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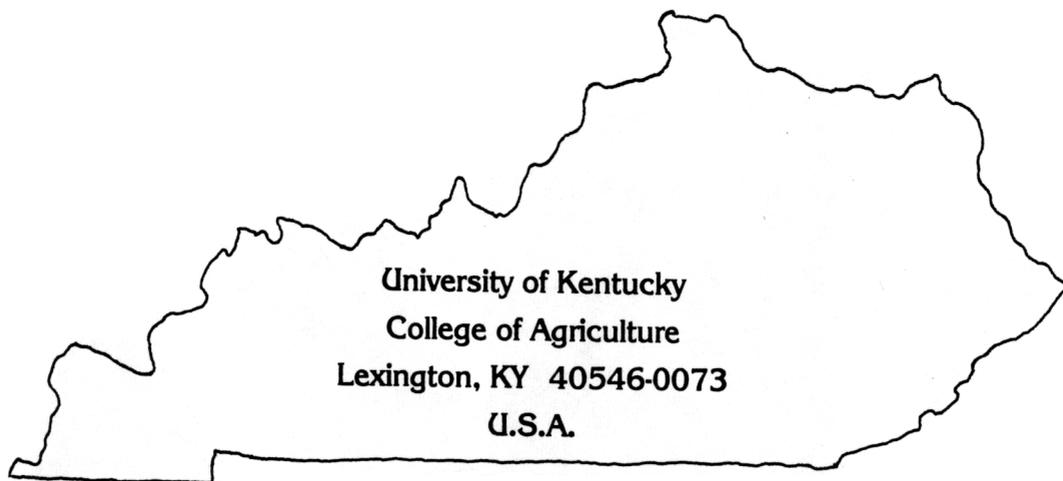
TECHNICAL REPORT

Residual Stand Damage From Crop Tree
Release Felling Operations in
White Oak Stands

by

Jeffrey W. Stringer, Gary W. Miller
and H. Clay Smith

Technical Report No. 8801



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Jeffrey W. Stringer, Gary W. Miller, and H. Clay Smith

This study was conducted at the University of Kentucky's Robinson Forest located in Breathitt, Knott, and Perry counties in eastern Kentucky. Three treatments including two levels of crop-tree release, leaving 20 and 34 crop trees per acre, and a control treatment were replicated 4 times and randomly distributed among 12 white oak (Quercus alba L.) stands. Details of the plot layout, determination of treatment levels, and results including treatment costs, volume removed, and three-year crop tree growth response were reported¹. This report focuses on residual stand damage from the two crop tree release treatments.

STAND DESCRIPTION

The twelve stands were dominated by white oak averaging 58 percent of the total 111 ft² of basal area per acre (stems ≥ 1.00 inch d.b.h.). Pre-treatment stand data for each thinned plot is located in Appendix I. Stands averaged 67 dominant-codominant trees/acre with an average d.b.h. of 13 in. Canopy trees consisted primarily of white oak, with scattered black oak (Q. velutina L.), yellow-poplar (Liriodendron tulipifera L.), American beech (Fagus grandifolia Ehrh.), and hickories (Carya spp.). White oak site index (base age 50) ranged from 65 to 83 ft., averaging 73 ft., with an average age of 73 years. Average stem diameter and number of stems per acre of all stems ≥ 1.00 in. d.b.h. before treatment was 5.2 in. and 760, respectively. All plots were located on steep mid- or lower slopes facing south or southeast. Slope percent ranged from 20 to 45 percent.

¹Stringer, J. W., Miller, G. W., and R. F. Wittwer. 1988. Applying a Crop Tree Release in Small Sawtimber White Oak Stands. USDA Forest Service, Northeast Forest Experiment Station, Research Paper NE-620.

METHODS

A two-acre treatment area was established in each of the stands selected for study. A one-half acre growth and yield plot was centered in each treatment area. All trees ≥ 1.00 in. d.b.h. in each plot were permanently tagged and measured. The two-acre treatment area acted as a buffer zone and the growth and yield plot was used to determine residual stand damage due to the release treatments. Pretreatment data in the growth and yield plots were recorded including, species, d.b.h., crown class, and stem condition remarks for each tree.

Crop trees were marked and released from competition by felling competing trees with a chainsaw. Trees were selected for removal using a crown-touching treatment. That is, any tree touching or overlapping the outer edge of the crop tree crown was eliminated by felling, unless the competing tree was another crop-tree. It is important to note that this treatment retains canopy trees other than crop trees in the residual stand.

Stand damage was strictly a result of felling operations as cut material was not skidded from the stand. Damage to residual trees was assessed by determining the injury type and severity for each stem. Damage was classified into six types as follows:

Swamp Out: normally small trees cut to facilitate felling of trees marked to be removed from the stand.

Knock-Down: trees which were uprooted.

Bent: trees which were permanently bent.

Top Damage: upper crown branches which were broken

Major Branch: breaking of a major branch.

Bark Peel: complete removal of outer bark on the main stem.

Severity of damage was also determined by classifying each damaged tree as severely or moderately damaged. A rating of severe was given to a tree if damage was perceived as affecting the merchantability of the stem at the end of the rotation. Volume of cut material was also determined for each plot. The number of trees which were lodged in the felling operations were also determined.

RESULTS

Volume of removals

Number of stems and basal areas removed from each plot is summarized by crown class in Appendix II. Crown release of 20 residual crop trees per acre resulted in removing about 27 percent of the initial basal area. The residual stand stocking was 70 percent of full stocking defined by the upland oaks stocking guide. Merchantable volume included in the cut averaged 2,462 BF/acre (International 1/4-Inch Rule) in 14 sawtimber trees (\geq 11.0 in. d.b.h.) per acre. Total merchantable volume in cut trees averaged 622 ft³/acre.

Releasing 34 crop trees per acre using the crown-touching guideline resulted in removing 31 percent of the initial stand basal area. Residual stocking averaged 68 percent of full stocking. Merchantable cut volume averaged 2,360 BF/acre in 17 sawtimber trees per acre. Total merchantable volume in cut trees average 764 ft³/acre.

Felling damage to residual stand

Residual tree damage data for each plot by crown class is located in Appendix III. Ten percent of the crop trees were damaged by the 20 tree treatment and 11 percent by the 34 tree treatment. Crop tree damage is categorized into damage types in Table 1.

Table 1. Crop-tree felling damage (percent of stems) for both 20 and 34 crop tree per acre treatments.

Damage severity	Damage type				TOTAL
	Knock-down	Top damage	Major branch	Bark peel	
Moderate ¹	0	0.72	1.97	0	2.69
Severe ²	2.68	0	0	1.25	3.93

¹ Damage not affecting merchantability of stem.

² Damage resulting in loss of tree and or integrity of butt log.

Knock-down and bark peel were the two most prevalent types of damage to the crop trees. Knock-down was associated with plots containing larger crop trees averaging 14" d.b.h. Large crowns were hard to manipulate during felling. Knock-down was also associated with a plot having one of the smallest average crop tree diameters 10". The soil on this plot was relatively thin and trees uprooted easily. This plot also had the lowest white oak site index (65 ft.) of any of the plots.

Total residual stand damage was not significantly different between treatments (Table 2). Suppressed trees, as would be expected, incurred the greatest amount of damage accounting for 53 percent of the damaged stems. Minimal damage occurred to trees occupying the main canopy. Sixteen percent of the total basal area of the 34 crop tree/acre treatment plots were damaged while 11 percent of the basal area of the 20 crop tree plots were damaged. Approximately 2.5 percent of the residual trees in the 20 crop trees per acre treatment had trees lodged in them while 5.7 percent of the trees in the 35 crop tree per acre treatment were lodged. Approximately four percent of the crop trees had trees lodged in them.

Table 2. Residual per acre felling damage (moderate¹) (severe²) for both 20 and 34 crop tree release treatments.

Crown ³ class	n	Damage type					
		Swamp out	Knock- down	Bent	Top damage	Major branch	Bark peel
----- Percent							
1	4						
2	42		(0.12)	(0.60)		2.98	1.79(1.19)
3	57		(1.30)	1.75(0.88)		0.92	1.75(0.87)
4	611	(0.04)	(2.05)	2.95(2.13)	2.25(0.90)	1.80(0.12)	0.37(0.25)

¹ Damage not affecting merchantability of stem.

² Damage resulting in loss of tree and or integrity of butt log.

³ 1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped.

SUMMARY

Felling trees in pole and small sawtimber white oak stands to release 20 and 34 crop trees per acre did not cause significant damage to residual crop trees. The majority of damage occurred to the smaller trees on the plot. Felled trees were not removed from the stump, although cut tree volumes were economical. Crop trees were selected, marked, and then released using a crown-touching technique. Three-year growth information is available in another publication.

Appendix I. Pre-treatment Data by Plot

Table I-1. Pre-treatment basal area (ft²/acre) by crown class, plot, and treatment.

Treatment	Plot	Crown class ¹				Total	Q. alba	
		1	2	3	4		Total	Percent
20	1	9.5	62.7	15.6	17.6	105.4	71.1	67
	4	11.2	46.9	27.9	21.7	107.7	53.4	50
	7	7.9	47.1	25.9	18.6	99.5	42.5	43
	8	10.0	38.7	30.3	17.5	96.6	61.8	64
Treatment mean		9.7	48.9	24.9	18.9	102.3	57.2	56
34	2	7.4	71.8	20.9	14.8	114.9	71.4	62
	3	22.8	36.1	19.6	21.6	100.1	63.8	64
	5	5.2	33.9	30.0	35.6	104.7	48.1	46
	10	0	66.8	25.5	13.6	105.9	64.6	61
Treatment mean		8.9	52.2	24.0	21.4	106.4	62.0	58.3

¹1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed

Table I-2. Pre-treatment stem number/acre by crown class, plot, and treatment.

Treatment	Plot	Crown class ¹			Total	
		2	3	4		
20	1	4	70	42	678	794
	4	6	44	60	588	698
	7	6	62	88	622	778
	8	6	52	104	506	668
Treatment mean		5.5	57	73.5	598.5	734.5
34	2	6	80	46	602	734
	3	16	74	100	610	800
	5	8	84	122	574	788
	10	0	56	42	722	820
Treatment mean		7.5	73.5	77.5	627.0	785.5

¹1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed.

Table I-3. Mean pre-treatment stem diameter (inches) by crown class, plot and treatment.

Treatment	Plot	Crown class ¹				Overall mean stem diameter
		1	2	3	4	
20	1	20.87	12.82	8.25	2.18	4.92
	4	18.50	13.98	9.23	2.60	5.30
	7	15.54	11.80	7.35	2.34	4.80
	8	17.48	11.68	7.31	2.52	5.13
Treatment mean		18.10	12.57	8.04	2.41	5.04
34	2	15.04	12.83	9.13	2.12	5.33
	3	16.16	9.46	5.99	2.55	4.78
	5	10.92	8.60	6.71	3.37	4.92
	10	-	14.79	10.55	1.86	4.85
Treatment mean		10.53	11.42	8.10	2.48	4.97

1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed.

Appendix II. Basal Area and Number of Stems Removed from Plot.

Table II-1. Basal area/acre and number of stems/acre removed by treatment, plot, and crown class.

Treatment	Plot	Crown class ¹				Total
		1	2	3	4	
		----- Basal area ² (number stems/acre) -----				
20	1	4.31 (2)	24.31 (26)	6.02 (12)	-	34.64 (40)
	4	7.05 (4)	16.91 (16)	9.73 (18)	-	33.69 (38)
	7	2.33 (2)	6.50 (10)	7.62 (20)	0.37 (6)	16.32 (38)
	8	8.08 (4)	10.34 (14)	6.69 (16)	0.45 (2)	25.56 (36)
Treatment mean		5.44 (3)	14.51(16.5)	7.52(16.5)	0.21 (2)	27.55 (38)
34	2	-	43.68 (44)	10.49 (22)	-	54.17 (66)
	3	8.41 (4)	13.98 (28)	6.49 (24)	0.30 (2)	29.18 (58)
	5	2.61 (4)	13.87 (34)	8.29 (26)	0.48 (4)	25.25 (68)
	10	-	16.43 (16)	10.70 (12)	-	27.13 (28)
Treatment mean		2.76 (2)	21.99(30.5)	8.99 (12)	0.20(1.5)	33.93 (55)

¹1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed.
²ft²/acre.

Appendix III. Damage Data by Plot.

Table III-1. Crop tree damage

Damage type	Percent of crop trees damaged/acre			
	20 crop trees/acre		34 crop trees/acre	
	Moderate ¹	Severe ²	Moderate	Severe
Knock-down	-	2.5		2.85
Top damage	-	-	1.43	-
Major branch	2.5	-	1.43	-
Bark peel	-	2.5	-	-
Lodged	2.5	-	5.7	
Total	5.0	5.0	8.56	2.85

¹Damage not affecting merchantability of butt log.

²Damage resulting in loss of tree and or integrity of butt log.

Table III-2. Number of stems ≥ 1.00 inch d.b.h. damaged per acre by plot and crown class for 20 crop trees/acre treatment.

Plot	Crown class ³	Total stem count	Damage type moderate ¹ and (severe) ²											
			Swamp out		Knock-down		Bent		Top damage		Major branch		Bark peel	
		2	-	-	-	-	-	-	-	-	-	-	-	-
	2	44	-	-	-	-	-	-	-	-	2	-	2	(2)
	3	30	-	-	-	-	-	-	-	-	2	-	-	-
	4	678	-	(2)	-	(24)	30	(14)	36	(4)	12	-	2	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	-
	2	28	-	-	-	(2)	-	-	-	-	-	-	-	-
	3	42	-	-	-	(2)	-	(2)	-	-	2	-	-	-
	4	588	-	-	-	(8)	16	(20)	8	(2)	6	-	2	(2)
7	1	4	-	-	-	-	-	-	-	-	-	-	-	-
	2	52	-	-	-	-	-	-	-	-	2	-	-	(2)
	3	68	-	-	-	-	6	-	-	-	-	-	2	-
	4	616	-	-	-	10)	4	(10)	6	(6)	8	-	-	-
8	1	2	-	-	-	-	-	-	-	-	-	-	-	-
	2	38	-	-	-	-	-	-	-	-	2	-	-	-
	3	88	-	-	-	(2)	-	-	-	-	-	-	-	-
	4	504	-	-	-	(20)	6	(6)	10	(6)	6	(2)	2	-
Mean	1	2.5	-	-	-	-	-	-	-	-	-	-	-	-
	2	40.5	-	-	-	(.05)	-	-	-	-	1.5	-	0.5	(1)
	3	57.0	-	-	-	(1.0)	2	(0.50)	-	-	1	-	0.5	-
	4	596.5	-	(0.5)	-	(11.0)	14	(12.5)	15	(4.5)	8	(0.	1.5	(0.5)

¹Damage not affecting merchantability of butt log.

²Damage resulting in loss of tree and or integrity of butt log.

³1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed

Table III-3. Number of stems > 1.00 d.b.h. damaged per acre by plot and crown class for 34 crop trees/acre treatment.

Plot	Crown class ³	Total stem count	Damage type moderate ¹ and (severe) ²											
			Swamp out		Knock-down		Bent		Top damage		Major branch		Bark peel	
2	1	6	-	-	-	-	-	-	-	-	-	-	-	-
	2	36	-	-	-	-	-	-	-	-	2	-	-	4
	3	24	-	-	-	-	2	-	-	-	-	-	-	2
	4	602	-	(4)	-	(22)	24	12)	30	(4)	30	(4)	-	4
3	1	12	-	-	-	-	-	-	-	-	-	-	-	-
	2	46	-	-	-	(4)	-	-	-	-	-	-	-	-
	3	76	-	-	-	-	-	(2)	-	-	2	-	-	-
	4	608	-	-	-	(6)	12	(8)	4	(6)	6	-	-	(2)
5	1	4	-	-	-	-	-	-	-	-	-	-	-	-
	2	50	-	-	-	-	-	(2)	-	-	2	-	-	-
	3	96	-	-	-	(2)	-	-	-	-	-	-	4	(4)
	4	570	-	(2)	-	(14)	34	(16)	6	14)	14	-	8	-
10	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	40	-	-	-	-	-	-	-	-	-	-	-	-
	3	30	-	-	-	-	-	-	-	-	-	-	-	-
	4	722	-	(4)	-	(14)	18	(18)	10	(2)	6	-	-	(8)
Mean	1	5.5	-	-	-	-	-	-	-	-	-	-	-	-
	2	43.0	-	-	-	(1)	-	(0.5)	-	-	1	-	-	-
	3	56.4	-	-	-	(0.5)	-	(0.5)	-	-	.05	-	1.5	(1)
	4	625.5	-	(2.5)	-	(14)	22	(13.5)	12.5	(6.5)	14	(1)	3	(2.5)

¹Damage not affecting merchantability of butt log.

²Damage resulting in loss of tree and or integrity of butt log.

³1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed

Table III-4. Basal area (ft²/acre) of trees \geq 1.00 inch damaged by plot and crown class for 20 crop trees/acre treatment.

Plot	Crown class ³	Total stem count	Damage type moderate ¹ and (severe) ²					
			Swamp out	Knock-down	Bent	Top damage	Major branch	Bark peel
	1	5.23	- -	- -	- -	- -	- -	- -
	2	37.55	- -	- -	- -	- -	1.16 -	2.09(1.25)
	3	10.45	- -	- -	- -	- -	.44 -	- -
	4	17.63	- (.03)	- (1.68)	.56 (.39)	.64(1.5)	.24 -	.03 -
4	1	4.14	- -	- -	- -	- -	- -	- -
	2	30.02	- -	- (3.94)	- -	- -	- -	- -
	3	18.23	- -	- (1.43)	- (.78)	- -	.84 -	- -
	4	21.67	- -	- (.28)	.94(1.29)	.78(.02)	.16 -	.03 (.03)
7	1	5.58	- -	- -	- -	- -	- -	- -
	2	40.61	- -	- -	- -	- -	3.3 -	- (1.47)
	3	18.28	- -	- -	1.84 -	- -	- -	.55 -
	4	18.21	- -	- (.42)	.05 (.10)	1.04(.07)	.63 -	- -
8	1	1.97	- -	- -	- -	- -	- -	- -
	2	28.37	- -	- -	- -	- -	.77 -	- -
	3	23.62	- -	- (.49)	- -	- -	- -	- -
	4	17.06	- -	- (.85)	.05 (.06)	.28(.23)	.17(.10)	.04
Mean	1	4.23	- -	- -	- -	- -	- -	- -
	2	34.14	- -	- (.99)	- -	- -	1.31 -	.52 (.68)
	3	17.65	- -	- (.48)	.46 (.20)	- -	.32 -	.14 -
	4	18.64	- (.01)	- (.81)	.40 (.46)	.69(.12)	.30(.03)	.03 (.01)

¹Damage not affecting merchantability of butt log.

²Damage resulting in loss of tree and or integrity of butt log.

³1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed.

Table III-5. Basal area (ft²/acre) of trees ≥ 1.00 inch damaged by plot and crown class for 34 crop trees/acre treatment.

Plot	Crown class ³	Total stem count	Damage type moderate ¹ and (severe) ²						
			Swamp out	Knock-down	Bent	Top damage	Major branch	Bark peel	
2	1	7.41	- -	- -	- -	- -	- -	- -	- -
	2	28.12	- -	- -	- -	- -	1.33 -	- -	3.71
	3	10.36	- -	- -	.53 -	- -	- -	- -	.59
	4	14.84	- (.05)	- (.62)	.56 (.19)	.52 (.14)	.68 .05)	- -	.17
3	1	14.38	- -	- -	- -	- -	- -	- -	- -
	2	22.07	- -	- (1.59)	- -	- -	- -	- -	- -
	3	13.15	- -	- -	- (.23)	- -	.39 -	- -	- -
	4	21.32	- -	- (.37)	1.2 (.15)	.05 (.30)	.36 -	- -	.27
5	1	2.57	- -	- -	- -	- -	- -	- -	- -
	2	20.73	- -	- -	- (.53)	- -	1.01 -	- -	- -
	3	21.72	- -	- (.27)	- -	- -	- -	- -	.65 (.86)
	4	35.08	- .02)	- (.62)	2.43 (.58)	.15 .76)	.77 -	- -	.87 -
10	1				No trees				
	2	50.36	- -	- -	- -	- -	- -	- -	- -
	3	14.80	- -	- -	- -	- -	- -	- -	- -
	4	13.59	- (.04)	- (.33)	.17 (.19)	.69 (.04)	.05 -	- -	- (.11)
Mean	1	6.09	- -	- -	- -	- -	- -	- -	- -
	2	30.32	- -	- (.40)	- (.13)	- -	.59 -	- -	.93 -
	3	15.01	- -	- (.07)	- (.13)	- -	.10 -	- -	.42 (.22)
	4	21.21	- (.03)	- (.49)	.09 (.28)	.35 (.31)	.47 (.14)	- -	.33 (.03)

¹Damage not affecting merchantability of butt log.

²Damage resulting in loss of tree and or integrity of butt log.

³1 = dominant, 2 = codominant, 3 = intermediate, 4 = overtopped/suppressed.

Table III-6. Percent of residual growing stock damaged during release.

Treatment	Plot	Percent basal area ¹ and (number of stems/acre)												
		Swamp out		Knock-down		Bent		Top damage		Major branch		Bark peel		Total
20	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	2.90	(0.12)	-	-	-	-	-	-	1.99	(2.47)	4.89 (2.59)
	3	-	-	2.72	(1.75)	1.13	(0.88)	-	-	-	-	-	-	3.85 (2.63)
	4	.05	.08)	4.35	(1.84)	2.41	(2.10)	0.64	(0.75)	0.16	(0.08)	0.05	(0.08)	7.66 (4.93)
Treatment mean		.05	.08)	9.97	(3.71)	3.54	(2.98)	0.64	(0.75)	0.16	(0.08)	2.04	(2.55)	16.44(10.15)
35	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	1.32	(2.33)	0.43	(1.16)	-	-	-	-	-	-	1.75 (3.49)
	3	-	-	0.47	(0.89)	.87	(0.89)	-	-	-	-	1.47	(1.77)	2.81 (3.55)
	4	0.14	(0.40)	2.31	(2.24)	1.32	(2.16)	1.46	(1.04)	0.66	(0.16)	0.14	(0.40)	6.03 (6.40)
Treatment mean		0.14	(0.40)	4.10	(5.46)	2.62	(4.21)	1.46	(1.04)	0.66	(0.16)	1.61	(2.17)	10.59(13.44)

¹ft²/acre.