EFFECT OF TIMBER STAND IMPROVEMENT ON POPULATION LEVELS OF THE RED OAK BORER, *ENAPHALODES RUFULUS* HALDEMAN (COLEOPTERA: CERAMBYCIDAE)

David E. Donley

Abstract.--Population levels of the red oak borer, *Enaphalodes rufulus* Haldeman, were estimated over a 4-year period in six 25-year-old oak/hickory stands in east-central Ohio just before, during, and after timber stand improvement (TSI).

Treated stands, 30 ha in total area, had a site index of 60 to 70, an average basal area $22m^2$/ha, and an oak component of $10m^2$/ha. Stand improvement consisted of cull tree removal, an average $5m^2$/ha, by girdling and poisoning. Two stands were treated during the fall of 1977 when red oak borer larvae were in the cambium and four stands were treated in the fall of 1978 when the borers were in the xylem.

Borer attacks per 18.6 m^2 units of host bark surface area were used as a population estimate. Treatment generation population levels were not reduced when TSI was applied to stands with larvae in the cambium. Posttreatment generation population levels in these stands were reduced from pretreatment levels by ca. 12%. Borer populations in stands treated with the larvae in xylem tunnels were not reduced in the treatment generation. Posttreatment levels were ca. 16% above pretreatment levels in these same stands. Population levels in untreated stands were unchanged during the study period. Both the 1977 and 1978 TSI operations removed only 6% of the red oak brood trees from treated stands.

I conclude that cull tree removal as a TSI practice has, at best, little positive effect on reducing red oak borer populations and, in fact, may even increase pest levels in residual stands.

Keywords: Red oak borer, cultural control, oak/hickory, timber stand improvement.

INTRODUCTION

The red oak borer *Enaphalodes rufulus* Haldeman (Coleoptera: Cerambycidae), hereafter ROB, is an important member of a complex of oak timber pests responsible for annual economic losses of $60 to $120 million throughout the Eastern United States (Donley 1974, Donley and Worley 1976). On the basis of 1979 lumber prices, the economic loss from ROB damage is about $50 per 1,000 board feet of factory grade lumber produced, and results from 60 to 280 pest attacks per merchantable tree (Donley 1980).

Hay (1962) reported that pest survival in poisoned trees ranged from 5 to 62% depending on the chronology of tree killing. Donley (1981) reported that ROB attacks were reduced by 90% from pretreatment levels by the removal of infested trees as a stand treatment. Both authors infer that the removal of ROB infested trees as a part of conventional timber stand improvement (TSI) would upgrade quality in residual stands. However, no data are available on how TSI affects borer population levels in managed stands. The objective of the research reported here was to quantify the response of ROB population levels to TSI.

MATERIALS AND METHODS

In 1976, ca. 41 ha of oak/hickory forest on a private holding in Perry County, Ohio were scheduled for TSI and marked by a consulting forester. The 41 ha management unit was even-aged, ca. 25 years old, had a site index of 60 to 70, and averaged 22m^2/ha of basal area per acre. The unit was being managed for timber production and wildlife habitat perpetuation. Tree species used for basal area estimates and marked for removal included: *Acer rubrum* L., *A. saccharum* Marsh., *Carpinus caroliniana* Walt., *Carya cordiformis* (Wangenh.) K. Koch, *C. glabra* (Mill.) Sweet., *C. ovata* (Mill.) K. Koch., *C. tomentosa* (Nutt), *Cornus florida* L., *Diospyros virginiana* L., *Fagus grandifolia* Ehrh., *Fraxinus americana* L., *F. pennsylvanica* Marsh., *Juglans nigra* L., *Liquidambar styraciflua* L., *Liriodendron tulipifera* L., *Ostrya virginiana* (Mill.) K., Koch., *Oxydendrum arboreum* (L.) DC., *Populus* spp., *Prunus serotina* Ehrh., *Quercus alba* L., *Q. coccinea* Muenchh., *Q. prinus* L., *Q. stellata* Wangenh., *Q. velutina* Lam., *Robinia pseudoacacia* L., *Sassafrass albidum* (Nutt.) Nees, *Tilia americana* L., *Ulmus americana* L., and *U. rubra* Muhl.

Timber stand improvement carried out in the study area was based on practices currently being used in Ohio. The treatment consisted of a cull tree removal and crop tree release (Lancaster 1975).

The 41 ha area was divided into eight contiguous "stands" on the basis of a stream and several narrow, steep ravines. Treatments were assigned at random to the stands as follows: TSI in the fall of 1977 (2 stands, 11 ha), TSI in the fall and winter of 1978 (4 stands, 19 ha), and untreated (2 stands, 11 ha).

The basal 2.4 meter section of each red, black, scarlet and white oak $\geq$ 9cm diameter at breast height (d.b.h.) was examined during the fall of 1977 for the 1976 ROB emergence holes and the 1977 early instar populations. The basal area of the oak component averaged 10m^2/ha over the 41 ha. In the fall of 1977, a selected host tree sample was established in each stand and subsequent ROB attacks on the selected trees were counted for the 1978 late instar larval estimate and for the new (posttreatment) generation in the fall of 1979. The sample units were ca. 18.6 m^2 of bark surface area in selected trees along line transects, parallel to the long axis of each stand. If one of the selected trees was lost to natural mortality or TSI, I replaced it for subsequent borer estimates with the nearest tree of the same species and diameter class just outside the original transect. Trees with a 50% probability for producing two or more adults were designated as "brood trees" during the initial ROB populations estimate (Donley 1981).

Treatment effect was expressed as a series of curves generated from insect counts in each stand before, during, and after TSI. Every surviving oak tree in the 41 ha was reexamined during the posttreatment fall and winter of 1979, and the fate of brood trees determined.

RESULTS AND DISCUSSION

Pretreatment ROB population levels in the 25-year-old management unit were about the same as those found elsewhere in Ohio (Donley 1981). They were moderately lower than reported for Indiana (Donley 1980), but were much lower than those reported for Kentucky (Hay 1974). Expressing borer population levels in the three studies as a ratio gives (present study) 12: (Ohio 1981) 11: (Indiana 1980) 19: (Kentucky 1974) 75. Timber stand improvement did not reduce ROB population levels and borer counts in untreated stands remained virtually unchanged during the study period.

Using the number of borer attacks per 18.6 m^2 of bark surface area as a ROB population estimate, variation within stands and between stands is greater than it is between borer generations. The change in ROB level between generations is given in Table 1. Considering ROB infestation levels remaining, in

Table 1.--Mean number of ROB attacks per 18.6 m^2 unit of bark surface area, 1976-79.*

	Generation		
Item	Pretreatment	Treatment	Posttreatment
TSI in 1977[a/]	14.1	12.6	12.4*
TSI in 1978[b/]	11.4	11.5	13.3*
No treatment[c/]	13.5	14.0	13.6*
41 ha average	13.3	13.7	13.2

a/ 19 sample units with 369 trees.
b/ 11 sample units with 210 trees.
c/ 10 sample units with 182 trees.

* Analysis of variance using untransformed posttreatment sample unit means gave no significant differences due to treatment (P=0.05 level).

the stands subjected to TSI, borer damage in residual stands will remain too high to take advantage of quality improvement from ROB control (Donley 1981, Donley and Worley 1976).

Using projected growth and yield values developed elsewhere (Dale 1972) and stand data from the test area, and assuming that current ROB population levels remain constant over the remainder of the rotation to age 80, economic losses will be similar to those found for Indiana (Donley 1980). For example, in 4 ha if we harvest 2,000 board feet of oak lumber attacked by 28 pest generations, we will lose some $1,000 in the quality of the oak resource (Donley 1974).

The failure of TSI to reduce ROB population levels in treated stands refutes the earlier inferences that ROB control could be accomplished without consideration of brood tree distribution. In our stands, TSI selected for larger and better form red, black, scarlet and white oak as crop trees. This selection removed only about 6% of the brood trees, regardless of TSI timing. The average d.b.h. was 11cm for killed oaks, 16cm for crop trees, and 17cm for brood trees.

If an objective of TSI is to shift growth to fewer trees of better form and higher value (USDA Forest Service 1978), this practice also shifts ROB attack to the same trees and seems to negate our aim of quality improvement. The results of this research show that the integration of ROB control with conventional forest management -- TSI -- is possible. However, information available on the delineation of borer brood trees must be incorporated into our definition of a cull tree if we are to improve oak quality in treated stands.

LITERATURE CITED

Dale, M. E. 1972. Growth and yield predictions for upland oak stands. USDA For. Serv. Res. Paper NE-241, 21 p.

Donley, D. E. 1974. Wood borer impact on Appalachian oak. South. Lumberman 229(2848):115-118.

Donley, D. E. 1980. Number, size, and location of red oak borer, Enaphalodes rufulus Haldeman, attack sites on red oaks in Indiana. In H. E. Garrett and G. S. Cox, eds. Proceedings of Central Hardwood Forest Conference III. University of Missouri, Columbia. p. 458-465.

Donley, D. E. 1981. Control of the red oak borer by removal of infested trees. J. For. 79(11):731-733.

Donley, D. E., and D. P. Worley. 1976. Insect impact on production of oak timber. South. Lumberman 223(2896):63-66.

Hay, C. J. 1962. Reduce red oak borer damage silviculturally. USDA For. Serv., Cent. States For. Exp. Stn., Stn. Note 154, 2 p.

Hay, C. J. 1974. Survival and mortality of red oak borer larvae on black, scarlet, and northern red oak in eastern Kentucky. J. Econ. Entomol. 67(6):981-986.

Lancaster, K. F. 1975. A guide to hardwood timber stand improvement. USDA For. Serv., Northeast. Area, State and Priv. For., Upper Darby, Pa.

USDA Forest Service. 1978. Service foresters handbook. USDA For. Serv., Northeast. Area, State and Priv. For., Broomall, Pa.