Considerations for Creating Canopy Gaps in Northern Hardwood Forests

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INTRODUCTION

For over 60 years, northern hardwood stands across the Great Lakes region have primarily been managed using single-tree selection (Tubbs 1977) in which a thinning is applied uniformly across a stand to reach a desired target basal area and diameter distribution. While this form of silviculture can create high quality, shade-tolerant trees, it can also create stands that lack diversity of structure and function (Neuendorff 2007). Increasingly, foresters are looking to manage northern hardwood stands for greater diversity and increased resilience to stressors such as climate or insect outbreaks. Past studies on group selection have shown benefits beyond producing timber, such as increased diversity of songbirds (Costello et al. 2000), fungal species (Dove and Keeton 2015), and insect pollinators (Proctor et al. 2012). Using group selection to increase diversity of tree regeneration can produce highly variable results (Knapp et al. 2021). Some reasons why group selection results could vary include the location and size of the gaps, as well as whether to remove all trees in the gap or leave saplings.

METHODS

In 2007, three northern hardwood stands across Wisconsin (i.e., Argonne, Flambeau, and Highlands) were selected for a large silviculture experiment called the Managed Old-Growth Silviculture Study (MOSS) (Fassnacht et al. 2015). Part of the MOSS experiment was to investigate group selection harvests to study short-, mid-, and long-term seedling responses. Two gap sizes of 18 and 24 m (i.e., 59 and 79 ft) diameter were created within the group selection stand. Gap size was randomly assigned at each desired gap location. There were a total of 14 and 12 gaps of 18 m created at Flambeau, Highlands, and Argonne, respectively. Similarly, there were a total of 14 and 12 gaps of 24 m created at Flambeau, Highlands, and Argonne, respectively. Additionally, half of the gaps had a nested treatment of sapling retention, while the remaining gaps had a nested treatment of sapling removal. In 2012, the 3-year post-harvest data were collected and evaluated (Reuling et al. 2019). In 2017, the 10-year post-harvest tree regeneration was measured, analyzed, and herein reported.

The considered response variable was stem density of tree regeneration, but the species of that tree regeneration were binned into two categories. The first category was called less shade tolerant tree species, which consisted of *Acer rubrum*, *Carya cordiformis*, *Betula alleghaniensis*, *Betula papyrifera*, *Fraxinus* spp., *Pinus strobus*, *Populus tremuloides*, *Prunus serotina*, *Quercus rubra*, and *Ulmus americana*. The second category was called merchantable tree species, which consisted of the less shade-tolerant tree species plus *Acer saccharum*, *Tilia americana*, *Tsuga canadensis*, and *Picea glauca*.

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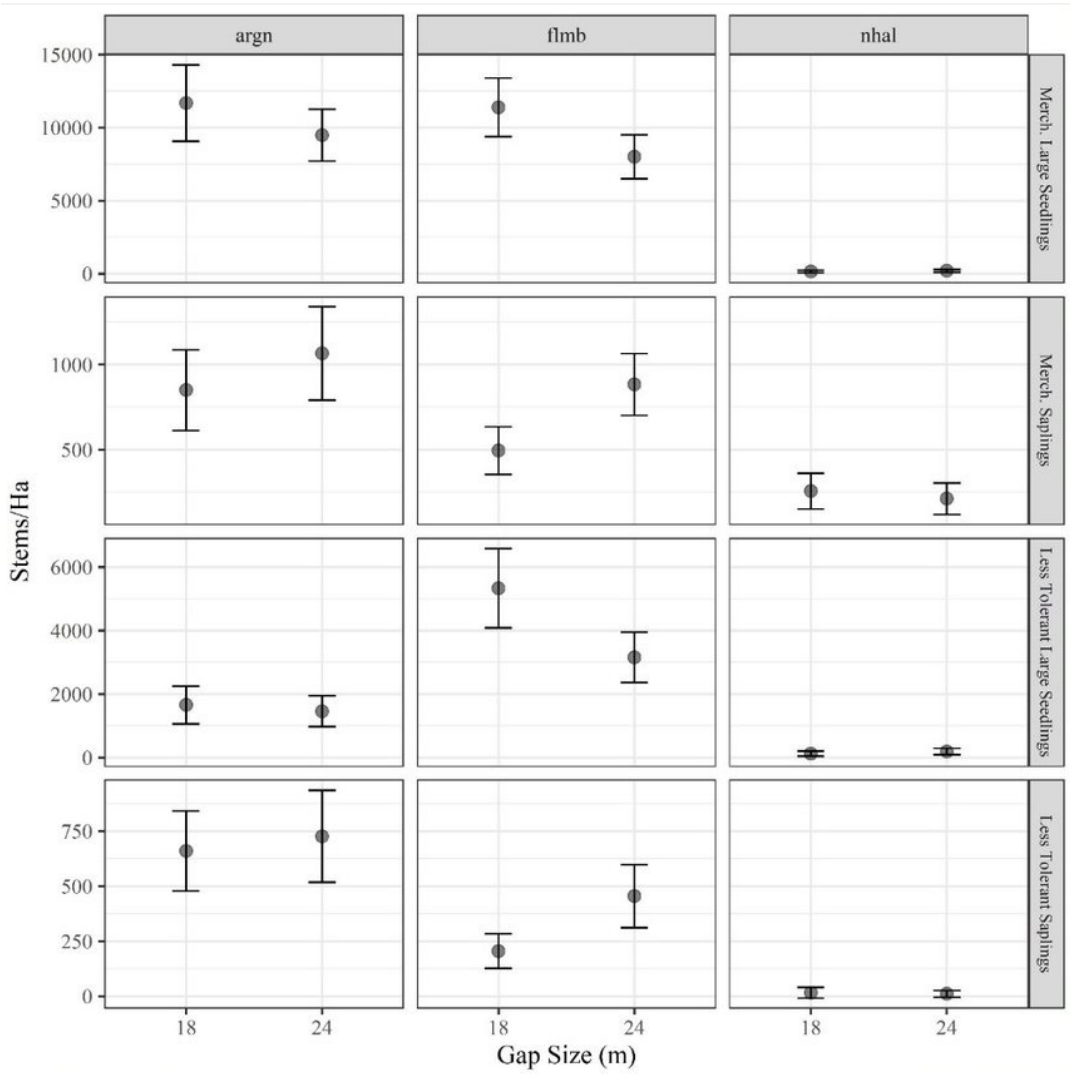

Figure 1.—Stem density for the two gap sizes and across the three sites Argonne (argn), Flambeau (flmb), and Highlands (nhal). Stem density is reported by merchantable and less shade-tolerant tree species for large seedlings and saplings.

RESULTS

Results showed that the effect of gap size and sapling retention had varying outcomes across the three sites. Specifically, tree regeneration of all tree species was significantly greater in 18 m gaps compared to 24 m gaps, but only at the Flambeau site, not Argonne or Highland sites (Fig. 1). The sapling removal treatment created a greater amount of regeneration for all tree species, but only at the Argonne site, not Flambeau or Highland sites (Fig. 2). The Highland site, which had the lowest amount of advance regeneration preharvest in 2007 continued to have poor regeneration in 2017 even with a group selection harvest. Neither gap size nor sapling removal were significant in explaining regeneration at Highlands.

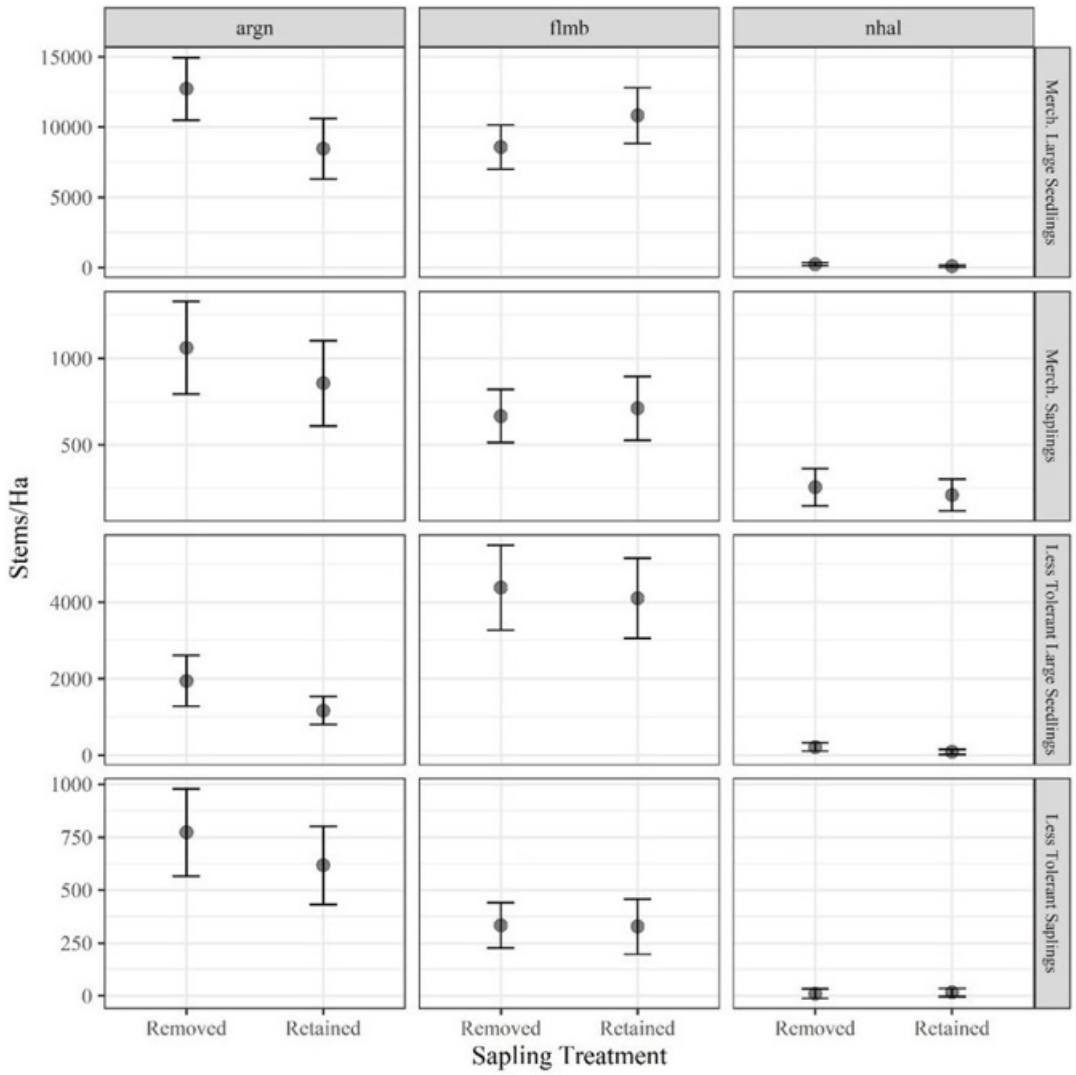

Figure 2. —Stem density for the two sapling treatments and across the three sites Argonne (argn), Flambeau (flmb), and Highlands (nhal). Stem density is reported by merchantable and less shade-tolerant tree species for large seedlings and saplings.

DISCUSSION

Group selection for the Highland site was not a successful harvest strategy for tree regeneration. This result at the Highlands may be explained by having lower nutrient sandy soils compared to Flambeau and Argonne sites. We question whether sandy sites like Highlands should continue to be managed for northern hardwoods or would benefit from conversion to other forest types such as oak and pine. In contrast, group selection produced tree regeneration that met or exceeded stocking standards on the more productive sites (i.e., Argonne and Flambeau). It is interesting the Flambeau site showed differences in tree regeneration between gap sizes but not the Argonne site, and the Argonne site exhibited differences with the sapling treatment but not the Flambeau site. Changes in light availability and microclimate from either gap size or the presence of a sapling mid-layer certainly can alter tree regeneration, but numerous other factors also contribute to results. Soil conditions, herbaceous competition, and presence of browsing from white-tailed deer (*Odocoileus virginianus*) are important when considering tree regeneration. Future analyses will focus on these factors and how their interactions may have contributed to final outcomes.

LITERATURE CITED

Costello, C.A.; Yamasaki, M.; Pekins P.J.; Leak, W.B.; Neefus, C.D. 2000. **Songbird response to group selection harvests and clearcuts in a New Hampshire northern hardwood forest.** Forest Ecology and Management. 127: 41–54. https://doi.org/10.1016/s0378-1127(99)00131-0.

Dove, N.C.; Keeton, W.S. 2015. **Structural complexity enhancement increases fungal species richness in northern hardwood forests.** Fungal Ecology. 13: 181–192. https://doi.org/10.1016/j.funeco.2014.09.009.

Fassnacht, K.S.; Bronson, D.R.; Palik, B.J.; D'Amato, A.W.; Lorimer, C.G.; Martin, K.J. 2015. **Accelerating the development of old-growth characteristics in second-growth northern hardwoods.** Gen. Tech. Rep. NRS-144. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 33 p. https://doi.org/10.2737/NRS-GTR-144.

Knapp, S.P.; Kern, C.C.; Webster, C.R. 2021. **Harvested opening size affects cohort development and failures in a second-growth northern hardwood forest.** Forest Ecology and Management. 482: 118804. https://doi.org/10.1016/j.foreco.2020.118804.

Neuendorff, J.K.; Nagel, L.M.; Webster, C.R.; Janowiak, M.K. 2007. **Stand structure and composition in a northern hardwood forest after 40 years of single-tree selection.** Northern Journal of Applied Forestry. 24: 197–202. https://doi.org/10.1016/j.foreco.2020.118804.

Proctor, E.; Nol, E.; Burke, D.; Crins, W.J. 2012. **Responses of insect pollinators and understory plants to silviculture in northern hardwood forests.** Biodiversity and Conservation. 21: 1703–1740. https://doi.org/10.1007/s10531-012-0272-8.

Reuling, L.F.; D'Amato, A.W.; Palik, B.J.; Martin, K.J.; Fassnacht, D.S. 2019. **Initial tree regeneration response to natural-disturbance-based silviculture in second-growth northern hardwood forests.** Canadian Journal of Forest Research. 49: 628–639. https://doi.org/10.1139/cjfr-2018-0406.

Tubbs. 1977. **Natural regeneration of northern hardwoods in the northern Great Lakes region.** Res. Pap. NC-150. St. Paul, NC: U.S. Department of Agriculture, Forest Service, North Central Forest Experimentation Station. 20 p.

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