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Abundance and Distribution of Vegetation under Four Hardwood Stands in North-Central West Virginia

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Abstract

Forest floor samples were collected from four hardwood forest stands in West Virginia to study species composition, abundance, and distribution of vegetation that originated from seeds, rootstocks, rhizomes, and so on. The abundance and distribution of plants on square-foot sections of forest floor that were lifted and moved to the greenhouse indicate that under the most ideal conditions upwards of 800,000 stems per acre may occur during the first year. Sweet birch was the most abundant tree species, blackberry the most abundant shrub, and species of violets were the most abundant herbaceous plants. Implications of this vegetation on the regeneration of the forest are discussed.

The Author

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Introduction

Control of species composition is a major regeneration problem in central Appalachian hardwood forests. After harvest cutting, dense stands of tree seedlings, shrubs, vines, and herbaceous plants become established. The species composition of the future forest is often determined at this time. The situation is further confounded by variation in the silvical requirements and relative desirability of tree species, changes in site quality over short distances, and the destruction of tree seeds by birds, mammals, insects, and diseases. Slower growing desirable species such as newly germinated oak seedlings are often overtopped by less desirable plant species that make it difficult to bring the oak through. This paper presents estimates of the quantity and distribution of species that were observed in 12-inch x 12-inch x 4-inch samples of forest floor from four hardwood stands on two areas with different site indexes. These data provide an insight to the competition problem and serve as a basis for designing studies to cope with it.

The Study Area

All of the forest floor sampling was done on 1/2-acre growth plots that were established earlier as part of the Fernow Experimental Forest growth study. The Fernow Experimental Forest is a 5,000-acre outdoor laboratory of the Northeastern Forest Experiment Station located in Tucker County near Parsons, West Virginia. Two forested areas encompassing three site index classes were sampled. Area I is about 39 acres of undulating, relatively flat land at an average elevation of about 2,300 feet. Area II approximately 80 acres in size has moderately steep topography with slopes mostly between 20 and 40 percent. Elevation on Area II ranges between 1,800 and 2,500 feet.

Average oak site index (Trimble and Weitzman 1956) for Area I, which varied little in topography and soil, was 70. Area II varied widely in site index and was divided into three oak site index strata: 64, 70, and 80.

The soils on both areas are silt loams derived from acid sandstone and shale from the Mauch Chunk and Pocono geologic formation. Calvin channery silt loam, a loamy-skeletal, mixed mesic Typic Dystrochrepts, is the predominant soil on both areas with scattered areas of Dekalb silt loam, a loamy-skeletal mixed mesic Typic Dystrochrepts near the ridge tops. Both soils are moderately well-drained and 2 to 4 feet deep to bedrock.

Precipitation averages 58 inches annually and is well distributed throughout the year. The average length of the frost-free season is about 145 days.

The existing forest is composed of second growth hardwood timber that came in after the cutting during the early 1900's, old residual trees of species that were in low demand during the early cutting, and trees that became established as the American chestnut died in the 1930's.

The three stands on Area II were stratified by oak site index. The site index 80 area is typical of Society of American Foresters (SAF) cover type 59—yellow-poplar—white oak—northern red oak (Eyre 1980) (Table 1). This type includes a large component of yellow-poplar, white oak, and northern red oak. At lower elevations black locust, white ash, and other mesic site species may be present. At higher elevations, American beech, red and sugar maple, and other species may become more abundant. The site index 64 and 70 areas are more typical of SAF cover type 55—northern red oak. On the more moist sites a rather large component of yellow-poplar, black cherry, sugar maple, beech, white ash, and white oak may be present. On drier sites, other oaks, hickories, black gum, and red maple may be more abundant.

Methods

On Area I, ten 1/2-acre square growth plots were sampled. Forest floor samples were 12-inches square and were lifted from 16 locations established on a 25- by 25-foot grid in each growth plot, 160 samples in all. On Area II, two 1/2-acre circular growth plots were sampled in each site index stratum. Twenty forest floor samples were lifted from five locations at 15-foot intervals on each cardinal direction from plot center in each plot, 40 samples from each site index strata. Because of greenhouse space limitations, Area II samples were collected in November 1982, and Area I samples were lifted in November 1983.

Forest floor samples were carefully cut with a machete to a depth of 4 inches around the inside of a wooden template. The sample trays were constructed of wood, 12-inches x 12-inches x 4-inches, with a 1/4-inch mesh hardware cloth bottom. The cut block of forest floor was carefully lifted with a spade and placed in a tray. Where stoniness prevented lifting the sample intact, the sample was carefully gathered with a trowel and placed in a tray. Usually a single layer of leaves was placed on the hardware cloth bottom in the tray to prevent soil sifting during transport of the samples.

The samples were labeled as to location and plot and randomly placed on greenhouse benches. No heat was maintained in the greenhouse during the winter, but flats were watered occasionally when the soil looked dry. About mid-March the automatic overhead watering system was started. Water was applied through a misting system for 2 hours each morning, and the greenhouse was heated to keep the flats from freezing during the early spring. Seeds that ger-

Table 1.—Average number and average basal area, ft²/acre, of stems larger than 1.0 inch d.b.h. in the four stands sampled

Species	Area I		Area II					
	Site Index 70		Site Index 64		Site Index 70		Site Index 80	
	Number	Basal area	Number	Basal area	Number	Basal area	Number	Basal area
Eastern hemlock	14	4	—	—	—	—	—	—
Sweet birch	7	3	15	1	—	—	8	2
White oak	22	35	24	27	1	4	3	8
Chestnut oak	15	17	34	35	—	—	2	2
Red oak	18	30	52	33	18	50	19	44
Cucumbertree	5	5	10	1	—	—	7	5
Fraser magnolia	14	4	6	<1	—	—	—	—
Yellow-poplar	3	3	—	—	1	2	17	25
Black locust	3	2	—	—	4	3	—	—
Sugar maple	8	4	—	—	249	46	220	14
Red maple	38	13	171	14	34	9	70	18
Sourwood	25	13	28	10	—	—	—	—
Hickories	—	—	—	—	5	4	12	5
American beech	—	—	55	2	—	—	6	<1
Downy serviceberry	—	—	81	2	—	—	8	<1
Black cherry	—	—	—	—	39	46	14	6
American basswood	—	—	—	—	6	1	12	7
White ash	—	—	—	—	8	6	8	7
American chestnut	—	—	19	<1	—	—	—	—
Scarlet oak	—	—	6	10	—	—	—	—
Sassafras	—	—	4	1	—	—	—	—
Black gum	—	—	29	5	—	—	—	—
Dogwood	—	—	—	—	—	—	10	<1
Striped maple	—	—	—	—	—	—	3	<1
Eastern hophornbeam	—	—	—	—	12	1	—	—
Slippery elm	—	—	—	—	3	2	—	—
Total	172	133	534	143	380	174	419	147

minated and/or root stocks that sprouted were allowed to grow until mid-September after which time species in each tray were identified, counted, and the number recorded by tray.

Results

Forty-four plant species were identified in the trays at the end of the study. A few sparsely occurring grasses and sedges were observed in the trays but were not identified.

Tree Species

Sweet birch was by far the most abundant and frequent of the nine tree species observed in all of the trays (Table 2). Numbers ranged from 126,000 per acre to more than 450,000 per acre with a frequency—percentage of flats containing at least one sweet birch—ranging from 68 to 98 percent. On the three Area II sites, sweet birch was most abundant in the trays that were collected from the site index 64 site.

Yellow-poplar was the second most abundant species. Projected field abundance was estimated at more than 100,000 seedlings per acre on the oak site index 80 area and about 23,000 per acre on the site index 64 area. Yellow-poplar frequency ranged from 73 percent on site index 80 to 40 percent on the site index 64 area.

Table 2.—Projected average number of tree seedlings (thousand/acre)[a] and frequency[b] of occurrence in forest floor samples collected at four locations in West Virginia

Species	Area I		Area II					
	Site Index 70		Site Index 64		Site Index 70		Site Index 80	
	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
Sweet birch	450	98	320	98	126	68	170	88
Yellow-poplar	89	73	23	40	48	50	101	73
Sourwood	36	31	74	68	—	—	1	3
Sassafras	22	29	70	73	1	3	4	5
Fire cherry	10	15	—	—	—	—	—	—
Red oak	2	5	6	5	1	3	—	—
Black locust	2	5	—	—	1	3	1	3
Fraser magnolia	2	2	—	—	—	—	—	—
Red maple	1	1	8	18	—	—	—	—
Sugar maple	—	—	—	—	—	—	1	3
Black cherry	—	—	4	5	9	15	5	3
Total	614	—	505	—	186	—	283	—

[a] Rounded to nearest 1,000.
[b] Percentage of flats with at least one seedling.

Sassafras also occurred in trays from all sites but was most abundant and well distributed on the site index 64 area—70,000 per acre with 73 percent frequency. Sassafras was also abundant on Area I site index 70, but its occurrence was considerably less than that in the trays from the Area II site index 64. Sassafras frequency was low in the trays from Area II, site index 70 and 80.

Red oak seedlings ranged from about 1,000 to more than 6,000 per acre on areas with site index 64 and 70. No red oaks were observed in the trays from the site index 80 area. Seedling frequency in trays from the site index 64 and 70 areas ranged from 3 to 5 percent. A heavy population of red squirrels, chipmunks, and other rodents was observed on both areas, and most of the uneaten acorns were observed to be weevil infested.

Sourwood abundance averaged between 36,000 and 74,000 seedlings per acre in the trays from site index 64, Area II and site index 70, Area I. Frequency ranged from 31 to 68 percent.

Other tree species that emerged in the trays were fire cherry, black locust, Fraser magnolia, red maple, sugar maple, and black cherry. Most of these were poorly distributed occurring in only a small percentage of the trays.

Semi-woody and shrub species

Of the nine shrub species identified in the flats, the most abundant was blackberry. Blackberry stems ranged from about 100,000 per acre to more than 200,000 per acre (Table 3). Frequency ranged from 73 to 88 percent of the trays. Blackberry was the most abundant in trays from the two site index 70 areas and least abundant in those from site index 64.

Wild grape was the second most abundant species in this class. The number of wild grape ranged from 5,000 to 100,000 seedlings per acre. Trays from the site index 64 area contained fewer wild grape seedlings than those from the site index 70 or 80 sites. Frequency ranged from 8 percent for trays from the site index 64 area to 61 percent for the trays from the higher site index areas.

Table 3.—Projected average number of shrub and semi-woody stems (thousand/acre)[a] and frequency[b] of occurrence in forest floor samples collected at four locations in West Virginia

Species	Area I		Area II					
	Site Index 70		Site Index 64		Site Index 70		Site Index 80	
	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
Striped maple	1	3	2	3	—	—	—	—
Devils-walkingstick	29	41	19	23	5	10	5	10
Blackberry	153	75	104	73	220	88	139	78
Wild grape	100	61	5	8	30	28	41	50
Flame azalea	—	—	14	23	3	8	—	—
Teaberry	—	—	88	13	—	—	—	—
Blueberry	—	—	12	3	—	—	—	—
Flowering dogwood	—	—	1	3	—	—	—	—
Total	283	—	245	—	258	—	185	—

[a] Rounded to nearest 1,000.
[b] Percentage of flats with at least one seedling.

Devils-walkingstick was abundant in the trays from the site index 64 and 70 (Area I) areas (Table 3). Frequency was 41 and 23 percent, respectively, for the two sites. On Area II, site index 70 and 80, there were fewer stems per acre and only 10 percent of the trays contained devils-walkingstick. Many of the other shrubs observed—teaberry, blueberry, azalea and flowering dogwood—were restricted to the site index 64 area. The most abundant was teaberry.

Herbaceous Species

Twenty-seven species of forbs, grasses, and ferns were identified in the flats. Sparse amounts of other grasses and sedges were not identified.

Species of violets were the most abundant and well distributed in the trays from the better sites (Table 4). Field estimates ranged from 34,000 to about 169,000 stems per acre. Violet frequency ranged from 39 to 80 percent in the trays from the site index 70 and 80 areas, compared to 20 percent in the trays from the area with site index 64.

Other common species that occurred on all sites were plantainleaf sedge, mountain spleenwort, pokeweed, and common cinquefoil. Knotweed occurred only in the trays from Area II, site index 64. Among the species occurring in trays from the two better sites in Area II were enchanters-nightshade, white snakeroot, two-leaved toothwort, Indian tobacco, wild stonecrop, cleavers, and wood nettle. There were more herbaceous species in Area I trays from site index 70 than there were from Area II samples, which also had an oak site index of 70.

Discussion

When forest stands in the Central Appalachians are disturbed by clearcutting, fire, or mechanical site preparation, rapid revegetation of the areas usually occurs (Kochenderfer and Wendel 1983; Wendel and Trimble 1968). Numerous observations on clearcut areas show that by the end of the second growing season site occupancy is usually attained. The potential for more than 800,000 stems per acre to become established in the first year as estimated from the observations in this study lends credence to the statement that "nature abhors a vacuum." In natural ecosystems that are scheduled to be managed, this can lead to problems. On the one hand, site stability is rapidly restored and on the other, an abundance of undesirable species often creates drastic and costly control procedures.

Table 4.—Projected average number of herbaceous plants (thousand/acre) and frequency[a] of occurrence in forest floor samples collected at four locations in West Virginia

Species	Area I		Area II					
	Site Index 70		Site Index 64		Site Index 70		Site Index 80	
	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
Plantainleaf sedge	47	39	1	3	13	20	14	23
Violet	34	31	6	20	169	80	87	70
Mountain spleenwort	33	56	11	40	6	33	4	15
Pokeweed	12	21	4	15	28	28	8	3
Common cinquefoil	10	12	12	15	17	15	5	3
Upright yellow wood sorrel	7	9	—	—	21	23	1	3
Deertongue grass	2	5	2	3	—	—	2	5
Fireweed	3	6	1	3	2	5	—	—
Woodnettle	—	—	—	—	140	75	57	40
Richweed	<1	1	—	—	24	5	—	—
Shield fern	8	5	—	—	—	—	—	—
Whorled loose strife	6	7	—	—	—	—	—	—
Wild yam	1	3	—	—	—	—	1	3
Enchanters-nightshade	—	—	—	—	2	5	1	3
White snakeroot	—	—	—	—	5	13	—	—
Two-leaved toothwort	—	—	—	—	1	3	19	10
Virginia avens	—	—	—	—	1	3	—	—
Indian tobacco	—	—	—	—	1	5	13	18
Wild stonecrop	—	—	—	—	25	25	1	3
Buttercup	—	—	—	—	2	5	—	—
Dodder	—	—	—	—	1	13	—	—
Cleavers	—	—	—	—	—	—	2	5
Trillium	—	—	—	—	—	—	3	8
Knotweed	—	—	2	3	—	—	—	—
Wild cranesbill	—	—	—	—	1	3	—	—
Total	164	—	39	—	459	—	218	—

[a] Percentage of flats with at least one seedling.

The important aspect is that ground cover is quickly established and that the loss in soil and nutrients is curtailed by plant roots and recycling of nutrients through the plants. Marks (1974) has emphasized the importance of early successional species such as fire cherry in accomplishing this. Similarly, the large number and wide distribution of sweet birch, yellow-poplar, blackberry, wild grape, and devils-walkingstick observed in the flats perform the same role in the natural environment. Sweet birch seedlings probably arose from seeds disseminated the previous winter, whereas much of the yellow-poplar, blackberry, wild grape, devils-walkingstick, arose from seed stored in the forest floor. Studies have shown that wild grape, yellow-poplar, black cherry, and sassafras seeds are known to retain their viability in the forest floor for several to many years (Clark and Boyce 1964; Wendel 1977, 1981).

Numerous grasses and forbs were identified in the flats. Some of these may have originated from seed stored for relatively long periods but this was not determined. Other species probably are biennials or perennials that are components of the spring or summer flora and originated from existing rootstocks.

The impact of herbaceous plants on tree reproduction in central Appalachian forests is not well understood. However, it has been shown in other areas that plant antagonisms exist between and among many species. With such a large and varied flora encountered in this study, there are undoubtedly some allelopathic relationships. Many studies in different areas support this contention (Horsley 1977; Fisher et al. 1978; Gabriel 1975; Tubbs 1973, 1976; Hook and Stubbs 1967).

The immediate effect of early and rapid natural revegetation of disturbed forest sites is site stabilization. Over the longer term, however, regeneration of forest stands may be delayed or seriously curtailed. A knowledge of the potential species mix for various sites and parent stand compositions can provide the forest manager with insight to this problem and highlight specific areas where preharvest treatment and research might be needed.

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List of Species Mentioned in this Paper

Tree Species

Common Name	Scientific Name
American basswood	*Tilia americana* L.
American beech	*Fagus grandifolia* Ehrh.
American chestnut	*Castanea dentata* (Marsh.) Borkh.
Black cherry	*Prunus serotina* Ehrh.
Black gum	*Nyssa sylvatica* Marsh.
Black locust	*Robinia pseudoacacia* L.
Chestnut oak	*Quercus prinus* L.
Cucumbertree	*Magnolia acuminata* L.
Downy serviceberry	*Amelanchier arborea* (Michx.f.) Fern.
Eastern hemlock	*Tsuga canadensis* (L.) Carr.
Eastern hophornbeam	*Ostrya virginiana* (Mill.) K.Koch
Fire cherry	*Prunus pensylvanica* L. f.
Flowering dogwood	*Cornus florida* L.
Fraser magnolia	*Magnolia fraseri* Walt.
Hickories	*Carya* sp. Nutt.
Red maple	*Acer rubrum* L.
Sugar maple	*Acer saccharum* Marsh.
Northern red oak	*Quercus rubra* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees
Scarlet oak	*Quercus coccinea* Muenchh.
Slippery elm	*Ulmus rubra* Muhl.
Sourwood	*Oxydendrum arboreum* (L.) DC.
Striped maple	*Acer pensylvanicum* L.
Sweet birch	*Betula lenta* L.
White ash	*Fraxinus americana* L.
White oak	*Quercus alba* L.
Yellow-poplar	*Liriodendron tulipifera* L.

Shrubs and Herbaceous Vegetation

Common Name	Scientific Name
Blackberry	*Rubus* sp.
Blueberry	*Vaccinium* spp. L.
Buttercup	*Ranunculus* L. spp.
Cleavers	*Galium Aparine* L.
Common cinquefoil	*Potentilla simplex* Michx.
Common dodder	*Cuscuta gronovii* Willd.
Deertongue grass	*Panicum clandestinum* L.
Devils-walkingstick	*Aralia spinosa* L.
Enchanters-nightshade	*Circaea quadrisulcata (Maxim.)* Franch. and Sav.
Fireweed	*Erechtites hieracifolia* L. Raf.
Flame azalea	*Rhododendron calendulaceum* (Michx.) Torr.
Indian tobacco	*Lobelia inflata* L.
Knotweed	*Polygonum* spp. L.
Mountain spleenwort	*Asplenium montanum* Willd.
Plantainleaf sedge	*Carex plantaginea* Lam.
Pokeweed	*Phytolacca americana* L.
Richweed	*Pilea pumila* (L.) Gray
Shield fern	*Dyropteris spinulosa* (O.F.Muell.) Watt
Teaberry	*Gaultheria procumbens* L.
Trillium	*Trillium* L. spp.
Two-leaved toothwort	*Dentaria diphylla* Michx.
Upright yellow wood sorrel	*Oxalis structa* L.
Violets	*Viola* spp. L.
Virginia avens	*Geum virginianum* L.
White snakeroot	*Eupatorium rugosum* Houtt.
Whorled loosestrife	*Lysimachia quadrifolia* L.
Wild cranesbill	*Geranium maculatum* L.
Wild grape	*Vitis* L. spp.
Wild stonecrop	*Sedum ternatum* Michx.
Wild yam	*Dioscorea villosa* L.
Woodnettles	*Laportea canadensis* (L.) Wedd.

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Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
- Berea, Kentucky, in cooperation with Berea College.
- Burlington, Vermont, in cooperation with the University of Vermont.
- Delaware, Ohio.
- Durham, New Hampshire, in cooperation with the University of New Hampshire.
- Hamden, Connecticut, in cooperation with Yale University.
- Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
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