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LOGGING IMPACT IN UNEVEN-AGED STANDS OF THE MISSOURI OZARK FOREST ECOSYSTEM PROJECT

Dr. John P. Dwyer

Abstract. Today, there is keen interest in using alternative silvicultural systems like individual-tree selection, group openings and shelterwood because the general public feels these systems are more acceptable than clearcutting. Consequently, due to repeated entries into forest stands and the fact that residual crop trees have to be carried for a long period of time between re-entries, the damage to residual trees arising from harvest operations has to be better understood so that it can be minimized. The Missouri Ozark Forest Ecosystem Project (MOFEP), located in southeastern Missouri, is a 9,200-acre landscape experiment designed to compare the impacts of even-aged, uneven-aged, and no management on a wide array of ecosystem components. Results from an extensive logging damage study show that careful logging can result in minimal damage to leave trees.

INTRODUCTION

The Missouri Ozark Forest Ecosystem Project (MOFEP), initiated in 1989 in southeastern Missouri, is a 9,200 acre long-term landscape experiment (Figure 1) designed to compare the impacts of even-aged, uneven-aged, and no management treatment regimes on a wide array of ecosystem components.

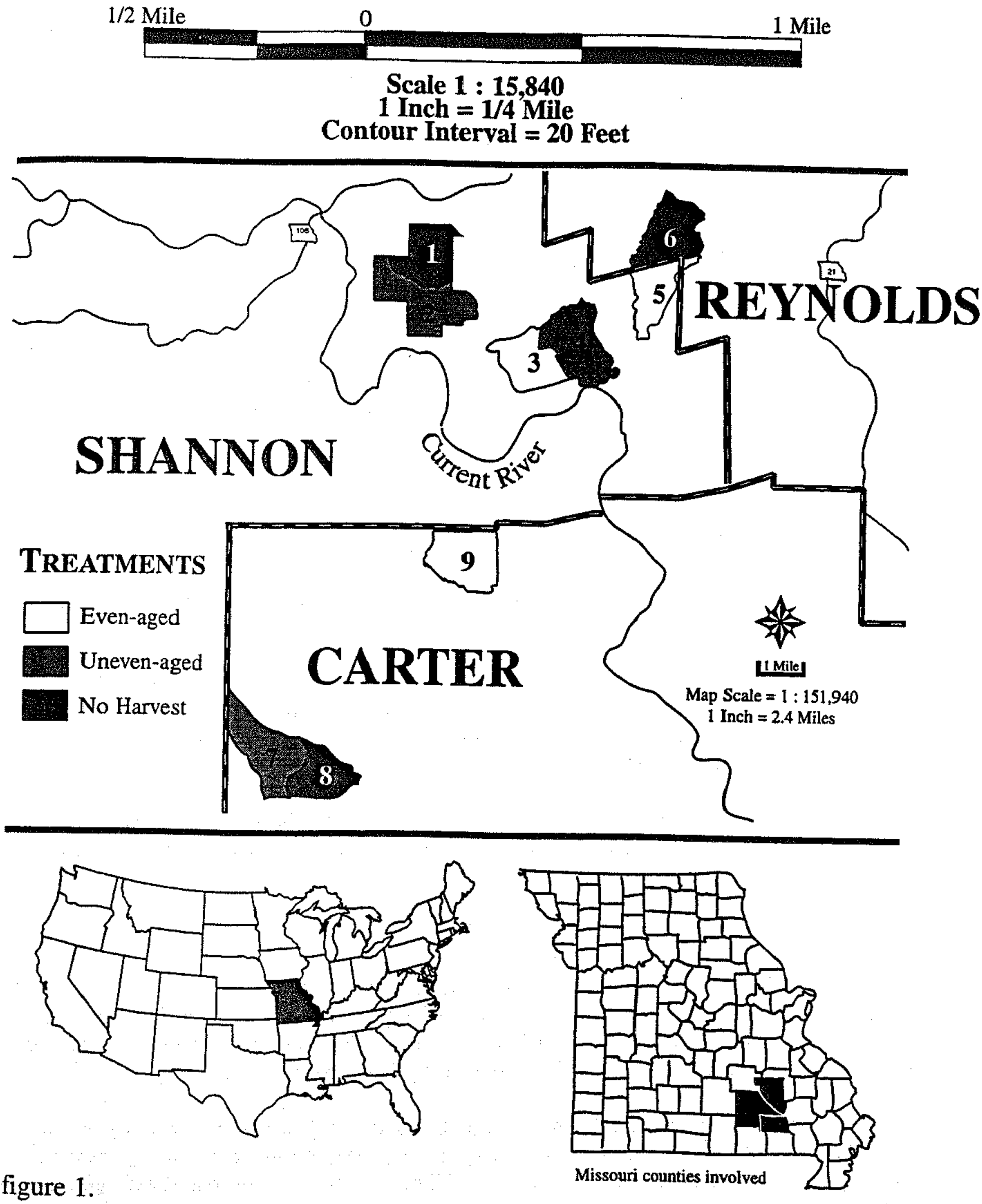
Following harvest on the MOFEP study sites which took place between the late fall of 1996 and early spring of 1997, researchers gathered logging damage information in the late spring and summer of 1997. Of the total of 648 permanent half-acre research plots located across the 9 research sites, 186 were harvested.

The purpose of this study was to; 1) summarize post-harvest logging impact data following the 1996 harvest of MOFEP sites, and 2) monitor the long-term impact of logging damage on residual tree health and quality.

PROCEDURE

Each of the three treatment regimes were replicated on three sites, and each site had to be a minimum of 600 acres in size, contiguous with minimal edge, largely free from manipulation for the past 40 years, and longer, if possible, owned by The Missouri Department of Conservation, located in the southeastern Ozarks, and relatively close to each other (Brookshire et al. 1997).

The MOFEP experiment is designed as a randomized complete block design using nine sites divided into three blocks. Treatments of uneven-aged, even-aged, and no-harvest management were randomly assigned to sites within each block (Sheriff and He 1997). A system of 648 permanent cluster plots was distributed across the nine MOFEP sites. Plots were allocated among forest stands based on stand size with the constraint that each include at least one plot. Each 0.5-acre plot contains a cluster of 4 subplots that are 0.01-acre in size. Plot center for the four subplots is located 56.5 feet


1/2 Mile
0
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SHANNON
REYNOLDS
CARTER
Current River
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21
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9
TREATMENTS
Even-aged
Uneven-aged
No Harvest
1 Mile
Map Scale = 1 : 151,940
1 Inch = 2.4 Miles
Missouri counties involved

figure 1.

from the center of the 0.5-acre plot and are situated in each of the four cardinal directions.

The research area consists of upland oak-hickory and oak-pine forest communities. Dominant tree species include white oak (Quercus alba L.), black oak (Q. velutina L.), post oak (Q. stellata Wang.), scarlet oak (Q. coccinea Muenchh.), blackjack oak (Q. marilandica Muenchh.), chinkapin oak (Q. muehlenbergii Engelm.), shortleaf pine (Pinus echinata Mill. and hickory (Carya spp.). Understory species include dogwood (Cornus spp.) and blackgum (Nyssa sylvatica Marsh) (Xu et al. 1997).

During 1997 a total of 66 one-half acre plots were harvested on MOFEP sites 3,5, and 9 which are the sites designated for even-aged management. Of the 66 plots, 28 plots were clearcut and 38 received an intermediate thin. The intermediate plots were young even-aged stands that required thinning. Likewise, on the uneven-aged sites 2, 4, and 7 there were a total of 120 plots harvested using single-tree and group selection methods.

RESULTS

Areal Impacts

For the clearcut treatment 12 percent of the area was impacted by primary and secondary skid trails (Table 1). On the intermediate plots 9 percent of the area was impacted by haul roads and primary and secondary skid trails. On the uneven-aged treatment plots 13 percent of the area was impacted. A study located in the same general area (Ficklin et. al 1997) found 9.7% of the logged area by was impacted by skid trails.

Root/Tree Damage

One area of interest concerning harvest on the MOFEP sites was the prevalence of uprooted trees, those residual trees larger than 4.5 inches dbh that were pushed out of the ground by skidding equipment. Twenty-eight clearcut plots were surveyed and there were a total of 3 plots which showed evidence of uprooting (Table 2). On these 3 plots the total number of trees affected by uprooting was 5 which represents about 0.2 percent of the total trees in this treatment. On these 3 plots the mean basal area in uprooted trees is 0.71 square feet per acre which represents about 0.8 percent of the total mean basal area. These 3 plots prior to harvest averaged 93.4 square feet per acre. Likewise, the percentage of uprooted trees was 0.8 percent for both the intermediate and uneven-aged treatments, respectively. On these treatment plots there were a total of 28 and 88 trees that showed evidence of uprooting, and their mean basal area was 1.0 and 0.7 square feet per acre, respectively which, for these two treatments is 1.0 percent and 0.7 of a percent of the total mean plot basal area per acre, respectively.

To determine impact of logging activity on the leave tree, logging activity and damage was measured in terms of whether or not it took place within the drip line of the leave tree, or within a distance of 1 to 1.5 times the crown radius of the leave tree. For example, if the crown radius of the leave tree was 16 feet then any logging activity that took place within that distance was considered to be within the dripline of the tree. For a distance of 16 to 24 feet the activity was considered to

Area Impacted by Trail Type and Treatment	Haul Road	Primary Skid Trail	Secondary Skid Trail
		---%---	
Even-aged	0.0	7.0	5.0
Intermediate (Even-aged)	1.0	6.0	2.0
Uneven-aged	2.0	7.0	4.0

Table 1.

A comparison of pre-harvest plot conditions versus post-harvest uprooted trees

	Pre-harvest		*Post-harvest*	
	Trees Per Acre	Basal area Per Acre	Trees Per Acre	Basal area Per Acre
Even-aged	79.2	93.4	1.7	0.7
Intermediate (Even-aged)	92.1	98.7	1.8	1.0
Uneven-aged	92.0	106.3	1.6	0.7

Table 2.

have taken place within the distance of 1.0 to 1.5 times the crown area of the subject leave tree.

For the uneven-aged treatment 3,145 leave trees were checked (Table 3). Under the table heading, "number of roots damaged" a '0' indicates no damaged roots, a '1' indicates there were some severed roots measured around the leave tree, and a '2' indicates abrasions were observed on roots. Only 0.2% of the trees showed any signs of severed roots, while 0.3 percent showed signs of abrasion. Such low levels of root damage can be explained by the fact that virtually 100 percent of the area that was measured fell in the 0 to less than 4" rut depth category. We don't know how much of the area had no ruts because ruts were measured and recorded in a 0 to 4-inch depth category. Logging was not permitted on erosive soils during wet weather.

Bole Damage

For the even-aged treatment 93.9 percent of the leave trees had no bole wounds (Figure 2), whereas, for the uneven-aged treatment there were no bole wounds on 91.5 percent of the leave trees. For the even-aged treatment 6.1 percent of the leave trees showed 1 or more bole wounds, and the uneven-aged treatment had 8.5 percent of the leave trees with 1 or more bole wounds.

The mean basal area of residual leave trees in the uneven-aged treatment was 56.9 sq.ft. per acre (Table 4). There was 4.8 sq.ft. per acre of basal area in trees that had 1 or more bole wounds. This represents about 8.4% of the total average basal area. For the intermediate thinning, the total average residual basal area was 54.4 sq.ft. per acre. There was 3.2 sq.ft. per acre of basal area in trees that had 1 or more bole wounds, and this represents about 5.9% of the total average basal area. The residual basal area in the clearcut treatment represents pine and hardwood snags that were not harvested.

The mean number of wounds per leave tree is highest in the uneven-aged treatment (Table 5). The higher occurrence of main haul roads in the uneven-aged treatment along with primary skid trails may help to explain the higher number of wounds. It may also be explained by the considerably larger sample of leave trees in the uneven-aged treatment.

The general trend seems to indicate that as the number of bole wounds per tree increases in number, the size of the tree decreases (Table 6). In other words, the smaller the tree the more likely it is to have multiple wounds. The average size of the leave trees with no wounds by treatment is 9.4 inches for the even-aged, 8.7 inches for the intermediate and 9.1 inches for the uneven-aged treatment. The size of wounded tree represents trees in the growing stock classes.

The average height from ground line to the base of the bole wound is 3.0, 2.4, and 3.2 for the even-aged, intermediate (even-aged), and uneven-aged treatments, respectively. The base of the bole wound starts at and extends into the first 8-foot log which represents a significant reduction in value and, quite possibly, the health of the leave tree over time.

For all treatments combined 27% of the bole wounds were in contact with mineral soil. For the intermediate treatment 34% of the trees with bole wounds were in contact with the mineral soil,

Leave trees with root damage within 1½ times the crown radius			
	Number of roots damaged		
	0	1	2
Even-aged	145	0	0
Intermediate (Even-aged)	1074	1	13
Uneven-aged	3128	6	11

Table 3.

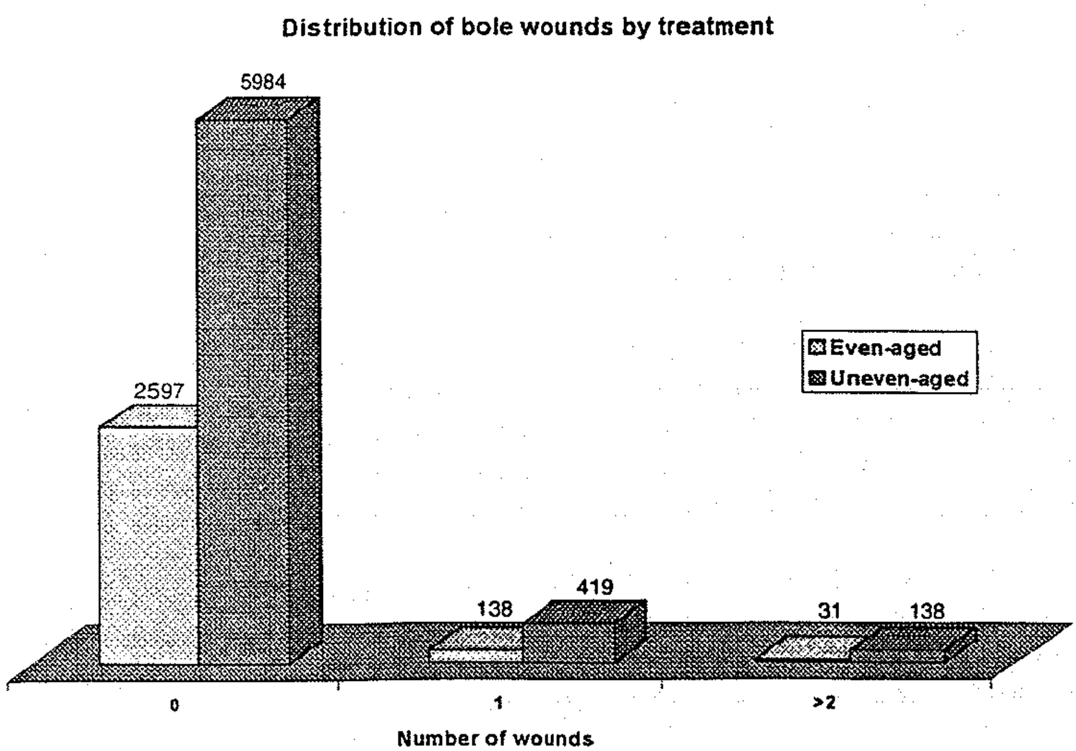

Figure 2.

Mean basal area of leave trees with wound damage					
	Number of wounds				
	0	1	2	3	≥4
	----ft² per acre----				
Even-aged	17.2	1.1	0.1	0	0
Intermediate (Even-aged)	51.2	2.6	0.5	0.1	0
Uneven-aged	52.1	3.9	0.6	0.2	0.1

Table 4.

Mean number and size of bole wounds

Treatment	Wounded Trees (no.)	Wound (no.)	Size (sq. ins.)
Even-aged	19	1.1	177.9
Intermediate (Even-aged)	150	1.2	106.1
Uneven-aged	557	1.4	140.8

Table 5.

The average size of wounded leave trees by harvest treatment					
	Number of bole wounds				
	0	**1**	**2**	**3**	**≥4**
	------(dbh inches)-----				
Even-aged	9.4	10.4	6.5	–	–
Intermediate (Even-aged)	8.7	8.1	7.6	6.9	–
Uneven-aged	9.1	9.0	8.5	9.1	8.4

Table 6.

and 25% for the uneven-aged treatment.

In the even-aged treatment there were 19 trees that were bole wounded (380 received no bole wound). Of this total, 21% of the leave trees (Figure 3) were in the dominant class and 42 percent in the co-dominant crown class. In the intermediate thinning treatment there were 150 trees that were bole wounded (2,217 received no wound). Six percent of these damaged trees were in the dominant class and 31 % in the co-dominant class. In the uneven-aged treatment there were 557 trees that were wounded (5,977 trees not wounded), of these trees 12 % were in the dominant class and 45 % in the co-dominant crown class.

Crown Damage

Over all four crown classes 99% of the leave trees had less than 10% damage to the crown (Figure 4). We don't really know what percentage of the leave trees had zero, or no crown damage, because the crown damage classes were not set up to record these data.

Another way of evaluating the extent of damage is to measure the basal area of leave trees with crown damage. Both the intermediate and uneven-aged treatments had in excess of 99% of their mean basal area per acre in the less than 10% crown damage. Overall, crown damage was minor for either scale of measurement. In a similar study located in the southeastern Ozarks (Ficklin et. al 1997) found that 22.0% of residual trees had some type of logging damage, and 8.6% of the leave trees had crown damage.

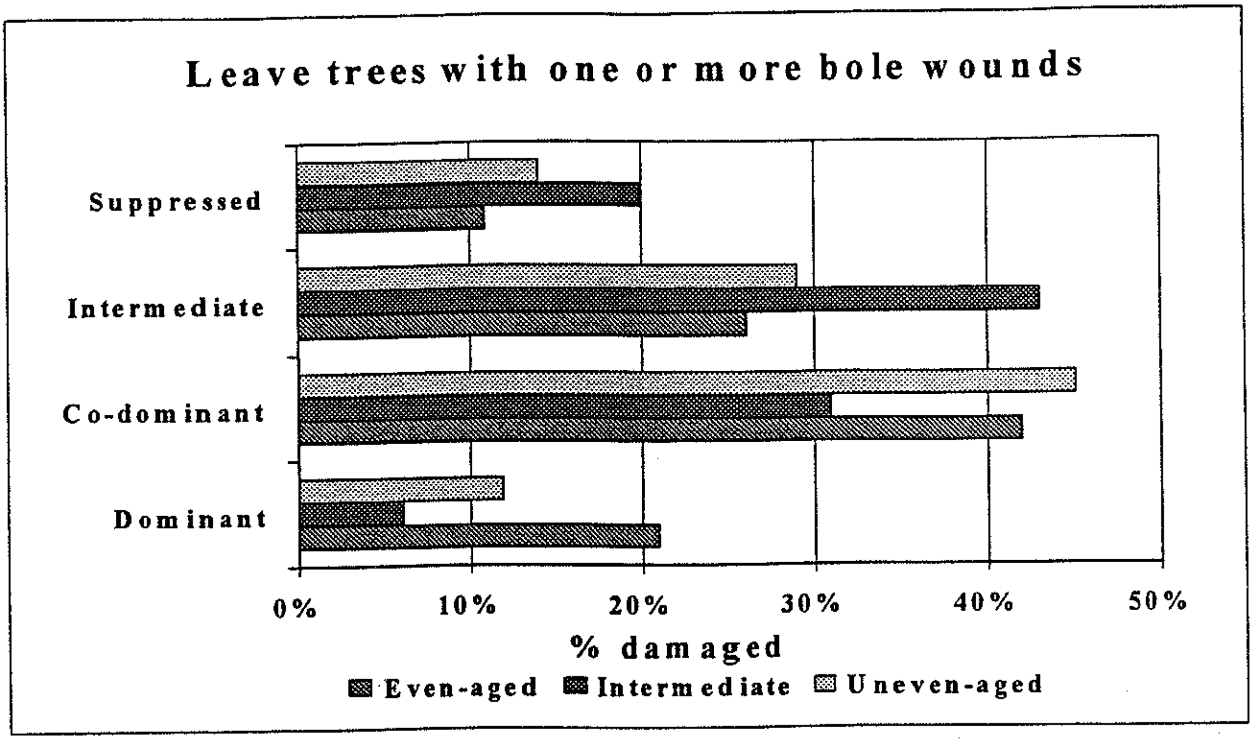

Figure 3.

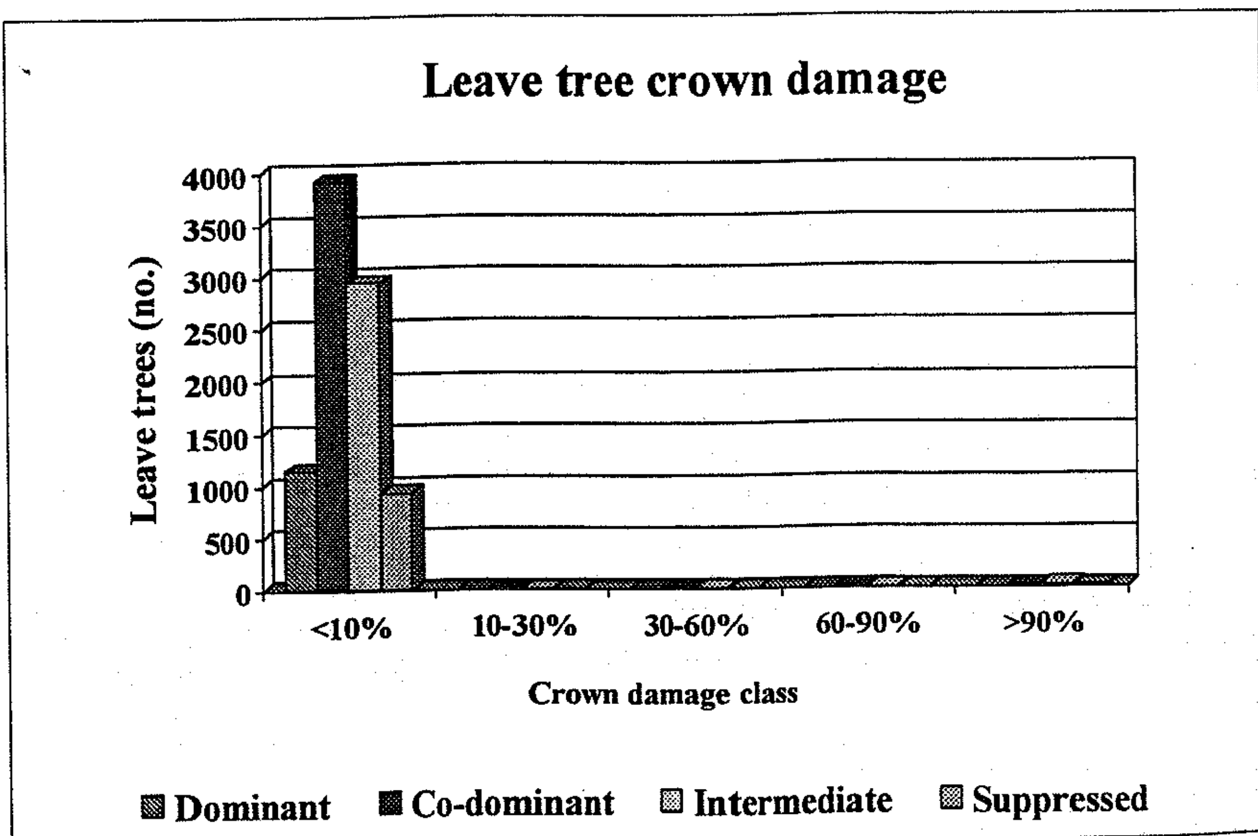

Figure 4

Indirect effects. In Figure 5 if one considers the area in blue as the dripline of the leave trees, then almost 37 % have had some type of logging activity. If we add in the distance of 1.5 times the crown radius we pick up another 13 % of the leave trees with some logging activity. In short, 50 % of the leave trees have had some logging activity within a distance of 1.5 times the crown radius of the tree.

In Table 7 logging activity is distributed by logging treatment within the crown radius of the leave tree. The uneven-aged treatment had the highest percentage of leave trees (34.6%) impacted by logging activity within the crown radius. Within 1.5 times the crown area of the leave tree both the intermediate and uneven-aged treatments had the highest distribution, 13.6 and 13.5 % of leave trees impacted, respectively.

Table 8 illustrates the level of logging activity by treatment within the crown radius of the leave tree. Looking at primary skid trails, the percentage of trees whose crowns were within the radius of this activity for the uneven-aged treatment was 51.7% and for the intermediate and even-aged treatment it was 67.0 and 67.3% respectively. Distance from logging activity to the leave tree is critical to protection of the tree. Of all the leave trees that had any activity within 1.5 times the crown radius of the leave tree, the average distance was 11.4 feet.

For a 10.0-inch tree there is about a 1 in 5 or 20 % chance (Figure 6) that it will be wounded if the logging activity is within 5 feet from its bole. For the same tree there is only about a 2 % chance of damage if the activity is 20 feet from the tree. As distance to logging activity increases and tree diameter increases the probability of damage decreases.

SUMMARY

Group and individual-tree selective harvests will require multiple logging entries. Due to the close proximity of the leave tree to logging activity it is imperative that foresters and loggers work closely laying out skid trails so as to minimize potential damage to crown and bole of leave trees that are retained in the stand.

The relatively low levels of damage to crown and bole of leave trees in this study are the result of a very good logging job. One, I would say, that is symptomatic of a close working relationship between forestry and logging. The fact that forest researchers were on the site, measuring and working with the loggers did insure that relatively low levels of tree damage were achieved.

In the future this project will continue to follow the fate of the trees that were wounded in the initial harvest. It will be the purpose of this study to determine the changes in tree quality and value over time. The economic analysis will consider the profitability of planned careful logging.

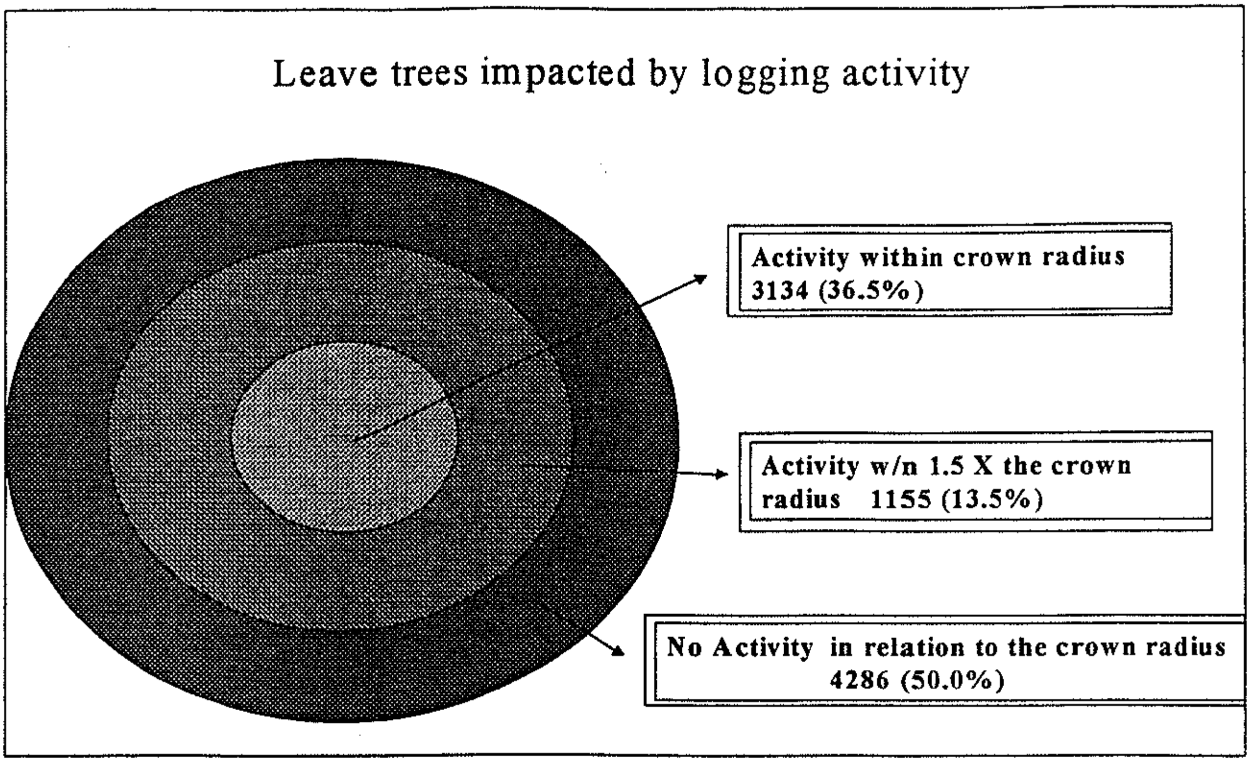

Figure 5.

Leave trees impacted by logging activity

Treatment	Activity w/n CR	Activity outside CR but w/n 1.5X CR	No activity 1.5X CR
		----------no. of trees ---------	
Even-aged	107	32	254
Intermediate	767	321	1279
Uneven-aged	2259	800	3458

Note: CR=crown radius

Table 7.

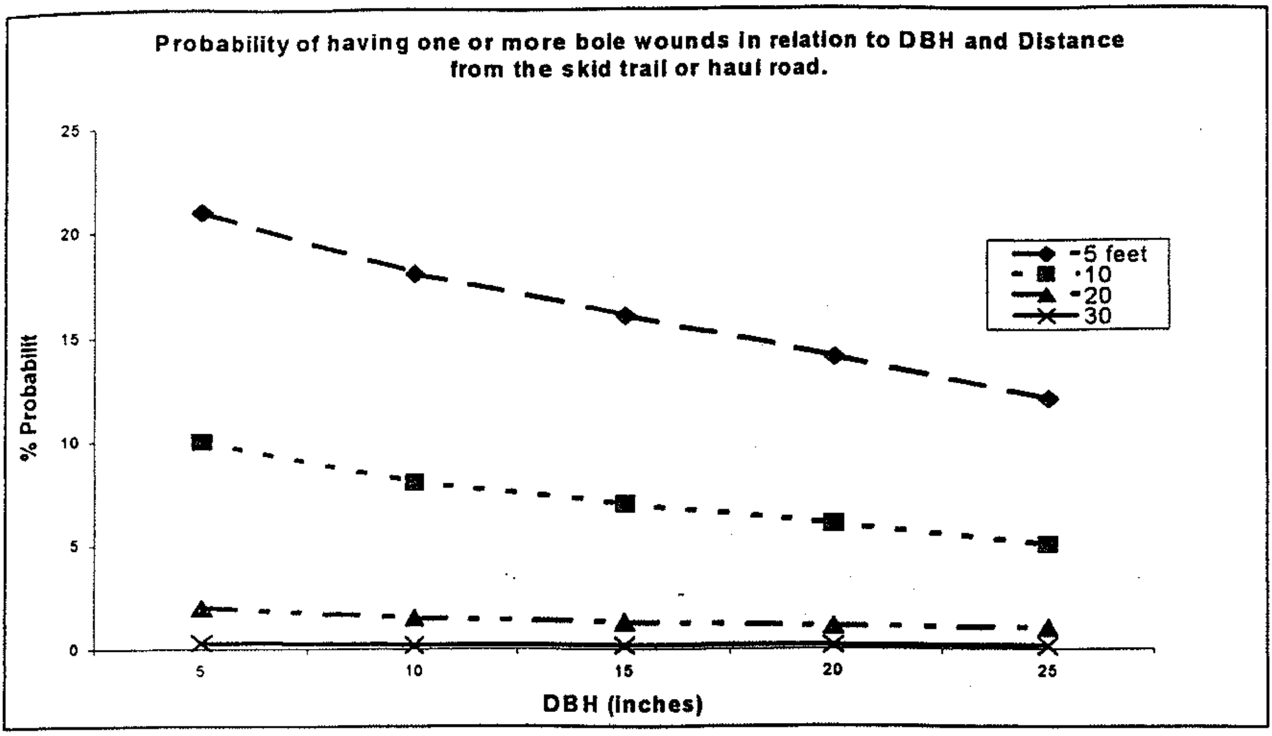

Figure 6.

Leave trees impacted by logging activity inside the crown radius

	Logging Activity Level 1	2	3	4	Total
	---------No. of trees---------				
Even-aged	11	72	21	3	107
Intermediate (Even-aged)	132	514	110	11	767
Uneven-aged	750	1233	258	19	2260
Grand total	893	1819	389	33	3134

Logging Activity Level Key
1= 1 or 2 pass skid trail 2= primary skid trail 3= haul road 4= decking area

Table 8.

LITERATURE CITED

Brookshire, B.L., R. Jensen and D.C. Dey. 1997. The Missouri Ozark Forest Ecosystem Project: Past, present, and future. USDA For. Serv. Gen. Tech. Rep. NC-193. 378 p.

Ficklin, R.L., J.P. Dwyer, B.E. Cutter and T. Draper. 1997. Residual tree damage during selection cuts using two skidding systems in the Missouri Ozarks. P. 36-46 *in* Proc. 11th Central Hardwoods For. Conf. Columbia, MO.

Sheriff, S.L. and Zhuoquiong He. 1997. The experimental design of the Missouri Ozark Forest Ecosystem Project. USDA For. Serv. Gen. Tech. Rep. NC-193. 378 p.

Xu. M., S.C. Sanders and J. Chen. 1997. Analysis of landscape structure in the southeastern Missouri Ozarks. USDA For. Serv. Gen. Tech. Rep. NC-193. 378 p.

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