grazing		
				Partial	Complete	Slight	Evidently none	
8	X				X	X		967
16		X			X	X		1272
22		X		X		X		1459
24			X[4]	X			X	1516
28			X	X		X		1748
31			X[5]	X			X	1766
32			X		X	X		1768

[1]Located in SW ¼ of section 1, and NW ¼ of section 12, T 2 S, R 2 E, Waterloo Twp., Jackson Co.

[2]Bellefontaine sandy loam.

[3]See Table IX for stand by stand occurrence of the principal herbaceous species.

[4]Above middle of slope.

[5]Below middle of slope.

TABLE XIV. Net positive differences in weighted importance values between indicated stand pairs[1] contrasted to illustrate influence of slope

Species	Contrasting stand pairs					
	22 vs. 28		16 vs. 32		24 vs. 31	
Acer rubrum	—	203	—	284	—	137
Acer saccharum	—	—	—	—	—	56
Amelanchier sp.	—	—	—	—	—	18
Carya ovalis	85	—	1	—	108	—
Cornus florida	—	—	—	22	—	22
Fagus grandifolia	—	—	—	—	47	—
Fraxinus americana	—	31	—	—	13	—
Ostrya virginiana	—	—	—	—	—	241
Prunus serotina	37	—	51	—	—	—
Quercus alba	74	—	130	—	221	—
Quercus rubra	—	278	—	553	—	167
Quercus velutina	43	—	159	—	2	—
Sassafras albidum	—	—	22	—	—	—
Tilia americana	—	48	—	—	—	—
Ulmus americana	32	—	—	—	—	—
Total net positive difference	271	560	363	859	391	641
Differential in continuum index number	289		496		250	

[1]See Table XIII for stand characteristics.

differences in weighted importance values which collectively produce these differentials in continuum index number are shown in the upper rows of this same table. These latter data indicate without exception that Acer rubrum and Quercus rubra are most important in the more mesic member of each stand pair, while Carya ovalis, C. alba and C. velutina are more important in the less mesic member.

A note of interest, and an indication of the reliability of the continuum index values compiled for stands 24 and 31, is provided by data from 10 quadrats oriented on a diagonal line from crest to base of the north-facing slope on which these two stands are located (Appendix Tables XXXVII and LXXIV). The continuum index number of 1653 computed from the data obtained by this sampling pattern might thus be regarded as representative of the entire tract. That such a number should be only 12 points from the mean of the continuum index values for stands 24 and 31 would therefore seem to constitute a favorable reliability check.

Influence of Slope on Other Community Components

Tree reproduction. The three classes of tree reproduction tend to show the same general response to slope influence as do the dominant elements. Correlation involving any given species, however, is less predictable, as evidenced particularly by Quercus rubra, which in all three reproduction classes was recorded in greater amount in stand 16 than in stand 32 (see Appendix Tables).

Shrubs. With the exception of three species, the shrubs recorded in two or more stands of this complex show no definite correlation with slope. The exceptions involve Ceanothus americanus which was not recorded on any north slope, Vitis aestivalis var. argentifolia which was not recorded in stands 28, 31 and 32, and Viburnum acerifolium which appears clearly most abundant on north slopes.

Herbs. Totals of species per stand (see Table X) and average species densities (see Table XI) agree in indicating restricted herb representation on north slopes of this complex. On a species basis, such restriction is explained by the relatively few herbs more abundantly represented on north slopes, as contrasted with the group evidently restricted in occurrence or absent on such sites. Of the 42 species listed in Table IX, only Uvularia grandiflora, Carex albursina and Adiantum pedatum appear clearly most abundant on north slopes. A much larger group, notably Helianthus divaricatus, Pteridium aquilinum var. latiusculum, Vicia caroliniana, Desmodium rotundifolium, Lespedeza intermedia and Anemone virginiana is evidently much restricted on such slopes.

The evident sparseness of the herb synusia on north slopes of this stand complex runs directly counter to the tendency for herb representation to increase in both species and species density with increasing continuum index number (see Fig. 37). The implications of this departure from the general synusial trend will be considered later in connection with other deviations from that trend.

Influence of Soil

Primarily because of differential patterns of past utilization, the influence of soil in contributing to the diversity of the oak upland community is peculiarly difficult to assess with any precision. Attention has previously been called to the need for basing each attempt at such evaluation upon data obtained from a single tract which appears to have had uniform treatment in the past.

Soil Variation within Single Tracts

Variations in soil profile of differing magnitude may usually be readily demonstrated in any oak upland tract in southern Michigan. Where such variation does not exceed the relatively narrow limits established for a given soil type, the associated vegetation might likewise be expected to vary relatively little. Most surprising, therefore, is the 649 point difference in continuum index number between stands 10 and 27, located in a 40 acre tract mapped entirely as Miami loam. Slope in this tract is to the west and averages less than 2 percent. There is no evidence that the pattern of past utilization of the two stands has been different. There is, however, evidence of greater moisture retentivity in stand 27 in the form of frequent wet depressions occupied by *Quercus bicolor* and *Carya ovata* (see Fig. 2). It would seem, therefore, that soil influence must be considered the prime variable correlated with the differential in continuum index number between these two stands.

In view of such a large differential evidently attributable to variation within a single soil type, it would seem likely that many replicate continuum index numbers would be necessary in order to provide a reliable estimate of the influence of soil variation greater than the limits of a single soil type. The likelihood that the remnants of the oak upland community in southern Michigan would prove too fragmental to permit such estimation seems very great. Only a few oak upland tracts developed on more than one soil type were encountered in the course of this study. None were considered suitable for measuring differences between soil types in terms of vegetational response. Usually only one of the represented types occupied sufficient area to permit sampling of the associated vegetation by the usual pattern of dispersed quadrats; often variation in soil type was found to be correlated with some obviously effective variation in topography; occasionally the included soil types were found to be so intricately distributed as to form a complex supporting vegetation representative of no soil type in particular. The latter condition is well exemplified in the 40 acre tract in which stand 36 is located. Over considerable portions of this tract small, alternating bodies of Brookston loam and Napanee silt loam form a mosaic with which is correlated a stand complex composed of elements of oak upland, beech-maple, and bottomland forest.

Correlation between Soil Type and Continuum Index Number

The contrast in continuum index value between stands 10 and 27 suggests that soil variation may profoundly influence the continuum index sequence. Fig. 35 was prepared in an effort to determine whether or not soil influence is of such magnitude as to permit recognition of a pattern of correlation between soil type and continuum index number despite the effective variation of the other environmental factors. Inspection of this figure reveals two facts of considerable significance: (1) with the exception of stands 24, 28, 31 and 32, developed on Bellefontaine sandy loam, no continuum index values compiled for stands associated

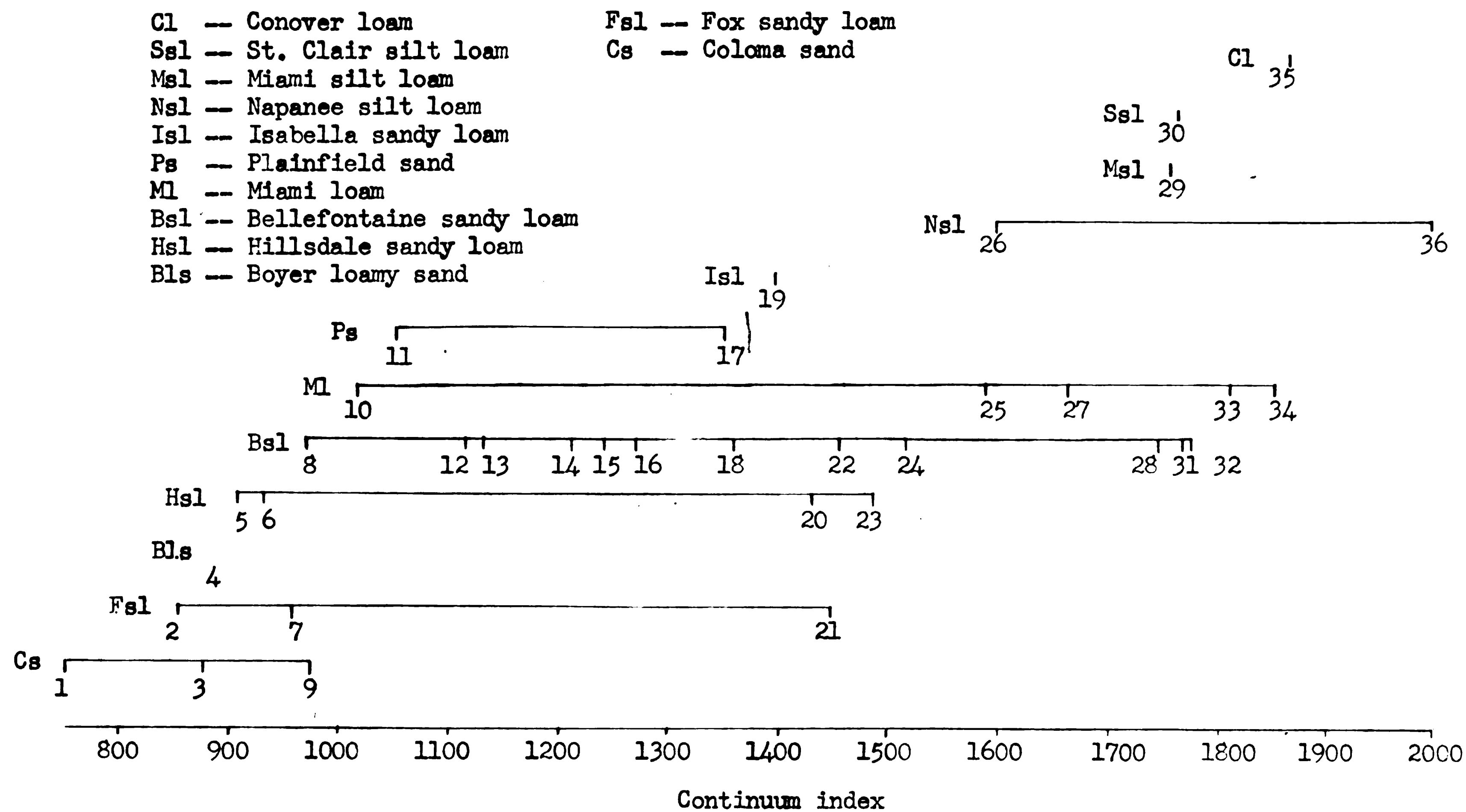

FIG. 35. Relation between soil type and continuum index position of associated stands.

with soil types designated as sands, loamy sands or sandy loams exceeded a value of 1500 points; (2) with the single exception of stand 10, developed on Miami loam, no continuum index values compiled for stands associated with soil types designated as loams or silt loams failed to exceed 1500 points.

It will be recalled that the four exceptional stands developed on Bellefontaine sandy loam are all located on slopes of northern exposure (Table XIII). Moreover, in comparison to the index positions of the four other stands developed on Miami loam, the index position of stand 10 appears clearly anomalous (Fig. 35). The general observation would therefore seem permissible that, in terms of vegetational response, index position 1500 serves to delimit two broad textural groupings of soils on which oak upland stands are developed in southern Michigan.

The sequence of soil types in Fig. 35 is not to be interpreted as representing an attempt to arrange the types in accordance with their moisture relationships as suggested by the data obtained in this study. Such data are far too scanty, and the influence of other environmental factors far too efective, to justify such an attempt. Nevertheless, the sequence, determined merely by the lowest continuum index number associated with each type, seems in reasonable accord with existing views (Veatch 1953) as to moisture relationships of the types represented. Thus, there is considerable support for the view that the edaphic factor may be considered the prime variable in the oak upland environment of southern Michigan.

Influence of Past Utilization

The full degree to which past patterns of utilization modify vegetational expression of other environmental influences cannot, of course, be determined by comparison of second growth stands. However, a well stocked, uneven-aged stand including a considerable proportion of old growth and showing no evidence of heavy pasturing might, with some justification, be considered a reasonable approximation of the primary condition. In any event such a stand should be expected to diverge from that condition in far less degree than one totally lacking old growth elements and showing a tendency toward even-aged second growth. Of the stands compared and contrasted in Table XIII, numbers 22 and 28 agree with the former characterization, while numbers 8, 16 and 32 fit the latter. A suggestion of these differences is shown in Fig. 36.

As previously indicated (Table XIII), the differential past treatment appears to be the only effective environmental variable correlated with compositional differences between stands 22 and 16, located on south slopes. The same observation applies likewise to stands 28 and 32, located on north slopes. Accordingly, Table XV was prepared to highlight contrasts in weighted importance value involving the members of these two stand pairs.

The 187 point difference in index position between stands 22 and 16 would seem definitely indicative for severe disturbance, under the conditions extant in these two stands, to be reflected in a more xeric assemblage of dominants. The 20 point difference in the continuum index numbers compiled for stands 28 and 32 appears of too low magnitude to be definitely indicative of an opposed trend under the environmental conditions common to these stands. It does, however, demonstrate that disturbance does not necessarily favor species of more xeric affinities.

The differences in weighted importance values, comprising the body

FIG. 36. View along the line fence between stands 16 and 22 showing older timber at the right and younger growth, including some of coppice origin, at the left.

TABLE XV. Net positive differences in weighted importance values between indicated stand pairs[1] contrasted to illustrate influence of past utilization

Species	Contrasting stand pairs			
	22	vs. 16	28	vs. 32
Acer rubrum	—	17	—	98
Carya ovalis	50	—	—	34
Cornus florida	—	—	—	22
Fraxinus americana	—	—	31	—
Prunus serotina	4	—	18	—
Quercus alba	206	—	262	—
Quercus rubra	60	—	—	215
Quercus velutina	—	126	—	10
Sassafras albidum	—	22	—	—
Tilia americana	—	—	48	—
Ulmus americana	32	—	—	—
Total net positive difference	352	165	359	379
Differential in continuum index number	187		20	

[1]See Table XIII for stand characteristics.

of Table XV, reveal the detailed pattern of changes correlated with both contrasts of differential stand disturbance. These changes are seen to be of a much higher order of magnitude than might be expected from the size of the differentials in continuum index number, especially the 20 point difference between stands 28 and 32. The marked decrease in importance of _Quercus_ _alba_ in the wholly second growth stands is the most conspicuous feature common to both contrasted pairs. _Acer_ _rubrum_ and _Q_. _velutina_ are indicated to be more important in the wholly second growth stands. However, the increase in weighted importance value of _A_. _rubrum_ in stand 16 is seen to be scarcely significant, as is true of that for _Q_. _velutina_ in stand 32.

The great relative increase in importance value of _Q_. _rubra_ in stand 32 together with that of _A_. _rubrum_ in the same stand, and of _Q_. _velutina_ in stand 16, is strongly suggestive of the possibility that slope influence may be augmented by stand disturbance. This suggestion is further supported by the data in Table XIV which show the total net positive differences in weighted importance values between stands 16 and 32 to reach considerably higher values than those between stands 22 and 28. Thus, even though evidence supplied by continuum index numbers does not appear decisive, significant differences in weighted importance values would seem to permit the tentative observation that, in reference to slope influence, second growth stands tend to show greater contrasts in composition than do primary stands.

Some conception of the degree to which stand disturbance may modify continuum index number is provided by stand 8 (Table XIII). Because of the absence of effective slope influence stand 8 is not comparable with any of the other stands of this complex. However, it would seem unlikely that the primary assemblage on this site should have been more xeric than stand 22, located on a south slope. The possibility must be acknowledged that the 305 point difference in continuum index number between stands 22 and 8 may in part be attributable to effective soil variation within the limits of a single type.[12] However, the likelihood of such influence in any important degree would appear small in view of the high importance value of *Quercus rubra* in stand 8.

In a classification based upon the two leading dominants as determined by the importance value index, stand 8, in company with stand 16, would necessarily be regarded as a black oak-red oak type; likewise, stands 31 and 32 would be designated as pignut hickory-red oak (see Fig. 33). Such combinations of leading dominants have previously been interpreted as anomalous and probably indicative of stand disturbance. This interpretation would appear valid in the case of these 4 stands. Numbers 22 and 28, representing the least disturbed members of a complex including these 4 stands, are clearly to be classified as white oak-red oak types on the basis of the two leading dominants (Appendix Tables XXII and XXVIII). The low importance of white oak in stands 16, 31 and 32, and its near absence in stand 8, would thus seem strongly suggestive of differential disturbance which evidently reached peak intensity in stand 8.

Correlation between Measures of Synusial Diversity and Continuum Index Sequence

By permitting establishment of a sequence of stands based upon

[12]Similar to that evidenced by stands 10 and 27, considered previously (see Fig. 35).

variations in the dominant synusia, the continuum concept provides a convenient means for determining the degree to which such variation is reflected in the lesser synusiae. Should correlation of this nature be found to exist, it would add, in proportion to the degree displayed, to the significance of the stand sequence as an expression of a parallel sequence of integrated environmental influences. Accordingly, the measures of total herb and shrub representation obtained in this study have been graphed below in a sequence based on continuum index numbers in an effort to determine the degree to which such correlation exists.

The Herb Synusia

Based on herb data from 10 x 10 m. quadrats, total species records per stand and average species densities, are graphed in Fig. 37. Though both curves are revealed to be extremely erratic, with increasing continuum index number, rising trends in herb representation may be recognized whether measured by species occurrence or by average species density. Yet, unless some valid explanation for the enormous fluctuations between certain adjacent curve points can be offered, such fluctuations must inevitably diminish the significance of the overall rising trends. Accordingly, qualitative data have been surveyed in a search for evidence of anomalous environmental influences which might be correlated with such extremes in herb representation.

With regard to positive deviations from the trend of total species occurrence, the values for stands 10 and 25 are revealed by Fig. 37, A, to be particularly extreme. Both of these stands are located in a single 40-acre tract characterized by many local areas of imperfect surface

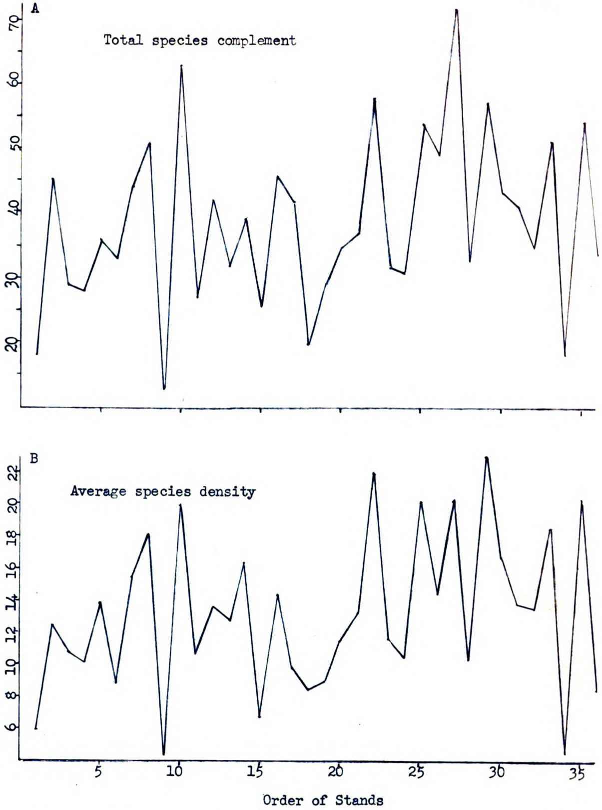

FIG. 37. Relation between two measures of diversity of the herb synusia and continuum index sequence.

drainage. Associated with these areas are a number of herbaceous species of high water requirement[13] which serve to increase the variety and size of the species complements for these two stands. Somewhat less extreme is the species total recorded in stand 22, located on a slope of southern aspect. Evidently correlated with the consequent greater amount of solar radiation reaching the forest floor in this stand is a species increment made up of intolerant herbs such as Desmodium rotundifolium, Lespedeza intermedia, Monarda fistulosa, Gerardia flava, G. pedicularia and G. virginica.

Negative deviations from the trend in size of species complement reach extreme values in stands 9 and 34. In both these stands abnormally dense understory layers result in particularly heavy interception of solar radiation. The second layer in stand 9 is composed primarily of Cornus florida (see Appendix Table IX), and where heaviest is correlated with a virtual absence of herbaceous vegetation (see Figs. 37 and 47). In stand 34, a dense understory of suppressed Acer rubrum, A. saccharum and Fagus grandifolia grades into the closed canopy of old growth Quercus alba and Q. rubra. The result is an intensity of shade comparable to that cast by a full beech-maple canopy. In addition to being thus heavily shaded, the forest floor of this, the only truly primary stand included in the study, is characterized by an extremely thick accumulation of litter and duff, which may further act to restrict mechanically the representation of herbaceous species.

Probably correlated also with decreased solar radiation is the restricted herb complement of stands 24, 28, 31 and 32, located on slopes

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[13]See especially the representation of Carex spp. in Appendix Table LXXVII.

of north aspect (see Table XIII). Although the species totals recorded in these stands are shown in Fig 37, A, to fall well within the normal range of deviation from the general trend, the totals are all low for the scale sector in which they occur and thus tend to depress the slope of the trend.

The general similarity in outline between graphs A and B of Fig. 37 suggests that the average species density of herbs in a given stand, as measured by 10 x 10 m. quadrats, is primarily a function of the number of species of herbs for that stand. Moreover, the approximate equivalence in slope of the two trends suggests further that the relationship is independent of sequence position of the stand. Confirmation of both indications is provided by computation of ratios between total species complement and average species density. Such ratios have a mean of 3.0 ± 0.5 and a range from 2.4 to 4.3, with 26 values clustered within the limits of 2.6 and 3.2. The only deviations in ratio to exceed one standard deviation are all positive, and comprise those for stands 2, 6, 15, 17, 27, 34 and 36.

Inspection of the values charted for these stands in Fig. 37, B, reveals that the low herb frequencies responsible for such high ratios result in improved correlation with the general trend of average species density in the case of stands 2 and 27, and contributes to serious deviation from that trend only in stands 34 and 36. The high ratio (4.0) of total species complement to average species density for stand 34 further attests to the sparseness of herbaceous vegetation in this primary stand. Observational data supply no explanation, however, for the relatively very low herb frequency implied by the peak ratio of 4.3 for stand 36.

Nevertheless, when previously qualified deviations from the related trend of total species complement are taken into account, the trend of average species density would seem to supply even stronger evidence of general correlation with stand sequence than does the former trend. Moreover, the significance of the trend in average species density is further enhanced by provision for the expression of frequency variations, which results in an ecologically more sound measure of herb representation than a trend based on species complement alone.

The Shrub Synusia

Based on shrub records from 10 x 10 m. quadrats, total species per stand, average species density, and the ratio between these two values are charted in continuum index sequence in Fig. 38. Although species complement and average species density of shrubs are indicated by graphs A and B of this figure to be correlated with continuum index number, the trend of such correlation is seen to be counter to that for the corresponding measures of herb representation.

Further comparisons reveal additional significant differences between the two sets of curves. Even though graphed on a larger scale, the values for species complement and average species density of shrubs show considerably less fluctuation than do the corresponding values for herb representation. Doubtless contributing in large measure to such moderation is the much smaller community complement of shrub species. That other influences are involved, however, is strongly suggested by the lack of coincidence, except in stand 34, of peak fluctuations in herb and shrub representation. Moreover, as indicated by the ratios charted in Fig. 38, C, the relationship between species complement and average species density is considerably less precise for shrubs than for herbs.

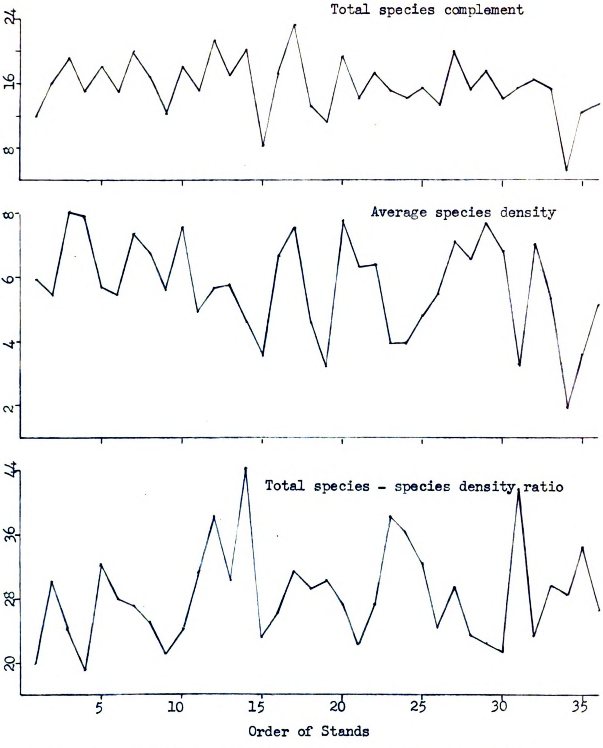

FIG. 38. Relation between three measures of diversity of the shrub synusia and continuum index sequence.

Furthermore, where there was obviously no correlation between stand sequence and such ratios for herb representation, in Fig. 38, C, there is at least a suggestion of a rising trend with increasing continuum index number. As suggested by these ratio differences, Fig. 38, A and B, show fewer points of similarity than do the corresponding graphs of herb representation.

A third measure of shrub representation is provided by density totals obtained from 2 x 2 m. quadrats (Fig. 39). Except for sporadic extreme deviations, the trend of this curve is seen to corroborate those of species complement and average species density in indicating negative correlation between shrub representation and increasing continuum index number. The extreme positive deviations from the trend of total density are attributable in all instances to exceptional clonal development, usually of a single species. Thus, in stands 2, 9, 15, 21 and 36 Parthenocissus quinquefolia makes up the greater portion of the density total; similarly predominant is Viburnum acerifolium in stand 20, and Gaultheria procumbens in stand 30. In stand 27 Rhus radicans and Cornus racemosa together comprise most of the shrub representation.

Far more difficult to interpret are the fluctuations in species complement and average species density of shrubs (Fig. 38, A and B). Except in stand 34 where both shrub and herb representation is markedly restricted, evidently by influences correlated with the primary condition of this stand, the shrub synusia apparently responds to a given integrated set of environmental influences in quite different fashion than the herb synusia. This is evidenced not only in contrary trends of correlation with continuum index sequence, but more particularly in the failure of

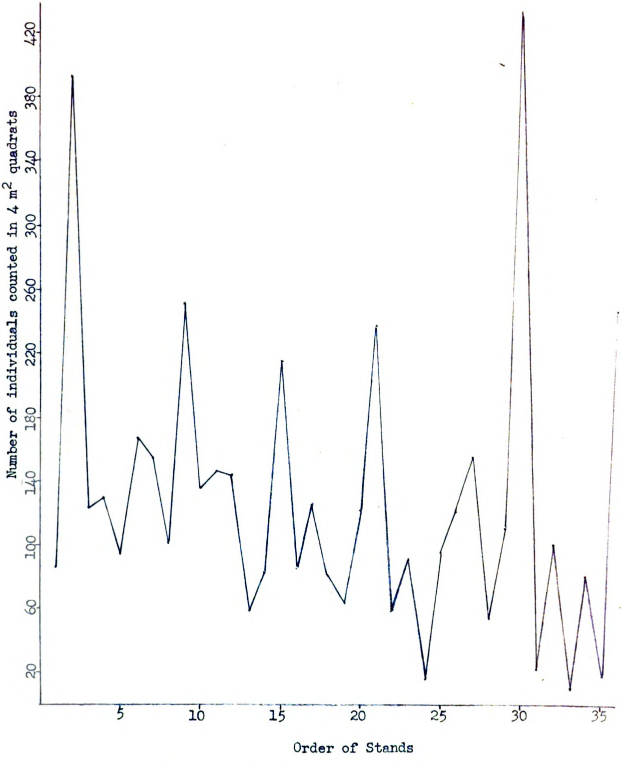

FIG. 39. Relation between total density records for the shrub synusia and continuum index sequence.

conspicuous deviations in representation of one synusia to be clearly reflected in that of the other.

The quantitative and qualitative data obtained in this study provide little more than suggestions as to what influences may be correlated with the more marked fluctuations in shrub species complement and average species density. That the low average species densities for stands 2, 9, and 15 may perhaps reflect the influence of unusually heavy competition, is suggested by the high total density values reached in these stands (see Fig. 39). The failure of the remaining extreme density values to coincide with abnormally low average species densities of course detracts from the credibility of this suggestion; such failure, however, might be found attributable to the more favorable moisture relations[14] prevailing in the other stands where exceptionally high densities occur.

A possible correlation of unusual edaphic influence with the high species total in stand 17 is suggested by the uncommonly large number of calcifugous species[15] recorded in this stand.

Although the collection of quantitative data in this study was restricted to stands which bore no evidence of recent pasturing, allowance in almost all cases should be made for residual influence of pasturing in the more distant past.

That grazing may not only profoundly alter the total mass of the shrub synusia but also effect marked changes in its species complement, was repeatedly demonstrated by property line contrasts encountered during the reconnaissance phase of this study. One of the most frequently

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[14]As implied by higher continuum index numbers.

[15]*Epigaea repens*, *Gaultheria procumbens*, *Gaylussacia baccata*, *Vaccinium angustifolium*, *V. lamarckii*, *V. vacillans*.

observed indications of differential intensity of grazing was a marked increase in the importance of "armed" species, such as Juniperus communis or Xanthoxylum americanum, as well as of unpalatable species, such as Gaylussacia baccata, Gaultheria procumbens or Prunus virginiana, at the expense of most other synusial elements. An extreme example of this phenomenon is illustrated in Fig. 40.

Because the influence of grazing might be expected to persist longer in shrub than in herb representation (see Fig. 41), such influence might at least in part account for the erratic ratios between shrub species complement and average species density (Fig. 38, C).

FIG. 40. View of an oak woodlot pasture showing effects of prolonged overgrazing.

FIG. 41. Depauperate clone of Juniperus communis persisting under closed canopy oaks.

DISCUSSION

The Vegetational Continuum Index as a Basis for Classification

The last three decades have witnessed the conflict of two widely divergent philosophies as to the organizational nature of concrete plant communities. The first holds these groupings to be highly integrated, functional units composed largely of inter-dependent individuals. Distinctive aggregations of such individuals are regarded to be segregated with such regularity and fidelity as to justify the recognition of abstract communities. A voluminous literature in support of, and based on this view, has accumulated. Egler (1951: 682) expresses surprise that so basic a concept as the abstract community should have been the subject of so much emphasis. Perhaps this emphasis reflects not unfamiliarity with classical precepts of inferential reasoning (as Egler suggests) but rather attempts to establish the validity of such reasoning as applied to units of vegetation. Suggestive of such an interpretation are the many and varied analogies identifying the concrete community with the individual plant, and the abstract community with the species (Clements 1916, 1936; Warming 1925; Nichols 1929; Phillips 1934, 1935; Tansley 1935; McDougall 1949).

The second view, embodied in the individualistic concept of Gleason (1926), denies that stand integration exists to a degree which can be determinative of stand composition. Rather, stand components are regarded as determined primarily by environmental selection from such available floristic elements as have compatible tolerance ranges. The concept of the abstract community is held to be untenable because, outside of very restricted areas, a given combination of environmental influences and floristic elements is seldom even approximately duplicated. Even the homogeniety of concrete communities has been considered subject to statistical verification (Curtis and McIntosh 1951: 481).

Proponents of the individualistic concept have long been handicapped by lack of a classification scheme to support and illustrate their conception of vegetational organization. They could effectively challenge the characterization of the concrete community as a complex, or quasi-organism, or as an element of an ecological "species" (Gleason 1926, 1929, 1939; Braun-Blanquet 1932; Mason 1947; Cain 1947; Whittaker 1951, 1953); they could point to biased selection of stands to support the existence of such "species" (Cain 1947; Ashby 1948). They could not, however, effectively counter arguments such as that of Conard (1939; 110) that "there has been nothing in ecological inquiry which has been so fertile and productive of results as the idea of the association. It is therefore so useful that whether logical or not, I am for it." Now, in the vegetational continuum index, an efficient means for orienting, and depicting the individualistic nature of concrete communities of a given physiognomic type, is at last available.

Orientation of compositional data according to continuum index sequence reveals that the bulk of upland forest stands in southern Wisconsin and of oak upland stands in southern Michigan are distinguished not so much by different <u>kinds</u> of dominants as by different <u>proportions</u> of dominants. The explanation of this phenomenon lies in the fact that the dominants of high importance potential have wide tolerance ranges which, while not coinciding, nevertheless broadly overlap. Thus, of the 15 species recognized by Quick (1924) as typical of the beech-maple community in southern Michigan, not less than eight species are frequently found in stands dominated by upland species of oak. Of these, four species attain relatively high importance values in oak upland stands; two are leading dominants of oak uplands. It is obvious, therefore, that recognition of beech-maple or oak upland communities in southern Michigan is justifiable only on pragmatic grounds.

The continuum concept accords significance to dominant stand components in proportion to their representation. However, because of the wide overlap in tolerance ranges of ecologically important tree species, the number of different combinations of weighted importance values which might approximate a given continuum index number appears almost limitless. Accordingly, such a number can provide only a gross indication of the importance of a given species in a given stand. For this reason, continuum index numbers, or even segments of the continuum index scale, must not be regarded as comparable to cover types such as those recognized by the Society of American Foresters (Anonymous 1940) where diagnostic significance is attached to the leading dominants only. Rather, a given continuum index number is an expression of the total dominant vegetation of a given site.

The Vegetational Continuum Index as an Index of Site and a Measure of Tolerance Range

Indirectly the vegetational continuum index may be regarded as an index of site since dominant vegetation is theoretically the best measure of environment. The value of the continuum index as a measure of site is enhanced by the fact that it is based only on positive evidence. As Billings (1952: 263) has pointed out, the absence of species is not a valid basis for site evaluation. This follows because environmental control is only one of many possible reasons for such absence.

If, as is contended here, the vegetational continuum index established for the oak upland community in southern Michigan represents a valid index of environment, as well as of vegetation, certain implications are at once evident. The data charted in continuum index sequence become graphical representations of tolerance ranges of the sort envisioned by Good (1931) in his Theory of Tolerance. Such charts likewise support Billings' (1952: 262) statement that "each species in a vegetation is distributed according to its own environmental tolerances." Charts, included herein, representing tree species show further that the principal dominants are seldom absent from sites indicated by index values to be well within their respective tolerance ranges.

It is more difficult to generalize concerning the charts based on data compiled for species of lesser stature. As a whole, they appear less convincing as graphical representations of tolerance ranges than those based on tree data. A sizeable group of shrub and herb species show no evident correlation with the continuum index sequence established in this study. This might be attributed to a capacity of accessory species to respond to minor environmental variations not reflected by the canopy layer, as Potzger and Friesner (1940a: 168) believe. Such a view does not appear to be tenable in the present case, however, Rather, a reverse relationship is indicated, at least for the more ubiquitous and widely ranging members of this group such as Ribes cynosbati, Parthenocissus quinquefolia, Smilacina racemosa and Geranium maculatum. These species are evidently capable of thriving under a great diversity of edaphic and microclimatic conditions and as such might be considered characteristic species of unistratal communities or unions (Lippmaa 1939). Such evident adaptability would likewise appear to support Cain's (1944: 22) contention that as a rule a species "consists of thousands of biotypes . . . sorted out on a combined habitat-tolerance basis." However, the majority of non-correlated accessory species are of sporadic occurrence. While the frequency and DF_r curves for such species are in consequence scarcely suggestive of a multiplicity of adaptive biotypes, neither are they indicative of narrow tolerance range, since most of them range over the greater portion of the continuum index scale.

It may thus be observed that while the non-correlative species of either ubiquitous or sporadic occurrence do not directly support the continuum concept, neither do they in any way refute it. They emphasize the futility of attempting to recognize discrete types of oak upland on the basis of phytosociological indices such as presence, constance, or fidelity.

A further contention, supported here, is that the absence of a given species from a given stand may be considered attributable to reasons other than environmental control when the index position of that stand lies well within the limits of the frequency and/or DF_r curve for that species. This view permits the majority of accessory species of the oak upland community to be regarded as correlated with continuum index sequence; likewise the frequency and/or DF_r curves of such species may be considered expressions of tolerance range. Such ranges form typically an overlapping gradational sequence similar to that of the tree dominants.

The lower synusiae of a forest community exist in an environment greatly modified by influences attributable primarily to the canopy layer. Therefore, the fact that the tolerance ranges of most of the components of the lower synusiae should occur in a sequence paralleling that of the tree dominants constitutes support from a different quarter for Kittredge's (1948) repeatedly emphasized view that site, overstory-composition, and forest influences are strongly interrelated. Such a parallel, of course, supplies further evidence of the validity and value of the continuum concept. It likewise reaffirms the utility of accessory species as indicators of physical environment, though there appears no reason to suppose they are in any way superior to the tree dominants in this regard. On the contrary, the most widespread and abundant accessory species are evidently of no value as indicators. Moreover, many species correlated with index sequence are of limited utility because of their restricted occurrence.

The Concept of Climax Adaptation Number

Perhaps the most controversial assumption involved in the continuum concept is that all the adaptive functions which collectively determine the relative degree of "climaxness" of a given species may be expressed by a single number. The climax adaptation number of a species reflects the relative position of its sector of optimum development in a subjectively determined order of stands. Such a sector does not necessarily reflect optimum physical environment for the species concerned. In the case of a leading dominant it could, and probably more often does, represent a range more or less removed from the sector of optimum physical environment by the influence of competition from other leading dominants. In consequence, the sector of optimum development for some species is located near one end of the tolerance range. In view of the biotypic and ecotypic richness of species in general, it would seem scarcely credible that the whole population of such species could be represented by a single climax adaptation number.

Camp (1950) has indicated that the wide distribution of Fagus grandifolia and Acer saccharum is not a reflection of uniform climate, but rather is a manifestation of the great ecotypic diversity of these two species. Each of the three ecotypes of F. grandifolia recognized by Camp appear so distinctive in their ecological requirements as to merit a separate climax adaptation number. Note has previously been made of apparent ecotypic variants of Carya ovata and Quercus macrocarpa in southern Michigan. Similar habitat forms of these species evidently occur in Indiana (Deam 1940), while in neighboring Ontario only the moist site variants are found (Anonymous 1949). The strong correlation between site and type of root system developed by Acer rubrum has been emphasized by Toumey (1929) and Kramer (1949). Such adaptation doubtless contributes to the unusually wide tolerance range of this species, one of two species which occurs in all the forest types recognized by Sampson (1930: 362) for northeastern Ohio. The capacity of red maple to develop well over a wide range of light intensities (Billings 1938) further complicates the task of designating a climax adaptation number for this species. A suggestion of two trends with considerably displaced maxima has been noted previously in the curve of significance value for Cornus florida. The possibility must be considered that these are indicative of the existence of two biotypes having differential potentialities for vegetative reproduction. The interruptions in the curves of importance value for _Fagus grandifolia_ and _Liriodendron tulipifera_ are of obscure significance. Camp (1950) has indicated that the population of beech north of the glacial boundary is genetically highly complex, a condition not conducive to the isolation of beech ecotypes noted elsewhere. Tulip poplar in the oak upland community is apparently at the xeric edge of its tolerance range (Sampson 1930) and could therefore be expected to occur sporadically. Moreover, as previously noted, its absence in some stands may be attributable directly to the selective cutting which occurred on an extensive scale in pioneer days. Nevertheless, the possibility that the curves for these two species may reflect ecotypic isolation remains.

From the above examples it is obvious that if climax adaptation numbers are to have maximum significance, studies directed toward determination of the physiological and morphological characteristics of ecotypes and ecads must be made for each species. Camp's (1950) analysis of the american beech could well serve as a pattern for such studies.

Successional Status of the Oak Upland Community

Data and observations bearing on the successional status of the oak upland community in southern Michigan have been presented in previous sections of this report. It is the purpose of the present section to integrate and complement these data and observations with pertinent information from other sources.

As Curtis and McIntosh (1951) have said, the word "climax" has a plethora of meanings. This ambiguity, together with interpretational difficulties of other nature, has prompted some workers to abandon the term and sometimes even the concept. Such a negative approach, however, seems scarcely justified. Certainly succession is not a universal process; wherever it has culminated in a vegetation in essential equilibrium with the other components of the ecosystem, a descriptive term to designate that condition of near-stability is meaningful and necessary. No term seems more appropriate than climax to denote such a condition. An obvious need exists, however, to isolate the term and the concept from deductive theory of the sort which Egler (1951) has referred to variously as speculative philosophy, ecological dogma, and one-factor ecology. Accordingly, an attempt has been made below to assemble a background of pertinent data by which the oak upland community in southern Michigan may serve as a measure of the objective reality of the various climax hypotheses currently used in interpreting vegetation.

The Oak Upland Community as a Test of Climax Hypotheses

Braun (1950), a proponent of the monoclimax hypothesis, indicates almost all of southern Michigan to lie within the boundaries of the beech-maple climax. This is to be interpreted as indicating that on well-drained, but moisture-retentive soils of intermediate texture and mixed mineralogic composition the primary forest is usually of the beech-maple type. As Cain (1941: 193) has so aptly said, the climatic climax is indeed "merely the edaphic climax of non-extreme sites." Implicit in the monoclimax hypothesis, however, is the added proposition that the natural vegetation of all other sites in southern Michigan represent successional stages trending toward the beech-maple type. According to this assumption, the oak upland community represents the subclimax stage of the xerosere. The question naturally follows: through the action of what influence or influences is the oak upland community in southern Michigan supposedly destined to be replaced by a beech-maple climax? Granting stability of climate and tolerance ranges of the dominants concerned (as the monoclimax hypothesis requires) plant reactions might conceivably effect such a change. Within what interval of time might one reasonably expect the potentialities of plant reactions to be fully expressed? Major (1951: 398) believes that successions of the type attributable to plant reactions are capable of stabilizing "most vegetation in less than 1000 years." In a study of succession initiated on abandoned upland fields in North Carolina, Billings (1938) found that reproduction of climax hardwood species was well established in little more than a century and in position to replace members of the pioneer overstory whenever a natural opening should occur. Moreover, correlated observations of soil profile development revealed that in as little as 30 years all evidence of a plow layer had disappeared, a typical forest floor had accumulated and a humus-rich A_1 horizon had developed to a thickness of three inches. Concerning the recent intrusion of forests in the Ozarks, Beilman and Brenner (1951a: 261) write: "This time-elapse study of only 12 years revealed a speeding succession of plant species not at all approaching the accepted trial-and-error elimination which is supposed to set the pattern for our forest areas." Of course, a primary succession nearing the point of approximate stability must be expected to progress at a slower rate. Nevertheless, if the potentiality of a given oak upland site could be raised through plant reaction to a level such that it could support a beech-maple type, there is no reason to believe that such change in potentiality would require the cumulative reactions of repeated generations of oak upland dominants.

Dominants of the oak upland type do not produce reactions directly inimical to repeated occupancy of a site by others of their kind (Braun 1947: 216). Accordingly, the only influences conducive to possible invasion by beech-maple elements would appear to be those which tend to better the physical, biological, and chemical condition of the soil. Such amelioration is effected primarily through the medium of the forest floor. The amount of forest floor under hardwoods does not increase indefinitely (Kittredge 1948; Ovington 1953). Kittredge (1948: 171, 174) indicates that in a given stand a balance between accumulation and decomposition may occur at about the time of culmination of growth. After that period the amount of forest floor may actually decrease. The forest floor serves as the principal source of the humus which becomes incorporated in the upper mineral soil. It would seem, therefore, that any tendency toward stabilization of the forest floor would be reflected in a tendency toward equilibrium in the A horizon between melanization on the one hand, and eluviation and decomposition of organic matter on the other. This contention would seem borne out by the fact that in upland forest sites in southern Michigan the melanized A_1 horizon very rarely ever attains a thickness of more than two or three inches (Veatch, et al. 1941: 36). Thus, the view of Quick (1924) that the beech-maple association is "capable of occupying all the soils of the [state in time] . . . [because] . . . the water retaining qualities of the soil may be increased or decreased by the addition of humus . . ." would seem to lack a factual basis.

Concerning chemical influences of the forest floor, it may be said in general that, except for potassium, the leaf litter from oak upland dominants return relatively low amounts of the major plant nutrients to the soil (McHargue and Roy 1932; Alway, Kittredge and Methley 1933; Alway, Maki and Methley 1934; Coile 1937; Broadfoot and Pierre 1939; Chandler 1941; Kittredge 1948). It follows, therefore, that occupancy of a site by such dominants, no matter how long, could hardly be expected to increase soil fertility to the level required by beech and sugar maple. On the contrary, the findings of Gorham (1953: 148) would seem to indicate that plant "pumping" and flushing from above does not even keep pace with the acid production and leaching promoted by litter from oaks. Admittedly, however, certain understory species, notably Cornus florida and Ostrya virginiana, tend to produce litter rich in minerals (McHargue and Roy 1932; Broadfoot and Pierre 1939; Kittredge 1948). Yet, the yield of litter derived from such species must be small compared to that of the overstory species. As Billings (1952: 261) has said, cumulative influences are attributable in the main to the principal dominants. Furthermore, Kittredge (1948: 176) emphasizes that species yielding litter high in calcium, nitrogen, and phosphorus "are those which are associated naturally with fertile soils usually well supplied with calcium." It would seem necessary, therefore, to regard such species as tending to maintain fertility rather than to build it.

The above considerations, viewed in the light of the pollen record for southern Michigan (see section on postglacial history), clearly indicate that the past has provided more than an ample test of the capacity of plant reactions to effect succession from oak upland to beech-maple forest. The fact that in southern Michigan oak uplands remain today the most widespread forest type, and beech-maple the least (Gysel and Arend

1953), supports the contention held here that such capacity is in general lacking.

A second possible means by which the theoretical monoclimax in southern Michigan might be attained is through the cumulative effects of weathering and podsolization on oak upland sites. Lutz and Chandler (1946: 85) state that soils developed on Wisconsin till are frequently immature. However, there is no reason to believe that soils supporting oak upland forest are further from that theoretical condition of near stability than are those of beech-maple sites. On the contrary, in view of the prevailingly greater perviousness of oak upland soils and resulting greater leaching, the reverse should be true. Such a contention is supported by the findings of Gorham (1953). Nevertheless, the processes of weathering and podsolization continue, and according to Wilde (1946: 63), both tend to increase water holding capacity. That the influence of podsolization in this regard may be less than generally supposed, however, is suggested by chemical analyses of Michigan soils which indicate that most of the clay in the water-retentive B-horizon is either inherited from the parent material or is the result of weathering in place (Veatch 1953: 27). Moreover, even weathering has failed to produce any semblance of a clay horizon in certain widespread soils of the region. These include the Coloma and Plainfield types formed from highly siliceous parent materials. It seems inconceivable that any process short of removal of the present surface through geological erosion could raise the potentialities of the areas on which these soils are developed to the beech-maple level.

Furthermore, even geological base-leveling does not necessarily produce vegetational uniformity. Cain (1947: 193) emphasizes that "even on a peneplain there are site differences and corresponding vegetational differences." Thus, even within the dimension of geologic time there is no reason to suppose that the influence of climate will be expressed over all the local habitats of the region in the form of a single vegetational type. Moreover, the monoclimax hypothesis ignores the simple truth that climate is clearly the least stable of all the major environmental variables. Veatch (1938) has noted the occurrence in southern Michigan of relic podzol soils dating back at least to the pine period, as well as relic hydromorphic soils antedating the thermal maximum. Leverett (1909), in considering the effectiveness of geological erosion and stream dissection on Cary drift, estimated that "scarcely one-tenth of the surface has been reduced below the original level as a result of drainage." In contrast to these indications of edaphic and topographic stability, Sears (1948: 331) has listed a total of six general climatic shifts since recession of the Mankato substage of Wisconsin glaciation. Surely Cain (1947: 193) is justified in his belief that "the monoclimax hypothesis has been not so much an ecological touchstone as a millstone."

If the monoclimax is untenable, what of the one-factor climaxes recognized by the polyclimax school? The lack of any great physiographic contrast in southern Michigan precludes any possibility of the differentiation of physiographic climaxes in this part of the state. Here, local relief features, insofar as they influence soil moisture, are far more important than physiography as a determinant of natural vegetation.

In general, the oak upland type in southern Michigan is developed on more pervious and less fertile soils than those supporting beech-maple. Yet, certain soils, such as the Miami and Hillsdale series, are pivotal in that they may support either oak upland or beech-maple types. Moreover, the lee slopes of sand dunes along Lake Michigan support vigorous sugar maple-basswood stands (Cowles 1899). Whether or not such phenomena are attributable even primarily to physical or chemical influences of the soil has not as yet been established. Thus, any reference to the oak upland type as an edaphic climax must be made with reservations.

The role of fire in maintaining the oak upland type in southern Michigan is obscure. Lanman (1839), Hubbard (1887) and Beal (1904) speak casually of the occurrence of early fires as though they were established facts and without need of confirmation. The first two authors imply that they were annual events during the period of Indian occupancy and had the effect of keeping underbrush in check in the oak openings. Lanman (1837: 324) states:

> Each kind of opening is subject to what are called grubs. These are formed by the fires which annually run through the woods, and burn the tops of the vegetation, leaving a root sometimes three feet square, and is firmly imbedded in the soil. Six yoke of cattle are frequently required to tear up these grubs, which is done by the plough.

Certain inferential evidence still extant provides additional support for the belief that recurring fires may have been at least locally effective in modifying forest composition and structure (see Fig. 42 and further in the next section).

On the other hand, the land survey notes for Ingham County, compiled during the period of Indian occupancy in the years 1825 to 1827, include frequent reference to dense underbrush in the oak upland areas and make no reference to fires. Moreover, the occasional occurrence of witness trees of such fire-sensitive species as *Prunus serotina*, *Ostrya virginiana*, and *Acer rubrum* in the oak upland areas suggest further that

FIG. 42. Old growth white oak with enormous lower branches forming a wide-spreading crown. This tree, 52 in. at d.b.h. and probably more than 300 years old, evidently reached maturity before the present closed canopy developed. (Photo by the author.)

fires were not important in determining forest composition in this particular county. It seems necessary to conclude, therefore, that the influence of recurring fire was not universally manifested in the oak uplands, but rather was probably confined mainly to the more xeric areas as determined by topography and soil. The intervening areas, by serving as barriers to fire, doubtless tended to prevent regional conflagrations of the sort which evidently occurred regularly in the prairie-forest border to the west (Marks 1942; Cottam 1949; Braun 1950; Beilmann and Brenner 1951a). It is evident, therefore, that no general reference to the oak upland type in southern Michigan as a fire climax is permissible.

From the discussion above, the general conclusion follows that the oak upland community is not subject to interpretation as a single-factor climax of any type. To attempt such interpretation would reflect disregard for the basic truth expressed by Billings (1952: 263) that "vegetation is an indicator of the whole environment and not just of climate, or parent material, or fire, or any other single factor."

Comprehending this fundamental truth, while at the same time providing for the "local relation of community gradients to environmental gradients," as well as recognizing the relativity of the concepts of succession and climax, the climax pattern hypothesis recently advanced by Whittaker (1953) would seem to fit best the facts as revealed by this study. Moreover, it has the necessary conceptual breadth to relate the oak upland continuum to other elements of the vegetational mosaic both in time and space. It has therefore been adopted as the working hypothesis for interpreting the inferential evidence assembled in the course of this study.

Past and Present Reproduction Trends in the Oak Upland Community

Rejection of the monoclimax hypothesis in favor of the climax pattern hypothesis permits consideration of the possibility that the oak upland continuum may represent climax vegetation for the range of sites on which it is developed. The fact that oak upland forest is today the most widespread forest type in southern Michigan, together with evidence that this ranking has been maintained continuously since the close of the pine period, clearly attests to the capacity of this type to maintain itself indefinitely. It would thus seem to satisfy the qualifications of a climax. Yet, the results of this study as well as those of others (Wood 1930; Young and Scholz 1949; Arend, et al. 1950; Gysel and Arend 1953) indicate that reproduction of the principal dominants is in general strikingly low compared to that of the accessory dominants and understory trees. Nevertheless, in the light of the obvious success of the oak upland type in persisting up to the present time, it would seem exceedingly presumptuous to infer from these results any marked decline in the capacity of oak upland forest to maintain itself on present sites. On the other hand, any serious attempt to support the contention that reproduction of the leading oak upland species is adequate to ensure continuation of the present level of dominance of these species can readily degenerate to special pleading. It is evident, therefore, that inferences concerning future composition based on present reproduction trends are subject to severe limitations. There is no intent here to disparage inferential reasoning as such. The point is that to be really effective as an ecological tool it must be used against a background of ecological fundamentals of the type outlined by Pelton (1951). As yet, little autecological information of this sort is available concerning the components of the oak upland community in southern Michigan. Without it, only tentative conclusions may be reached.

In part, the dearth of oak reproduction may be attributed to relatively low seed production compared with that of other trees (Korstian 1927: 105). In more important part, it is due to extremely heavy utilization of acorns by insects, rodents, and birds. Insect infestation is a prime source of acorn destruction in southern Michigan (Allen 1943; Gysel 1953). Gysel's data, obtained from two Clinton County woodlots, show the following incidence of damaged acorns: white oak 84 percent, black oak 62 percent, red oak 43 percent. Of the damaged acorns, 81, 78, and 67 percent, respectively, were insect infested. To the toll of insects must be added the consumption of viable seeds by rodents and birds. Experiments conducted in a Washtenaw County woodlot by Cahalane (1942) indicate that by spring, squirrels may recover as much as 99 percent of the nuts buried the previous fall. Evidently only a small proportion of acorns survive to produce seedlings.

Yet, the results of this study, though based on too short a period of observation to be really conclusive, suggest that oak reproduction is limited not so much by small yield, or great destruction of acorns as by failure of most seedlings to survive beyond the class 1 stage. Actually, class 1 seedlings of the three leading species of oak compare favorably in number with those of other species (see Appendix Tables XXXVIII to LXXIV). Under especially favorable circumstances, seedlings of this class may even be abundant (see Fig. 43). In size classes 2 and 3, however, there is a progressive and marked decrease in oak reproduction relative to that

FIG. 43. Seedlings of Quercus rubra developed from acorns concentrated by gravity on the floor of a moist ravine.

of other species. The latter class which, theoretically at least, should be most likely to presage future stand composition, includes far less oak reproduction than any other class. There is also a marked tendency for oak reproduction of classes 2 and 3 to be of low vigor. Indeed, much of the class 2 reproduction of _Quercus alba_ represents seedling sprouts, including some of the second or even third order (see Fig. 44).

The decline in number and vigor of oak seedlings in the more advanced reproduction classes is not a universal phenomenon. In larger clearings within stands, or in abandoned fields bordering oak upland stands, reproduction of all three size classes is usually ample and vigorous (see Figs. 45 and 46). White and, especially, black oak is able to invade such areas even in the absence of litter which Korstian (1927) holds to be so important for survival of oak seedlings (see Fig. 46). The conclusion would seem to follow that oak reproduction in general has a low survival capacity under the conditions of low light intensity and strong root competition prevailing under closed canopies. The fact that so many class 1 seedlings of oak are to be found would appear to be explained by Baker's (1950: 140) observation that seedlings derived from large trees are comparatively tolerant for the first few years because of the initial advantage of a large food reserve.

Such a conclusion raises the question of how closed canopy dominance by upland oaks is attained and maintained. There is ample evidence to support the view that the canopy of the primary oak forests in southern Michigan was, in general, of more open character than that of present secondary stands. Such evidence is to be found in historical accounts (see Literature Review), in the original land survey notes, and in the

FIG. 44. Sprouts developed at the crown of a class 2 individual of _Quercus alba_ which evidently died back in consequence of inability to compete under closed canopy conditions.

FIG. 45. Reproduction of _Quercus velutina_ under a seed tree growing in a clearing. (Photo by author.)

FIG. 46. Reproduction of *Quercus velutina* established on bare mineral soil in an abandoned field adjoining a black oak stand.

general observation that with advancing age a canopy intercepts less solar radiation (Shirley 1943, Kittredge 1948). Acorn production under such conditions must have been far heavier than now, since trees having ample crown space fruit much more regularly and far more abundantly than those growing in close stands (Toumey and Korstian 1937; Baker 1950). Beilmann and Brenner (1951a: 273) report that even in woodland rated as "understocked" many oaks have produced no fruit in ten years, while isolated individuals may bear heavy crops in alternate years. It seems very likely, however, that then (as now) production and utilization of fruit were in close balance. Well-documented reports of enormous squirrel populations in pioneer days (Allen 1943) suggest that, even when the great reduction in forest area is taken into account, squirrel pressure on the acorn supply was no less in presettlement times than at present. Any advantage to oak reproduction through more open growth would seem to be restricted, therefore, to better survival conditions for seedlings. Conditions for survival of reproduction in the oak openings were evidently far from optimum in the light of the accounts (Lanman 1839; Hubbard 1888) indicating that these areas were swept by periodic fires which kept down the undergrowth and favored formation of sod. On the other hand, the relatively sparse crowns of old growth oak canopies may have admitted sufficient light for effective development of dispersed oak reproduction. That decreased interception of solar radiation with advancing age of stand may effectively influence reproduction of some species, at least, is indicated by Shirley (1943: 341), who speaks of the vigorous growth of reproduction possible in aspen and pine forests "after they have passed their prime and begun to open up naturally." Kittredge (1948: 51) indicates that the maximum interception of solar radiation in well stocked stands coincides approximately with the culmination of annual increment and thereafter decreases. The greatest annual increment for most species occurs within 60 years after establishment (ibid: 32).

While, in general, the stands included in this study are older than 60 years, the overstories remain relatively dense, and especially where associated with well developed understories of Cornus florida and Ostrya virginiana, the amount of intercepted radiation is great (see Fig. 47). In these second growth stands occasional evidence of sprout regeneration of canopy individuals is to be observed (see Fig. 48). However, the great bulk of the dominant individuals seem to be of seedling origin. This fact suggests that such individuals represent elements of the first regeneration following removal of the old growth, since recutting of second growth could be expected to result in a preponderance of sprout reproduction (Westveld 1939). The added fact that in a given stand so many of these individuals appear even-aged suggests further that reproduction of oaks was well distributed and established at the time of the original timber harvest. Such reproduction need not necessarily have been of high vigor. Beal (1888: 76) has called attention to the extreme tenacity of seedling sprouts of black and white oak, and Baker (1950: 6) has stated that such sprouts may develop into trees comparable in stature to those originating directly from seeds.

As Gysel and Arend (1953: 14) have suggested, heavy cutting could be expected to result in compositional differences between old and second growth stands on a given site. The net effect of such cutting would seem most likely to be reflected in a lowering of the continuum index number for the site, owing to the initial advantage provided less tolerant species.

FIG. 47. Heavy shade cast by a second canopy of mature <u>Cornus florida</u>. Where such a canopy layer is developed under an overstory of oaks, herb and shrub representation is scanty or absent altogether.

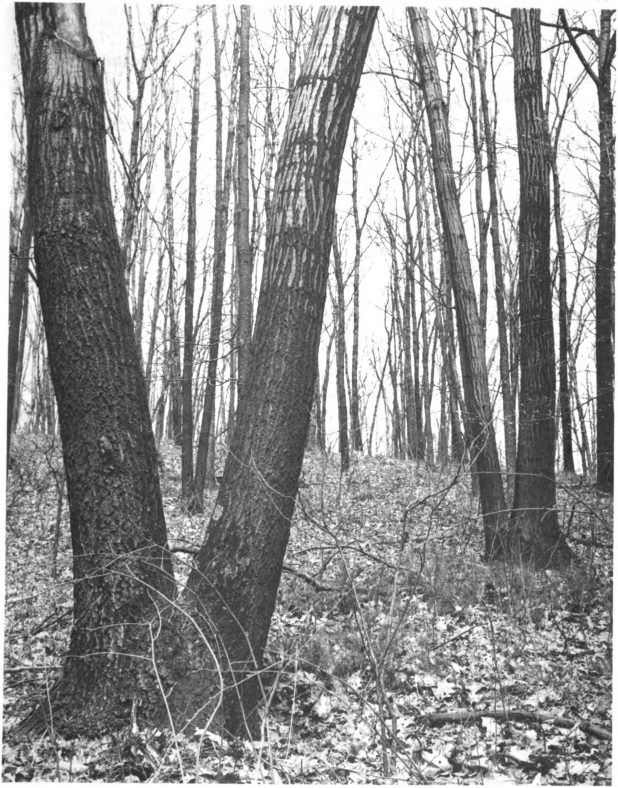

FIG. 48. Trees of obvious sprout origin as indicated by multiple bole development.

Evidence in support of this contention is to be found in Table XV, where the proportion of black oak in an entirely second growth stand is seen to be considerably greater than in an adjacent stand containing considerable old growth.

It must not be inferred, however, that black oak was an uncommon tree in old-growth oak uplands. A check of the records of the original land survey for Ingham County reveals that, in the oak upland areas in the southern part of the county, black oak was second in importance to white oak. Significantly, however, in almost all cases where all witness trees for a corner were black oaks, the distance from stake to trees were considerably greater than at those corners where white or red oaks served as witness trees. Many of the distances from corner stakes to black oak-witness trees exceeded two chains (132 ft.). It seems obvious, therefore, that the density of black oaks in present stands is much greater than it was in old growth stands. The resulting greater interception of radiation in such second growth stands doubtless accounts for the almost complete failure of the reproduction of this species to attain class 3 size in well-stocked sites.

Advanced reproduction of certain accessory dominants of the oak upland continuum tends to be as conspicuous by its abundance as that of the oaks is by its scarcity. In the majority of stands *Carya ovalis*, *Acer rubrum*, *Prunus serotina*, and *Fraxinus americana* collectively comprise the bulk of such reproduction. All four of these species are capable of developing deep and extensive root systems in the characteristically pervious soils supporting the oak upland type (Van Dersal 1938; Harlow and Harrar 1950). Supposedly, therefore, they should be able to compete effectively with the dominant oaks for nutrients and water. Yet, the results of this study reveal the importance potentials of these species to be decidedly low compared to those of the oaks (see Table VI). Data provided by Curtis and McIntosh (1951: Table 1) indicate that these species are also to be regarded as minor dominants in the upland forests of southern Wisconsin.

The failure of Prunus serotina and Fraxinus americana to attain high importance values despite abundant reproduction of all three size classes may be attributed to inability of these species to withstand suppression, except when young (Harlow and Harrar 1950; Gunther 1950). Individuals of these species which had attained class 3 and even class 4, size before dying were repeatedly encountered in the course of this study.

The low importance potentials of Carya ovalis and Acer rubrum cannot be explained so simply. Both species are frequently well represented by vigorous individuals of size class 4. Evidence of this sort, as Billings (1938) has pointed out, seems strongly suggestive of high survival capacity leading to greater importance in the future. Evidence concerning the status of pignut hickory and red maple in the primary forests of southern Michigan is inconclusive. Witness trees of these species were recorded only sporadically in the original land survey of Ingham County. On the other hand, Beal (1904) described a virgin oak woods in this county in which red maples up to 24 inches in diameter formed a conspicuous element. The possibility must be considered, therefore, that red maple, at least, may be in the process of returning to a former level of importance in the oak upland continuum. Although Steyermark (1940) has described a white oak-red maple association for the Ozarks, it is doubtful, however, whether red maple will ever merit recognition as a major upland dominant in southern Michigan. Otis (1931) describes this species as a tree not exceeding 50 feet on upland sites in Michigan. This limit is well below the upper canopy formed by its upland associates. It would seem more logical, therefore, to regard it as a secondary tree component of the oak upland type, a view previously expressed by Cain (1936), Billings (1938), and Oosting (1942).

To the uncertainties involved in inferential evidence attributable to lack of information concerning the ultimate fate of trangressives must be added those arising out of the relativity of the concepts of succession and climax. Cowles (1901: 81) has referred to succession leading toward a climax as "a variable approaching another variable." This comparison highlights with particular clarity the difficulty experienced in attempting to interpret a given inferential trend of reproduction as evidence of succession or simply as "fluctuation about an average" that represents the climax condition (Whittaker 1953: 61). The opinion is expressed here that for the most part reproduction trends for tree components of the oak upland continuum are best interpreted as of the latter type. With few exceptions they appear to involve conserving or consolidating species in the sense of Braun-Blanquet (1932: 316). This would appear true of the trends for Carya ovalis and Acer rubrum considered above. Similarly the xeric maximum in the curve of significance value for Quercus alba (see Fig. 7) probably merely reflects a trend toward the compositional pattern which presumably prevailed in the primary stands on sites that now support stands largely dominated by Q. velutina.

Definite evidence of succession involving dominants potentially destructive of present compositional patterns was obtained in a few instances, however. The most striking examples are provided by the class 3 and 4 representation of Acer saccharum and Fagus grandifolia in stands 30, 34 and 36. All three stands are developed on soils which most frequently support the beech-maple type. Since stands 30 and 36 are secondary, the possibility may logically be considered, therefore, that present reproduction trends may, in these two instances, merely reflect secondary succession toward the type which prevailed before timber removal. Stand 34, however, was in essentially primary condition at the time quadrat data were obtained. It has since been cut over and whether or not beech and sugar maple would have assumed dominance in the course of natural events will, of course, never be known. The evidence, however, particularly the suppressed but vigorous understory of sugar maple, strongly supports the view held here that such a change would have ultimately occurred. Braun (1950: 319) has interpreted a strikingly similar canopy condition in oak-dominated parts of the Russ Forest in Cass County as evidence of succession toward beech-maple. Like stand 34, the oak-dominated portion of the Russ tract has been little disturbed by cutting and is developed on soils typically associated with beech-maple cover. That both sites concerned have the capacity to support beech-maple as dominants would seem adequately established by the vigorous understory of these species which seem in position to assume dominance whenever a canopy opening should occur. The most puzzling aspect of these stands, therefore, is not that they should be trending so strongly toward beech-maple at present, but rather that dominance by these species should have been deferred so long. The action of some retarding factor or factors seems indicated. The occurrence of fire-scarred, old growth individuals of *Liriodendron tulipifera* within stand 34 and in a tract adjacent to the Russ Forest suggests the hypothesis that fire may have been instrumental in retarding the development of beech-maple on these sites. Support for this hypothesis is provided by Beal (1904), who attributed the evidently similar invasion by sugar maple of an oak woods in Ingham County to cessation of fires.

In summation, the inferential evidence considered in this study suggests that reproduction trends in the oak upland continuum prevailingly reflect the sort of variation around an average associated with the climax state. In those few instances where definite evidence of succession exists, the forces involved seem to be traceable to the activities of man and to have been set in motion by events of the recent past.

SUMMARY AND CONCLUSIONS

1. Examples of oak upland forests in 17 counties of southern Michigan were studied by the quadrat method of sampling. Data on tree, shrub and herb representation were obtained from nested quadrats located in 36 stands.

2. Importance values were computed for each tree species in each stand. These values were weighted by climax adaptation numbers to yield continuum index values ranging from 751 to 1999.

3. Data representing tree, shrub and herb composition of each stand were charted in a sequence determined by continuum index numbers. The resulting curves were regarded as graphical expressions of tolerance ranges for the species concerned. No tendency for such ranges to occur in patterns suggesting discrete combinations of species was observed in any habit category.

4. The charts based on tree data reveal that stands of the oak upland community in southern Michigan form a continuous cline differing, even at the extremes, less by kind of dominants than by proportions of dominants. This was regarded as a result of the broad overlapping of tolerance ranges of most tree species.

5. Trends in representation of the majority of shrub and herb species show definite correlation with continuum index sequence if indicator significance is accorded only to the presence of species in

a given site. Among those species which show no evident correlation with continuum index sequence are certain of the more ubiquitous species, as well as those of too sporadic occurrence to yield conclusive trends. Such species are held to be of no utility as indicators of site.

6. A gross correlation was observed between continuum index sequence and the number and frequency of species in both the shrub and herb synusiae. Within the limits of the continuum index scale established for the oak upland community in southern Michigan, the number and frequency of components of the herb synusia varies directly with continuum index sequence; an inverse relationship is indicated for the shrub synusia.

7. The leading pairs and trios of dominants in each stand were correlated with continuum index sequence in order to determine the validity of each as bases for empirical classification of oak upland stands. For this purpose two leading dominants are held to be superior to three because of the fewer number of unduplicated combinations and the narrower overlapping in scale position of the stand groupings characterized by the same leading dominants. The scale sector between index values of 1350 and 1400 was tentatively recognized as a boundary separating stands having black oak as one of the two leading dominants from those in which red oak has a similar position.

8. The influence of certain environmental variables on continuum index number has been noted as follows:

a. In those few instances where other environmental influences could be judged to be constant or to vary ineffectively, stands developed on slopes of southern aspect had significantly lower continuum index numbers than those developed on slopes of northern exposure.

b. Under similar conditions of 1-factor variation, and except on north slopes, severe disturbance was likewise reflected by a significant lowering in continuum index numbers.

c. Despite effective variation of other environmental influences, a general correlation between continuum index number and soil texture was noted. Such gross correlation permitted the designation of index position 1,500 as an approximate boundary, in terms of vegetational response, between sands and sandy loams on the one hand and loams and silt loams on the other.

9. The results of this study were supplemented and complemented with data from other sources in an effort to test the validity of the various climax hypotheses as applied to the oak upland continuum in southern Michigan. The climax-pattern hypothesis of Whittaker was found to agree most closely with observable facts as opposed to speculative theory.

10. Few reproduction trends indicative of important changes in stand composition are evident from the results of this study. Such as occur seem attributable to events of the recent past and not to developmental trends produced by plant reactions.

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APPENDIX

TABLE I. Summary of tree data based on ten 100 m^2 quadrats from stand 1, St. Joseph County, Lockport Twp., T. 6 S., R. 11 W., NW $\frac{1}{4}$ section 11.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	10	7	1.5	—	—	—	—	—	—	—	—	—	10	7	1.1	—	—
Carya ovalis	80	28	5.9	40	6	8.6	30	4	21.1	10	1	1.8	80	39	6.3	1.7	2.1
Castanea dentata	30	4	0.8	10	2	2.9	—	—	—	—	—	—	40	6	1.0	—	—
Cornus florida	100	208	43.6	90	32	45.7	20	2	10.5	—	—	—	100	242	39.0	0.8	1.0
Crataegus sp.	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Juglans nigra	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Prunus serotina	100	151	31.7	30	8	11.4	—	—	—	—	—	—	100	159	25.6	0.1	0.1
Quercus alba	90	50	10.5	80	13	18.6	20	3	15.8	10	1	1.8	100	67	10.8	1.6	2.0
Quercus rubra	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Quercus velutina	10	1	0.2	—	—	—	30	4	21.1	100	53	96.4	100	58	9.3	74.8	93.4
Sassafras albidum	80	25	5.2	40	8	11.4	40	6	31.5	—	—	—	80	39	6.3	1.1	1.4
Ulmus americana	—	—	—	10	1	1.4	—	—	—	—	—	—	10	1	0.2	—	—
TOTALS		477	69.8		70	11.3		19	3.1		55	8.8		621		79.7	

TABLE II. Summary of tree data based on ten 100 m^2 quadrats from stand 2, Cass County, Howard Twp., T. 7 S., R. 16 W., NW ¼ NE ¼ section 11.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	90	155	19.7	—	—	—	—	—	—	—	—	—	90	155	17.5	—	—
Amelanchier sp.	30	6	0.8	10	1	12.5	—	—	—	—	—	—	30	7	0.8	—	—
Carya ovalis	70	18	2.3	—	—	—	50	5	15.6	10	1	1.7	80	24	2.7	1.8	1.8
Cornus florida	10	2	0.3	—	—	—	—	—	—	—	—	—	10	2	0.2	—	—
Prunus serotina	90	50	6.3	30	4	50.0	100	24	75.1	60	7	12.1	100	85	9.6	12.3	12.6
Quercus alba	80	54	6.8	10	2	25.0	10	1	3.1	10	1	1.7	90	58	6.5	1.7	1.7
Quercus velutina	40	13	1.6	—	—	—	—	—	—	100	48	82.8	100	61	6.9	79.7	81.6
Sassafras albidum	90	53	6.7	—	—	—	10	1	3.1	—	—	—	90	54	6.1	0.1	0.1
Tilia americana	—	—	—	—	—	—	10	1	3.1	—	—	—	10	1	0.1	0.2	0.2
Ulmus americana	—	—	—	10	1	12.5	—	—	—	—	—	—	10	1	0.1	—	—
Ulmus rubra	90	438	55.5	—	—	—	—	—	—	10	1	1.7	90	439	49.5	1.9	1.9
TOTALS		789	88.9		8	1.0		32	3.6		58	6.5		887		97.9	

TABLE III. Summary of tree data based on ten 100 m^2 quadrats from stand 3, Barry County, Thornapple Twp., T. 4 N., R. 10 W., NE ¼ section 15.

	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
SPECIES	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	50	15	6.4	10	1	1.2	30	3	10.3	—	—	—	60	19	4.6	0.8	0.7
Amelanchier sp.	10	2	0.9	—	—	—	—	—	—	—	—	—	10	2	0.5	—	—
Carya ovalis	10	2	0.9	—	—	—	—	—	—	—	—	—	10	2	0.5	—	—
Celtis occidentalis	10	1	0.4	10	2	2.4	—	—	—	—	—	—	20	3	0.7	0.1	0.1
Cornus florida	10	1	0.4	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Crataegus sp.	20	2	0.9	—	—	—	—	—	—	—	—	—	20	2	0.5	—	—
Fagus grandifolia	10	1	0.4	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Fraxinus americana	20	3	1.3	10	1	1.2	—	—	—	—	—	—	20	4	1.0	—	—
Juglans cinerea	10	1	0.4	20	2	2.4	20	2	6.9	—	—	—	30	5	1.2	0.4	0.3
Juglans nigra	30	3	1.3	20	2	2.4	20	2	6.9	—	—	—	50	7	1.7	0.4	0.3
Prunus nigra	—	—	—	10	1	1.2	—	—	—	—	—	—	10	1	0.2	0.1	0.1
Prunus serotina	100	67	28.7	80	30	35.6	70	14	48.3	—	—	—	100	111	27.1	2.6	2.3
Pyrus ioensis	20	5	2.1	20	4	4.8	—	—	—	—	—	—	20	9	2.2	—	—
Quercus alba	20	9	3.8	60	23	27.4	40	6	20.7	—	—	—	70	38	9.3	1.6	1.4
Quercus velutina	20	8	3.4	—	—	—	—	—	—	100	63	100.0	100	71	17.3	108.3	94.1
Sassafras albidum	90	109	46.5	50	12	14.3	20	2	6.9	—	—	—	100	123	30.0	0.5	0.4
Ulmus americana	—	—	—	30	4	4.8	—	—	—	—	—	—	30	4	1.0	0.2	0.2
Ulmus rubra	20	5	2.1	10	2	2.4	—	—	—	—	—	—	20	7	1.7	—	—
TOTALS		234	57.1		84	20.5		29	7.1		63	15.3		410		115.1	

TABLE IV. Summary of tree data based on ten 100 m^2 quadrats from stand 4, St. Joseph County, Constantine Twp., T. 7 S., R. 12 W., NE ¼ section 7.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	40	11	0.8	—	—	—	—	—	—	—	—	—	40	11	0.8	—	—
Acer saccharum	20	2	0.2	—	—	—	—	—	—	—	—	—	20	2	0.1	—	—
Amelanchier sp.	70	13	1.0	—	—	—	—	—	—	—	—	—	70	13	0.9	—	—
Carya ovalis	50	15	1.2	40	9	20.9	50	7	20.0	50	5	11.4	100	36	2.5	5.8	9.9
Cornus florida	100	963	74.2	100	28	65.2	60	10	28.6	—	—	—	100	1001	70.5	2.0	3.4
Crataegus sp.	10	1	0.1	10	1	2.3	—	—	—	—	—	—	20	2	0.1	—	—
Juniperus virginiana	10	1	0.1	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Ostrya virginiana	20	5	0.4	—	—	—	—	—	—	—	—	—	20	5	0.4	—	—
Prunus serotina	100	174	13.4	20	2	4.7	30	3	8.6	—	—	—	100	179	12.6	1.0	1.7
Quercus alba	70	26	2.0	20	2	4.7	60	11	31.5	20	2	4.5	100	41	2.9	4.4	7.5
Quercus velutina	20	2	0.2	—	—	—	20	4	11.4	100	37	84.1	100	43	3.0	45.3	77.3
Sassafras albidum	100	82	6.3	10	1	2.3	—	—	—	—	—	—	100	83	5.9	0.1	0.2
Ulmus americana	20	3	0.2	—	—	—	—	—	—	—	—	—	20	3	0.2	—	—
TOTALS		1298	91.4		43	3.0		35	2.5		44	3.1		1420		58.6	

TABLE V. Summary of tree data based on ten 100 m^2 quadrats from stand 5, Jackson County, Leoni Twp., T. 2 S., R. 1 E., NW ¼ section 30.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	$FT.^2$	%
Acer rubrum	70	17	3.9	20	4	4.2	—	—	—	—	—	—	70	21	3.5	0.1	0.1
Amelanchier sp.	50	14	3.2	30	6	6.2	—	—	—	—	—	—	60	20	3.3	—	—
Carya ovalis	70	31	7.1	—	—	—	50	8	32.0	50	7	13.0	100	46	7.5	13.4	15.9
Cornus florida	30	10	2.3	20	2	2.1	—	—	—	—	—	—	30	12	2.0	—	—
Crataegus sp.	20	3	0.7	—	—	—	—	—	—	—	—	—	20	3	0.5	—	—
Ostrya virginiana	30	33	7.5	—	—	—	—	—	—	—	—	—	30	33	5.4	—	—
Prunus serotina	100	219	50.0	100	71	74.0	30	7	28.0	—	—	—	100	297	48.4	2.5	3.0
Quercus alba	40	10	2.3	—	—	—	30	4	16.0	60	9	17.0	100	23	3.8	16.4	19.5
Quercus rubra	50	14	3.2	—	—	—	10	1	4.0	—	—	—	50	15	2.4	0.4	0.5
Quercus velutina	20	2	0.5	—	—	—	10	1	4.0	100	37	70.0	100	40	6.5	50.8	60.3
Sassafras albidum	100	80	18.2	60	13	13.5	30	4	16.0	—	—	—	100	97	15.7	0.6	0.7
Tilia americana	10	2	0.5	—	—	—	—	—	—	—	—	—	10	2	0.3	—	—
Ulmus americana	40	4	0.9	—	—	—	—	—	—	—	—	—	40	4	0.7	—	—
TOTALS		439	71.5		96	15.7		25	4.1		53	8.7		613		84.3	

TABLE VI. Summary of tree data based on ten 100 m^2 quadrats from stand 6, Cass County, La Grange Twp., T. 6 S., R. 15 W., E $\frac{1}{2}$ NE $\frac{1}{4}$ section 33.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	75	13.4	60	25	39.7	40	7	18.4	—	—	—	100	107	15.0	1.7	2.2
Acer saccharum	30	4	0.7	10	1	1.6	—	—	—	—	—	—	30	5	0.7	—	—
Amelanchier sp.	20	6	1.1	10	2	3.2	—	—	—	—	—	—	20	8	1.1	0.1	0.1
Carya ovalis	80	66	11.8	10	1	1.6	20	4	10.5	40	5	9.6	90	76	10.6	7.2	9.3
Celtis occidentalis	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Cornus florida	60	54	9.6	20	3	4.8	10	1	2.6	—	—	—	60	58	8.1	0.1	0.1
Crataegus sp.	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Fagus grandifolia	—	—	—	20	2	3.2	—	—	—	—	—	—	20	2	0.3	—	—
Morus rubra	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Prunus serotina	100	119	21.2	80	16	25.4	80	15	39.7	—	—	—	100	150	21.0	3.3	4.2
Pyrus ioensis	—	—	—	10	1	1.6	—	—	—	—	—	—	10	1	0.1	—	—
Quercus alba	80	36	6.4	20	3	4.8	40	3	7.9	40	4	7.7	90	46	6.4	6.1	7.9
Quercus velutina	30	14	2.5	—	—	—	30	5	13.2	90	43	82.7	100	62	8.7	58.6	75.5
Sassafras albidum	90	174	31.0	30	3	4.8	20	3	7.9	—	—	—	90	180	25.3	0.4	0.5
Ulmus americana	10	4	0.7	10	6	9.5	—	—	—	—	—	—	20	10	1.4	0.2	0.3
Ulmus rubra	40	6	1.1	—	—	—	—	—	—	—	—	—	40	6	0.8	—	—
TOTALS		561	78.6		63	8.8		38	5.3		52	7.3		414		77.7	

TABLE VII. Summary of tree data based on ten 100 m^2 quadrats from stand 7, Jackson County, Waterloo Twp., T. 1 S., R. 2 E., SW ¼ NW ¼ section 17.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.^{2}	%
Acer rubrum	70	47	10.7	40	10	16.7	10	1	3.7	—	—	—	70	58	10.1	0.3	0.5
Acer saccharum	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Amelanchier sp.	60	16	3.6	50	9	15.0	—	—	—	—	—	—	70	25	4.4	0.1	0.2
Carya ovalis	100	49	11.1	10	1	1.7	40	10	37.1	40	7	15.2	100	67	11.7	10.1	15.2
Ostrya virginiana	20	2	0.5	—	—	—	—	—	—	—	—	—	20	2	0.3	—	—
Prunus serotina	100	59	13.4	80	29	48.3	20	4	14.8	—	—	—	100	92	16.0	1.2	1.8
Quercus alba	50	14	3.2	40	5	8.3	80	9	33.4	10	1	2.2	100	29	5.1	3.9	5.9
Quercus rubra	50	15	3.4	—	—	—	20	2	7.4	30	3	6.5	70	20	3.5	4.8	7.2
Quercus velutina	20	6	1.4	—	—	—	10	1	3.7	100	35	76.1	100	42	7.3	45.4	68.4
Sassafras albidum	100	222	50.3	40	6	10.0	—	—	—	—	—	—	100	228	39.7	0.5	0.8
Ulmus americana	40	10	2.3	—	—	—	—	—	—	—	—	—	40	10	1.7	—	—
TOTALS		441	76.8		60	10.5		27	4.7		46	8.0		574		66.4	

TABLE VIII. Summary of tree data based on ten 100 m^2 quadrats from stand 8, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., SW ¼ section 1.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	—	—	—	10	2	3.8	—	—	—	—	—	—	10	2	0.5	0.1	0.2
Amelanchier sp.	40	12	4.2	10	1	1.9	—	—	—	—	—	—	40	13	3.2	—	—
Carya ovalis	100	120	41.8	90	37	69.7	60	6	25.0	20	2	4.3	100	165	40.2	3.6	5.6
Crataegus sp.	80	30	10.4	—	—	—	—	—	—	—	—	—	80	30	7.3	—	—
Fraxinus americana	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Juniperus virginiana	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Prunus serotina	90	41	14.3	30	6	11.3	10	1	4.2	—	—	—	90	48	11.7	0.2	0.3
Quercus alba	—	—	—	20	2	3.8	50	5	20.8	20	3	6.5	70	10	2.4	2.6	4.1
Quercus rubra	80	26	9.1	10	2	3.8	30	4	16.7	70	12	26.1	80	44	10.7	16.2	25.1
Quercus velutina	30	12	4.2	—	—	—	40	8	33.3	90	29	63.1	100	49	12.0	41.6	64.6
Sassafras albidum	80	37	12.9	10	2	3.8	—	—	—	—	—	—	80	39	9.5	0.1	0.1
Tilia americana	40	6	2.1	—	—	—	—	—	—	—	—	—	40	6	1.5	—	—
Ulmus americana	10	1	0.3	10	1	1.9	—	—	—	—	—	—	20	2	0.5	—	—
TOTALS		287	70.0		53	12.9		24	5.9		46	11.2		410		64.4	

TABLE IX. Summary of tree data based on ten 100 m^2 quadrats from stand 9, Berrien County, Bainbridge Twp., T. 4 S., R. 17 W., SW ¼ NE ¼ section 32.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ. %	DENSITY D	DENSITY %	FREQ. %	DENSITY D	DENSITY %	FREQ. %	DENSITY D	DENSITY %	FREQ. %	DENSITY D	DENSITY %	FREQ. %	DENSITY D	DENSITY %	BASAL AREA FT.²	BASAL AREA %
Acer rubrum	40	10	2.4	50	8	4.7	20	2	5.9	—	—	—	70	20	2.9	0.4	0.4
Acer saccharum	—	—	—	—	—	—	10	1	2.9	—	—	—	10	1	0.1	0.1	0.1
Amelanchier sp.	20	3	0.7	—	—	—	—	—	—	—	—	—	20	3	0.4	—	—
Carya ovalis	30	4	1.0	20	5	2.9	30	7	20.6	10	1	1.4	70	17	2.5	2.7	2.6
Cornus florida	100	348	83.0	100	124	73.0	40	11	32.4	—	—	—	100	483	70.0	3.0	2.9
Crataegus sp.	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Fagus grandifolia	—	—	—	10	1	0.6	—	—	—	—	—	—	10	1	0.1	0.1	0.1
Liriodendron tulip.	—	—	—	10	1	0.6	—	—	—	—	—	—	10	1	0.1	—	—
Prunus serotina	70	26	6.2	30	4	2.4	20	3	8.8	—	—	—	70	33	4.8	0.4	0.4
Quercus alba	10	1	0.2	—	—	—	20	3	8.8	50	12	17.4	70	16	2.3	24.3	23.4
Quercus rubra	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Quercus velutina	10	1	0.2	—	—	—	20	3	8.8	80	55	79.8	90	59	8.5	71.7	69.2
Sassafras albidum	70	23	5.5	80	27	15.9	20	4	11.8	10	1	1.4	90	55	8.0	1.2	1.2
Ulmus americana	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
TOTALS		419	60,6		170	24.6		34	4.9		69	9.9		692		103.9	

TABLE X. Summary of tree data based on ten 100 m^2 quadrats from stand 11, Jackson County, Leoni Twp., T. 2 S., R. 1 E., NE¼ section 28.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	449	52.8	80	19	38.0	20	3	17.7	10	1	2.2	100	472	49.2	2.9	3.5
Amelanchier sp.	80	47	5.7	10	1	2.0	—	—	—	—	—	—	90	48	5.0	—	—
Carya ovalis	70	18	2.1	50	7	14.0	40	5	29.5	10	1	2.2	100	31	3.2	1.6	2.0
Celtis occidentalis	10	1	0.1	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Cornus florida	50	37	4.4	40	9	18.0	10	1	5.9	—	—	—	50	47	4.9	0.2	0.2
Prunus serotina	100	139	16.3	30	4	8.0	—	—	—	10	1	2.2	100	144	15.0	1.7	2.1
Quercus alba	80	44	5.2	—	—	—	50	6	35.1	90	13	28.8	100	63	6.6	27.5	33.6
Quercus rubra	20	2	0.2	—	—	—	—	—	—	—	—	—	20	2	0.2	—	—
Quercus velutina	50	21	2.5	—	—	—	—	—	—	100	29	64.6	100	50	5.2	46.9	57.3
Sassafras albidum	90	90	10.6	50	10	20.0	20	2	10.8	—	—	—	100	102	10.5	1.0	1.2
Ulmus americana	10	1	0.1	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
TOTALS		849	88.3		50	5.2		17	1.8		45	4.7		961		81.9	

TABLE XI. Summary of tree data based on ten 100 m^2 quadrats from stand 12, Oakland County, Springfield Twp., T. 4 N., R. 7 E., SE ¼ section 1.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	50	16	2.4	20	5	9.3	10	1	3.0	--	--	--	50	22	2.7	0.3	0.5
Amelanchier sp.	100	74	11.1	20	4	7.4	--	--	--	--	--	--	100	78	9.6	0.1	0.2
Carpinus caroliniana	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Carya ovalis	70	41	6.2	50	7	13.0	30	3	9.1	20	2	3.6	100	53	6.6	2.5	3.8
Carya ovata	20	3	0.5	--	--	--	--	--	--	--	--	--	20	3	0.4	--	--
Cornus florida	10	4	0.6	--	--	--	--	--	--	--	--	--	10	4	0.5	--	--
Crataegus sp.	70	23	3.5	--	--	--	--	--	--	--	--	--	70	23	2.8	--	--
Fraxinus americana	80	38	5.7	10	1	1.9	--	--	--	--	--	--	80	39	4.8	--	--
Prunus serotina	100	128	19.2	70	12	22.2	50	7	21.2	--	--	--	100	147	18.1	1.5	2.3
Quercus alba	70	44	6.6	40	12	22.2	70	18	54.6	50	12	21.8	100	86	10.6	14.4	21.7
Quercus rubra	70	28	4.2	10	1	1.9	10	1	3.0	70	7	12.7	90	37	4.6	9.8	14.8
Quercus velutina	--	--	--	--	--	--	30	3	9.1	100	34	61.9	100	37	4.6	37.2	56.2
Sassafras albidum	90	266	40.0	60	10	18.5	--	--	--	--	--	--	90	276	34.3	0.2	0.3
Tilia americana	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Ulmus americana	--	--	--	10	2	3.7	--	--	--	--	--	--	10	2	0.2	0.1	0.2
TOTALS		669	82.4		54	6.7		33	4.1		55	6.8		809		66.1	

TABLE XII. Summary of tree data based on ten 100 m^2 quadrats from stand 13, Ingham County, Ingham Twp., T. 2 N., R. 1 E., SW ¼ section 16.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	20	7	1.3	10	2	1.6	—	—	—	—	—	—	20	9	1.3	—	—
Acer saccharum	20	2	0.4	—	—	—	—	—	—	—	—	—	20	2	0.3	—	—
Amelanchier sp.	70	20	3.8	50	21	16.4	10	1	4.2	—	—	—	90	42	5.9	0.6	1.1
Carya ovalis	20	4	0.8	10	1	0.8	10	1	4.2	—	—	—	30	6	0.8	0.1	0.3
Cornus florida	70	224	43.0	100	81	63.3	—	—	—	—	—	—	100	305	42.9	1.6	2.9
Crataegus sp.	10	2	0.4	—	—	—	—	—	—	—	—	—	10	2	0.3	—	—
Fagus grandifolia	10	1	0.2	20	2	1.6	10	1	4.2	—	—	—	30	4	0.6	0.2	0.3
Fraxinus americana	30	8	1.5	—	—	—	—	—	—	—	—	—	30	8	1.1	—	—
Ostrya virginiana	80	55	10.6	60	9	7.0	10	1	4.2	—	—	—	80	65	9.1	0.4	0.7
Populus grandident.	—	—	—	—	—	—	10	1	4.2	—	—	—	10	1	0.1	0.2	0.4
Prunus serotina	90	162	31.1	40	6	4.7	10	2	8.3	—	—	—	100	170	23.9	0.6	1.0
Quercus alba	30	4	0.8	20	2	1.6	30	5	20.8	70	15	39.5	80	26	3.7	22.9	40.2
Quercus rubra	40	7	1.3	20	2	1.6	—	—	—	30	4	10.5	50	13	1.8	5.0	8.8
Quercus velutina	—	—	—	—	—	—	30	9	37.5	100	19	50.0	100	28	3.9	24.6	43.3
Sassafras albidum	50	25	4.8	10	2	1.6	20	3	12.5	—	—	—	50	30	4.2	0.6	1.1
Tilia americana	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
TOTALS		521	73,3		128	18,0		24	3,4		38	5,3		711		56,9	

TABLE XIII. Summary of tree data based on ten 100 m^2 quadrats from stand 20, Hillsdale County, Camden Twp., T. 8 S., R. 4 W., SE ¼ section 5.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	60	17	3.6	60	14	23.7	80	22	61.1	40	4	6.8	100	57	9.1	9.2	9.0
Amelanchier sp.	10	4	0.8	—	—	—	—	—	—	—	—	—	10	4	0.6	—	—
Carya cordiformis	30	5	1.1	20	3	5.1	10	1	2.8	—	—	—	40	9	1.4	0.1	0.1
Carya ovalis	20	3	0.6	20	2	3.4	—	—	—	—	—	—	40	5	0.8	0.1	0.1
Carya ovata	20	5	1.1	20	3	5.1	10	1	2.8	20	3	5.1	30	12	1.9	3.8	3.7
Cornus florida	90	122	25.9	60	14	23.7	—	—	—	—	—	—	90	136	21.7	0.4	0.4
Fagus grandifolia	—	—	—	—	—	—	10	1	2.8	—	—	—	10	1	0.2	0.3	0.3
Fraxinus americana	60	55	11.6	—	—	—	10	1	2.8	—	—	—	60	56	9.0	0.1	0.1
Juglans nigra	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Liriodendron tulip.	10	1	0.2	—	—	—	10	1	2.8	20	3	5.1	30	5	0.8	4.7	4.6
Ostrya virginiana	80	83	17.6	60	13	22.1	20	3	8.3	—	—	—	80	99	15.8	0.7	0.7
Prunus serotina	90	136	28.8	20	8	13.5	—	—	—	10	1	1.7	100	145	23.2	1.9	1.8
Quercus alba	—	—	—	—	—	—	20	3	8.3	40	6	10.2	60	9	1.4	8.3	8.1
Quercus rubra	—	—	—	—	—	—	—	—	—	50	10	17.0	50	10	1.6	15.3	14.8
Quercus velutina	—	—	—	—	—	—	20	2	5.6	90	32	54.2	90	34	5.4	57.8	56.2
Sassafras albidum	70	37	7.8	20	2	3.4	10	1	2.8	—	—	—	70	40	6.4	0.2	0.2
Ulmus americana	10	3	0.6	—	—	—	—	—	—	—	—	—	10	3	0.5	—	—
TOTALS		472	75.4		59	9.4		36	5.8		59	9.4		626		102.9	

SPECIES

TABLE XIV. Summary of tree data based on ten 100 m^2 quadrats from stand 14, Washtenaw County, Dexter Twp., T. 1 S., R. 4 E., NW ¼ section 20.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	50	65	14.6	50	10	6.4	30	3	7.5	—	—	—	70	78	11.3	0.5	0.5
Acer saccharum	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Amelanchier sp.	50	9	2.1	60	12	7.1	—	—	—	—	—	—	70	21	3.1	0.2	0.2
Carya ovalis	80	141	31.7	90	58	37.3	50	14	35.0	70	16	34.0	100	229	33.3	27.5	26.5
Cornus florida	40	94	21.2	20	20	12.8	10	1	2.5	—	—	—	40	115	16.7	0.4	0.4
Prunus nigra	50	16	3.6	50	38	24.4	40	5	12.5	—	—	—	70	59	8.6	1.5	1.5
Prunus serotina	70	27	6.1	30	3	1.9	50	7	17.5	10	1	2.1	90	38	5.5	2.8	2.7
Quercus alba	30	14	3.1	10	8	5.1	30	5	12.5	60	12	25.6	80	39	5.7	37.3	36.0
Quercus rubra	40	9	2.1	—	—	—	—	—	—	20	3	6.4	60	12	1.7	8.1	7.8
Quercus velutina	10	2	0.4	—	—	—	10	1	2.5	80	15	31.9	90	18	2.6	24.5	23.6
Sassafras albidum	80	59	13.3	20	6	3.8	10	1	2.5	—	—	—	90	66	9.6	0.3	0.3
Tilia americana	30	6	1.3	—	—	—	—	—	—	—	—	—	30	6	0.9	—	—
Ulmus americana	20	2	0.4	10	1	0.6	20	3	7.5	—	—	—	40	6	0.9	0.5	0.5
TOTALS		445	64.7		156	22.7		40	5.8		47	6.8		688		103.6	

TABLE XV. Summary of tree data based on ten 100 m^2 quadrats from stand 15, Cass County, Jefferson Twp., T. 7 S., R. 15 W., NW ¼ section 8.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	30	5	1.3	50	8	10.1	—	—	—	10	1	1.9	60	14	2.4	1.2	1.5
Acer saccharum	60	25	6.3	—	—	—	20	2	4.7	—	—	—	70	27	4.7	0.6	0.8
Carya ovalis	20	4	1.0	—	—	—	40	4	9.3	30	4	7.4	70	12	2.1	5.7	7.3
Cornus florida	100	294	74.2	100	60	76.0	70	11	25.6	—	—	—	100	365	63.9	2.2	2.8
Fagus grandifolia	20	2	0.5	30	3	3.8	50	11	25.6	—	—	—	60	16	2.8	2.4	3.1
Prunus serotina	20	4	1.0	20	4	5.1	20	2	4.7	20	2	3.7	60	12	2.1	2.4	3.1
Quercus alba	—	—	—	—	—	—	40	5	11.5	100	15	27.8	100	20	3.5	13.9	17.9
Quercus rubra	—	—	—	—	—	—	—	—	—	10	1	1.9	10	1	0.2	2.2	2.8
Quercus velutina	—	—	—	—	—	—	20	2	4.7	90	29	53.7	100	31	5.4	43.4	55.7
Sassafras albidum	40	11	2.8	—	—	—	30	4	9.3	20	2	3.7	50	17	3.0	3.1	4.0
Tilia americana	20	7	1.8	10	2	2.5	10	1	2.3	—	—	—	20	10	1.7	0.5	0.7
Ulmus americana	30	28	7.1	20	2	2.5	10	1	2.3	—	—	—	50	31	5.4	0.2	0.3
Ulmus rubra	60	16	4.0	—	—	—	—	—	—	—	—	—	60	16	2.8	—	—
TOTALS		396	69.3		79	13.8		43	7.5		54	9.4		572		77.8	

TABLE XVI. Summary of tree data based on ten 100 m^2 quadrats from stand 16, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., NE ¼ section 11.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	60	16	3.4	20	5	17.3	20	2	3.1	--	--	--	70	23	3.8	0.2	0.4
Acer saccharum	--	--	--	10	1	3.4	--	--	--	--	--	--	10	1	0.2	--	--
Amelanchier sp.	70	26	5.6	10	1	3.4	--	--	--	--	--	--	70	27	4.4	--	--
Carya ovalis	90	27	5.8	40	7	24.2	90	21	32.2	10	1	1.9	100	56	9.2	4.6	8.3
Cornus florida	30	80	17.2	40	8	27.6	--	--	--	--	--	--	80	88	14.4	0.2	0.3
Crataegus sp.	70	17	3.6	--	--	--	--	--	--	--	--	--	70	17	2.8	--	--
Fraxinus americana	50	34	7.3	--	--	--	--	--	--	--	--	--	50	34	5.6	--	--
Prunus serotina	100	54	11.6	30	4	13.8	10	1	1.5	20	2	3.8	100	61	10.0	2.8	5.0
Quercus alba	80	41	8.8	10	1	3.4	50	8	12.3	60	7	13.5	100	57	9.3	6.6	12.0
Quercus rubra	90	25	5.4	10	1	3.4	80	18	27.6	80	21	40.3	100	65	10.6	20.4	36.9
Quercus velutina	--	--	--	--	--	--	80	13	20.0	70	21	40.3	80	34	5.6	20.0	36.2
Sassafras albidum	70	141	30.4	10	1	3.4	20	2	3.1	--	--	--	70	144	23.7	0.5	0.8
Tilia americana	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.2	--	--
Ulmus americana	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.2	--	--
Ulmus rubra	10	2	0.4	--	--	--	--	--	--	--	--	--	10	2	0.3	--	--
TOTALS		465	76.2		29	4.7		65	10.6		52	8.5		611		55.2	

TABLE XVII. Summary of tree data based on ten 100 m^2 quadrats from stand 17, Allegan County, Heath Twp., T. 3 N., R. 1 W., S $\frac{1}{2}$ section 22.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	45	8.1	60	13	14.7	--	--	--	--	--	--	100	58	7.6	0.1	0.1
Amelanchier sp.	20	3	0.5	10	6	6.7	--	--	--	--	--	--	30	9	1.2	0.1	0.1
Carpinus caroliniana	20	12	2.2	10	1	1.1	--	--	--	--	--	--	20	13	1.7	--	--
Carya ovalis	40	7	1.3	--	--	--	--	--	--	--	--	--	40	7	0.9	--	--
Cornus florida	100	226	40.5	90	57	64.1	10	1	1.9	--	--	--	100	284	37.4	0.9	1.2
Crataegus sp.	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Fagus grandifolia	20	2	0.4	10	1	1.1	10	1	1.9	--	--	--	20	4	0.5	0.2	0.3
Fraxinus americana	10	4	0.7	--	--	--	10	1	1.9	20	3	4.8	20	8	1.1	2.6	3.6
Liriodendron tulip.	--	--	--	--	--	--	--	--	--	10	1	1.6	10	1	0.1	1.7	2.4
Ostrya virginiana	10	2	0.4	10	1	1.1	10	1	1.9	--	--	--	30	4	0.5	0.1	0.1
Pinus strobus	--	--	--	--	--	--	20	3	5.6	--	--	--	20	3	0.4	0.7	1.0
Populus grandident.	--	--	--	--	--	--	--	--	--	10	1	1.6	10	1	0.1	0.7	1.0
Populus tremuloides	20	3	0.5	--	--	--	--	--	--	--	--	--	20	3	0.4	--	--
Prunus serotina	70	20	3.6	--	--	--	--	--	--	--	--	--	70	20	2.6	--	--
Pyrus ioensis	20	5	0.9	--	--	--	--	--	--	--	--	--	20	5	0.7	--	--
Quercus alba	70	12	2.2	50	8	9.0	90	36	66.6	60	21	33.9	90	77	10.1	23.8	33.0
Quercus macrocarpa	--	--	--	--	--	--	--	--	--	10	1	1.6	10	1	0.1	0.7	1.0
Quercus rubra	50	20	3.6	10	1	1.1	--	--	--	40	14	22.6	70	35	4.6	16.4	22.7
Quercus velutina	40	9	1.6	--	--	--	30	10	18.5	50	21	33.9	50	40	5.3	24.0	33.1
Sassafras albidum	90	185	33.3	10	1	1.1	10	1	1.9	--	--	--	90	187	24.6	0.3	0.4
TOTALS		556	73.0		89	11.7		54	7.1		62	8.2		761		72.3	

TABLE XVIII. Summary of tree data based on ten 100 m^2 quadrats from stand 18, Van Buren County, Pine Grove Twp., T. 1 S., R. 13 W., NW ¼ SW ¼ section 15.

	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
SPECIES	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	90	51	11.0	60	31	29.3	50	10	19.6	—	—	—	100	92	13.6	2.6	3.6
Amelanchier sp.	20	2	0.4	10	1	0.9	—	—	—	—	—	—	20	3	0.4	—	—
Carya cordiformis	—	—	—	10	1	0.9	—	—	—	—	—	—	10	1	0.1	0.1	0.1
Carya ovalis	30	3	0.6	10	1	0.9	30	3	5.9	—	—	—	60	7	1.0	0.9	1.0
Cornus florida	100	361	77.8	100	65	61.4	10	1	2.0	—	—	—	100	427	62.9	1.5	2.1
Fagus grandifolia	—	—	—	10	1	0.9	—	—	—	—	—	—	10	1	0.1	—	—
Liriodendron tulip.	10	2	0.4	10	1	0.9	—	—	—	30	4	6.9	40	7	1.0	4.4	6.1
Pinus strobus	—	—	—	—	—	—	10	2	3.9	10	1	1.7	10	3	0.4	1.0	1.4
Populus grandident.	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Prunus serotina	80	26	5.6	10	1	0.9	—	—	—	—	—	—	80	27	4.0	—	—
Quercus alba	20	2	0.4	10	1	0.9	60	9	17.6	30	3	5.2	70	15	2.2	4.6	6.4
Quercus rubra	10	1	0.2	20	2	1.9	80	12	23.6	70	23	39.7	90	38	5.6	26.1	36.4
Quercus velutina	—	—	—	10	1	0.9	50	14	27.5	90	27	46.6	90	42	6.2	30.6	42.7
Sassafras albidum	60	16	3.4	—	—	—	—	—	—	—	—	—	60	16	2.3	—	—
TOTALS		465	68.4		106	15.6		51	7.5		58	8.5		680		71.8	

TABLE XIX. Summary of tree data based on ten 100 m^2 quadrats from stand 19, Kent County, Courtland Twp., T. 9 N., R. 10 W., NW ¼ section 24.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	602	64.0	70	14	25.0	10	1	8.3	20	2	5.0	100	619	59.1	2.6	2.7
Acer saccharum	30	3	0.3	—	—	—	—	—	—	—	—	—	30	3	0.3	—	—
Amelanchier sp.	30	4	0.4	—	—	—	—	—	—	—	—	—	30	4	0.4	—	—
Carya ovalis	40	9	1.0	20	3	5.4	40	5	41.7	10	1	2.5	70	18	1.7	1.4	1.5
Ostrya virginiana	10	1	0.1	10	1	1.8	—	—	—	—	—	—	10	2	0.2	—	—
Pinus strobus	—	—	—	—	—	—	10	1	8.3	10	1	2.5	20	2	0.2	1.1	1.1
Prunus serotina	100	253	26.9	80	33	59.0	—	—	—	—	—	—	100	286	27.2	0.4	0.4
Quercus alba	10	1	0.1	—	—	—	—	—	—	90	20	50.0	90	21	2.0	65.3	67.7
Quercus rubra	50	26	2.8	—	—	—	30	3	25.0	50	8	20.0	90	37	3.5	16.0	16.6
Quercus velutina	—	—	—	—	—	—	—	—	—	30	5	12.5	30	5	0.5	6.3	6.5
Sassafras albidum	70	38	4.0	30	5	8.9	20	2	16.7	10	3	7.5	70	48	4.6	3.4	3.5
Ulmus americana	20	2	0.2	—	—	—	—	—	—	—	—	—	20	2	0.2	—	—
TOTALS		939	89.7		56	5.4		12	1.1		40	3.8		1047		96.5	

TABLE XX. Summary of tree data based on ten 100 m^2 quadrats from stand 10, Clinton County, Essex Twp., T. 8 N., R. 3 W., NW ¼ SW ¼ section 10.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	60	32	6.6	20	5	9.8	10	1	3.4	—	—	—	60	38	6.6	0.5	1.4
Amelanchier sp.	90	135	28.8	30	6	11.8	—	—	—	—	—	—	90	141	24.2	0.1	0.3
Carpinus caroliniana	10	2	0.4	10	1	2.0	—	—	—	—	—	—	10	3	0.5	—	—
Carya ovalis	70	14	3.0	20	6	11.8	80	18	62.1	20	5	17.2	100	43	7.4	8.2	23.0
Carya ovata	10	1	0.2	—	—	—	10	1	3.4	—	—	—	20	2	0.3	0.4	1.1
Crataegus sp.	100	59	12.6	20	2	3.9	—	—	—	—	—	—	100	61	10.6	—	—
Fraxinus americana	100	65	13.9	10	1	2.0	—	—	—	—	—	—	100	66	11.4	—	—
Juglans nigra	20	6	1.3	—	—	—	—	—	—	—	—	—	20	6	1.0	—	—
Ostrya virginiana	—	—	—	10	2	3.9	10	1	3.4	—	—	—	10	3	0.5	0.1	0.3
Prunus avium	10	4	0.9	—	—	—	—	—	—	10	1	3.4	10	5	0.9	0.1	0.3
Prunus serotina	90	57	12.1	60	15	29.4	10	1	3.4	—	—	—	100	73	12.6	0.7	1.9
Prunus americana	10	20	4.3	—	—	—	—	—	—	—	—	—	10	20	3.5	—	—
Quercus alba	60	24	5.1	50	10	19.6	50	5	17.2	50	8	27.6	80	47	8.1	8.9	25.0
Quercus rubra	50	12	2.6	—	—	—	—	—	—	—	—	—	50	12	2.1	—	—
Quercus velutina	20	8	1.7	—	—	—	10	2	6.9	90	15	51.8	90	25	4.3	16.5	46.4
Ulmus americana	50	23	4.8	20	3	5.9	—	—	—	—	—	—	50	26	4.5	0.1	0.3
Ulmus rubra	30	8	1.7	—	—	—	—	—	—	—	—	—	30	8	1.4	—	—
TOTALS		470	81.2		51	8.8		29	5.0		29	5.0		579		35.6	

TABLE XXI. Summary of tree data based on ten 100 m^2 quadrats from stand 21, St. Joseph County, Lockport Twp., T. 6 S., R. 11 W., NE ¼ section 3.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	40	7	2.0	10	1	1.9	—	—	—	—	—	—	40	8	1.6	0.1	0.1
Acer saccharum	70	17	4.8	20	2	3.7	—	—	—	—	—	—	70	19	3.9	—	—
Carya ovalis	90	64	18.2	40	5	9.3	70	10	23.2	10	1	2.3	100	80	16.3	2.8	2.7
Celtis occidentalis	40	16	4.5	10	1	1.9	10	1	2.3	—	—	—	60	18	3.7	0.1	0.1
Cornus florida	40	5	1.4	30	5	9.3	—	—	—	—	—	—	40	10	2.0	0.1	0.1
Prunus avium	—	—	—	10	2	3.7	10	1	2.3	—	—	—	10	3	0.6	0.5	0.5
Prunus serotina	50	21	6.0	50	22	40.6	90	23	53.6	—	—	—	100	66	13.4	5.1	5.0
Quercus alba	20	2	0.6	—	—	—	—	—	—	70	14	32.6	70	16	3.3	46.4	45.0
Quercus rubra	70	14	4.8	—	—	—	40	5	11.6	80	21	48.8	100	43	8.7	37.9	36.8
Quercus velutina	—	—	—	—	—	—	—	—	—	20	6	14.0	20	6	1.2	9.3	9.0
Sassafras albidum	40	27	7.7	20	3	5.6	10	1	2.3	—	—	—	40	31	6.3	0.1	0.1
Ulmus americana	60	14	4.0	20	2	3.7	—	—	—	10	1	2.3	60	17	3.5	0.2	0.2
Ulmus rubra	80	162	46.1	20	11	20.4	10	2	4.7	—	—	—	80	175	35.5	0.4	0.4
TOTALS		352	71.6		54	11.0		43	8.7		43	8.7		492		103.1	

TABLE XXII. Summary of tree data based on ten 100 m^2 quadrats from stand 22, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., NW ¼ section 12.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	90	49	10.6	60	10	15.8	10	1	4.8	—	—	—	100	60	10.1	0.4	0.5
Amelanchier sp.	70	29	6.2	30	5	7.9	—	—	—	—	—	—	70	34	5.7	0.1	0.2
Carya ovalis	100	106	22.9	60	19	30.1	80	14	66.6	40	6	13.3	100	145	24.5	9.0	11.3
Cornus florida	40	25	5.4	40	6	9.5	—	—	—	—	—	—	50	31	5.2	0.1	0.1
Crataegus sp.	30	7	1.5	—	—	—	—	—	—	—	—	—	30	7	1.2	—	—
Fraxinus americana	70	57	12.3	10	1	1.6	—	—	—	—	—	—	80	58	9.8	—	—
Juniperus virginiana	10	2	0.4	—	—	—	—	—	—	—	—	—	10	2	0.3	—	—
Prunus serotina	90	25	5.4	40	5	7.9	30	4	19.0	—	—	—	90	34	5.7	0.6	0.8
Pyrus ioensis	20	9	1.9	20	3	4.8	—	—	—	—	—	—	20	12	2.0	—	—
Quercus alba	80	39	8.4	30	7	11.1	—	—	—	90	14	31.1	100	60	10.1	29.7	37.1
Quercus rubra	100	54	11.7	40	6	9.5	10	1	4.8	90	21	46.6	100	82	13.8	34.7	43.3
Quercus velutina	—	—	—	—	—	—	—	—	—	30	4	8.9	30	4	0.7	5.0	6.3
Sassafras albidum	80	58	12.6	—	—	—	—	—	—	—	—	—	80	58	9.8	—	—
Ulmus americana	10	3	0.6	10	1	1.6	10	1	4.8	—	—	—	2	5	0.8	0.2	0.2
TOTALS		463	78.3		63	10.6		21	3.5		45	7.6		592		79.9	

TABLE XXIII. Summary of tree data based on ten 100 m^2 quadrats from stand 23, Oakland County, Addison Twp., T. 5 N., R. 11 E., section 28.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	90	58	7.5	70	14	13.0	70	8	22.2	--	--	--	100	80	8.2	2.0	2.0
Acer saccharum	40	18	2.3	20	3	2.8	--	--	--	--	--	--	40	21	2.2	0.1	0.1
Amelanchier sp.	90	60	7.8	40	7	6.5	--	--	--	--	--	--	90	67	6.9	0.1	0.1
Carya cordiformis	20	4	0.5	--	--	--	--	--	--	--	--	--	20	4	0.4	--	--
Carya ovalis	30	8	1.0	20	3	2.8	70	7	19.4	40	6	10.9	90	24	2.5	7.1	7.3
Carya ovata	--	--	--	20	2	1.9	--	--	--	--	--	--	20	2	0.2	0.1	0.1
Cornus florida	100	324	41.8	100	60	55.4	40	4	11.1	--	--	--	100	388	40.0	1.7	1.7
Fagus grandifolia	30	7	0.9	--	--	--	20	2	5.6	--	--	--	40	9	0.9	0.2	0.2
Fraxinus americana	100	138	17.8	30	3	2.8	20	2	5.6	--	--	--	100	143	14.7	0.2	0.2
Nyssa sylvatica	10	10	1.3	--	--	--	--	--	--	10	1	1.8	10	11	1.1	1.6	1.6
Ostrya virginiana	50	21	2.7	30	7	6.5	--	--	--	--	--	--	50	28	2.9	0.2	0.2
Pinus strobus	--	--	--	--	--	--	20	2	5.6	--	--	--	20	2	0.2	0.3	0.3
Populus grandident.	--	--	--	--	--	--	--	--	--	10	1	1.8	10	1	0.1	0.5	0.5
Prunus serotina	100	70	9.0	30	3	2.8	--	--	--	10	1	1.8	100	74	7.6	0.9	0.9
Quercus alba	20	2	0.3	--	--	--	20	2	5.6	30	5	9.1	60	9	0.9	5.1	5.1
Quercus rubra	20	3	0.4	10	1	0.9	50	8	22.2	80	24	43.6	100	36	3.7	46.9	48.1
Quercus velutina	--	--	--	--	--	--	--	--	--	70	17	31.0	70	17	1.7	30.3	31.1
Sassafras albidum	70	36	4.7	30	4	3.7	--	--	--	--	--	--	80	40	4.1	0.1	0.1
Tilia americana	50	12	1.6	10	1	0.9	10	1	2.8	--	--	--	50	14	1.4	0.2	0.2
Ulmus americana	10	3	0.4	--	--	--	--	--	--	--	--	--	10	3	0.3	--	--
TOTALS		774	79.5		108	11.1		36	3.7		55	5.7		973		97.8	

TABLE XXIV. Summary of tree data based on ten 100 m^2 quadrats from stand 24, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., SW ¼ section 1.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	30	10	3.2	10	1	1.0	--	--	--	--	--	--	30	11	2.2	--	--
Acer saccharum	20	2	0.6	--	--	--	--	--	--	--	--	--	20	2	0.4	--	--
Amelanchier sp.	60	10	3.2	20	3	3.1	--	--	--	--	--	--	60	13	2.7	0.1	0.1
Carya ovalis	10	1	0.3	40	6	6.2	100	26	68.5	50	8	17.8	100	41	8.4	10.4	16.2
Cornus florida	50	24	7.7	10	1	1.0	--	--	--	--	--	--	50	25	5.1	--	--
Crataegus sp.	30	3	1.0	--	--	--	--	--	--	--	--	--	30	3	0.6	--	--
Fagus grandifolia	--	--	--	--	--	--	10	1	2.6	--	--	--	10	1	0.2	0.1	0.1
Fraxinus americana	100	147	47.5	90	59	61.5	20	2	5.3	--	--	--	100	208	42.6	2.4	3.7
Ostrya virginiana	70	61	19.7	80	19	19.8	--	--	--	--	--	--	80	80	16.3	0.5	0.8
Prunus serotina	70	29	9.4	40	4	4.2	--	--	--	--	--	--	90	33	6.8	0.1	0.2
Quercus alba	20	2	0.6	--	--	--	10	2	5.3	40	7	15.6	40	11	2.2	15.2	23.8
Quercus rubra	20	7	2.3	--	--	--	60	7	18.4	100	28	62.2	100	42	8.6	32.7	51.1
Quercus velutina	--	--	--	--	--	--	--	--	--	20	2	4.4	20	2	0.4	2.4	3.7
Sassafras albidum	20	13	4.2	20	2	2.1	--	--	--	--	--	--	30	15	3.1	0.1	0.2
Ulmus americana	10	1	0.3	10	1	1.0	--	--	--	--	--	--	10	2	0.4	--	--
TOTALS		310	63.9		96	19.1		38	7.8		45	9.2		489		63.9	

TABLE XXV. Summary of tree data based on ten 100 m^2 quadrats from stand 25, Livingston County, Oceola Twp., T. 3 N., R. 5 E., NE ¼ section 22.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.[2]	%
Acer rubrum	90	344	47.2	--	--	--	10	1	25.0	40	5	10.0	100	350	44.3	4.2	4.7
Amelanchier sp.	80	65	8.9	30	4	66.6	--	--	--	--	--	--	80	69	8.7	0.2	0.2
Carya ovalis	20	3	0.4	--	--	--	--	--	--	--	--	--	20	3	0.4	--	--
Carya ovata	10	1	0.1	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Crataegus sp.	10	1	0.1	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Fraxinus americana	100	120	16.5	10	2	33.3	--	--	--	--	--	--	100	122	15.6	--	--
Ostrya virginiana	10	1	0.1	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Prunus americana	20	4	0.5	--	--	--	--	--	--	--	--	--	20	4	0.5	--	--
Prunus avium	20	2	0.3	--	--	--	--	--	--	--	--	--	20	2	0.3	--	--
Prunus serotina	80	103	14.1	--	--	--	10	1	25.0	30	5	10.0	80	109	13.8	7.0	7.8
Quercus alba	--	--	--	--	--	--	10	1	25.0	20	2	4.0	30	3	0.4	1.8	2.0
Quercus rubra	30	3	0.4	--	--	--	10	1	25.0	90	28	56.0	90	32	4.1	60.9	68.0
Quercus velutina	--	--	--	--	--	--	--	--	--	60	9	18.0	60	9	1.1	14.7	16.4
Sassafras albidum	90	48	6.6	--	--	--	--	--	--	10	1	2.0	90	49	6.2	0.7	0.8
Tilia americana	10	1	0.1	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Ulmus americana	70	27	3.7	--	--	--	--	--	--	--	--	--	70	27	3.4	--	--
Ulmus rubra	30	6	0.8	--	--	--	--	--	--	--	--	--	30	6	0.8	--	--
TOTALS		729	92.4		6	0.8		4	0.5		50	6.3		789		89.6	

TABLE XXVI. Summary of tree data based on ten 100 m^2 quadrats from stand 26, Berrien County, New Buffalo Twp., T. 8 S., R. 21 W., SW ¼ SW ¼ section 2.

SPECIES	SIZE CLASS TOTALS: 2 FREQ. %	2 DENSITY D	2 DENSITY %	3 FREQ. %	3 DENSITY D	3 DENSITY %	4 FREQ. %	4 DENSITY D	4 DENSITY %	5 FREQ. %	5 DENSITY D	5 DENSITY %	SPECIES TOTALS: FREQ. %	DENSITY D	DENSITY %	BASAL AREA FT.²	BASAL AREA %
Acer rubrum	30	4	2.8	50	7	5.0	20	2	15.4	--	--	--	50	13	3.7	0.3	0.3
Acer saccharum	80	38	26.8	60	33	23.8	10	1	7.7	--	--	--	90	72	20.4	0.9	0.8
Amelanchier sp.	30	7	4.9	10	2	1.4	--	--	--	--	--	--	30	9	2.5	--	--
Carpinus caroliniana	30	5	3.5	10	3	2.2	--	--	--	--	--	--	30	8	2.3	--	--
Carya cordiformis	20	2	1.4	--	--	--	--	--	--	--	--	--	20	2	0.6	--	--
Carya ovalis	20	3	2.1	40	5	3.6	20	2	15.4	20	4	6.8	80	14	4.0	6.7	6.2
Carya ovata	--	--	--	--	--	--	--	--	--	10	1	1.7	10	1	0.3	1.5	1.4
Cornus florida	70	11	7.7	90	50	36.0	20	2	15.4	--	--	--	100	63	17.8	1.2	1.1
Crataegus sp.	20	3	2.1	--	--	--	--	--	--	--	--	--	20	3	0.9	--	--
Fagus grandifolia	--	--	--	30	3	2.2	--	--	--	--	--	--	30	3	0.9	0.1	0.1
Fraxinus americana	90	43	30.3	10	1	0.7	--	--	--	--	--	--	90	44	12.5	--	--
Ostrya virginiana	40	9	6.3	90	16	11.5	10	1	7.7	--	--	--	90	26	7.4	0.4	0.4
Prunus serotina	30	6	4.2	20	2	1.4	--	--	--	--	--	--	40	8	2.3	--	--
Quercus alba	--	--	--	10	2	1.4	20	2	15.4	60	19	32.2	80	23	6.5	30.0	27.8
Quercus rubra	10	3	2.1	20	3	2.2	20	2	15.4	90	28	47.5	100	36	10.2	53.5	49.6
Quercus velutina	--	--	--	--	--	--	--	--	--	40	6	10.2	40	6	1.7	12.4	11.5
Sassafras albidum	20	4	2.8	30	4	2.9	10	1	7.7	--	--	--	40	9	2.5	0.2	0.2
Tilia americana	20	3	2.1	30	7	5.0	--	--	--	10	1	1.7	40	11	3.1	0.8	0.7
Ulmus americana	10	1	0.7	10	1	0.7	--	--	--	--	--	--	10	2	0.6	--	--
TOTALS		142	40.2		139	39.4		13	3.7		59	16.7		353		108.0	

TABLE XXVII. Summary of tree data based on ten 100 m^2 quadrats from stand 27, Clinton County, Essex Twp., T. 8 N., R. 3 W., NW ¼ SW ¼ section 10.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	90	51	7.3	60	12	16.4	60	16	40.0	40	5	22.7	90	84	10.0	9.8	24.6
Amelanchier	100	176	25.1	40	13	17.8	—	—	—	—	—	—	100	189	22.7	0.2	0.5
Carpinus caroliniana	—	—	—	10	7	9.6	—	—	—	—	—	—	10	7	0.8	0.7	1.8
Carya ovalis	50	26	3.7	40	8	11.0	50	9	22.5	10	1	4.5	90	44	5.3	2.3	5.8
Carya ovata	10	1	0.1	10	2	2.7	10	2	5.0	—	—	—	10	5	0.6	0.2	0.5
Crataegus sp.	100	65	9.3	20	3	4.1	—	—	—	—	—	—	100	68	8.1	0.1	0.3
Fraxinus americana	100	274	39.0	60	12	16.4	10	1	2.5	—	—	—	100	287	34.4	0.2	0.5
Ostrya virginiana	10	10	1.4	20	3	4.1	—	—	—	—	—	—	20	13	1.6	0.1	0.3
Populus grandident.	—	—	—	—	—	—	—	—	—	10	1	4.5	10	1	0.1	1.0	2.5
Prunus avium	10	1	0.1	10	4	5.5	10	1	2.5	—	—	—	20	6	0.7	0.1	0.3
Prunus sp.	10	2	0.3	—	—	—	—	—	—	—	—	—	10	2	0.2	—	—
Prunus serotina	80	35	5.0	20	2	2.7	20	2	5.0	—	—	—	80	39	4.6	0.4	1.0
Pyrus ioensis	10	1	0.1	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Quercus alba	50	18	2.6	20	3	4.1	30	5	12.5	20	2	9.1	70	28	3.3	8.7	21.8
Quercus bicolor	—	—	—	—	—	—	10	1	2.5	—	—	—	10	1	0.1	0.1	0.3
Quercus rubra	40	13	1.9	—	—	—	30	3	7.5	60	10	45.5	80	26	3.1	12.8	32.0
Quercus velutina	—	—	—	—	—	—	—	—	—	30	3	13.6	30	3	0.4	3.1	7.8
Tilia americana	—	—	—	10	1	1.4	—	—	—	—	—	—	10	1	0.1	—	—
Ulmus americana	50	29	4.1	10	2	2.7	—	—	—	—	—	—	60	31	3.7	—	—
Ulmus rubra	—	—	—	10	1	1.4	—	—	—	—	—	—	10	1	0.1	—	—
TOTALS		702	83.9		73	8.7		40	4.8		22	2.6		837		39.8	

TABLE XXVIII. Summary of tree data based on ten 100 m^2 quadrats from stand 28, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., NW ¼ section 12.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	82	28.6	90	43	51.8	20	6	33.3	20	2	4.0	100	133	30.4	5.9	7.2
Acer saccharum	10	4	1.4	10	1	1.2	—	—	—	—	—	—	10	5	1.1	—	—
Amelanchier sp.	70	16	5.6	30	5	6.0	—	—	—	—	—	—	70	21	4.8	0.1	0.2
Carya ovalis	50	44	15.4	30	7	8.4	10	1	3.6	50	5	10.1	80	57	13.1	8.3	10.2
Cornus florida	40	42	14.7	40	6	7.2	—	—	—	—	—	—	40	48	11.0	0.1	0.2
Crataegus sp.	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Fraxinus americana	100	44	15.4	40	9	10.8	10	1	5.6	—	—	—	100	54	12.4	0.2	0.3
Prunus serotina	90	29	10.1	40	4	4.8	10	1	5.6	—	—	—	90	34	7.7	0.3	0.3
Quercus alba	10	3	1.1	—	—	—	—	—	—	70	9	18.0	80	12	2.7	26.8	32.8
Quercus rubra	40	11	3.9	10	4	4.8	60	8	44.4	100	34	68.0	100	57	13.1	39.3	48.4
Sassafras albidum	20	2	0.7	—	—	—	—	—	—	—	—	—	20	2	0.5	—	—
Tilia americana	10	3	1.1	10	4	4.8	10	1	5.6	—	—	—	10	8	1.8	0.3	0.4
Ulmus americana	20	5	1.7	—	—	—	—	—	—	—	—	—	20	5	1.1	—	—
TOTALS		286	65.5		83	19.0		18	4.1		50	11.4		437		81.4	

TABLE XXIX. Summary of tree data based on ten 100 m^2 quadrats from stand 29, Lenawee County, Adrian Twp., T. 6 S., R. 3 E., NW $\frac{1}{4}$ section 12.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	80	32	4.4	50	8	7.8	40	8	25.8	40	7	12.3	10	55	6.0	8.1	8.7
Acer saccharum	20	3	0.4	20	5	4.9	10	1	3.2	—	—	—	40	9	1.0	0.3	0.3
Amelanchier sp.	70	17	2.3	—	—	—	—	—	—	—	—	—	70	17	1.8	—	—
Carpinus caroliniana	80	49	6.7	—	—	—	—	—	—	—	—	—	80	49	5.3	—	—
Carya cordiformis	30	4	0.5	—	—	—	—	—	—	—	—	—	30	4	0.4	—	—
Carya ovalis	60	32	4.4	20	4	3.9	20	2	6.5	40	4	7.0	90	42	4.6	6.9	7.4
Carya ovata	30	21	2.9	20	2	2.0	10	2	6.5	30	6	10.5	60	31	3.4	9.1	9.7
Crataegus sp.	40	7	1.0	—	—	—	—	—	—	—	—	—	40	7	0.8	—	—
Fraxinus americana	100	108	14.8	20	2	2.0	20	2	6.5	—	—	—	100	112	12.2	0.7	0.7
Ostrya virginiana	100	97	13.3	80	27	26.5	10	1	3.2	—	—	—	100	125	13.6	0.7	0.7
Prunus serotina	50	16	2.2	—	—	—	—	—	—	10	1	1.8	50	17	1.8	0.7	0.7
Pyrus ioensis	10	2	0.3	—	—	—	—	—	—	—	—	—	10	2	0.2	—	—
Quercus alba	10	2	0.3	—	—	—	40	10	32.3	40	11	19.3	60	23	2.5	16.9	18.1
Quercus rubra	50	10	1.4	—	—	—	10	1	3.2	80	26	45.6	90	37	4.0	44.5	47.7
Quercus velutina	10	1	0.1	—	—	—	10	1	3.2	20	2	3.5	40	4	0.4	4.6	4.8
Sassafras albidum	30	4	0.5	—	—	—	—	—	—	—	—	—	30	4	0.4	—	—
Tilia americana	60	9	1.2	10	2	2.0	20	2	6.5	—	—	—	60	13	1.4	0.3	0.3
Tsuga canadensis	10	2	0.3	—	—	—	—	—	—	—	—	—	10	2	0.2	—	—
Ulmus americana	40	4	0.5	—	—	—	—	—	—	—	—	—	40	4	0.4	—	—
Ulmus rubra	40	60	8.2	20	3	2.9	—	—	—	—	—	—	70	63	6.8	—	—
TOTALS		731	79.3		102	11.1		31	3.4		57	6.2		921		93.6	

TABLE XXX. Summary of tree data based on ten 100 m^2 quadrats from stand 30, St. Clair County, Clyde Twp., T. 7 N., R. 16 E., SW ¼ section 4.

	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
SPECIES	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	70	29	6.8	60	14	8.2	40	4	8.3	--	--	--	90	47	6.8	0.8	1.0
Acer saccharum	100	173	40.9	90	101	59.5	60	10	20.8	--	--	--	100	284	39.8	2.4	3.1
Amelanchier sp.	90	70	16.5	60	23	13.5	--	--	--	--	--	--	90	93	13.4	0.4	0.5
Carpinus caroliniana	60	19	4.5	60	12	7.1	--	--	--	--	--	--	70	31	4.5	0.1	0.1
Carya cordiformis	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Carya ovata	30	12	2.8	--	--	--	--	--	--	10	3	5.8	30	15	2.2	2.7	3.4
Crataegus sp.	10	3	0.7	10	1	0.6	--	--	--	--	--	--	10	4	0.6	--	--
Fagus grandifolia	10	1	0.2	10	1	0.6	--	--	--	--	--	--	20	2	0.3	--	--
Fraxinus americana	70	32	7.6	--	--	--	10	1	2.1	--	--	--	80	33	4.8	0.4	0.5
Ostrya virginiana	80	46	10.9	70	12	7.1	--	--	--	--	--	--	90	58	8.4	0.3	0.4
Pinus strobus	10	1	0.2	10	1	0.6	10	1	2.1	--	--	--	30	3	0.4	0.1	0.1
Prunus serotina	30	7	1.6	10	1	0.6	50	6	12.5	--	--	--	70	14	2.0	1.4	1.8
Quercus alba	20	3	0.7	10	1	0.6	80	22	45.8	80	26	50.0	100	52	7.5	31.4	39.9
Quercus rubra	10	1	0.2	10	1	0.6	20	2	4.2	80	23	44.2	80	27	3.9	38.3	48.8
Sassafras albidum	20	15	3.5	10	1	0.6	--	--	--	--	--	--	20	16	2.3	--	--
Tilia americana	30	4	0.9	--	--	--	--	--	--	--	--	--	30	4	0.6	--	--
Tsuga canadensis	30	4	0.9	10	1	0.6	20	2	4.2	--	--	--	50	7	1.0	0.3	0.4
Ulmus americana	10	1	0.2	--	--	--	--	--	--	--	--	--	10	1	0.1	--	--
Ulmus rubra	10	2	0.5	--	--	--	--	--	--	--	--	--	10	2	0.3	--	--
TOTALS		424	61.1		170	24.5		48	6.9		52	7.5		694		78.6	

TABLE XXXI. Summary of tree data based on ten 100 m^2 quadrats from stand 31, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., SW ¼ section 1.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	80	25	3.9	20	2	4.5	20	3	10.7	10	1	2.3	90	31	4.1	1.9	3.1
Acer saccharum	80	160	25.1	—	—	—	—	—	—	10	1	2.3	80	161	21.4	0.6	1.0
Amelanchier sp.	60	15	2.4	20	3	6.8	10	1	3.6	—	—	—	60	19	2.5	0.1	0.2
Carya ovalis	—	—	—	—	—	—	50	9	32.1	40	5	11.6	70	14	1.9	7.3	12.1
Cornus florida	60	77	12.1	20	3	6.8	10	1	3.6	—	—	—	60	81	10.8	0.2	0.4
Fraxinus americana	100	183	28.8	50	11	25.0	—	—	—	10	1	2.3	100	195	26.0	1.5	2.5
Ostrya virginiana	100	149	23.4	60	24	54.4	50	8	28.5	—	—	—	100	181	24.1	2.2	3.6
Prunus serotina	90	22	3.5	—	—	—	—	—	—	—	—	—	90	22	2.9	—	—
Quercus alba	—	—	—	—	—	—	—	—	—	10	1	2.3	10	1	0.1	0.5	0.9
Quercus rubra	20	4	0.6	—	—	—	40	6	21.4	90	32	74.3	90	42	5.6	44.6	73.7
Quercus velutina	—	—	—	—	—	—	—	—	—	20	2	4.6	20	2	0.3	1.5	2.5
Sassafras albidum	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.1	—	—
Tilia americana	—	—	—	10	1	2.3	—	—	—	—	—	—	10	1	0.1	—	—
TOTALS		636	84.8		44	5.9		28	3.7		43	5.7		751		60.6	

TABLE XXXII. Summary of tree data based on ten 100 m^2 quadrats from stand 32, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., NE ¼ section 11,

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	70	148	12.2	40	14	26.9	30	10	20.0	20	3	6.3	80	75	13.8	8.0	13.4
Amelanchier sp.	50	15	3.8	30	3	5.8	—	—	—	—	—	—	60	18	3.3	—	—
Carya ovalis	60	17	4.3	60	15	28.8	70	17	34.0	—	—	—	90	49	9.0	3.1	5.2
Cornus florida	70	155	39.4	40	14	26.9	10	1	2.0	—	—	—	70	170	31.2	0.4	0.7
Fraxinus americana	90	97	24.6	—	—	—	—	—	—	—	—	—	90	97	17.8	—	—
Prunus serotina	80	36	9.1	30	3	5.8	—	—	—	—	—	—	90	39	7.2	0.1	0.1
Quercus alba	30	9	2.3	10	2	3.8	30	3	6.0	10	1	2.1	40	15	2.8	1.7	2.9
Quercus rubra	40	12	3.0	10	1	1.9	50	18	36.0	100	44	91.6	100	75	13.8	46.4	77.2
Quercus velutina	—	—	—	—	—	—	10	1	2.0	—	—	—	10	1	0.2	0.3	0.5
Sassafras albidum	10	3	0.8	—	—	—	—	—	—	—	—	—	10	3	0.6	—	—
Ulmus americana	20	2	0.5	—	—	—	—	—	—	—	—	—	20	2	0.4	—	—
TOTALS		394	72.4		52	9.6		50	9.2		48	8.8		544		60.1	

TABLE XXXIII. Summary of tree data based on ten 100 m^2 quadrats from stand 33, Shiawassee County, Sciota Twp., T. 6 N., R. 1 E., SW ¼ section 11.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	100	150	10.4	20	3	9.4	20	3	12.5	—	—	—	100	156	10.1	0.7	0.9
Acer saccharum	100	177	12.3	10	1	3.1	20	2	8.3	10	1	2.6	100	181	11.8	1.2	1.6
Amelanchier sp.	70	22	1.5	30	6	18.8	20	3	12.5	—	—	—	80	31	2.0	0.3	0.4
Carpinus caroliniana	10	3	0.2	—	—	—	—	—	—	—	—	—	10	3	0.2	—	—
Carya ovalis	20	4	0.3	10	2	6.2	20	2	8.3	50	6	15.4	70	14	0.9	5.5	7.4
Carya ovata	10	4	0.3	—	—	—	—	—	—	20	3	7.7	30	7	0.4	2.6	3.4
Cornus florida	60	33	2.3	10	1	3.1	20	2	8.3	—	—	—	60	36	2.3	0.3	0.4
Crataegus sp.	70	18	1.2	—	—	—	—	—	—	—	—	—	70	18	1.2	—	—
Fraxinus americana	100	485	33.4	—	—	—	10	1	4.2	20	2	5.1	100	488	31.7	3.0	4.0
Ostrya virginiana	100	374	25.9	70	16	50.0	40	7	29.2	—	—	—	100	397	25.7	1.2	1.6
Prunus serotina	80	20	1.4	10	1	3.1	—	—	—	20	2	5.1	90	23	1.5	1.8	2.4
Quercus alba	—	—	—	—	—	—	—	—	—	60	9	23.1	60	9	0.6	33.1	44.6
Quercus rubra	40	8	0.6	—	—	—	20	3	12.5	60	10	25.6	90	21	1.4	18.6	25.0
Tilia americana	60	23	1.6	20	2	6.2	10	1	4.2	50	6	15.4	90	32	2.1	6.2	8.3
Ulmus americana	80	78	5.4	—	—	—	—	—	—	—	—	—	80	78	5.1	—	—
Ulmus rubra	60	46	3.2	—	—	—	—	—	—	—	—	—	60	46	3.0	—	—
TOTALS		1445	93.8		32	2.1		24	1.6		39	2.5		1540		74.2	

TABLE XXXIV. Summary of tree data based on ten 100 m^2 quadrats from stand 34, Ionia County, Boston Twp., T. 6 N., R. 8 W., NW ¼ section 29.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.^{2}	%
Acer rubrum	10	2	0.6	20	3	2.7	50	10	35.7	10	1	2.1	60	16	3.1	4.9	2.9
Acer saccharum	90	166	50.3	100	85	75.9	30	6	21.4	—	—	—	100	257	49.7	2.3	1.3
Amelanchier sp.	30	3	0.9	—	—	—	—	—	—	—	—	—	30	3	0.6	—	—
Carpinus caroliniana	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Carya cordiformis	—	—	—	—	—	—	10	1	3.6	10	1	2.1	20	2	0.4	0.7	0.4
Carya ovalis	10	1	0.3	—	—	—	10	1	3.6	—	—	—	20	2	0.4	0.4	0.2
Cornus florida	40	54	16.4	20	2	1.8	10	1	3.6	—	—	—	50	57	11.0	0.1	0.1
Fagus grandifolia	40	16	4.9	50	16	14.3	20	4	14.3	—	—	—	70	36	7.0	0.7	0.4
Fraxinus americana	80	66	20.0	—	—	—	10	1	3.6	—	—	—	80	67	13.0	0.2	0.1
Liriodendron tulip.	—	—	—	—	—	—	—	—	—	10	2	4.2	10	2	0.4	4.8	2.8
Ostrya virginiana	30	6	1.8	50	6	5.4	20	2	7.1	—	—	—	70	14	2.7	0.3	0.2
Prunus serotina	40	9	2.7	—	—	—	10	1	3.6	10	1	2.1	50	11	1.9	1.0	0.6
Quercus alba	—	—	—	—	—	—	—	—	—	90	21	43.7	90	21	4.1	106.9	62.2
Quercus rubra	—	—	—	—	—	—	10	1	3.6	90	19	39.6	90	20	3.9	44.1	25.6
Quercus velutina	—	—	—	—	—	—	—	—	—	20	2	4.2	20	2	0.4	2.5	1.5
Tilia americana	30	5	1.5	—	—	—	—	—	—	10	1	2.1	40	6	1.2	3.1	1.8
Ulmus americana	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
TOTALS		330	63.6		112	21.6		28	5.4		48	9.2		518		172.0	

TABLE XXXV. Summary of tree data based on ten 100 m^2 quadrats from stand 35, Ingham County, Bunker Hill Twp., T. 1 N., R. 1 E., NW $\frac{1}{4}$ section 29.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	60	17	5.2	50	7	11.5	20	2	5.9	30	3	5.8	60	29	6.1	4.5	5.3
Acer saccharum	70	51	15.6	60	14	23.0	50	7	20.6	20	2	3.8	90	74	15.4	3.7	4.3
Amelanchier sp.	10	2	0.6	10	2	3.3	—	—	—	—	—	—	10	4	0.8	—	—
Carpinus caroliniana	60	22	6.7	40	6	9.8	—	—	—	—	—	—	60	28	5.9	0.1	0.1
Carya cordiformis	20	5	1.5	10	1	1.6	10	2	5.9	10	1	1.9	50	9	1.9	0.8	1.0
Carya ovalis	10	1	0.3	—	—	—	20	2	5.9	—	—	—	30	3	0.6	0.4	0.5
Cornus florida	50	18	5.5	40	10	16.4	10	1	2.9	—	—	—	50	29	6.1	0.3	0.3
Crataegus sp.	10	5	1.5	10	1	1.6	—	—	—	—	—	—	10	6	1.3	0.1	0.1
Fagus grandifolia	10	4	1.2	20	3	4.8	—	—	—	10	1	1.9	20	8	1.7	2.2	2.5
Fraxinus americana	90	54	16.5	10	1	1.6	30	3	8.8	10	1	1.9	100	59	12.4	1.4	1.6
Fraxinus nigra	10	2	0.6	—	—	—	10	1	2.9	—	—	—	10	3	0.6	0.2	0.2
Ostrya virginiana	80	67	20.5	30	5	8.2	20	4	11.8	—	—	—	80	76	16.0	0.5	0.6
Populus grandident.	20	2	0.6	—	—	—	—	—	—	—	—	—	20	2	0.4	—	—
Prunus serotina	50	13	4.0	10	1	1.6	—	—	—	10	1	1.9	60	15	3.2	1.0	1.2
Quercus alba	—	—	—	—	—	—	10	2	5.9	20	4	7.7	20	6	1.3	6.4	7.5
Quercus rubra	30	6	1.8	—	—	—	—	—	—	90	28	53.8	100	34	7.2	47.4	55.5
Quercus velutina	—	—	—	—	—	—	—	—	—	60	8	15.4	60	8	1.7	11.0	12.9
Sassafras albidum	30	7	2.1	—	—	—	—	—	—	—	—	—	30	7	1.5	—	—
Tilia americana	60	30	9.2	50	10	16.4	40	9	26.5	10	2	3.8	60	51	10.8	3.3	3.8
Ulmus americana	30	9	2.7	—	—	—	—	—	—	—	—	—	30	9	1.9	—	—
Ulmus rubra	30	12	3.7	—	—	—	10	1	2.9	10	1	1.9	30	14	3.0	2.0	2.3
TOTALS		327	68.9		61	12.9		34	7.2		52	11.0		474		85.2	

TABLE XXXVI. Summary of tree data based on ten 100 m^2 quadrats from stand 36, Berrien County, Chikaming Twp., T. 7 S., R. 20 W., E ½ NW ¼ section 22.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	FT.²	%
Acer rubrum	60	30	9.6	10	1	1.9	30	4	21.0	10	1	1.5	90	36	8.0	1.6	1.5
Acer saccharum	80	56	18.0	70	12	22.2	40	4	21.0	—	—	—	100	72	16.0	0.8	0.8
Amelanchier sp.	20	3	1.0	—	—	—	—	—	—	—	—	—	20	3	0.7	—	—
Carpinus caroliniana	60	32	10.3	10	1	1.9	—	—	—	—	—	—	60	33	7.3	—	—
Carya ovata	20	2	0.6	10	2	3.7	10	1	5.3	—	—	—	20	5	1.1	0.2	0.2
Cornus florida	50	13	4.2	10	1	1.9	—	—	—	—	—	—	50	14	3.1	—	—
Fagus grandifolia	90	24	7.7	90	36	66.7	30	4	21.0	20	2	3.0	100	66	14.6	2.7	2.6
Fraxinus americana	100	81	25.9	10	1	1.9	—	—	—	10	1	1.5	100	83	18.4	0.7	0.7
Liriodendron tulip.	—	—	—	—	—	—	10	1	5.3	40	5	7.6	40	6	1.3	5.3	5.1
Ostrya virginiana	20	3	1.0	—	—	—	—	—	—	—	—	—	20	3	0.7	—	—
Prunus serotina	100	47	15.1	—	—	—	—	—	—	20	2	3.0	100	49	10.9	1.3	1.3
Quercus alba	—	—	—	—	—	—	—	—	—	40	9	13.6	40	9	2.0	7.6	7.3
Quercus rubra	50	11	3.5	—	—	—	30	4	21.0	100	46	69.7	100	61	13.5	83.4	80.3
Sassafras albidum	20	3	1.0	—	—	—	—	—	—	—	—	—	20	3	0.7	—	—
Tilia americana	10	1	0.3	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Ulmus americana	20	3	1.0	—	—	—	—	—	—	—	—	—	20	3	0.7	—	—
Ulmus rubra	10	3	1.0	—	—	—	—	—	—	—	—	—	10	3	0.7	—	—
Ulmus thomasii	—	—	—	—	—	—	10	1	5.3	—	—	—	10	1	0.2	0.4	0.4
TOTALS		312	69.2		54	12.0		19	4.2		66	14.6		451		103.9	

TABLE XXXVII. Summary of tree data based on ten 100 m^2 quadrats from stands 24 and 31, Jackson County, Waterloo Twp., T. 2 S., R. 2 E., SW ¼ section 1.

SPECIES	SIZE CLASS TOTALS												SPECIES TOTALS				
	2			3			4			5							
	FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		FREQ.	DENSITY		BASAL AREA	
	%	D	%	%	D	%	%	D	%	%	D	%	%	D	%	$FT.^2$	%
Acer rubrum	50	16	3.6	10	1	1.8	10	2	5.7	10	1	2.4	50	20	3.5	0.9	1.7
Acer saccharum	40	13	2.8	—	—	—	—	—	—	—	—	—	40	13	2.3	—	—
Amelanchier sp.	60	24	5.4	10	4	7.1	—	—	—	—	—	—	60	28	4.9	0.1	0.2
Carya ovalis	10	1	0.2	40	5	8.9	60	15	42.8	20	3	7.3	70	24	4.2	5.2	10.1
Carya ovata	—	—	—	—	—	—	10	1	2.9	—	—	—	10	1	0.2	0.4	0.8
Cornus florida	40	47	10.6	20	3	5.4	—	—	—	—	—	—	40	50	8.7	0.1	0.2
Fraxinus americana	100	171	38.6	70	22	39.3	10	1	2.9	10	1	2.4	100	195	33.7	1.1	2.1
Ostrya virginiana	100	133	30.0	80	19	33.9	10	4	11.4	—	—	—	100	156	27.2	0.7	1.4
Prunus serotina	90	30	6.8	20	2	3.6	—	—	—	—	—	—	90	32	5.6	0.1	0.2
Quercus alba	—	—	—	—	—	—	—	—	—	10	2	4.9	10	2	0.3	5.1	9.9
Quercus rubra	10	5	1.1	—	—	—	80	12	34.3	100	31	75.7	100	48	8.4	36.0	69.6
Quercus velutina	—	—	—	—	—	—	—	—	—	30	3	7.3	30	3	0.5	2.0	3.9
Sassafras albidum	10	1	0.2	—	—	—	—	—	—	—	—	—	10	1	0.2	—	—
Tilia americana	10	2	0.5	—	—	—	—	—	—	—	—	—	10	2	0.3	—	—
TOTALS		443	77.1		56	9.8		35	6.1		41	7.1		575		51.7	

TABLE XXXVIII. Summation indices compiled for trees of stand 1.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	3.4	—	—	—
Carya ovalis	1	1	13.9	20.9	31.9	22.4	67
Castanea dentata	—	—	—	6.5	8.7	—	—
Cornus florida	3	4	58.1	62.5	124.2	12.1	54
Crataegus sp.	—	—	—	2.1	—	—	—
Juglans nigra	—	—	—	2.1	—	—	—
Prunus serotina	2	2	27.4	50.6	26.4	—	—
Quercus alba	1	1	13.9	27.5	67.8	20.7	103
Quercus rubra	—	—	—	2.1	—	—	—
Quercus velutina	2	3	34.2	2.1	—	217.5	435
Sassafras albidum	4	5	62.0	20.2	35.5	27.3	82

Continuum index value 751

TABLE XXXIX. Summation indices compiled for trees of stand 2.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	35.0	—	—	—
Amelanchier sp.	—	—	—	5.9	39.5	—	—
Carya ovalis	3	3	28.1	14.2	—	25.2	76
Cornus florida	—	—	—	2.0	—	—	—
Prunus serotina	4	18	75.3	21.6	172.4	80.1	280
Quercus alba	1	1	9.5	20.4	52.0	10.6	53
Quercus velutina	6	12	72.4	8.4	—	168.7	338
Sassafras albidum	1	3	14.8	22.0	—	4.5	14
Tilia americana	—	—	—	—	—	4.6	41
Ulmus americana	—	—	—	—	36.1	—	—
Ulmus rubra	—	—	—	70.8	—	—	—

Continuum index value 852

TABLE XL. Summation indices compiled for trees of stand 3.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	2	16.6	17.5	5.0	14.0	105
Amelanchier sp.	—	—	—	3.1	—	—	—
Carya ovalis	—	—	—	3.1	—	—	—
Celtis occidentalis	—	—	—	2.6	—	—	—
Cornus florida	—	—	—	2.6	—	—	—
Crataegus sp.	—	—	—	5.3	—	—	—
Fagus grandifolia	—	—	—	2.6	—	—	—
Fraxinus americana	—	—	—	5.7	4.6	—	—
Juglans cinerea	1	2	10.0	2.6	10.9	9.4	56
Juglans nigra	—	—	—	8.0	11.7	9.3	47
Prunus nigra	—	—	—	—	7.0	—	—
Prunus serotina	2	2	16.6	50.9	94.8	40.1	140
Pyrus ioensis	—	—	—	6.5	12.1	—	—
Quercus alba	—	—	—	8.2	77.4	20.5	103
Quercus velutina	9	52	146.8	7.8	—	197.9	396
Sassafras albidum	1	2	10.0	66.5	41.4	9.2	28
Ulmus americana	—	—	—	—	20.7	—	—
Ulmus rubra	—	—	—	6.5	6.2	—	—

Continuum index value 875

TABLE XLI. Summation indices compiled for trees of stand 4.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	7.2	—	—	—
Acer saccharum	—	—	—	3.4	—	—	—
Amelanchier sp.	2	3	24.0	12.1	—	—	—
Carya ovalis	3	3	30.7	9.1	48.8	49.3	148
Cornus florida	2	4	27.6	90.1	193.3	32.8	148
Crataegus sp.	—	—	—	1.7	8.2	—	—
Juniperus virginiana	—	—	—	1.7	—	—	—
Ostrya virginiana	—	—	—	3.6	—	—	—
Prunus serotina	2	7	38.3	29.3	15.5	14.6	51
Quercus alba	—	—	—	13.1	22.5	42.1	210
Quercus velutina	2	4	27.6	3.4	—	161.2	322
Sassafras albidum	4	7	51.6	11.7	—	—	—
Ulmus americana	—	—	—	3.4	—	—	—

Continuum index value 879

TABLE XLII. Summation indices compiled for trees of stand 5.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	15.0	17.0	—	—
Amelanchier sp.	—	—	—	11.1	21.4	—	—
Carya ovalis	4	5	43.9	18.2	—	62.0	186
Carya ovata	1	1	9.9	—	—	—	—
Cornus florida	—	—	—	7.1	12.3	—	—
Crataegus sp.	—	—	—	3.9	—	—	—
Ostrya virginiana	—	—	—	12.3	—	—	—
Prunus serotina	3	4	34.1	65.9	201.5	18.5	66
Quercus alba	2	2	19.8	8.7	—	60.2	301
Quercus rubra	2	2	19.8	11.1	—	4.7	31
Quercus velutina	2	3	24.1	3.7	—	139.7	279
Sassafras albidum	3	5	38.4	34.1	47.8	14.5	44
Tilia americana	—	—	—	2.1	—	—	—
Ulmus americana	1	1	9.9	—	—	—	—
Ulmus rubra	—	—	—	7.3	—	—	—

Continuum index value 907

TABLE XLIII. Summation indices compiled for trees of stand 6.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	6	31.2	28.3	99.5	21.5	161
Acer saccharum	--	--	--	5.2	6.0	--	--
Amelanchier sp.	--	--	--	4.1	12.2	--	--
Carya ovalis	3	5	28.5	23.7	6.0	31.5	94
Celtis occidentalis	--	--	--	1.7	--	--	--
Cornus florida	--	--	--	18.6	15.7	4.2	19
Crataegus sp.	--	--	--	1.7	--	--	--
Fagus grandifolia	--	--	--	--	13.4	--	--
Morus rubra	--	--	--	1.7	--	--	--
Prunus serotina	3	5	25.8	36.1	78.6	44.7	157
Pyrus ioensis	--	--	--	--	6.0	--	--
Quercus alba	1	2	10.4	18.3	15.7	30.9	154
Quercus velutina	3	6	31.2	7.0	--	157.4	315
Sassafras albidum	6	12	62.4	44.4	22.4	9.8	29
Ulmus americana	1	1	7.4	2.2	24.6	--	--
Ulmus rubra	--	--	--	7.1	--	--	--

Continuum index value 929

TABLE XLIV. Summation indices for trees of stand 7.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	2	37.5	22.0	41.9	4.7	35
Acer saccharum	—	—	—	1.8	—	—	—
Amelanchier sp.	—	—	—	13.3	41.4	—	—
Carya ovalis	1	1	18.7	27.2	10.1	60.8	182
Ostrya virginiana	—	—	—	3.7	—	—	—
Prunus serotina	—	—	—	29.5	118.7	12.6	44
Quercus alba	1	2	25.0	11.3	31.7	44.6	223
Quercus rubra	1	1	18.7	11.5	—	26.8	174
Quercus velutina	—	—	—	4.6	—	150.6	301
Sassafras albidum	3	10	99.0	66.4	56.4	—	—
Ulmus americana	—	—	—	8.8	—	—	—

Continuum index value 960

TABLE XLV. Summation indices for trees of stand 8.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	—	19.6	—	—
Amelanchier sp.	—	—	—	11.2	9.6	—	—
Carya ovalis	1	2	14.8	59.3	182.2	35.8	107
Crataegus sp.	3	3	34.7	24.4	—	—	—
Fraxinus americana	—	—	—	2.1	—	—	—
Juniperus virginiana	—	—	—	2.1	—	—	—
Prunus serotina	—	—	—	30.1	36.8	4.8	17
Quercus alba	—	—	—	—	15.9	35.5	172
Quercus rubra	4	16	85.0	23.1	10.7	71.9	467
Quercus velutina	1	4	21.2	9.5	—	152.0	304
Sassafras albidum	3	6	44.3	26.9	16.4	—	—
Tilia americana	—	—	—	9.1	—	—	—
Ulmus americana	—	—	—	2.1	8.8	—	—

Continuum index value 967

TABLE XLVI. Summation indices compiled for trees of stand 9.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	12.9	23.7	8.4	63
Acer saccharum	—	—	—	—	—	4.2	42
Amelanchier sp.	—	—	—	6.0	—	—	—
Carya ovalis	1	1	9.0	8.9	9.1	22.7	68
Cornus florida	—	—	—	109.3	74.4	24.2	109
Fagus grandifolia	—	—	—	—	6.3	—	—
Crataegus sp.	—	—	—	2.8	—	—	—
Liriodendron tulipifera	—	—	—	—	4.2	—	—
Prunus serotina	6	10	74.7	24.6	14.1	9.4	31
Quercus alba	—	—	—	2.8	—	60.6	303
Quercus rubra	—	—	—	2.8	—	—	—
Quercus velutina	6	8	60.9	2.8	—	155.4	311
Sassafras albidum	5	8	55.4	23.9	58.2	15.1	45
Ulmus americana	—	—	—	2.8	—	—	—

Continuum index value 974

TABLE XLVII. Summation indices compiled for trees of stand 10.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	4	13	28.1	14.3	26.6	6.3	45
Amelanchier sp.	2	2	8.0	40.3	28.2	—	—
Carpinus caroliniana	—	—	—	1.7	6.7	—	—
Carya ovalis	8	20	48.0	12.0	33.0	92.9	279
Carya ovata	—	—	—	1.5	—	6.3	41
Crataegus sp.	3	4	13.3	25.4	14.1	—	—
Fraxinus americana	4	7	20.0	26.7	7.5	—	—
Juglans nigra	—	—	—	3.9	—	—	—
Ostrya virginiana	—	—	—	—	10.8	5.3	42
Prunus americana	—	—	—	5.6	—	—	—
Prunus avium	1	1	4.0	2.2	—	5.3	19
Prunus serotina	6	9	28.0	23.6	88.0	5.6	20
Quercus alba	2	8	16.1	12.6	63.1	71.0	355
Quercus rubra	4	4	15.9	9.0	—	—	—
Quercus velutina	—	—	—	4.3	—	107.3	215
Ulmus americana	4	6	18.6	11.2	22.0	—	—
Ulmus rubra	—	—	—	5.5	—	—	—

Continuum index value 1016

TABLE XLVIII. Summation indices compiled for trees of stand 11.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	9	19	64.0	68.1	103.8	19.4	145
Amelanchier sp.	—	—	—	17.8	7.0	—	—
Carya ovalis	1	1	5.3	12.7	58.5	24.3	73
Celtis occidentalis	—	—	—	1.6	—	—	—
Cornus florida	2	3	12.3	12.0	50.3	4.9	22
Prunus serotina	3	8	23.8	31.5	25.5	6.8	24
Quercus alba	4	8	27.7	17.3	—	96.7	483
Quercus rubra	—	—	—	3.2	—	—	—
Quercus velutina	6	25	61.6	10.1	—	136.9	272
Sassafras albidum	1	1	5.3	24.2	54.9	10.8	32
Ulmus americana	—	—	—	1.6	—	—	—

Continuum index value 1051

TABLE XLIX. Summation indices compiled for trees of stand 12.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	1	1	8.2	9.1	27.2	4.2	31
Amelanchier sp.	1	1	8.2	24.4	21.9	—	—
Carpinus caroliniana	—	—	—	1.5	—	—	—
Carya ovalis	3	4	27.0	15.5	48.8	20.7	62
Carya ovata	—	—	—	3.2	—	—	—
Cornus florida	—	—	—	4.5	—	—	—
Crataegus sp.	—	—	—	12.8	—	—	—
Fraxinus americana	—	—	—	16.4	7.1	—	—
Prunus serotina	5	16	68.7	30.0	60.0	24.5	86
Quercus alba	2	7	29.0	15.9	60.6	78.8	399
Quercus rubra	2	3	18.8	13.5	7.1	44.2	288
Quercus velutina	—	—	—	—	—	127.6	255
Sassafras albidum	4	7	40.1	52.0	53.6	—	—
Tilia americana	—	—	—	1.5	—	—	—
Ulmus americana	—	—	—	—	14.0	—	—

Continuum index value 1116

TABLE L. Summation indices compiled for trees of stand 13.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	--	--	--	4.9	5.9	--	--
Acer saccharum	--	--	--	4.0	--	--	--
Amelanchier sp.	1	2	8.2	16.5	49.5	5.4	22
Carya ovalis	2	2	12.9	4.4	3.7	5.4	16
Cornus florida	5	32	78.0	55.7	148.9	--	--
Crataegus sp.	--	--	--	2.2	--	--	--
Fagus grandifolia	--	--	--	2.0	9.2	5.4	54
Fraxinus americana	--	--	--	7.0	--	--	--
Ostrya virginiana	2	5	18.0	25.1	34.5	5.4	43
Populus grandidentata	--	--	--	--	--	5.6	8
Prunus serotina	3	5	22.8	47.5	23.0	7.5	26
Quercus alba	--	--	--	6.3	9.9	99.5	498
Quercus rubra	1	1	6.5	8.6	10.2	26.3	171
Quercus velutina	5	9	39.1	--	--	126.5	253
Sassafras albidum	2	3	14.6	13.9	5.2	13.0	39
Tilia americana	--	--	--	2.0	--	--	--

Continuum index value 1130

TABLE LI. Summation indices compiled for trees of stand 14.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	6	41.0	23.5	25.9	10.4	78
Acer saccharum	--	--	--	2.0	--	--	--
Amelanchier sp.	--	--	--	11.0	31.0	--	--
Carya ovalis	4	6	47.2	46.0	112.5	82.8	248
Cornus florida	--	--	--	28.3	28.7	3.4	15
Fraxinus americana	--	--	--	18.6	12.3	25.2	151
Prunus nigra	1	1	9.9	12.5	57.8	15.5	54
Prunus serotina	3	8	48.4	--	--	--	--
Quercus alba	1	1	9.9	8.5	13.6	74.4	372
Quercus rubra	2	2	19.9	9.3	--	15.9	104
Quercus velutina	2	3	23.6	2.2	--	60.7	121
Sassafras albidum	--	--	--	27.6	13.1	3.5	10
Tilia americana	--	--	--	6.6	--	--	--
Ulmus americana	--	--	--	4.0	5.9	8.2	57

Continuum index value 1210

TABLE LII. Summation indices compiled for trees of stand 15.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	2	18.5	8.8	44.2	4.2	31
Acer saccharum	1	1	9.3	21.3	--	6.7	67
Carya ovalis	5	5	46.3	6.0	--	27.3	82
Cornus florida	4	9	55.5	99.2	185.6	26.0	117
Fagus grandifolia	--	--	--	5.5	22.8	23.4	239
Prunus serotina	2	4	25.9	6.0	22.4	12.8	45
Quercus alba	--	--	--	--	--	58.2	291
Quercus rubra	--	--	--	--	--	5.8	38
Quercus velutina	3	4	31.5	--	--	108.8	218
Sassafras albidum	--	--	--	12.8	--	19.9	60
Tilia americana	--	--	--	6.8	10.6	3.4	31
Ulmus americana	1	2	13.0	14.6	14.4	3.0	21
Ulmus rubra	--	--	--	19.0	--	--	--

Continuum index value 1240

TABLE LIII. Summation indices compiled for trees of stand 16.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	—	—	—	11.5	38.0	6.8	51
Acer saccharum	—	—	—	—	12.3	—	—
Amelanchier sp.	—	—	—	15.1	12.3	—	—
Carya ovalis	—	—	—	18.0	89.1	48.1	144
Cornus florida	1	2	15.1	21.3	74.5	—	—
Crataegus sp.	—	—	—	13.1	—	—	—
Fraxinus americana	—	—	—	14.1	—	—	—
Prunus serotina	2	3	26.5	25.1	42.0	14.7	51
Quercus alba	1	1	11.4	19.6	10.6	43.9	220
Quercus rubra	7	13	102.0	17.6	10.6	94.5	615
Quercus velutina	1	1	11.4	—	—	84.7	169
Sassafras albidum	1	7	33.6	39.9	10.6	7.3	22
Tilia americana	—	—	—	1.5	—	—	—
Ulmus americana	—	—	—	1.5	—	—	—
Ulmus rubra	—	—	—	1.7	—	—	—

Continuum index value 1272

TABLE LIV. Summation indices compiled for trees of stand 17.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	4	10	22.2	22.6	44.3	--	--
Amelanchier sp.	--	--	--	3.4	14.7	--	--
Carpinus caroliniana	--	--	--	5.1	6.4	--	--
Carya ovalis	1	1	4.1	7.1	--	--	--
Cornus florida	3	10	19.0	55.0	158.6	4.2	19
Crataegus sp.	--	--	--	1.7	--	--	--
Fagus grandifolia	--	--	--	3.3	5.7	4.2	42
Fraxinus americana	--	--	--	2.2	--	13.4	80
Liriodendron tulipifera	--	--	--	--	--	6.5	32
Ostrya virginiana	--	--	--	1.9	5.7	4.2	34
Pinus strobus	--	--	--	--	--	10.0	50
Populus grandidentata	--	--	--	--	--	5.1	8
Populus tremuloides	--	--	--	3.4	--	--	--
Prunus serotina	2	6	12.1	13.7	--	--	--
Pyrus ioensis	--	--	--	3.8	--	--	--
Quercus alba	2	14	19.6	12.3	52.5	114.8	574
Quercus macrocarpa	--	--	--	--	--	5.1	10
Quercus rubra	3	5	14.4	10.9	5.7	51.2	333
Quercus velutina	7	23	44.1	7.4	--	76.7	154
Sassafras albidum	9	38	64.5	46.9	6.4	4.5	14

Continuum index value 1350

TABLE LV. Summation indices compiled for trees of stand 18.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	1	1	15.0	32.0	82.4	25.0	188
Amelanchier sp.	--	--	--	5.1	5.1	--	--
Carya cordiformis	--	--	--	--	6.6	--	--
Carya ovalis	1	1	15.0	7.6	6.9	12.0	36
Cornus florida	--	--	15.0	101.1	154.6	3.6	16
Fagus grandifolia	--	--	--	--	5.1	--	--
Liriodendron tulipifera	--	--	--	--	5.1	--	--
Pinus strobus	--	--	--	--	--	--	--
Populus grandidentata	--	--	--	2.5	--	--	--
Prunus serotina	1	1	15.0	--	5.1	--	--
Quercus alba	--	--	--	5.1	7.3	35.9	178
Quercus rubra	1	1	15.0	2.1	14.8	93.3	607
Quercus velutina	5	8	95.0	--	6.9	105.5	211
Sassafras albidum	1	1	15.0	17.4	--	--	--
Tilia americana	1	1	15.0	--	--	--	--

Continuum index value 1359

TABLE LVI. Summation indices compiled for trees of stand 19.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	9	23	58.7	85.8	73.0	15.2	114
Acer saccharum	--	--	--	6.9	--	--	--
Amelanchier	1	1	4.2	6.9	--	--	--
Carya ovalis	6	8	28.5	9.7	28.2	29.5	89
Ostrya virginiana	--	--	--	2.3	7.9	--	--
Pinus strobus	--	--	--	--	--	11.7	58
Prunus serotina	3	5	15.7	48.7	153.0	--	--
Quercus alba	6	8	28.5	2.3	--	133.2	668
Quercus rubra	6	20	45.9	13.7	--	61.2	398
Sassafras albidum	4	5	18.5	19.2	37.9	23.0	69
Ulmus americana	--	--	--	4.6	--	--	--

Continuum index value 1396

TABLE LVII. Summation indices compiled for trees of stand 20.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	1	1	12.4	14.3	77.7	57.8	433
Amelanchier sp.	—	—	—	2.6	—	—	—
Carya cordiformis	—	—	—	6.5	14.4	3.6	31
Carya ovalis	—	—	—	4.2	13.2	—	—
Carya ovata	—	—	—	4.7	18.2	12.8	83
Cornus florida	1	1	12.4	42.0	65.8	—	—
Fagus grandifolia	—	—	—	—	—	3.8	38
Fraxinus americana	2	4	35.3	22.3	—	3.6	22
Juglans nigra	—	—	—	2.0	—	—	—
Liriodendron tulipifera	—	—	—	2.0	—	—	—
Ostrya virginiana	—	—	—	31.9	68.4	8.4	66
Prunus serotina	6	9	90.2	44.9	27.2	5.3	19
Quercus alba	—	—	—	—	—	32.3	162
Quercus rubra	—	—	—	—	—	37.8	250
Quercus velutina	3	3	37.2	—	—	114.9	230
Sassafras albidum	1	1	12.4	20.3	14.9	3.6	11
Ulmus americana	—	—	—	2.4	—	16.1	81

Continuum index value 1426

TABLE LVIII. Summation indices compiled for trees of stand 21.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	--	--	--	8.7	11.3	--	--
Acer saccharum	--	--	--	16.5	13.9	--	--
Carya ovalis	4	5	52.6	33.2	36.9	33.4	100
Celtis occidentalis	--	--	--	11.2	6.9	3.9	31
Cornus florida	--	--	--	8.1	27.4	--	--
Prunus avium	--	--	--	--	12.4	4.3	15
Prunus serotina	1	1	11.9	14.3	115.7	54.1	189
Quercus alba	1	4	26.1	3.9	--	79.6	398
Quercus rubra	5	7	69.0	16.5	--	90.5	588
Quercus velutina	1	2	16.6	--	--	21.2	42
Sassafras albidum	--	--	--	14.4	17.2	3.9	12
Ulmus americana	--	--	--	14.0	14.6	4.0	28
Ulmus rubra	2	2	23.8	54.9	43.7	5.1	41

Continuum index value 1444

TABLE LIX. Summation indices compiled for trees of stand 22.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	2	9.6	21.9	49.6	4.6	34
Amelanchier sp.	—	—	—	15.1	27.1	—	—
Carya ovalis	3	6	18.9	35.6	79.0	64.8	194
Cornus florida	2	10	21.9	10.5	28.5	—	—
Crataegus sp.	3	4	15.9	5.3	—	—	—
Fraxinus americana	5	6	25.3	21.2	6.1	—	—
Juniperus virginiana	—	—	—	1.7	—	—	—
Prunus serotina	4	8	25.2	16.7	27.7	15.6	55
Pyrus ioensis	—	—	—	4.4	13.9	—	—
Quercus alba	1	1	4.7	18.5	27.9	85.3	426
Quercus rubra	7	21	54.9	24.4	34.1	103.7	675
Quercus velutina	—	—	—	—	—	21.4	43
Sassafras albidum	2	5	14.2	22.7	—	—	—
Ulmus americana	2	2	9.6	1.9	6.1	4.6	32

Continuum index value 1459

TABLE LX. Summation indices compiled for trees of stand 23.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	5	25	73.7	18.3	54.7	24.2	181
Acer saccharum	--	--	--	7.1	12.7	--	--
Amelanchier sp.	3	3	19.3	18.6	19.9	--	--
Carya cordiformis	1	1	6.5	2.9	--	--	--
Carya ovalis	2	2	12.9	4.6	11.2	37.7	113
Carya ovata	--	--	--	--	8.9	--	--
Cornus florida	1	1	6.5	53.9	125.0	12.8	58
Fagus grandifolia	--	--	--	4.5	--	6.5	65
Fraxinus americana	4	8	34.1	29.9	12.3	6.4	38
Nyssa sylvatica	--	--	--	2.5	--	4.8	38
Ostrya virginiana	--	--	--	8.7	21.0	--	--
Pinus strobus	--	--	--	--	--	6.5	32
Populus grandidentata	--	--	--	--	--	3.6	5
Prunus serotina	4	5	27.8	21.1	13.4	3.9	14
Quercus alba	--	--	--	2.7	--	23.1	116
Quercus rubra	1	1	6.5	2.8	3.7	102.6	667
Quercus velutina	--	--	--	--	--	64.7	129
Sassafras albidum	1	1	6.5	13.1	13.5	--	--
Tilia americana	--	--	--	7.6	3.7	3.2	29
Ulmus americana	1	1	6.5	1.6	--	--	--

Continuum index value 1485

TABLE LXI. Summation indices compiled for trees of stand 24.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	--	--	--	9.1	4.5	--	--
Acer saccharum	--	--	--	4.5	--	--	--
Amelanchier	--	--	--	15.0	11.6	--	--
Carya ovalis	--	--	--	2.3	28.1	91.7	272
Cornus florida	--	--	--	17.5	4.5	--	--
Crataegus sp.	--	--	--	6.9	--	--	--
Fagus grandifolia	--	--	--	--	--	4.7	47
Fraxinus americana	3	4	50.0	67.1	149.3	10.7	64
Ostrya virginiana	--	--	--	33.4	63.5	--	--
Prunus serotina	2	2	30.0	23.1	21.0	--	--
Quercus alba	--	--	--	4.5	--	49.5	249
Quercus rubra	5	14	120.0	6.2	--	130.2	858
Quercus velutina	--	--	--	--	--	13.2	26
Sassafras albidum	--	--	--	8.1	12.6	--	--
Ulmus americana	--	--	--	2.3	4.9	--	--

Continuum index value 1516

TABLE LXII. Summation indices compiled for trees of stand 25.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	10	133	84.0	60.6	--	33.6	252
Acer saccharum	--	--	--	--	--	--	--
Amelanchier sp.	5	12	18.4	20.8	217.9	--	--
Carya ovalis	1	2	3.5	3.4	--	--	--
Carya ovata	--	--	--	1.6	--	--	--
Crataegus sp.	--	--	--	1.6	--	--	--
Fraxinus americana	7	16	25.4	31.4	82.1	--	--
Ostrya virginiana	--	--	--	1.6	--	--	--
Prunus americana	--	--	--	3.5	--	--	--
Prunus avium	--	--	--	3.3	--	--	--
Prunus serotina	8	59	46.6	26.0	--	33.3	117
Quercus alba	--	--	--	--	--	18.3	92
Quercus rubra	4	5	12.7	4.9	--	153.9	1000
Quercus velutina	1	2	3.5	--	--	54.6	109
Sassafras albidum	--	--	--	20.0	--	6.3	19
Tilia americana	--	--	--	1.6	--	--	--
Ulmus americana	1	1	3.0	14.1	--	--	--
Ulmus rubra	1	1	3.0	5.3	--	--	--

Continuum index value 1589

TABLE LXIII. Summation indices compiled for trees of stand 26.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	2	17.8	8.6	18.6	8.9	66
Acer saccharum	2	2	17.8	42.2	62.1	4.5	45
Amelanchier sp.	--	--	--	10.7	4.4	--	--
Carpinus caroliniana	--	--	--	9.3	4.8	--	--
Carya cordiformis	--	--	--	5.2	--	--	--
Carya ovalis	2	2	17.8	5.9	14.9	26.4	79
Carya ovata	--	--	--	--	--	5.6	36
Cornus florida	--	--	--	21.2	88.1	8.9	40
Crataegus sp.	--	--	--	5.9	--	--	--
Fagus grandifolia	--	--	--	--	10.2	--	--
Fraxinus americana	5	7	53.0	47.6	3.3	--	--
Ostrya virginiana	2	2	17.8	14.0	40.9	4.4	35
Prunus serotina	4	5	40.0	10.0	6.4	--	--
Quercus alba	--	--	--	--	4.0	81.2	406
Quercus rubra	2	2	17.8	4.0	9.2	118.9	773
Quercus velutina	--	--	--	--	--	31.9	64
Sassafras albidum	--	--	--	6.6	12.3	4.4	13
Tilia americana	2	2	17.8	5.9	17.5	4.9	40
Ulmus americana	--	--	--	2.6	2.9	--	--

Continuum index value 1552

TABLE LXIV. Summation indices compiled for trees of stand 27.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	9	31.6	20.1	81.6	72.2	542
Amelanchier sp.	3	6	25.0	39.2	37.1	--	--
Carpinus caroliniana	1	2	8.3	--	28.1	--	--
Carya ovalis	2	5	18.9	10.7	29.1	40.0	120
Carya ovata	--	--	--	1.5	7.8	6.5	42
Crataegus sp.	--	--	--	23.4	12.2	--	--
Fraxinus americana	4	5	26.9	53.1	39.5	4.9	29
Ostrya virginiana	--	--	--	2.8	12.5	--	--
Populus grandidentata	--	--	--	--	--	7.3	11
Prunus avium	1	1	6.2	1.5	12.4	4.9	17
Prunus serotina	2	2	12.3	16.3	11.5	10.1	35
Prunus sp.	--	--	--	1.7	--	--	--
Pyrus ioensis	--	--	--	1.5	--	--	--
Quercus alba	2	5	18.9	9.6	12.2	49.8	249
Quercus bicolor	--	--	--	--	--	4.9	25
Quercus rubra	4	8	33.4	7.5	--	77.0	550
Quercus velutina	1	1	6.2	--	--	22.4	45
Tilia americana	--	--	--	--	5.0	--	--
Ulmus americana	2	2	12.3	11.1	6.3	--	--
Ulmus rubra	--	--	--	--	4.7	--	--

Continuum index value 1665

TABLE LXV. Summation indices compiled for trees of stand 28.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	1	1	8.3	46.1	137.9	31.6	237
Acer saccharum	--	--	--	3.2	5.0	--	--
Amelanchier sp.	--	--	--	17.9	23.3	--	--
Carya ovalis	1	2	10.2	24.2	23.1	36.4	109
Cornus florida	--	--	--	21.7	27.9	--	--
Crataegus sp.	1	3	12.2	2.1	--	--	--
Fraxinus americana	1	1	8.3	32.9	29.0	5.2	31
Prunus serotina	2	3	18.1	25.9	26.1	5.1	18
Quercus alba	--	--	--	2.9	--	70.9	352
Quercus rubra	10	41	142.9	10.9	15.4	145.5	953
Sassafras albidum	--	--	--	4.2	--	--	--
Tilia americana	--	--	--	2.9	12.3	5.3	48
Ulmus americana	--	--	--	5.2	--	--	--

Continuum index value 1748

TABLE LXVI. Summation indices compiled for trees of stand 29.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	13	48.3	12.3	35.4	38.8	291
Acer saccharum	--	--	--	2.4	15.8	3.9	39
Amelanchier sp.	--	--	--	9.2	--	--	--
Carpinus caroliniana	--	--	--	14.6	--	--	--
Carya cordiformis	--	--	--	3.4	--	--	--
Carya ovalis	1	1	7.8	10.3	13.7	27.4	82
Carya ovata	1	2	10.3	5.8	12.9	26.8	181
Cornus florida	2	3	18.0	44.2	110.5	3.8	17
Crataegus sp.	--	--	--	4.9	--	--	--
Fraxinus americana	--	--	--	24.6	8.7	8.3	50
Ostrya virginiana	3	7	33.3	23.1	84.0	3.8	30
Prunus serotina	4	5	33.5	7.1	--	4.5	16
Pyrus ioensis	--	--	--	1.3	--	--	--
Quercus alba	--	--	--	1.3	--	58.1	291
Quercus rubra	4	8	41.0	--	--	100.4	653
Quercus velutina	--	--	--	1.1	--	16.3	33
Sassafras albidum	--	--	--	3.4	--	--	--
Tilia americana	--	--	--	7.1	7.2	7.9	71
Tsuga canadensis	--	--	--	1.3	--	--	--
Ulmus americana	--	--	--	4.4	--	--	--
Ulmus rubra	1	1	7.8	12.1	11.7	--	--

Continuum index value 1754

TABLE LXVII. Summation indices compiled for trees of stand 30.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	5	13.3	16.8	36.4	10.2	77
Acer saccharum	6	10	26.8	55.2	131.0	25.5	255
Amelanchier sp.	3	10	17.9	29.4	40.7	--	--
Carpinus caroliniana	--	--	--	13.1	24.8	--	--
Carya cordiformis	1	1	3.8	1.6	--	--	--
Carya ovalis	--	--	--	7.1	--	--	--
Carya ovata	1	1	3.8	--	--	9.5	62
Crataegus sp.	1	2	4.7	2.1	3.3	--	--
Fagus grandifolia	--	--	--	1.6	4.0	--	--
Fraxinus americana	3	3	11.5	17.6	--	4.4	26
Ostrya virginiana	3	23	29.7	22.3	33.0	--	--
Pinus strobus	--	--	--	1.6	3.3	4.0	20
Prunus serotina	4	25	34.5	5.9	4.7	22.0	77
Quercus alba	1	1	3.8	3.6	4.4	118.0	590
Quercus rubra	6	27	42.2	1.6	5.0	98.3	640
Sassafras albidum	--	--	--	6.4	4.4	--	--
Tilia americana	2	2	7.6	5.2	--	--	--
Tsuga canadensis	--	--	--	5.2	5.0	8.1	81
Ulmus americana	--	--	--	1.6	--	--	--
Ulmus rubra	--	--	--	1.9	--	--	--

Continuum index value 1758

TABLE LXVIII. Summation indices compiled for trees of stand 31.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	4	16.3	17.2	21.8	18.3	137
Acer saccharum	1	1	6.2	38.4	--	5.6	56
Amelanchier sp.	--	--	--	12.4	24.1	4.7	18
Carya ovalis	2	3	14.3	--	--	54.6	164
Cornus florida	--	--	--	22.1	27.2	4.9	22
Fraxinus americana	6	14	53.0	45.5	67.2	6.9	51
Ostrya virginiana	2	5	18.3	40.1	149.7	30.1	241
Prunus serotina	2	2	12.3	18.5	--	--	--
Quercus alba	2	3	14.3	--	--	5.5	28
Quercus rubra	7	18	65.3	3.9	--	157.5	1025
Quercus velutina	--	--	--	--	--	11.9	24
Sassafras albidum	--	--	--	1.9	--	--	--
Tilia americana	--	--	--	--	10.0	--	--

Continuum index value 1766

TABLE LXIX. Summation indices compiled for trees of stand 32.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	4	5	19.5	25.7	78.7	44.7	335
Amelanchier sp.	--	--	--	13.4	21.5	--	--
Carya ovalis	4	6	20.7	15.8	87.6	47.8	143
Cornus florida	3	13	25.3	52.9	66.1	4.9	22
Fraxinus americana	4	5	19.5	41.9	--	--	--
Prunus serotina	3	9	20.6	24.5	23.6	--	--
Quercus alba	1	1	4.5	8.1	12.6	18.0	90
Quercus rubra	10	48	89.8	10.7	9.9	179.4	1168
Quercus velutina	--	--	--	--	--	5.2	10
Sassafras albidum	--	--	--	2.7	--	--	--
Ulmus americana	--	--	--	4.3	--	--	--

Continuum index value 1768

TABLE LXX. Summation indices compiled for trees of stand 33.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	8	47	36.3	20.8	29.1	10.0	75
Acer saccharum	2	2	4.5	22.7	9.9	13.1	131
Amelanchier sp.	3	11	10.5	8.8	45.4	9.5	38
Carpinus caroliniana	—	—	—	1.3	—	—	—
Carya ovalis	1	1	2.2	2.4	14.3	33.4	100
Carya ovata	1	1	2.2	1.4	—	12.7	83
Cornus florida	4	10	11.6	8.5	16.1	7.9	36
Crataegus sp.	2	2	4.5	8.5	—	—	—
Fraxinus americana	10	57	44.5	43.8	—	15.6	94
Ostrya virginiana	4	21	16.9	36.3	145.6	21.0	168
Prunus serotina	5	8	12.4	9.7	12.4	10.0	35
Quercus alba	—	—	—	—	—	72.6	363
Quercus rubra	5	9	12.9	4.8	—	63.6	414
Tilia americana	7	30	26.4	7.8	27.2	30.6	275
Ulmus americana	5	6	11.5	13.7	—	—	—
Ulmus rubra	1	4	3.6	9.4	—	—	—

Continuum index value 1812

TABLE LXXI. Summation indices compiled for trees of stand 34.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	3	14.2	3.0	14.6	31.6	237
Acer saccharum	3	57	119.1	71.7	194.0	15.4	154
Amelanchier sp.	--	--	--	8.0	--	--	--
Carpinus caroliniana	5	6	33.3	2.7	--	--	--
Carya cordiformis	--	--	--	--	--	7.8	66
Carya ovalis	--	--	--	2.7	--	3.9	12
Cornus florida	--	--	--	25.7	11.4	3.8	17
Fagus grandifolia	--	--	--	14.4	47.1	10.4	104
Fraxinus americana	3	4	20.6	39.1	--	3.8	23
Liriodendron tulipifera	--	--	--	--	--	7.8	39
Ostrya virginiana	1	1	6.4	8.9	32.9	7.5	60
Prunus serotina	--	--	--	12.2	--	8.0	28
Quercus alba	--	--	--	--	--	111.9	595
Quercus rubra	--	--	--	--	--	73.7	480
Quercus velutina	--	--	--	--	--	8.9	18
Tilia americana	1	1	6.4	8.6	--	5.5	49
Ulmus americana	--	--	--	2.7	--	--	--

Continuum index value 1852

TABLE LXXII. Summation indices compiled for trees of stand 35.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	2	5	15.1	13.4	36.7	19.3	145
Acer saccharum	3	4	17.4	25.2	65.7	29.0	290
Amelanchier sp.	---	---	---	2.0	8.2	---	---
Carpinus caroliniana	---	---	---	14.9	26.2	---	---
Carya cordiformis	---	---	---	4.2	8.5	8.6	73
Carya ovalis	---	---	---	1.7	---	7.0	21
Cornus florida	1	3	8.5	12.3	38.1	3.4	15
Crataegus sp.	---	---	---	2.9	7.8	---	---
Fagus grandifolia	1	1	5.3	2.6	14.8	5.8	58
Fraxinus americana	4	13	35.4	29.0	6.5	12.5	75
Fraxinus nigra	1	2	6.9	---	---	3.5	18
Ostrya virginiana	1	4	10.0	31.6	26.9	9.3	74
Populus grandidentata	2	2	10.6	3.3	---	---	---
Prunus serotina	3	15	34.9	10.8	7.8	4.4	15
Quercus alba	1	1	5.3	---	---	---	---
Quercus rubra	6	10	38.1	5.9	---	107.9	701
Quercus velutina	---	---	---	---	---	34.9	70
Sassafras albidum	---	---	---	6.2	---	---	---
Tilia americana	---	---	---	17.4	52.8	28.8	259
Ulmus americana	---	---	---	6.8	---	---	---
Ulmus rubra	2	3	12.2	7.8	---	6.7	54

Continuum index value 1868

TABLE LXXIII. Summation indices compiled for trees of stand 36.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	1	4	19.2	18.1	11.0	18.5	139
Acer saccharum	--	--	--	29.3	75.6	16.3	163
Carpinus caroliniana	--	--	--	18.8	7.2	--	--
Carya ovata	1	1	9.8	3.4	11.6	4.1	27
Cornus florida	--	--	--	11.2	7.2	--	--
Fagus grandifolia	--	--	--	20.4	177.7	22.7	227
Fraxinus americana	6	8	65.0	40.0	9.7	4.7	28
Liriodendron tulipifera	--	--	--	--	--	23.4	117
Ostrya virginiana	--	--	--	3.8	--	--	--
Prunus serotina	4	11	61.1	29.2	--	8.8	31
Quercus alba	1	1	9.8	--	--	29.2	146
Quercus rubra	2	7	35.1	10.5	--	167.9	1090
Sassafras albidum	--	--	--	3.8	--	--	--
Tilia americana	--	--	--	1.7	--	--	--
Ulmus americana	--	--	--	3.8	--	--	--
Ulmus rubra	--	--	--	2.4	--	--	--
Ulmus thomasii	--	--	--	--	--	4.4	31

Continuum index value 1999

TABLE LXXIV. Summation indices compiled for trees of stands 24 and 31.

	Class 1			Class 2	Class 3	Classes 4 and 5	
	No. Quads.	No. Stems	DF_r Value	DF_r Value	Significance Value	Importance Value	Weighted Importance Value
Acer rubrum	3	5	31.4	13.2	6.6	9.7	73
Acer saccharum	1	1	8.4	10.5	--	--	--
Amelanchier sp.	--	--	--	16.9	21.6	--	--
Carya ovalis	1	1	8.4	2.1	39.4	57.6	173
Carya ovata	--	--	--	--	--	6.1	40
Cornus florida	--	--	--	18.3	18.2	--	--
Fraxinus americana	5	9	54.4	57.9	102.1	12.0	72
Ostrya virginiana	5	11	60.7	49.3	95.7	10.1	81
Prunus serotina	2	3	19.9	24.1	16.4	--	--
Quercus alba	--	--	--	--	--	16.7	84
Quercus rubra	2	2	16.8	3.0	--	167.9	1090
Quercus velutina	--	--	--	--	--	19.9	40
Sassafras albidum	--	--	--	2.1	--	--	--
Tilia americana	--	--	--	2.4	--	--	--

Continuum index value 1653

TABLE LXXV. Number of occurrences of tree species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Acer rubrum	1	9	6	4	7	10	7	1	7	6	10	5	2	7	6	7	10	10	10	10	4	10	10	3	10	5	9	10	1	9	9	8	10	6	6	9
Acer saccharum	X*	--	--	2	--	3	1	--	1	--	--	--	2	1	7	1	--	--	3	--	7	--	4	2	--	9	--	1	4	10	8	--	10	10	9	10
Amelanchier sp.	X	3	1	7	6	2	7	4	2	9	--	10	9	7	--	7	3	2	3	1	X	7	9	6	8	3	10	7	7	9	6	6	8	3	1	2
Carpinus caroliniana	--	--	--	--	--	--	--	--	--	1	9	1	--	--	--	--	2	--	--	--	--	--	--	--	--	3	1	--	8	7	--	--	1	1	6	6
Carya cordiformis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	4	--	--	2	--	--	2	--	--	3	1	--	--	--	2	5	--
Carya ovalis	8	8	1	10	10	9	10	10	7	10	10	10	3	10	7	10	4	6	7	4	10	10	9	10	2	8	9	8	9	--	7	9	7	2	3	--
Carya ovata	--	--	--	--	--	--	--	--	--	2	--	2	--	--	--	--	--	--	--	3	--	--	2	--	1	1	1	--	6	3	--	--	3	--	X	2
Castanea dentata	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Celtis occidentalis	--	--	2	--	--	1	--	--	--	--	1	--	--	--	--	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cornus florida	10	1	1	10	3	6	--	--	10	--	5	1	10	4	10	5	10	10	--	9	4	5	10	5	--	10	--	4	10	--	6	7	6	5	5	5
Crataegus sp.	1	--	2	2	2	1	--	8	1	10	--	7	1	--	--	7	1	--	--	--	X	3	--	3	1	2	10	1	4	1	--	--	7	--	1	--
Fagus grandifolia	--	--	1	X	--	2	--	--	1	--	X	--	3	--	6	--	2	1	--	1	--	--	4	1	--	3	--	--	--	2	--	--	--	7	2	10
Fraxinus americana	--	--	2	--	--	--	--	1	--	10	--	5	3	--	--	5	2	--	--	6	--	8	10	10	10	9	10	10	10	8	10	9	10	8	10	10
Fraxinus nigra	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Juglans cinerea	X	--	3	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juglans nigra	1	--	5	--	--	--	--	--	--	[illegible]	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Juniperus virginiana	--	--	--	1	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Liriodendron tulipifera	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1	4	--	3	--	--	X	--	--	X	--	--	--	--	--	--	--	1	--	4
Morus rubra	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nyssa sylvatica	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Ostrya virginiana	--	--	--	2	3	--	2	--	--	1	--	--	5	--	--	--	3	--	1	8	--	--	5	8	1	9	2	--	10	9	10	X	10	7	8	2
Pinus strobus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1	2	--	--	--	2	--	--	--	--	--	--	3	--	--	--	--	--	--
Populus grandidentata	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1	1	--	--	--	--	1	--	--	--	1	--	--	--	--	--	--	--	2	--
Populus tremuloides	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Prunus americana	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	1	--	--	--	--	--	--	--	--	--
Prunus avium	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1	--	--	--	2	--	2	--	--	--	--	--	--	--	--	--
Prunus nigra	--	--	1	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Prunus serotina	10	10	10	10	10	10	10	9	7	10	10	10	10	9	6	10	7	5	10	10	10	9	10	9	8	4	8	9	5	7	9	9	9	5	6	10
Pyrus ioensis	--	--	2	--	--	1	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	2	--	--	--	--	1	--	1	--	--	--	--	--	--	--
Quercus alba	10	9	7	10	10	9	10	7	7	8	10	10	5	8	10	10	9	7	9	6	7	10	6	4	3	8	7	8	6	10	1	4	6	9	2	4
Quercus bicolor	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	X	--
Quercus ellipsoidalis	X	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quercus macrocarpa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quercus rubra	1	--	--	--	5	--	7	8	1	5	2	9	5	6	1	10	7	9	9	5	10	10	10	10	9	10	8	10	9	8	9	10	9	9	10	10
Quercus velutina	10	10	10	10	10	10	10	10	9	9	10	10	10	9	10	8	5	9	3	9	2	3	7	2	6	4	3	--	4	--	2	1	--	2	6	--
Sassafras albidum	8	9	10	10	10	9	10	8	9	--	10	9	5	9	5	7	9	6	7	7	4	8	8	3	9	4	--	2	3	2	1	1	--	--	3	2
Thuja occidentalis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Tilia americana	--	1	--	--	1	X	--	4	--	--	--	1	1	3	2	1	X	X	--	X	--	--	5	--	1	4	1	1	6	3	1	X	9	4	6	1
Tsuga canadensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	1	5	--	--	--	--	--	--
Ulmus americana	1	1	3	2	4	2	4	2	1	5	1	1	--	4	5	1	--	--	2	1	6	2	1	1	7	1	6	2	4	1	--	2	8	1	3	2
Ulmus rubra	--	X	2	--	--	4	--	--	--	3	--	--	--	X	6	1	--	--	--	--	8	--	--	--	3	--	1	--	7	1	--	--	6	--	3	1
Ulmus thomasii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	1

*The symbol 'X' indicates presence in stand.

TABLE LXXVI. Number of occurrences of shrub species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Asimina triloba	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Berberis vulgaris	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ceanothus americanus	X*	--	1	X	X	X	4	6	--	2	X	--	--	--	--	1	--	--	--	--	--	2	--	--	--	--	--	--	X	--	--	--	--	--	--	--
Celastrus scandens	X	--	--	6	--	--	7	1	--	3	3	1	3	1	X	--	1	--	--	5	2	--	X	X	--	1	1	--	6	--	X	1	--	--	4	--
Chimaphila umbellata	--	--	X	--	--	1	1	1	--	--	--	4	--	1	--	--	3	1	--	--	--	--	1	--	--	--	--	5	--	--	1	2	--	--	--	1
Cornus alternifolia	--	--	5	--	--	--	--	--	--	--	--	X	--	--	--	--	1	--	--	2	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Cornus racemosa	1	1	7	1	8	3	7	5	--	7	4	3	1	4	--	X	3	--	3	--	6	5	--	1	4	1	4	--	--	1	--	2	6	X	--	--
Cornus rugosa	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	X	--	--	--	--	--	3	5	1	--	--	--	2	--	--	3	9	--	--	--	--
Corylus americana	9	2	8	3	4	3	1	--	--	4	--	1	--	1	1	--	2	--	1	1	2	2	1	--	--	--	6	--	1	5	--	1	1	--	--	--
Diervilla lonicera	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	1	--	--	--	--	X	--	--	--	--	--	--	2	--	--	--	--	--	--
Epigaea repens	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--
Euonymus atropurpurous	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gaultheria procumbens	--	X	--	--	X	--	--	--	1	--	[illegible]	--	--	--	--	--	10	--	--	--	--	--	2	--	--	--	--	--	--	8	--	--	--	--	--	--
Gaylussacia baccata	X	2	X	--	1	--	4	1	--	--	[illegible]	3	--	--	--	--	3	1	X	1	--	--	X	--	--	--	--	--	--	1	--	--	--	--	--	--
Ilex verticillata	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Hamamelis virginiana	--	--	1	--	1	--	1	2	--	[illegible]	4	5	3	1	--	1	[illegible]	3	4	6	--	3	3	--	2	7	2	3	2	9	1	9	1	--	3	3
Juniperus communis	--	--	--	--	X	--	10	2	--	--	--	--	--	1	--	4	--	--	--	--	--	4	--	1	--	--	--	9	--	--	1	6	--	--	--	--
Lindera benzoin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1	4
Lonicera canadensis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
Lonicera dioica	--	X	--	--	--	--	1	--	[illegible]	[illegible]	--	[illegible]	1	1	--	--	1	--	--	1	--	--	2	--	1	X	8	2	--	7	--	--	1	--	--	--
Lonicera sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Parthenocissus quinquefolia	9	8	3	7	3	5	2	X	5	1	2	3	5	7	10	5	1	1	2	6	10	1	1	1	5	6	1	X	9	--	1	--	1	3	2	7
Prunus virginiana	--	9	10	5	9	1	1	5	2	5	--	[illegible]	5	[illegible]	--	6	1	1	4	5	10	4	2	9	2	6	6	3	6	3	3	3	9	1	4	--
Pyrus melanocarpa	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quercus prinoides	6	--	--	--	--	--	--	7	--	--	--	X	--	X	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhus aromatica	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhus radicans	X	6	2	8	1	5	5	X	7	--	4	--	4	5	7	3	2	1	--	--	4	X	--	1	6	3	3	1	7	--	1	2	8	--	1	5
Ribes cynosbati	8	9	8	10	2	10	--	7	4	8	--	1	10	1	7	8	1	1	10	10	10	7	--	5	--	8	9	6	8	6	7	10	9	6	6	6
Ribes sativum	--	--	--	--	1	--	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	1	--	1	2	--	--	1	--	--	--	--	--
Rosa carolina	6	3	7	10	7	7	7	6	3	8	[illegible]	6	--	2	3	7	5	3	2	2	--	8	5	6	--	2	6	7	3	3	6	3	2	--	2	--
Rubus allegheniensis	3	1	3	--	6	1	3	--	1	1	--	--	1	--	--	--	1	X	6	1	4	--	--	--	10	--	2	--	3	--	--	--	--	--	2	1
Rubus idaeus	--	--	--	--	--	1	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rubus occidentalis	2	7	5	5	4	4	--	3	--	4	--	1	2	2	--	5	--	X	1	2	3	1	--	4	6	--	4	2	6	--	1	2	3	--	--	--
Rubus sp.	5	1	6	4	1	1	5	10	--	3	3	1	--	2	--	6	5	--	--	1	--	2	--	1	1	--	1	3	1	--	2	--	3	--	--	--
Salix humilis	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sambucus canadensis	--	1	--	--	--	--	--	--	2	--	--	--	--	--	X	--	--	X	--	--	--	--	--	--	2	--	--	--	--	--	--	--	2	--	--	2
Sambucus pubens	1	1	2	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	3	--	2	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--
Smilax rotundifolia	--	--	--	1	--	--	--	--	8	--	--	--	--	--	--	--	10	6	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	8
Smilax tamnoides	--	--	--	X	--	1	--	2	--	--	--	--	--	--	--	1	--	--	--	7	1	3	X	3	--	--	2	6	7	--	3	2	--	X	7	--
Vaccinium angustifolium	--	--	--	--	--	--	--	--	--	7	--	1	--	--	--	--	X	1	X	--	--	--	6	--	--	--	2	--	--	6	--	--	--	--	--	--
Vaccinium corymbosum	X	--	--	--	4	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Vaccinium lamarckii	--	1	--	--	--	--	--	--	--	--	--	--	2	--	X	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vaccinium myrtilloides	--	--	--	X	--	--	--	--	--	1	--	3	--	--	--	--	--	--	X	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Vaccinium vacillans	--	1	--	--	--	--	6	--	9	--	2	1	--	2	--	--	1	--	--	1	X	--	1	--	--	3	--	--	1	--	2	--	--	--	--	--

*The symbol 'X' indicates presence in stand.

TABLE LXXVI. (continued) Number of occurrences of shrub species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Viburnum acerifolium	--	--	2	2	2	--	--	1	5	--	[illegible]	--	5	1	3	3	8	10	--	10	--	7	5	1	1	8	--	10	10	7	7	10	--	7	2	9
Viburnum cassinoides	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Viburnum lentago	--	--	1	--	2	--	1	--	--	1	--	1	--	--	--	--	--	--	1	6	1	--	--	--	--	--	1	--	--	--	--	2	--	--	--	--
Viburnum prunifolium	--	--	--	1	--	1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	X	--	--	1	--	--	--	--	--	--	--
Viburnum recognitum	--	--	5	7	--	--	--	3	--	5	--	5	--	--	--	7	2	--	--	5	--	[illegible]	--	--	--	--	9	10	4	7	--	7	3	1	--	--
Vitis aestivalis	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vitis aestivalis var.	5	1	X*	7	1	7	3	3	6	--	4	4	1	[illegible]	1	6	1	[illegible]	--	5	--	4	1	1	4	3	--	--	1	X	--	--	--	--	--	1
Vitis riparia	1	--	3	--	1	--	3	X	--	4	1	1	[illegible]	1	--	1	--	--	--	--	7	1	--	1	--	--	1	--	--	--	--	--	2	X	--	--
Xanthoxylum americanum	--	--	--	--	1	--	--	--	--	--	--	--	[illegible]	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1	--

*The symbol 'Z' indicates presence in stand.

TABLE LXXVII. Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Achillea lanulosa	—	—	—	—	—	X	—	2	—	1	—	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Actaea pachypoda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1	1	—	4	—	X	4	—	2	X	X	1	2	2
Actaea rubra	—	—	—	—	X	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Adiantum pedatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	X	—	—	1	—	1	1	1	6	4	—	—	2	—
Agastache nepetoides	X*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrimonia gryposepala	—	2	—	—	3	—	3	4	—	—	X	1	X	—	1	X	—	X	—	2	1	3	1	—	—	1	—	3	5	—	1	1	X	—	2	—
Agrimonia pubescens	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrimonia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Agrostis alba	X	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrostis perennans	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	1	—	X	—	—	X	—	—	—
Agrostis scabra	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphicarpa bracteata	1	—	3	1	2	1	5	9	X	6	5	3	1	1	2	3	3	X	1	1	4	10	3	3	7	1	8	5	5	3	1	X	5	X	4	2
Anemone cylindrica	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anemone quinquefolia	—	2	—	5	—	—	—	—	—	5	—	—	—	—	1	—	—	—	2	—	—	1	—	—	—	—	5	—	—	—	—	—	1	—	—	—
Anemone virginiana	—	1	X	X	X	—	X	7	—	—	—	—	—	X	—	2	—	—	—	—	X	3	—	—	1	—	—	1	—	—	—	—	—	—	—	—
Angelica venenosa	—	1	—	—	—	—	2	1	—	—	X	3	—	—	—	—	—	—	—	—	—	—	—	X	1	—	—	—	2	—	—	—	—	—	—	—
Antennaria plantaginifolia	—	2	—	—	—	1	—	1	—	4	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Antennaria neodioica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Antennaria sp.	—	—	7	1	—	—	1	6	—	—	—	—	—	—	—	1	—	—	—	—	X	7	—	—	—	—	—	4	X	—	1	—	X	—	—	—
Apocynum androsaemifolium	X	—	—	—	—	1	3	1	—	7	—	1	1	—	—	—	1	—	—	—	3	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—
Aquilegia canadensis	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—	—	X	3	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Arabis canadensis	—	—	1	—	—	—	—	—	—	—	—	—	X	—	—	2	—	—	—	1	—	3	—	—	—	—	—	2	—	—	—	—	—	—	—	—
Arabis laevigata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
Arabis missouriensis	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aralia nudicaulis	—	—	—	—	1	—	4	X	—	1	1	—	5	4	—	—	1	8	—	2	—	2	3	1	—	8	1	3	4	4	2	6	—	—	1	2
Aralia racemosa	X	2	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	1	—	—	X	1	—	—	—	—	—	—	—	—	—
Arisaema sp.	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	X	—	—	—	—	—	—	5
Asclepias exaltata	X	—	3	—	X	—	2	—	—	—	1	—	1	1	—	X	1	1	1	4	X	—	X	—	—	1	1	X	1	1	1	X	—	—	—	—
Asclepias purpurescens	1	—	—	—	—	1	—	—	—	—	P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asclepias tuberosa	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asclepias viridiflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Aster cordifolius	X	1	2	1	2	2	1	10	1	2	—	2	4	2	X	1	1	—	—	2	2	9	4	2	2	2	1	7	6	6	3	4	4	—	4	1
Aster laevis	—	—	—	—	X	—	X	3	—	6	—	2	—	X	—	3	—	—	—	—	—	3	—	—	—	—	—	1	—	3	1	1	—	—	—	—
Aster lateriflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1	—	5	—
Aster macrophyllus	X	—	3	8	6	3	10	3	—	5	9	7	10	3	—	4	5	8	2	—	4	6	9	9	—	5	6	3	7	8	9	6	X	—	7	3
Aster sagittifolius	X	—	—	X	—	—	4	1	—	7	—	1	—	1	—	6	—	—	—	5	—	8	—	4	1	—	3	2	—	—	4	3	—	—	—	—
Aster sp.	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Athyrium filix-femina	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Baptisia tinctoria	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachyelytrum erectum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	5	—	1	—	X	X	1	—	1	1	—	4	1	3	—	—	—	6	2
Bromus inermis	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bromus latiglumis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Bromus purgans	—	X	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	3	X	X	—	X	2	—	—	5	4	—	—	X	—	7	—
Bromus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Botrychium dissectum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Botrychium multifidum	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Botrychium virginianum	X	3	—	—	4	1	1	X	—	—	—	—	X	3	3	1	—	1	1	2	1	X	1	—	4	5	1	—	1	3	X	1	—	1	X	—
Cacalia atriplicifolia	—	1	X	—	—	1	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Campanula americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Uvularia grandiflora	—	—	—	—	5	—	—	2	—	—	—	1	—	3	—	—	1	4	—	—	2	1	—	2	—	2	—	6	2	—	6	7	—	—	1	—
Uvularia sessilifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
Verbena urticifolia	X*	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Veronicastrum virginicum	—	—	X	—	1	—	X	X	—	1	—	—	—	—	—	1	—	—	—	—	X	—	—	—	—	—	—	2	—	—	—	3	—	—	—	—
Vicia caroliniana	—	—	—	X	—	—	—	4	—	—	1	—	—	—	—	2	—	—	—	—	—	2	—	—	X	—	—	—	1	—	—	—	—	—	—	—
Viola canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	1
Viola pedata	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Viola pubescens	—	—	—	—	3	—	4	1	—	1	—	1	1	4	—	X	1	2	6	1	—	2	X	—	5	2	2	2	6	6	2	2	6	1	7	2
Viola sororia	—	—	6	1	1	—	1	—	—	8	—	—	—	—	—	3	—	X	—	—	5	—	X	—	1	—	3	—	—	—	—	—	4	—	6	1
Viola striata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2	—
Viola sp.	X	3	—	—	—	4	—	—	2	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	2	2	—	2	—	—	—	1	—	—	—
Zizia aurea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Achillea lanulosa	—	—	—	—	—	X	—	2	—	1	—	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Actaea pachypoda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1	1	—	4	—	X	4	—	2	X	X	1	2	2
Actaea rubra	—	—	—	—	X	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Adiantum pedatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	X	—	—	1	—	1	1	1	6	4	—	—	2	—
Agastache nepetoides	X*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrimonia gryposepala	—	2	—	—	3	—	3	4	—	—	X	1	X	—	1	X	—	X	—	2	1	3	1	—	—	1	—	3	5	—	1	1	X	—	2	—
Agrimonia pubescens	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrimonia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Agrostis alba	X	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrostis perennans	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	1	—	X	—	—	X	—	—	—
Agrostis scabra	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphicarpa bracteata	1	—	3	1	2	1	5	9	X	6	5	3	1	1	2	3	3	X	1	1	4	10	3	3	7	1	8	5	5	3	1	X	5	X	4	2
Anemone cylindrica	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anemone quinquefolia	—	2	—	5	—	—	—	—	—	5	—	—	—	—	1	—	—	—	2	—	—	1	—	—	—	—	5	—	—	—	—	—	1	—	—	—
Anemone virginiana	—	1	X	X	X	—	X	7	—	—	—	—	—	X	—	2	—	—	—	—	X	3	—	—	1	—	—	1	—	—	—	—	—	—	—	—
Angelica venenosa	—	1	—	—	—	—	2	1	—	—	X	3	—	—	—	—	—	—	—	—	—	—	—	X	1	—	—	—	2	—	—	—	—	—	—	—
Antennaria plantaginifolia	—	2	—	—	—	1	—	1	—	4	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Antennaria neodioica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Antennaria sp.	—	—	7	1	—	—	1	6	—	—	—	—	—	—	—	1	—	—	—	—	X	7	—	—	—	—	—	4	X	—	1	—	X	—	—	—
Apocynum androsaemifolium	X	—	—	—	—	1	3	1	—	7	—	1	1	—	—	—	1	—	—	—	3	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—
Aquilegia canadensis	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—	—	X	3	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Arabis canadensis	—	—	1	—	—	—	—	—	—	—	—	—	X	—	—	2	—	—	—	1	—	3	—	—	—	—	—	2	—	—	—	—	—	—	—	—
Arabis laevigata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
Arabis missouriensis	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aralia nudicaulis	—	—	—	—	1	—	4	X	—	1	1	—	5	4	—	—	1	8	—	2	—	2	3	1	—	8	1	3	4	4	2	6	—	—	1	2
Aralia racemosa	X	2	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	1	—	—	X	1	—	—	—	—	—	—	—	—	—
Arisaema sp.	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	X	—	—	—	—	—	—	5
Asclepias exaltata	X	—	3	—	X	—	2	—	—	—	1	—	1	1	—	X	1	1	1	4	X	—	X	—	—	1	1	X	1	1	1	X	—	—	—	—
Asclepias purpurescens	1	—	—	—	—	1	—	—	—	—	P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asclepias tuberosa	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asclepias viridiflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Aster cordifolius	X	1	2	1	2	2	1	10	1	2	—	2	4	2	X	1	1	—	—	2	2	9	4	2	2	2	1	7	6	6	3	4	4	—	4	1
Aster laevis	—	—	—	—	X	—	X	3	—	6	—	2	—	X	—	3	—	—	—	—	—	3	—	—	—	—	—	1	—	3	1	1	—	—	—	—
Aster lateriflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1	—	5	—
Aster macrophyllus	X	—	3	8	6	3	10	3	—	5	9	7	10	3	—	4	5	8	2	—	4	6	9	9	—	5	6	3	7	8	9	6	X	—	7	3
Aster sagittifolius	X	—	—	X	—	—	4	1	—	7	—	1	—	1	—	6	—	—	—	5	—	8	—	4	1	—	3	2	—	—	4	3	—	—	—	—
Aster sp.	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Athyrium filix-femina	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Baptisia tinctoria	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachyelytrum erectum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	5	—	1	—	X	X	1	—	1	1	—	4	1	3	—	—	—	6	2
Bromus inermis	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bromus latiglumis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Bromus purgans	—	X	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	3	X	X	—	X	2	—	—	5	4	—	—	X	—	7	—
Bromus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Botrychium dissectum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Botrychium multifidum	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Botrychium virginianum	X	3	—	—	4	1	1	X	—	—	—	—	X	3	3	1	—	1	1	2	1	X	1	—	4	5	1	—	1	3	X	1	—	1	X	—
Cacalia atriplicifolia	—	1	X	—	—	1	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Campanula americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Uvularia grandiflora	—	—	—	—	5	—	—	2	—	—	—	1	—	3	—	—	1	4	—	—	2	1	—	2	—	2	—	6	2	—	6	7	—	—	1	—
Uvularia sessilifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
Verbena urticifolia	X*	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Veronicastrum virginicum	—	—	X	—	1	—	X	X	—	1	—	—	—	—	—	1	—	—	—	—	X	—	—	—	—	—	—	2	—	—	—	3	—	—	—	—
Vicia caroliniana	—	—	—	X	—	—	—	4	—	—	1	—	—	—	—	2	—	—	—	—	—	2	—	—	X	—	—	—	1	—	—	—	—	—	—	—
Viola canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	1
Viola pedata	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Viola pubescens	—	—	—	—	3	—	4	1	—	1	—	1	1	4	—	X	1	2	6	1	—	2	X	—	5	2	2	2	6	6	2	2	6	1	7	2
Viola sororia	—	—	6	1	1	—	1	—	—	8	—	—	—	—	—	3	—	X	—	—	5	—	X	—	1	—	3	—	—	—	—	—	4	—	6	1
Viola striata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2	—
Viola sp.	X	3	—	—	—	4	—	—	2	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	2	2	—	2	—	—	—	1	—	—	—
Zizia aurea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Campanula rotundifolia	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex albursina	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1	—	—	—	—	—	1	2	—	1	—	2	—	4	4	3	—	—	1	X
Carex alopecoidea	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Carex blanda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
Carex cephalophora	—	2	—	—	—	—	—	X	—	1	—	—	—	—	—	—	—	—	—	—	X	—	—	—	2	—	1	—	2	—	—	—	—	—	—	—
Carex convoluta	—	—	—	—	—	—	—	X	—	2	—	—	X	—	1	X	—	X	—	—	—	2	2	5	—	3	1	X	—	—	6	1	1	—	1	—
Carex crinita	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Carex digitalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	2	—	—	—	5	1	3	—	—	—
Carex gracilescens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Carex gracillima	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	3	—	—	—	—	—	5	—	2	2
Carex hirsutella	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex hirtifolia	—	3	—	1	—	—	—	—	—	—	—	—	—	—	1	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Carex pensylvanica	10	6	6	9	7	8	9	10	4	9	10	10	8	9	3	8	8	6	7	2	4	10	7	—	10	1	8	9	9	7	4	10	10	X	6	—
Carex rosea	—	X*	—	—	—	—	—	—	—	2	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	4	X	2	—	—	—	—	—	—	1
Carex scoparia	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Carex sparganioides	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Carex tenera	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex sp.	—	1	—	—	—	—	—	1	—	1	—	—	1	—	—	1	1	—	1	—	—	1	—	—	2	—	—	—	—	—	—	—	1	—	3	—
Caulophyllum thalictroides	—	—	X	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—
Cicuta maculata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—
Cinna arundinacea	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	X	—	—	1	—	1	1
Circaea quadrisulcata	1	8	1	—	10	7	1	X	1	1	—	X	X	9	4	1	—	—	5	2	8	1	X	1	9	1	—	—	2	X	X	—	9	1	3	—
Collinsonia canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	1	—	—	—	2	—	2	5	—	—	—	—	X	6	—	5	4	—	—	6	—
Comandra umbellata	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—
Conopholis americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	1	X
Coptis groenlandica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Corallorhiza maculata	X	—	—	—	—	—	X	1	X	—	—	1	—	—	X	X	—	1	—	1	—	2	1	X	2	4	—	X	—	3	1	1	2	—	X	—
Corallorhiza odontorhiza	X	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coreopsis tripteris	—	1	—	—	—	—	X	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Cryptotaenia canadensis	—	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	2	1	1	—	3	—	—	—	1	—	5	—
Cystopteris fragilis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Danthonia spicata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Desmodium ciliare	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Desmodium cuspidatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	X	X	—	—	3	—	—	—	—	—	—	—
Desmodium glutinosum	5	1	4	—	—	—	5	7	—	1	2	4	1	9	3	8	5	3	3	3	X	10	9	5	1	—	1	5	4	2	8	5	X	—	1	—
Desmodium illinoense	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Desmodium marilandicum	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Desmodium nudiflorum	10	7	8	7	7	7	9	5	10	1	8	10	6	10	9	5	9	10	4	7	5	8	8	1	2	3	5	4	4	2	X	4	—	3	7	—
Desmodium paniculatum	X	X	—	—	—	—	X	—	—	—	—	1	—	X	—	—	3	X	—	—	X	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—
Desmodium panicul. var.	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Desmodium rigidum	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Desmodium rotundifolium	X	—	1	—	—	X	—	X	—	—	—	1	—	—	—	5	X	—	—	—	X	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diarrhena americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Dioscorea villosa	—	—	—	1	1	5	1	1	—	—	2	—	—	X	1	1	1	X	—	—	2	4	—	4	—	—	1	X	2	—	1	X	—	—	—	—
Dryopteris noveboracensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Dryopteris spinulosa	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	X	—	—	—	—	—
Equisetum hyemale	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Erigeron strigosus	—	—	—	X	—	—	—	X	—	2	—	—	—	—	—	X	—	X	1	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Eryngium yuccifolium	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Euonymus obovatus	—	—	—	—	—	—	—	—	—	—	—	—	3	—	1	—	—	—	—	—	—	—	X	—	—	4	1	—	—	4	—	—	X	2	X	2
Eupatorium purpureum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Eupatorium rugosum	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	—	3	—	—	—	—	—	3	—
Euphorbia corollata	X*	X	X	—	—	X	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Festuca obtusa	1	5	—	5	2	1	2	5	—	—	—	1	5	5	3	4	—	—	1	—	8	5	1	3	9	3	7	3	6	5	2	—	6	—	1	1
Fragaria virginiana	—	—	—	—	X	1	3	X	—	2	1	2	—	2	—	—	1	X	—	1	1	3	1	—	—	—	2	—	—	—	—	1	X	—	X	—
Galium aparine	—	—	—	—	X	—	1	—	—	8	—	—	3	—	—	—	—	—	8	—	—	—	1	X	—	—	10	—	—	—	—	—	—	—	—	—
Galium boreale	—	2	—	—	3	X	—	4	—	9	—	6	—	5	—	5	—	—	X	9	1	9	—	4	1	2	6	8	8	X	4	6	—	—	—	2
Galium circaezans	—	6	7	3	10	6	9	10	1	4	7	2	9	10	6	9	6	5	3	3	4	9	9	6	9	5	3	9	5	1	4	3	8	X	10	1
Galium concinnum	—	X	—	X	—	—	—	—	—	—	—	—	—	—	X	1	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Galium lanceolatum	—	—	X	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	6	—
Galium pilosum	2	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Galium triflorum	X	—	—	—	X	4	1	—	—	—	—	—	—	7	3	—	1	—	—	—	—	2	3	—	10	—	1	X	3	4	X	—	4	1	10	3
Geranium maculatum	2	5	6	4	10	X	8	10	2	10	7	9	2	8	X	5	4	4	5	5	2	7	7	2	6	8	9	4	9	5	3	4	7	1	1	2
Gerardia flava	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	2	X	—	1	—	—	—	—	—	—	—	—	—	—	—
Gerardia pedicularia	—	—	—	X	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gerardia virginica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geum canadense	1	6	—	1	1	1	1	X	—	2	—	—	2	4	2	X	—	—	4	—	7	—	2	—	6	—	2	—	9	—	—	—	10	—	5	3
Geum laciniatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—
Glyceria striata	—	X	—	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	2	—	—	—
Gnaphalium obtusifolium	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hackelia virginiana	1	2	—	—	1	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hedeoma pulegioides	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Helianthus decapetalus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	1	—	1	—	—	—	—	—	4	—
Helianthus divaricatus	X	2	X	5	2	1	7	9	X	7	X	7	4	3	—	7	1	X	—	3	2	8	1	1	3	—	4	6	1	—	1	3	1	—	—	—
Helianthus giganteus	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Helianthus strumosus	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hepatica americana	—	—	—	6	9	2	4	10	—	—	4	2	—	2	—	9	1	1	—	—	X	10	—	10	—	4	—	10	—	8	10	10	—	—	—	—
Heuchera richardsonii	—	—	—	—	X	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	—	1	—	1	—	2	—	—	1	2	1	—	—	—
Hieracium aurantiacum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium canadense	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium gronovii	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium scabrum	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium venosum	—	—	—	—	X	—	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium sp.	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hydrastis canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—
Hystrix patula	X	1	4	1	—	—	—	—	—	—	—	X	—	—	—	1	—	—	—	X	2	2	X	4	9	—	4	—	3	4	X	—	10	—	2	—
Krigia biflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—
Lactuca canadensis	—	1	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Lathyrus venosus	—	—	X	X	X	1	—	—	—	—	4	2	X	—	—	1	—	—	1	—	—	2	—	—	—	—	—	X	—	—	—	1	—	—	—	—
Leersia virginica	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leonurus cardiaca	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lespedeza hirta	—	X	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lespedeza intermedia	—	—	—	X	—	—	X	2	—	—	—	—	—	—	—	1	X	—	—	—	X	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lespedeza violacea	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lespedeza virginica	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Liatris aspera	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lobelia spicata	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lupinus perennis	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Luzula acuminata	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	1	—	—	6	—	—	—	—	—	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Luzula multiflora	—	—	X	—	X	—	1	X	—	6	—	—	—	—	—	X	—	—	X	—	X	—	—	X	1	—	4	—	—	—	—	—	X	—	X	—
Lycopodium lucidulum	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	X	—	—	—	1	1
Lysimachia ciliata	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Lysimachia lanceolata	X*	X	3	2	—	—	—	—	X	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lysimachia quadrifolia	1	—	3	2	2	—	4	2	—	—	8	2	—	2	—	2	—	—	—	1	—	1	—	—	—	—	—	1	—	—	—	—	—	X	—	—
Maianthemum canadense	1	—	1	—	1	2	X	—	—	—	—	—	—	—	—	X	3	3	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	1	—	6
Medeola virginiana	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Melampyrum lineare	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Milium effusum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Mitchella repens	—	—	—	—	X	X	—	—	—	—	—	—	—	X	—	—	2	1	—	—	—	—	X	—	—	—	—	—	—	7	—	—	—	—	—	3
Mitella diphylla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	1	—
Monarda fistulosa	X	1	2	X	—	—	1	7	—	—	2	—	2	—	—	5	—	—	—	—	X	3	—	1	—	—	—	2	—	—	—	—	1	—	—	—
Monotropa hypopithys	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—	—	—	—	—	—	—	—	X
Monotropa uniflora	—	—	—	—	—	—	X	—	—	—	—	X	—	1	X	—	3	2	1	—	—	—	X	—	1	X	—	X	1	1	—	—	—	3	1	1
Muhlenbergia schreberi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Oenothera fruticosa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Onoclea sensibilis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—
Osmorhiza claytonii	5	2	—	—	10	1	6	X	1	1	X	X	9	10	7	5	—	X	5	7	8	1	X	1	7	—	2	X	10	5	2	X	7	1	8	4
Osmorhiza longistylis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
Osmunda regalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panicum boscii	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panicum commutatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panicum dichotomum	—	1	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panicum huachucae	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panicum latifolium	X	2	2	X	X	—	X	3	X	—	2	3	—	—	1	X	—	—	—	—	2	X	X	—	1	1	1	—	X	—	—	1	X	—	—	—
Panicum sp.	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	1	—	—	—
Parietaria pensylvanica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Paronychia canadensis	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—
Pedicularis canadensis	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	1	—	—	—	1	—	—	1	—	—	—	—	—	—
Phlox divaricata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2	—	2	—
Phlox pilosa	—	X	—	X	—	—	X	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Phryma leptostachya	—	—	7	—	—	3	—	—	—	1	—	—	—	2	1	—	—	—	—	7	8	—	—	—	1	—	—	—	—	—	—	—	3	1	3	—
Phytolacca americana	X	2	3	—	—	X	—	—	—	—	—	—	—	X	—	—	—	—	—	X	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pilea pumila	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	1	—	—	—	—	—	—	1	—	—	—
Poa angustifolia	1	2	—	—	—	1	5	X	—	4	—	—	1	—	—	1	3	—	—	—	—	—	—	X	—	—	2	—	—	—	—	—	—	—	—	—
Poa compressa	—	1	—	3	1	1	—	1	—	3	2	6	2	2	—	4	1	X	4	—	—	1	—	—	—	2	—	1	—	2	1	—	1	—	—	—
Poa palustris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Poa sp.	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Podophyllum peltatum	—	—	1	1	—	X	—	—	—	1	—	—	—	—	X	—	1	—	—	1	—	—	—	—	5	—	1	—	—	—	—	—	1	2	X	—
Polygonatum biflorum	5	—	—	6	—	—	—	3	—	3	—	—	—	—	2	4	—	—	—	—	8	1	8	—	3	—	—	—	—	—	1	—	3	—	—	—
Polygonatum pubescens	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	1	—	—	—	9	—	1	—	4	—	—	—	10	—	—	6	9	—	—	6	7
Polygonatum sp.	—	4	6	—	5	3	5	—	6	—	4	6	10	6	—	—	—	10	3	—	—	—	—	—	—	8	—	—	8	6	—	—	—	7	—	—
Polypodium virginianum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	4	—	—	—	5	—	—	—	—	—	4
Polystichum acrostichoid	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Potentilla simplex	3	3	X	2	2	3	5	3	2	5	3	4	X	—	1	1	1	X	—	—	X	2	2	—	10	—	8	1	3	—	2	—	8	—	2	—
Prenanthes alba	X	—	—	—	—	—	X	2	X	—	—	X	3	—	—	2	—	—	—	—	—	—	—	—	8	—	9	—	X	—	—	X	7	—	—	3
Prenanthes altissima	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2	—	—	1	—	X	1	—	—	—	9	—
Prenanthes trifoliata	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Prenanthes sp.	—	—	X	—	2	X	2	—	—	8	—	1	—	1	—	—	2	—	2	6	1	—	7	—	—	2	—	—	7	6	—	—	1	X	—	—

*The symbol 'X' indicates presence in stand.

TABLE LXXVII. (continued) Number of occurrences of herb species recorded in sets of ten 10 x 10 m. quadrats established in all stands.

	Stand																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Prunella vulgaris	—	1	—	—	X	—	—	1	—	4	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2	1	1	—	—	—	2	—	—	—
Pteridium aquilinum var.	X*	3	1	—	4	—	4	4	—	—	8	9	X	3	—	5	1	X	—	—	—	4	2	—	—	—	1	2	—	5	—	—	—	—	—	—
Pyrola elliptica	X	—	—	—	1	1	1	1	—	—	X	1	—	4	—	—	2	—	X	—	—	1	2	—	1	—	—	4	—	—	1	6	—	—	—	—
Pyrola rotundifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Pyrola secunda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Ranunculus abortivus	—	X	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	3	—	—	—
Ranunculus acris	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ranunculus recurvatus	—	—	—	—	X	—	—	—	—	—	—	—	—	1	X	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	1	—	X	—
Ranunculus septentrionalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Ranunculus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Rudbeckia serotina	X	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sanguinaria canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	1	1	X	—
Sanicula canadensis	—	8	—	—	—	3	—	—	X	—	—	—	—	1	1	—	—	—	—	3	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	1
Sanicula gregaria	—	—	—	—	—	—	X	1	—	1	—	3	—	3	—	—	—	—	—	—	—	—	4	—	1	X	1	—	6	6	—	1	2	—	9	—
Sanicula marilandica	X	—	—	—	X	—	—	3	—	2	—	—	4	X	—	2	—	—	—	1	X	3	—	—	1	3	7	9	2	—	5	5	5	—	—	—
Sanicula trifoliata	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	1
Sanicula sp.	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—
Satureja vulgaris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scutellaria elliptica	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Silene stellata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Silphium integrifolium	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sisyrinchium albidum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Smilacina racemosa	6	8	8	5	8	9	10	6	5	10	10	10	10	10	6	9	3	6	9	8	5	8	3	5	9	8	7	4	9	5	4	1	9	7	3	6
Smilacina stellata	—	—	—	—	—	—	—	X	—	—	X	X	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Smilax ecirrhata	3	3	—	—	1	2	2	—	2	—	—	—	3	X	3	4	—	—	—	4	6	1	X	X	—	1	3	1	6	—	—	—	X	—	3	—
Smilax herbacea	—	—	—	4	—	X	—	—	—	—	—	—	—	—	X	3	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X	3	—	—	3	—
Solanum dulcamara	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago caesia	—	—	7	10	—	—	—	9	6	—	—	—	9	—	X	10	8	4	4	3	X	9	6	10	—	8	1	10	9	7	10	9	1	X	7	1
Solidago canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	X	—
Solidago flexicaulis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Solidago hispida	—	—	—	—	—	—	1	4	—	—	—	2	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—
Solidago juncea	—	X	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago nemoralis	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago rugosa	—	X	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago speciosa	X	2	—	—	—	X	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago ulmifolia	—	—	—	5	—	—	—	—	—	—	2	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago sp.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stipa avenacea	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Taenidia integerrima	—	—	—	X	—	—	—	1	—	3	—	2	—	—	—	—	—	—	—	—	—	1	—	X	—	X	3	—	—	X	—	—	—	—	—	—
Taraxacum sp.	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Tephrosia virginiana	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Thalictrum dioicum	—	—	—	—	5	—	1	2	—	3	—	2	X	2	—	2	—	—	—	1	X	6	X	7	7	7	7	9	7	1	6	5	7	X	X	—
Thaspium trifoliatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Torilis japonica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—
Tovara virginiana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	—	—	—	4	—	5	3
Tradescantia ohiensis	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Trillium grandiflorum	—	—	—	—	1	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	X	—	7	4	2	—	7	—	—	—	8	8	X	1
Triosteum aurantiacum	—	—	X	—	—	—	—	—	—	1	—	—	—	X	—	—	X	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	X	—	—
Triosteum perfoliatum	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—

*The symbol 'X' indicates presence in stand.