A FIVE YEAR RECORD OF CHANGE FOR A DECLINING SCARLET OAK STAND IN THE MISSOURI OZARKS 1/

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Abstract -- Oak decline following extreme droughts in 1980 and 1983 was monitored in an uncut 29-acre sixty-four year old scarlet/black oak sawtimber stand showing signs of decline, on the Winona District of the Mark Twain National Forest in Missouri. Annual evaluation of 74 overstory trees and reproduction on 30 1/735 acre plots in the stand shows that the percentage of dead trees in the overstory has increased from 36% in 1984 to 62% in 1987 and that tree species composition in the understory is shifting towards post oak (Quercus stellata Wangenh.) and white oak (Quercus alba L.) with red maple (Acer rubrum L.) and shortleaf pine (Pinus echinata Mill.) appearing even though good seed sources are not readily apparent. No significant increases in grasses, forbs, or undesirable woody vegetation has occurred.

Keywords: forest decline, Mark Twain National Forest, forest ecology, Quercus coccinea Muenchh., Quercus velutina Lam., Quercus stellata Wangenh., Quercus alba L., Acer rubrum L., Pinus echinata Mill.

INTRODUCTION

As early as 1978, large numbers of trees in some scarlet oak stands on the Mark Twain National Forest began dying (Law and Gott 1987). A severe drought in 1980 (Decker 1986) significantly increased the number of oak sawtimber stands exhibiting signs of decline (Robbins et al. 1980). The area of the Forest reporting the largest number of declining stands was a three Ranger District unit with 321,000 acres of National Forest land located in Carter, Oregon, Ripley, and Shannon counties in south central Missouri.

A field survey of oak sawtimber stands there in 1982, found that stands where scarlet oak predominated or occurred in mixtures with black oak over the age of 60 years, located on broad flat ridges had the highest percentage of dead and declining trees (Auerbach 1982). With 70,000 acres of forest type 57 Scarlet Oak and an estimated volume of 28 million board feet in scarlet oak over the age of 60 (USDA-FS 1979), the loss of resource in the three Ranger District area, should the decline continue, could be significant to management (Law and Gott 1987).

Annual precipitation returned to near normal during 1981 and 1982 in the area of the decline. However, a drought of less duration (<4 months) occurred in 1983 from June through September, with two months classified as extreme (Decker 1986). Based on aerial reconnaissance in September and the interpretation of color-infrared photography flown in August of 1983 that showed increasing areas of stressed oak, a decision was made to continue a timber salvage sale program started in 1981.

A question remained: If no harvesting were done in the declining stands, how many trees with decline symptoms might recover? Our purpose was to study the change in health of individual trees in the overstory of a declining stand and the development of trees in the understory.

MATERIALS AND METHODS

Selection of Study Site

In the spring of 1984, a 29-acre segment of an 84-acre, 64-year old stand of scarlet oak sawtimber was left uncut. The larger area had

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been under consideration for a Research Natural Area designation under a cooperative study between the Forest Service's North Central Forest Experiment Station and the National Forest's Eastern Region. The area was seen as representative of the Society of American Foresters former Forest Type 41 Scarlet Oak (1967). This type was dropped in the 1980 Forest Cover Types of the United States and Canada by the Society. The Scarlet oak type is currently referenced as a variant of Type 44 Chestnut Oak (SAF 1980).

This study area was selected because 60% of the overstory trees were scarlet oak over the age of 60 years and the site had not been recently disturbed by fire or logging. The stand was typical of other declining stands as it already had 36% of the overstory in dead trees.

The rapidly deteriorating health of this sawtimber stand and others nearby, resulted in most of the oaks in the area being cut in salvage operations by 1984 with the exception of the reserved undisturbed 29-acre study stand. The study area was bordered on three sides by regenerating stands of oak and oak-pine seedlings/saplings and on the North side by a forest access road which separated the study stand from a young pole/sawtimber stand of mixed oak and shortleaf pine.

PLOT ESTABLISHMENT

Eight 10 factor variable radius plots, two chains apart, were located in the center of the stand on the flatter section of the ridge so that influences from logging adjacent areas and topographic variations could be minimized. The center of each plot was marked and azimuths and distances to trees on the plot were recorded. No attempt was made to replicate the study or the plots as the major reason for the study was to observe and record change in the condition of the individual trees.

All trees 1.5 inches DBH and larger were recorded starting in the summer of 1984. Trees were tallied by species with DBH being measured to the nearest 1/10 of an inch. Based on the condition of the foliage and branches in the crown, each tree was assigned a decline status. A tree was listed as showing "symptoms of decline" if there was flagging (brown or red foliage), leaves were unusually small and yellowing, foliage was sparse, or the tree had one or more bare limbs above green branches.

The classification of "healthy" was given to trees with no symptoms of decline, those showing signs of recovery by refoliation and improved color in leaves, and with no dead branches in the upper crown above the first green branch. Those classified as dead were trees that had passed from a state of decline to one where no live foliage was present in mid or late growing season.

The plots were visited in the spring and fall to record the appearance of each tree at the start and end of the growing season to see what changes in tree health were taking place. All measurements and tree health classifications were done by the senior author. Earlier observations showed that some foliage would die shortly after reaching full leaf or in the last months of the growing season (late August or early September). Visits in the spring and fall were made to determine the best time of the year to evaluate the full impacts of decline.

Changes in the number of seedlings and saplings less than 1.5 inches DBH were recorded using four circular 1/735 acre plots located twelve feet in cardinal directions from the centers of the 10 factor B.A. plots. A total of 30 small plots were located. Considerable care was taken not to step inside the plot radius when recording information. These plots were also measured in spring and fall.

RESULTS

Species Composition

The overstory at first measurement in 1984 had 172 trees that were larger than 1.5 inches DBH. The major species was scarlet oak with 74 trees representing 43% of the trees in the stand. The next species with the highest number of trees was sassafras Sassafras albidum (Nutt.) Nees. with 50 trees accounting for 29%. Blackgum Nyssa sylvatica Marsh. was represented by 26 trees or 15% of the total number in the stand. Both sassafras and blackgum trees were intermediate or suppressed. Black oak Quercus veluntina Lam. and white oak Quercus alba L. each represented 5% of the overstory. Other dominants included four post oaks Quercus stella Wangenh. and one hickory Carya glabra (Mill.) Sweet.

The total stand stocking averaged 90 square feet of basal area per acre. The overstory was predominately scarlet and black oak sawtimber sized trees. The calculated number of trees per acre over 1.5 inch DBH was 172, based on the 74 trees recorded on the 8 plots.

There were 1594 trees per acre less than 1.5 inches DBH in the initial measurement of the 30 1/730 acre plots (see table 1). All of the species present in the overstory were represented in the initial inventory of seedlings. Red maple Acer rubrum L., which had not been recorded in the overstory plots, had 49 seedlings per acre. The stems of small blackgum and sassafras were believed to be too numerous to count. (See table 1.)

Table 1.--Number of Trees Per Acre found in four Measure-Measurements. From 30 1/735 acre plots. Trees 1.5" DBH and smaller.

Species	Overstory Trees	Seedlings 1984	Seedlings 1985/86	Seedlings 1987	Seedlings 1988	Total Seedlings
Scarlet Oak	74	171	+74	+147 -25	+128 -25	470
Black Oak	9	74	-	-	-25	49
White Oak	8	368	+74	+294 -74	-49	613
Post Oak	4	809	+49	-	+49 -128	779
Hickory	1	123	-	-	-	123
Blackgum	26	Numerous but not counted		-	-	-
Red Maple	-	49	-	-	+49	98
Pine	-	-	+25	-	-	25
Sassafras	50	Numerous but not counted		-	-	-
Total	172	1594	+222	+342	- 1	2157

Almost all of the seedlings, as counted in 1988, are still less than two (2) feet tall, with only a few of the blackgum, hickory, and sassafras being taller than two feet.

In 1984, most of the reproduction was post oak, white oak, and blackgum with minor amounts of desirable species. In 1985-86, there were substantial increases in reproduction of white, scarlet, and post oaks and pine. In 1987, there was another significant increase in white and scarlet oak seedlings, although each of them also had some one- or two-year old seedlings that died. The new seedlings appeared to be clumped around certain seed trees rather than uniformly distributed in the stand.

In the spring of 1988, several new seedlings were found, but a number of seedlings that were 1-2 years old the previous fall had disappeared. Overall, there was a net loss of 1 seedling per acre in 1988.

Over the course of four years, there has been an increase in seedlings, particularly ones of desirable species. There has not been a significant increase in grass, forbs, or undesirable woody vegetation, except in isolated openings.

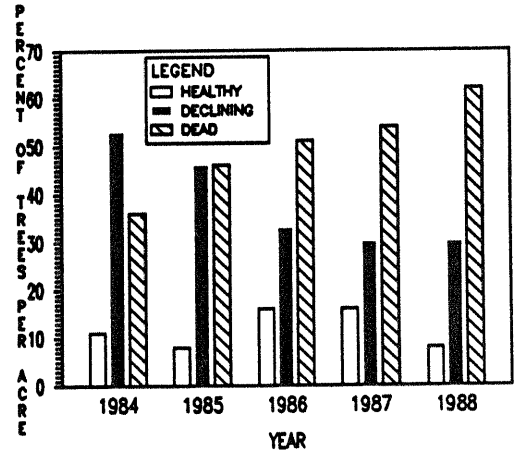

Figure 1.--Changes in health of trees in uncut stand of Scarlet Oak.

The observed changes in tree health over the five year period is shown in Figure 1. Since the summer of 1984, there has been a steady increase in the number of dead trees from 36% in 1984 to

62% in 1988. The number of trees classified as healthy has remained relatively unchanged, from 11% in 1984 to 8% in 1988. In 1986, it appeared that a recovery might be beginning, but by the fall of 1987, the trees that were apparently recovering were once again showing new signs of decline. In the spring of 1988, measurements showed that the conditions had worsened with only one tree showing signs of improved health, while eight others showed increasing signs of decline.

As of June 1988, only 24 of the 74 scarlet oaks were alive and all 9 of the black oaks were dead. The one hickory and all 50 of the sassafras present in 1984 had also died. Only 38% of the original overstory trees were alive at this spring remeasurement. All of the white and post oaks and blackgums were still considered healthy, showing no symptoms of decline. Only one of the surviving scarlet oak was considered to be in a healthy growing condition, while the other 23 had symptoms of decline.

DISCUSSION

It had been recognized that the trees in the stand were predisposed to decline by a combination of adverse weather events (drought and snowless severe winters) and defoliations (late spring frosts and insect attacks such as the looper complex) and that it was the organisms of secondary action (OSA) such as Armillariella mella. Vahl., the black shoestring root rot and Agrilus bilineatus Weber, the two-lined chestnut borer that attacked the stressed trees and caused their death (Sinclair and Hudler 1988; Wargo 1977). We observed that these two agents were very active in the area of the declining stands (Law and Gott 1987; Robbins et al 1980).

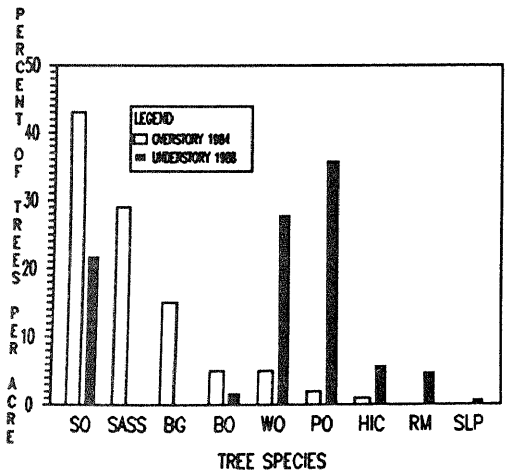

Figure 2.--Changes in species composition in declining Scarlet Oak stand.

By comparing the species composition of the overstory trees in 1984 with the seedling inventory of 1988 (Figure 2), it is apparent that the species change is from a scarlet/black oak type to a future stand with a greater mix of species and one with more trees of the white oak group. Seedlings of post oak, red maple and shortleaf pine are becoming established even though the seed source is sparse or almost non-existent in the immediate area.

At this time, almost all of the seedlings are less than two feet in height with only blackgum, hickory and sassafras having a few taller individuals. Based on an evaluation system for determining the adequacy of oak reproduction to replace the existing stand (Sanders et al 1984), a stocking value (SV) for the current regeneration was determined to be 5. To be able to reasonably insure that the oaks would survive and successfully compete with the many established blackgum and sassafras seedlings, should the overstory be completely removed, the size of the oak seedling would have to increase to where the stocking value was at least thirty, SV = 30. Due to the age and size of the overstory oaks and the fact that many of them are now dead or dying (and not resprouting), the contribution from stump sprouts to the regenerating stand, if the overstory trees were cut at this time, would be very small.

SUMMARY

The observations made concerning the decline and subsequent mortality of scarlet and black oak sawtimber trees in a declining stand in this area of the Mark Twain National Forest are very limited. It is recognized that the reliability of any findings concerning changes in species composition could be improved through the replication of the study and the inclusion of a greater variety of forest conditions and locations.

The objective has been met of establishing a continuing record of changes in tree health for an uncut declining stand representative of common situations where all declining trees were being harvested. Recovery of older scarlet and black oaks now seems very doubtful where they are predominant in the composition of unlogged declining stands on the broad flat ridges of this three District area of the Forest.

This one situation does show that most trees that appear to be healthy and vigorous at the onset of a decline may remain in that condition for at least a five-year period if no other disturbance takes place. This study did not compare what happens to apparently healthy trees left after some harvesting had taken place in a declining stand with one where no man-caused

disturbances occur. A study of this nature would be helpful in making management decisions about future activities in declining stands.

The shift in species composition as shown in the development of tree seedlings in the understory is not totally surprising. The study area is located in Oak-Pine Breaks (Sandstone) landtype association based on the ecological classification system developed on the Mark Twain (Miller 1981). The stand is on an ecological landtype (ELT) 15 which is characterized by a flat landform on a neutral aspect with soils of sandstone origin such as captina and where the naturally occurring vegetation community is Dry chert forest.

In the Dry chert forest community on this ELT, the potential natural vegetation would have white oak, shortleaf pine, black and scarlet oak flowering dogwood, Cornus florida L. and Townbush blueberry Vaccinium vacillans Torr. as dominant plants (Miller 1981). The historic presence of shortleaf pine on the lands in this area has been well documented in the history of the lumber industry in the early days of settlement in Leslie Hills 1949 dissertation, History of the Missouri Lumber and Mining Company 1880-1909. This area has been mapped by Liming as being where the cover of the shortleaf pine was continuous in his The Range of Shortleaf Pine in Missouri (1946) and supported by in the U.S.D.A. - Forest Service publication Atlas of United States Trees, Volume 1 (1971).

Fletcher and McDermott (1957) were able to correlate the occurrence of shortleaf pine with soils of sandstone origin (Roubidoux Formation), and the fact that it was the soil moisture regime that was the most important single factor to influence the relative abundance of pine over large areas. Steyermark (1940 and 1959) recognized oak-pine association as an edaphic climax type in the Ozarks.

The movement of the more drought-hearty shortleaf pine and white oak back to these upland Dry chert forests in south central Missouri may actually be a visual sign that the natural forces of the ecology of the Ozarks are again at work.

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