Long-Term Evolution of Composition and Structure After Repeated Group Selection: 80 Year Results

Nicole S. Rogers, Anthony W. D'Amato, and William Leak[1]

INTRODUCTION

Selection systems have a long history of application across a range of forest types as a means for sustained yield and preserving diverse forest structure (O'Hara 2002). In the northeastern United States, group selection is a commonly used method for management of northern hardwood forests (Leak et al. 2014). This approach is well regarded for maintaining uneven-aged stand attributes as well as retaining a range of shade tolerant and intolerant species. However, forest characteristics following management with group selection are primarily assessed at the stand level. This approach leaves uncertainty about ecological developments at the cohort level as well as the cumulative influence of each cohort over time.

STUDY SITE

To further explore these knowledge gaps, we examined a long-term group selection study at the Bartlett Experimental Forest in New Hampshire (Rogers et al. 2020). The Bartlett Experimental Forest is home to one of the longest running group selection treatments in North America with repeated application over eight decades. The duration of this study provided a unique opportunity to evaluate structural and compositional evolution at the stand and cohort level. Specifically, we assessed the stand-level diameter distribution and overstory composition relative to individual cohorts.

RESULTS AND DISCUSSION

Results highlight cohorts developing as small even-aged stands that collectively create an uneven-aged condition at the stand level. For example, the overstory stand diameter distribution follows rotated sigmoid curve, a shape seen in other uneven-aged northern hardwood forests (Fig. 1). The stand distribution shape was largely influenced by the number of small stems in the 1993 cohort as well as the number of large trees in the 1938 and matrix cohorts. Overstory trees are those 11.43 cm at breast height or greater. Stand structure is also the result of mortality and successional dynamics within each cohort. The elevated levels of pin cherry (*Prunus pensylvanica*) downed woody material ($m^3\ ha^{-1}$) in the 1960 cohort and paper birch (*Betual papyrifera*) downed woody material in the 1960 and 1951 cohorts reflect the ecological properties of these species, specifically, their short life span relative to other northern hardwood species (Burns and Honkala 1990). The amount of American beech (*Fagus grandifolia*) downed woody material across cohorts is the byproduct of beech bark disease. The disease complex, part nectria canker (*Neonectria spp.),* part scale insect (*Cryptococcus fagisuga*), has been present in the region since the early 1900s (Houston 1975). As mature American beech succumb to the disease, overstory trees are replaced by dense thickets of root suckers increasing overall composition of American beech relative to

[1] Assistant Professor of Silviculture (NSR), University of Maine, Nutting Hall, Orono, ME 04469; Professor (AWD), Director of the Forestry Program and Director of UVM Research Forests, University of Vermont, Burlington; Research Forester (WL), U.S. Department of Agriculture, Forest Service, Northern Research Station, Durham, NH. NSR is corresponding author: to contact, email nicole.s.rogers@maine.edu.

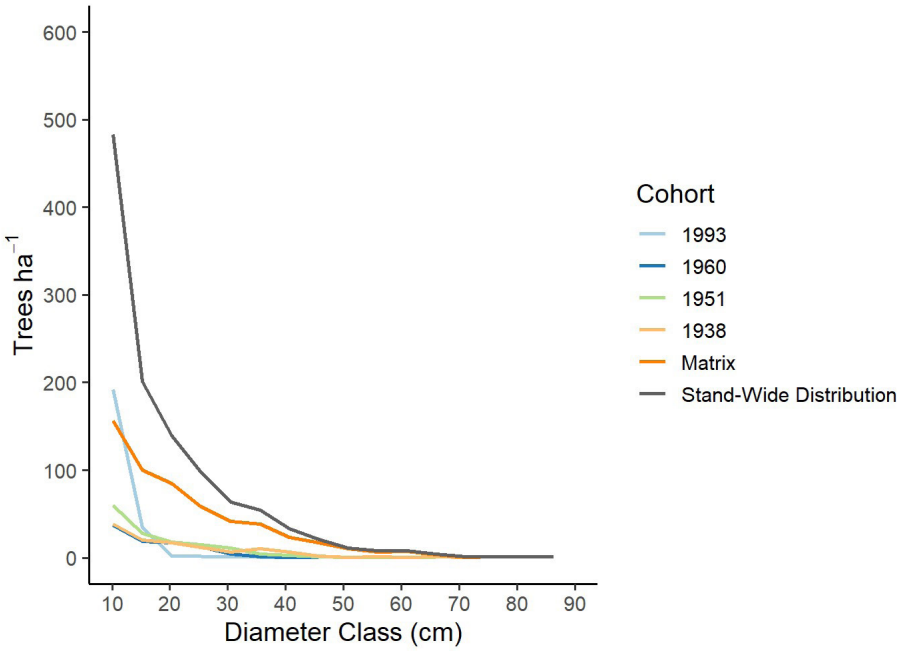

Figure 1.—Overstory diameter distribution (tree ha-[1]), cohort-level, and cumulative stand outcomes.

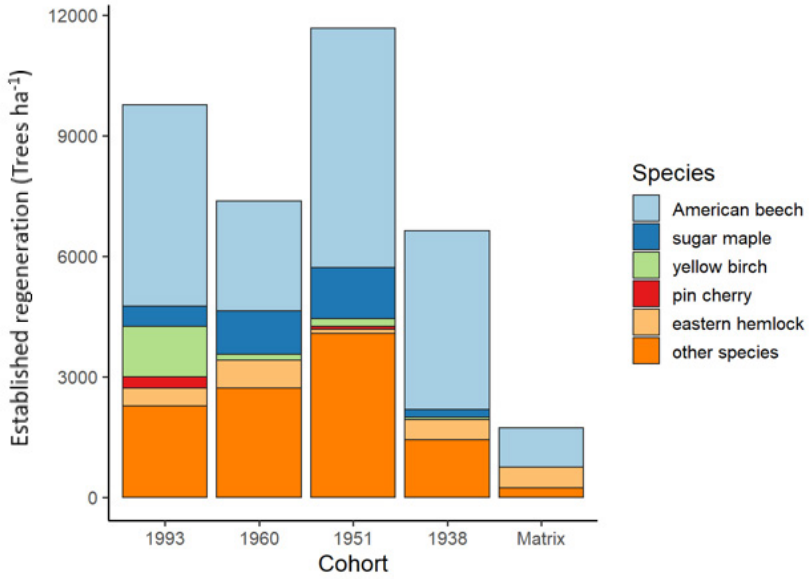

Figure 2.—Density of established regeneration (trees ha-[1]) by species and cohort.

other more commercially desirable species like sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*). Dominance of American beech is especially likely, and problematic, on moderate to poor sites, including those at the Bartlett Experimental Forest. A benefit of group selection on such sites is the maintenance of species with a wide range of shade tolerances (Leak et al. 2014). The cumulative stand includes more shade tolerant species, such as eastern hemlock (*Tsuga canadensis*) and American beech, but also intolerant and mid-tolerant species. Species diversity is also seen in the regeneration layer following each harvest (Fig. 2). Although American beech is still dominant in this smaller size class, sugar maple and yellow birch regeneration are present in all cohorts excluding the matrix. These findings suggest group selection maintains diverse regeneration even on a moderate site. Over time, cohort development mirrored

successional dynamics associated with even-aged forest systems while stand-scale attributes reflected conditions anticipated in uneven-aged systems. These long-term results offer important knowledge about processes that may impact recruitment of desirable regeneration. Further, these findings provide important details on emergent cohort and stand-level conditions for forests managed using this approach over numerous cutting cycles.

ACKNOWLEDGMENTS

We thank Ella Chapman for help with field data collection. We also thank Mariko Yamasaki and Chris Costello of the USDA Forest Service, Northern Research Station, for help locating field sites and for providing additional context for this work. Funding was provided by the University of Vermont Rubenstein School of Environment and Natural Resources and USDA Forest Service Northern Research Station.

LITERATURE CITED

Burns, R.M.; Honkala, B.H., tech. coords. 1990. **Silvics of North America: volume 2. hardwoods**. Agric. Hdbk. 654. Washington, DC: U.S. Department of Agriculture, Forest Service. 876 p.

Houston, R. 1975. **Beech bark disease: the aftermath forests are structured for a new outbreak.** Journal of Forestery.73: 660–663.

Leak, W.B.; Yamasaki, M.; Holleran, R. 2014. **Silvicultural guide for northern hardwoods in the northeast.** Gen. Tech. Rep. NRS-132. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 46 p. https://doi.org/10.2737/NRS-GTR-132.

O'Hara, K.L. 2002. **The historical development of uneven-aged silviculture in North America.** Forestry. 75(4): 339–346. https://doi.org/10.1093/forestry/75.4.339.

Rogers, N.S.; D'Amato, A.W.; Leak, W.B. 2020. **Long-term evolution of composition and structure after repeated group selection over eight decades.** Canadian Journal of Forest Research. 51(7): 1080–1091. https://doi.org/10.1139/cjfr-2020-0339.

CITATION: Rogers, Nicole S.; D'Amato, Anthony W.; Leak, William. 2023. **Long-Term Evolution of Composition and Structure After Repeated Group Selection: 80 Year Results.** In: Kern, Christel C.; Dickinson, Yvette L., eds. Proceedings of the first biennial Northern Hardwood Conference 2021: Bridging science and management for the future. Gen. Tech. Rep. NRS-P-211. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station: 69–71. https://doi.org/10.2737/NRS-GTR-P-211-paper17.