

Tree Regeneration Response to Clearcutting on the USFS Brownstown Ranger District

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Introduction

In 1969 the United States Forest Service (USFS) Hoosier National Forest adopted even-aged silviculture using clearcut harvesting with natural regeneration as the forest management system for upland central hardwoods. This decision was based on over 20 years of research summarized in a handbook by Roach and Gingrich (8). They conclude that "upland hardwoods are best suited to even-aged silviculture" and "clearcutting should be used for regeneration." In recent years a number of forest managers have indicated that when upland central hardwood stands, which are oak (*Quercus* spp.) dominated, are clearcut they regenerate primarily to non-oak species, particularly on the better sites.

Only recently have researchers in Indiana and Ohio begun to examine clearcuts and quantify the situation. Hilt (5) studied 29 clearcuts (18 in southeastern Ohio, 7 in eastern Kentucky and 4 in south central Indiana) ranging from 5 to 26 years of age and found that only on the poorer sites is oak successfully regenerating. On the better sites mixtures of yellow-poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), bigtooth aspen (*Populus grandidentata*) and white ash (*Fraxinus americana*) are dominating. Heiligmann, et. al. (4) found in a study of 28-year-old reproduction on clearcuts in southeastern Ohio that the proportion of oak regeneration was significantly lower than the oak composition of the original stand. Many of Indiana's professional foresters suggest that similar results would be found for Indiana clearcuts.

The objectives of this study were: 1) to determine the tree and vine regeneration response to clearcut harvesting on the USFS Hoosier National Forest, Brownstown Ranger District, and 2) compare species composition on these clearcuts to the original stand composition (sawtimber volume) and site quality.

Study Sites

Clearcuts of mature, upland hardwood stands made prior to 1982 in the Pleasant Run and Lost River Management Units of the USFS Brownstown Ranger District were identified from office records. Those clearcuts with complete records that included age, acreage, cut volume by species group, and location were selected for field study and are listed in Table 1. Data on advance regeneration before clearcutting was not available.

Figure 1 shows the location of the Pleasant Run and Lost River Units of the Brownstown Ranger District. The summary by Homoya, et. al. (6) on the natural regions of Indiana clearly delineates the similarities and differences between the features of these units.

The Pleasant Run Unit is located in the Highland Rim Natural Region, Brown County Hills Section - 10B. This section features deeply dissected uplands underlain by siltstone, shale and sandstone. It is in Indiana Soil Region 11 and is characterized by well drained acid silt loam soils of the Berks-Gilpin-Weikert Association (7). The Weikert soil series is the shallowest soil in the region. The characteristic forest vegetation on the uplands is oak-hickory with typical upper slopes having stands dominated by chestnut oak (*Q. prinus*) and greenbriar (*Smilax* spp.). Ravines contain mesic species such as American beech (*Fagus grandifolia*), red oak (*Q. rubra*), sugar maple (*Acer saccharum*) and white ash.

The Lost River Unit lies within the Shawnee Hills Natural Region, Crawford Upland

TABLE 1. Percent species composition by harvest sawlog volume for sampled clearcuts on the Pleasant Run and Lost River units of the USFS Brownstown Ranger District.

Clearcut Name	and	No.	Age	Percent Sawlog Volume					
				White Oak	R & B Oak	Other Oak	Yellow-poplar	Ash & Other	Mixed Hdwd
<u>Pleasant Run Unit</u>									
Knob Creek		1	15	5	9	16	2	0	69
Henderson Creek		1	14	14	22	3	9	0	52
Henderson Creek		2	14	19	41	20	6	0	14
Cope Hollow		1	12	35	28	6	5	0	26
Jackie Branch		2	12	40	29	5	5	0	22
Moore Hollow		1	12	9	5	7	22	0	57
Jackie Branch		1	12	24	40	27	3	0	6
Cope Hollow		2	11	33	35	16	5	0	12
Kurtz Road		1	11	36	40	1	0	0	24
South Hickory Ridge		3	11	13	18	34	4	0	30
Berry Ridge		1	10	29	21	40	1	0	10
Berry Ridge		2	10	6	20	11	9	0	53
South Hickory Ridge		2	9	7	23	49	7	0	15
Ponderosa Camp		2	8	11	24	58	0	0	8
Skin Ridge		1	8	18	5	5	16	0	57
Berry Ridge		3	7	24	34	27	10	1	5
Berry Ridge		2	7	10	24	21	26	1	18
Berry Ridge		1	7	14	36	16	10	5	19
Hillenburg Cemetery		1	7	37	24	12	1	1	26
South Hickory Ridge		1	7	14	9	44	12	0	21
Wt. Average*				19	23	22	8	0	29
<u>Lost River Unit</u>									
Union Cemetery		1	16	16	20	0	18	0	45
Union Cemetery		2	15	27	23	1	10	1	38
Union Cemetery		4	15	17	20	4	10	1	48
Union Cemetery		3	15	40	33	1	14	0	12
Beaver Creek		1	14	19	28	14	0	0	40
Pleasant View		2	14	16	8	0	16	0	61
Beaver Creek		3	14	21	29	2	19	1	29
Beaver Creek		2	14	30	14	4	5	3	45
Pleasant View		3	14	15	22	5	11	0	48
Carpenter Tract		3	13	11	23	2	15	0	49
Shirley Creek		1	10	34	20	4	9	0	33
Bonds Chapel		1	7	15	48	0	13	1	24
Bonds Chapel		2	7	35	21	0	6	0	37
Georgia Tract		1	7	18	14	1	7	6	54
Georgia Tract		2	7	13	19	2	41	6	20
Yenne Tract		3	6	7	22	2	30	4	36
Sulphur Creek		1	6	25	40	0	11	0	25
Wt. Average*				20	23	2	14	2	39

* Based on acreage

Section - 9A. This section features rugged hills with sandstone cliffs and rockhouses. The characteristic soils of this section are well drained acid silt loams of the Wellston-Zanesville-Berks Association. They are moderately deep to deep and are in Indiana Soil Region 11 (7). The characteristic forest vegetation on the upper slopes is an oak-hickory assortment with black (*Q. velutina*), white (*Q. alba*), chestnut and scarlet oak (*Q. coccinea*), and assorted hickories (*Carya* spp.). The cove forests most resemble the mixed

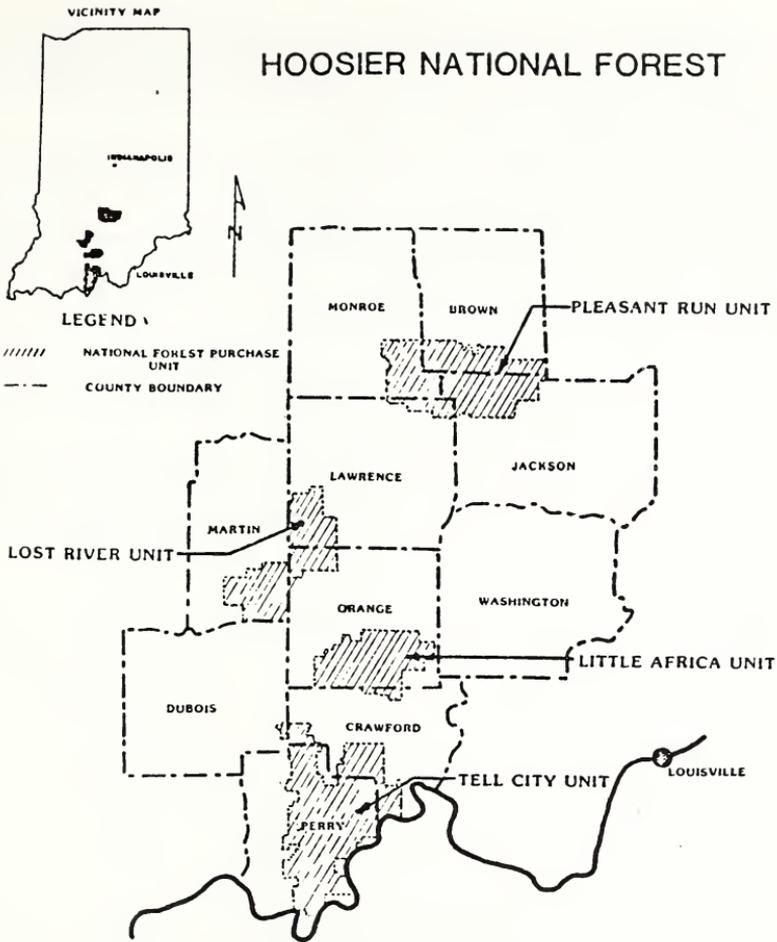


FIGURE 1. Location of the management units on the USFS Hoosier National Forest.

mesophytic type with characteristic species being American beech, yellow-poplar, red oak, sugar maple, black walnut (*Juglans nigra*) and white ash.

Based on these descriptions of the two units it can be concluded that the Pleasant Run Unit is located on drier sites than the Lost River Unit, and this is reflected in the different composition of tree species that dominate the two units.

Methods

Data Collection

Sampling on each clearcut was done using 1/100-acre circular plots with each plot center permanently marked with a 16-inch orange plastic surveyor's stake. A three chain, square grid systematic sampling system was chosen to obtain approximately a one percent minimum sampling intensity per clearcut. Sampling commenced using a random start for each clearcut. Plots overlapping the edge of the clearcut were not sampled.

Clearcut size ranged from 10 to 43 acres and averaged 22 acres for the 37 sampled clearcuts. Sample intensity averaged 1.2 percent and varied from 0.9 to 1.9 percent. For the Pleasant Run Unit 20 clearcuts, totaling 404 acres and 477 plots were sampled. The Lost River Unit sample was 17 clearcuts, totaling 418 acres and 502 plots. All data were collected between July 1986 and October 1986.

On each plot regeneration, wild grapevine (*Vitis* spp.) and site factor data were collected. All regeneration greater than breast height (4.5 feet) were sampled. Residual trees left from the previous forest were recorded separately. Each woody plant was recorded by species, crown position (dominant, codominant or suppressed) and origin (seedling, seedling sprout or stump sprout). Codominant trees were classified as trees whose crowns were part of the main canopy, while dominants were classified as trees with crowns above the main canopy and suppressed trees were classified as individuals with crowns below the canopy.

A tally of the number of wild grapevines in the main canopy on each regeneration plot was recorded. A grapevine was tallied if it was rooted within the plot and then directly entered the crown of a tree in the plot (10).

On each plot the aspect and slope position code were determined. Aspect was expressed in degrees of azimuth measured clockwise from true north to the nearest 10 degrees. Slope position code was determined for each plot using the system developed by Bowersox and Ward (2), which is based on slope curvature and shown in Figure 2.

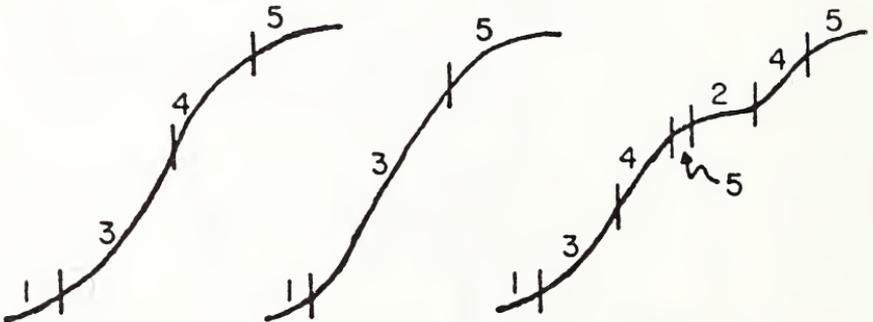


FIGURE 2. From Bowersox and Ward, 1972: Slope position code numbers for typical topography of the ridge and valley region of Pennsylvania.

Analysis

For analysis purposes, data from the clearcuts were summarized within each of the two USFS management units as shown in Table 1. The data were not combined because each of the management units was located in different and distinct Indiana natural region. Only the stems of tree species in the dominant and codominant crown classes on each 1/100-acre plot were used in the analysis. Non-commercial tree species such as American hornbeam (*Carpinus caroliniana*), serviceberry (*Amelanchier arborea*), redbud (*Cercis canadensis*), devils-walking-stick (*Aralia spinosa*), dogwoods (*Cornus* spp.), hawthorns (*Crataegus* spp.), eastern hophornbeam (*Ostrya virginiana*), sumac (*Rhus* spp.), pawpaw (*Asimina triloba*) and miscellaneous shrubs were also excluded. The dominant-codominant commercial tree species data consisted of 7,778 stems (total stems recorded = 20,472) on the Pleasant Run Unit and 8,641 stems (total = 23,637) on the Lost River Unit.

To analyze species composition the dominant-codominant tree species were divided into 6 species groups consisting of: 1) white oak (white and chinkapin oak (*Q. muehlenbergii*)); 2) red and black oak; 3) other oak (chestnut, scarlet, pin (*Q. palustris*))

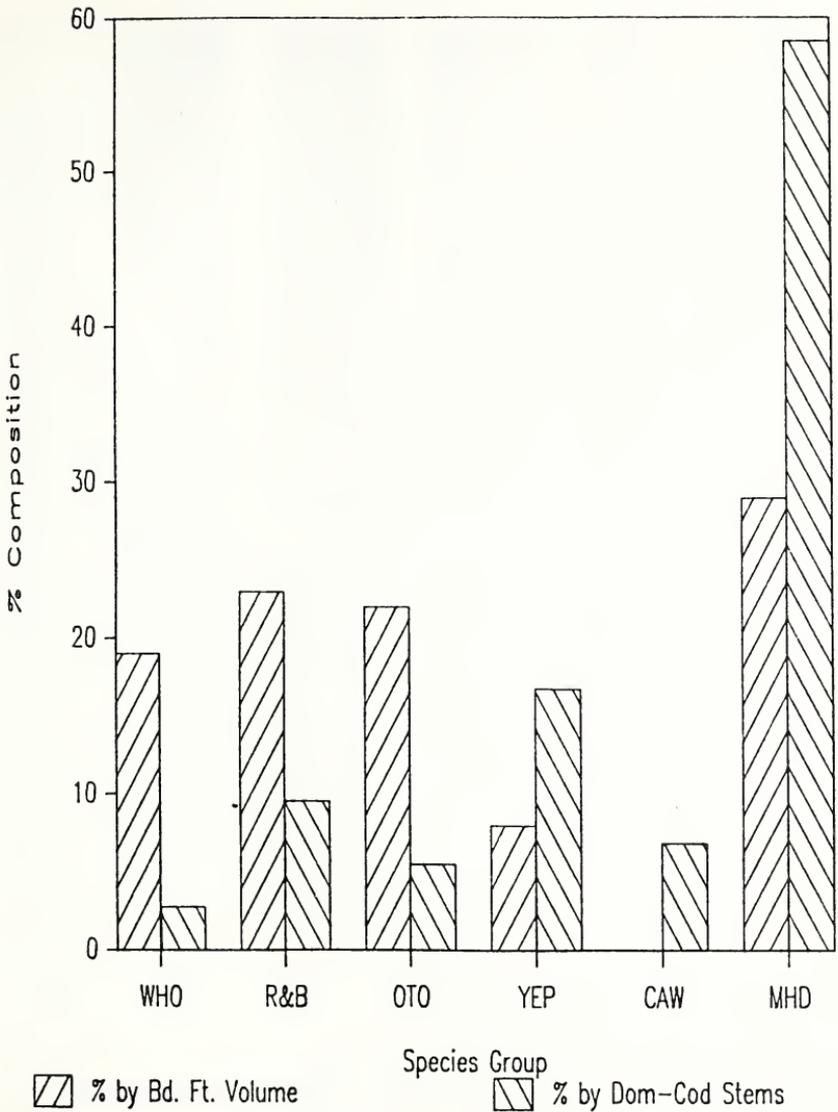


FIGURE 3. Comparison of percent species composition by preharvest sawtimber volume to dominant-codominant regeneration on the Pleasant Run Unit of the USFS Brownstown Ranger District.

and post (*Q. stellata*); 4) yellow-poplar; 5) cherry-ash-walnut (black cherry (*Prunus serotina*), ash and black walnut); and 6) mixed hardwoods (primarily bigtooth aspen, American beech, red elm (*Ulmus rubra*), hickories, red and sugar maple, and sassafras (*Sassafras albidum*). Since the number of regeneration stems per acre is a function of stand age and site quality, percentages were used to analyze species composition. The weighted average of the dominant-codominant stems was determined for each of the six species groups and expressed as a percent (Figures 3-8).

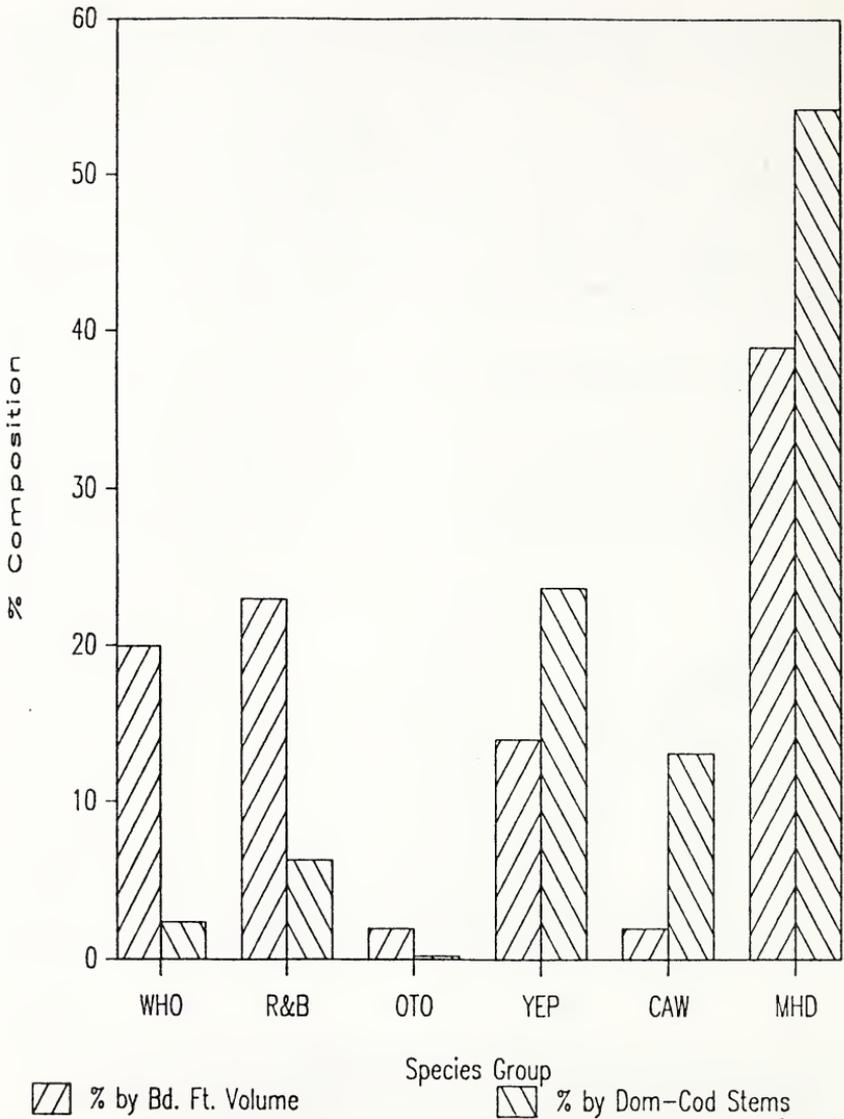


FIGURE 4. Comparison of percent species composition by preharvest sawtimber volume to dominant-codominant regeneration on the Lost River Unit of the USFS Brownstown Ranger District.

Timber sale records for each clearcut were summarized for sawtimber volume (board feet) and the percent volume by species group was calculated. These percentages are shown in Table 1.

For the analysis the aspect for each plot was reduced to a 1 to 5 scale using a modification of Beers et al. (1) aspect transformation procedure:

$$A' = (\text{COS } (45 - A) + 1) \times 2 + 1$$

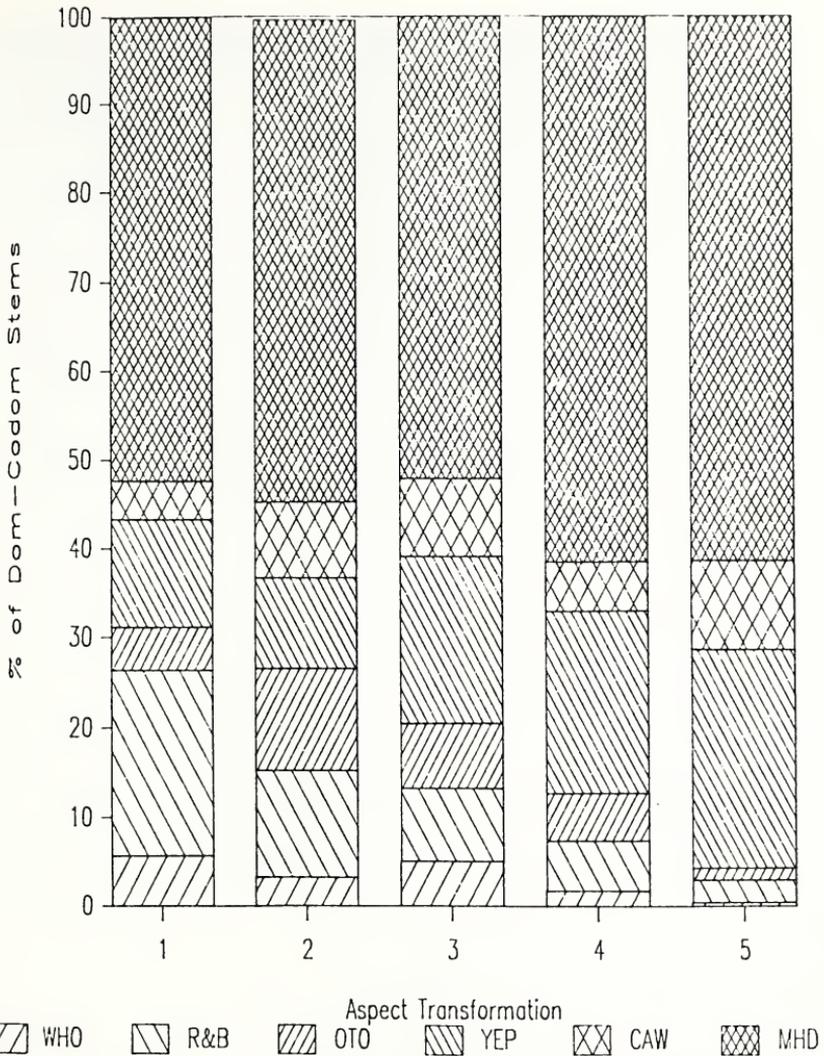


FIGURE 5. Percent species composition by aspect code for dominant-codominant regeneration on the Pleasant Run Unit of the USFS Brownstown Ranger District.

where A' = aspect code, COS = cosine, and A is aspect in degrees of azimuth

After transformation an azimuth of 190 to 260 has an aspect code (A') of 1, an azimuth of 150 to 180 or 270 to 300, has an aspect code 2, an azimuth of 130 to 140 or 310 to 320 has an aspect code 3, an azimuth of 90 to 120 or 330 to 0 has an aspect code 4 and an azimuth of 10 to 80 has an aspect code 5. This transformation is reasonable because forest growth is usually considered to be greater on northern and eastern slopes. Several studies in the oak-hickory type support this concept (3).

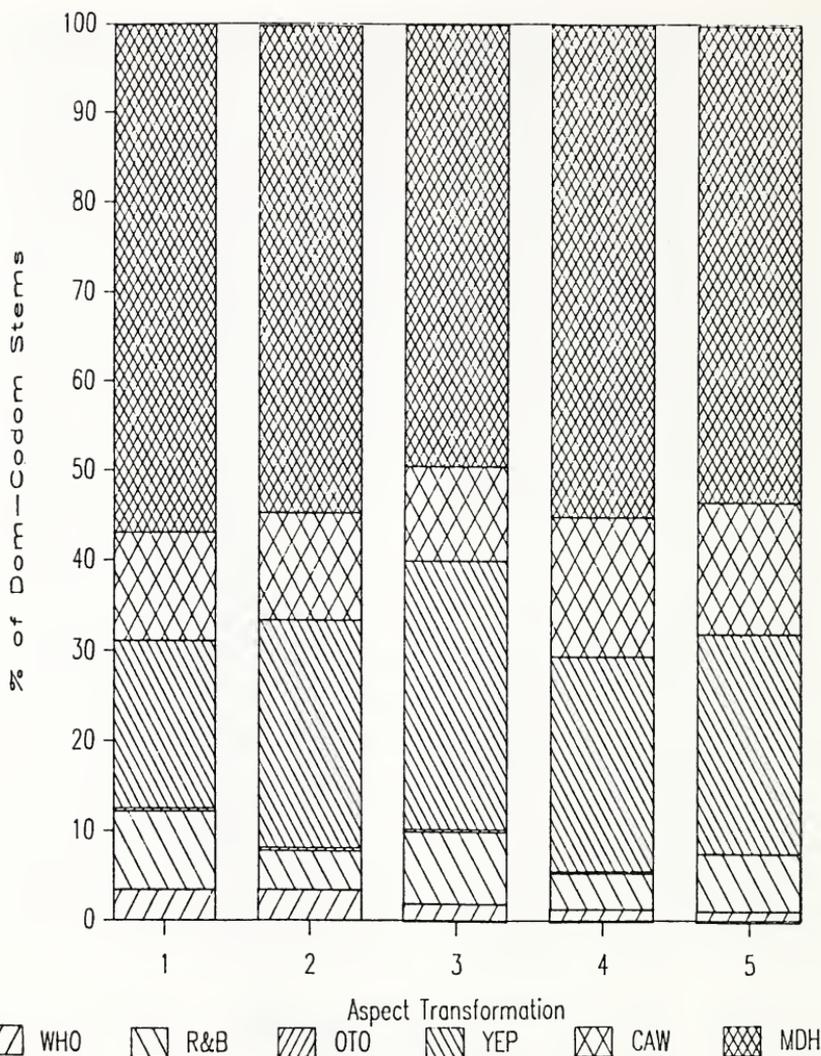


FIGURE 6. Percent species composition by aspect code for dominant-codominant regeneration on the Lost River Unit of the USFS Brownstown Ranger District.

Results and Discussion

The number of stems per acre in the dominant and codominant crown classes for tree species ranged from 628 (12 years old clearcut) to 2031 (7 year old clearcut) for the Pleasant Run Unit and from 494 (14 year old clearcut) to 2566 (7 year old clearcut) for the Lost River Unit. The average clearcut age and number of dominant-codominant stems per acre for each unit was 10 years and 1144 stems for Pleasant Run, and 11 years and 1480 stems for Lost River. These averages are comparable to those found by Hilt (5). Also, as expected the number of dominant-codominant stems decreased as age increased.

A comparison of the percent species composition before clearcutting (sawtimber

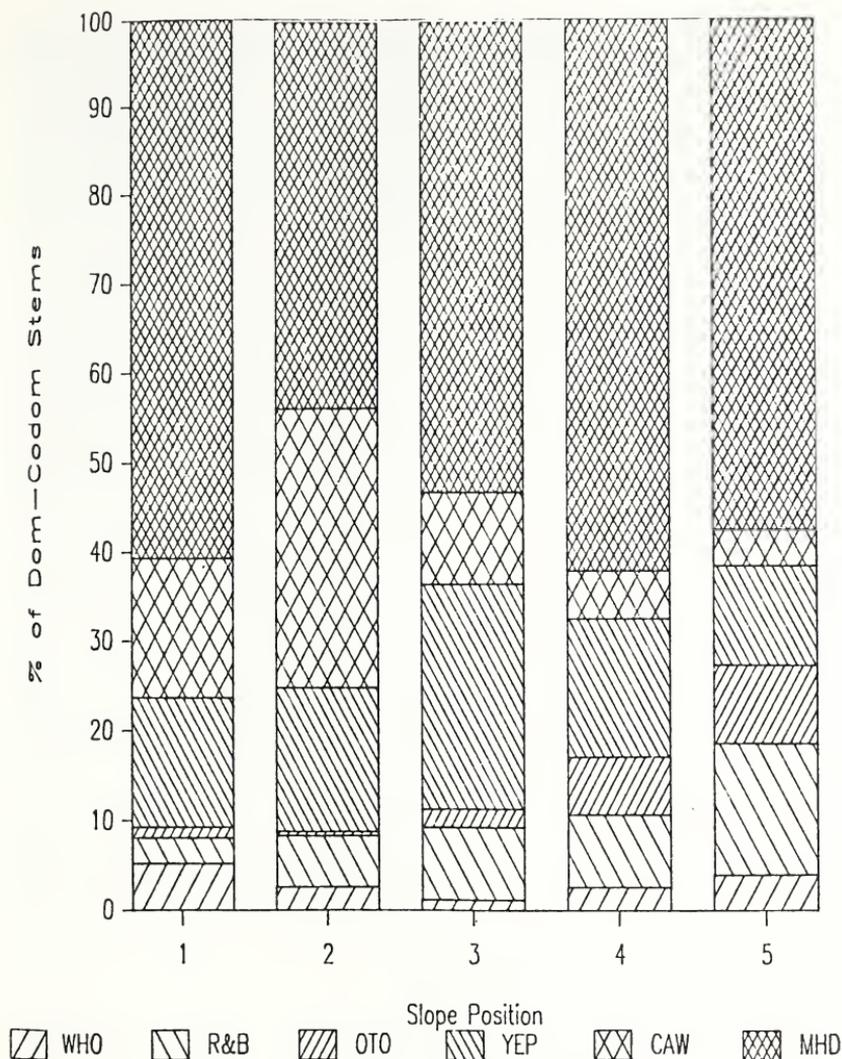


FIGURE 7. Percent species composition by slope position code for dominant-codominant regeneration on the Pleasant Run Unit of the USFS Brownstown Ranger District.

volume) and after clearcutting (dominant-codominant stems) is shown in Figures 3 and 4 for the two units. In both units the percentage of white oak (WHO), red and black oak (R&B) and other oak (OTO) is much lower in the regeneration layer, and the yellow-poplar (YEP), black cherry, ash and black walnut (CAW), and mixed hardwoods (MHD) are much higher. There is a higher percentage of other oak, primarily chestnut oak, in the Pleasant Run Unit both before and after clearcutting.

Figures 5 and 6 show the percent species composition for the regeneration on the two management units by aspect code. The trend of decreasing amounts of total oak (WHO + R&B + OTO) with aspect changing from southwest (aspect code 1) to north-

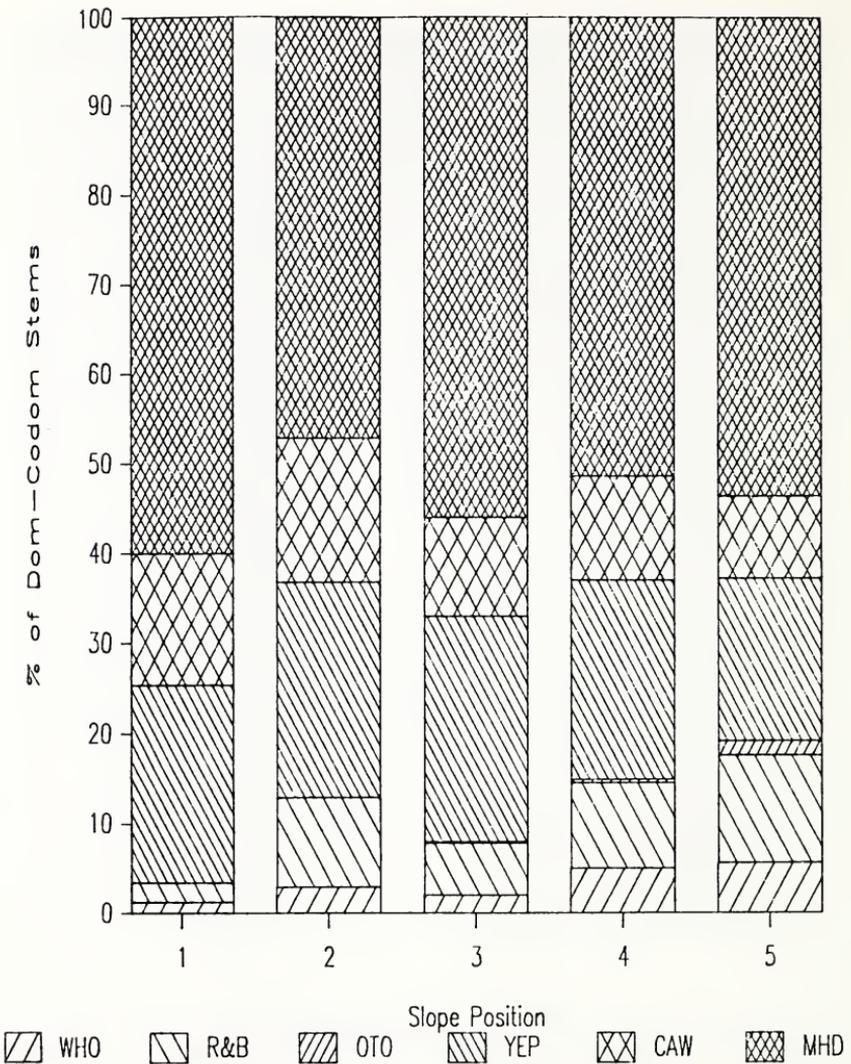


FIGURE 8. Percent species composition by slope position code for dominant-codominant regeneration on the Lost River Unit of the USFS Brownstown Ranger District.

east (aspect code 5) is evident on the Pleasant Run Unit (Figure 5). The Lost River Unit has lower percentages of oak and higher percentages of yellow-poplar and cherry-ash-walnut than the Pleasant Run Unit for all aspect codes (Figure 6). The percentage of oak is highest on aspect code 1, while the percentage of yellow-poplar plus cherry-ash-walnut is lowest on aspect code 1 for both units (Figures 5 and 6). The percentages of mixed hardwoods ranges from 50 to 60+ percent on all aspect codes for both units. Other oaks, primarily chestnut oak, was absent in aspect code 5, the best site in terms of aspect, on the Lost River Unit (Figure 6).

Figures 7 and 8 show the percent species composition for the regeneration on the two management units by slope position. The trends for oak regeneration are again more pronounced for the Pleasant Run Unit with the oak composition increasing from the lower slopes, position 1, to ridge tops, position 5, (Figure 7). For the Lost River Unit other oaks are only evident on slope positions greater than 2 (Figure 8). Yellow-poplar percentages were lowest on slope position 5 for both units, but appreciable on all slope positions. For both units, slope position 2 (benches, which should have more moisture), appears to have a different species composition than all other slope positions. The percentage of cherry-ash-walnut is greatest on this slope position and the mixed hardwood percentage is lowest.

In a similar study, Hilt (5) found that for clearcuts 6 to 15 years of age (the age range of this study) that the percentage of oak regeneration in the dominant-codominant class was fairly consistent (22-31 percent) regardless of site. We found lower percentages of oak than Hilt and a difference between the two management units with an average of 19 percent oak for Pleasant Run and 8 percent oak for Lost River. However, Hilt only selected clearcuts composed of at least 60 percent upland oaks (by volume) prior to harvest while our study sites contained much less preharvest oak volume, averaging 64 percent oak by sawtimber volume for Pleasant Run and only 45 percent for Lost River (Table 1).

Finally, we found that wild grapevines were a major vegetation component of the regeneration, and actually dominated a number of plots and a few clearcuts. The number of grapevines averaged 336 per acre for Pleasant Run and 530 per acre for Lost River. Averages per clearcut ranged from 148 to 1068 grapevines per acre for Pleasant Run and 174 to 988 per acre for Lost River. No preharvest grapevine control was done in any of these clearcuts. Standiford and Fischer (10) found that 12-15 years following patch clearcutting of upland hardwoods stands at the Southern Indiana Purdue Agricultural Center, in Dubois County, Indiana, grapevines averaged 236 per acre. These stands were similar in stocking and treatment to those in this study. To our knowledge, no other grapevine data exists for clearcut sites in Indiana.

Smith and Lamson (9) have summarized research on wild grapevines in immature Appalachian hardwoods. In sapling stands (average diameter at breast height less than 5 inches) managed for timber production they suggest that "50 grapevines per acre is the most that they would want." For sapling stands they estimate that 300 grapevines per acre would represent 25 percent of the stand area occupied by grapevines, and 500 grapevines represents 40 percent coverage. We found that the range of 150 to 1050 grapevines per acre would represent 14 to 82 percent of the stand area according to these authors.

Conclusions

Clearcuts made 6 to 16 years ago on the Brownstown Ranger District are regenerating to mixed species stands. The species composition of the dominant-codominant regeneration layer appears to be influenced by natural region with the drier sites of the Pleasant Run Unit (Highland Rim Natural Region - Brown County Hills Section) regenerating more to oak species than those on the Lost River Unit (Shawnee Hills Natural Region - Crawford Upland Section). The harvested sawtimber volumes from these units reflects a similar difference with higher percentages of oak on the Pleasant Run Unit.

Sites with northeastern aspects or a lower slope position (better sites) have lower percentages of oak and higher percentages of yellow-poplar and cherry-ash-walnut than southwest facing sites or a upper slope/ridge slope positions. Wild grapevines are regenerating in larger numbers on all clearcuts and may present a timber management problem.

Acknowledgments

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