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Forest Stearns

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J. E. Potzger

The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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FOREST COMMUNITIES IN VERSAILLES STATE PARK, INDIANA[1]

FOREST STEARNS
Purdue University
Lafayette, Indiana

Continuity of observation over an extended period of time is a difficult but vital phase of the study of the natural vegetation of any area. Such continuity is difficult to obtain. The vegetation may be destroyed or the investigator may move before sufficient time has elapsed to permit any significant development. Dr. J. E. Potzger realized the difficulties inherent in a long-time study but he also considered such studies valuable. Hence in 1950 he and Mrs. Potzger published the results of their studies on several areas in Versailles State Park. These were planned as the ground work for a long-time study of succession.

This paper supplements the original observations with data obtained by a different method. It is to be hoped that this long-time study will be continued and extended. The increased quantitative background presented here should clarify changes as they become apparent in the future.

GEOGRAPHY AND PHYSIOGRAPHY

Versailles State Park in Ripley County, Indiana lies in the Illinoian Till Plain region often called the "Flats." This is an extensive area of poorly drained, severely leached soils, chiefly silt loams and clay loams underlain in many places by clay pan. In the region of the park Laughery Creek and its tributaries have cut deep valleys and ravines into the plateau thus providing a variety of slope gradients and exposures and improving the natural drainage of much of the area.

Prior to establishment of the park most of the forested areas were subjected to severe cutting and some of the land was under cultivation. Thus the vegetation now present shows a wide variety of successional communities as well as numerous physiographic segregates. This area lies within the Western Mesophytic Forest region as described by Braun (1950).

METHODS

Field data were obtained by means of the random pairs method (Cottam and Curtis, 1949) which is based on the sampling of a pair of trees at each of many randomly selected points. The method has an advantage over the quadrat method

[1]This is paper 6 of the Conservation Education Camp faculty.

in that it provides a large number of sample units with a relatively small expenditure of time and labor. In this study an exclusion angle of 180° was used and a correction factor was applied (Cottam and Curtis, 1955). Four stands were chosen to represent different topographic and historic patterns. A total of 70 points were established and 140 trees measured and recorded in stands 1, 2 and 3 and 140 points were established and 280 trees recorded in stand 4. All stems 4 inches or over d.b.h. were recorded as trees. Stems over 4 feet in height but under 4 inches d.b.h. were recorded in 6 foot wide transects between each sample pair of trees. These stems were classed as reproduction. Tree seedlings and herbaceous species were not studied in detail.

Frequency, relative density and basal area were determined for each species in each stand and the number of trees per acre was calculated. The expressions of frequency and relative density are used as defined by Curtis and McIntosh (1950). The importance value for each species was also determined by summing the frequency, relative density and per cent basal area values for that species. Field sampling was accomplished in June of 1955 by students of the Conservation Education Camp with the assistance of Mr. A. N. Liming, District Forester, Professor Howard Michaud, Director of the Conservation Education Camp, and the author. Nomenclature follows that of *Trees of Indiana* (Deam and Shaw, 1953).

RESULTS AND DISCUSSION

The primary characteristics of the four stands studied are shown in Table I. Stands 1 and 2 are on the poorly drained flats and are essentially the same as the two areas examined by Dr. Potzger and Mrs. Potzger in their study of secondary succession on the Illinoian Tillplain (1950). Stand 3 covers the upper portion of a well-drained southwest-facing slope near the Conservation Education Camp, and overlaps an area described by Dr. Potzger (see table 1, Potzger, 1950) in his work on forest types in Versailles State Park. Stand 4 is a relatively undisturbed old-growth stand described in table 2 of the same paper.

An examination of the diameter class data presented by Dr. Potzger indicates that no drastic change has taken place in the composition of the four stands. However, after only eight years, some indication of future change is available and this will be discussed in reference to individual stands. The similarity of results obtained by the random pairs method with that from the quadrat method used by Dr. Potzger validates the use of the more rapid method in this vegetational area.

TABLE I

Characteristics of four forest communities in Versailles State Park

	Dominant species	Number of Trees per Acre	Basal Area per Acre, sq. ft.	Tree species present
Stand 1. Young stand "Flats" type Poorly drained.	Acer rubrum Liquidambar styaciflua	67	9.9	10
Stand 2. Older stand "Flats" type.	Acer rubrum Fagus grandifolia Quercus alba Carya ovata	236	191.8	16
Stand 3. Mixed hardwood on south-west slope.	Acer saccharum Quercus rubra Carya cordifomis Carya glabra	191	101.1	22
Stand 4. Oldgrowth forest on level well drained residual soil.	Acer saccharum Fagus grandifolia	122	160.4	18

TABLE II

Composition of a young forest community on the "flats" (Stand 1)

Species	Frequency	Relative Density	% Basal Area	Importance Value	% Reproduction
Liquidambar styraciflua	78.6	62.0	56.0	196.6	29.5
Acer rubrum	34.3	19.3	19.5	73.1	20.5
Robinia pseudoacacia	12.8	7.9	11.3	32.0	19.6
Prunus serotina	7.2	3.5	6.3	17.0	3
Platanus occidentalis	4.3	2.1	2.5	8.9	1.5
Liriodendron tulipifera	4.3	2.1	2.3	8.7	2.4
Juniperus virginiana	2.9	1.4	1.4	5.7	3.5
Fraxinus americana	1.4	.7	.4	2.5	2.0
Nyssa sylvatica	1.4	.7	.4	2.5	1.5

TABLE III

Change in stem size in a young forest community (Stand 1) on the "Flats"[1] shown by number of trees in each size class

Species	Year	Size Class 1-2 inches[2]	3-5 inches	6-10 inches	Total stems
Liquidambar styraciflua	1948	384	45	—	429
	1955	158	70	17	245
Acer rubrum	1948	409	4	1	414
	1955	110	21	6	137
Robinia pseudo-acacia	1948	4	—	—	4
	1955	105	6	5	116
Prunus serotina	1948	10	—	—	10
	1955	16	1	4	21
Platanus occidentalis	1948	11	1	—	12
	1955	8	1	2	11
Liriodendron tulipifera	1948	40	1	—	41
	1955	13	2	1	16

1. 1948 data from Table 3, Potzger 1950.

2. Includes all stems classed as reproduction in the 1955 study, i.e. under 4 inches d.b.h. and over 4 feet tall, and all stems included in the under 1 inch and 1-2 inch classes in the 1948 study.

Stand 1

As indicated in Tables I and II, stand 1 is a relatively open stand dominated by sweet gum and red maple with an intermixture of other intolerant pioneer species. The area had originally been under cultivation and was abandoned about 1930. The soil is Clermont silt loam, very poorly drained, acid and infertile, and supports a preponderance of the herbaceous plants common to such a habitat including *Plantago artistata, Antennaria spp., Rubus spp.* and *Andropogon virginicus*. Black locust has been planted in the area and is now a minor component of the vegetation. The soil has only a slight accumulation of humus and lichens are abundant as ground cover in the open areas. Comparison of the data with those obtained by Dr. Potzger in 1948 (Potzger, 1950) indicates virtually no change in the species composition of the stand. There has been a considerable shift in size distribution (Table III) indicating that growth conditions have been relatively favorable in the intervening years despite the drouthy summers of 1953 and 1954. Oaks continue to be missing from the stand, in all probability because seed is not readily available anywhere save on the fringe of the stand where it joins the older forest.

TABLE IV

Composition of older forest community on "Flats" (Stand 2)

Species	Frequency	Relative Density	% Basal Area	Importance Value	% Reproduction
Fagus grandifolia	33	18.5	36.1	87.6	17.3
Acer rubrum	33	21.4	12.7	67.1	6.5
Quercus alba	18.6	10.7	16.6	45.9	5.0
Carya ovata	18.6	10.0	4.8	33.4	12.9
Liquidambar styraciflua	11.4	6.4	6.8	24.6	1.4
Liriodendron tulipifera	14.3	6.4	4.0	24.7	0.7
Sassafras albidum	14.3	6.4	1.9	22.6	15.1
Quercus rubra	11.4	5.7	4.2	21.3	5.7
Nyssa sylvatica	5.7	3.6	5.7	15.0	2.2
Fraxinus americana	5.7	2.9	2.2	10.8	12.2
Acer saccharum	4.3	2.9	0.8	8.0	0
Ulmus americana	4.3	2.1	0.6	7.0	2.2
Quercus muhlenbergii	1.4	.7	2.2	4.3	0
Tilia americana	1.4	.7	0.6	2.7	1.4
Ulmus rubra	1.4	.7	0.2	2.3	1.4
Carpinus caroliniana	1.4	.7	0.1	2.2	0.7

Stand 2

In stand 2 drainage and soil conditions closely approximate those in stand 1. Lacking prior cultivation the soil structure is somewhat better than in stand 1 and in addition there are numerous inconspicuous small hummocks resulting from windfalls. The dominant species of the community are beech, red maple, white oak and shagbark hickory (Table IV). This stand had been subjected to some cutting and other disturbance prior to 1930. The presence of a few old oak stumps almost 30 inches in diameter is evidence that oak was once a stronger component of the stand. The stand is so dense, with 236 stems over 4 inches d.b.h. per acre, that little light penetrates the canopy. The floor of the forest is open with only a sparse herbaceous cover and few shrubs. A thick layer of leaf mould and litter has developed on the soil surface.

The total basal area of trees of this community is larger than that found in any of the other three stands (Table I). Even so there are few trees over

TABLE V

Stem size is a well-established forest community on the "flats"[1] as indicated by number of trees in each size class (Stand 2).

Species	Year	Size Class 0-2 in.[2]	3-5 in.	6-8 in.	9-15 in.	16-20 in.	over 20 in.	Total stems
Fagus grandi-	1948	72	18	2			3	95
folia	1955	24	7	2	5	3	9	50
Acer rubrum	1948	32	24	16	16	4	1	93
	1955	9	6	9	14	1		39
Quercus alba	1948	16	7	3	3		1	30
	1955	7		5	6	1	3	22
Carya ovata	1948	45	8	2	2			57
	1955	18	6	2	5			31
Liquidambar	1948	4	9	5	5	4		27
styraciflua	1955	2	2	1	5	3		13
Liriodendron	1948	1	1	1	1	1		5
tulipifera	1955	1		5	4			10
Sassafras	1948	1	8	11	1			21
albidum	1955	21	3	5	1			30
Quercus rubra	1948	9	4	2	6	1		22
	1955	8	1	2	5			16

1. 1948 Data taken from Table I Potzger and Potzger, 1950

2. Includes all stems classed as reproduction in this study and in the 1948 study. (i.e. under 4 inches d.b.h. and over 4 feet tall).

20 inches d.b.h. A check of the diameter distribution of stems in both the 1955 and the 1948 (Potzger and Potzger, 1950) data shown in Table V indicates that there are probably two major age groups present in the beech and the white oak. No explanation is immediately available for this particular condition. Oaks have been shown to be major components of most stands found on the "flats" (Potzger and Liming, 1953). The major problem seems to be to determine the time and mode of invasion of oaks into communities such as stand 1 which at approximately 25 years after abandonment still is devoid of oak.

Dr. Potzger had suggested that, "If the oaks and beech are prevented for another 10 to 15 years from invading the area removed 300 feet from the mature forest it appears likely that sweet gum, red maple and tulip poplar will have formed a closed crown cover under which invasion may be impossible. Here would then develop a different forest cover type than in the area which is

TABLE VI

Composition of a forest community on a south facing slope (Stand 3).

Species	Frequency	Relative Density	% Basal Area	Importance Value	% Reproduction
Quercus rubra	27	17.1	31.9	76.0	5.6
Acer saccharum	36	18.6	6.4	61.0	35.2
Carya glabra	23	14.3	14.8	52.1	6.4
Carya cordiformis	20	12	9.6	41.6	0.8
Ulmus rubra	18.5	10	7.3	35.8	4.8
Fraxinus americana	11.5	5.7	5.6	22.8	13.6
Quercus muhlenbergii	10	5.0	6.9	21.9	4.8
Prunus serotina	7.1	3.6	4.0	14.7	
Ulmus americana	7.1	3.6	1.4	12.1	1.6
Juglans nigra	2.9	1.4	2.5	6.8	
Acer rubrum	2.9	1.4	1.6	5.9	3.2
Sassafras albidum	2.9	1.4	1.4	5.7	1.6
Tilia americana	2.9	1.4	1.3	5.6	8.8

a few feet closer to the source of seed dissemination, even though habitat conditions otherwise would be alike." (Potzger and Potzger, 1950). However, crown cover is not closing as rapidly as might be expected and it may be that the process will extend over a period of 30 to 50 years. In this event there is still ample opportunity for invasion by oaks and other species in the openings between thickets of gum and maple. In this respect also Chapman (1942) has stated, "It is recognized that the composition of the forest stand does not vary greatly from that of the established seedling stand during many years of subsequent development; that is, the crucial period in composition determination is during the early seedling stages. The relation between seedlings and their environment is often undervalued as a determinant of the species composition of forest stands."

He also says that "In the central hardwood region, where a wealth of species is found, the influence upon forest composition of changes of even a few inches of elevation is expressed clearly on poorly drained flat lands, and may be observed also on areas of greater relief."

TABLE VII

Composition of an old-growth forest community on well drained soil (Stand 4)

Species	Frequency	Relative Density	% Basal Area	Importance Value	% Reproduction
Fagus grandifolia	42	27.5	60.1	129.6	2.2
Acer saccharum	55	33.9	15	103.9	65.0
Fraxinus americana	14.3	7.1	3.5	24.9	1.3
Nyssa sylvatica	8.5	4.6	5.4	18.5	1.1
Juglans nigra	9.3	4.6	3.8	17.7	1.3
Cornus florida	8.6	5.0	0.6	14.2	7.1
Liriodendron tulipifera	3.5	1.8	2.2	7.5	0.7
Prunus serotina	4.2	2.1	1.2	7.5	1.1
Carya ovata	4.3	2.4	0.7	7.4	1.3
Ulmus rubra	4.3	2.1	0.7	7.1	1.8
Tilia americana	3.5	2.1	1.6	7.2	0.2
Quercus rubra	3.5	1.8	1.7	7.0	0.2
Quercus alba	2.1	1.1	0.6	3.8	
Celtis occidentalis	2.1	1.1	2.0	5.2	1.1
Ostrya virginiana	1.4	.7	0.08	2.2	1.3

Obviously several lines of investigation are indicated if the position of the component species in the stand is to be properly evaluated. Investigation is needed on seedling requirements and on the site preferences of saplings and mature trees. The long range study initiated by Dr. Potzger will make it possible to note actual changes as they occur.

Stand 3

This forest community lies on the upper portion of a long south slope just east of the Conservation Education Camp. The soil, classed as Switzerland, is residual material derived from the underlying shales and limestone and has good surface drainage and aeration. The forest is a mixed mesophytic type community with a variety of species sharing the dominant position. The composition of the stand is shown in Table VI. Windfall, disease and other natural catastrophe will probably provide sufficient openings to maintain the mixed character of the stand although the bulk of the reproduction is sugar maple. The ground cover includes many herbaceous species and the shrub layer is more

varied and conspicuous than in stand 2. There has been very little disturbance in the stand for many years although it was once partly lumbered. The lower and steeper portion of this slope not sampled in this study is considerably more xeric and with a much greater abundance of oak. Shifts in the relative importance of sugar maple and white ash on the one hand and red oak and the hickories on the other will probably occur but it is too early to predict the final outcome in stand composition.

Stand 4

Stand 4, located on residual soils in the southeastern portion of the park, is an old-growth stand which has not been recently subjected to appreciable disturbance. It is primarily a beech and sugar maple community with a considerable admixture of other species as indicated in Table VII. The area slopes slightly toward a small stream that winds along the edge of the community. Nowhere is the surface flat and without adequate drainage. Although beech is a major dominant the community is obviously different from those found on the "flats" in that the associated species are different (Braun, 1953) and the presence of sugar maple in particular is evidence of lower acidity and better drainage.

Large stems of sassafras, black cherry and other species indicate that some factor caused the stand to be opened-up considerably, probably between 100 and 200 years ago. The extremely high percentage of maple reproduction has been noted by other authors and does not mean that sugar maple will eventually be the sole dominant. Many of the beech trees are of great size and have reached the point where windthrow or death of a single individual will influence a considerable area of the community. Thus within a relatively few years it will probably be possible to observe some shifts taking place in composition.

SUMMARY

Four different forest communities in Versailles State Park were studied using the random pairs method of sampling.

These include a young and an older community on the poorly drained Illinoian till, a well developed mixed-mesophytic community on sloping residual soils and an old-growth beech and sugar maple community on level well drained residual soils.

The young stand on the "flats" is open and is composed primarily of red maple and sweet gum. The older stand on the "flats" is dominated by a mixture of beech, red maple, white oak and shagbark hickory in a dense stand. The community on the south slope included 22 different arboreal species among which sugar maple, red oak, bitternut hickory and pignut hickory have the

highest importance values. The old-growth beech and sugar maple community appears closer in type to the beech-maple forests north and east than to the mixed mesophytic or the "flats" type of community.

Data are presented to add to that already available so that in the future periodic studies can be made to follow the development of communities of various ages and composition in this area.

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