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NOTES ON SOME OLD-GROWTH FORESTS IN OHIO, INDIANA, AND ILLINOIS

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The disturbing increase in acreage of abandoned land in the Central States has heightened interest in the region's few remnants of old-growth hardwood forest. Studies are being made to determine what kinds of trees originally grew on different kinds of soil, what was the original character of the soil, how many trees grew on an acre, and how large the trees were at maturity.

Many of the reputedly original forest remnants in Ohio, Indiana, and Illinois were visited by the writer during the summer of 1930. Figure 1 represents a typical old-growth stand, the Cox Woods in Orange County, Indiana. Such remnants were scarce even then. Out of 50 stands visited, only 22 were found to have been little disturbed by cutting, fire, or grazing. Most of the 22 had been preserved for purely sentimental reasons. Relative inaccessibility before the advent of hard roads had saved a few old woods from early destruction. These stood for a long time because they were rarities, but in recent years they have been cut one by one until today very few remain. The best timber probably was cut early in the period of white settlement. Later, many woods of better-than-average quality were preserved through pride of ownership. Just how much better than average these remnants were could not be determined. They were the only possible source of a record that can never be complete.

The 22 widely scattered old-growth forest remnants differed greatly in tree species composition. In most cases two or three species predominated; accordingly, the stands were grouped on the basis of the two or three most prevalent species. In table 1 the forests are ranked with reference to moistness of site, from white pine on dry sites to elm - ash - maple on wet sites. The forest-association names used in this paper can easily be correlated with officially recognized types.

Basal Area

Basal area, or the sum of the cross-sectional areas at breast height of all trees 1 inch and more in diameter on an acre, varied between 106 and 185 square feet, averaging 139 square feet. A single tree having a diameter of 13 feet would approximately equal in basal area all the trees on an average acre of virgin hardwood forest. Of the average basal area per acre, 139 square feet, only 13 square feet was in the understory and 126 square feet (91 percent) was in trees 12 inches and more in diameter.

Basal area might reasonably be expected to vary greatly with soil moisture and topography, but the largest basal area is not always found on moist sites. Yellow poplar is found at its best in cool, moist, sheltered coves where the soil is deep, well watered, and well drained; on uplands its growth rate is less, its height and form poorer; on dry, exposed uplands it either does not occur at all or merely persists. A dry site that would not support a stand of ash, yellow poplar, and walnut is often capable of supporting a good growth of pine. The sites occupied by the white pine stands represented in table 1 probably would not have met the requirements of yellow poplar, but they supported an average of 185 square feet basal area of timber per acre, compared with 139 square feet per acre in the mixed mesophytic stands containing yellow poplar.

Trees per Acre

A casual glance through an old-growth hardwood stand sometimes gives the impression of large numbers of trees, but usually an actual count shows that the number per acre is small. In the stands of types other than white pine and oak - chestnut, dominant and codominant trees averaged 55 per acre. The average number of intermediate and overtopped trees per acre in these stands, including all trees of the understory, was 222. The pine and oak - chestnut sites had more trees of large size per acre than any other of the sites examined.

Largest Trees

Only one tree more than 4 feet in diameter was found in the 22 old-growth woods--a 49-inch bur oak. A 44-inch black walnut found in Turkey Run State Park, Ind., and a 48-inch yellow poplar found near Haverhill Station, Ohio, were unique for their species in this

study. Although this survey did not include a river-bottom forest, it is known that sycamore trees 8 feet in diameter, fairly common on river-bottom lands 40 years ago, are rare now. The maximum diameters for the 22 individual woods averaged 43 inches. The greatest height measured, that of an American elm in Paulding County, Ohio, was 160 feet. Mean height of dominant stand averaged 97 feet.

Species Recorded

Tree species tallied in the overstories of the 22 woods totaled 41. The greatest average number of species for any forest type was 19. Table 2 summarizes the data on species distribution, by forest type, of the basal area of the 22 stands. In nearly every case two species made up the greater part of the total basal area of the dominant stand. The preponderant part of the total basal area was of 11 hardwood species: white, black, red, and bur oaks, white ash, red and sugar maples, beech, sycamore, yellow poplar, and black walnut. White pine was scarce. Chestnut, having been killed by blight, remained only as scattered sprouts.

Density of Stands

The popular picture of virgin hardwoods is one of closed canopy, dense stands of large trees, and deep shade. This is a true picture of some virgin woods, but not of all. Some of the virgin hardwood stands of this region were dense, some were sparse. Many dry ridges on the western margins of the region supported only very open stands of scrubby timber. East of the Mississippi, except for prairie openings, the forests were more dense and contained larger trees. Board-foot volume per acre varied greatly. The 20 hardwood stands examined in this study probably were above the average of the original hardwood stands in volume. Their average volume per acre was 20,800 board feet, whereas the average for the 2 white pine stands was 30,500 board feet. These board-foot volumes were calculated on the basis of tree diameters and dominant heights, by use of volume tables from various sources

Soils

The arrangement of forest associations in order of moistness of site in table 1 discloses relations between forest association and soil. For instance, the white pine and oak - chestnut plots were on Lordstown soil and

Table 1.--Some observations and measurements on timber and soil of 22 old-growth forest remnants

Forest Association[1/]	Stands	Average trees per acre: Dominant and co-dominant	Average trees per acre: Intermediate and overtopped	Average trees per acre: All crown classes	Average basal area per acre: Dominant and co-dominant trees	Average basal area per acre: Intermediate and overtopped trees	Average basal area per acre: All trees	Average height of dominant stand
	Number	Number	Number	Number	Sq.ft.	Sq.ft.	Sq.ft.	Feet
White pine	2	183	225	408	174	11	185	100
Oak-chestnut	2	110	285	395	157	12	169	102
Oak-hickory	3	56	190	246	118	9	127	83
Oak-beech	3	47	288	335	114	12	126	88
Beech-maple	3	63	308	371	102	10	112	98
Oak hickory-yellow poplar	4	57	203	260	134	14	148	100
Mixed mesophytic	3	53	251	304	123	16	139	98
Elm-ash-maple	2	52	95	147	89	17	106	113

1/ Associations are listed in order of increasing moistness of the sites on which they were found.

Volume per acre of trees 12 inches and larger in d b h.	Largest tree			Soil types represented	Average depth of litter	Average depth of A_1 soil horizon
	Species	Diameter	Height			
Board feet		Inches	Feet		Inches	Inches
30,500	Eastern white pine	32	106	Dubuque silt loam Lordstown silt loam	0.4	1.0
25,900	White oak	48	124	Muskingum silt loam Lordstown silt loam	.5	2.0
22,900	Bur oak	49	82	Meigs silt loam Dubuque silt loam Clarion silt loam	.4	2.0
16,700	White oak	45	98	Avonburg silt loam Canfield silt loam Avonburg silt loam	.4	1.3
19,700	Beech	37	102	Crosby silt loam Cincinnati silt loam Griffin sandy loam	.5	1.8
24,500	Yellow poplar	48	152	Muskingum sandy loam Bainbridge silt loam Orleans silt loam Ava silt loam	.5	2.8
21,100	Black walnut	44	130	Plainfield sand Genesee silt loam Bratton silt loam	.4	3.0
14,800	American elm	48	160	Fulton silt loam Clyde silty clay loam	.2	3.0

Table 2.--Basal area per acre of the overstories of 22 remnant old-growth stands, by tree species and forest association

Tree species 1/	White pine	Oak-chestnut	Oak-hickory	Oak-beech	Beech-maple	Oak-hickory-yellow poplar	Mixed mesophytic	Elm-ash-maple
	Sq.ft.	Sq.ft.	Sq.ft.	Sq.ft.	Sq.ft.	Sq.ft.	Sq.ft.	Sq.ft.
Eastern white pine	147.0							
Chestnut	17.5	37.1		3.7			0.6	
Chestnut oak	4.8		0.9					
Red maple	4.2	16.1		1.6		0.1		17.9
Sassafras	0.6		0.2	1.5		1.6	0.2	
White oak		39.1	19.7	39.8		42.2	10.2	
Black oak		3.9	24.9	2.5		2.7	1.0	
Bitternut hickory		2.6		0.2				3.0
Shagbark hickory		5.7	3.2	1.4		5.7	0.6	
Northern red oak		1.2	18.5	5.4	0.1	6.5		9.1
Black cherry		0.5			0.4			
Black gum		0.3		10.6		6.4	5.3	
Beech		0.4	0.8	29.0	52.1	4.3	19.1	0.9
Pignut hickory		0.2		0.5		5.3	0.7	
Yellow oak			11.1			0.1		
Bur oak			17.5					
White ash			3.6	2.3	1.0	1.8	7.5	9.8
Yellow poplar			2.3		1.7	49.2	15.1	2.4
Sugar maple			8.3	8.4	40.1			3.8
Basswood			3.9		0.1	0.3	1.9	4.2
Hackberry			3.2		2.0		0.5	
Pin oak				1.8				
Red elm				1.6	0.1	0.9		
American elm				3.7	1.4		1.2	23.1
Black walnut				0.4	0.1	4.5	11.9	2.0
Sycamore					1.7		34.8	
Ohio buckeye					0.9			
Red mulberry						1.4		
Mockernut hickory						0.8	3.1	
Butternut							2.6	
Rock elm							4.9	
Shellbark hickory							1.5	
Black ash								11.6
Swamp white oak								0.7
Black willow								0.7

1/ Both species and associations are listed in order of increasing moistness of the sites on which they were found.

ridge phases of Muskingum and Dubuque soils--all dry soil types, rapidly drained. The elm - ash - maple type, at the other end of the scale, was on Fulton and Clyde soils, which had comparatively high water tables. The mixed mesophytic type occurred on Plainfield, Genesee, and Bratton soils; of these the first two are deep, moist old lake-bed and stream-terrace soils, the third a well-drained limestone residual upland soil. The oak - hickory and oak - beech forest associations occurred on soils not quite so rapidly drained and dry as the Lordstown, intermediate in drainage and oxidation. Stands of the beech-maple forest type, with one exception, were on more slowly drained soils like Crosby and Griffin. The soil-forest type relations defined are broad, and there was some overlapping.

The forest soils examined were not all moist, deep, black, and mellow; some were gray, shallow, and dry. An increase in depth of the darkened upper layer (the A_1 soil horizon) from dry to moist sites is disclosed by table 1. Dark color and mellowness of the surface soil generally denote fertility; in considerable degree, the depth to which a soil is colored by organic debris classifies it for forest type. It does not, however, always indicate the quantity of wood the soil will produce. Comparison of basal areas on the dry and the moist sites contradicts any assumption that soils rich in organic matter are always superior in this respect. Soil under elm, ash, maple, yellow poplar, or walnut was in some instances blackened and enriched by organic matter to a depth of 6 or 8 inches, whereas that on some dry sites supporting pine or dry oaks was gray almost to the surface; but natural adaptation of tree species to varying degrees of site dryness tended to make yields comparable.

Litter is the principal source of organic matter in the soil, hence its quantity is important. Litter depths presented in table 1, taken in late summer, are averaged by forest association. Ten measurements were taken on each sampling area. For instance, the figure for oak - hickory - yellow poplar woods, 0.5 inch, is the average of 40 measurements = 10 on each of four plots.

Infiltration

Erosion was practically absent from the virgin woods. Interlacing roots held the soil, and litter protected it from surface disturbance. As a result of soil surface protection a porous structure developed, which permitted rapid absorption of rainfall. The virgin forest soils had very highly developed porosity, and therefore great capacity for absorbing rainfall. High growth rates were made possible by large quantities of soil water. When forests were cleared and the soil cultivated, a large part of the virgin soil porosity was lost. The sites became dry because the surface soil no longer was easily penetrated by rainfall. The difference in infiltration rate is illustrated in figure 2. In an extensive series of tests forest soil at 1-inch depth absorbed water about 50 times as fast as adjacent field soil. At 3-inch depth the rate was 14 times that of field soil. Even 8 inches below the surface the rate for forest soil was more than twice that for field soil. These comparisons emphasize the superior porosity of old-growth forest soil.

Summary

Old-growth forest stands are exceedingly scarce in the central hardwood region. Most of those remaining in the region have been preserved for sentimental reasons. A study of 22 old-growth stands was made in 1930 in Ohio, Indiana, and Illinois.

When the 22 stands were grouped into eight forest associations and ranged in order of increasing moistness of their sites from white pine to elm - ash - maple, it was found that basal area was greatest on the two driest sites and that depth of A_1 soil horizon increased with moistness of site. Litter depth was fairly uniform for all forest types; at its annual minimum, in August, it averaged less than 0.5 inch. The basal areas of the 22 stands averaged 139 square feet per acre, of which 91 percent was in the overstory. On the average, in stands of types other than white pine and oak - chestnut there were 55 trees per acre in the overstory and 222 in the understory. The largest tree found was 49 inches in diameter; the tallest, 160 feet high. At depths of 1, 3, and 8 inches, respectively, the old-growth woods soil absorbed water 50, 14, and 2 times as fast as comparable field soils.

Figure 2 Comparative rates of absorption of water by the soil in old growth woods and in adjacent fields, at three depths