SPECIES IMPORTANCE WITHIN A VIRGIN AND A TIMBERED BEECH–MAPLE FOREST ECOSYSTEM[1]

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Abstract. A virgin forest, Hueston Woods in southwestern Ohio, and a selectively-cut forest, Lewis Woods in east central Indiana, were sampled by a modified point-quarter method in order to evaluate the impact of timbering on community structure. Timbering occurred in Lewis Woods in 1910, 1935, and 1955. Importance values were computed for each species encountered (>1 inch diameter breast height) within each study area in order to determine the timbering impact on community structure. Hueston Woods was clearly dominated by sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) with importance values of 132.6 and 117.3, respectively. Lewis Woods was characterized by a more even importance distribution patterns, although sugar maple and American beech were still found to be of greatest importance with values of 120.8 and 76.8, respectively. Sixteen species were encountered in Lewis Woods as compared to 13 species for Hueston Woods. The significance of these differences is discussed.

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Schmelz and Lindsey (1970) defined the major forest types of Indiana and adjacent areas as beech-maple, mixed woods, western mesophytic, oak-hickory, and lowland-depressional. These types were characterized by the species importance sums based on analysis of 36 least disturbed hardwood stands in the area. Additional publications which describe the natural vegetation of this area based on importance values include Lindsey *et al* (1961), Beals and Cope (1964), Crankshaw *et al* (1965), Lindsey *et al* (1965), and Lindsey and Schmelz (1965; 1970). None of these studies, however, were directly concerned with the utilization of importance values to measure and evaluate the effects of a man-made stress (timbering) on the structure and function of a mature beech-maple forest type which was the major objective of our investigation.

METHODS

Two study areas were selected to provide for an experimental design of a control (virgin) and a treated (stressed) area. Hueston Woods, a 200-acre preserve of virgin timber located in Hueston Woods State Park, Preble County, Ohio, was chosen as the control site. Lewis Woods, a privately-owned 80-acre tract of selectively cut timber located one-half mile south of Williamsburg, Wayne County, Indiana, was selected as the treated site. Both areas represent beech-maple forest community types of the glacial till plains of Indiana and Ohio and both have similar soil types, namely, Russell silt loam in Hueston Woods (Vankat *et al*, 1975) and Crosby silt loam in a majority of Lewis Woods (Beals and Cope, 1964). Topographically, Hueston Woods is a flat upland surface with a dissected descending slope, whereas Lewis Woods is strongly undulating and crossed by small intermittent streams.

Similarity between the stands was measured using a coefficient of similarity index, $C = 2w/a+b$, where a is the sum of the frequencies of the species in stand a and b is the sum of the frequencies of the species in stand b; w is the sum of the frequencies of the species common to both (Bray and Curtis, 1957).

A modified point-quarter method (Cottam and Curtis, 1965) was used for sampling the trees in each area. A total of 60 points equally spaced at 105-ft (32.0 m) intervals was taken in each 15-acre (6.1 ha) area. Initially, four size classes were established for woody plants in order that detailed structural information be obtained. For each quarter, four trees nearest the point were selected. Size classes selected were as follows: size class 1, <1 inch diameter breast height (dbh) but greater than 1 ft in height; size class 2, 1–4 inch dbh; size class 3, 4–15 inch dbh; and size class 4, >15 inch dbh. Size class data are summarized by Adams and Barrett (1976). However, for the purpose of sampling the woods independent of

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size class, the nearest tree over 1 inch dbh in each quarter was tabulated. This sample, hereafter referred to as total woods, was intended to represent the total forest community.

To determine community structural differences in each woods, two analyses were computed for the total woods category, namely, total diversity and importance values. Total diversity was the total number of tree species sampled within each study area. Importance values were computed according to Cottam and Curtis (1965) by summing the relative density, the relative frequency, and the relative basal area.

RESULTS

Importance values for the total woods category (>1 inch dbh) within each study are summarized in table 1. As noted, sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) were the most important species in each area. In Hueston Woods these two species were clearly dominant with importance values of 132.6 and 117.3, respectively, as compared to values of 120.8 and 76.8, respectively, for Lewis Woods. Slippery elm (*Ulmus rubra*) ranked third in importance in Lewis Woods with a value of 43.1 as compared to a value of 12.4 for white ash (*Fraxinus americana*), which ranked third in Hueston Woods. Interestingly, nine of 13 species (69%) exhibited importance values less than ten in Hueston Woods; 11 of 16 species (also 69%) exhibited importance values less than ten in Lewis Woods. Thus, a

TABLE 1

Summary of tree community parameters representative of the total woods.

Species*	Relative density (A)	Relative frequency (B)	Relative basal area (C)	Importance Value (A+B+C)
	Hueston Woods			
*Acer saccharum***	52.1	38.8	41.7	132.6
Fagus grandifolia	30.8	32.1	54.4	117.3
Fraxinus americana	4.2	6.7	1.5	12.4
Liriodendron tulipifera	3.8	6.7	1.3	11.8
Ulmus rubra	2.1	3.7	0.8	6.6
Prunus serotina	1.7	3.0	0.0	4.7
Carpinus carolina	1.7	2.2	0.0	3.9
Celtis occidentalis	0.8	1.5	0.0	2.3
Cornus florida	0.8	1.5	0.0	2.3
Lindera benzoin	0.8	1.5	0.0	2.3
Crataegus crux-gallii	0.4	0.8	0.0	1.2
Ulmus americana	0.4	0.8	0.0	1.2
Carya ovata	0.4	0.8	0.0	1.2
Total	100.0	100.1	99.7	299.8
	Lewis Woods			
Acer saccharum	44.6	33.6	42.6	120.8
Fagus grandifolia	15.8	16.1	44.9	76.8
Ulmus rubra	17.5	18.7	6.9	43.1
Fraxinus americana	3.8	5.8	4.7	14.3
Ulmus americana	4.6	6.5	0.3	11.4
Carpinus carolina	3.3	4.5	0.3	8.1
Aesculus glabra	3.3	3.9	0.1	7.3
Prunus serotina	2.5	3.9	0.1	6.5
Celtis occidentalis	1.3	1.9	0.0	3.2
Quercus bicolor	0.8	1.3	0.0	2.1
Ostrya virginiana	0.4	0.7	0.0	1.1
Cornus florida	0.4	0.7	0.0	1.1
Tilia americana	0.4	0.7	0.0	1.1
Quercus muehlenbergii	0.4	0.7	0.0	1.1
Lindera benzoin	0.4	0.7	0.0	1.1
Asimina triloba	0.4	0.7	0.0	1.1
Total	99.9	100.4	99.9	300.2

*Diameter at breast height greater than 1 inch for each study area.

**Scientific names from Gleason and Cronquist, 1963. Listed in order of relative density.

distinct difference between the two communities was represented by the array of importance (dominance) of top canopy species. In general, Lewis Woods exhibited a gradually declining set of importance values whereas in Hueston Woods there was a distinct break in values between the beech-maple complex and the remaining sub-canopy species; this illustrates a more even distribution pattern for Lewis Woods as compared to a true beech-maple dominance for Hueston Woods. It should also be pointed out that 16 species were sampled in Lewis Woods as compared to 13 species for Hueston Woods.

DISCUSSION

Computations based on the data of Yankat *et al* (1975) and Beals and Cope (1964) were utilized to determine similarity between the two study areas. A value of 62.8% indicated a high degree of similarity. Differences between the two areas were the result of selective cutting in Lewis Woods. Timbering occurred three times, in 1910 for white oak (*Quercus alba*) and black walnut (*Juglans nigra*), in 1935 for American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), and in 1955 for white ash (*Fraxinus americana*) (Beals and Cope, 1964).

Several investigators have found that acute stresses (e.g., pesticides, radiation, and fire) applied to certain terrestrial communities have tended to decrease species diversity and, in general, to simplify community structure (Woodwell, 1962; Barrett, 1968; Bulan and Barrett, 1971). In these studies, however, measurements were mainly based on the first year following treatment. Few studies have attempted to evaluate stress effects on a long-term basis. In the present study, we have attempted to measure and evaluate the effects of timbering on Lewis Woods, a beech-maple forest in east central Indiana, eighteen years following community alteration. Hueston Woods, a virgin beech-maple forest in southwestern Ohio, was sampled in an identical manner for comparative purposes.

Importance values revealed that beech-maple dominance had been diminished on a long-term basis as a result of timbering (see table 1). However, the forest ecology seems to be able to compensate for decreased dominance by increasing both total diversity and importance of sub-canopy species. This may be long-term recovery strategy of mature forest ecosystems when subjected to man-made stresses. These timbered communities also appear to resemble the diversified pre-climax forest communities as described by Nicholson and Monk (1974) for the Eastern Deciduous Forest Biome. Timbering apparently reverts the beech-maple climax community back to a multi-stratified and diversified tree seral stage of ecological succession (Adams and Barrett, 1976).

The need for environmental indices to evaluate long-term community impact has been called to the attention of resource managers (Train, 1972). We suggest that species diversity and importance values be considered as such indices. Data collected and evaluated from different forest types, and at various time intervals (years) following community alteration, should reveal differences in response and recovery strategy for various forest ecosystems. Guidelines for evaluating stress effects in this manner have been outlined by Barrett *et al* (1976).

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