Proceedings of the Iowa Academy of Science

Volume 62 | Annual Issue

Article 25

1955

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INTRODUCTION

During the summer of 1954 the author was privileged to conduct floristic and ecological studies on the Edmund Niles Huyck Preserve, located near Rensselaerville, in Albany County, New York. This Preserve is about 470 acres in size and centers about two bodies of water. The larger is called Lake Myosotis, after the wild forget-me-not, *Myosotis laxa* Lehm, which is abundant along its margin. The Preserve was established in 1931, in memory of Edmund Niles Huyck, by his widow and friends, and the majority of it has been under strict and complete protection from disturbance since that time. Parts of the Preserve have been without disturbances (principally logging and grazing) since the latter part of the 19th century.

During the 19th century and the early part of the 20th century, the majority of the area was under agricultural use, however. When Mr. Huyck first began to buy up the area (in 1889), much of it was cleared, fallow, hay fields. Beginning in 1924 and ending in 1932 a number of evergreen plantings were made in these fields, These were principally stands of white spruce (*Picea glauca*[1]) and red or Norway pine (*Pinus resinosa*). Originally these trees were planted with the expectation of eventually harvesting a timber crop to help pay for the upkeep of the Preserve. However, especially following the establishment of a biological field station here in 1939, this policy was changed, and these stands have not been touched since their planting. At the time of planting the ground was, in nearly every instance, apparently completely cleared of other tree growth, so that the stands were originally pure red pine, pure white spruce, or, in two cases, a mixture of red pine and white spruce.

The Helderberg Plateau, upon which the Huyck Preserve is located, is in general dominated by the hemlock-hardwood forests (Dansereau, 1948; Braun, 1950). This certainly seems to be the case on the Preserve itself, and plant succession in this region tends to restore these forests. Evidence from sampling both by Odum (1943) and the present author (1955) support the idea of direct change from the herbaceous vegetation of old fields to the various

[1]Taxonomic nomenclature throughout this paper is taken from Fernald (1950).

forest types comprising the hemlock-hardwood "association". Some additional data supporting this is cited later in this paper.

A search of the ecological literature indicates that little is known regarding the effect of planting red pine and white spruce on the direction and rate of natural vegetational change in this area. On the Huyck Preserve it was possible to observe some early effects of this procedure. Though, as will be shown below, native species have barely entered many of the plantations sampled, in others they have invaded the conifers in force, and future vegetational trends appear evident. The purpose of the present analysis is to demonstrate the nature and extent of plant succession in these forests and to compare the rate with that in adjacent "old fields".

Methods

The evergreen plantations were sampled in two ways. The pine forests were studied with the random pairs method (Cottam and Curtis, 1949). This method was used in a somewhat modified fashion as described elsewhere (Dimit and Russell, 1954). It was possible to sample the pine forests accurately and very rapidly with this technique. Generally, forty points could be run by the investigator in two to three hours, depending upon the terrain. The random pairs were run along compass lines evenly distributed through the stands.

It proved impossible to use this method in the white spruce communities, due to lack of natural pruning of the trees and the consequent denseness of the forest. Instead, two belt transects, 2m. X 75m., were run in each forest. In these transects, all trees 1″ DBH or larger were measured and all trees below this size counted as reproduction. The two mixed pine-spruce forests were handled differently. The more open one was sampled with forty random pairs; the less open one with the two 75m. transects. In all cases only woody vegetation was sampled. In both the spruce and the pine forests herbaceous vegetation was very sparse, occurring often only in forest openings. The sampling was done between June 24th and July 5th, 1954.

Discussion

Sampling data from the five red pine stands are summarized in Table 1. In every case the data demonstrate the dominance of pine. In these forests there are only occasional openings, and in these the deciduous invaders are concentrated. These openings are invariably due to death of one or more of the red pines. White ash (*Fraxinus americana*) is easily the most successful invader, although sugar maple (*Acer saccharum*), trembling aspen (*Populus tremuloides*), and other deciduous trees are present also. The larger deciduous trees are almost all white ashes, many of which almost reach the height of the pine canopy (about 40 ft.).

Table 1

Summary of sampling data from five red pine plantations. Quantitative data (with the exception of number of woody species) doubled in the case of stand P-1, where only 20 random pairs were run. In the other four stands the data are based on 40 random pairs.

		(Stand)				
		P-1	P-2	P-3	P-4	P-5
Age (in years) when sampled		26	26	26	24	26
Total number of woody species		8	7	6	3	4
Total Density—	Pine	70	77	90	87	82
	Others	64	28	9	4	10
% Density	Pine	52	73	91	96	89
	Others	48	27	9	4	11
Total basal area	Pine	14.964	18.043	21.065	15.527	19.097
	Others	4.750	2.638	0.598	0.491	0.715
% basal area	Pine	76	87	97	97	96
	Others	24	13	3	3	4
Total reproduction	Pine	0	1	0	0	0
	Others	596	321	144	6	77

Of the five pine stands sampled, invasion has apparently just begun in stands P-3, P-4, and P-5. However, in stands P-1 and P-2, the invading species have appreciable percentages of both density and basal area. One feature that renders the eventual replacement of the pine inevitable is its inability to reproduce naturally in this region. This is illustrated by the fact that only a single pine below 1″ DBH was found during the sampling.

In Table 2, diameter distributions in a typical red pine forest are plotted to illustrate this early invasion of deciduous trees. In this particular forest white ash is the only important invader. The great majority of pines are relatively uniform in size, varying between 5 and 7 inches in diameter, while the ash occurs, though sparingly, in all size classes.

Table 2

Diameter distribution in the red pine plantation P-2.

	(DBH)																	
Species	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5
Pinus resinosa			1	1		2			5	13	8	16	15	7		8	1	
Fraxinus americana	3	2	3	2	2		2			4	1	1		1			1	
Populus tremuloides										2								
Acer saccharum	2																	
Ostrya virginiana	2																	

Data from the three white spruce forests are considered in Table 3. On the average these forests have been more successfully invaded than the red pine, perhaps due to the slower growth of the spruce and the depredations of the spruce saw-fly (Odum, 1943, p. 77), resulting in more openings. In stand S-1 the spruce is being effectively crowded out by the white ash and several species of *Prunus,* these deciduous species overtopping the short spruces. Like red pine, white spruce reproduces naturally very rarely in this area. Certainly it cannot maintain itself. In Table 4, diameter distributions in Stand S-1 are shown. These clearly indicate the future replacement of white spruce by a variety of deciduous trees.

Table 3

Summary of sampling data from three white spruce plantations. Each plantation was sampled with two belt transects, each 2 m. X 75 m.

		(Stand) S-1	S-2	S-3
Age (in years) when sampled		30	30	30
Total number of woody species		10	15	12
Total Density —	Spruce	57	79	71
	Others	76	64	50
% Density	Spruce	43	55	59
	Others	57	45	41
Total basal area	Spruce	8.153	7.243	5.630
	Others	1.279	0.893	3.787
% basal area	Spruce	86	89	60
	Others	14	11	40
Total reproduction	Spruce	0	2	3
	Others	239	150	43

Table 4

Species	(DBH) 1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Picea glauca	1	2	3		4	3	10	5	8	8	2	4	1	3		1	1	1	
Fraxinus americana	18	12	7		1		1												
Prunus spp.	6	6	2	3		2	1												
Amelanchier arborea			2	1															
Alnus rugosa	3	4	2																
Acer rubrum			1																
Populus tremuloides	1	2	1																

Two of the forests were mixed plantings of white spruce and red pine, and the sampling data from these are given in Table 5. It should be noted that the quantitative data are not exactly equivalent due to the difference in sampling methods utilized. In both these forests, particularly PS-1, a relatively large number of important deciduous species (and also white pine), is found. This is shown partly by the data in Table 6. In general appearance and successional stage these forests are much closer to the spruce forests than to the pure red pine plantations. Their canopy is uneven and ragged, and there are more and larger forest openings. This may be due in part to irregular and incomplete planting.

Table 5

Summary of sampling data from two mixed red pine-white spruce plantations. Stand PS-1 was sampled with 40 random pairs. Stand PS-2 was sampled with two plots, each 2 m. X 75 m.

		(Stand) PS-1	PS-2
Age (in years) when sampled		26	23
Total number of woody species		19	8
Total Density—	Spruce-pine	66	78
	Others	35	41
% Density	Spruce-pine	66	66
	Others	34	34
Total basal area	Spruce-pine	14.000	9.189
	Others	10.889	1.640
% basal area	Spruce-pine	56	85
	Others	44	15
Total reproduction	Spruce-pine	0	2
	Others	302	20

Table 6

Diameter distribution in the red pine-white spruce plantation PS-2.

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Pinus resinosa			1	1	1	2	5	4	2	5	4	8	1	1		1	
Picea glauca		3	10	3	4	1	6	2	8	3	1	1					
Fraxinus americana	9	4	4		4	4	4		1								
Betula papyrifera					1	2	1		1								
Populus tremuloides	1	1	2														
Prunus americana		1	1														

Though a large number of deciduous trees were occasionally found in openings in these forests, a limited number of species seemed to be actually successful. These are listed in Table 7 in their approximate order of importance. By far the most important of them is the white ash. In almost every opening in these forests one or more white ash transgressives and many seedlings are found. In addition, the seedlings are occasionally seen in the thick, sterile leaf mold in denser parts of the forest. Sugar maple is also frequent, though it usually occurs as seedlings, only 8 plants with stem diameters of 1″ or more being found in all ten forests. The cherries (*Prunus* spp.) were especially characteristic of the spruce forests. The only species likely to become an important part of the invading forest, however, is *Prunus serotina,* the black cherry. Trembling aspen and especially alder (*Alnus rugosa*) were found in moist openings in the forests.

White pine (*Pinus Strobus*) represented a special case In two of the forests in which it occurred the trees were large and apparently pre-dated the red pine plantings. In the third, the trees were younger than the planted red pines and seemed to have grown from seed from an adjacent natural hemlock-beech-white pine forest.

Table 7

Principal deciduous species invading the white spruce and red pine plantations.

Species	Presence % (in ten stands)	Total density above 1″	Total density below 1″ (DBH)
Fraxinus americana	100	163	1143
Prunus spp. (*virginiana, serotina, pensylvanica, americana*)	90	34	208
Acer saccharum	70	8	113
Populus tremuloides	50	34	1
Ulmus americana	30	21	1
Pinus Strobus	30	26	....
Rhus typhina	30	7	16
Populus grandidentata	30	5	1
Amelanchier arborea	30	7	....
Tilia americana	20	3	....
Alnus rugosa	20	21	14

Old Field Successions

In July, 1954, six "old fields" on the Preserve were sampled, using 25 small plots each. In these plots presence and coverage class were noted for each species. The data from these samples are summarized in Table 8 for purposes of comparing old field succession with that in the evergreen plantations. Only the more important species are listed, together with their frequency percentages in each of the six stands. All are herbaceous. Coverage data are not listed, but the grasses tended to have greater coverage than the forbs. These old fields served originally as hay fields and for cattle grazing, but have not been disturbed since at least the time of planting of the pine and spruce forests. In spite of the time available for possible divergence in direction of vegetational change, all six are very similar in general appearance and actual dominant and associated species.

Table 8

Summary of certain data obtained in sampling six old fields. Twenty-five 0.5m. X 2m. plots run at 10-meter intervals in each area. Only species with a frequency of 70% or more in at least one community are listed below. Sampling done in July, 1954.

Species	Stand (Frequency %) 1	2	3	4	5	6	Total
Potentilla simplex	92	96	100	88	100	100	576
Hieracium spp.[1]	72	72	92	88	100	92	516
Fragaria virginiana	96	92	80	52	60	92	472
Phleum pratense	88	32	36	100	84	100	440
Ranunculus acris	88	68	60	88	20	92	416
Solidago juncea	80	72	96	52	44	24	368
Poa compressa	88	24	80	52	36	76	356
Danthonia spicata	76	28	96	....	100	52	352
Chrysanthemum Leucanthemum var. *pinnatifidum*	60	44	64	88	8	76	340
Agrostis alba	44	76	44	36	36	88	324
Trifolium agrarium	88	16	76	76	28	36	320
Anthoxanthum odoratum	64	76	16	48	....	92	296
Solidago graminifolia	36	76	76	8	44	4	244
Total number of species	53	53	60	64	40	55	
Species of shrubs & trees	7	10	12	7	3	6	
Total coverage percentage of shrubs and trees	18	39	43	14	19	8	
Successional rank of community (1 = lowest)	4	5	6	2	3	1	

[1]This includes *Hieracium scabrum, H. aurantiacum,* and *H. florentinum.*

In the old field communities invasion by woody species was apparently only beginning. No trees with trunk diameters of an inch or more were noted in the sample plots, although a few were seen in the fields. However, the coverage of woody plants was significant and is given in the lower part of Table 8. In field number 3 the shrubs and young trees covered almost half the ground. This does not, of course, indicate their relative importance, as the grasses and forbs present, if considered together, would have had a total coverage in the neighborhood of 200%. The "invading" tree species here were again white ash principally, and in addition trembling aspen, sugar maple, and *Prunus virginiana.* All these species were found in the conifer forests. In addition, such shrubs as *Spirea latifolia, Rubus* spp., and *Crataegus* sp. were of some importance.

Conclusions

Sampling data from ten red pine and white spruce plantations and from old fields have been examined to attempt to fix the approximate stage of deciduous forest invasion in each. Though the old fields have actually had less direct disturbance by man in the last thirty years, they have apparently changed very little in their composition during that time. On the other hand, deciduous forest species have very definitely begun the invasion of planted conifer forests here. It would seem that the clearing of old fields and planting of red pine and particularly white spruce has actually speeded up natural succession instead of hindering it. This may well be because of the amelioration of certain environmental factors, such as temperature maxima and minima and evaporation rate, by the forest canopy and even significant extensions of the growing season for native tree species (Hough, 1945; Wood, 1935).

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