A Decade of Oldfield Succession in an Indiana Biological Reserve[1]

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Introduction

The Ross Biological Reserve is a 54 acre tract located 8 miles southwest of West Lafayette, Indiana in the southwestern portion of Tippecanoe County. Prior to 1949 the tract had been used for various agricultural purposes. In that year the Biological Sciences Department of Purdue University acquired the tract as its various abandoned oldfields and second growth forest offered wide opportunities for research and teaching. From early research in the Reserve Kenneth H. Bush determined three major vegetation types: oldfield, woodland, and forest; Chester W. Miller determined the flora, and Clifford R. Faulkner delimited the soil types (2, 3, 4). The present study was the second in an expected series to determine seral developments over ten year periods.

Methods

Following the procedures used by Bush (2), quantitative data were obtained from permanent herbaceous quadrats five links square (1/4000 A.), and woody quadrats 10 links by 50 links (1/200 A.). These quadrats were located at permanent metal posts, 2 chains apart, which divide the Reserve into a grid pattern. All species in the herbaceous quadrats were counted while tree species under four inches diameter breast height (dbh) in the woody quadrats were counted and listed as to height classes. Attributes of frequency and density per acre were determined for the various species and these compared to similar data from the 1950 analysis. Quantitative data were supplemented by photographs taken from the exact location and direction as those of the 1950 analysis (1).

Bush (2) recognized, and designated after dominant species, 13 vegetation sub-divisions in the Reserve. These were recognized in the present study but for clarity the designations were not changed even though new dominants were present. Only three sub-divisions of the oldfield type will be presented since these show the most striking changes.

Results

The first of these sub-divisions of the oldfield type is the Grass-Ambrosia Upland. This area, located on the upland plateau, is relatively flat, 2-6% slope, and has Russell Silt Loam soil type. Although quadrats were not laid out in this particular area in 1950, Bush (2) indicated that *Ambrosia elatior*, *Rubus flagellaris*, *Verbena urticaefolia*, *Daucus Carota*, and *Sonchus* sp. were the dominant herbaceous species. Attributes determined in the present analysis show *Poa compressa*, 261,796/A., and *Rubus flagellaris*, 38,333/A., as the dominant herbs. *Poa* represented 61% and *Rubus* 9% of the total density for all species combined. Respective frequencies were 92 and 62. The former dominants, *Ambrosia elatior* and *Daucus Carota*, now having respective densities of 5,227/A. and 871/A.

1. Part of a thesis submitted to the Graduate School of Purdue University in partial fulfillment of the requirements for the degree of Master of Science.

and frequencies of 46 and 8, are minor species representing only 1% and .2% of the total density for all species. *Verbena urticaefolia* and *Sonchus* sp. were so infrequent that none were counted in the quadrats.

Liriodendron tulipifera and *Ulmus fulva* were the only tree species present in 1950; neither had a dbh of 4 in. or greater. Seventeen tree species, represented by 113 individuals all less than 4 in. dbh, were found in the quadrats in 1960. *Liriodendron* and *Fraxinus americana*, representing 35% and 18% of the total number of individuals in the quadrats, were the most abundant. Reproduction density (for all species combined) decreased through the 3-4, 1-2, and 5-7 foot height classes.

Table 1. Herbaceous species of the Poa-Andropogon-Rubus Upland Oldfield.

Species	1960		1950	
	Density/A.	Freq.	Density/A.	Freq.
Poa compressa	525,769	100	not counted	
Rubus flagellaris	38,333	89	3,354	88
Monarda fistulosa	30,828	50	1,581	65
Potentilla simplex	28,750	22		
Draba repens	17,860	22		
Panicum spp.	14,810	67		
Daucus Carota	11,326	61	1,176	59
Lysimachia lanceolata	11,326	6		
Rhus radicans	10,454	22		
Achillea millifolium	7,841	33		
Danthonia spicata	6,970	6	653	29
Desmodium spp.	6,098	61		
Veronica verna	5,227	17		
Andropogon virginicus	4,792	33	5,184	88
Lactuca sp.	3,920	39		
Solidago spp.	3,920	22		
Cerastium spp.	2,614	22		
Rubus allegheniensis	2,614	22		
Ambrosia elatior	1,307	17	4,763	82
Cirsium sp.	1,307	17		
Dianthus Armeria	1,307	6		
Melilotus officinalis	1,307	6		
Carex spp.	871	17		
Fragaria virginiana	871	11		
Galium spp.	871	11		
Plantago spp.	871	6	479	29
Rumex acetosella	871	17		
Solanum sp.	871	11		
Potentilla erecta	436	6		
Erigeron sp.	218	6		
Mentha sp.	218	6		
Specularia perfoliata	218	6		
Oxalis sp.	218	6		
Total	744,996		18,440	

The Poa-Andropogon-Rubus Upland is another oldfield sub-division having 2-6% slope and Russell Silt Loam soil type. Eight herbaceous species were noted in the 1950 analysis; *Poa compressa*, *Andropogon vir-*

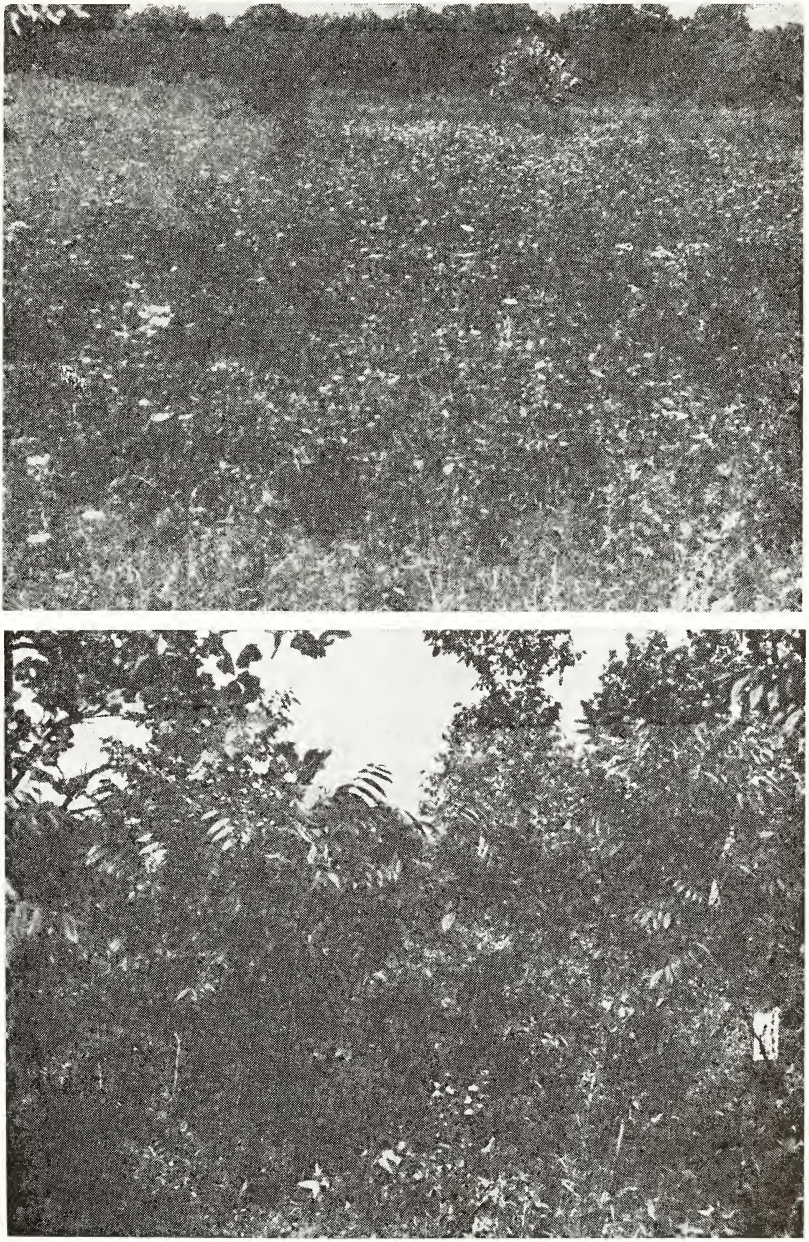

Figure 1. Poa-Andropogon-Rubus Upland Oldfield taken from the same location and direction. (upper—1950, lower—1960)

ginicus, 5,184/A., *Ambrosia elatior*, 4,763/A., and *Rubus flagellaris*, 3,354/A., were the dominants. Respective frequencies (except *Poa*) were 88, 83, and 88. *Andropogon* represented 28%, *Ambrosia* 26%, and *Rubus* 18% of the total density for all species in 1950. Thirty-two herbaceous species were noted in the present analysis; *Poa compressa*, 525,769/A., *Rubus flagellaris*, 38,333/A., and *Monarda fistulosa*, 30,828/A., were the dominants. Respective frequencies were 100, 89, and 50. *Rubus* represented 18% and *Monarda* 14% of the total density for all species.[3] Former dominants, *Andropogon* and *Ambrosia*, now have respective densities of 4,792/A. and 1,307/A., and represented only 2% and .6% of the total density for all species combined (Table 1).

No data were collected for trees under 4 in. dbh in the 1950 analysis. In the 1960 analysis of woody quadrats 24 tree species, represented by 376

Table 2. Herbaceous Species of the Andropogon Sandslope Oldfield.

Species	1960		1950	
	Density/A.	Freq.	Density/A.	Freq.
Poa compressa	252,648	67	not counted	
Andropogon virginicus	20,909	83	55,321	83
Rubus flagellaris	19,166	50	16,553	67
Potentilla simplex	8,276	33		
Rumex acetosella	5,663	17		
Panicum spp.	3,920	67		
Convolvulus spp.	3,049	33	7,840	33
Desmodium spp.	3,049	33		
Galium spp.	3,049	33		
Lactuca sp.	2,613	33		
Lysimachia lanceolata	2,613	17		
Tradescantia canaliculata	2,613	33		
Parthenocisus quinquefolia	1,742	17	6,870	33
Solidago spp.	1,307	17		
Monarda fistulosa	1,307	17		
Achillea millifolium	436	17		
Antennaria Parlinii	436	17		
Oxalis sp.	436	17		
Potentilla erecta	436	17		
Rudbeckia hirta	436	17		
Ambrosia elatior	0	0	26,572	67
Danthonia spicata	0	0	3,049	17
Rubus allegheniensis	0	0	1,307	17
Total	329,311		127,095	

individuals, were found. Based on the percentage of the total number of individuals in the quadrats *Ulmus fulva*, 24%, *Fraxinus americana*, 15%, *Acer saccharum*, 14%, *Malus* sp., 9%, and *Rhus glabra*, 8%, were the major species. Reproduction density for all species ranged downward through the 3-4, 1-2, and 5-7 foot height classes. No trees were recorded

3. Since *Poa* was not counted in the 1950 study, its 1960 density was not included in the total density for all species in order that percentages for the two years would be comparable.

with a 4 in. or greater diameter in the 1950 quadrat analysis; in the present study a *Quercus velutina*, dbh 4.95 in., *Fraxinus americana*, dbh 6.0 in., and *Populus grandidentata*, dbh 5.1 and 7.0 in., were recorded.

Figure 2. Andropogon Sandslope Oldfield taken from the same location and direction. (upper—1950, lower—1960)

Other individuals having 4 in. or greater dbh were scattered throughout the field; e.g., *Platanus occidentalis*, 4-8.4 in. dbh, *Liriodendron tulipifera*, 4-7.1 in. dbh, (Fig. 1).

The last oldfield sub-division to be discussed is the Andropogon Sand-slope. This area has a 12-18% slope. Its soil is Oaktown Loamy Fine Sand except in the draw which is Russell Sandy Loam. Eight herbaceous species were recorded in the quadrats in 1950. *Andropogon virginicus*, 55,321/A., *Ambrosia elatior*, 26,572/A., and *Rubus flagellaris*, 16,553/A., were the dominants representing 43%, 21%, and 13% of the total density for all species. Twenty herbaceous species were found in the same quadrats in the present study. *Poa compressa*, 252,648/A., *Andropogon virginicus*, 20,909/A., and *Rubus flagellaris*, 19,166/A., were dominant. The latter two represented 27% and 25% of the total density for all species. *Ambrosia elatior* was so infrequent that none were found in the quadrats (Table 2).

Large trees were restricted to a natural draw cutting through the field; *Platanus occidentalis, Juglans nigra, Fraxinus americana, Sassafras albidum, Quercus velutina*, and *Liriodendron tulipifera* predominate. Small *Juglans nigra* and *Quercus velutina* were present on the sand ridge-crest (Fig. 2). Considering tree species under 4 in. dbh, 18 species were found in the 1960 quadrat analysis. *Ulmus fulva, Quercus alba, Fraxinus americana*, and *Juglans nigra*, having respective percentages (of the total number) of 20, 15, 13, and 12 were the most prevalent in the quadrats. Reproduction density for all species decreased through the 1-2, 3-4, and 8-10 foot height classes.

Discussion and Conclusions

Herbaceous cover in the Grass-Ambrosia and Poa-Andropogon-Rubus Upland oldfields has increased during the decade in the number of species present as well as density of these species. The majority are perennials rather than annuals as formerly. Dominance has shifted in 10 years from *Ambrosia elatior* and *Daucus Carota* to *Poa compressa* and *Rubus flagellaris* in the Grass-Ambrosia Upland oldfield. In the Poa-Andropogon-Rubus Upland oldfield, *Poa* and *Rubus* are dominants. *Andropogon*, a former dominant, has decreased drastically in density representing 28% of the total density for all species in 1950 and only .2% in 1960. *Ambrosia* decreased in density from 25% of the total density in 1950 to .6% in 1960. *Liriodendron, Fraxinus, Ulmus*, and *Acer* are early-invasion tree species. In the Grass-Ambrosia Upland 53% of the individuals noted in the quadrats were *Liriodendron* and *Fraxinus*. In the Poa-Andropogon-Rubus Upland, *Ulmus, Fraxinus*, and *Acer* composed 53% of the individuals noted in the quadrats. *Liriodendron* represented only 2% of the individuals in the quadrats. This latter condition appears to be related to the number of seed sources in the adjacent forest. In considering the rate of succession during the decade in both areas, there has been rapid ecesis of various herbaceous and woody species. Both oldfields have the same general appearance and species present, varying only in the density of these species. Marked physiognomic changes in the future will be much slower since future dominants are present and need only to expand in density. Eventually both upland oldfields will probably support a mixed mesophytic climax forest.

Herbaceous species have also increased in the number present and density in the Andropogon Sandslope oldfield. *Andropogon*, which once practically covered the area, is now restricted to the sand ridge-crest, represented 43% of the total density for all species in 1950 and only 27% in 1960. *Ambrosia* was completely lacking in the quadrats. Only *Rubus flagellaris*, of the former dominants, had an increase in density per acre; representing 13% of the total density in 1950 and 25% in 1960. *Ulmus fulva*, *Quercus alba*, *Fraxinus americana*, and *Juglans nigra* composed 60% of the tree species under 4 in. dbh in the quadrats. Large trees are restricted to the draw running through the area where soil moisture is sufficient to support their development. As in the above-mentioned oldfields, marked physiognomic changes will be much slower in the future. Succession will probably terminate at a sub-climax of oak-hickory due to the relative xeric edaphic conditions of the area.

Literature Cited

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