Creating & Maintaining Open Woodlands to Promote Regeneration & Development of Oaks

Wayne K. Clatterbuck
Professor Emeritus
School of Natural Resources
University of Tennessee

Oak & Fire in the Eastern US
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Presentation Outline

- Stand Conditions --- 60+ years ago and today
- Species – Site Relationships
- Oak Ecology --- Intermediate Environmental Conditions
- Regeneration Practices for Oak
- Options to Perpetuate Oak
- Summary, Take Home Messages

Stand Conditions 60+ Years Ago

- Frequent disturbances and stand entries, every 10 to 15 years for various purposes
- More open stands
- Low-intensity disturbances and harvesting, but more frequent such as --- partial harvests, grazing, burning, weather events, insects & disease

Stand Conditions Today

1st Condition

- Closed canopy stand for many years
- Prominent midstory and understory
- Stand entries infrequent, limited disturbances
- Few, if any, intermediate treatments
- Limited markets
- Larger trees --- sawtimber
- More intense harvests when they occur

Stand Conditions Today

2nd Exploited Condition

- Highly Disturbed Landscape from previous harvest(s) or burns --- exploitive
- Cut Repeatedly w/o thought of future stand
- Results in: Poor stocking
  Undesirable Species Mix
  Defective, Low Vigor, Poor Form Trees

Stands with less than 50 sq ft BA of desirable growing stock are degraded should be regenerated

Solution ???

- Intermediate sunlight --- not too much and not too little, fine line
- More frequent disturbances to maintain sunlight for open forests
- Establish oak advance reproduction to compensate for slower growth of oaks – growth head start

Why We Have Oaks Today

Oaks are disturbance dependent and advance growth dependent

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1. The frequent, less intense disturbances 60+ years ago created intermediate light conditions favorable for regeneration of oaks compared to other species

Why the Future of Oaks is a Concern

Oaks are disturbance dependent and advance growth dependent

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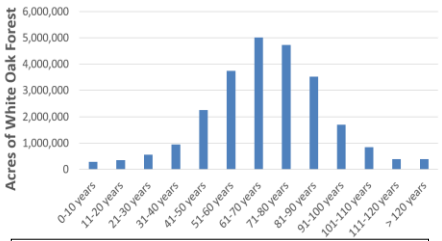
2. The closed canopy, limited light conditions, and greater harvesting intensities do not create the environmental conditions that benefit oak.

Why the Future of Oaks is a Concern



Number of acres of white oak-dominated forests by age class across Illinois, Indiana, Kentucky, Missouri, Ohio, and Tennessee. *Source: White Oak Initiative*

Species - Site Relationships

Oak Presence

Lower Site Productivity (SI < 65 ft for oak)
Oak generally abundant

Oak Presence

Medium Site Productivity (SI 65-75 ft for oak)
Oak presence more intermediate

Oak Presence

Highly Productive Site (SI > 75 ft for oak)
Oak presence absent or small

Site Productivity	# of Species	Leaf Area	Sunlight @ Ground	Abundance of Oak Regeneration
Low (dry)	low	low	high	abundant
Medium				
High (moist) Source: Stringer UK	high	high	low	sparse

Ultimately

- In mixed species stands, species grow where they can successfully compete with other species and tolerate local conditions, NOT where they grow best ---
  --- COMPETITION

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Thus matching species and sites is instrumental in hardwood management --- multitude of sites and species

Fire & Oak Regeneration

NO DOUBT **---** Burning was a contributor to the oak forests we have today.

Can we simulate past environmental conditions? I am skeptical.

Difficult to conduct --- variable weather conditions, fuels, substrate/soils, vegetation, moisture

Burning factors interconnected & highly variable: *duration, residence time, rate of spread, frequency, intensity, season and timing of burning, fuel properties such as type, amount, size, moistures, and susceptibility of species based on size and age*

Fire & Oak Regeneration

Reflections

Burning is a BLUNT tool!

All hardwoods sprout

Even with oak's sprouting ability, oak reproduction is as likely to be killed as perpetuated

Repeated burns ???

Burning days within a fire Rx

Potential damage to residuals, especially repeated burns

Fire & Oak Regeneration

Questions:

1. How can fire be used to develop sufficient size and number of oak reproduction?
2. What is a feasible oak regeneration Rx using fire considering that most competitors sprout AND soil exposure creates seedbeds for light-seeded species?
3. How can stands of mature hardwoods or immature stands of developing hardwoods be burned without damaging residual trees?

Oak Ecology

Oaks Have **Intermediate** Properties Compared to Other Species

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- Intermediate in light tolerance and successional process

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Oaks Have **Intermediate** Properties Compared to Other Species

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- Intermediate in light tolerance and successional process
- Initial growth strategy prioritizes root over top growth --- slow initial top growth --- ability for trees to persist with faster-growing species
- Regenerates more readily from sprouting and advance reproduction than from seeding

Oak Ecology

More sun-loving, intolerant species outgrow oak

More shade-tolerant species are omni-present and will outgrow oak and must be controlled

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Intermediate oaks with their slow growth need a HEAD START to compete with these intolerant and tolerant species

ANSWER: Advance Reproduction!!!

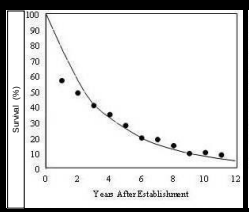
Oak Ecology

"the answer to the question of how to ensure adequate oak regeneration" . . . "is not the development of some radically new method of cutting, but recognition that all cutting operations in the stand, from the very first , should have as some of their objectives creation of an environment, largely light conditions, favorable for oak regeneration" . . . "and furthermore" . . . "ensure that cuttings occur frequently enough to maintain growth of oak regeneration."

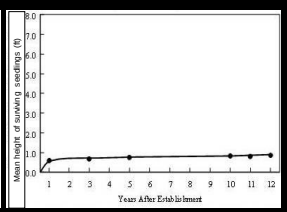
Dr. John Hodges, MS State University 1989

Oak Population Dynamics

Survival curve for NRO seedlings in undisturbed conditions (Loftis 1983)

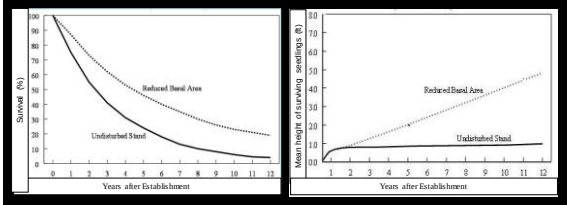


Height growth for NRO seedlings in undisturbed conditions (Loftis 1983)



Response to reductions in Basal Area (Loftis 1983)

Survival **Height**



Intermediate and/or Regeneration Practices Favorable for Oak

Principles:

- Maintain intermediate light conditions
- More open canopies ---- BA < 75 ft^2 --- low densities
- More frequent disturbances or imposed practices to maintain more open canopies

Issue: Cost and availability of small-diameter markets

Intermediate and/or Regeneration Practices Favorable for Oak

Practices --- Options:

1. Shelterwood (SW)
2. Variable Overstory Retention (thinnings)
3. Midstory Removal (in conjunction with SW)

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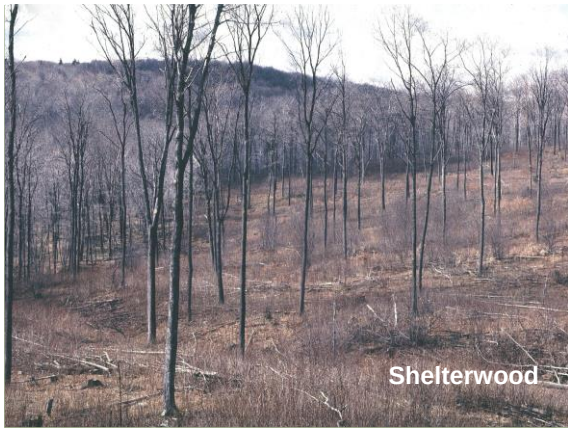
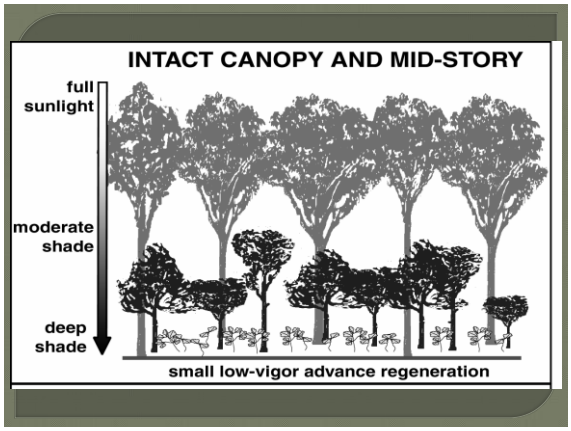
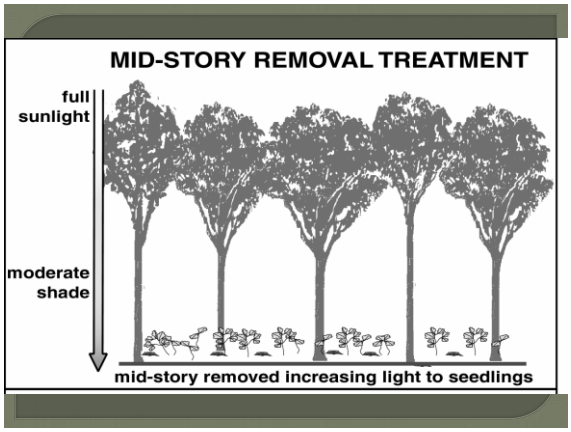
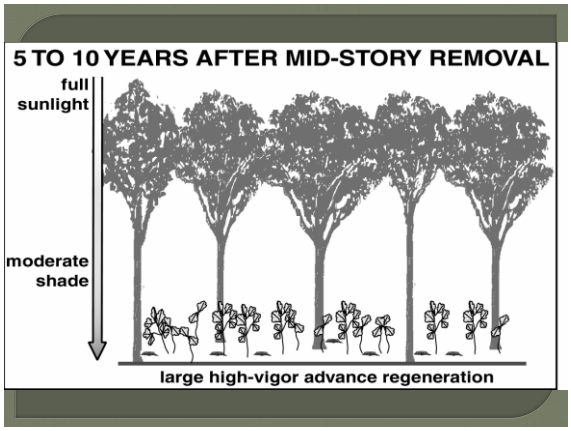
3. Midstory Removal (in conjunction with SW)
4. Varying and Small Opening Sizes ---- groups, edges, islands, clusters --- cut or leave
5. Expanding Gap or Femelschlag
6. Deferment Cuts ---- Two-Age Mgmt, Sparse Tree Retention
7. Planting

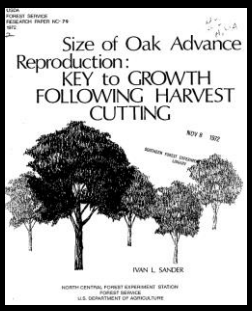


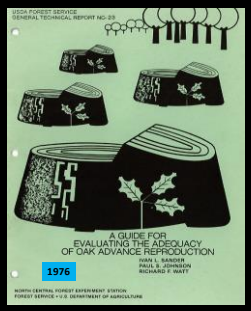

INTACT CANOPY AND MID-STORY
full sunlight
moderate shade
deep shade
small low-vigor advance regeneration


MID-STORY REMOVAL TREATMENT
full sunlight
moderate shade
mid-story removed increasing light to seedlings


5 TO 10 YEARS AFTER MID-STORY REMOVAL
full sunlight
moderate shade
large high-vigor advance regeneration

Ivan Sander (1970s)





Advance Regeneration of Oaks

Must develop advance reproduction before the harvest with:

--- Adequate Size

--- Adequate Number

To be successful

Natural Regeneration

What are the light levels to favor oaks?

Research Indicates

20-30%

Sources: Dey et al. 2012, Phares 1971, Dillaway & Stringer 2006, Gardiner & Hodges 1998, Lorimer et al. 1994, Gottschalk 1987, 1994, Lhotka & Lowenstein 2009, many more

Shelterwood with Oaks

- In theory, tends to be favorable to more "intermediate" species such as oaks
- Must have advanced reproduction of oak (seedling in place) for method to work well
- Otherwise waiting for good mast year (highly variable) and favorable germination conditions to obtain oak seedlings. *Low probability!*

Shelterwood with Oaks

- Usually a precommercial, midstory removal treatment is required
- DIFFICULT to Apply. Why?

Shelterwood with Oaks

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- DIFFICULT to Apply. Why?

COST! w/o revenue $$$

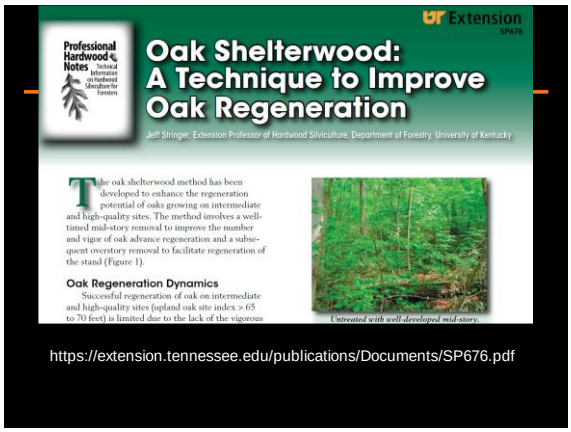
Shelterwood with Oaks

Sunlight Regulation

- If canopy too open, excessive sunlight will favor more shade-intolerant species such as poplar rather than oak
- If do not open the canopy enough, creates shady conditions that will favor more shade-tolerant species (maple/beech) rather than oak

Summary --- Oak Shelterwood Process

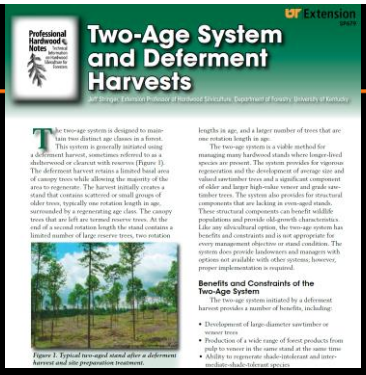
- **Establishment** of new seedlings in existing stands (if not present) is necessary before harvest
- **Light** is the limiting factor in oak seedling survival
- **Development** of established seedlings into regeneration sources that can compete successfully when released (adv. repro.)
- **Release** --- Crop Tree Release --- timely and sufficient


Extension
SP676
Professional Hardwood Notes
Technical information on hardwood silviculture for foresters
Oak Shelterwood: A Technique to Improve Oak Regeneration
Jeff Stringer, Extension Professor of Hardwood Silviculture, Department of Forestry, University of Kentucky
The oak shelterwood method has been developed to enhance the regeneration potential of oaks growing on intermediate and high-quality sites. The method involves a well-timed mid-story removal to improve the number and vigor of oak advance regeneration and a subsequent overstory removal to facilitate regeneration of the stand (Figure 1).
Oak Regeneration Dynamics
Successful regeneration of oak on intermediate and high-quality sites (upland oak site index > 65 to 70 feet) is limited due to the lack of the vigorous
Untreated with well-developed mid-story.
https://extension.tennessee.edu/publications/Documents/SP676.pdf


Midstory Removal


Midstory Removal


Overstory Release
Small Opening



Two-Age System and Deferment Harvests

Jeff Stringer, Extension Professor of Hardwood Silviculture, Department of Forestry, University of Kentucky

The two-age system is designed to maintain two distinct age classes in a forest. This system is generally initiated using a deferment harvest, sometimes referred to as a shelterwood or clearcut with reserves (Figure 1). The deferment harvest retains a limited basal area of canopy trees while allowing the majority of the area to regenerate. The harvest initially creates a stand that contains scattered or small groups of older trees, typically one rotation length in age, surrounded by a regenerating age class. The canopy trees that are left are termed reserve trees. At the end of a second rotation length the stand contains a limited number of large reserve trees, two rotation lengths in age, and a larger number of trees that are one rotation length in age.

The two-age system is a viable method for managing many hardwood stands where longer-lived species are present. The system provides for vigorous regeneration and the development of average size and valued sawtimber trees and a significant component of older and larger high-value veneer and grade sawtimber trees. The system also provides for structural components that are lacking in even-aged stands. These structural components can benefit wildlife populations and provide old-growth characteristics. Like any silvicultural option, the two-age system has benefits and constraints and is not appropriate for every management objective or stand condition. The system does provide landowners and managers with options not available with other systems; however, proper implementation is required.

Figure 1. Typical two-aged stand after a deferment harvest and site preparation treatment.

Benefits and Constraints of the Two-Age System

The two-age system initiated by a deferment harvest provides a number of benefits, including:

- Development of large-diameter sawtimber or veneer trees
- Production of a wide range of forest products from pulp to veneer in the same stand at the same time
- Ability to regenerate shade-intolerant and intermediate-shade-tolerant species

https://extension.tennessee.edu/publications/Documents/SP679.pdf

Caveats

- How to obtain adequate Advance Reproduction when absent? Bumper acorn crops are relatively rare. If not present, must wait for a good mast year or plant if oaks are desired. Can be several years of waiting.

Caveats

- Should we try to recreate the mosaic of past disturbance regimes to promote oak? ---- chestnut blight, grazing, indiscriminant cutting, burning, human lifestyles, cultural burning, weather (drought/wind), climate variability
- Probably cannot create past/previous environmental conditions

Tending Small Oaks for Future Stand

Today, stand entries are about every 30 years (closed canopies for an extended amount of time) instead of 10 to 15 years previously that allowed development and release of advance reproduction.

Lack of small diameter markets.

Oak Growth and Regeneration

Oak Regeneration is a process, not an event

Oak is advance-growth dependent

Oak is disturbance dependent

'If you go into a 10-year-old stand and you're wondering what you can do to control composition, you're probably 20 years too late' (Dr. Don Beck)

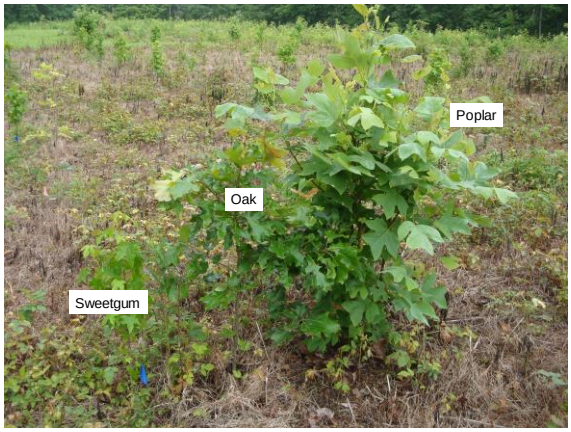
Options to Successfully Regenerate Oak

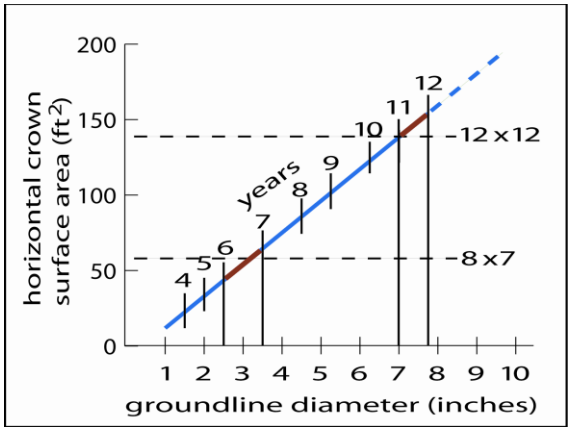
1. Natural Regeneration

2. Artificial Regeneration (Planting)

   ---- Enrichment or Supplemental Planting in Existing Stands

   ---- Afforestation --- planting fields or open areas


Poplar
Oak
Sweetgum


horizontal crown surface area (ft²)
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10
groundline diameter (inches)
years
4
5
6
7
8
9
10
11
12
12 x 12
8 x 7

Natural Regeneration

- Advance Reproduction necessary --- number and large size

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- Must plan regeneration well before the harvest cut --- not occurring on private land
- Must enter stand more frequently to begin the advance reproduction process --- not occurring presently b/c of markets

Natural Regeneration

Several Options --- Advance Regen Present

1. Shelterwood
2. Midstory Removal
3. Varying and Small Opening Sizes ---- groups, edges, islands, clusters --- cut or leave
4. Variable Overstory Retention (thinnings, open stands)
5. Deferment Cuts ---- Two-Age Mgmt, Sparse Tree Retention

Alternatives to Have Oak in the Future Stand

1. Develop oak advance reproduction prior to harvest --- natural regeneration takes time and effort, but less capital costs

- Adequate number and size of advanced reproduction
- Frequent stand entries (*for whatever purpose*) to maintain partial light conditions --- disturbances
- Rarely occurs on private land. Costs (without discernible revenue) are accepted to have oak in future stand

Alternatives to Have Oak in the Future Stand

2. Plant oaks afterward --- supplemental plantings

- Much more time, effort, and expense
- Site preparation initially and control of unwanted/competing vegetation several times before crown closure
- Impacts of herbicides and application on oak seedlings ---- broadleaf herbicides impact broadleaf oaks even with directed sprays
- Success rate is poor

Alternatives to Have Oak in the Future Stand

3. Manage stand throughout the rotation with open forest conditions to grow and regenerate oak for the present and the future

- Oak advance reproduction has been building during the rotation ---- advance growth dependent with frequent disturbances
- No need to take measures to create and develop oak reproduction prior to harvest

Alternatives to Have Oak in the Future Stand

My conclusion and preference is #3

3. Manage stand throughout the rotation with open forest conditions to grow and regenerate oak for the present and future

With frequent disturbances to maintain more open forests with intermediate light conditions throughout the rotation. NO NEED to take separate actions to develop oak advanced reproduction

Inherent Obstacles

- Long time period --- frequent ownership turnover
- Requires active mgmt. throughout rotation
- Poor markets for small diameter materials
- Costs vs revenues
- Risks --- social as well as environmental

Creation of Pine-Oak Stands

- History
- Unstable Community Type --- Different
- Pine seed source is absent, must plant pine
- Disturbance dependent
- Similar site characteristics --- shortleaf pine and oak
- Methods
  - a. Cluster planting within hardwoods
  - b. Planted pine at wide spacings w/i hdwd clearcut

Take Home Messages

1. Know your species. Know your sites for each species
2. Advance reproduction is necessary to regenerate oak. Implement partial light conditions (at least 20-30 %).

   Several options available

Take Home Messages

3. Oaks are **disturbance** dependent and **advance growth** dependent. Process oriented, regeneration is not an event

Competing species often grow faster and displace oak before oak can grow into the overstory

Take Home Messages

4. Intermediate and regeneration practices are necessary to maintain more open stand structures that benefit the development of oaks
5. Oak planting has generally NOT been successful in natural stands

Recognition / Credits

Some data and PPT slides obtained and modified from:

1. Tara Keyser, Research Forester, USFS, Bent Creek Experimental Forest
2. Jeff Stringer & John Lhotka, University of Kentucky