

## Early Northern Hardwood Silvicultural Research at the Dukes Experimental Forest, Michigan

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A Loaded Railcar Typical of Early 20th-Century Production From Old-Growth Hardwood Forests in the Upper Peninsula of Michigan

Commercial lumber production in the Lake States, which began in the early 1800s with eastern white pine (*Pinus strobus* L.), shifted to hardwoods in the late 1800s (Whitney 1994). Much of the hardwood forest was rapidly cut over; as a consequence, mill capacity exceeded available stumpage by the 1920s (Eyre and Zillgitt 1953). The forest industry recognized the need for sustained-yield practices, but faced numerous financial and managerial problems and most landowners continued to liquidate their timber. USDA Forest Service photograph [FS#208189] taken in 1925.



Felling Old-Growth Northern Hardwood Timber with a Two-Man Crosscut Saw at the Dukes EF

In the 1920s, many foresters recommended the selection system for northern hardwood management. Unfortunately, little reliable information on uneven-aged silviculture existed (Eyre and Zillgitt 1953) and most early attempts at partial cutting resulted in high grading (selective cutting) of the most valuable species and trees. USDA Forest Service photograph [FS#243115] taken in 1929.

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Carl Arbogast Jr. of the USDA Forest Service (left) and Norm Smith of the Michigan Department of Natural Resources (right) in a "Virgin" Northern Hardwood Stand at the Dukes EF

To help address the silvicultural needs of northern hardwood timberland owners in the Lake States, the USDA Forest Service established the Upper Peninsula Experimental Forest (EF) near Marquette, Michigan in 1926 on 640 acres of old-growth northern hardwoods, cutover hardwoods, and swamps donated by the Cleveland-Cliffs Iron Company (Mowat 1940). This forest was regarded as "virgin" timber, though a selective harvest of scattered mature American elm (*Ulmus americana* L.) and American basswood (*Tilia americana* L.) amounting to less than 5% of volume had occurred in 1906 (Mowat 1940). Soils were well-drained sandy loams and loams deemed to be "medium to good" for northern hardwoods in the Lake States (Eyre and Zillgitt 1953). More than 80% of merchantable-sized trees were sugar maple (*Acer saccharum* Marsh.); common associates included yellow birch (*Betula alleghaniensis* Britton), eastern hemlock (*Tsuga canadensis* (L.) Carr.), American beech (*Fagus grandifolia* Ehrh.), American basswood, and American elm. Over the years, this property would grow to 6,000 acres and be renamed the Dukes EF, eventually becoming incorporated as part of the Hiawatha National Forest (Eyre and Zillgitt 1953). USDA Forest Service photograph taken in 1953.



Hardwood Sawlogs (Foreground) and Lower-Quality Chemical Wood (Background) were Loaded onto LS&I Flatcars Using an American Hoist and Derrick Company Side Loader

The land for the Dukes EF had been deeded to the government by the Cleveland-Cliffs Iron Company with the stipulation that the USDA Forest Service would return to the company within 20 (later extended to 40) years the volume of merchantable timber standing on the site in 1926 (Zillgitt 1951). In addition to sawlogs, small and poor-quality trees and tops were used for mine timbers and "chemical" or distillation wood (Mowat 1940). The Cleveland-Cliffs Iron Company, for example, produced charcoal and operated a large wood distillery in Marquette (Hudson 1922). Because green hardwood logs do not float well, railroads were integral to logging operations in the region (Stearns 1997). The Lake Superior & Ishpeming (LS&I) Railroad Company, a subsidiary of Cleveland-Cliffs Iron Company, transported wood from the Dukes EF and surrounding forests to local processors, mills, and ports. USDA Forest Service photograph [FS#208799] taken in 1925.

## A Slash Burning Experiment on the Dukes EF

The primary objective of the Dukes EF was to study different approaches to managing mature northern hardwoods for continuous production of forest products (USDA Forest Service 1930). The experimental forest served as a “woods laboratory” (Mowat 1940) for research and demonstration of regional forestry practices related to cutting methods, planting, slash removal, and other cultural treatments. The experiments were planned by Raphael Zon, formerly Chief of the Forest Service’s Office of Silvics and then-Director of the Lake States Forest Experiment Station (LSFES). Zon’s advocacy for research led to establishment of the first forest experiment stations, beginning with the Fort Valley EF in 1908. As Director of the LSFES he personally organized, supervised, and coordinated the work at the Dukes EF (Schmaltz 1980). USDA Forest Service photograph [FS#242636] taken in 1929.



USDA Forest Service Scientist Carl Arbogast Jr. inspecting a Permanent Sample Plot in the Clearcut Treatment in the Cutting Methods Study on the Dukes EF

One of the earliest experiments on the Dukes EF was the Cutting Methods Study, which included different approaches to managing old-growth northern hardwoods, ranging from clearcutting to light selection cutting (USDA Forest Service 1930). Before treatment, the area used for the Cutting Methods Study averaged 130 merchantable trees per acre, dominant heights of 100 ft, and a net volume (after cull deduction) of 10,500 board feet per acre (Eyre and Zillgitt 1950, 1953). Many of the large trees were more than 300 years old. Experimental treatments included clearcutting, diameter-limit cutting, single-tree and group selection cutting, and improvement cutting. Over the long-term, the clearcut and group selection treatments maintained higher proportions of shade-intolerant species (i.e., yellow birch) than other treatments in the Cutting Methods Study, while the single-tree selection stands remained sugar maple-dominated. USDA Forest Service photograph [FS#503372] taken in 1955.

## A Selection Stand on the Dukes EF after the First Cut to a Residual Basal Area of 50 ft<sup>2</sup> per acre in Trees Greater than 10 in. dbh

Based on 20-year results at the Dukes EF, researchers Frank “Windy” Eyre and William Zillgitt published comprehensive assessments of the outcomes from the Cutting Methods Study and recommended single-tree selection cutting for northern hardwoods (Eyre and Zillgitt 1950, 1953). They concluded that selection cutting as applied in the Dukes EF “Overmature and Defective” treatment resulted in the best combination of rapid growth and a sustainable tree-size distribution and developed a residual structural goal for uneven-aged northern hardwoods (Eyre and Zillgitt 1950, 1953). This goal, which specified a residual of 118 trees and 84 ft<sup>2</sup> of basal area per acre in merchantable-sized trees, was later presented as a practitioner-oriented guide for uneven-aged management of northern hardwoods (Arbogast 1957). Commonly known as the “Arbogast Guide,” this publication remains influential in the Lakes States and Northeast. The Cutting Methods Study continues today and provides a more than 80-year perspective on the response of northern hardwoods to a range of silvicultural treatments. Recent remeasurements after 3 to 4 selection cuts confirmed the long-term sustainability of structure and quality improvements (e.g., proportion of grade 1 or better sawtimber increased three-fold in the selection stands between years 15 and 80; Kenefic and Kern 2013). Long-term data on tree growth, mortality, and changes in stand composition and structure provide the basis for assessing treatment outcomes in light of contemporary forest management problems (Kern et al. 2014). USDA Forest Service photograph [FS#494613] taken in 1933.



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