EARLY
CROP-TREE RELEASE
in even-aged stands of Appalachian hardwoods

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GUIDELINES NEEDED

NOW THAT EVEN-AGED silviculture is well established as a successful method of growing Appalachian hardwoods, a pressing need exists for guidelines for precommercial operations.

We started research several years ago on the Fernow Experimental Forest near Parsons, West Virginia, to learn more about the cost and methodology of early crop-tree release in mountain hardwood stands. In addition, we designed studies to evaluate the biological response of stands and stems to various treatments or combinations of treatments to get some measure of their response in the framework of a practical type of operation.

In our study, selected crop trees were released at an early age from the competition of surrounding woody stems. In addition, grapevines were cut out of the crop trees. The objective was to improve the species composition of the final stand, favor stems of superior quality, and shorten the rotation by giving the crop trees more space to grow. The success of this operation will eventually be determined by an evaluation of the biological response of the crop trees weighed against the cost of the operation.

In this paper, we are reporting on costs and methodology and discussing the factors to be considered in carrying out this operation; we have only 2-year measurement data on the biological response to our treatments. However, competition within these young stands is intense; and release of crop trees in such cases has generally proved beneficial (*Downs 1942; Conover and Ralston 1959; Williams 1964; Allen and Marquis 1970*).

PROCEDURES AND RESULTS

Our research gave us considerable information that should be useful to foresters who contemplate doing crop-tree release work. The fact that the study areas covered a total of 88 acres adds significance to the applicability of the results. A number of factors should be considered in planning this type of work, and the forester should ask himself these questions before proceeding:

- At what age—or at what stage of stand development—should a crop-tree release be made?
- How many crop trees per acre should be selected?
- What type of trees should be selected—species, crown class, stem form?
- Who is qualified to select crop trees?; how should these trees be designated?
- What method should we use to release crop trees?; how heavy should be the release?
- What can we expect this operation to cost?

Timing of the Crop-Tree Release

We felt that crop trees could not satisfactorily be selected until the new stand had closed and crown dominance was expressed. In the six areas where we did crop-tree releases, dominance was satisfactorily expressed when the stands were 7 to 9 years old; three of the stands met the criterion at 7 years, one at 8 years, and two at 9 years (table 1). We released the crop trees immediately after this condition was met because we felt that the sooner we did the job, the greater was our opportunity to improve species composition and maintain rapid growth. In a similar operation at Bartlett, New Hampshire (*Blum and Filip 1962*), it proved feasible to select crop trees in 10-year-old stands of even-aged hardwoods.

Site index (for oak) in our areas ranged from 63 feet to 77 feet (table 1); we found no relationship, within the range of our data, between the time the stands closed and site quality. Perhaps the influence of other factors obscured it.

Table 1. — Basic data on the crop-tree release areas

Area number	Area	Oak site index	Age at time of release	Release trees per acre	Selecting and designating crop trees		Releasing crop trees	
					Time per acre	Trees per man-hour	Time per acre	Trees per man-hour
	Acres	*Feet*	*Years*	*No.*	*Man-hours*	*No.*	*Man-hours*	*No.*
				5-FOOT RADIUS RELEASE				
43	12.2	77	7	109	2.3	47	6.0	18.1
38	13.2	63	7	117	1.8	64	10.3	11.4
36	12.1	68	9	84	4.4	19	10.4	8.1
Total	37.5	—	—	—	—	—	—	—
Weighted average	12.5	—	—	104	2.8	44	8.9	12.5
				JUDGMENT RELEASE				
39	16.9	71	7	111	(1)	(1)	3.6	30.1
34	11.2	63	8	109	(1)	(1)	3.0	35.9
32	22.0	76	9	124	(1)	(1)	3.8	32.9
Total	50.1	—	—	—	—	—	—	—
Weighted average	16.7	—	—	116	—	—	3.6	32.6
Total weighted average	14.6	—	—	111	—	—	5.9	24.0

[1] Releaser designated trees; all time was included under release work.

Our observations lead us to believe that a high proportion of sprout growth favors early stand closure (area 38, table 1), while extremely heavy herbaceous cover (area 32, table 1) and high density of grapevines (area 36, table 1) hold back tree growth and slow up canopy closure. In area 36, grapevines had to be cut out of 60 percent of the crop trees!

Number of Released Trees Per Acre

We released crop trees on a spacing of about 20 x 20 feet, or about 109 stems per acre. (We found that maintaining a 20 x 20 spacing was not difficult; measuring between trees was not necessary.) This is many more trees than are needed for the final sawtimber crop; and enough, if the majority survive, to make up a high portion of the last thinning.

The number of trees actually released in the six areas varied from 84 to 124 per acre and averaged 111 (table 1). The area in which we picked only 84 trees was so densely occupied by grapevines that, in parts of it, we were hard put to find suitable stems to release.

Type of Trees Selected for Crop Trees

In the site index 80 areas, we found enough black cherry and yellow-poplar stems to select a preponderance of these two species (table 2). On the site index 70 areas, we also found these two species but were forced to pick more stems of other species, too—such as red oak and sugar maple. In the two areas of lowest site—site index 60 for oak—we released red oak, chestnut oak, and red maple stems in that order. In all site classes, the selected crop-tree stand had a more desirable species mixture than the unselected stand of dominant stems (table 3).

We favored seedlings and seedling sprouts but were obliged to select some stump sprouts (table 2, fig. 1, fig. 2).

We tried to select vigorous trees of good form; that is, those with healthy-looking crowns and unforked straight stems.

Table 2. — Crop trees by origin for the four most numerous species

Area	10-foot site index class (for oak)	Release trees by species and origin[1]							
		1		2		3		4	
		Seedling	Sprout	Seedling	Sprout	Seedling	Sprout	Seedling	Sprout
43	80	*Yellow-poplar*		*Black cherry*		*White ash*		*Sugar maple*	
No. stems/acre		59	0	38	0	7	0	2	0
Percent of total no.		55	0	35	0	6	0	2	0
32	80	*Yellow-poplar*		*Black cherry*		*Basswood*		*Sugar maple*	
No. stems/acre		42	0	31	0	9	18	9	0
Percent of total No.		35	0	25	0	7	15	7	0
39	70	*Yellow-poplar*		*Black cherry*		*Basswood*		*White ash*	
No. stems/acre		45	2	31	7	5	7	4	2
Percent of total No.		40	2	28	6	4	6	4	2
36	70	*Sugar maple*		*Yellow-poplar*		*Red oak*		*Black cherry*	
No. stems/acre		20	5	11	7	13	2	13	0
Percent of total No.		25	6	13	8	16	2	16	0
38	60	*Red oak*		*Chestnut oak*		*Red maple*		*Yellow-poplar*	
No. stems/acre		41	20	16	20	2	16	2	0
Percent of total No.		35	17	14	17	2	13	2	0
34	60	*Red oak*		*Chestnut oak*		*Red maple*		*White oak*	
No. stems/acre		29	13	13	14	9	18	5	2
Percent of total No.		27	12	12	13	8	16	5	2

[1] Seedlings include seedling sprouts: stems from stumps 2 inches and less in diameter.

Table 3. — Comparison of the four most numerous species between the crop-tree population and the dominant reproduction population of the areas

Area and population	Four most numerous species in numerical order			
	1	2	3	4
43				
Crop trees	Yellow-poplar	Black cherry	White ash	Sugar maple
Dominant reproduction	Sugar maple	Black cherry	Yellow-poplar	White ash
32				
Crop trees	Yellow-poplar	Black cherry	Basswood	Sugar maple
Dominant reproduction	Sweet birch	Sugar maple	Black cherry	White ash
39				
Crop trees	Yellow-poplar	Black cherry	Basswood	White ash
Dominant reproduction	Sugar maple	Yellow-poplar	Sweet birch	Black cherry
36				
Crop trees	Sugar maple	Yellow-poplar	Red oak	Black cherry
Dominant reproduction	Sugar maple	Sassafras	Yellow-poplar	Red maple
38				
Crop trees	Red oak	Chestnut oak	Red maple	Yellow-poplar
Dominant reproduction	Sassafras	Black gum	Chestnut oak	Red maple
34				
Crop trees	Red oak	Chestnut oak	Red maple	White oak
Dominant reproduction	Sassafras	Chestnut oak	Sweet birch	Red maple

Figure 1. — A released black cherry seedling sprout.

Figure 2. — A yellow-poplar stump sprout flagged to be released.

Crop-Tree Selection and Stem Designation

Foresters, well-trained technicians, and competent woodsmen all selected crop trees in the study areas. Our experience convinced us that, *with clear direction and some training*, any conscientious experienced woodsman can do the job. It seemed to us that the role of a forester in this type of work should be to set the guidelines on the ground at the start of each operation.

We picked crop trees in five of the six treated areas when the leaves were off; in the other area, we selected and designated crop trees when the stand was in foliage. We could see better without the leaves, and the work went faster; we probably did a better job of selecting crop trees, too.

We designated crop trees by tying a piece of plastic flagging to a branch or stem. Where we did separate operations of selecting and releasing crop trees, the man picking the tree tied the flagging on; and the release crew pulled it off after the stem was released. Tying the flagging on as he progressed kept the designator oriented and enabled him to maintain good spacing; removing it enabled the release crew to know where they had worked and move across the areas in orderly fashion. No other physical guides were necessary.

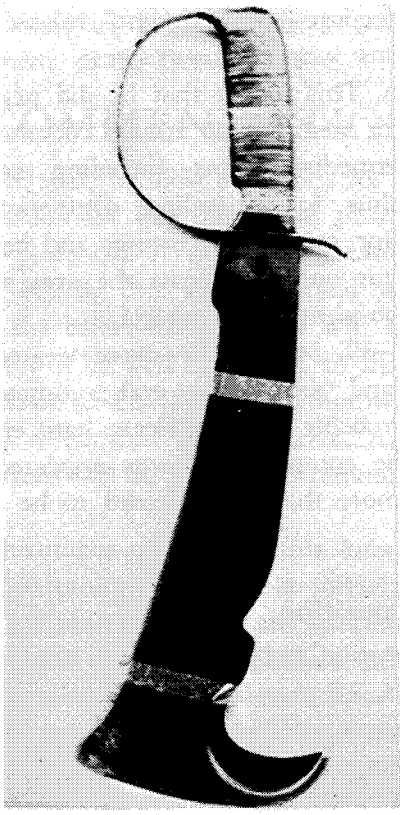
When the same man both designated and released crop trees, he tied a piece of flagging to the tree after release and left it there. In this way, he kept himself oriented.

Method of Release

In the beginning, we debated whether to use chemical or physical methods of release. We decided against the chemical (with the size stems involved, this would logically have been a basal spray job) for the following reasons: (1) We would have difficulty getting around in the thick briary young stands with spraying equipment and with refill supplies. (2) We reasoned that it would take a great quantity of spray to treat the hundreds of small stems per acre that were in competition with the crop trees, and in such stands it would require time-consuming care not to damage the crop trees in treating their competitors —all adding up to a really costly operation. (3) We could not hand-spray one or several stems in a group of stump sprouts to release a companion sprout without killing it—and stump sprouts represented 23 percent of our selected trees. And (4) in the dense young stands it appeared that we would run a risk of root grafts between treated stem and crop tree.

So we decided to cut the stems, and after some preliminary testing with ax, machete, and the Woodsman's Pal, chose the Woodsman's Pal as the preferred tool (fig. 3). The Sandvik bush ax was found satisfactory in a similar study in New Hampshire (*Blum and Filip 1962*). Most of the stems cut were between ½ inch and 3 inches d.b.h. The Woodsman's Pal served equally well in cutting these and in severing grapevines. It was heavy enough to girdle the few larger stems.

Figure 3. — The Woodsman's Pal.



In eliminating competing stems, we cut them at the most convenient height, following the suggestion of Jemison and Hepting (*1949*). We also followed their advice in selecting and releasing single stems of sprout clumps; that is, we chose low-origin sprouts from U-shaped clumps.

In the three areas where the trees were designated ahead of the release job (43, 38, and 36), a separate crew did the release work. Each man carried a 5-foot measuring stick which he used in determining the 5-foot release radius around each crop tree. Within this radius, he cut all the woody stems that were over half as tall as the crop tree; he also cut the grapevines out of each crop tree.

In the three areas where the same man both designated and

released crop trees at one time (areas 39, 34, and 32), we used a different procedure—a "judgment" release: the releaser cut only those stems whose crowns were encroaching upon the crop-tree crown. This meant that he did practically no cutting around dominant stems, some around codominant stems, and a lot around intermediate stems—including reaching out beyond the 5-foot radius for offending competitors. Overall, this method called for much less cutting; and because of this and the fact that only one trip across the area was necessary, the whole release job went faster (table 1).

These areas—39, 34, and 32—were treated during the dormant season; and because we underestimated the degree of crowding, we probably did not release hard enough; the following summer the competing crowns appeared to be crowding the crop tree more than had seemed to be the case the previous winter.

Cost of the Operation

Where designation and release were carried out as two separate operations, 2.8 man-hours per acre were required, on the average, for selecting and designating crop trees; or a man did 44 trees per hour (table 1).

Actual release work required, on the average, 8.9 man-hours per acre; or a man released 12.5 trees per hour (table 1).

The complete job required 11.7 man-hours per acre on the ground (vehicle travel costs, planning time, and other overhead time were not included). At a rate of $2.00 an hour, the cost was $23.40, plus about $0.75 per acre for flagging.

In the second method, where the designator also released the crop trees, progress was much faster. The job required only 3.6 hours per acre, and the man selected and released 32.6 trees per hour (table 1). At $2.00 per hour, the cost was $7.20, plus the cost for flagging.

The difference in cost between the two types of operation is considerable—$23.40 compared to $7.20. The difference may be exaggerated, however, because area number 36 (one of the study areas in the first group) was the most difficult of all areas to work. In addition, crop-tree selection in this area was

made with the leaves on the trees. If area 36 is left out of the comparisons, the costs are $20.40 versus $7.20, which is still a big difference in favor of the second method.

RECOMMENDATIONS

First, we believe that, in most situations for which crop-tree releases are planned, the job should be postponed until the stand is 9 to 12 years old. A number of reasons support this recommendation: (1) By this age the stand will be easier to work in because the briary-thicket stage will have passed. (2) Crown dominance will be well expressed, so that potential crop trees will be easy to select. (3) Sprout regrowth of cut stems will be less likely to outgrow released trees. And (4) regrowth of severed grapevines will be less apt to remount into crop-tree crowns.

Potential disadvantages of waiting this long are: (1) There might be less opportunity to favorably influence species composition. And (2) if stump sprouts are selected for crop trees, cutting the companion sprouts will provide increased chance of rot entry with increasing diameter of cut stems.

Future research may uncover other disadvantages of waiting this long; but to date, indications favor waiting.

Second, we recommend the use of "judgment" release by carefully trained woodsmen. Release work should be done in the dormant season by mechanical, rather than chemical, means. Deliberate care should be taken to release hard enough since crowns without leaves appear less crowded than they actually are.

Third, we recommend that selection among intolerant species be restricted to dominant and codominant stems; but where appropriate, the better intermediate trees of tolerant species may be released. This is in accord with the work of Jemison and Hepting (*1949*). Moreover, 2-year measurements on some of our release areas indicate that release of subdominant intolerant species may be largely a waste of time because they appear to retrogress quickly in dominance.

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APPENDIX

List of common and scientific names of species referred to in this study.

Ash, white	*Fraxinus americana* L.
Basswood	*Tilia americana* L.
Beech	*Fagus grandifolia* Ehrh.
Birch, sweet	*Betula lenta* L.
Cherry, black	*Prunus serotina* Ehrh.
Grape	*Vitis*
Gum, black	*Nyssa sylvatica* Marsh.
Maple, red	*Acer rubrum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, red	*Quercus rubra* L.
Oak, chestnut	*Quercus prinus* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Yellow-poplar	*Liriodendron tulipifera* L.

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