

Importance Per Cent Values of a Browsed Southeastern Indiana Forest¹

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Abstract

White ash (*Fraxinus americana*), hop hornbeam (*Ostrya virginiana*), red oak (*Quercus rubra*), yellow poplar (*Liriodendron tulipifera*) and beech (*Fagus grandifolia*) exhibited importance per cent values of 49.4, 37.4, 28.6, 26.5 and 20.3 respectively, for a 10-acre forest located on the Brookville Ecology Research Center in southeastern Indiana. These values represented 54 per cent of the total tree species sampled within an area which had recently been released from browsing. White ash, hophornbeam, sugar maple (*Acer saccharum*), redbud (*Cercis canadensis*) and honey locust (*Gleditsia triacanthos*) were represented by a high density of seedlings (< 1 inch Diameter Breast Height), while canopy species of yellow poplar, red oak, beech and bitternut hickory (*Carya cordiformis*) were poorly represented in smaller size classes.

Introduction

Systematic sampling of a forest area following removal of cattle reveals much quantitative information regarding secondary succession. Cattle prefer tender grasses, forbs and herbs, in addition to shoots and tree seedlings (6). Effects of browsing also include such physical changes as compaction of soil, promotion of erosion, damage to root systems, litter removal, and general degradation of the natural seedbed conditions (6). Although several recent studies have been concerned with deciduous forests in this region of the midwest (2, 7, 8, 11), only limited information is available regarding the effects of browsing on the composition of forest communities. Thus far, only the study by Day and DenUyl (3) has provided specific information on browsing pressures by cattle in Indiana forests. We attempted to better measure and evaluate the effects of browsing on the composition of a mature deciduous forest community located in southeastern Indiana.

Study Area

The study area is located in Union County, south of Liberty, Indiana, specifically in the NW 1/4, Sec. 22, T11N, R2W on the Fairfield, Indiana, Quadrangle. The site is included within the Brookville Ecology Research Center, administered by Miami University, Oxford, Ohio, and Earlham College, Richmond, Indiana. The actual study area was comprised of 10 acres of forest located on the 140-acre research station leased in 1969 from the Army Corps of Engineers. The remaining 130 acres had been used annually for agricultural crops (*e.g.*, corn, soybeans, etc.) until the spring

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of 1970. The total area had since been left undisturbed to proceed through secondary succession. The 10-acre forest area had been periodically grazed by a herd of cattle for at least the past 8-10 years. This herd ranged in size from 6-15 cattle and was permitted to graze this area periodically during the spring and summer months out of each year. Cattle were permanently removed from the study site approximately 3 months before sampling was initiated.

The forest is located on a gradual-moderate slope with a total relief of 140 feet from the highest to lowest points and lies just north of the Wisconsin glacial boundary. The physiography is defined as Dearborn Upland, a dissected plateau north and west of the Ohio River with streams in deeply incised valleys (12). Soils for this area have been reported by Alfred, Ulrich and Zachary (1). Climatic conditions for this area have also been previously described by Schaal (10).

Methods and Materials

The nested quadrat method was used for sampling the vegetation (9). This method provides adequate sampling within a community of varying plant sizes. Ten nested quadrats, each 66 feet by 66 feet (0.1 acre each), were placed randomly within the 10-acre forest area. Thus, 10 per cent of the total forest area was sampled. Each 0.1-acre quadrat contained one 6.6 feet by 66.0 feet plot (0.01 acre) and two 6.6 feet by 6.6 feet square plots (0.001 acre or 1 milacre).

During October, 1970, all trees greater than 3 inches in diameter breast height (dbh) were tallied in the 0.1-acre plots. All saplings over 12 inches in height and less than 3 inches dbh were tallied in the 0.01-acre plot and all seedlings less than 12 inches in height were tallied in each milacre plot. The number of trees per acre, relative density, frequency of occurrence, relative frequency, total basal area, relative cover, and importance per cent values were computed (9). Frequency distribution of all species was computed by size classes. Diameter measurements of all trees were rounded to the nearest inch. Basal area for each species was calculated using a conversion table (9).

Results and Discussion

White ash (*Fraxinus americana*), hop hornbeam (*Ostrya virginiana*), red oak (*Quercus rubra*), yellow poplar (*Liriodendron tulipifera*), and beech (*Fagus grandifolia*) were clearly dominant, having importance per cent values of 49.4, 37.4, 28.6, 26.5, and 20.3, respectively. These species constituted 54% of all tree species sampled. (Table 1). Hop hornbeam, usually a mid-canopy species in white ash-yellow poplar-red oak associations (5) was the most frequently encountered species. White ash, red oak, yellow poplar, and beech, the major canopy species, had relative cover values of 20.7, 18.9, 13.6, and 12.8%, respectively, representing approximately 66% of the total cover (see Table 1).

The above-mentioned dominant trees (*i.e.*, white ash, hop hornbeam, red oak, yellow poplar, and beech) exhibited maximum dbh measurements of 18, 9, 34, 31, and 23 inches, respectively. Other large trees in-

TABLE 1. Summary of plant community parameters based on all trees over 3.0 inches dbh.

Tree species ¹	No. trees per acre	Relative density (A)	Frequency	Relative frequency (B)	Basal area per acre ft. ²	Relative cover (C)	Importance per cent value (A+B+C)
1. Fa	27	16.9	8	11.8	20.9	20.7	49.4
2. Ov	34	21.2	7	10.3	6.0	5.9	37.4
3. Qr	6	3.8	4	5.9	19.1	18.9	28.6
4. Lt	16	10.0	4	2.9	13.7	13.6	26.5
5. Fg	5	3.1	3	4.4	12.9	12.8	20.3
6. C cor	10	6.2	5	7.4	4.1	4.1	17.7
7. Ur	9	5.6	6	8.8	2.0	2.0	16.4
8. As	6	3.8	5	7.4	4.3	4.3	15.5
9. C can	13	8.1	3	4.4	1.7	1.7	14.2
10. Ps	4	2.5	4	5.9	5.8	5.7	14.1
11. C car	9	5.6	5	7.4	1.0	1.0	14.0
12. C oc	5	3.1	4	5.9	1.3	1.3	10.3
13. C cr	5	3.1	3	4.4	0.6	0.6	8.1
14. Sa	2	1.3	2	2.9	1.5	1.5	5.7
15. Mp	2	1.3	2	2.9	0.2	0.2	4.4
16. Fo	1	0.6	1	1.5	1.8	1.8	3.9
17. Gt	2	1.3	1	1.5	1.0	1.0	3.8
18. Q mu	2	1.3	1	1.5	0.7	0.7	3.5
19. C ov	1	0.6	1	1.5	1.2	1.2	3.3
20. Fq	1	0.6	1	1.5	1.1	1.1	3.2
Totals	160	100.0		100.2	100.9	100.1	300.3

¹Full nomenclature (5) is as follows: 1. *Frazinus americana* L., White ash; 2. *Ostrya virginiana* (Mill.) K. Koch, Hop hornbeam; 3. *Quercus rubra* L., Red oak; 4. *Liriodendron tulipifera* L., Yellow poplar; 5. *Fagus grandifolia* Ehrh., Beech; 6. *Carya cordiformis* (Wang.), K. Koch, Bitternut hickory; 7. *Ulmus rubra* Muhl., Slippery elm; 8. *Acer saccharum* Marsh., Sugar maple; 9. *Cercis canadensis* L., Redbud; 10. *Prunus serotina* Ehrh., Black cherry; 11. *Carpinus caroliniana* Walt., Blue beech; 12. *Celtis occidentalis* L., Hackberry; 13. *Crataegus crax-gallii* L., Hawthorn; 14. *Sassafras albidum* (Nutt.), Nees, *Sassafras*; 15. *Machera pomifera* (Raf.) Schneider, Osage orange; 16. *Platanus occidentalis* L., Sycamore; 17. *Gleditsia triacanthos* L., Honey locust; 18. *Quercus muhlenbergii* Engelm., Chinkapin oak; 19. *Carya ovata* (Mill.), K. Koch, Shagbark hickory; 20. *Frazinus quadrangulata* Michx., Blue ash.

cluded black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), sassafras (*Sassafras albidum*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*), with maximum dbh measurements of 18, 17, 16, 15, and 12, respectively. Such major canopy species as red oak, beech, bitternut hickory, yellow poplar, and black cherry were not well represented in the small size classes (< 5.0 inches dbh), nor in the seedling class. The paucity of reproduction of the major canopy species may be due to the influence of livestock. Species dominating the mid-canopy were redbud (*Cercis canadensis*), slippery elm (*Ulmus rubra*), sugar maple, hawthorn (*Crataegus crux-galli*), paw-paw (*Asimina triloba*) and wafer ash (*Ptelea trifoliata*).

Seedlings present were mainly white ash (78,500/A), hop hornbeam (54,000/A), redbud (9,500/A), honey locust (*Gleditsia triacanthos*) (8,500/a) and sugar maple (6,000/A). Slippery elm and blue ash (*Fraxinus quadrangulata*) exhibited a seedling density of 1,500/A each. Five taxa with 500/A seedlings each were sassafras, blue beech (*Carpinus caroliniana*), osage orange (*Maclura pomifera*), chinkapin oak (*Quercus muehlenbergii*), and sycamore (*Platanus occidentalis*).

In an earlier study concerned with browsed Indiana forests Day and DenUyl (3) reported that seedlings of white ash, sugar maple, and slippery elm were selected by cattle under all browsing intensities, whereas, under light to moderate browsing (*i.e.*, 10 or more acres per cow), red oak, beech, sassafras, bitternut hickory, sycamore, honey locust, and black cherry were selected. They also reported that seedlings utilized under heavy to very heavy browsing conditions (*i.e.*, less than 4 acres per cow) included shagbark hickory, hawthorn, blue beech, hophornbeam and paw-paw. Comparing the results of Day and DenUyl (3) to those of this study, it would appear that this forest had been under moderate browsing stress due to the paucity of red oak, beech, bitternut hickory, and black cherry seedlings.

DenUyl, Dillen and Day (4) reported that white ash, slippery elm, and sugar maple were found to be prolific seed producers. This, perhaps, helps to explain much of the data in the present study, in which white ash, slippery elm, and sugar maple were represented by 27, 9, and 6 mature trees per acre, respectively, as well as each exhibiting an abundance of small seedlings.

In summary, the disturbance (browsing) of this forest community was clearly reflected by an absence of reproduction (seedlings) of over 50% of the dominant canopy species. It appears that certain dominant species based on importance per cent values (*e.g.*, red oak, yellow poplar, and beech) were adversely affected by browsing. It also appears that white ash and hop hornbeam are able to maintain their dominance even under moderate browsing stress. The reason for this browsing selection factor awaits further investigation.

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