OAK MORTALITY IN EASTERN KENTUCKY[1/]

JEFFREY W. STRINGER, THOMAS W. KIMMERER, AND JOHN C. OVERSTREET[2/]

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INTRODUCTION

During the past several years oak (Quercus spp.) mortality has been noticably heavy in Kentucky and many surrounding states. Preliminary analysis of data presented in this poster summary characterizes the nature of recent canopy tree mortality at the University of Kentucky's Robinson Experimental Forest. Robinson Forest, located in southeastern Kentucky, contains stands typical of the second-growth forests of the Cumberland Plateau and has been subjected to recent regional droughts associated with this mortality.

SURVEY METHODS AND ANALYSIS

A photographic and a ground-based survey were used to determine the distribution of canopy tree mortality. In early September of 1985, photographs were taken from a firetower to determine canopy tree mortality. The survey covered 304 ha, encompassing a broad range of sites and forest types. Data from a ground-based inventory completed in 1982 was used to determine species composition of stands included in the photographic survey. The ground-based inventory was composed of a systematic grid of sample points distributed with a 20 x 20 m square grid. A 10 baf prism was used to determine trees (≥12.5 cm dbh and greater) to be sampled. Data recorded for each tree included, species, dbh, and crown class. Each of the sample points were located on projections of the aerial photographs and live and dead trees (retaining at least a portion of their first order branches) were determined in four quadrants surrounding each point. Mortality was expressed as a percent of the total number of canopy trees and each point placed into one of four mortality classes, <1% (1), 1 <5% (2), 5 <10% (3), ≥10% (4) mortality. Each point was also placed into one of three subjective moisture availability classes (xeric, intermediate, and mesic) based on their topographic position.

PCA ordination using detrended correspondence analysis and reciprocal averaging was used to display the similarity of the sample points relative to species composition as determined by basal area. Sample points on the ordination were subjectively grouped into broad vegetational groups for further analysis. Statistical analysis (ANOVA and DMR) was used to determine mortality differences among vegetational groups and moisture availability classes.

RESULTS AND DISCUSSION

Individual point mortality ranged from 0 to 20%. Mortality class 4, comprised of 5 stands, averaged 16% mortality (2.05 m^2 ha^{-1}). These stands ranged in total basal area from 9.0 to 18.37 m^2 ha^{-1}, and averaged 5 m^2 ha^{-1} basal area for both scarlet and black oak, 1.38 m^2 ha^{-1} white oak, and 0.92 m^2 ha^{-1} mockernut hickory. Mortality class 3 contained 9 stands averaging 7.3% mortality. Scarlet oak was the most prominent species occupying an average basal area of 6.66 m^2 ha^{-1}. Other species having a significant basal area in mortality class 3 included yellow-poplar and chestnut oak. The stands in both of these groups generally occupied mid or upper slope positions having southerly or westerly exposures. Mortality class 1 contained 42 stands and class 2 contained 22 stands, averaging 0.1 and 3.3% mortality, respectively.

Vegetation groups, mortality classes, and moisture availability classes are delineated on the ordination in figure 1. The ordination indicates a gradation ranging from forest types typical of more mesic sites to those occurring on xeric ridge-tops. Points in mortality class 4 are clustered near the junction of the white - red oak, oak-hickory, and red-white oak groups. The oak-pine group, while maintaining scarlet oak as a major component, did not exhibit heavy losses.

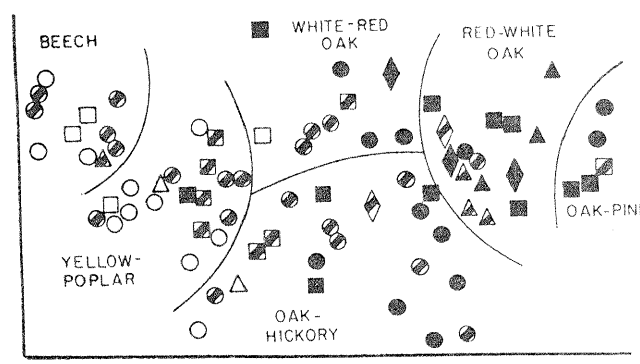

Figure 1.--PCA ordination of inventory points based on basal area of trees ≥12.5 cm dbh. Symbols represent percent mortality classes; circles <1; squares 1 <5; triangles 5 <10; and diamonds ≥ 10. Moisture availability classes are denoted by infill; unfilled-mesic, strip-intermediate, and solid-xeric.

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[2/] Research Specialist, Assistant Professor and Superintendent of Robinson Forest, University of Kentucky, Lexington, KY 40546-0073.

Vegetation groups containing oak as a principal component exhibited greater losses than those that did not. Mortality ranged from 6.3% to 1.9% for the red-white oak and beech groups, respectively. While mortality did not differ statistically among moisture classes, the xeric class did exhibit nearly twice (4.2%) the mortality of the intermediate and mesic classes (2.2% each). Topographic position as it relates to moisture availability therefore can not be used solely to explain the mortality patterns.

While quantification of mortality by species has not been completed, observations of the stands surveyed indicated that scarlet, black, and northern red oaks were experiencing mortality. Hickories were also experiencing mortality. The hickory mortality was often occurring as scattered individuals. While excavations of the root systems of 4 declining and 4 dead oaks uncovered Armillaria mellea rhizomorphs in the surrounding soil, no indication of root infection could be found. No significant tissue necrosis or mycelial fans were present on any of the large lateral roots and the majority of the smaller roots were also unaffected. Evidence of Agrilus bilineatus colinization was found in all declining or dead oak trees examined.

Annual precipitation deficits have occurred since 1980 (fig. 2). Precipitation averaged 116 cm for the years 1920-1970. Between 1972 and 1980, levels were above the 50 year average declining to 75 cm in 1980, and remaining below average until 1984. The trends in total precipitation were also apparent during the growing season. During the period 1980-1985 all months from January to September, with the exception of May, had negative departures. The positive departure in May was due to 23.7 cm of precipitation in May of 1984. All other years exhibited negative departures in May.

Precipitation at Robinson Forest has maintained an average pH of 4.2 since 1972. No recent indications of late spring frost or extreme cold could be found in the weather record, nor has any recent defoliation been encountered at the forest. It should also be noted that no monitoring of atmospheric pollutants other than acidic deposition has been conducted at the forest. Therefore, the only known recent natural environmental perturbation associated with oak mortality at Robinson Forest was drought.

SUMMARY

Average canopy tree mortality ranged from less than 2% for beech and yellow-poplar dominated stands to over 6% for red-white oak stands. Of the 15 stands in the red-white oak group, 3 stands averaged greater than 10% mortality. A subjective classification and analysis of the data by potential moisture availability was not useful in determining differences in stand mortality. This mortality is associated with a 'severe' drought occurring in 1980 followed by several years of below average precipitation. Previous droughts of this nature in the southern Appalaching region in 1925, the 1950's, and 1960's were also associated with mortality similar to the mortality now occurring in Kentucky and surrounding states. Agrilus bilineatus (two-lined chestnut borer) has been found to be directly associated with this mortality. Therefore, it is probable that the mortality patterns are governed by a decline complex involving drought, intra-stand competition, and beetle activity. While the beetle may account for the ultimate death of the individual tree, it can be viewed as a fatalistic biomonitor of stress in these stands.

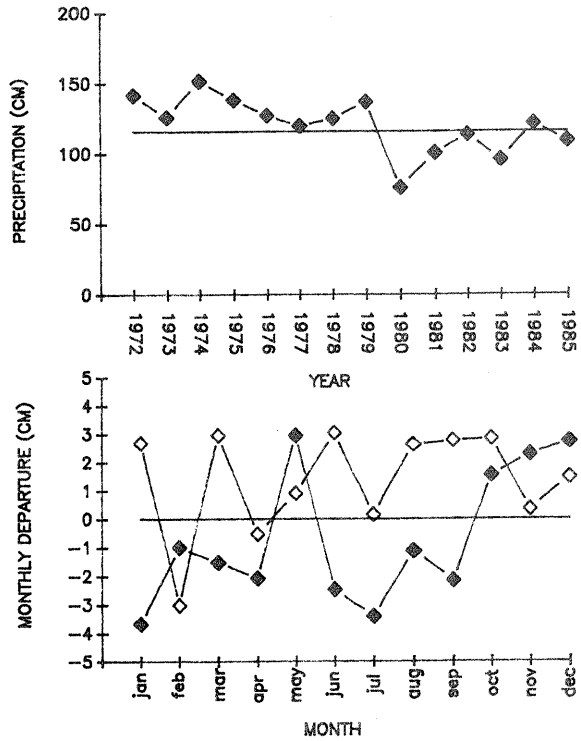

Figure 2.--(Top) Diamonds represent total annual precipitation at Robinson Forest. Solid line represents 50 year mean for eastern Kentucky. (Bottom) Solid diamonds represent mean monthly departures from 50 year means for 1980-1985 and open diamonds 1974-1979.