Analysis of an Original Forest of the Lower Wabash Floodplain and Upland

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The Smithsonian naturalist Robert Ridgway, by means of letters and photographs sent to Charles C. Deam (1, 3) and by size measurements of trees and general descriptions of communities (5, 6, 7), substantiated his claims as to the extraordinary nature of the Lower Wabash Valley bottomland forests *circa* 1870. None of the stands in this region recently analyzed by Lindsey *et al.* (3) represented the original type which Ridgway depicted, and it appeared that every example of such superb timber had been sacrificed, necessarily or unnecessarily, to the march of our culture. Fortunately, however, one sizeable remnant of this forest still stands. Although the timber has been marked for cutting, a campaign to raise funds for its purchase and preservation, aided by the Nature Conservancy, is underway in Illinois.

Beall Woods, near the village of Keensburg, Illinois, comprises 279 acres on both sides of Sugar Creek, Wabash County. (The narrow western lobe across the road, aside from a few remaining large trees, is hardly better than an ordinary cut-over woodlot; it is not included in this report.) The floodplain of Sugar Creek where it meets the Wabash is 400 feet above mean sea level. The floodplain surface varies about 3 feet in elevation, but since it lacks clear differentiation, of either physiographic or vegetational sort, into first and second terrace, the bottomland stand will be treated as a single community. The bottomland portion is on Genessee soil.

The ecoclimate of the Mt. Carmel area has been discussed earlier (3).

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Procedure

The one-fifth acre areal strip was the sampling unit used. Twenty such strips were applied in the floodplain forest, and 25 strips in the upland. Each strip was 200 feet long, surveyed by a central steel tape of that length, and 43.56 ft. wide. The width was not marked by surveyed boundaries; the more efficient method (2) of checking only the borderline trees was used, by twice laying out, at 90° to the center line, a stick of quarter-round 10.89 feet long. Most tree centers are obviously inside or outside the 21.8 foot half-strip width by estimation, and need not be checked for distance by use of the stick.

Each fifth-acre strip plot has 8 times the area of the 10 x 10 meter quadrat which has been used in many investigations in Midwest forests. Placement of strips was roughly stratified-random. Diameters (of all live trees at least 4 inches dbh) were measured to inches and tenths by diameter tape at 4.5 feet aboveground.

Frequency was based on tenth-acre strip sections, i.e., on 100 x 43.5 foot plots. Therefore, the straight frequency (F_1) figures are not comparable with F_1 percentages derived from smaller quadrats by other workers and are not reported here, but the relative frequency (F_3) percentages are comparable with F_3 from other size areal plots, and are presented. Detailed definitions of the vegetational attributes used may be found in Lindsey *et al.* (3), Table 3.

TABLE 3. Upland stand analysis, showing absolute attributes of first 20 species and their relative attributes as per cent of entire stand. (See legend of Table 1 for symbols). Figures rounded from 5 places.

	B_2	B_3	D_2	D_3	F_3	Y_3
Quercus alba	73	48	27	24	17	30
Acer saccharum	15	9.6	29	25	12	15
Q. velutina	15	9.6	6.2	5.3	5.6	6.9
Q. rubrum	8.0	5.3	2.3	2.0	3.5	3.6
Carya ovata	7.6	5.0	7.8	6.8	6.3	6.0
Fraxinus americana	6.5	4.3	5.3	4.6	6.6	5.2
Q. shumardii	6.0	4.0	1.2	1.0	2.1	2.4
Nyssa sylvatica	5.8	3.8	3.2	2.7	3.5	3.3
Q. bicolor	3.9	2.6	1.5	1.3	1.0	1.6
Carya ovalis	2.3	1.5	3.0	2.6	5.6	3.2
Other Carya*	2.0	1.3	2.0	1.7	—	—
Liquidambar styraciflua	1.4	0.9	2.2	1.9	3.8	2.2
Ulmus americana	0.94	0.62	3.5	3.0	1.4	1.7
Carya glabra	0.83	0.55	1.2	1.0	2.1	1.2
Fraxinus pennsylvanica	0.65	0.43	2.0	1.7	1.7	0.78
Celtis occidentalis	0.61	0.40	2.5	2.2	4.2	2.2
Cornus florida	0.56	0.37	4.8	4.2	5.6	3.4
Ostrya virginiana	0.46	0.30	3.8	3.3	4.5	2.7
Sassafras albidum	0.36	0.24	2.2	1.9	2.4	1.5
Prunus serotina	0.29	0.19	1.7	1.4	2.1	1.2
Cercis canadensis	0.13	0.09	1.2	1.0	2.8	1.3
Other species*	0.97	0.64	2.0	1.7	—	—
Stand values	B_9 152	—	D_9 115	—	—	—

* *Carya laciniosa, C. tomentosa, C. cordiformis, Juglans nigra, Quercus imbricaria, Q. muehlenbergii, Tilia americana, Ulmus rubra, Fagus grandifolia, Morus rubra, Vitis* sp.

Results on Floodplain Forest

Thirty-one tree species occurred on the bottomland (Table 1), including *Populus deltoides* which fell outside the sampling units. Two species, *Quercus shumardii* and *Liquidambar styraciflua* contributed 40% of the stand basal area, and with the next two species made up slightly more than 60%. Both basal area and importance percentage type this as an oak-gum-elm-hickory forest. *Ulmus americana* has by far the highest importance percentage (21) but ranked only fourth in basal area, since there were many small, widely scattered trees and only one large individual sampled (Table 2).

TABLE 1. Bottomland stand analysis of tree stratum (4" +) showing absolute attributes of first 18 species and their relative attributes as per cent of entire stand. B_2 is basal area in square feet per acre, B_3 relative basal area, D_2 is density per acre, D_3 relative density, and Y_3 is importance percentage. Figures rounded from five places.

	B_2	B_3	D_2	D_3	F_3	Y_3
Quercus shumardii	49	25	7.8	6.8	7.9	13
Liquidambar styraciflua	31	15	8.2	7.2	9.5	11
Quercus macrocarpa	22	11	3.8	3.3	5.8	6.7
Ulmus americana	19	9.8	41	36	18	21
Carya laciniosa	16	8.2	9.0	7.9	11	8.8
Acer saccharinum	10	5.2	8.3	7.2	4.7	5.7
Quercus palustris	9.9	5.0	1.5	1.3	2.6	3.0
Q. bicolor	9.5	4.8	2.0	1.7	3.7	3.4
Q. falcata var. pagodaefolia	7.2	3.6	1.2	1.1	2.1	2.3
Carya cordiformis	5.0	2.5	2.0	1.7	3.7	2.7
Betula nigra	3.0	1.5	1.0	0.87	1.1	1.2
Ulmus rubra	3.0	1.5	1.0	0.87	1.6	1.3
Platanus occidentalis	2.9	1.5	0.75	0.65	1.1	1.1
Fraxinus pennsylvanica	2.4	1.2	3.7	3.3	2.1	2.2
Carya ovata	2.3	1.2	2.5	2.2	3.2	2.2
Celtis occidentalis	1.6	0.8	8.5	7.4	8.4	5.5
Sassafras albidum	0.53	0.27	2.0	1.8	1.6	1.2
Cercis canadensis	0.05	0.03	2.7	2.4	3.2	1.9
Other species*	3.9	—	7.0	—	—	—
Stand values	B_9 199.	—	D_9 114.5	—	—	—

* *Juglans nigra, Ulmus racemosa, Carya glabra, C. tomentosa, C. illinoensis, C. aquatica* (?), *Gleditsia triacanthos, Acer negundo, Diospyros virginiana, Gymnocladus dioica, Crataegus* sp., *Fraxinus americana.*

Although the stand is unusually mixed for bottomland timber, *Acer saccharinum, Betula, Platanus, Populus,* and *Carya illinoensis* are confined to the lowest spots, i.e., floodflow troughs and the edges of the floodplain along Sugar Creek. Six of the 20 strips represented this low end of the elevational gradient.

Table 2 gives the size class distribution for the major species separately, and for several minor ones lumped together. The proportion of large trees is very high; this applies from the 30 in. size class on up. The 18-26 inch classes are poorly represented. These points were brought out by plotting the totals (Table 2, bottom row) for the size classes on semi-log paper.

The mean diameter of floodplain trees was 13.7 inches, the stand density was 114.5 trees per acre, and the stand basal area 199 square feet per acre. The latter figure is the highest I know of for any old-growth hardwood stand in the Midwest.

TABLE 2. Species density per acre of bottomland stand by 4 inch size classes, indicated by size-class midpoints heading the columns. Species abbreviations refer to species names in Table 1.

	6	10	14	18	22	26	30	34	38	42	46
Qs	—	—	—	.25	—	1.25	1.75	1.75	1.25	1.25	.25
Ls	1.5	1	0.5	.25	0.5	0.25	1.75	1.25	0.5	—	—
Qm	.25	—	—	—	.25	.75	0.5	.75	.25	.5	—
Ua	20.	7.5	4.25	1	1	—	—	—	—	.25	—
Cl	1.5	2.25	1.75	1.2	1	0.5	1	—	.25	—	—
Asi	4.25	2.25	1.5	—	—	—	—	—	.25	.25	.25
Qp	—	—	—	.25	—	.25	—	.25	.25	.5	—
Qb	.25	—	—	—	.25	0.5	0.5	—	.25	.25	—
Qfp	—	—	—	—	—	.25	.25	.25	—	.25	—
CC	.25	.25	—	.25	0.5	0.5	.25	—	—	—	—
Bn	—	—	.25	.5	—	—	—	—	.25	—	—
Ur	1.25	0.5	—	.25	.25	0.5	—	—	—	—	—
Po	—	—	—	.25	—	—	0.5	—	—	—	—
Fp	3.0	—	.25	—	—	—	—	.25	—	—	—
Cov	.25	1.25	0.5	—	—	—	—	—	—	—	—
Coc	7.5	.75	—	—	—	—	—	—	—	—	—
Others	9.0	2.0	0.5	.25	0.5	—	—	—	—	—	—
Total	49.	24.5	9.5	4.45	4.	4.75	6.5	4.5	3.25	3.00	0.5

Results on Upland Forest

Thirty tree species at least 4 in. dbh were tallied from the 5 upland acres included in the sampling strips and tabulated in Table 3. The prominence of *Quercus alba* is clearly shown. Although *Acer saccharum* ranked second only to *Q. alba* in both importance and basal area, only one individual of its normal associate *Fagus* was recorded. All species of hickory combined showed lower than the maple in both importance and basal area, but the dominance of *Quercus alba* and of oaks in general (more than 70% of B_3) suggests the designation of oak-hickory-maple for this stand. The low importance of other trees contraindicates the mixed mesophytic type.

Table 4 gives the size class distribution in the upland stand, from the same 25 fifth-acre strips. Sugar maple was remarkably limited to

TABLE 4. Species density per acre of upland stand by 4 inch size classes, indicated by size-class midpoints heading the columns. Species abbreviations refer to species names in Table 3.

	6	10	14	18	22	26	30	34	38
Qa	1.8	3	3.6	7.4	5	6.2	3.2	1.8	0.8
As	31	3	0.2	—	0.4	—	—	—	—
Qv	0.2	0.6	1	1.4	1.4	1	0.4	0.4	—
Qr	0.2	—	0.2	0.2	1	0.6	0.8	—	—
Cot	1.2	3.2	3.4	1.4	1	—	—	—	—
Fa	3	0.6	1	0.4	0.2	1.2	—	—	—
Qs	—	—	—	—	—	0.4	0.6	0.2	0.2
Ns	0.4	0.6	0.4	1.2	0.6	0.6	—	—	—
Qb	—	—	0.2	—	0.6	0.2	0.2	—	—
Col	0.6	1.8	0.8	0.4	—	—	—	—	—
Cfl	6	—	—	—	—	—	—	—	—
Ls	2	—	—	0.2	0.2	—	—	—	—
Fp	1.6	0.8	0.4	—	—	—	—	—	—
Dv	5	—	—	—	—	—	—	—	—
Ss	2.6	—	—	—	—	—	—	—	—
Ps	1.2	0.4	—	—	—	—	—	—	—
Others	8	1.6	0.8	—	0.4	—	—	—	—
Total	64.6	15.6	12	12.6	10.8	10.2	5.2	2.4	1

the two lowest size classes, while oaks were almost as strikingly sparse in those 6 and 10 inch classes.

The mean diameter of trunks in the upland stand was 12.8 inches, the stand density was 115 trees per acre, and the stand basal area 152 square feet per acre. Although the density was identical with that on the bottomland, the upland had a stand basal area only 76% of the bottomland basal area.

Largest Individual Trees

Maximum measurements of large species in the floodplain stand were: *Platanus*, 55.2 in. dbh; *Quercus macrocarpa*, 53.0; *Q. shumardii*, 49.6; *Fraxinus pennsylvanica*, 49.1; *Q. palustris*, 44.1; *Ulmus americana* (dead), 45.3; *Liquidambar*, 43.6; *Acer saccharinum*, 44.3; *Q. bicolor*, 41.7; *Carya illinoensis* 36.8, and *Populus deltoides*, 31.3.

On the upland, some maximum species figures were: *Quercus alba*, 40.1 dbh; *Q. velutina*, 38.2; *Fraxinus americana*, 33.6, *Nyssa*, 26.7, and *Sassafras*, 21.2.

There may be larger trees that were not within the sample units nor encountered outside them. The report of the timber cruise, when trees were marked for cutting, included a 62 inch *Q. macrocarpa* measurement. I did not see this tree.

Professor Elroy Rice helped me take some of these diameters on a preliminary visit to the stand.

Discussion

Like Donaldson's Woods (2), a virgin stand of white oak-beech-maple in Spring Mill State Park, Lawrence County, Indiana, Beall Woods upland is clearly gravitating toward a less xerophytic dominance as indicated by the heavy sampling in lower size classes and observations on reproduction less than 4 inches dbh. That two best examples of oak-dominated old-growth forests between the 38 and 39 parallel in Indiana and the Wabash Valley share this trait is a challenging fact. Are these stands, which are as undisturbed as it is possible to find for their type, actually preclimax under present climate? Less technically put, are they stands which, even though essentially "virgin stands" (especially Donaldson's Woods), have not yet reached the climatic type under current climate? The advance of the mesophytic *Acer* strongly indicates a late stage of succession rather than a stabilized condition. Paradoxically, the climatic trend that occurred during this successional period is generally agreed to be toward more warm-dry climate, or counter to that which would be expected to promote succession favoring *Acer saccharum*. Although this may have been too minor to affect vegetation in this respect, at least the changes in these stands cannot be attributed to climatic changes as causal.

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