Recruitment of Shortleaf Pine into the Upper Canopy of Mixed Species Even Aged Forest in Southeast Missouri Ozarks

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Introduction

Shortleaf pine (*Pinus echinata*), historically, had a large distribution throughout the southern Missouri Ozarks and was present in around 44 percent of Missouri's forested land (Fletcher and McDermott 1957). Mixed oak-pine stands are now more common throughout the Ozarks and being researched and managed for habitat and economic values (Blizzard et al. 2007). Forests that represent a shortleaf pine component are estimated to be around 72,000 hectares (Moser et al. 2006). This reduction is due to the unregulated and exploitative logging that took place in the past (Cunningham 2007). Today, very few locales in the Ozarks are a pure shortleaf pine forests (Larsen 2007). Some other species associated with shortleaf pine include; white oak (*Quercus alba*), scarlet oak (*Q. coccinea*), black oak (*Q. velutina*), post oak (*Q. stellata*), and blackjack oak (*Q. marilandica*) (Lawson and Kitchens 1983).

Foresters seem to agree that the lack of natural disturbances, such as fire being absent from the landscape, is a large contributor to the decline in shortleaf pine in the Ozarks (Guyette et al. 2006). Shortleaf pine is uniquely adapted to fire in the early stages of its life (Tauer et al. 2012). Shortleaf pine needs certain conditions to establish and grow such as bare mineral soil, viable seed source, and plentiful sunlight as it is a shade intolerant species (Lawson and Kitchens 1983). Foresters have been attempting to reestablish shortleaf pine into mixed hardwood forests by applying regeneration techniques from past research (Blizzard et al. 2007).

Little research has been done on how shortleaf pine emerges as a dominant in the canopy when growing within a mixed oak-pine forest type. The primary problem in even aged stands seems to be is that early successional shortleaf pine is often overtopped and suppressed by late successional oak if recruitment is not managed throughout its life. Thus, a gap in research exists from the establishment phase, to the pine being a dominant member of the canopy in a mature forest. The purpose of this paper is to: 1) present the problems of shortleaf pine recruitment into an even aged mixed species canopy; 2) present original research from stem analysis that shows the growth required for pines to become dominant or co-dominant members of an even aged mixed species forest canopy; 3) present possible management solutions that will help foresters successfully establish and recruit pines into the upper canopy of even aged mixed species forests in the Missouri Ozarks.

Methods

The study sites were located in the Missouri Ozark Highlands. The counties where sites were located were Carter, Reynolds, Ripley, and Wayne of southeast Missouri (Figure 1). These sites were chosen

based on past management practices to the forest, specifically targeting 20 year old clear-cut stands that had not sustained any other disturbances since the time of the cut. Potential study sites were located by examining harvest records kept by the Missouri Department of Conservation. Ten stands were chosen based on factors such as species composition, hill slope, aspect, and accessibility. Within each stand a 0.05ha plot was located and the shortleaf pine was marked with flagging and the crown position was recorded. When possible, a shortleaf pine from each crown class was selected on each plot. Other information taken at this time was the standing total height, DBH (diameter at breast height), azimuth from plot center.

Figure 1. This map shows the counties of Carter, Reynolds, Ripley and Wayne represented in black.

The first step prior to felling the tree for stem analysis, was to mark the selected trees with a permanent marker at the 25cm, 50cm, 75cm, 1m, 1.25m and 1.37 (DBH). Next, the soil was removed around the base of the tree in order to make a cut at ground level without damage to the chainsaw. Once the soil is removed, a paint line was placed on the opposite side of the marks starting from the ground up to head height so that disks could be oriented properly in the lab. Each tree was then safely felled. In order ensure each disk is able to be collected, the cut was made between the 25cm and 50cm marks. Once the tree is on the ground, all of the limbs were removed. At this time the marks were continued up the tree, every 25cm, to the apical meristem. The felled height was also recorded at this time, keeping in mind that the stump height needed to be added to the total. The paint line was also continued all the way to the top of the tree as well.

Because the tree was felled between the 25cm and 50cm mark, the 25cm disk and ground level disk were to be cut first from the stump. The ground level disk was marked as “G” and the 25cm was marked as “.25”. Thereafter, a disk was cut every 25cm and labeled with the height it was taken at. An additional disk was taken at the diameter breast height (1.375m). Each disk was cut an inch thick to prevent check crack and warp, and to minimize the weight of the disks when carried out of the woods.

The disk size did increase when the diameter of the stem was less than one inch. This facilitated cutting reduces the chance of the bark stripping off, and made it easier to prepare in the lab.

Once the disks are in the lab, each one was sanded. Sanding the disks allowed a clear view of the rings. The rings were counted on each disk and recorded with their respective heights. To ensure accuracy in the counting process, each disk was counted twice. On the second round of counting the starting point is on a different radius than the original. This process was repeated until the two counts were identical.

Results and Discussion

Of the samples collected in the field, 10 of them were classified as dominant or co-dominant in the canopy. Some trees observed multiple disks per one year of growth. This shows that the tree has grown more than .25m in one year. In this instance, the tallest height was used and the others were discarded from the data set. From this reduced data set, the maximum and minimum heights of the trees, for each year, was used to develop a success envelope (Figure 2). The success envelope without the sample trees (Figure 3) is a window in which other trees may be compared to determine if growth patterns are comparable to those observed in this study. By knowing the height and age of a specific shortleaf pine, it may be compared to the success envelope in order to help determine crown class potential. If a tree in question falls within the success envelope, it is growing at a rate consistent with the trees that were known to successfully recruit into the upper canopy. If an observed tree falls below the minimum line of the success envelope, it is growing at a rate slower than that of trees that have successfully made it into the upper canopy. It is important to state that just because a pine falls into the success envelope; it is not guaranteed that the tree will recruit into the canopy.

To illustrate the potential of the success envelope, four shortleaf pines were sampled representing all four crown classes on a single plot (Figure 4). Each tree was plotted against the success envelope from figure 3. The dominant pine on this plot started, and remained within the success envelope throughout its lifespan. The co-dominant pine showed to have better early growth than the aforementioned dominant tree. Around age 16 the growth showed a slowdown in the co-dominant tree that ultimately sealed its canopy position. The intermediate

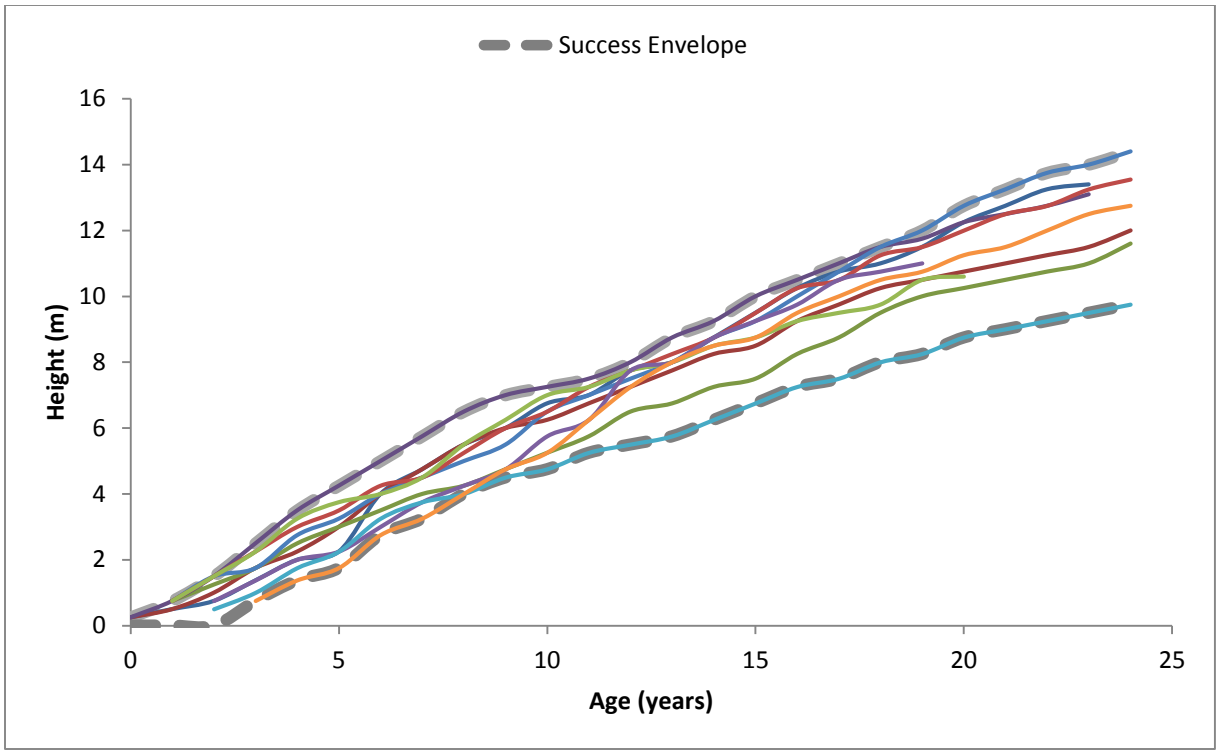

Figure 2. The success envelope was developed out of using the 10 dominant and co-dominant trees. Each of the trees are represented on this graph between the upper and lower limits of the success envelope.

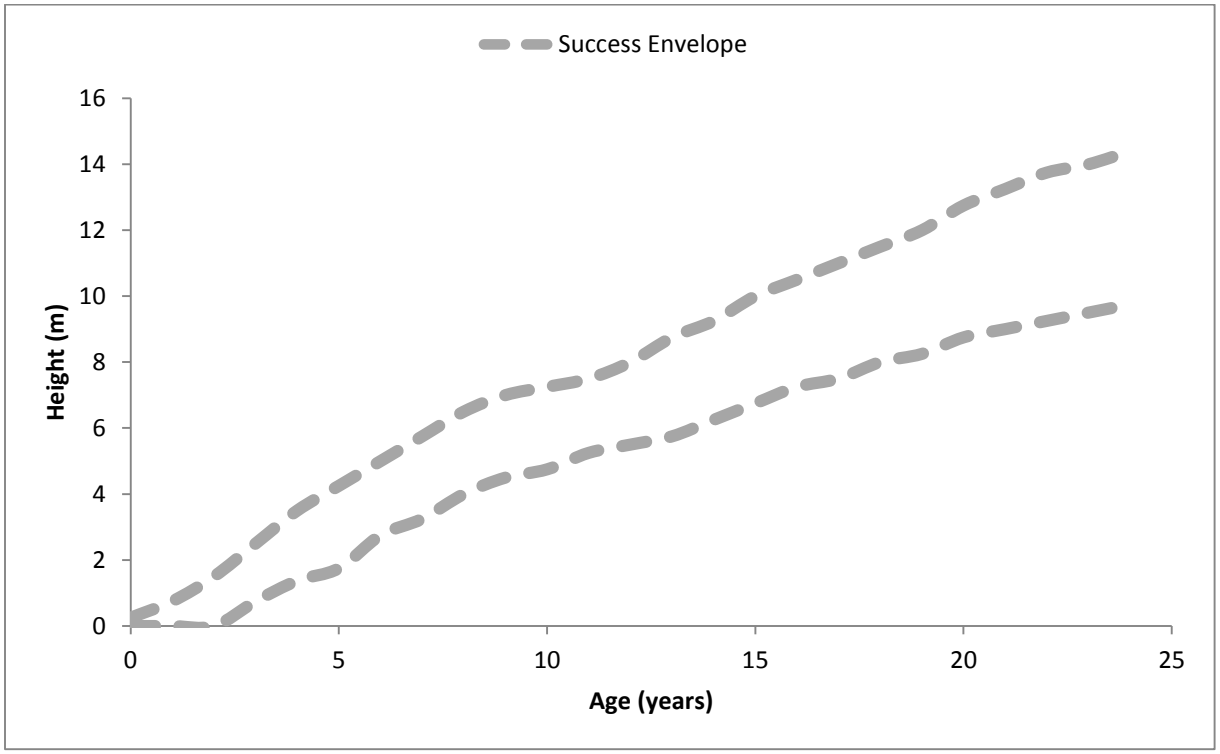

Figure 3. The shaded area of the graph shows a success envelope for other trees to be compared.

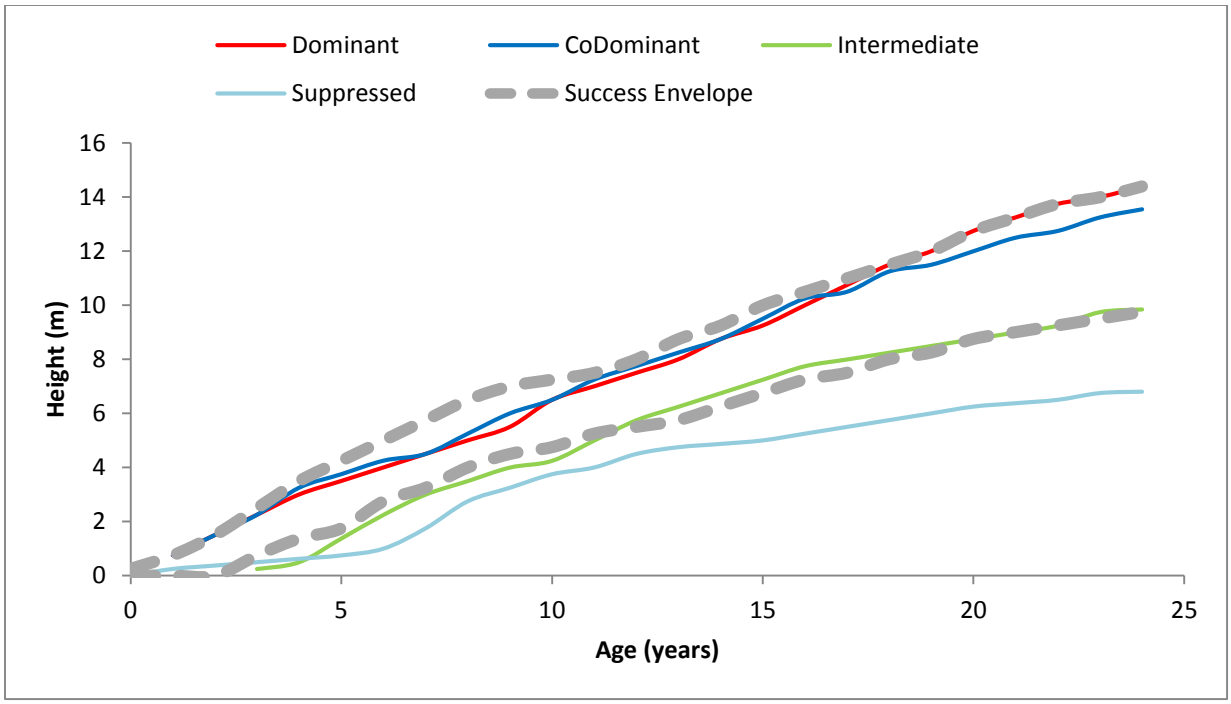

Figure 4. Four trees were taken off of the same plot, in four different crown classes. Each tree is compared against the success envelope represented by the gray lines.

tree in the plot observed growth that started below the success envelope but was able to make it into the envelope around age 12 (Figure 4). At the time of sampling this intermediate tree was on the lower side of the envelope. At this point, the tree was very susceptible to stand crowding. For example, if a tree in this position were released from competition, either autogenically or allogenically, the likelihood to maintain or improve its current canopy position is greater. In the absence of a disturbance the likelihood of this tree to improve or maintain its current canopy position is minimal due to continued competition from neighboring trees. The suppressed tree in this plot showed minimal early growth and therefore had little chance to compete for upper canopy positions (Figure 4). Even when the tree reaches its highest growth rates around year 6, the effects of the early growth deficits had already reduced its potential to compete with currently successful trees.

Conclusion

The results show that shortleaf pine is able to recruit into the upper canopy following a clear-cut in some cases. It also suggests that there is potential to improve shortleaf pine recruitment with timely management. Once a tree has fallen out of the success envelope growth is slowed, making it unlikely to reach the upper canopy without intervention. The intermediate tree in figure 4 is a perfect example of a pine that may have the potential to reach a co-dominant canopy position, but without management or some allogenic disturbance, the pine may not have ever successfully recruited into the upper canopy. The success envelope (Figure 3) can be a useful tool for foresters to evaluate shortleaf pine recruitment into the canopy. By comparing growth rates of other pines to the success envelope, it may be possible to determine when thinning is appropriate or when a tree growing a sufficient rate without intervention.

This tool provides researchers a baseline growth rate that silvicultural systems should strive to maintain. Future researchers in this field can use this data in order to develop silvicultural interventions that improve the chances of shortleaf pine successfully recruiting into the upper canopy of mixed species, even aged forest. More research on the effectiveness of treatments to establish pines is needed. However, if existing pines are not able to successfully recruit into the upper canopy, and eventually serve as a seed source for future rotations, any gains that may be realized through establishment research will have been wasted.

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