Natural oak regeneration after clearcutting on the Hoosier National Forest

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Project overview

We examined 32 clearcut sites on the Tell City Ranger District of the Hoosier National Forest (HNF) (Figure 1) to examine regeneration of oak *(Quercus* spp.) in relation to site variables; this study is a follow-up to work done in 1987 by Fischer et al.

Oaks play a very important role in the Central Hardwood Forest Region (CHFR) historically, ecologically and commercially (Figure 2). Even-aged silviculture has been deemed the most suitable method for oak regeneration in the CHFR (Roach and Gingrich, 1968); however, many studies have observed that oaks are being replaced by less desirable hardwood species (Heiligman et al, 1985; Hilt, 1985; Fischer et al, 1987; Wright et al, 1998; Shostak et al, 2002). Mesic sites are most often dominated by maples (*Acer* spp.), yellow-poplar (*Liriodendron tulipifera*), white ash (*Fraxinus americana*) and various other less desirable species, while oak species have better success on more xeric sites.

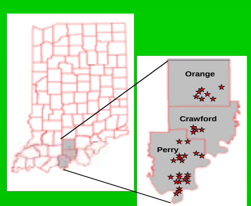

Figure 1. Location of the 32 stands in the Tell City District of the Hoosier National Forest.

Figure 2. Example of a mature oak.

Figure 3. Typical sampled stand.

Methods

Sites ranged in age from 22-35 years and were 2.2 to 20.2 hectares (ha) in size, while distributed across a variety of landscapes (Figure 3). A total of 572 permanent plots were established to evaluate species composition change on clearcut sites over time. Aspect, slope percent, elevation, stoniness, slope position and average canopy height were determined at plot centers.

A 63.7 x 63.7 meter grid was generated over the stand and sample plots were established at grid intersections, for a resultant sampling intensity of 2.5 plots/ha. Regeneration sampling consisted of recording all trees < 2.54 cm diameter at breast height (DBH) by species in a 0.004 ha plot. Individual tree data in a 0.04 ha plot included species, DBH, crown classification (suppressed, intermediate, or dominant), estimates of merchantable volume, and estimation of origin (sprout vs. seed) for all trees with a DBH > 2.54 cm. If a measured tree hosted any grapevines, all were tallied and vine diameter recorded.

References: Beers, T. W., P.E. Dress and L.C. Wenzel. 1966. J. For. 64:691-692; Fischer, B.C, J.A. Kershaw, D.W. George, C.A. George and W.L. Mills. 1987. In. Acad. Sci. 96:231-242; Heiligman, R.B., E.R. Norlund and D.E. Hilt. 1985. N. J. App. For. 2:17-22. Hilt, D.E. 1985. *In:* Proc. 5[TH] Cent. Hard. For. Conf., p. 11-14; Jenkins, M.A. and G.R. Parker. 1998. For. Ecol. Manage., 109:57-74; Roach, B.A. and S.F. Gingrich. 1968. USDA For. Serv., Ag. Hand. 355; Sander, I.L. and D.L. Graney. 1992. USDA For. Serv. GTR SE-84. p. 174-183; Shostak, D., M.S. Golden and M.R. Dubois. 2002. *In:* Proc. 11[th] Bi. South. Silv. Res. Conf. USDA For. Serv. GTR SRS-48. p. 383-389; Van Kley, J. E., Parker, G.R., Franzmeier, D.P., Randolph, J.C. (1994). Field Guide: Ecological classification of the Hoosier National Forest and surrounding areas of Indiana. Bedford, IN, Hoosier Nat. For., USDA For. Serv.; Wright, D.K., D.Wm. Smith, S.M. Zedaker and T.L. Sharik. 1998. *In:* Proc. 9[th] Bi. South. Silv.

Analysis

We considered only dominant-codominant trees of the 1987 and 2004 data sets because they are the best indicators of what species are established on a site. This may provide us with a clearer glimpse of future stand composition.

We used the importance value (IV=RD+RF)/2) to examine nine species groups of interest across aspect and slope positions. Change in the IV of each species group over the 17 year time period allows us to examine how these species compete for resources in this period of stand development.

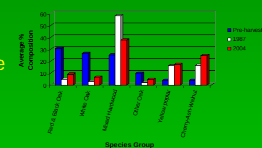

Figure 4. Average stand composition in Tell City Ranger District for pre-harvest, 1987 and 2004 measurement periods.

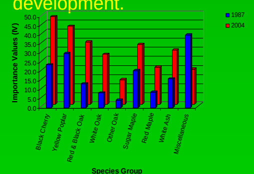

Figure 5. IV for species groups of interest in Tell City Ranger District for 1987 and 2004 measurement periods.

Results

The concern regarding decline of oaks in the CHFR appears to be valid. Average percent dominant species composition for six species group are shown in Figure 4. It is evident that the composition of sampled stands looks much different today. Pre-harvest stands were dominated by oak species, an average of 66.8 percent, with a relatively small percentage of yellow-poplar, black cherry, ash, and walnut. The post-harvest data shows a considerable shift in average species composition of these stands.

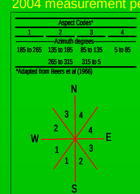

Figure 6. Aspect transformation codes.

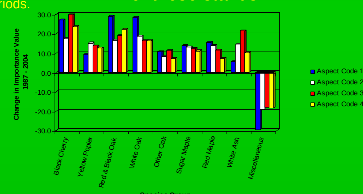

Figure 7. Change in IV of species groups by aspect code in Tell City Ranger District between 1987 and 2004 measurement periods.

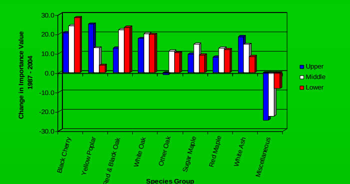

Figure 8. Change in IV of species group by slope position in Tell City Ranger District between 1987 and 2004 measurement periods.

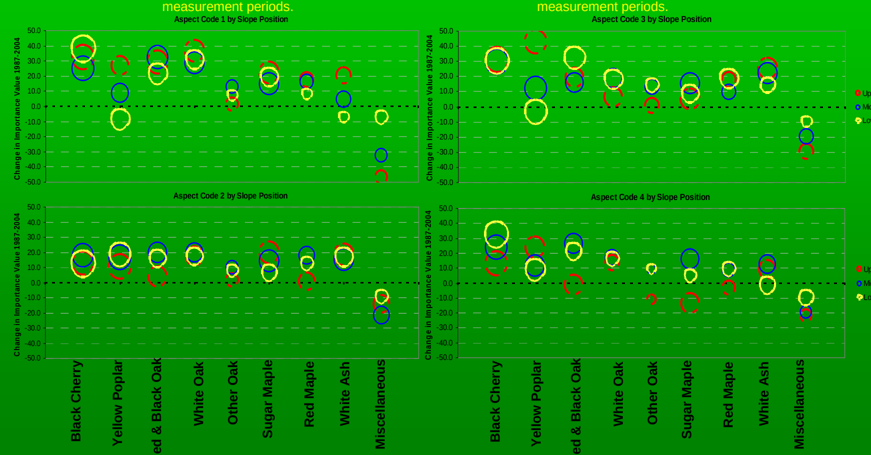

Figure 9. Change in IV of species group by aspect code and slope position in 32 sampled stands of the Tell City Ranger District between 1987 and 2004 measurement periods. Each bubble represents the change in IV for a species group on a given slope position; the size of the bubble also indicates the average IV of the species group within the stands today.

Results continued

The black cherry, red and black oak, and white oak groups showed the largest increases in IV over time, while more mesic species such as sugar maple, red maple, white ash and yellow-poplar made more modest gains in IV (Figure 5).

The change in IV of the species groups across slope aspect codes (Figure 6) shows that on the poorer sites, aspect codes 1 and 2, the red and black and white oak groups show substantial improvements alongside the black cherry group (Figure 7). In aspect codes 3 and 4, again the red and black and white oak groups make notable gains, although black cherry has the greatest increase in IV on both aspect codes.

An examination of the data across slope positions shows that on the lower and middle slope positions, black cherry exhibits the greatest positive change over time in IV, followed by the red and black oak group and the white oak group (Figure 8).

The white oak group is the only group to exhibit a positive increase in IV across all categories when influence of slope and aspect are combined (Figure 9). The red and black oak group showed modest to great improvement in IV across all categories with the exception of aspect code 4 on the upper slope positions. The other oak group showed a similar pattern, although it had very modest gains in the upper slope positions overall.

Despite limited success of oak regeneration relative to pre-harvest conditions of sampled stands, the picture may not be as bleak as much literature would suggest. The fact that all three oak groups increased in IV across all categories of combined aspect code and slope position but one, speaks to the competitive ability of oaks the period of stem exclusion. These findings are important because they exhibit oaks ability to withstand intense competition for resources on these productive sites at a critical period of stand development.

Future directions

We will conduct a more thorough investigation of the influence of site and age on the changes in oak composition over time. From that information we hope to better identify suitable variables to characterize the potential for natural oak regeneration across various sites. We will also examine the potential for oak-dominated sites to naturally regenerate to their pre-harvest Ecological Landtype Phases (ELTP) designations, as defined by Van Kley et al. (1994), within the HNF.