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WHAT HAPPENS TO LIVING CULL TREES LEFT AFTER HEAVY CUTTING IN MIXED HARDWOOD STANDS?

In the Appalachian Mountains, the logging operator usually cuts only those trees that he thinks will yield a profit, and leaves the trees that appear to be unprofitable. Generally these unprofitable trees are either below merchantable size or are culls[1]—trees of merchantable size that contain too little sound material to justify harvesting costs.

In stands that have been burned badly or have suffered repeated high-grading in the past, a large number of the stems may be culls. After logging in such stands, these defective trees threaten the new stand with serious competition. How valid is this threat? What happens to these culls after logging? Do they thrive and develop? Do they merely hang on? Or do they die out? Forest managers in the Appalachian Region would like to have answers to these questions to help determine which culls to kill, and when.

An opportunity to learn something about cull-tree behavior was recently provided by records taken on several commercially clearcut areas on the Fernow Experimental Forest near Parsons, West Virginia, as part of an overall study of management systems for Appalachian hardwoods. Analysis of these records did not provide a complete set of answers on cull-tree behavior, but it did help to define some trends and point up some research needs.

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[1] The definition of a cull as used in this study is as follows: any tree 5 to 11 inches d.b.h. that does not have a sound 12-foot section to a 4-inch top inside bark, or, in case the tree is too small to contain 12 feet to a 4-inch top, does not have a potentially sound 12-foot section; any tree over 11 inches d.b.h. (sawtimber tree) that does not scale at least 50 percent sound to an 8-inch top inside bark or does not contain a 16-foot log of sound merchantable material. In addition to rot, sweep or extreme roughness can make a tree a cull.

Our interest in the development of residual culls arose when we observed that many culls died after heavy cutting. It had been the general belief that the opposite might be true: that after heavy release most culls would gain in vigor or at least would persist a long time and would compete with the new stand. These casual observations of heavy mortality among culls led us to attempt a closer evaluation of what was happening.

The Study

The study areas were four compartment-sized units and one 5-acre plot (table 1). These areas, in fact the whole Fernow Forest, were covered by virgin hardwoods until the first logging was done about 1905. Then, between 1949 and 1958, commercial clearcuttings were made; the stands at the time consisted of second-growth Appalachian hardwoods with a heavy admixture of scattered old growth left from the original logging. Volumes per acre in merchantable sawlog-size trees ranged from about 5,000 to 15,000 board feet and averaged 10,000.

The species included the oaks (mostly red, chestnut, and white), sugar maple and red maple, beech, yellow-poplar, black cherry, several hickories, white ash, basswood, sweet birch and a scattering of yellow birch, and a number of minor species typical of Appalachian mountain hardwoods.

The purpose of the cutting was to remove all merchantable trees down to 5.0 inches d.b.h. This objective was more nearly met on some areas than on others (table 1). Cull trees were left intentionally. Logging was done with a crawler tractor and sulky. Trees were winched to main skidroads and skidded tree-length to the deck for bucking.

Immediately after or 5 years after the commercial clearcuttings (table 1), 100-percent inventories were made of the residual stands—stem tallies by d.b.h. class and species for three categories of trees: merchantable, cull, and dead. Cull trees were not permanently marked during the inventories taken immediately after logging; however, they were scribed at the 5- and 10-year cruises. These periodic remeasurements, which revealed changes in numbers of living culls, provided a fairly good indication of cull behavior although more precise information could have been obtained if all individual cull trees had been identified immediately after logging.

Two areas—14-A and 14-B—offered better study opportunities than the other areas because: (1) three periodic inventories were available, immediately after logging and 5 and 10 years later; and (2) fewer merchantable trees were left per acre as a source of new culls to distort the record (table 1).

Table 1.—*The cull-tree study areas*

Area	Size	Site index for oak	Tally period	Culls[1] left after logging		Merchantable trees[1] left after logging	
				Total	Per acre	Total	Per acre
	Acres	*Feet*	*Years*	*No.*	*No.*	*No.*	*No.*
14-A	11.15	77	0, 5, 10	34	3.0	81	7.3
14-B	15.87	67	0, 5, 10	121	7.6	239	15.1
1-A	51.86	75	0, 5	663	12.8	1188	22.9
1-B	22.58	64	0, 5	478	21.2	784	34.7
Plot A	5.0	78	5, 10	(2)	(2)	—	—

[1] Trees over 5.0 inches d.b.h.
[2] The first after-logging cull tally here was made 5 years after logging.

Results

Area 14-A.—The number of culls in all size classes decreased (table 2). Of 6 culls larger than 21 inches d.b.h. on the area immediately after logging, 5 were left at both the 5- and 10-year tallies. Of 27 culls over 11 inches d.b.h., the number dropped to 18 at 5 years and 12 at 10 years. Of 31 culls over 7 inches d.b.h., 20 were left at 5 years and 13 at 10 years. The 6-inch culls were not included because many small culls that were below this size at the time of logging grew up into the 6-inch class during the inventory periods.

Area 14-B.—Cull behavior on this area was much like that on Area 14-A (table 2). The 12 culls over 21 inches d.b.h. that were present immediately after logging declined to 9 at both the 5- and 10-year remeasurements. Of 76 culls over 11 inches d.b.h., the number dropped to 54 at 5 years and to 45 at 10 years. Of 110 culls over 7 inches d.b.h., 66 remained at 5 years and 63 at 10 years.

From these results on these two areas, two important relationships become apparent:

- After heavy cutting, a higher proportion of small culls than of large culls died over the 5- and 10-year periods.

- Losses of cull trees were generally greater during the first 5 years after logging. For trees over 21 inches d.b.h., losses during the first 5-year period equaled those over the entire 10-year period; no additional losses occurred during the second 5-year period. For trees over 11 or 7 inches, losses were greater during the first 5 years than during the second 5 years.

Actual mortality of cull trees might have been somewhat greater than the losses shown (table 2) because a few trees that were classified as merchantable immediately after cutting may have deteriorated later into culls—most likely because of rot development resulting from logging damage.

Plot A.—The cull record on this 5-acre area is complete only for the 5- and 10-year after-logging remeasurements; culls were not tallied immediately after logging. Between the 5- and 10-year periods the number of culls over 21 inches d.b.h. remained at 2; the number over 11 inches d.b.h. declined from 13 to 9; and the number over 7 inches d.b.h. dropped from 26 to 13.

Areas 1-A and 1-B combined.—The 5-year tally on these two areas showed a large number of culls. There were 627 culls over 7 inches d.b.h. compared to 594 immediately after logging. This appeared strange in view of the fact that a number of culls had died during the 5-year period (fig. 1). The explanation apparently is that out of the large number of residual merchantable trees left after logging (table 1), many deteriorated and became culls. This situation prevented any valid quantitative analysis of what happened to the culls after these two areas were logged.

Discussion

A surprisingly large proportion of cull trees died in the period after logging, more in the first 5 years than in the next 5 years. For the two areas for which reliable figures are available (14-A and 14-B combined),

Table 2.—***Change in number of cull trees after logging: Areas 14-A and 14-B***

D.b.h. size class (inches)	Cull trees, years after logging			Change in proportion of culls after 5 years		Change in proportion of culls after 10 years	
	0	5	10				
	No.	*No.*	*No.*	*No.*	*%*	*No.*	*%*
				AREA 14-A			
21	6	5	5	—1	—17	—1	—17
11	27	18	12	—9	—33	—15	—56
7	31	20	13	—11	—35	—18	—58
				AREA 14-B			
21	12	9	9	—3	—25	—3	—25
11	76	54	45	—22	—29	—31	—41
7	110	66	63	—44	—40	—47	—43

Figure 1.—A 15-inch beech that died shortly after logging. This was one of the culls left in Area 1-A.

39 percent of the culls over 7 inches d.b.h. died within 5 years, and 46 percent were dead within 10 years. These heavy losses shortly after logging indicate that the shock of sudden exposure may have been an important factor contributing to cull mortality.

Mortality among small culls was much higher than among large culls. This too indicates that the shock of sudden exposure contributed to cull mortality. The smaller stems had been subordinate trees of low vigor, with a large proportion of shade leaves in their crowns. The larger culls were more vigorous, with a larger proportion of their leaves accustomed to exposure to sunlight. (A large part of the mortality among the big culls was due to windthrow.)

Left unanswered by this study are a number of pertinent questions such as:

- What are the differences among species in the survival pattern of culls? Too few stems by diameter classes were available to permit valid species comparisons.
- Are there characteristics of cull trees—such as vigor class, size, and type of defect—that can be identified and used to predict the probability of survival or the length of time that a cull may survive?
- What is the relationship between residual stand density after logging and cull behavior?

Yet the study provides some useful information for the forester engaged in stand improvement. On the basis of this research, it seems reasonable to recommend that large culls be killed before, during, or immediately after logging—whichever time is most feasible—since few of them will die soon after logging, and few large culls will be destroyed during logging.

For small culls it might be desirable for two reasons to wait 5 years or so before killing them: (1) fewer residual cull stems will need to be killed, because as many as 40 percent may die in the first 5 years after logging, and (2) many additional small trees damaged in logging will have developed toward being culls that obviously need to be removed at the end of 5 years.

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