 0030-0950/78/0005-0255$1.00/0

VEGETATIONAL CHANGES ON AN OLDFIELD IN SOUTHEASTERN OHIO[1]

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Abstract. Former agricultural land in Strouds Run State Park was sampled by the quadrat method in 1962 and again in 1975. Comparisons of data show a 31% decrease in herbaceous plant cover with only a 6% increase in shrub cover, but with a shift in species composition. Stem density of trees (≥2.5 cm dbh) increased by a factor of 3.2. Indexes of similarity reveal that the field has become increasingly similar to the adjacent forest during the 13-year interim between study dates.

OHIO J. SCI. 78(5): 255, 1978

Changes in species composition as vegetation develops from an open field toward a closed-canopy forest is a basic concept in forest ecology (Little and Escheman 1976). A great number of oldfields in different stages of succession occur in southeastern Ohio. Merz and Plass (1952) estimated that at least 404,700 ha (1 million acres) of the unglaciated portion of Ohio, and 22,000 ha of the Athens Ranger District of the Wayne National Forest were in oldfields. Since 1952, there has been an increase in the number of oldfield ecosystems as farmland was abandoned. Little and Escheman (1976) state that published data on long term changes in vegetation on a specific area in different forest types are rare. This study concerns changes which have occurred in an oldfield ecosystem of Strouds Run State Park, Athens County, over a 13-year period, 1962–1975.

The research site (30°20′45″N, 82°02′00″W) is located in section 29, Canaan Township, Athens County, on a northeast-facing slope southwest of Dow Lake in Strouds Run State Park, approximately 8 km east of Athens, Ohio. The area is the 1.5 ha field used by McConnell (1963) as his "main old field". The field (34% slope) lies between Dow Lake and a steeper (54%) wooded slope at an elevation of appproximately 152.4 m (500 ft). The Muskingum series soil is slightly acidic (pH 5.1–5.7), has a sandy texture (52.5–71.6% sand), and was formed from weathered sandstone of the Conemaugh Series which is greater than 31.0 m (102 ft) thick in the vicinity (McConnell 1963, Sturgeon *et al* 1958).

MATERIAL AND METHODS

In 1962, McConnell laid out two parallel rows of 10 nested quadrats in the oldfield, and 5 nested quadrats in the forest, parallel to the quadrats in the old field. Quadrats 10 x 10 m in size were used to determine the density, frequency, and basal area of all trees ≥2.5 cm in diameter at breast height (dbh). Within each 10 x 10 m quadrat, a 2 x 10 m area was delimited from which densities of tree saplings and visual cover estimations of shrubs were determined. At both ends of each 2 x 10 m area, a 0.5 x 2 m area was delimited, within which densities for tree seedlings and visual estimations of cover for herbaceous plants were determined. Seedlings were considered to be individuals of tree species <30.4 cm in height; saplings were >30.4 cm in height, but <2.5 cm dbh; and trees were >30.4 cm in height and ≥2.5 cm dbh. McConnell's quadrats were not permanently marked: therefore, the locations of quadrats in the present study were close to, but not identical with his. Names used to identify all species of vascular plants were those of *Gray's Manual of Botany*, 8th edition (Fernald 1950).

Sørenson's indexes of similarity (IS_s) were calculated to compare similarities between the oldfield in 1962 and in 1975 and between the field and forest in 1962 and 1975. The formula used was $IS_s = \frac{2w}{A+B} \times 100$, where w represents

[1]Manuscript received February 11, 1977 and in revised form May 10, 1978 (#77-19).

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the number of species common to the two communities, A represents the total number of species in one community and B represents the total number of species in the second community (Mueller-Dombois and Ellenberg 1974).

In addition to the above qualitative (species present or absent) calculations, indexes were also determined quantitatively using density values and thus modifying the equation so that w represented the sum of the lower stem density values and A and B represent the total stems in each community, respectively.

RESULTS AND DISCUSSION

The work of McConnell (1963) in the Strouds Run State Park provided a basis for determining the vegetational changes in the oldfield. McConnell determined from increment borings that the larger trees were 10–12 years old in 1962, and concluded that the field had been agriculturally abandoned approximately 15 years prior to his study. Comparisons of the vegetational data from McConnell's study with those of the present study (Barcus 1976) showed that the field was taking on the characteristics of the adjacent secondary forest, and included many of the species reported by Merz and Plass (1952). Their study reported 57 species of trees from 60 separate oldfields in Hocking and Perry counties. Twenty-six of the 32 species recorded in the present study were also recorded in theirs. Although a single field was considered in the present study, its tree species composition was approximately 50% of that of the 60 fields studied by Merz and Plass (1952). This indicated that the successional trends in southeastern Ohio were similar, although there may be a variation in species composition from site to site. There has been a proliferation of tree stems from 2380 per 0.1 ha in 1962 to 7939 in 1975 on this study site. Thus, approximately 28 years after abandonment, the site was developmentally intermediate between that of a field and a forest.

A comparison of the percentages of herbaceous plant cover for 1962 (66%) and 1975 (35%) revealed that there had been a considerable reduction in individuals of Gramineae, Cyperaceae, Juncaceae, and *Solidago* (McConnell 1963, Barcus 1976). Of those species present only in the 1962 data, many were representatives of oldfield-type vegetation (e.g. *Cassia nictitans*, *Eupatorium fistulosum*, and *Oenothera biennis*), while of those present only in 1975, many were representative of forest-type vegetation, including *Polystichum acrostichoides*, *Sanguinaria canadensis*, and *Asarum canadense*. Although the field had many woody plants in 1975, the total shrub cover values for 1962 and 1975 were essentially the same (54–60%). Also, individuals of the following species not present in 1962 were recorded in 1975: *Ligustrum vulgare*, *Celastrus scandens*, and *Hamamelis virginiana*. By 1975, there was some reduction in cover of *Rhus radicans*, *R. glabra*, and *Rubus allegheniensis* and, conversely, an increase in *Parthenocissus quinquefolia*.

Vegetational changes in densities of tree species over the 13-year interim (1962 to 1975) were evident. There were more individuals (from 90 to 289 per 0.1 ha) in the three size classes of trees, as well as a greater number of saplings (from 790 to 1000 per 0.1 ha) and seedlings (from 1500 to 6650 per ha) (table 1). The only exception to the increase was in the largest size class, >25.4 cm dbh, where a single individual of *Platanus occidentalis* was recorded in 1962, but not recorded in 1975 since the quadrats were not in the exact location of McConnell's quadrats. An increase in the number of seedlings of *Cornus florida* from 400 to 3950 and of *Cercis canadensis* from 50 to 100 accounted for most of the change in seedling population. Several species were represented in the 1975 data which were not recorded in 1962. These included forest species such as *Carya cordiformis*, *Aesculus octandra*, and *Quercus velutina*. Some species, such as *Gleditsia triacanthos*, *Oxydendron arboreum*, *Asimina triloba*, and *Acer saccharum* which were recorded in the data as seedlings for 1962 but not for 1975, occurred on the field, but not within the 1975 quadrats.

The similarity indexes for the field in 1962 and 1975, based upon species of trees for individuals in all size classes (table 2), was 0.80. This shows that there was very little change in species composition over the 13-year period. The index calculated quantitatively using stem density values was markedly different (31%). The presence of larger numbers of seedlings

TABLE 1

Density of stems by size classes of tree species per 0.1 hectare on Strouds Run oldfield in 1962 and in 1975.

Species	Seedlings		Saplings		Tree size-classes* 2.5–9.9		10.0–25.3		≥25.4	
	1962**	1975	1962	1975	1962	1975	1962	1975	1962	1975
Liriodendron tulipifera	100	50	15	30	11	26	0	9	0	0
Cornus florida	400	3950	25	180	43	56	0	4	0	0
Ulmus rubra	350	200	65	100	2	8	1	0	0	0
Crataegus spp.	100	150	70	135	4	18	1	0	0	0
Cercis canadensis	50	1000	65	70	2	38	0	5	0	0
Ulmus americana	100	450	40	0	1	5	0	0	0	0
Acer rubrum	50	150	10	35	1	15	0	4	0	0
Carpinus caroliniana	50	150	5	45	0	25	0	0	0	0
Gleditsia triacanthos	50	0	5	5	4	0	1	2	0	0
Oxydendrum arboreum	150	0	10	0	0	3	0	0	0	0
Asimina triloba	50	0	20	15	0	1	0	0	0	0
Acer saccharum	50	0	0	55	0	1	0	1	0	0
Sassafras albidum	0	200	5	125	1	14	0	2	0	0
Prunus serotina	0	50	0	5	1	5	0	1	0	0
P. americana	0	100	5	0	0	0	0	0	0	0
Carya cordiformis	0	50	0	0	0	2	0	2	0	0
Diospyros virginiana	0	50	0	10	0	0	0	0	0	0
Fraxinus spp.	0	100	415	140	0	7	0	0	0	0
Juglans nigra	0	0	5	0	1	1	3	3	0	0
Pyrus malus	0	0	15	0	12	6	0	3	0	0
Nyssa sylvatica	0	0	15	5	0	2	0	0	0	0
Platanus occidentalis	0	0	0	0	0	0	0	0	1	0
Ostrya virginiana	0	0	0	40	0	2	0	0	0	0
Celtis occidentalis	0	0	0	0	0	1	0	0	0	0
Quercus velutina	0	0	0	5	0	5	0	2	0	0
Aesculus octandra	0	0	0	0	0	3	0	7	0	0
Total	1500	6650	790	1000	83	244	6	45	1	0

*Diameters in cm at breast height.
**1962 Data from McConnell (1963).

TABLE 2

*Indexes of similarity for tree species in an oldfield and adjacent forest in Strouds Run State Park determined from data obtained in 1962 and 1975.**

	Seedlings	Saplings	Tree size-classes (cm dbh) 2.5–9.9	10.0–25.3	≥2.5	All sizes
Field 1962–Field 1975						
IS_s	61	68	66	23	28	80
Density	24	45	45	15	44	31
Field 1962–Forest 1962						
IS_s	41	55	42	0	38	50
Density	14	29	34	0	31	20
Field 1975–Forest 1975						
IS_s	38	64	52	45	52	63
Density	15	3	35	33	46	18

*The similarity indexes (%) were calculated on the basis of species present or absent (IS_s) as well as the number of stems per 0.1 hectare (density).

and saplings in 1975 (table 1) changed the character of the field, although most species of trees present in 1962 were also present in 1975. The index (63%) for all size classes of trees, based upon a field-to-forest comparison of species present or absent, in 1975 was greater than in 1962 (50%), revealing a compositional trend toward that of the forest. The proximity of a source of propagules from the forest undoubtedly contributed to this trend. Comparisons of indexes for the field and the forest, based upon stem densities, revealed low values for all size classes combined (20% and 18%) but with an increase from 31% to 46% for individuals over 2.5 cm dbh. This was to be expected, as diametrical growth advanced some of the 1962 saplings into larger size-classes.

The suitability of the unglaciated hill country of southeastern Ohio for forest and recreational use rather than for agricultural use has been documented (DeBald and McCay 1969, Melvin 1974). The present study indicated that land abandoned from agricultural use (in this case converted to recreational use as part of a state park) may change, within 13 years, from a sparsely wooded field to a dense stand of young trees. The species of woody plants may not differ greatly during this period of time, but increases in number of stems, notably of *Cornus florida*, *Sassafras albidum*, *Cercis canadensis*, *Ulmus americana*, and species of *Crataegus*, *Prunus*, and *Fraxinus* occur with a concurrent reduction in the cover of herbaceous plants and thereby advance the field successionally to a community intermediate in development to an oak dominated forest.

Acknowledgments. The study was supported in part by graduate research assistantships from Ohio University and by a grant (UT1867) from the Ohio Biological Survey. The authors are grateful to Dr. Irwin A. Ungar for his critical review of the manuscript.

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