REGENERATION OF AMERICAN BEECH (FAGUS GRANDIFOLIA EHRH.) IN MICHIGAN: INTERACTIONS OF BEECH BARK DISEASE AND MANAGEMENT PRACTICES

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Abstract

Distribution and origin of American beech (*Fagus grandifolia* Ehrh.) regeneration is being studied as part of the Michigan Beech Bark Disease Monitoring and Impact Analysis System. As overstory basal area of all species decreased in stands, the amounts of beech regeneration and total regeneration increased. Both beech regeneration and regeneration of all species were more abundant in the Upper Peninsula compared to the Lower Peninsula. The majority of beech regeneration in Michigan was of seed origin. Also, more beech regeneration and total regeneration were present in mechanically thinned stands as compared to unthinned stands. As overstory beech trees are killed by beech bark disease and overstory basal area decreases, both beech regeneration and total regeneration will probably increase in affected stands. Currently, stands with beech bark disease have lower beech regeneration and total regeneration; this is likely a result of management practices that have lead to the maintenance of high basal areas since many of these stands are in state parks. Structural and compositional changes in regeneration are expected to be observed in infected stands once beech bark disease has been present for a greater length of time, overtaking the effects of past management practices.

Introduction and Literature Review

The major objectives of this regeneration study are to: (1) determine location and size distribution of beech regeneration and regeneration of other overstory species in Michigan's northern hardwood stands, (2) monitor changes in beech regeneration and total regeneration in relation to beech bark disease, (3) determine origin (seed or sprout) of beech regeneration in Michigan and (4) study influences of management practices on beech regeneration and total regeneration. American beech can reproduce either by seed or vegetatively by root sprouts; the extent of each type has been little studied (Jones and Raynal, 1986; Held, 1983; Ward, 1961). In the absence of disturbance sexual reproduction is thought to be the most common form of reproduction throughout most of its range.

Asexual reproduction of beech occurs mainly in the beech gaps of the Smoky Mountains (Russell, 1953) and in more severe environments in the northern and western parts of its range (Ward, 1961). Beech sprouts generally occur when the roots are injured, causing adventitious buds to form, although sprouts can occur where injury is not evident (Tubbs and Houston, 1990; Held, 1983). Beech sprouts are more abundant on exposed south-facing slopes where freeze and thaw activity can damage shallow roots and stimulate sprouting (Held, 1983). Although beech sprouts have high mortality rates, they also have rapid growth and there is continual production of new sprouts, ensuring that the mechanism of asexual sprouting contributes significantly to individuals reaching the sapling stage (Forcier, 1973).

Methods

The 61 forest stands used in this study were part of the Beech Bark Disease Monitoring and Impact Analysis System (Thompson and Witter, 2002) (Figure 1). In each stand regeneration plots were placed at every other prism point beginning with the first, for a total of 15 regeneration plots per stand. Plots were 2m X 10m, with the prism point centered on one short edge and the long sides extending out in the direction of the next prism point. Each plot was divided into 4 quadrants.

Within each regeneration plot, all trees >90 cm in height and <12.5 cm in diameter at breast height (DBH) were identified to species and tallied by height class: (1) 0.91-1.20 m, (2) 1.21-1.50 m, (3) 1.51-1.80 m and (4) >1.80 m. Presence or absence of American beech ≤ 90 cm in height was recorded for each quadrant, and overall beech seedling density (low, <10%; medium, 10-25%; high, >25%) was determined for each regeneration plot based on the percentage of the plot area covered by American beech seedlings and then an average density per stand was calculated (Figure 1).

Origin (seed or sprout) was determined for 60 beech stems (four stems per regeneration plot) ≤ 90 cm tall within each stand. If the regeneration plots did not contain enough individuals, origin was determined for stems outside the plots but within the stand. Origin was

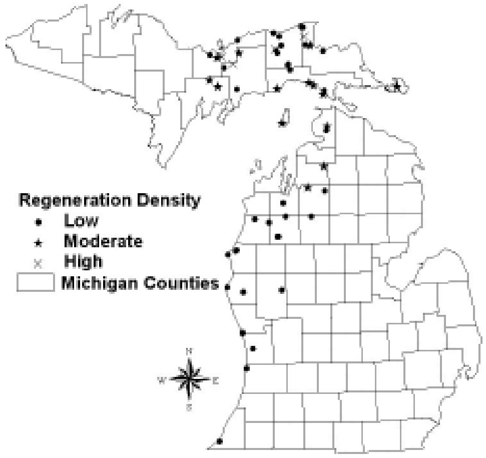

Figure 1.–Location of research stands and regeneration density in Michigan. Overall beech seedling density (low, <10%; medium, 10-25%; high, >25%) was determined for each regeneration plot based on the percentage of the plot area covered by American beech seedlings and then an average density per stand was calculated.

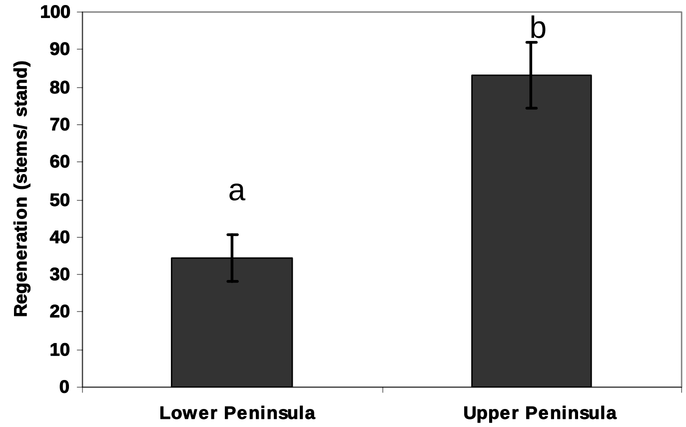

Figure 2.–Mean amounts of beech regeneration in the Lower and Upper Peninsulas of Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different.

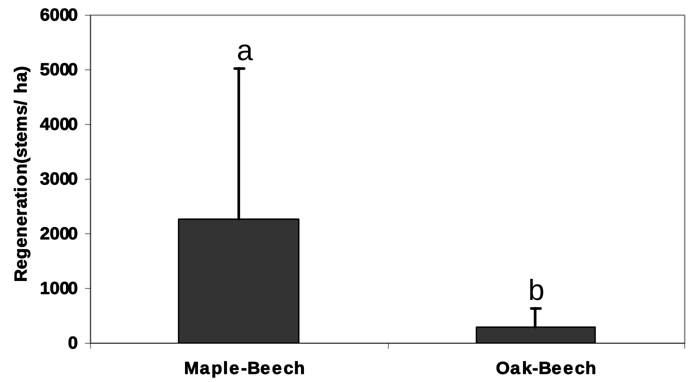

Figure 3.–Mean amounts of beech regeneration in two forest types in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different.

determined by removing debris from the base of the stem and searching for lateral roots, which easily distinguished seed or sprout origins.

Results and Discussion

Beech regeneration was more abundant in stands that had lower overstory basal area, whether from natural disturbances or anthropogenic factors. Lower growing season, higher precipitation, and absence of beech scale were important factors in explaining where high amounts of beech regeneration were found. Stands located in close proximity to Lake Michigan and Lake Superior had the longest growing seasons (Albert et al., 1986). Beech and all species regeneration was more abundant in the Upper Peninsula (UP) compared to the Lower Peninsula (LP) (Figure 2). The stands with the highest amounts of beech regeneration were along the coast of Lake Superior, and some were in areas that had been thinned. Stands thinned in the late 1980's and early 1990's are likely to have higher amounts of advanced regeneration (stems > 1.8m) 10 to 20 years later. A combination of the lake-moderated climate along with the presence of thinning may explain the higher amounts of beech regeneration in these areas.

Significantly more beech regeneration is present in stands dominated by sugar maple and American beech or compared to stands with a strong northern red oak (*Quercus rubra* L.) component (oak-beech) (Figure 3).

Amounts of beech regeneration were lowest in the oak-beech stands due to their lower productivity and lower moisture availability.

As BBD progresses throughout Michigan, the gaps created by the death of overstory beech will likely be dominated by beech and sugar maple regeneration (Forrester and Runkle, 2000; Woods, 2000; Barnes et al., 1998; Barnes, 1991). These are the most common species currently present in the understory of the northern hardwood stands that were studied; both of these species respond positively to canopy gaps. The dense canopies found in northern hardwood forests often exclude regeneration of other tree species. Twery and Patterson (1984) predicted that the beech-sugar maple forest type would be very successful after BBD moves through a stand. Houston (1975) found that while the structure of forests in Maine were very different after BBD moved through than before this disease was present, beech was still a very important component in terms of both relative numbers of stems and basal area following disease outbreak. Others have also extensively studied replacement patterns of beech and sugar maple (Hane, 2003; Forrester and Runkle, 2000; Poulson and Platt, 1996; Runkle, 1981; Woods, 1979). From these studies, it seems likely that future stand composition may depend at least partially upon climatic conditions of the area. In southern Michigan, self-replacement of beech may be frequent (Forrester and Runkle, 2000; Poulson and Platt, 1996) but in northern Michigan where severe climates are present, reciprocal replacement- in which the presence of overstory beech promotes sugar maple regeneration- may be common (Runkle, 1981; Woods, 1979).

Beech reproduction by seed was by far more common in Michigan as compared to reproduction by sprouting, which differs from findings in the eastern U.S. and Wisconsin (White, 1991; Jones and Raynal, 1986; Held, 1983; Ward, 1961) (Figure 4). When sprouting did occur, this type of reproduction was more common in the Lower Peninsula compared to the Upper Peninsula, again differing with Ward's (1961) Wisconsin study (Figure 4). Held (1983) determined that freeze-thaw injury is a primary cause of beech sprouting. The Lower Peninsula is more vulnerable to late spring freezes and frost throughout the growing season as compared to the Upper Peninsula (Albert et al., 1986); this may explain the high numbers of beech sprouts in the Lower Peninsula relative to the Upper Peninsula.

Regeneration by sprouting was similar in stands with and without BBD (Figure 4). Jones and Raynal (1986), studying stands in NY, also found that BBD did not seem to have a stimulatory effect on sprout production. However, number of beech sprouts was also similar in unthinned and thinned stands in Michigan, in contrast to findings of White (1991), who determined that sprouts of several species, including beech, dominated woody plant biomass after harvesting in Maine (Figure 5).

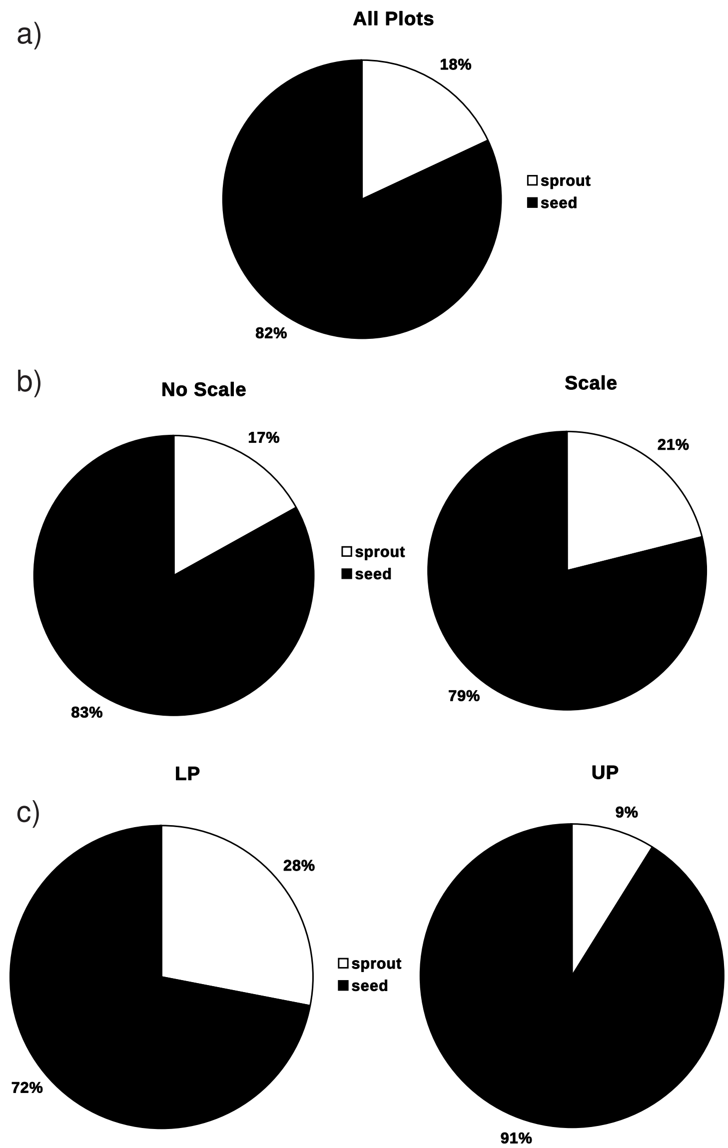

Figure 4.–Percent of beech stems from seed and sprout origins in a) all research stands in Michigan b) stands with and without beech scale and c) the Lower Peninsula (LP) and Upper Peninsula (UP) of Michigan.

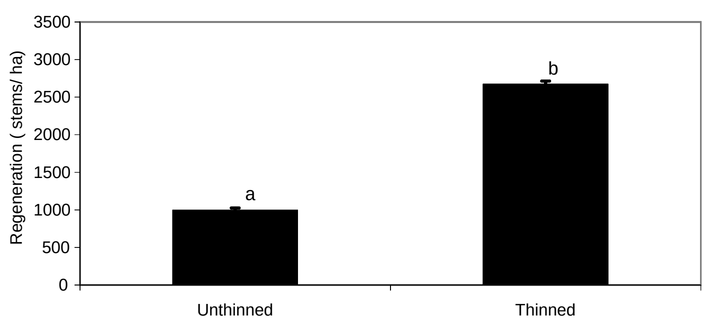

Figure 5.–Mean amounts of beech regeneration in unthinned and thinned stands in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different.

Acknowledgments

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Contains invited papers, short contributions, abstracts, and working group summaries from the Beech Bark Disease Symposium in Saranac Lake, NY, June 16-18, 2004.

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