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Medium or Heavy Selection Cutting? New Results Challenge Conventional Practice

Nestled in the Chequamegon-Nicolet National Forest in northern Wisconsin, the Argonne Experimental Forest has supported foundational silviculture research for more than 75 years. Generations of scientists have collected and analyzed data to better understand the effects of different management strategies on second-growth northern hardwood forests.

The highest priority study on the Argonne Experimental Forest, the Cutting Methods Study, was established in 1951 to compare partial cutting methods for maximum economic returns. The study was recently revisited by Christel Kern, a research forester with the U.S. Department of Agriculture Forest Service Northern Research Station, and two collaborators from Michigan Technological University, Robert Froese and Maeve Draper. They compared the growth and yield of trees under different management practices from 1952 to 2012 and recently published their findings.

Decades of Data Collection

About one-third of the Argonne Experimental Forest contains northern hardwood forest stands. Since 1952, the Cutting Methods Study has used five cutting methods (plus a control) on three 40-acre blocks of northern hardwoods, allowing researchers to study the long-term management outcomes and tradeoffs:

- Three levels of single-tree cutting intensity (residual tree density): light selection (90 ft2/ac), medium selection (75 ft2/ac), and heavy selection (60 ft2/ac)
- Diameter-limit cutting (all trees ≥7-in diameter cut)
- Crop tree release (thinning)

Earlier analyses of the Cutting Methods Study found that single-tree selection, a common management practice in uneven-aged stands of this forest type, produced the highest economic return. Single-tree selection aims to sustain a stand with three or more age classes of high quality trees through frequent, partial cuttings. Typical stands have many trees with small diameters and a few quality trees with larger diameters. The cuttings in this study have occurred every 10 years at the three treatment levels and have reduced stocking by removing trees with poor form, overtopped crowns, and defects. These earlier analyses also indicated that light selection resulted in high quality residual trees but poor regeneration, and that heavy selection led to greater growth and high economic returns but reduced residual stand quality. Medium selection produced the best balance of growth, yield, regeneration, and mortality; and for more than 50 years, regional forest plans and silviculture guides have often recommended variations of medium selection.

KEY MANAGEMENT CONSIDERATIONS

- Single-tree selection outperformed diameter-limit cutting (7-inch limit) and crop tree release in terms of growth, yield, and economic returns.
- After 65 years, heavy selection (60 ft2/ac residual basal area) produced similar growth and yield results to medium selection (75 ft2/ac) but greater economic returns, challenging the accepted wisdom that medium selection is preferable for balancing growth, yield, and economic returns.

Retired research forester T. Strong assists with tree size measurements in permanent plots on the Argonne Experimental Forest (2016). USDA Forest Service photo by Christel Kern

Heavy Selection: The Heavy Hitter

In the recent analysis, Kern and her collaborators examined the same cutting methods—three single-tree selection variations, diameter-limit cutting, and crop tree release—to determine whether past findings apply today.

The authors reported that the single-tree selection variations again outperformed diameter-limit cutting and crop tree release. Compared to earlier analyses, however, they found that removing more basal area (i.e., heavy selection) in single-tree selection produced a better return on investment: higher financial returns, increased growth, reduced mortality, and greater volumes of high quality saw timber. Medium selection again proved most effective for maximizing diameter growth and performed similarly to heavy selection in the other measurements. These findings suggest more flexibility in implementing variations of single-tree selection.

Neither the diameter-limit cutting method nor the uncut control produced high quality trees or consistent yield. Diameter-limit cuttings are typically done for short-term gains over long-term objectives. As applied in this study (repeated two times in 65 years), the treatment resulted in smaller trees, poorer tree grades, and lower financial performance than the other treatments. On the other end of the spectrum, the uncut control resulted in the largest average tree diameters and the greatest mortality of all methods.

Crop tree release was also less effective than the three selection treatments. Although crop tree release increased the percentage of high quality harvested volumes and residual tree grade after 50 years, the annual tree mortality was high compared to the other treatments. The financial performance was low for this treatment because the residual trees of value were not harvested and are now at greater risk of dying.

More Options for Managers

Although managers of northern hardwoods forests practicing single-tree selection may be concerned about cutting too heavily, this study shows that heavy selection can produce optimal benefits after 65 years, depending on the stand objectives. "Over time, heavy selection is optimizing growth, yield, and financial returns similar to the medium selection, which was not clear in the early results," says Kern. "The study also shows some of the tradeoffs between leaving too many trees and cutting too many trees in terms of the financial performance and growth over decades."

Implementing heavy selection accelerates desired stand condition and regeneration outcomes, but the method requires long-term monitoring because rotations in northern hardwood forests are managed for 100 to 150 years. "Having 65 years of observations of these treatment effects is phenomenal," says Kern. "Even more will be learned in the next 65 years for sustainable forest management."

Changing Conditions

Focused on conventional silviculture, the new analysis is limited to practices developed for production-driven values: timber volume, tree growth and mortality, and regeneration. The authors acknowledge the need to consider other aspects of sustainable forest management, including the recognition of indigenous people's values, wildlife habitat, carbon sequestration, biodiversity, and other nontimber forest products.

The study is best interpreted for the soil and habitat types found in the Argonne Experimental Forest. These results are most relevant to high quality, second-growth sites managed for conventional objectives. According to Kern, more research and monitoring are needed to understand the interplay between economic and ecological outcomes on other sites and in other environmental conditions. Incorporating new practices to address contemporary concerns, such as climate change, are also crucial.

The Value of Long-Term Research

Sustained, long-term research provides valuable insights into forest development over time and aids forest managers in achieving sustainability and economic goals. This study's extensive temporal measurements, replication, and comparison of contrasting treatments make it a valuable addition to the small collection of long-term studies of silvicultural systems in different forest types across the United States. This type of research is made possible by the commitment of the Forest Service to maintaining long-term studies.

"Even if I were at the beginning of my career and I worked for the next 30 years, I couldn't set up an experiment and see these kinds of results," Kern says. "The Forest Service is an organization that can maintain studies like these over multiple scientists' careers."

PROJECT LEAD

Christel Kern is a research forester with the Northern Forest Science and Applications unit at the Northern Research Station in Rhinelander, Wisconsin.

FURTHER READING

Draper, Maeve C.; Kern, Christel C.; Froese, Robert E. 2021. Growth, yield, and financial return through six decades of various management approaches in a second-growth northern hardwood forest. Forest Ecology and Management. 499: 119633. https://doi.org/10.1016/j.foreco.2021.119633.