REGENERATION DYNAMICS DURING OAK DECLINE IN ARKANSAS

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ABSTRACT

Methods

From 2000 to 2008 hardwood regeneration <5 cm diameter at breast height were individually tagged and monitored in the Boston Mountains of northern Arkansas. The study site is a 32-ha area in an upland oak-hickory stand that was approximately 70 years old in 2000. Mean basal area for all standing trees in 2000 was 25.9 m^2/ha, and there were 417 standing trees/ha. Stocking was 88 percent. In 2000 we established 480 permanent circular regeneration plots, each with a 1.31-m radius. In each quarter of each regeneration plot, we measured species, distance, azimuth, height, ground diameter, stem age, and origin of the two tallest trees of northern red oak (*Quercus rubra*) and white oak (*Q. alba*). By mid-2001 this stand began to exhibit symptoms of severe oak decline. In 2004, a prescribed fire was applied to one-fourth of the study area.

Results and Discussion

In this preliminary analysis, survival probability of red and white oak regeneration in the burned and unburned areas was examined by using logistic regression. Red oak survival increased with increasing initial stem diameter. For red oak with initial basal stem diameters <7 mm, regeneration had a lower probability of survival in the burned area than in the unburned area. However, for stem diameters of ≥7 mm that relationship was reversed (Fig. 1). Maximum probability of survival for the largest stem diameters for red oak was 0.78 in the burned areas and 0.70 in the unburned area. The highest

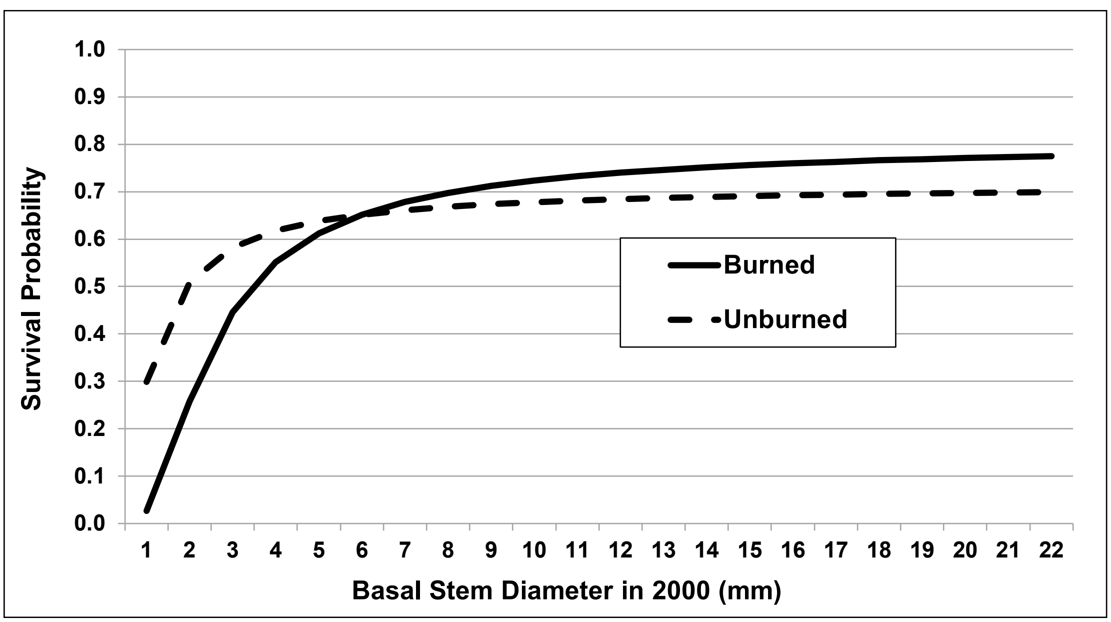

Figure 1.—Probability of 2008 red oak regeneration survival, Boston Mountains, Arkansas.

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probability of survival occurred in stems >6 mm basal stem diameter for both burned and unburned areas. The logistic regression model for red oak regeneration survival in the area treated with prescribed fire in 2004 is as follows:

$$PSROb = \frac{1}{1 + EXP\left\{-\left[1.466 - \left(5.046 * \frac{1}{BSD}\right)\right]\right\}}$$

where
PSROb = probability of survival of red oak regeneration in burned area, and
BSD = basal stem diameter in mm in the year 2000.

The predictor 1/BSD *p*-value was <0.001. The Hosmer-Lemeshow goodness of fit (*p*-value) of the model was 0.317. Small *p*-values designate a poor fit of the equation to the data whereas large values (>0.05) indicate a good fit. Based on the Hosmer-Lemeshow goodness-of-fit statistic, differences between estimated survival probabilities and observed responses were not significant.

The logistic regression model for red oak regeneration survival in the unburned area is:

$$PSROub = \frac{1}{1 + EXP\left\{-\left[0.922 - \left(1.774 * \frac{1}{BSD}\right)\right]\right\}}$$

where
PSROub = probability of survival of red oak regeneration in the unburned area, and
BSD = basal stem diameter in mm in the year 2000.

The predictor 1/BSD *p*-value was 0.007. The goodness-of-fit (*p*-value) of the model was 0.748. As with the results for the model of red oak regeneration survival in the burned area, the goodness-of-fit statistic indicates that the estimated survival probabilities and observed responses were not significantly different.

In the white oak model, stem diameter by itself was not a significant factor. White oak survival increased with increasing initial stem age. However, there was very little difference in white oak survival between the burned and unburned areas with maximum survival probabilities of 0.81 in the burned area and 0.83 in the unburned area for the oldest initial stem ages (Fig. 2). High survival probabilities for white oak began to be reached at a stem age of 5 years. The logistic regression model for white oak regeneration survival in the area treated with prescribed fire in 2004 is below:

$$PSWOb = \frac{1}{1 + EXP\left\{-\left[1.671 - \left(3.209 * \frac{1}{AGE}\right)\right]\right\}}$$

where
PSWOb = probability of survival of white oak regeneration in burned area, and
AGE = stem age in years of seedling in the year 2000.

The predictor 1/AGE *p*-value was 0.001. The Hosmer-Lemeshow goodness of fit (*p*-value) was = 0.287, indicating a good fit of this model to the observed data.

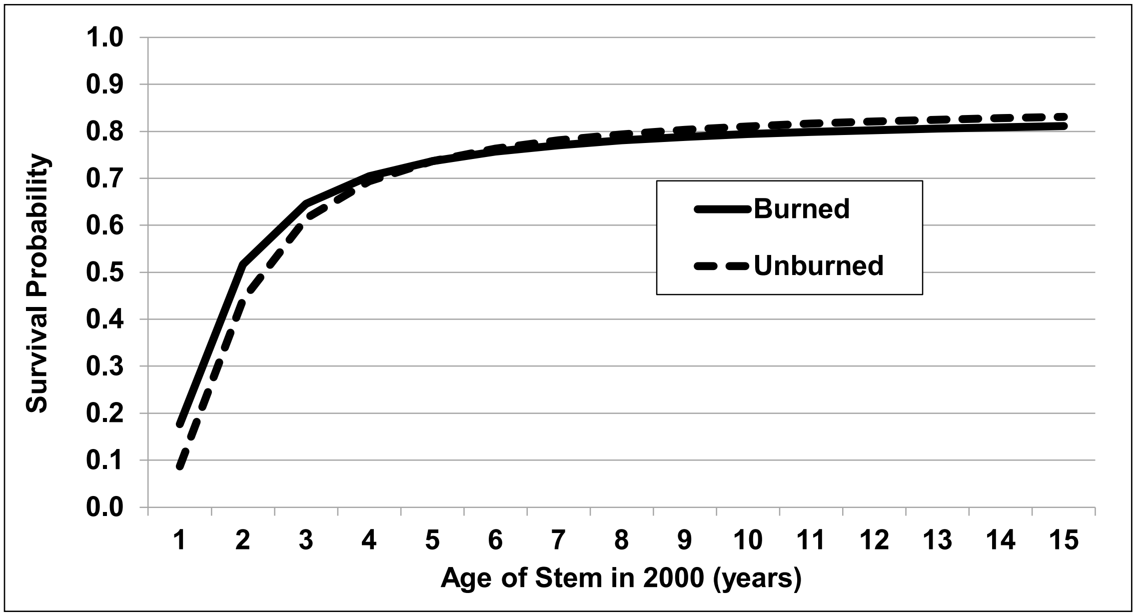

Figure 2.—Probability of 2008 white oak regeneration survival, Boston Mountains, Arkansas.

The logistic regression model for white oak regeneration survival in the unburned area is as follows:

$$PSWOub = \frac{1}{1 + EXP\left\{-\left[1.875 - \left(4.224 * \frac{1}{AGE}\right)\right]\right\}}$$

where
PSWOub = probability of survival of white oak regeneration in the unburned area, and
AGE = stem age in years of seedling stem in the year 2000.

The predictor 1/AGE *p*-value was <0.001. The Hosmer-Lemeshow goodness of fit (*p*-value) was 0.731, which indicates there is no significant difference between the model-predicted and observed survival values.

Conclusions

Based on preliminary results of this study, a reasonable management target for red oak regeneration of ≥6 mm basal stem diameter regardless of fire treatment is recommended. For white oak a 5-year stem age maximized the probability of survival regardless of treatment and may be a useful predictor of survival.