REGENERATING OAK-DOMINATED FORESTS USING IRREGULAR, GAP-BASED SILVICULTURAL SYSTEMS

John M. Lhotka, Michael R. Saunders, John M. Kabrick, and Daniel C. Dey[1]

Abstract—Throughout the Eastern United States, practitioners have primarily focused on using uniformly applied even-aged approaches to regenerate oak species. Irregular, gap-based silvicultural systems offer an alternative that retains continuous canopy cover, creates heterogeneous forest structure, and provides multiple income flows over a rotation. Although commonly used in Europe, there are few documented applications of these systems in oak forests of North America. Our objective is to establish a regionwide trial of two variants of an irregular group shelterwood system that successively expands gaps outward until the entire stand has been regenerated. Both variants will use cutting cycles that are 10 percent of the rotation length and harvest approximately 20 percent of the area at each entry. Initial gap size for both variants will be 2.0 to 2.2 times the dominant canopy height, and the overstory will be removed in either one or two stages. In addition, the midstory canopy will be removed from areas of the surrounding forest matrix scheduled for harvest in the next cycle for both variants. Soil scarification, competition control, and/or underplanting may be used in areas lacking sufficient advance reproduction. These treatments will create a light gradient extending from the gap center into the surrounding matrix that should allow intolerant species, like yellow-poplar (*Liriodendron tulipifera* L.) or shortleaf pine (*Pinus echinata* Mill.), to prevail in areas high in direct beam radiation and oaks to dominate in the diffuse light conditions created on the gap margins and within the surrounding matrix. Successive expansions will release the developing oak reproduction and will result in a stand with a diverse mixture of commercial species.

[1] Assistant Professor of Silviculture, University of Kentucky, Department of Forestry, Lexington, KY; Assistant Professor of Hardwood Silviculture, Purdue University, Department of Forestry and Natural Resources, West Lafayette, IN; Research Forester, and Research Forester, U.S. Department of Agriculture Forest Service, Northern Research Station, Columbia, MO, respectively.

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Regenerating Oak Dominated Forests Using Irregular, Gap-Based Silvicultural Systems

John M. Lhotka[1], **Michael R. Saunders**[2], **John M. Kabrick**[3], and **Daniel C. Dey**[3]

[1] University of Kentucky, Department of Forestry, Lexington, KY 40546 (john.lhotka@uky.edu)

[2]Purdue University, Department of Forestry and Natural Resources, West Lafayette, IN 47907

[3]USDA Forest Service, Northern Research Station, Columbia, MO 65211

Project Overview: Throughout the eastern United States, practitioners have primarily focused on using uniformly applied even-aged approaches to regenerate oak species. Irregular, gap-based silvicultural systems offer an alternative that retains continuous canopy cover, creates heterogeneous forest structure, and provides multiple income flows over a rotation. Although commonly used in Europe, there are few documented applications of these systems in oak forests of North America. Our objective is to establish a region-wide trial of two variants of an irregular group shelterwood system that successively expand gaps outward until the entire stand has been regenerated. Both variants will use cutting cycles that are 10% of the rotation length and harvest approximately 20% of the area at each entry. Initial gap size for both variants will be 2.0-2.2 times the dominant canopy height and the overstory will be removed in either one or two stages. In addition, the midstory canopy will be removed from areas of the surrounding forest matrix scheduled for harvest in the next cycle for both variants. Soil scarification, competition control, and/or underplanting may be used in areas lacking sufficient advance reproduction. These treatments will create a light gradient extending from the gap center into the surrounding matrix that should allow intolerant species, like yellow-poplar or shortleaf pine, to prevail in areas high in direct beam radiation and oaks to dominate in the diffuse light conditions created on the gap margins and within the surrounding matrix. Successive expansions will release the developing oak reproduction and will result in a stand with a diverse mixture of commercial species.

Background and Justification

- Gap-based, hybrid silvicultural systems incorporate aspects of even- and uneven-aged regeneration methods and are an attractive alternative for oak dominated forests
- Expanding group shelterwood is a hybrid system where cuttings are applied in a pattern of expanding gaps or patches
- Treatment formulation builds upon shelterwood, group selection, a patch clearcutting research
- Expanding group shelterwood results in resource gradients from gap centers extending into the forest matrix (Figure 1)
- Size and juxtaposition of gaps, and timing of gap expansions can be manipulated to regenerate a wide variety of species, from intolerants in gap centers to intermediates and shade tolerants along gap edges
- Potential benefits: 1) maintenance of continuous forest cover, 2) species diversity and structural complexity, and 3) multiple income flows over rotation

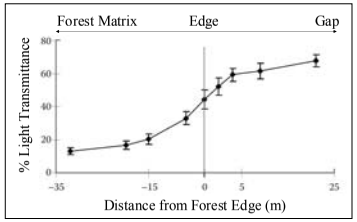


Figure 1. Hypothesized relationship between light transmittance and distance from forest edge (Adapted from Schmid, I., K. Klumpp, and M. Kazda. 2005. Light distribution within forest edges in relation to forest regeneration. J. For. Sci. 51(1):1-5)

Objectives

The long-term goal of this project is to develop alternative silvicultural systems that can be used to successfully regenerate oak within the Central Hardwood Forest Region. This study is novel in that it uses common treatment regimes and monitoring protocols at multiple sites around the region that differ significantly in species composition, competitors, and environments. It is hoped that this design will lead to interdisciplinary investigations of other components of oak ecosystems. Primary objectives include:

1. Test the effectiveness of two expanding group shelterwood variants for regeneration of oak-dominated communities in a variety of ecosystems and forest types.
2. Characterize biotic and abiotic factors that affect the abundance and spatial distribution of advance oak regeneration within natural stands. Estimate the range of conditions under which oak can compete successfully and be recruited into the successive stand.
3. Determine the effect of expanding group shelterwood systems on other biotic components of these ecosystems.

We actively seek collaborators interested in expanding the regional extent of the study and/or quantifying the response of wildlife and other biotic components to the study's gap-based silvicultural treatments

Common Treatment Regimes

Study Areas (Figure 2):

- Mature, oak-dominated upland stands without harvests over past 10-20 years
- A minimum of 30 acres to accommodate treatments

Expanding Group Shelterwood Treatments:

- Initial Gap/Group Size: 2.0 to 2.2 times dominant tree height (0.5 – 1.0 ac)
- Two Variants of Group Shelterwood Tested:
  1. Entire overstory removed in single cut
  2. Two-stage removal with an initial shelterwood cut of 40 to 50 % residual stocking
- Preparatory Cuts: Midstory removal in areas scheduled for harvest in next cycle
  - Goals: Work in synergy with gap treatments to increase light availability and seedling survival/growth in forest matrix
- Cutting Regime: Area controlled with 5 to 6, ten-year cutting cycles (Figure 3)
- Soil scarification, underplanting, and/or chemical competition control may be used in areas lacking sufficient advance reproduction.

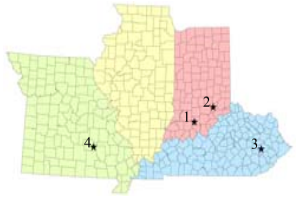
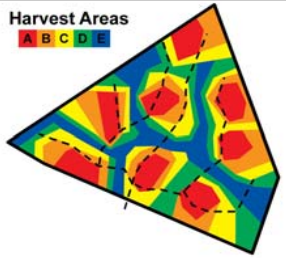


Figure 2. Proposed Study Locations

1. Southern Indiana Purdue Agricultural Center
2. Southwest Purdue Agricultural Center
3. Robinson Forest (University of Kentucky)
4. Sinkin Experimental Forest (Forest Service)



Harvest	Variant 1		Variant 2		
Area	Prep	Overstory	Prep	Establish	Overstory
A	-	1*	-	1	2
B	1	2	1	2	3
C	2	3	2	3	4
D	3	4	3	4	5
E	4	5	4	5	6

* Ten-year harvest cycle number

Figure 3. Conceptual harvest layout and cutting cycles for expanding group shelterwood systems

Harvest areas (A – E) and cutting cycle for two variants of expanding group shelterwood. Harvests include a preparatory cut removing all midstory trees (Prep), an establishment cut with 40 to 50% residual stocking (Establish), and an overstory removal cut (Overstory). Cutting cycles are 10 years. Dashed black lines are one potential permanent skid trail layout.

Monitoring Protocols

Stand-Level

- Stands sampled with minimum of 5% area sample on a five year inventory cycle
- Overstory trees, saplings, tree regeneration, and herbaceous vegetation (Figure 4)

Gap/Group Level

- Sampling transects extending from gap center into surrounding matrix
  1. Understory environmental factors such as photosythetically active radiation
  2. Establishment and development of natural regeneration

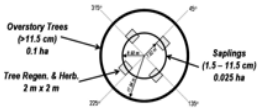


Figure 4. Sample Plot Layout