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An ecological study of the floodplain forest along the White River system in Indiana

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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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AN ECOLOGICAL STUDY OF THE FLOODPLAIN FOREST ALONG THE WHITE RIVER SYSTEM OF INDIANA*

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As pointed out by Potzger and Friesner (9), Conard (3) and Cain (1), a mere empirical description of a forest means little as a definite presentation of conditions operating, and becomes nil in comparative studies. Most of the work on forest ecology in the United States has considered upland climax communities, and very little attention has been given the great transitional forests of the floodplains, and to the writer's knowledge only Oosting (8) has given specific quantitative data on the sociology of the species constituting the crown cover of the floodplain forests.

The present study of 20 stands was made within the White River system because it bisects not only the state from east to west but crosses four of Deam's (5) differentiated botanical areas. It was expected that forests of such a river valley would show a considerable degree of uniformity of habitat over a wide geographical area and that this would be reflected by fidelity and frequency of key species controlling the crown cover of the forest.

METHODS

Twenty stations were established. At each station twenty 100-square-meter quadrats were studied. Each of the 20 quadrats in every station was separated by a 10-meter skip.

A stout cord, subdivided into four 10-meter sections, each section having a loop, was used for delimiting each quadrat. Corner stakes were used at each loop and thus the cord could be stretched tightly, resulting in a more efficient tabulation. Wooden calipers were used to measure the DBH. of all stems one inch or over in diameter. All stems below one inch DBH. but three feet or over in height were recorded for density, frequency and fidelity. The nomenclature was that of Deam's "Flora of Indiana" (5).

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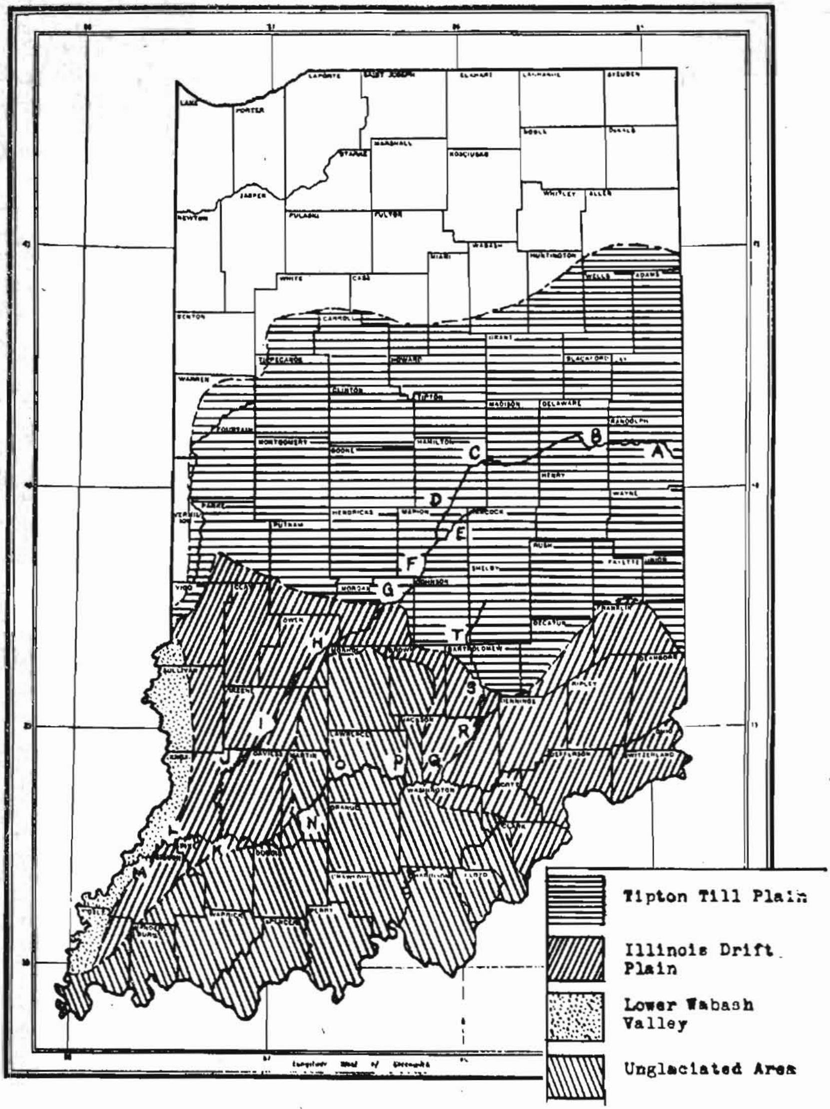
* A contribution in recognition of the 25th Anniversary of the Botany Department of Butler University.



Shrubs and vines were listed and recorded only for frequency and fidelity.

LOCATION AND EXTENT OF AREA

Sample stands were located chiefly within the floodplain of the east and west forks of White River and the main river, formed by the junction of these two. Exceptions were one station on Fall Creek near its mouth on the west fork of White River and one station each on Sugar Creek and Driftwood River, the last two streams being the chief tributaries of the east fork.

The course of these valleys crossed the following of Deam's (5) botanical areas: the Tipton Till Plain, the Illinois Drift Plain, the Lower Wabash Valley and the Unglaciated Area. The location of the various stations in respect to Deam's botanical areas are s follows: Tipton Till Plain, Stations A-B-C-D-E-F-S-T; Illinois Drift Plain, Stations G-H-I-J-K-L-R; Lower Wabash Valley, Station M; Unglaciated Area, Stations N-O-P-Q. The 20 stations were established as nearly as possible at regular intervals. Their distribution is shown graphically in fig. 1.

LOCATION OF STATIONS

Station	Location
A	Cox farm, 6 mi. se. of Winchester, Randolph county.
B	South bank of White river, 3 mi. s. of Selma, Delaware county.
C	North bank of White river, 0.5 mi. sw. of Perkinsville. Hamilton county.
D	East bank of White river, just s. of Marion-Hamilton county line.
E	North bank of Fall creek, nw. boundary line of Fort Harrison. Marion county.
F	West bank of White river, 4 mi. nw. of Glenns Valley, Marion county.
G	East bank of White river, 0.75 mi. n. of jct. of Rds. 39 and 67, Morgan county.
H	McCormack's creek, McCormack's Creek State park, Owen county.
I.	East bank of White river, 3 mi. sw. of Bloomfield, Greene county.
J	East bank of White river, 3 mi. se. of Edwardsport, Daviess county.
K	North bank of White river, 3 mi. nw. of Petersburg, Pike county.
L	South bank of White river, 2 mi. s. of Giro, Gibson county.
M	North bank of White river, 8 mi. w. of Patoka, on Bingham farm, Gibson county.

N East bank of the east fork of White river, 5 mi. se. of Loogootee, Martin county.

O East bank, east fork of White river, 4.5 mi. s. of Williams, Lawrence county.

P South bank, east fork of White river, 0.75 mi. n. of Rivervale, Lawrence county.

Q East bank, east fork of White river, 3 mi. se. of Medora, Jackson county.

R West bank, east fork of White river, 3 mi. w. of Seymour, Jackson county.

S West bank of Driftwood river, 3.5 mi. nw. of Columbus, Bartholomew county.

T East bank of Sugar creek, 2.5 mi. we. of Edinburg, Johnson county.

RESULTS AND OBSERVATIONS

Seventy-one woody species play a part in the vegetation cover for the 20 stations. These are divided into 40 species of tall trees, 9 of small trees, 14 of shrubs and 8 of vines. The crown cover is controlled chiefly by 9 species as shown by the density, frequency and basal area (table I). These species are *Acer negundo, A. saccharinum, Celtis occidentalis, Fraxinus americana, Platanus occidentalis, Populus deltoides, Salix nigra, Ulmus americana* and *U. thomasi*. It is interesting to note that *Celtis occidentalis,* although high in frequency and density, was low in basal area, and in the number of larger trees as compared to *Acer saccharinum, Platanus occidentalis, Populus deltoides,* and *Ulmus americana.*

In Station "C" the predominant species was *Celtis occidentalis* (table V). At no other station did Celtis reach the position attained here; in fact, the status of Celtis is disjunct in its distribution, being prominent in one quadrat and entirely lacking in an adjoining one. Yet it attained a high fidelity for the entire study. *Acer saccharinum* and *Ulmus americana* ranked highest in F. I. and fidelity: the former having F. I. 50.0% and fidelity 100%; the latter having F. I. 55.75% and fidelity 100%.

A comparison of species in the first 5 stations (table V) will show that *Acer saccharinum* plays a very minor role as far as frequency and abundance are concerned.

Salix nigra shows a more disjunct distribution that *Celtis occidentalis.* It is entirely absent in Stations D, H, K and S (table V).

This may at first seem surprising, but since most of these individuals are normally found colonized at the edge of the water, and since few quadrats extended to the edge of the banks, it is obvious that Salix should be lacking in some of the stations.

Populus deltoides is wanting in four stations, A, D, F and I, and is similar to Salix nigra in regard to density, frequency and fidelity (table I).

Fraxinus americana, absent in Stations E, G, I, P and Q, also shows a disjunct distribution although adding materially to the density, frequency and fidelity of the crown cover (table V).

An interesting fact of this floodplain group is the large sizes recorded for some of the individuals. A few of these with the DBH. in inches are listed as follows: *Acer saccharinum,* 38, 40, 53, 55; *A. saccharum,* 37, 47; *Populus deltoides,* 38, 39, 47; *Platanus occidentalis,* 54, 61, 66; *Quercus imbricaria,* 39, 40; and *Ulmus americana,* 37 and 38.

The second layer, i. e. small tree stratum, is weakly represented, only three species show a pronounced frequency over the others (table II). These are *Cercis canadensis* (F. I. 7.25%), *Cornus florida* (F. I. 9.25%) and *Crataegus* sp. ? (F. I. 11%). Crataegus was the outstanding small tree since it exceeded the others in density, frequency and in basal area.

In the shrub layer, *Sambucus canadensis* was the outstanding species as indicated by density and frequency (table III). However, it was surpassed in basal area by *Asimina triloba, Evonymus atropurpureus* and *Forestiera acuminata*. The latter had a basal-area of 46.9242 square inches, a total several times greater than Sambucus. These results are to be expected since Sambucus never extended beyond the 1-inch size class.

Among the vines *Rhus radicans* was the predominant species as reflected by its frequency and fidelity (F. I. 78.5% and fidelity 100%). Its closest rival was Vitis (F. I. 48.25% and a fidelity of 100%, (table IV).

The crown cover of the floodplain forest within the Tipton Till Plain, based on frequency and abundance (table V), is as follows: *Acer saccharinum, Celtis occidentalis, Platanus occidentalis, Ulmus americana* and *U. thomasi.* Crataegus was the outstanding small tree of this area.

Only one species, *Acer saccharinum,* was found in all 7 of the stations of the Illinois Drift Plain (table V). Other species contributing to the crown cover were: *Acer negundo, Fraxinus americana, Platanus occidentalis, Populus deltoides,* and *Ulmus americana.* Crataegus, again, was the predominent small tree of this area (table V).

The lower Wabash Valley area was represented only by Station "M" (table V). The narrowness of this area accounted for the fact that only one station was located there. The species contributing to the crown cover, as reflected by their frequency and abundance, were: *Acer saccharinum, Carya tomentosa, Celtis occidentalis, Fraxinus americana Gymnocladus dioica* and *Ulmus thomasi.* It will be noted that there were no outstanding figures for frequency and density in this station: *Acer saccharinum* having F. I. 15% and density of 31, and *Ulmus thomasi* having F. I. 40% and density of 13. It is interesting to note that *Carya tomentosa* and *Gymnocladus dioica* were not represented in the other stands. Station "M" recorded abundant representation of tall trees, but small trees were limited to one species, *Carpinus caroliniana,* var. *virginiana.*

The crown cover for the portion of the floodplain within the unglaciated area consisted of the following species: *Acer negundo, A. saccharinum, Celtis occidentalis, Populus deltoides, Salix nigra, Ulmus americana* and *U. thomasi. Prunus americana* was the predominant small tree in this area, being present in two of the four stations.

The genus Acer appeared in 307 of the total 400 quadrats for a F. I. of 76.75% and Ulmus, as a genus, appeared in 319 quadrats for a F. I. of 79.75%. Each had a fidelity of 100%. The total density of Acer, however, far exceeded that of Ulmus (table I).

DISCUSSION

Quantitative data form the only adequate basis of any ecological study. That some species of trees are characteristically limited more or less to floodplains, e. g., the willow and sycamore, is common knowledge, but the composition of a floodplain forest is more complex than the superficial impression attained by casual observances indicates. It is only by such data as presented in size-classes, density, frequency index, and fidelity that any true conception can be reached regarding the relation of plants to their environment and the real composition of a forest stand.

The east and west forks of White river and the principal river itself, today are in mature age, as evidenced by the meandering courses which they pursue, and by the wide river valley enclosed by gentle slopes. The study of forests in such an environment may lead one to suspect a diversity of forest cover types, since the waters of these valleys pass through four of the five of the botanical areas (5) of Indiana (figure 1). That the facts are contrary to this supposition can readily be seen by comparing the frequency index and abundance of trees found in these stations (table V). As shown by tables I and V, the forest cover is primarily, and more or less uniformly, controlled by *Acer negundo, A. saccharinum, Celtis occidentalis, Fraxinus americana, Platanus occidentalis, Populus deltoides, Salix nigra, Ulmus americana* and *U. thomasi.*

The 9 principal species of the crown cover are typically colonial or gregarious in distribution as Cain (2) described the condition, for they do not form a close association as do the species constituting the climax forest (9) but rather giving rise to a mosaic pattern of "colony association."

It was, indeed, surprising that so large a number of species participate in the crown cover of a floodplain forest. Gordon (6) states that "a classification of floodplain or bottomland forest is difficult because of the large number of species involved and on account of rapid physiographic changes; such changes affect local drainage conditions, destroy old habitats and create new ones." While in the floodplain forest a larger number of species play an important part (F. I. 35% or above) in the crown cover, and the total number of species of tall trees is greater than in either the mixed mesophytic of oak-hickory types of climax forest, as recorded by Potzger and Friesner (9), the difficulty which Gordon points out is really a result of the lack of a true association of species, and the gregarious habit which determines distribution, producing, as pointed out before, a sort of "colonial association." This is plainly supported by the unusually low F. I. even for the leading species.

Acer saccharinum is the outstanding species in the lowland forest as shown by density, frequency, fidelity and basal area (table I). *Ulmus americana* has a greater F. I. than *Acer saccharinum* (*Ulmus americana* 55.75% and *Acer saccharinum* 50.0%), however, it is surpassed by the latter in density and basal area.

The leading and most characteristic genera in the floodplain forest are Acer and Ulmus. A comparison of these genera with respect to F. I. and fidelity shows that there is little difference in importance between the two (table I), and even for these genera the F. I. seems rather low (Acer F. I. 76.76% and Ulmus 79.75%) when compared with the F. I. of the leading genera in upland forest of the same regions. Potzger and Friesner (9) show that on southeast slopes in central Indiana *Acer saccharum, Carya glabra,* and *Quercus montana* attain a frequency index of 100%. This apparently is further proof of a gregarious habit even for the genera which primarily control the crown cover in floodplain forests.

The mortality among the young of Celtis is evidently very high as shown by the large number of stems below one inch DBH. and the relatively small number of trees that are above one inch DBH. (table I). Potzger and Friesner (10) found that a similar condition existed with *Fraxinus americana* in their comparison between virgin forest and adjacent areas of secondary succession. Weaver and Clements (12) state that "in the case of woody plants, seedlings are notably tolerant of shade when contrasted with their demands in later life." Apparently Celtis reproduces well but suffers high mortality beyond the seedling stage.

The remaining eight members most commonly participating in the crown cover as listed earlier in this discussion show good reproduction as evidenced by the large number of stems above one inch DBH. in comparison with the totals for the seedling stage (table I). It is interesting to note that *Fraxinus americana* is included among those members of the floodplain forest type capable of good reproduction.

Cowles (4) shows that *Salix nigra, Acer saccharinum, Populus deltoides* and *Fraxinus americana* are important in the establishment of a floodplain forest because they are the first to appear. "The willows are found on the margin and the river maple (*Acer saccharinum*), the cottonwood (*Populus deltoides*), and the ash (*Fraxinus americana*) soon come in." This analysis agrees well with the present study. Oosting (8) found that the earliest woody community on floodplains and islands is invariably a willow-alder thicket and if the habitat remains poorly drained other hardwoods may not appear in significant numbers for a much longer time than on better drained sites. Since no attempt at zonation was made in this study, some stations being established farther back from the river and on higher banks than other sites, and since both conditions eliminate to some extent disturbances caused by flooding, the absence of Acer, Fraxinus, Populus and Salix in a few of the stations (table V) is only natural. The remaining members adding to the cover show a better representation throughout the entire floodplain.

The distribution of all the species just discussed emphasize the modified association of species which can perhaps be attributed to the influence of light. All of the species are very likely more or less intolerant, and all produce abundant seeds which germinate well. Reproduction is thus limited to open spaces after windfall or death of old trees, and the species which chance to be nearest such an unoccupied space will establish a colony. Soil moisture is not a limiting factor for the species involved in floodplain forest. A floodplain forest, thus, is somewhat similar to the rainforest where dominance is absent or poorly defined (12).

The small tree and shrub layers were poorly expressed. Crataegus, typical of early secondary succession, was the predominant small tree (table II). *Sambucus canadensis,* also an invader of secondary succession, was outstanding for the shrub layer (table II). Both Crataegus and Sambucus were found only in more or less open regions. This would indicate their intolerance of shade. Potzger, Friesner and Keller (11) found that in a mature stand of forest primeval, a well-developed small-tree under-story is lacking and that the shrub layer is represented chiefly by one species, *Asimina tribola.* Thus it can be said that the position of small trees and shrubs in a floodplain forest is similar to that found in some mature upland stands.

A list of the forest climax by botanical areas will show the following: for the Tipton Till Plain, beech-maple is the principal climax (6). The Illinois Drift Plain has two principal climaxes as shown by Potzger and Friesner (9), i. e., a heech-maple climax on north-facing slopes and an oak-hickory climax on the south-facing slopes; the unglaciated area consists chiefly of beech and beech-maple stands and mixed forest areas with oak-hickory on the uplands, beech-sugar maple, and heech-sugar maple-yellow poplar sub-types as segregates of the mixed mesophytic forest, as determined by Gordon (7); the Lower Wabash Valley area has the nearest approach to the floodplain forest, the association being elm-ash-maple and may include sweet gum, pin oak and a wide variety of other mixed hardwoods. The Wabash Valley area is, of course, a floodplain with variation in maturity because of greater width.

The floodplain is apparently a very uniform habitat where macroclimate more definitely determines the establishment of tree species, and where modifying effect of microclimate is reduced to a minimum. The established floodplain, the habitat considered in this study, is controlled hy forest which is the immediate predecessor to the climax mesophytic forest, where soil moisture conditions are less rigorous than in the uplands and the habitat is quite uniform over wide geographical areas. not influenced by heterogeneous upland sites which border on the river valley.

SUMMARY AND CONCLUSIONS

1. The paper presents an ecological study of the floodplain forest within the White River system. It is based on four hundred 100-square-meter quadrat tabulations.

2. Forty species of tall trees take part in the crown cover, nine species in the small tree stratum, and fourteen species in the shrub layer.

3. The outstanding species in the crown cover are *Acer negundo, A. saccharinum, Celtis occidentalis, Fraxinus americana, Platanus occidentalis, Populus deltoides, Salix nigra, Ulmus americana* and *U. thomasi*.

4. *Acer saccharinum* and *Ulmus americana* ranked highest in fidelity, each having 100%. *U. americana* had the highest frequency index with 55.75%.

5. A well developed small tree and shrub layer is lacking. The most common small tree is Crataegus with F. I. 11.0%. The outstanding shrub is *Sambucus canadensis* with F. I. 37.0%.

6. Celtis is the only member in the principal crown cover that has a high rate of mortality among the seedlings.

7. There is no decided difference in the floodplain forest within a river system which bisects four of Deam's botanical areas encountered in this investigation.

8. While fidelity is high for 9 species of tall trees commonly important in the crown cover, the association is poorly expressed. This is due to gregarious or colonial habits which influence or determine the distribution of the species within the stand.

9. Macroclimate apparently is more of a determining factor for the establishment of tree species in the floodplain than is macroclimate.

10. The outstanding features shown by the study: (a) the large number of tall tree species participating in control of the crown, (b) the gregarious or colonial habit of the most prominent species in the stands, making for a poorly expressed association, (c) the simi-

larity of the numerous stands throughout the river system which passes through a number of botanical areas marked by striking differences in the association complex of the upland forest.

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TABLE I

Tall trees in size classes, showing Frequency Index, Fidelity and Basal Area.

Species	Below 1 in.	1 in.	2-5	6-10	11-15	16-20	Above 20	Total Stems	F. I.	Fidelity	Basal Area Sq. Ft.
Acer negundo	689	54	118	62	15	11	2	951	46.25	90.0	63.620
A. rubrum	335	22	59	11	3			477	15.00	40.0	33.960
A. saccharinum	735	92	341	301	136	63	30	1698	50.00	100.0	486.542
A. saccharum	4					1		5	.50	5.0	2.180
Aesculus glabra	32	5	16	17	4	1	2	77	7.75	35.0	17.700
Ailanthus altissima	2		2	2				6	1.25	10.0	7.745
Carya cordiformis	9		1			1	2	13	1.00	15.0	7.467
C. illinoensis				2	1			3	1.00	5.0	1.816
C. laciniosa	12			1	2			15	1.25	10.0	2.493
C. tomentosa			1	2				3	1.00	5.00	.567
Catalpa speciosa	2		1					3	.50	5.0	.049
Celtis occidentalis	1688	133	158	99	23	22	9	2132	39.24	95.0	138.306
Fagus grandifolia			1			1	1	3	.25	5.00	4.918
Fraxinus americana	451	47	49	47	15	17	3	629	34.75	85.0	92.740
F. lanceolata	28	1	2	4				35	5.50	40.0	1.965
F. nigra	20			4			2	26	1.25	20.0	6.944
F. pennsylvanica						2		2	.50	5.0	3.736
F. quadrangulata	3		1	1	2			7	1.50	20.0	2.209
F. tomentosa	2	2	4					8	1.75	20.0	.190
Gleditsia aquatica	15		3			1		19	.75	10.0	1.619
G. triacanthos	139	7	17	20	13	14	4	214	17.75	75.0	55.14
Gymnocladus dioica	5	2	6		2			15	1.00	5.0	2.601
Juglans cinerea			4	5				9	1.50	15.0	1.843
J. nigra	29	4	12	8	13	5		71	12.50	90.0	23.753

TABLE I (Continued)

Tall trees in size classes, showing Frequency Index, Fidelity and Basal Area.

Species	Below 1 in.	1 in.	2-5	6-10	11-15	16-20	Above 20	Total Stems	F. I.	Fidelity	Basal Area Sq. Ft.
Liquidambar styraciflua	32	1	2	7	3			45	1.00	20.0	5.508
Morus rubra	78	6	6	5		1		96	10.25	75.0	5.479
Nyssa sylvatica	6		1					7	.75	10.0	.218
Platanus occidentalis	90	14	52	67	89	58	94	464	37.00	95.0	643.633
Populus deltoides	10	1	14	36	54	69	68	252	27.50	80.0	376.357
Prunus serotina	36	5	2	1				44	1.75	10.0	.218
Quercus bicolor	11	2	2	2			3	20	3.50	20.0	20.828
Q. imbricaria	3	3	2	3	1			12	.75	15.0	2.383
Q. montana	1		1		1			3	.75	10.0	1.058
Q. muhlenbergii	5	3					1	9	.50	5.0	4.734
Q. stellata			1	1				2	.50	10.0	.218
Salix nigra	96	7	19	60	32	5	3	222	44.75	85.0	70.549
Tilia americana	21	2	10	7	6	2	3	51	4.00	45.0	24.587
Ulmus americana	188	37	150	137	78	24	28	642	55.75	100.0	246.945
U. fulva	88	9	26	24	6	1	2	156	20.75	67.0	20.736
U. thomasi	35	18	166	117	36	6	4	382	33.25	80.0	90.995

TABLE II

Small trees in size classes showing Frequency Index, Fidelity and Basal Area.

Species	Below 1 in.	1 in.	2-5	6-10	Total Stems	F. I.	Fidelity	Basal Area Sq. In.
Carpinus caroliniana var. virginiana	10	11	3		24	1.75	15.0	18.0642
Cercis canadensis	64	11	18	3	96	7.25	40.0	308.1622
Cornus florida	323	23	7		353	9.25	50.0	66.0536
Crataegus	306	75	114		510	11.00	45.0	1571.5856
Maclura pomifera			3		3	.50	5.0	17.2788
Ostrya virginiana	26	22	27		75	1.00	20.0	205.7748
Prunus americana	89	10	16	2	117	.75	5.0	253.2420
P. hortulana	5	3	1		9	1.25	5.0	9.4248
Salix discolor	5	2	3		10	.50	10.0	31.4160

TABLE III

Shrubs in size classes, showing Frequency Index and Fidelity

Species	Below 1 in.	1 in.	2-5	Total Stems	F. I.	Fidelity
Amorpha fruticosa					1.0	5.0
Asimina triloba	45	2	4	51	3.0	25.0
Evonymus atropurpureus	144	10	2	156	7.5	35.0
Forestiera acuminata	112	19	6	137	.75	5.0
Gaylussacia baccata					5.5	15.0
Grossularia cynosbati					.75	10.0
Lindera benzoin	173	7	2	182	6.0	40.0
Prunus virginiana	13			13	1.0	5.0
Ptelea trifoliata	144	3	2	149	3.5	40.0
Rosa sp. ?					5.25	10.0
Rubus sp. ?					3.0	20.0
Sambucus canadensis	1537	16		1553	37.0	68.0
Staphylea trifolia	3			3	.75	10.0
Viburnum lentago					.75	15.0

TABLE IV

Showing Frequency Index and Fidelity of Vines.

Species	F. I.	Fidelity
Aristolochia tomentosa	1.0	5.0
Bignonia capreolata	1.75	15.0
Campsis radicans	25.5	55.0
Celastrus scandens	.75	10.0
Parthenocissus quinquefolia	15.5	60.0
Rhus radicans	78.5	100.0
Smilax	39.5	95.0
Vitis	48.25	100.0

TABLE V

Frequency Index and Density of Species by Stations.

Species	A F. I.	A Density	B F. I.	B Density	C F. I.	C Density	D F. I.	D Density	E F. I.	E Density
Acer negundo			45.0	21	25.0	8	65.0	29	95.0	45
A. saccharinum	5.0	1	20.0	7	10.0	5	45.0	23	95.0	38
A. saccharum							5.0	1		
Aesculus glabra	5.0	1	5.0	1			15.0	6	15.0	6
Carya cordiformis	15.0	3			5.0	2				
Celtis occidentalis	10.0	2	15.0	6	100.0	102	80.0	47	40.0	29
Cercis canadensis							10.0	2	10.0	2
Crataegus sp. ?	85.0	156			25.0	13	5.0	2		
Fagus grandifolia	10.0	2								
Fraxinus americana	25.0	8	60.0	27	15.0	6	15.0	6		
F. lanceolata			5.0	6			5.0	1	10.0	3
F. nigra	10.0	2								
F. pennsylvanica	10.0	4								
F. quadrangulata	5.0	1			5.0	1	5.0	1		
F. tomentosa			15.0	3						
Gleditsia aquatica			20.0	5						
G. triacanthos	45.0	12			10.0	6	15.0	3	5.0	1
Juglans cinerea									10.0	2
J. nigra	5.0	1	15.0	3			5.0	1		
Ostrya virginiana									10.0	3
Platanus occidentalis	15.0	7	45.0	31	55.0	25	25.0	11	50.0	21
Populus deltoides			25.00	12	10.0	2			45.0	12
Prunus americana	20.0	7								
Quercus bicolor	50.0	5							25.0	9

TABLE V (Continued)

Frequency Index and Density of Species by Stations.

Species	A F. I.	A Density	B F. I.	B Density	C F. I.	C Density	D F. I.	D Density	E F. I.	E Density
Q. imbricaria					5.0	1				
Q. montana	5.0	1								
Q. stellata			5.0	1						
Salix discolor					10.0	4				
S. nigra	15.0	9	25.0	14	35.0	15			25.0	6
Ulmus americana	30.0	7	45.0	13	85.0	56	50.0	14	70.0	53
U. fulva	30.0	12	30.0	6	40.0	12	85.0	9		
U. thomasi	15.0	4	75.0	23	60.0	28	25.0	8	80.0	35

Species	F F. I.	F Density	G F. I.	G Density	H F. I.	H Density	I F. I.	I Density	J F. I.	J Density
Acer negundo	40.0	19	40.0	23	35.0	26	15.0	6	25.0	14
A. rubrum			35.0	18			5.0	2	30.0	9
A. saccharinum	40.0	22	75.0	67	15.0	18	80.0	103	35.0	24
Aesculus glabra	5.0	1								
Catalpa speciosa									10.0	3
Celtis occidentalis	65.0	50	5.0	2	5.0	2	65.0	43	60.0	34
Cercis canadensis			5.0	2						
Cornus florida					5.0	2	10.0	4		
Crataegus sp. ?	10.0	6					10.0	11	10.0	4
Fraxinus americana	25.0	13			15.0	14			10.0	3
F. lanceolata	5.0	1								
F. tomentosa					5.0	3				
Gleditsia triacanthos	25.0	9					30.0	18		

TABLE V (Continued)

Frequency Index and Density of Species by Stations.

Species	F F. I.	F Density	G F. I.	G Density	H F. I.	H Density	I F. I.	I Density	J F. I.	J Density
Juglans nigra	10.0	2					5.0	4		
Morus rubra			5.0	3					10.0	3
Platanus occidentalis	15.0	3	5.0	1	65.0	62	55.0	20	50.0	19
Populus deltoides			65.0	58	10.0	3			50.0	26
Quercus bicolor									5.0	1
Salix discolor							5.0	1		
S. nigra	10.0	2	5.0	2			15.0	4		
Tilia americana	5.0	1	5.0	1			15.0	5		
Ulmus americana	65.0	19	30.0	9	10.0	2	50.0	35	40.0	4
U. fulva	10.0	3	15.0	5	20.0	5	10.0	3		
U. thomasi	20.0	6	40.0	16	30.0	17	30.0	12	50.0	20

Species	K F. I.	K Density	L F. I.	L Density	M F. I.	M Density	N F. I.	N Density	O F. I.	O Density
Acer negundo	20.0	12			5.0	2	60.0	22	10.0	3
A. rubrum	20.0	15	65.0	106	15.0	4			5.0	4
A. saccharinum	45.0	29	50.0	64	15.0	31	25.0	13	90.0	103
A. saccharum					10.0	2				
Aesculus glabra							70.0	30		
Carpinus caroliniana var. virginiana					5.0	1				
Carya illinoensis					30.0	18				
C. laciniosa	5.0	1			5.0	1				
Celtis occidentalis	35.0	14			20.0	12	40.0	21	50.0	22
Cercis canadensis	5.0	1					10.0	5		

TABLE V (Continued)
Frequency Index and Density of Species by Stations.

Species	K F. I.	K Density	L F. I.	L Density	M F. I.	M Density	N F. I.	N Density	O F. I.	O Density
Cornus florida	10.0	2			5.0	1	15.0	4		
Crataegus sp. ?	30.0	15								
Fagus grandifolia	5.0	1								
Fraxinus americana	5.0	1	45.0	33	35.0	13	30.0	24	55.0	42
F. lanceolata					10.0	2				
F. nigra					5.0	5				
F. quadrangulata			5.0	3			5.0	1		
Gleditsia triacanthos	25.0	14	5.0	1	5.0	1	10.0	3	15.0	9
Gymnocladus dioica					15.0	10				
Juglans cinerea									10.0	4
J. nigra	10.0	2			10.0	2	40.0	11	25.0	8
Liquidambar styraciflua			5.0	1	15.0	7			5.0	2
Morus rubra	5.0	1					10.0	3		
Nyssa sylvatica			10.0	2			5.00	1		
Ostrya virginiana	10.0	3					50.0	34		
Platanus occidentalis	80.0	42			20.0	5	30.0	16	80.0	29
Populus deltoides	25.0	10	60.0	27	15.0	6	10.0	6	30.0	11
Prunus hortulana			30.0	26			5.0	1		
Quercus bicolor	5.0	1								
Q. imbricaria	20.0	6								
Salix nigra			25.0	15	10.0	7	10.0	4	40.0	10
Tilia americana	5.0	1			5.0	1	10.0	2	10.0	2
Ulmus americana	45.0	21			30.0	6	60.0	23	80.0	39
U. fulva	5.0	13			10.0	2			10.0	2
U. thomasi	60.0	45			40.0	13	40.0	17	35.0	16

TABLE V (Continued)

Frequency Index and Density of Species by Stations.

Species	P		Q		R		S		T	
	F. I.	Dessity	F. I.	Dessity	F. I.	Dessity	F. I.	Dessity	F. I.	Density
Acer negundo	5.0	3	30.0	9	40.0	14	35.0	16	50.0	29
A. rubrum	20.0	104	20.0	19						
A. saccharinum	60.0	65	50.0	46	85.0	80	85.0	89	50.0	73
Aesculus glabra									5.0	2
Celtis occidentalis	15.0	6	55.0	42	50.0	31	20.0	6	35.0	16
Cercis canadensis									20.0	6
Cornus florida									25.0	10
Crataegus sp. ?			5.0	5						
Fraxinus americana					20.0	8	30.0	7	60.0	36
F. lanceolata	65.0	48	15.0	6	5.0	1			10.0	2
F. pennsylvanica							5.0	1		
F. quadrangulata					5.0	1			20.0	6
F. tomentosa							5.0	1		
Gleditsia triacanthos			10.0	3			5.0	1		
Juglans nigra	10.0	4	10.0	2	5.0	2			10.0	3
Liquidambar styraciflua	5.0	3								
Maelura pomifera									5.0	3
Morus rubra	10.0	3	5.0	1	5.0	1				
Platanus occidentalis			5.0	1	10.0	3	30.0	6	35.0	28
Populus deltoides	75.0	42	30.0	10	55.0	34	20.0	6	5.0	4
Prunus americana	5.0	1	65.0	33						
Quercus imbricaria	5.0	1							10.0	6
Q. muhlenbergii									5.0	3
Q. stellata			5.0	1						

TABLE V (Continued)

Frequency Index and Density of Species by Stations.

Species	P F. I.	P Dessity	Q F. I.	Q Dessity	R F. I.	R Dessity	S F. I.	S Dessity	T F. I.	T Density
Salix nigra	60.0	29	20.0	4	15.0	9			5.0	1
Tilia americana	20.0	9								
Ulmus americana	80.0	29	70.0	34	60.0	37	55.0	21	90.0	59
U. fulva			30.0	9	45.0	21	20.0	4	5.0	1
U. thomasi	40.0	23	25.0	16	35.0	12	35.0	8	60.0	19