

# Forest Analysis of a Mesic Ravine, Parke County, Indiana

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## Introduction

The specific effects of physiography upon forest composition, and more particularly the nature of exposure under which particular plant communities develop has been the subject of many phytosociological studies. In Indiana, such studies were reported by Friesner and Potzger (1) and Potzger (5) (6). Their studies dealt with the older physiographic sections of the state and demonstrated that north-facing slopes provide microenvironmental conditions which result in the development of forests whose composition is in marked contrast to those of south-facing slopes. Little or no data have been published concerning species expression on soils of contrasting exposure in narrower more mesic ravines. This paper reports a study of slope forest analysis in a relatively narrow east-west ravine in the Allee Memorial Woods.

## Location and Description of the Area

The Allee Memorial Woods comprises 180 acres of partially virgin timber located in Parke County, one and three quarter miles west-northwest of the village of Annapolis on the east-south bank of Sugar Creek. This area was subjected to both Illinois and Wisconsin glaciation. Meltwater outwash of the latter and subsequent erosion left the terminal upland dissected by steep ravines which drain into Sugar Creek. The soil is underlain by a thin veneer of glacial drift supported by massive coarse-grained Pennsylvania sandstone of the Mansfield formation (7). Soil of the ravine sides has been classified as Hennepin, derived from a mixed parent material of drift and bedrock.

## Site Analysis

The ravine itself is approximately 1000 feet in length. Its mouth empties into Sugar Creek. The upland discontinuity averages 100 feet with a mean gorge depth of 90 feet. The north-facing exposure is 92% slope and the south-facing exposure 80% slope. The ravine terminates in a "box-canyon" with face-walls to 50 feet. An intermittent tributary produces a waterfall at this point. Evaporation losses from the south-facing slope as measured by Livingston atmometers ranged from 30% higher near the mouth of the ravine where the width is approximately 160 feet to 10% lower on the south-facing slope in the narrow end. Jackson (3), working in this same ravine three years later found the higher figure to be 27%.

Midslope air temperatures recorded at one foot gave south-facing maxima which averaged 8 degrees higher (Jackson, 3 degrees higher) and minima one degree higher than the north-facing slope. Soil reaction of the north-facing slope averaged pH 6.6; for the south-facing slope, 5.0. Soil phosphate compared 41.9 ppm on north-facing slope, 7.5 ppm on south-facing slope. Potassium was found slightly higher on

the south-facing slope. The soil of the slopes is shallow sandy loam with little to no B-Horizon development.

### Forest Tally

A full tally was made of both slopes in the summer of 1960 using a continuous grid of 1/40 acre quadrats. Forty quadrats were laid out on the north-facing slope; 29 on the south-facing slope. The latter number is smaller due to the presence of two lateral cuts in the north wall which are not a southern exposure. All individuals one inch or more *dbh* or 3 feet or more in height were tallied. Twenty-three tree species were identified on the north-facing slope which comprised a total of 577 stems. Of these, 107 were above 3 inches *dbh* giving a stand density of 107 trees per acre. On the south-facing slope 22 tree species were identified with a total of 463 stems. Of these, 104 were above 3 inches *dbh* giving a stand density for south-facing slope of 144 per acre. Reproduction as reflected in stem diameters below 3 inches gives a stand density of 496 for the south-facing slope; 470 for the north-facing slope. These data are presented in Tables 1 and 2, and Figure 1.

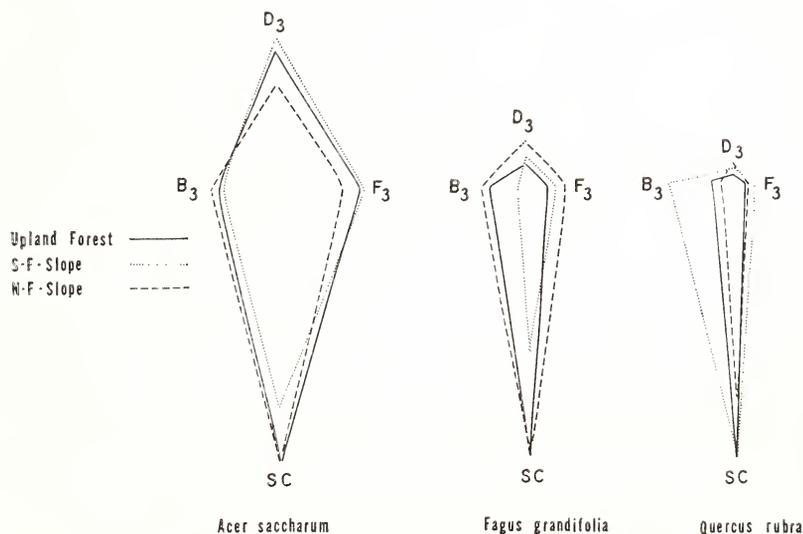


Figure 1. Phytograph polygons for three tree species on three site types.

The three dominant species on both slopes are sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and red oak (*Quercus rubra*). Bitternut hickory (*Carya cordiformis*), shagbark hickory (*C. ovata*) and white ash (*Fraxinus americana*) were absent from the north-facing slope in the size classes above 3 in. d.b.h. Dogwood (*Cornus florida*) was not found on the south-facing slope. Variation in forest attributes of the slopes from the upland is shown in Table 3 and the phytographs in Figure 1. Symbols are after Lindsey (4):  $D_3$  (relative density),  $F_3$  (relative frequency),  $B_3$  (relative basal area),  $V_3$  (importance value) and SC (maximum size class). Nomenclature follows Gleason (2).

TABLE 1.—Tree Species Composition of the North-Facing Slope Base on forty 1/40 acre plots.

	Diameter Size Classes										total above 3" dbh	
	below one	1-2	3-4	5-9	10-14	15-19	20-25	26-30	above 30	above 30		
<i>Acer negundo</i>	1				1							1
<i>A. rubrum</i>	3				7	4	2	1	1			41
<i>A. saccharum</i>	220	49	13	13								1
<i>Carpinus caroliniana</i>	4	2	1									1
<i>Carya cordiformis</i>	13											
<i>C. glabra</i>	8		1	1								2
<i>C. ovalis</i>					1							
<i>C. ovata</i>	1											
<i>Celtis occidentalis</i>	37	2										1
<i>Cornus florida</i>	23	3	1									
<i>C. racemosa</i>	2											
<i>Fagus grandifolia</i>	18	3	6	4	4	2	2	1	1			19
<i>Fraxinus americana</i>	23											
<i>Gymnocladus dioica</i>	1											
<i>Liriodendron tulipifera</i>	3	1			1							1
<i>Ostrya virginiana</i>	7	4	1	4								5
<i>Quercus alba</i>			1		1					1		4
<i>Q. rubra</i>	2		1	1	2	3						7
<i>Q. velutina</i>	8			1						1		2
<i>Sassafras albidum</i>	2		1	2	4							7
<i>Tsuga canadensis</i>	10	1	1	2	2	3	3					11
<i>Ulmus americana</i>	19			1	1	1						3
<i>U. rubra</i>				1				1				2
Total	470											107

Stand Reprod. Density — 470/acre

Stand Density — 107/acre

TABLE 2.—Tree Species Composition of the South-facing Slope

Based on twenty-nine 1/40 acre plots.

Diameter Size Classes

	below one	1-2	3-4	5-9	10-14	15-19	20-25	26-30	above 30	total above 3" dbh
<i>Acer negundo</i>	10									
<i>A. rubrum</i>	3	8								
<i>A. saccharum</i>	51	43	25	22	11	1				59
<i>Carpinus caroliniana</i>	13	4								
<i>Carya cordiformis</i>	4	1				1				1
<i>C. glabra</i>	1	1	1			2				2
<i>C. ovata</i>			1							1
<i>Celtis occidentalis</i>	13									
<i>Cercis canadensis</i>	2									
<i>Cornus florida</i>	3	1								
<i>Fagus grandifolia</i>	22	1	4	8						12
<i>Fraxinus americana</i>	21							1		1
<i>Liriodendron tulipifera</i>	11	1						1		1
<i>Ostrya virginiana</i>	8		1							1
<i>Quercus alba</i>	2	4	4	2						6
<i>Q. rubra</i>	2						3	1	2	6
<i>Q. velutina</i>	43							1		1
<i>Sassafras albidum</i>	20				2					2
<i>Tilia americana</i>	3									
<i>Tsuga canadensis</i>	8	7	1	1		1	3			6
<i>Ulmus americana</i>	38	1			3	1				4
<i>U. rubra</i>			1							1
Total	359									104
Stand Reprod. density	— 496/acre									Stand Density — 144/acre

TABLE 3.—Forest Attributes for Principal Tree Species of  
North and South Facing Slopes

(F<sub>3</sub> = relative frequency; D<sub>3</sub> = relative density;  
B<sub>3</sub> = relative basal area; V<sub>3</sub> = importance value;  
B<sub>3</sub> = Stand basal area in sq. ft. per acre)

	F <sub>3</sub>		D <sub>3</sub>		B <sub>3</sub>		V <sub>3</sub>		Upland Forest
	N	S	N	S	N	S	N	S	
<i>Acer saccharum</i>	32.4	40.9	38.3	54.8	31.2	26.8	34.0	32.0	39.5
<i>Fagus grandifolia</i>	18.9	13.1	17.7	11.5	21.7	3.2	19.5	8.2	12.4
<i>Quercus rubra</i>	6.8	8.2	6.5	5.8	6.5	30.9	6.6	14.8	7.1
<i>Tsuga canadensis</i>	9.45	8.18	10.3	4.8	14.9	.70	11.58	4.36	0.0
<i>Q. alba</i>	4.1	4.9	3.7	5.8	1.0	1.1	2.9	3.7	7.1
<i>Q. velutina</i>	2.7	3.3	1.9	1.9	3.0	2.1	2.5	1.7	2.7
<i>Sassafras albidum</i>	5.4	1.6	6.5	1.9	3.7	2.1	5.2	1.2	4.9
<i>Ulmus americana</i>	2.7	3.3	1.9	3.8	1.0	5.3	1.9	2.4	3.5
<i>Ostrya virginiana</i>	5.4	1.6	4.7	1.0	0.1	1.1	3.7	0.9	.19
<i>Liriodendron tulipifera</i>	2.5	1.6	0.9	1.0	0.8	5.8	1.0	0.9	14.3
<i>Carya glabra</i>	2.7	4.9	1.9	2.9	0.3	4.3	1.6	2.6	1.48
<i>C. ovata</i>	0.0	1.6	0.0	1.0	0.0	0.1	0.0	0.9	.9
<i>C. cordiformis</i>	0.0	1.6	0.0	1.0	0.0	2.1	0.0	0.9	1.16
<i>Cornus florida</i>	1.4	0.0	0.9	0.0	0.1	0.0	0.8	0.0	.99
<i>Fraxinus americana</i>	0.0	3.3	0.0	2.0	0.0	6.1	0.0	0.8	2.8
					B <sub>3</sub>	101.7			117.0

### Conclusions

Friesner and Potzger (1) working in Brown and Bartholomew counties, reported a definite moisture stress occurring on south-facing slopes during late spring and summer. Potzger (6) found that "surface soil had 30% and soil at six inches had 28% more moisture on the north than on the south-facing slope." He also measured evaporation losses 61% greater on south-facing slopes. From their forest stand analyses, they concluded that "the transition from Beech-Maple on the north-facing slopes to Oak-Hickory on the south-facing slopes is not gradual, but abrupt and decisive." The current study indicates that in narrower valleys of physiographic areas, younger than those studied by Friesner and Potzger, the transition from South to North slope is not abrupt for the majority of species, rather they grade into greater or lesser expression, measured only occasionally by the absence of certain dominant species, the transition being expressed primarily as a variation in density, frequency, growth rate and total number of species.

### Literature Cited

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