HARD MAPLES INCREASING IN AN UPLAND HARDWOOD STAND

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ABSTRACT

Changes in a mature forest stand are generally gradual. Following a 38-year period, a well stocked stand in southern Illinois has more large trees, but little regeneration of the species composing the overstory--the oaks, hickories, and yellow-poplar. Flowering dogwood, an understory species, has declined in total number, while the hard maples, which were only in the understory initially, have increased dramatically in importance in the stand, and are beginning to emerge in the overstory. Unless a major disturbance occurs, a gradual replacement of the present overstory by the maples seems likely.

KEY WORDS: species composition, mixed oak type.

INTRODUCTION

The species composition and stand structure of most forest stands in the central deciduous forest region have resulted from a series of irregular disturbances. For many centuries, wind storms, ice storms, and wildfires have been the principal disturbances, being supplemented during the last 200 years by timber cutting and grazing of domestic animals. If existing stands are protected from fire, grazing, and cutting, their composition and structure will change, but the nature and extent of change are not fully understood.

A study on the Kaskaskia Experimental Forest in southeastern Illinois provides a basis for assessing the changes that have occurred during a 38-year period in a mixed oak stand, classed as a variant of the Society of American Foresters cover type 52 (Society of American Foresters 1954). Although 38 years is not a long time in terms of stand development, analyses of the study records suggest that, without major disturbance, hard maples (*Acer barbatum* Michx., *A. nigrum* Michx. and *A. saccharum* Marsh.), white ash (*Fraxinus americana* L.), and eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch) will increase, while white oak (*Quercus alba* L.), the red oaks (*Q. coccinea* Muench., *Q. rubra* L., and *Q. velutina* Lam.), flowering dogwood (*Cornus florida* L.), and others will decline.

BACKGROUND

The study area is located in the unglaciated hill country (Shawnee Hills Division) of southeastern Illinois. The soils are a mixture of weathered parent material (limestones and sandstones) and loess. They are well drained silt loams, predominantly of the Alford and Baxter soil series. The climate is continental, with hot summers and cool winters. Annual precipitation averages 1092 mm, and is generally well distributed throughout the year, although a two or three week dry period during the growing season is common.

Since the area was acquired by the U.S. Forest Service in 1933, it has been protected from grazing and fire, and no timber harvesting or silvicultural work has been done. Increment core data show an abrupt increase in diameter growth rates in 1880 and also in 1910. This period coincides with the rapid expansion of the nation's railroads, and since most of the older trees are yellow-poplar (*Liriodendron tulipifera* L.) and hickories (*Carya cordiformis* (Wangenh.) K. Koch, *C. glabra* (Mill.) Sweet, and *C. tomentosa* Nutt.), whose wood is not preferred for railroad ties, we believe that a heavy cutting for red and white oaks, which are favored for ties, may have occurred.

Tree growth would be expected to be good on the study area. The general tilt of the land is toward the northeast, and the surface is moderately dissected by small, intermittent streams. Tree heights range as high as 33 m, with the average height of the overstory being 27 m.

PROCEDURE

Eight permanent plots were established in 1935 near the center of a 7.4-hectare area thought at the time to be an essentially undisturbed forest. Within each 0.101 hectare (1/4 acre) plot, each tree 4 cm in diameter breast height (1.3 m above ground) and larger was assigned a permanent number. Stems less than 4 cm d.b.h. were mapped on four 4 sq. m (1 milacre) subplots located in each of the corners of the main plots. The plots were remeasured in 1940, 1958, 1965, and 1973, at which time trees growing into the lowest diameter class were assigned numbers. Diameters were measured to the nearest 0.25 cm.

Analyses of growth, mortality, ingrowth, and changes in species composition were made using the individual tree records. An importance value (IV-200), defined as the sum of the percent basal area and the percent number of trees, was computed for each species or species group.

RESULTS

The principal changes during the 38-year period are an increase in the importance of the hard maples, white ash, and eastern hophornbeam

and a decrease in the importance of flowering dogwood, sassafras (Sassafras albidum (Nutt.) Ness), and the hickories. The other species have generally retained their importance during this period, although lack of ingrowth may affect their future place in the community.

The hard maples have increased steadily in importance value (IV 200), basal area, and numbers (Tables 1, 2, and 3). The number of trees increased 2.3 times, and the basal area increased 3.6 times. Not only is the relative increase large, but the absolute increase of 2.61 sq. m/hectare is surpassed only by the increase in the red oak group. More significant for the future of the stand is the ingrowth and mortality (Table 3). Of the total ingrowth, the maples accounted for 47 percent, while only 11 percent of the mortality was due to the maples.

In 1935 the overstory trees were generally larger than 37.5 cm d.b.h. Of the species represented by these larger trees (Table 4), all have decreased in total numbers (Table 3). For the red oaks, white oak, and yellow-poplar, the total basal area increased, but there was little or no ingrowth and a substantial amount of mortality. Seventy percent of the hickories died, with little replacement, while 50 percent of the black tupelo (Nyssa sylvatica var. sylvatica) died, but there was sufficient ingrowth of this species to partially offset the mortality.

The total number of overstory trees increased from 45.5 per hectare in 1935 (Table 4) to 91.4 per hectare in 1973 (Table 5). Mortality of these larger trees totaled 12.3 trees per hectare (Table 6), certainly not excessive, but replacements are lacking in the smaller sizes for all species except the hard maples, which were not represented in the larger sizes in 1935 but had joined the other overstory species by 1973.

The understory dogwood and sassafras show high mortality and little ingrowth (Table 3). Sassafras is considered an intolerant species (Fowells 1965), and thus its decline is not unexpected. Dogwood, on the other hand, is thought to be tolerant of shade. Although some ingrowth did occur, five times as many trees died as grew into the lowest size class (4 cm).

Both white ash and eastern hophornbeam increased in numbers, ingrowth being 3 and 4 times as great as mortality (Table 3). White ash is fairly tolerant of shade when young, becoming less tolerant as it becomes older. Thus, its increase in numbers during this study period does not necessarily indicate its role in the future of the stand. Eastern hophornbeam is quite tolerant, and might be expected to inhabit the understory indefinitely.

Although the reproduction plots comprise a small sample, they substantiate the trends evidenced by the main plot records. During the study period, only hard maples, beech (Fagus grandifolia Ehrh.) and eastern hophornbeam seedlings have grown into the 4 cm and larger sizes. Other species (e.g., yellow-poplar) dominated the seedling count at a

particular inventory, but proved to be ephemeral. The numbers and species of the seedlings on these plots at any single point in time was of no value for projecting stand development.

Table 1. Importance value for trees 4 cm and larger

Species	Year 1935	1940	1958	1965	1973
Hard maples	21.9	27.7	48.3	50.0	55.5
Red oaks	39.5	41.4	42.9	43.7	42.0
White oak	27.6	28.5	23.5	22.8	23.4
Yellow-poplar	18.7	18.6	18.8	18.8	20.0
Hickories	27.0	26.7	21.0	18.2	14.2
White ash	1.7	2.0	10.1	12.0	12.4
Black tupelo	15.5	15.1	11.3	11.8	11.5
Eastern hophornbeam	1.9	1.6	7.0	7.8	8.3
Dogwood	26.3	20.2	7.4	7.2	6.6
Miscellaneous	7.6	7.5	7.8	6.7	5.4
Sassafras	12.3	10.7	1.9	1.0	0.7

Table 2. Basal area of trees 4 cm d.b.h. and larger (m^2/h)

Species	Year 1935	1940	1958	1965	1973
Hard maples	1.02	1.24	2.54	2.91	3.63
Red oaks	6.13	6.96	9.56	10.62	10.77
White oak	3.42	3.71	4.39	4.70	5.17
Yellow-poplar	3.64	3.77	4.59	4.97	5.49
Hickories	3.17	3.28	3.63	3.65	2.92
White ash	0.08	0.08	0.23	0.30	0.37
Black tupelo	2.04	2.06	1.72	1.81	1.87
Eastern hophornbeam	0.09	0.05	0.14	0.16	0.21
Dogwood	1.49	0.97	0.26	0.27	0.25
Miscellaneous	0.61	0.61	0.37	0.37	0.38
Sassafras	0.96	0.80	0.21	0.10	0.07
Total	22.65	23.53	27.64	29.86	31.13

Table 3. Number of trees 4 cm d.b.h. and larger (per hectare)

Species	Year 1935	1940	1958	1965	1973	Mortality 1935-1973	Ingrowth 1935-1973
Hard maples	154.3	179.0	335.8	346.9	356.8	69.1	271.6
Red oaks	109.9	95.1	71.6	69.1	60.5	49.4	-
White oak	111.1	101.2	65.4	60.5	55.6	59.2	3.7
Yellow-poplar	23.5	21.0	18.5	18.5	19.8	4.9	1.2
Hickories	116.0	101.2	67.9	51.9	39.4	79.0	2.4
White ash	12.3	13.6	79.0	95.1	91.4	39.4	118.5
Black tupelo	58.0	50.6	44.4	49.4	44.4	30.8	17.2
Eastern hophornbeam	13.6	11.1	55.6	61.7	61.7	16.1	64.2
Dogwood	175.3	128.4	55.6	54.3	46.9	160.5	32.1
Miscellaneous	43.2	39.5	55.6	46.9	34.6	69.1	60.5
Sassafras	71.6	58.0	9.9	6.2	3.6	69.2	1.2
Total	888.8	798.7	859.3	860.5	814.7	646.7	572.6

DISCUSSION

The lack of oak reproduction in this mixed oak stand is not unusual nor surprising. Den Uyl (1961) found that protecting a stand from grazing and fire was not sufficient to stimulate the establishment of oak reproduction. Indeed, Cottam (1949) concluded that fire played a dominant role in maintaining the "oak openings" in southwestern Wisconsin woodlands.

Only a few of the larger trees died during the study period. Most of the mortality has been of understory trees of intolerant species, an ideal situation for stimulating the development of seedlings of tolerant species such as the maples. A similar increase in the maple component was noted by Lindsey (1962) for stands considered to be remnants of the original central deciduous forest (Beall Woods in Illinois and Donaldson's Woods in Indiana).

Once mortality of the larger trees becomes more frequent, the degree of disturbance will be greater, perhaps providing an opportunity for trees of the less tolerant species to develop. More likely, though, is that the oaks, hickories, and yellow-poplar may have to wait for the "rare and infrequent" events (Raup 1956), such as fire, hurricanes, or tornadoes, for the opportunity to begin anew. If so, the trends observable during this small segment of a long term cycle may prove to be of value for understanding the development of the community only to the point of the next major disturbance.

Table 4. Number of trees 4 cm d.b.h. and larger in 1935, by diameter class (per hectare)

D.b.h. cm	Hard maples	Red oaks	White oak	Yellow-poplar	Hickories	White ash	Black tupelo	Eastern hophornbeam	Dogwood	Miscellaneous	Sassafras	Total
6	132.1	9.9	66.6	2.5	74.1	11.1	28.4	11.1	127.2	28.4	39.5	530.9
15	13.6	29.6	19.8	9.9	24.7	1.2	13.6	2.5	41.9	7.4	27.2	191.4
24	8.6	33.4	7.4		3.7		2.5		6.2	7.4	4.9	74.1
33		23.5	6.2	1.2	8.6		7.4					46.9
42[1]		12.3	7.4	1.3			4.9					25.9
51		1.2	2.5		2.5		1.2					7.4
60			1.2	2.5	1.2							4.9
69				4.9								4.9
78				1.2	1.2							2.4
87												–
Total	154.3	109.9	111.1	23.5	116.0	12.3	58.0	13.6	175.3	43.2	71.6	888.8

[1]Trees 37.5 cm and larger are considered overstory trees.

Table 5. Number of trees 4 cm d.b.h. and larger in 1973, by diameter class (per hectare)

D.b.h. cm	Hard maples	Red oaks	White oak	Yellow-poplar	Hickories	White ash	Black tupelo	Eastern hophornbeam	Dogwood	Miscellaneous	Sassafras	Total
6	275.4		13.6	1.2	8.6	87.7	23.4	61.7	43.2	28.4	1.2	544.4
15	58.0	1.2	12.3		8.6	2.5	7.4		3.7	2.5	1.2	97.4
24	14.8	2.5	8.6	2.5	9.9	1.2	3.7			2.5	1.2	46.9
33	7.4	11.1	2.5	2.5	6.2		3.7			1.2		34.6
42[1]	1.2	17.3	7.4	1.2	1.2		3.7					32.0
51		16.0	6.2	3.7	1.2		2.5					29.6
60		9.9	2.5		2.5							14.9
69		2.5	2.5	2.5	1.2							8.7
78				3.7								3.7
87				2.5								2.5
Total	356.8	60.5	55.6	19.8	39.4	91.4	44.4	61.7	46.9	34.6	3.6	814.7

[1]Trees 37.5 cm and larger are considered overstory trees.

Table 6. Number of trees 4 cm d.b.h. and larger dying between 1935 and 1973, by diameter class (per hectare)

D.b.h. cm	Hard maples	Red oaks	White oak	Yellow-poplar	Hickories	White ash	Black tupelo	Eastern hophornbeam	Dogwood	Miscellaneous	Sassafras	Total
6	65.4	8.7	49.4	1.2	63.0	39.4	21.0	13.6	113.6	56.8	32.1	464.2
15	3.7	22.2	7.4	3.7	12.3		4.9	2.5	40.7	7.4	30.9	135.7
24		8.6					1.2		6.2	4.9	6.2	27.1
33		1.2	1.2		2.5		2.5					7.4
42[1]		5.0	1.2				1.2					7.4
51												-
60		1.2										1.2
69												-
78		2.5			1.2							3.7
87												-
Total	69.1	49.4	59.2	4.9	79.0	39.4	30.8	16.1	160.5	69.1	69.2	646.7

[1]Trees 37.5 cm and larger are considered overstory trees.

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Richard Schlesinger received a B.A. in geography from Middlebury College in 1963, a M.F. in silviculture from Yale University School of Forestry in 1965, and a Ph.D. in forest micrometeorology from SUNY College of Forestry at Syracuse in 1970. He worked for a year as a forester on the Monongahela National Forest in West Virginia, and since 1969 has been a research forester at the Forestry Sciences Laboratory in Carbondale, Illinois, in the Culture, Genetics and Protection of Fine Hardwoods project. He is the author or coauthor of 12 publications in the field of silviculture

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