# Site variables and stand factors associated with severe oak decline in the Ozark Mountains of Arkansas

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## Abstract

We studied 32 red oak stands in a watershed on the Ozark National Forest in northwest Arkansas to examine the influence of stand and site factors on the severity of oak decline. Using the importance values of dead red oaks as a classification criterion, nine stands were severely damaged, 13 stands were moderately damaged, and 10 stands had low damage. There were no significant differences between damage classes for stand age, total tree density, site index, and slope percent. Aspect and topographic position did vary by damage class. However, both severely and low damaged stands were associated with the most xeric sites (south-facing aspects near ridgetops). Our results suggest that oak decline is most severe on certain sites, but not all such sites have been impacted by decline.


## Introduction

Beginning in 1999, oak decline in the Ozark Mountains of northern Arkansas and southern Missouri resulted in high mortality of red oaks, primarily northern red oak (*Quercus rubra*), black oak (*Q. velutina*), and southern red oak (*Q. falcata*) Factors associated with this decline included a preponderance of mature and susceptible red oaks (predisposing factor); a regional drought from 1998-2000 (inciting factor); and a large increase in the population of red oak borer (*Enaphalodes rufulus* (Handelman)), a native wood-boring insect (contributing factor).

One of the areas most severely impacted by oak decline was the Pleasant Hill Ranger District on the Ozark National Forest in northwest Arkansas (Figure 1). Field observations on the Pleasant Hill indicated red oak mortality was not uniformly distributed throughout the district. Instead, some stands were heavily damaged while others suffered little to no mortality.

We wanted to investigate what stand characteristics and site factors, if any, were associated with oak decline. This information would allow forest managers to identify which stands are most at risk from subsequent oak declines. This poster examines the relationship between decline and stand density, tree age, site index, percent slope, aspect, and topographic position in severely, moderately, and low impacted red oak stands on the Pleasant Hill Ranger District.

## Methods

In the summer of 2006, 32 red oak stands were selected for study in the Little Piney Creek watershed on the Pleasant Hill. Earlier data collected in 2001 by the Forest Service indicated these stands exhibited varying levels of damage by oak decline. All stands had a minimum red oak basal area (based on living plus recently dead trees) of 20 ft2/ac. Recently dead trees were those that were estimated to have died in the past 5 years. In each stand, ten 0.1 acre plots were established. All living and recently dead trees ≥ 4.5 inches dbh were recorded by species and dbh. Aspect, percent slope, and topographic position were also measured at each plot. Topographic position was recorded on a scale of 1-6 as floodplain, low slope, mid slope, bench, upper slope, or ridgetop. Total heights of two dominant or codominant red oaks per stand were collected for site index. Stand age was found from Forest Service records on year of establishment. Site index curves from Graney and Bower (1971) for the Boston Mountains of Arkansas were used to determine site index at base age 50 for each stand.

Plot data of recently dead red oaks were used to classify the stands into 3 oak decline damage classes: severe, moderate, and low damage. Damage classes were based on importance values of the recently dead red oaks using the formula:

$$\text{Damage IV} = \frac{\text{Relative BA of dead RO} + \text{Relative density of dead RO} + \text{Relative frequency of dead RO}}{3}$$

After stands were grouped into damage classes, means of a given attribute (e.g., percent slope) were compared between classes using Tukey's HSD test in SAS 9.1. Significance was accepted where $P \leq 0.05$.

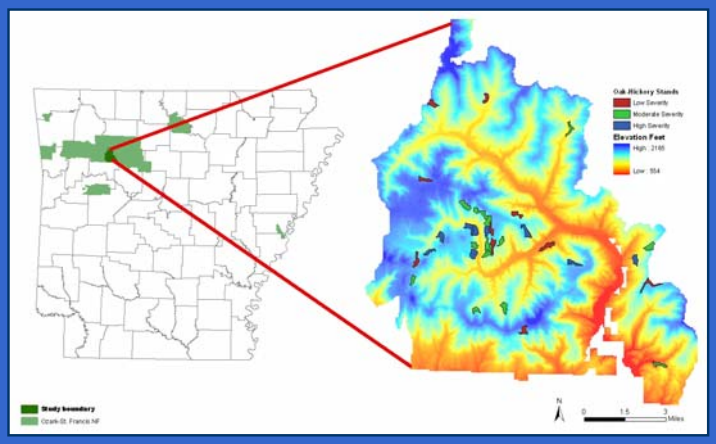


Figure 1. Map of Little Piney Creek watershed with the 32 stands used for analysis.

## Results and Discussion

Damage IVs ranged from 0 to 0.66. Only one stand had no dead red oaks. Nine stands were severely damaged (IV >0.55), 13 stands were moderately damaged (IV 0.4-0.55), and 10 stands had low damage (IV<0.4).

There were no significant differences between damage classes in terms of total age, density, site index, and slope percent (Table 1). Although we anticipated the most severely impacted stands would be relatively old and highly dense on low site indices and steep slopes, this was not the case. However, aspect and topographic position did vary among damage classes. Yet these relationships were not as expected: although severely damaged stands occurred most frequently on southerly-facing aspects and upper slopes, so did stands with low damage.

Although it seems intuitive that forests stressed by resource limitations are more susceptible to oak decline, our results suggest there is little evidence that red oak stands severely damaged by oak decline are older, denser, or grow on poorer sites than stands with lower levels of damage. Although the severely damaged stands we examined do grow on relatively xeric sites, not all xeric sites are associated with moderate or high levels of oak decline. Perhaps factors other than, or in addition to, those we examined, such as crown position or species composition, are important determinants for predicting oak decline.

**Table 1. Means of the three class by variable and p-value.**

| | LOW | MODERATE | HIGH | P-VALUE |
|---|---|---|---|---|
| AGE (years) | 87[a] | 83[a] | 90[a] | 0.5125 |
| ASPECT (azimuth) | 189[ab] | 213[a] | 174[b] | 0.0342 |
| DENSITY (tpa) | 169[a] | 194[a] | 166[a] | 0.063 |
| SITE INDEX (feet) | 62[a] | 67[a] | 64[a] | 0.2311 |
| SLOPE (%) | 21.69[a] | 24.84[a] | 25.06[a] | 0.1889 |
| TOPOGRAPHIC POSITION | 4.46[a] | 3.84[b] | 4.26[a] | <0.0001 |

## Literature Cited

- Graney, D.L. and Bower, D.R. 1971. Site index curves for red and white oaks in the Boston Mountains of Arkansas. USDA Forest Service Res. Pap. SO-121, 4 p. South. For. Exp. Stn., New Orleans, LA



## Acknowledgements

**This study was supported by the U.S. Forest Service Forest Health Monitoring Program - Evaluation Monitoring Project SO-EM-04-02.**