Comparison of landscape attributes to level of tree damage determined by a rapid estimation procedure for red oak borer, *Enaphalodes rufus* (Haldeman) (Coleoptera: Cerambycidae)

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Objective: To assess red oak borer distribution and relate red oak borer occurrence to landscape features across the Ozark National Forest using a nondestructive rapid estimation procedure developed by the Forest Entomology Lab at the University of Arkansas. This procedure is used to determine the infestation history of northern red oaks in a stand. Twenty-six variables were analyzed of which three were significant and were used to create a model to predict rapid estimation indices for stands containing northern red oak. These three significant variables were percent oak, basal area of northern red oak and size of aspect (north vs. south). This model is a first step in generating more precise and detailed models for determining susceptibility of forest stands to red oak borer outbreaks.

Introduction

Large areas of dead and drying trees can be seen throughout much of the Ozark National Forest (Figure 1) due to oak decline, a widespread disease complex that has been occurring since the 1950’s. It currently affects about 1.6 million hectares in the southeastern United States.

In 2001, the United States Forest Service estimated that oak decline affects over 1 million acres of forest in this area. Red oak borer (Figure 2) is native to eastern North America and ranges from New England to Florida and from Minnesota to Texas. In the past ten years, increasing populations of red oak borer have been implicated as contributing to oak mortality in this oak decline event in Arkansas, Oklahoma and Missouri.

The Ozark Highlands of Missouri, Arkansas, and Oklahoma (Figure 3) along with the Boston Mountains of Arkansas and Eastern Oklahoma have well over 10 million acres of timberland, 90 percent of which is oak or oak pine dominated. Because there is so much oak (Figure 4), there is great potential for damage in this current epidemic.

Methods

A sampling method to quickly assess red oak borer density and infestation history was developed by the University of Arkansas forest entomology lab. This procedure uses a percent crown condition index, which combines foliage transparency due to crown dieback and crown measurement outlines along with a basal emergence-hole index.

Basal emergence-hole index is a categorized count of red oak borer emergence holes on the lowest two meters of the tree. Zero represents no emergence holes; one represents 1 to 5 emergence holes; two represents 6 to 20 emergence holes; and three represents more than 20 emergence holes.

Crown condition index has four categories: zero represents no crown dieback; one represents 1 to 33% dieback; two represents 34 to 66% dieback; and three represents 67 to 100% dieback.

Methods continued

From June through August of 2003, 328 prism plots containing northern red oak were established. Seventy of these were recorded at 0.5-mile intervals using off-highway vehicle trails in several regions of the Ozark National Forest. Fifteen plots were located along the Ozark Highlands Trail, which is accessible only to hikers. These 15 plots were separated by ten to fifteen minutes of walking, which was estimated to be approximately 0.5 miles. Forest Service employees established 467 prism plots randomly generated in ArcView GIS 3.2 between May and August 2003 to assess borer activity across the Ozark National Forest. Of these plots, 328 contained northern red oak and were used to create the model.

Global positioning systems (GPS) were used to navigate to previously determined coordinates and to record newly collected coordinates as plots were being established. All coordinates were transferred from GPS units to the geographic information system (GIS) and used to relate plots according to spatial distribution in all analyses. Prisms used by each group had basal area factors of 10 R² acre.

For each plot, GPS coordinates, species of all trees within the plots, all northern red oak diameters at breast height (DBH) and information to rank insect infestation history were recorded. Sites were classified as high, medium or low infestation based on the average damage estimation of the trees in the plot.

Results and Discussion

An initial regression model relating average REI to the biotic and abiotic variables tested was used in the analysis. Backward elimination was used to remove variables that did not have a significant effect on average REI. The removal criteria was P>0.05.

Three variables remained to create the model: percent oak, basal area of northern red oak and size of aspect. The adequacy of the final model was decided by plotting residual versus predicted values and using standard diagnostic statistics.

Model:

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\text{Average REI} = .9641 + .01656 \times B + .004892 \times C - .2293 \times D
\]

where:

- B = observed percent oak
- C = observed basal area
- D = observed size of aspect

Increase in percent oak = increase in REI = greater infestation
Increase in basal area of northern red oak = increase in REI = greater infestation
If size of aspect is negative (south-facing) = increase in REI = greater infestation
If size is positive (north-facing) = decrease in REI = lower infestation

The distributions of red oak borer populations will be included in a map series to provide advanced warning of red oak borer infestations to the Forest Service, and state agencies as well as private land owners. It will be available through the CAST website: www.cast.uark.edu by the end of 2004.

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