PILOT TEST OF RED OAK BORER[1] SILVICULTURAL CONTROL IN COMMERCIAL FOREST STANDS[2]

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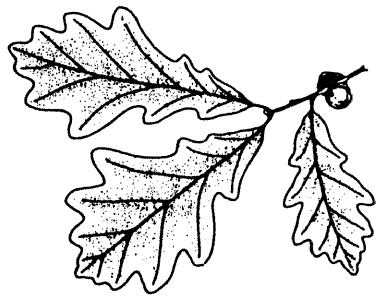

ABSTRACT.--The results of a pilot test of a silvicultural control for the red oak borer, Enaphalodes Rufulus (Haldeman), is presented. The control method consisted of felling brood trees with two or more ongoing borer attacks and sectioning them into pieces 18 to 24 inches long. Six stands, 219 acres total, were selected on the Tell City Ranger District, Hoosier National Forest, Indiana. Stands were 30 to 60 years old, had 444 to 6,020 board feet of oak volume/acre, and were 15 to 100 acres. Treatment costs ranged from $5 to $41/acre. Treatments applied in March and April 1981, showed that borer population densities can be too high or too low to allow efficacious treatment. Stand growth was projected with the GROAK computer simulation model and potential profits of losses were calculated. Errors in brood-tree detection and failure to treat marked trees reduced treatment efficiency in all stands. Ant predation was the primary cause of larval and pupal mortality in treated trees.

INTRODUCTION

The red oak borer, Enaphalodes rufulus (Haldeman), is found throughout some 200 million acres of oak-hickory forests in the Eastern United States. It is one of a complex of five wood borers that reduces the value of products from trees attacked by these pests.

Associated insects in the borer complex include the oak timberworm, Arrhenodes minutus (Drury); two species of carpenterworm, Prionoxystus robiniae (Peck) and P. macmurtrei (Guerin); and the living beech borer, Goes pulverulentus (Haldeman). The latter is a primary borer but usually attacks trees that are 4 to 5 inches in diameter at breast height (d.b.h.). The first three species are secondary in that they enter a tree through old logging wounds, fire scars, limb stubs, and old insect galleries, notably those of the red oak borer (Donley et al. 1969). Along with these insects, carpenter ants, Camponotus spp., extend the damage by the red oak borer and allow entry of various heartrot fungi in the wood-producing zone from which quality boards are sawed (Berry 1978).

Estimates of economic losses due to these pests are numerous (Bryan 1960, Burns 1971, Donley 1974, Hay and Wooten 1955, Lockard et al. 1963, Morris 1964, Snyder 1927). Mill studies in West Virginia, Ohio, Kentucky, and Indiana designed to partition losses attributable to each of these pests showed that the red oak borer was directly or indirectly responsible for 40 to 80 percent of the total loss (Donley 1974).

The red oak borer has a 2-year life cycle with a peak emergence in odd numbered years (Hay 1969). Adults are nocturnal and present in the woods from mid-June to early August. After the female lays her eggs, the ensuing larvae chew through the bark and into the cambium where they feed for about 11 months. The rest of their life cycle is spent tunneling in the xylem, where they eventually pupate

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and transform into adults.

During the 1970's, a considerable effort was directed toward the silvicultural control of the red oak borer. Since the borers are in the tree for most of their 2-year life cycle, they are not controlled by current forest management practices (Donley 1982). Survival of red oak borers in infested trees girdled and left standing has been between 5 and 62 percent, depending on larval location within treated trees (Hay 1962). In even-aged, 45-year-old oak stands in Ohio the red oak borer was controlled by felling and sectioning infested trees (Donley 1981). Red oak borer attacks were identified by techniques developed by Donley and Terry (1977). The goal was to reduce the borer population by 50 percent. Earlier economic assessments showed that such a reduction increases the value of high-quality oak lumber by $40/Mbf of factory-grade lumber sawed (Donley and Worley 1976). A reduction of about 50 percent was achieved (Donley 1981) with a continuing reduction of about 90 percent the following generation. Further, oak timberworm attacks were reduced by 75 percent and carpenterworm attacks by 40 percent. The net effect was an 88 percent reduction in borer damage 2 years after treatment (Feicht et al. 1985).

Following the earlier experimental success, research on silvicultural control has moved from the experimental forest to the production forest. Host-tree removal was pilot tested on the Tell City Ranger District of the Hoosier National Forest in Indiana in cooperation with, the USDA Forest Service, State and Private Forestry and the timber management staff on the forest. This pilot test evaluated the operational effectiveness of a "stand classification-brood tree removal system" to help forest managers minimize red oak borer damage. With this system, stands were selected and located where red oak borer control was deemed most feasible, currently infested trees were identified, and populations were reduced by tree removal.

METHODS

With the assistance of personnel with Region 9 of the USDA Forest Service, TIMIS compartment/stand data for the Tell City Ranger District was obtained from the USDA Fort Collins (Colo.) Computer Center. Each stand was classified for treatment feasibility relative to the following red oak borer stand/tree attack preference criteria: 1) management objective: standard and marginal components for timber production; 2) size: 2+ acres; 3) species composition: should contain one-half to two-thirds in red, black, or scarlet oak; 4) tree diameter distribution: two-thirds of the timber in pole size (5 to 9 inches in diameter); 5) stocking: at least 50 percent stocked; and 6) age: 12 to 75 years old. Of the nearly 74,000 acres that comprise the Tell City Ranger District, 6,819 acres were drawn on the initial printout. From this, 3,686 acres were selected for field verification. If the field check indicated that the classification was inaccurate, the stand was dropped from further consideration.

Once a stand was selected, it was systematically surveyed for the incidence of red oak borer brood trees to decide if treatment was warranted. The survey involved examining the basal 8-foot section of red, black, and scarlet oaks for the number of current-generation attacks, and recording these by species and d.b.h. One 200-ft^2 sample of bark surface area was taken for each 5 acres in candidate stands. Trees with two or more current attacks were considered potential brood trees. The number of brood trees per 200-ft^2 sample of bark surface area and the number of brood trees per acre were calculated. Stands selected as feasible for treatment had 5 to 30 new borer attacks per 200-ft^2 sample. Stands with higher or lower borer incidence were rejected.

Six stands, 219 acres in all, were choosen for treatment (Table 1). Tell City district personnel examined the 8-foot basal section of all red, black and scarlet oaks within each stand and marked brood trees for treatment. Treatments were made during March and April of 1981, under a contract administered by the Tell City Ranger District. Treatment consisted of felling brood trees and cutting them into 18- to 24-inch sections left to lay on the ground. This allowed the borers in the treated trees to be devoured by foraging ants.

TABLE 1.--Stand silvicultural characteristics.

Stand No.	Number of acres	Percent red oak	Current volume/acre	Volume/acre at harvest	Basal area of red oak	Average d.b.h.	Age	Site Index
			--- Board Feet --			Inches	Years	
62-43	15	73	2176	16448	75	7.0	38	80
63-2	44	54	444	17129	38	6.0	30	80
14-62	22	48	3055	6228	40	8.0	60	50
34-28	17	54	3409	15531	60	7.3	50	80
34-26	100	54	2587	15272	50	7.2	51	80
34-22	21	40	6070	16237	40	8.5	54	80

RESULTS AND DISCUSSION

Forty-five percent of the red oak borer attacks in treated trees were examined for larval survival at various times after treatment. Ant predation accounted for most of the larval mortality. The principal predators, Aphaenogaster rudis Emery[5] and Camponotus sp., reduced the numbers of borers in treated trees by 96 percent within 6 weeks after treatment. Initial larval survival was high in treated trees examined in March and early April. However, temperatures were still low and ant activity negligible. Lynch et al. (1980) also reported low activity in Aphaenogaster rudis Emery and some Camponotus spp. with temperatures below 59°F. All other observations were made later in April and early May when temperatures were more conducive to ant activity. Ants chewed through the larva's overwintering plug of tightly packed slivers to gain access to the borer galleries that were not exposed when the trees were sectioned. If the trees had been cut the previous year, ant predation would not have been important because the 1-year-old larvae already would have desiccated. Hay (1962) showed that once the larvae reached the wood tunneling stage, host-tree death would not cause larval mortality. However, the method of felling and sectioning brood trees enhanced the effectiveness of ant predation, which was imperative in achieving the goal of a 50 percent reduction in red oak borers.

Actual reduction in red oak borer attacks in treated stands the following generation averaged 76 percent (Table 2). An attempt was made to evaluate six stands, 256 total acres, that were not treated. Scheduling problems prevented full use of these checks, though two of the stands that were checked concurrently with the treated stands had population densities of 3.0 and 3.4 borers per square foot of bark surface area (pretreatment), and posttreatment densities of 3.6 and 3.3, respectively.

[5] Identifications made by Dr. David R. Smith, USDA Systematic Entomology Laboratory.

An attempt was made to determine red oak borer impact of potential forest products from these stands using GROAK, a forest-stand growth simulation model, and comparing the defects from red oak borer attack densities before and after treatment. Future growth on each individual stand was projected with GROAK (Dale 1972), which was developed for upland oak stands. Being a stand model versus an individual tree model Hilt (1983), assumptions made on growth and survival by species and age class will not have nearly the resolution of the latter.

Another assumption was that red oak borer populations per unit of host material would remain relatively stable for the remainder of the rotation, as reported by Hay (1974) and Donley (1981, 1982). Histograms of borer populations from an Ohio stand in which fifteen 90- to 120-year-old black and scarlet oaks were sectioned and all red oak borer attacks dated revealed only minor fluctuations in borers per cubic foot of wood during the rotation of the stand (unpublished data).

By superimposing the posttreatment attack densities over the projected stand growth, increases in timber value were then calculated using a table derived from information gathered during all of the previously mentioned mill studies (Fig. 1). Overall, a profit was realized from all but one of the stands. Estimated losses, or profits less than expected, were attributed to several factors: 1) the initial borer population was too high; 2) the stand was too old; 3) the volume of red oak projected at harvest was too low; 4) a combination of factors. Errors in identifying brood trees and marked trees missed by the fellers also reduced treatment efficiency.

Results showed that borer populations can be too high or too low, and that stands can be too old to allow for efficacious treatment. A maximum financial return of $462/acre was estimated in a 100-acre stand, 50 years old with a site index of 80, and a pretreatment borer population level of 3.6 borers/ft^2 of oak basal area that had 1,400 board feet/acre of red oak when treated (Table 3). On the other hand, a loss of $52/acre was estimated in a 22-acre stand, 60 years old with a site index of 50,

TABLE 2.--Pre- and post-treatment population densities of the red oak borer, Enaphalodes rufulus.

Stand No.	ROB[a]/200 FT.^{2} BSA		ROB/FT.^{2} BA		ROB/M BD FT		Percent reduction
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	
62-43	21.0	6.5	4.8	1.4	700	200	69
63-2	10.0	2.0	2.9	0.6	300	60	80
14-62	21.0	7.0	5.5	1.7	1440	500	66
34-28	21.3	3.3	4.7	0.7	660	100	84
34-26	17.4	3.4	3.6	0.7	400	77	81
34-22	16.0	3.7	3.3	0.7	422	90	77

[a]ROB = red oak borer, BSA = bark surface area, BA = basal area, M BD FT = thousand board feet.

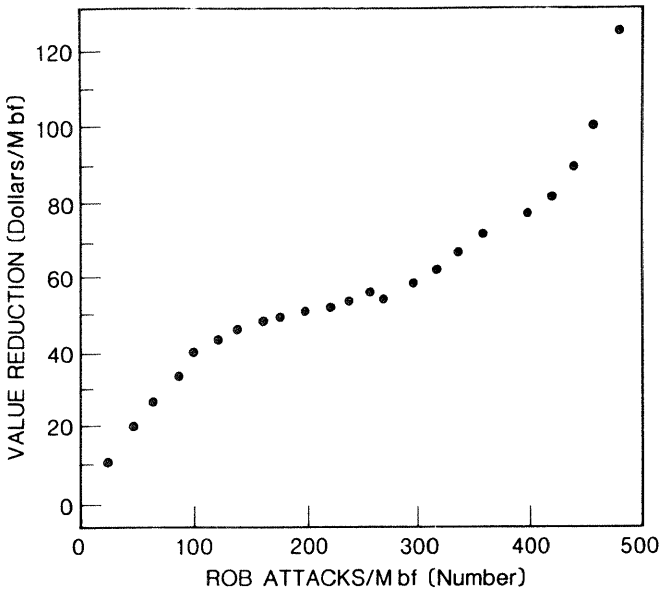

FIGURE 1.--Effect of red oak borer attack density on lumber recovery values.

and a pretreatment borer population density of 5.5 borers/ft.^{2} of oak basal area that had 1,400 board feet/acre of red oak when treated. This estimated loss reflects a high pretreatment borer population density and the advanced age of the stand. This leaves little time to put on clear wood in an 80-year rotation.

Taking red oak borer silvicultural control from the pilot testing phase to the operational phase in production forests looks promising. A 50-percent reduction can be readily achieved by treating stands with borer populations levels less than 30 attacks/200 ft.^{2} of bark surface area. By further tailoring the control to stands between 25 to 50 years old with at least 50 percent oak stocking, the estimated economic returns seem attractive. Ant predation on 2-year-old larvae in cut trees allow this method of control to be used almost any time during the two years it takes the borers to complete their life cycle in the tree. Attention must be given while marking stands for treatment so that brood trees are not overlooked, but are clearly marked and removed on schedule.

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TABLE 3.--Economic evaluation of red oak borer control by stand.

Stand No.	Treatment Cost: Initial	Treatment Cost: Per acre	Treatment Cost: At 6% to rotation	Red oak volume/acre protected	Value increase to lumber	Value increase to stand: Gross	Value increase to stand: Net	Net value increase/acre
62-43	161	11	1655	10448	45/M	7052	5397	360
63-2	400	10	7368	8993	50/M	19785	12416	282
14-62	357	16	1142	1523	0/M	-1142	-1142	-52
34-28	693	41	3978	6424	75/M	8190	4212	248
34-26	952	10	5150	6849	75/M	51367	46217	462
34-22	98	5	446	4067	75/M	6405	5959	284

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