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COMPOSITION DIAGRAMS FOR FORESTS

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There is still much room for new methods in obtaining field data for study of vegetation and in summarizing and depicting the facts after they are found. One rather simple way of showing the character and make-up of a forest is by use of composition diagrams and tables. Such diagrams show for a forest area or for a set of plots the average size and the number of the trees of each important species. The species are arranged in order of some measure of relative importance, here basal area per acre. (Basal area of an individual tree is the cross-sectional area in square feet of its trunk, measured at breast height.) For each species a bar or rectangle shows by its height the number of trees per acre; by its width, basal area per tree. The area of a bar shows basal area per acre. It is a fairly dependable measure of relative significance of that species in terms of bulk or of area covered. Numerical values of these and related quantities are shown in the composition table.

The first example (fig. 1) shows the make-up of a little-disturbed old-growth stand near Urbana that has been much studied. The 52-acre sample is complete except for smaller trees of the eight most common species, for which the numbers were estimated from values for all sizes in 12.8 acres and from all larger trees in 39.2 acres. It covers the upland part of Brownfield Woods (omitting a flood-plain area and the outer margins). All trees three inches in diameter or larger are included. The survey was made the autumn of 1939. The twelve leading species, with symbols, are shown below.

As may be seen from the table, the thirteen minor species make up less than two percent of the stand.

It is seen at once that there is great difference among the species and little relation between average size and number of trees.

Three species attained enormous dimensions in this forest, bur oak 54 inches diameter, yellow oak 49.5 inches, walnut 44.5 inches (estimated

Acer saccharum	hard maple	HM
Quercus rubra	(northern) red oak	RO
Ulmus rubra (U. fulva)	slippery elm	SE
Ulmus americana	white elm	WE
Tilia americana	basswood, linden	L
Quercus muhlenbergii	yellow oak	YO
Quercus macrocarpa	bur oak	BO
Fraxinus quadrangulata	blue ash	BA
Fraxinus americana	white ash	WA
Celtis occidentalis	hackberry	H
Juglans nigra	black walnut	BW
Aesculus glabra	buckeye	B

BROWNFIELD WOODS, 1939. 52 ACRES.

SPECIES	TREES PER ACRE	B.A. PER TREE	D.B.H., AV. TREE	B.A. PER ACRE	% OF STAND
1 HM	56.87	.521	9.8 IN.	29.63	26.4
2 RO	10.76	2.068	19.5	22.25	19.8
3 SE	9.04	1.169	14.3	10.56	9.4
4 WE	11.32	.754	11.3	8.58	7.6
5 L	7.23	1.108	14.3	7.79	6 9
6 YO	1.98	3.474	25.2	6.88	6.1
7 BO	1.65	3.604	25.7	5.96	5.3
8 BA	4.19	1.374	15.9	5.76	5.1
9 WA	4 29	1.338	15.6	5.75	5.1
10 H	4.27	1.052	13.9	4.49	4.0
11 BW	.92	1.657	17.4	1.53	1.4
12 B	5.60	.238	6.6	1.41	1.3
13 MINOR SPECIES	7.095	.3210	7.7	2.19	1.94
ALL 25 SPECIES	125.27	.9013	12.9	112.84	100.34

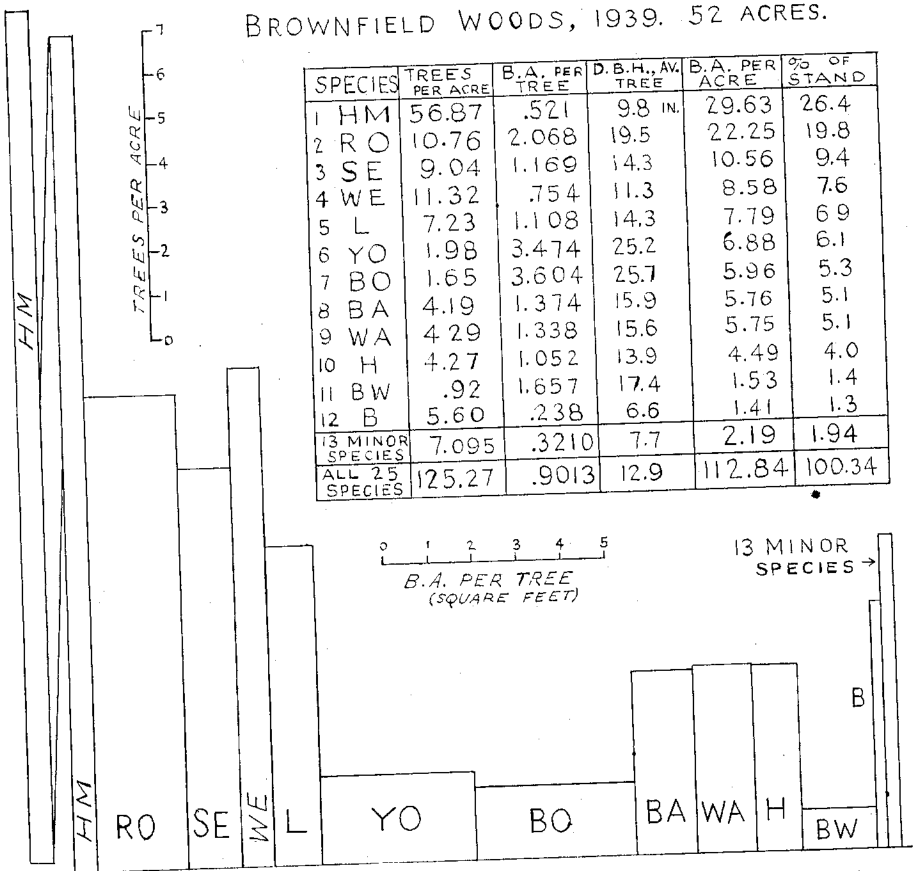


FIG. 1.—Composition diagram and table for 52 acres of upland mixed forest in Brownfield Woods in 1939.

from largest stump). These have been on the decline for some years, with few small trees to replace them. Some cutting over many years, mostly of oaks and walnut, has greatly accelerated the increase of hard maple, represented in 1939 by three times as many small and middle-sized trees as are necessary to maintain the observed population of 124 large maples (18 to 36 inches d.b.h.). Consequently the diagram shows a small average size (9.8-inch d.b.h.) with very high density (nearly 57 per acre: 2,958 maples in all). Only one species, red oak, shows large average size as well as fairly high density.

The second diagram and table (fig. 2) are for a large sample in the same forest from the same 1939 survey. It comprises 16 plots each of 0.8 acre size. These differences show in the diagrams: hard maple has nearly 8 more trees per acre; white elm is in 8th place (instead of 4th); bur oak is in 10th place (instead of 7th). This 24.6-per cent sample is a

BROWNFIELD WOODS, 1939. 12.8 ACRES

SPECIES	TREES PER ACRE	B. A. PER TREE	D.B.H., AV. TREE	B. A. PER ACRE	PER CENT OF STAND BY NO.	BY B. A.
1 HM	64.59	.520	9.8	33.60	51.2	29.4
2 RO	8.36	2.375	20.9	19.85	6.6	17.4
3 SE	9.22	1.243	15.1	11.46	7.3	10.0
4 L	7.58	1.193	14.8	9.04	6.0	7.9
5 YO	2.27	3.433	25.1	7.78	1.8	6.8
6 BA	4.38	1.674	17.5	7.33	3.5	6.4
7 WA	4.61	1.522	16.7	7.02	3.7	6.1
8 WE	9.61	.684	11.2	6.58	7.6	5.8
9 H	3.67	1.055	13.9	3.87	2.9	3.4
10 BO	1.25	2.792	22.6	3.49	1.0	3.1
11 B	5.94	.245	6.7	1.45	4.7	1.3
12 BW	.63	2.066	19.5	1.29	.5	1.1
MINOR SPP. (10)	3.98	.374	8.3	1.49	3.2	1.3
ALL SPP. (22)	126.09	.906	12.9	114.25	100.0	100.0

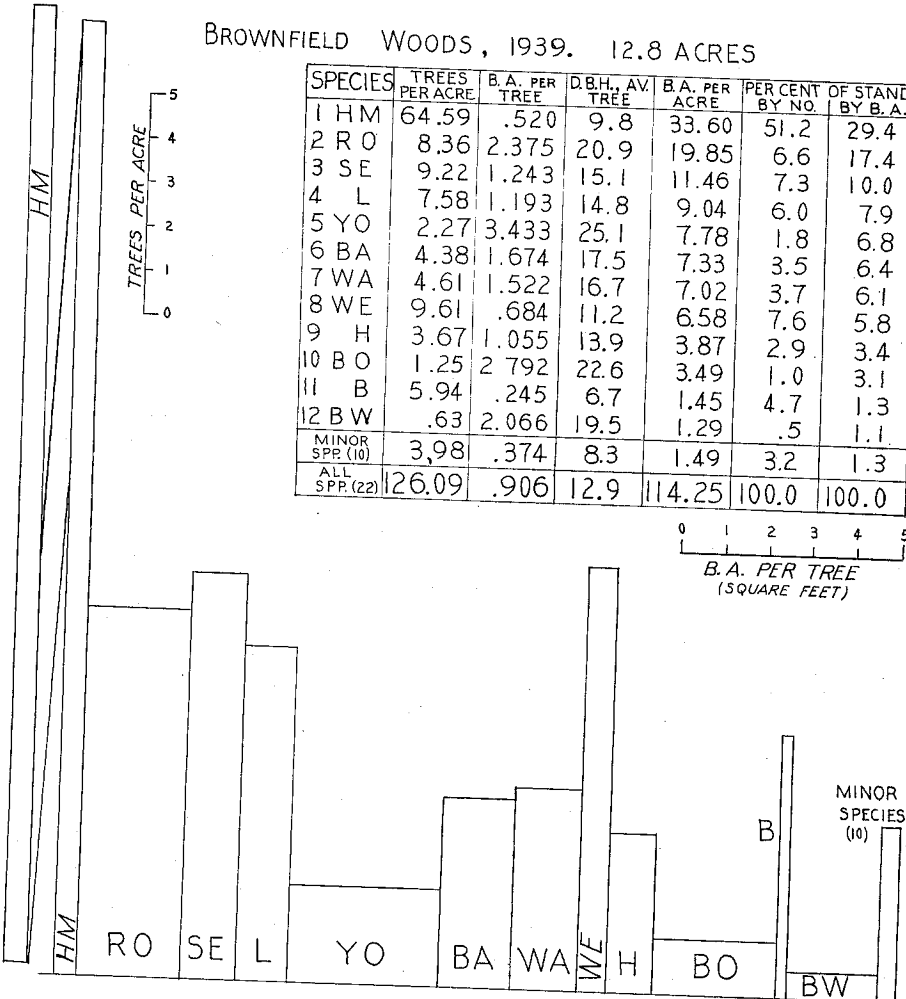


FIG. 2.—Aggregate of 16 plots, each 0.8 acre, Brownfield, 1939.

less faithful reflection of the stand as a whole than one might expect. The same may be true in greater degree for many smaller forest samplings commonly thought to be adequate.

The third diagram and table (fig. 3) are for the same 16 plots as resurveyed 12 years later by Dean F. Cortright. We now note a change in the appearance of the diagram as a whole: it is lower and broader, showing that most species have increased in average size and decreased in number of individuals. Hard maple, with 4½ fewer trees per acre, has advanced in bulk from 29.4 to 32.9% of stand. White elm is up from 8th place to 4th. Linden, yellow oak, both species of ash, buckeye, and the minor species have lost ground. Two minor species have been lost, one

BROWNFIELD WOODS, 1951. 12.8 ACRES

SPECIES	TREES PER ACRE	B.A. PER TREE	D.B.H., AV. TREE	B.A. PER ACRE	PER CENT OF STAND BY NO.	BY B.A.
1. HM	60.16	.747	11.7	44.92	52.8	32.9
2. RO	7.81	3.253	24.4	25.42	6.9	18.6
3. SE	8.75	1.570	17.0	13.74	7.7	10.1
4. L	6.41	1 493	16.6	9.57	5.6-	7.0-
5. WE	8.45	.978	13.4	8.25	7.4-	6 1
6. YO	1.80	4.094	27.4	7.36	1.5-	5.4-
7. WA	3.05	2 260	20 4	6.88	2.7-	5.0-
8. BA	2 73	2.352	20.8	6.43	2.4-	4 7-
9. H	4.06	1.207	14.9	4.89	3.6	3.6
10. BO	1.09	3.888	26.7	4.25	1.0	3.1
11. B	6.25	.270	7.0	1 69	5.5	1.2-
12. BW	.55	2 879	23.0	1.57	.5	1.2
MINOR SPP. (9)	2 73	.528	9.8	1.44	2.4-	1.1-
ALL SPP. (21)	113.83	1 198	14.8	136.41	100.0	100.0

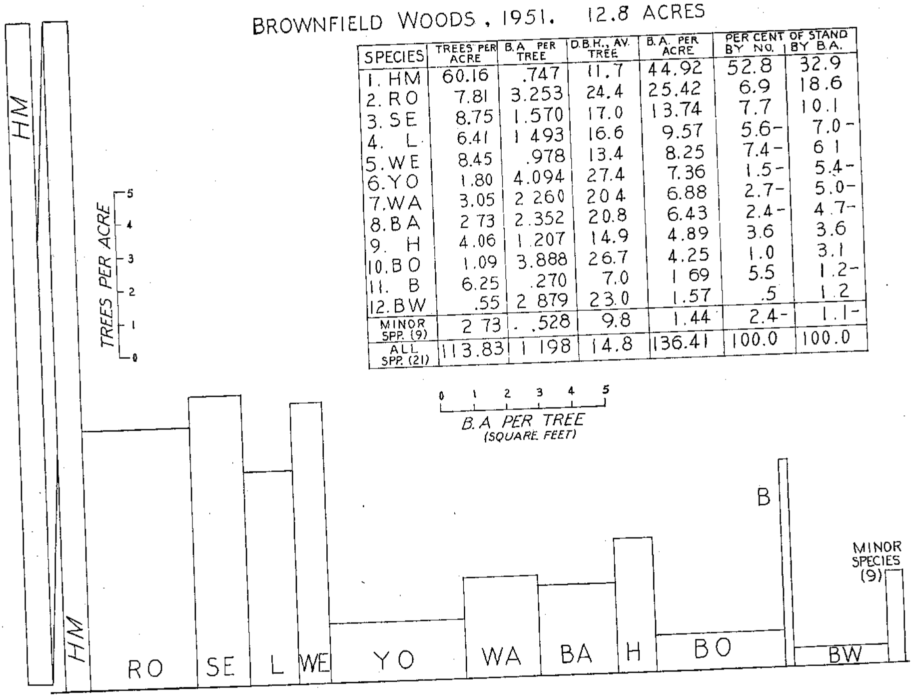


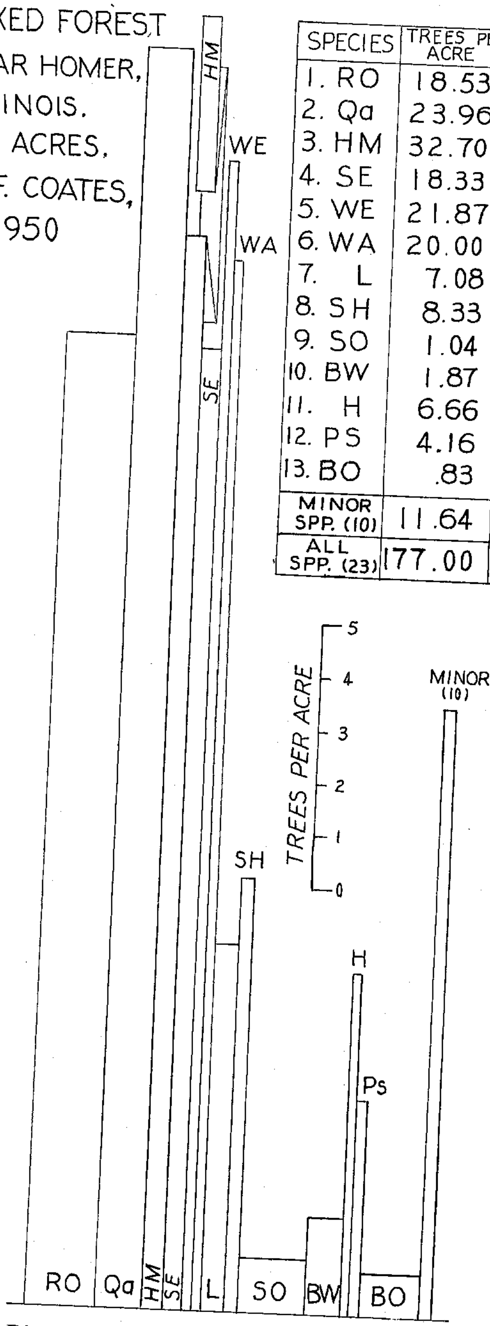
Fig. 3.—Same 16 plots 12 years later, 1951.

(black cherry) is now represented by one new tree. For all species, trees per acre are down from 126 to 114.

The other stand used for illustration is in the main timberbelt of Salt Fork, something over 20 miles downstream from Brownfield. It was surveyed in 1949-50 by James F. Coates. Its diagram (fig. 4) is strikingly different, in opposite direction from the last. It is tall and narrow, as are most of its bars for individual species. This obviously represents a stand of mostly smaller trees and higher density. This is due probably to poorer site and to a history of disturbance, including considerable cutting. It is rich in species, 23 of them in 4.8 acres. The east side is close to the edge of the stand, and includes several species not found in the interior. Species here that are not found in Brownfield are white oak (second in importance), and among minor species pignut hickory, black oak, sassafras, and boxelder.

Diagrams and tables such as these are only one of many devices for giving information about a forest. Many other types of summary, especially stand tables (which show the numbers of trees in successive diameter-classes) are also useful and for certain purposes more appropriate. However, composition diagrams and tables do present much significant information in a minimum of space, and do so in readily understandable form.

MIXED FOREST
NEAR HOMER,
ILLINOIS.
4.8 ACRES.
J. F. COATES,
1950



SPECIES	TREES PER ACRE	B.A. PER TREE	D.B.H., AV. TREE	B.A. PER ACRE
1. RO	18.53	1.312	15.5	24.34
2. Qa	23.96	.868	12.6	20.81
3. HM	32.70	.417	8.8	13.64
4. SE	18.33	.352	8.0	6.46
5. WE	21.87	.201	6.1	4.39
6. WA	20.00	.182	5.8	3.63
7. L	7.08	.452	9.1	3.20
8. SH	8.33	.250	6.8	2.08
9. SO	1.04	1.278	15.3	1.33
10. BW	1.87	.697	11.3	1.31
11. H	6.66	.160	5.4	1.04
12. PS	4.16	.204	6.1	.85
13. BO	.83	1.015	13.6	.85
MINOR SPP. (10)	11.64	.249	6.8	2.91
ALL SPP. (23)	177.00	.490	9.5	86.84

SPP.	PER CENT OF STAND BY NO.	BY B.A.
1.	10.5	27.9
2.	13.5	24.0
3.	18.5	15.7
4.	10.3	7.4
5.	12.4	5.1
6.	11.3	4.2
7.	4.0	3.7
8.	4.7	2.4
9.	.6	1.5
10.	1.0	1.5
11.	3.7	1.2
12.	2.4	1.0
13.	.5	1.0
MINOR	6.6	3.4
ALL	100.0	100.0

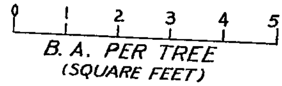


FIG. 4.—Diagram and table for 4.8 acres of upland mixed forest near Homer, 1950.

In a conversation following the presenting of this paper at the Macomb meeting, Dr. Leon S. Minckler stressed the desirability of supplementing the composition diagram by some form of graph showing diameter-distribution for the stand as a whole or for some of the principal species. If such a graph can be combined with or incorporated into the composition diagram, much more information can be shown. In any case, a stand table or stand graph can usually be supplied in addition.

One of the simplest and most compact forms of graph showing diameter distributions is that described in a probably little-known article by J. Paczoski (1928). His figures show a curve (apparently smoothed) for each species, indicating range and proportions of the different size-classes. Different kinds of line (solid, dashed, dotted, etc.) are used for different species. Not more than six or seven species can ordinarily be shown thus in a single compact figure, but more than one figure can be supplied.

A week later a letter and memorandum arrived from Dr. Minckler; he had experimented with diagrams for 21.8 acres of forest in southern Illinois. In these he superposed a line graph for the stand, showing diameter-distribution by one-inch classes. In one diagram he used, instead of basal area, cubic volume of average tree as the measure of size. Another measure he suggested is diameter of average tree; of the three measures, volume is closest to reality. In this same diagram Dr. Minckler used one of several possible ways of dividing the bar for a species into size-classes. He showed a narrow part for pole-sized trees (4.6 to 10.5-inch diam.) just atop a broader part for trees of saw-timber size (10.6-inch d.b.h. and larger). Thus white oak poles, 10 per acre, average 2.4 cu. ft. in volume. Larger white oaks, 5.5 per acre, average 20.7 cu. ft. per tree. The combined height of both parts of the bar is the same as if the species had not been divided into two size-classes. Another innovation was his printing of numerical values for volume directly at each bar in the diagram.

These experiments illustrate again the wide range of possible new ways of representing field counts and measurements graphically. It is hoped that Dr. Minckler and others will develop still other new forms of diagram.

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