Woodland Stewards Webinar Series
Session 2: Managing Your Woodlands

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WOODLAND STEWARDS
A Regional Extension Program for Landowners

Session 2 Moderator
Dr. Robert Bardon
NC STATE EXTENSION

The Woodland Stewards Webinar Series was created by a team of Extension professionals from the following programs:

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DIVISION OF AGRICULTURE RESEARCH & EXTENSION, University of Arkansas System
UNIVERSITY OF KENTUCKY, College of Agriculture Forestry Extension
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Managing Your Woodlands

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WOODLAND STEWARDS
A Regional Extension Program for Landowners

Basics of Pine Plantation Management

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WOODLAND STEWARDS
A Regional Extension Program for Landowners

Presentation Outline

- Advantages/disadvantages of pine management
- Pine ecology
- Site selection
- Site preparation
- Regeneration
- Post planting management
- Thinning
- Other management considerations
- Final harvest
- Summary

Advantages of Planting Pines

- Well-adapted to poor fertility or erodible soils
  - Many soils will not support good hardwood growth
  - Drought tolerant
- Less costly and easier to plant than hardwoods
- Less time to harvest than hardwoods
- Important habitat component for some wildlife species

Disadvantages of Pine Management

- Some species are not tolerant of ice storms
- Potential for destructive insect outbreaks
  - Example: Southern pine beetle
- Timber production goals require active management
- Markets may not be available or favorable in all locations

Ecology of Southern Pines

- Four species: loblolly, shortleaf, longleaf, and slash pine
- Southern pines are shade intolerant
  - Broadleaf trees, weeds, and grasses can outcompete young pines for resources and sunlight
- Most species are fast growing
  - Some species develop an extensive root system before faster height growth occurs e.g. longleaf and shortleaf pine
- Cone and seed production usually begins between ages 10-20
  - Varies by species

Ecology of Southern Pines

- Most species do not produce adequate seed annually
  - Bumper and near failure years
  - Prediction is difficult
  - Spread by gravity and wind
  - Prescribed fire often improves seedbed for germination
- Disturbance dependent forest types
  - Will transition to mixed pine-hardwood and pure hardwood over time
  - Depends on site conditions
  - Natural and human disturbances

Site Selection for Pine Management

Four species are soil generalists, but some differences exist

Pine Species	Native Range Rank	Common Soil Conditions	Soil Limitations
Shortleaf	1: 24 states; most cold hardy	Upland sites (moderate drought tolerance), low organic matter content, and usually clay texture	High soil pH, high calcium content, or poorly drained soils
Loblolly	2: 14 states; naturalized throughout the world fastest growing	Soil generalist, good growth with a variety of soil moistures and textures	Absent or poor growth on high pH soils or excessively sandy soils

Site Selection for Pine Management

Pine Species	Native Range Rank	Common Soil Conditions	Soil Limitations
Longleaf	3: Gulf and Atlantic Coastal Plain	Tolerant of sandy, acidic, and infertile sites. Most commonly found on these sites	Better productivity sites where competing vegetation influence is greater limits longleaf
Slash	4: Coastal Plain; limited by minimum average temperature	Soil generalist, tolerant of a variety of soil moistures and textures	Growth is slowed on excessively sandy soils. Lacks cold-hardiness

Stand Establishment: Site Preparation

- Improves regeneration success of pines
- Alters soil conditions and pre-existing vegetation on site
- Type and amount dependent on previous land use and cover type

<u>Mechanical</u>

- Remove litter and upper organic layers (scarification)
- Improve soil aeration, temperature, and permeability of upper soil layers
- Modify structure and porosity of moderately deep soil horizons (subsoiling)
- Improve soil drainage (bedding, ditching)

Stand Establishment: Site Preparation

Chemical Site Preparation

- Herbicides labeled for forestry use
- Products and rates used depends on vegetation present and soil properties
- Different product formulations affect timing
- Applied as broadcast-aerial or ground (<100 acres), band, or spot treatments
- Often applied at full leaf out during mid-late summer
- May be followed by other site preparation methods
- Usually a waiting period after application

Stand Establishment: Site Preparation

Prescribed Fire

- Most common on cutover sites
- Cheap and effective if mechanical treatments are unavailable or not economical
- Clears debris and makes site more accessible
- Exacting weather conditions
- Prescription necessary
- Smoke management concerns

Question

Would mechanical or chemical site preparation offer better long term control of small hardwood stems (<1”diameter) on a site that is scheduled to be planted with pine?

Natural vs Artificial Regeneration

Natural Regeneration

- Occurs after harvest of a forested site
- Must have mature, seed producing trees on site or nearby and/or regeneration in place
- Results more variable than artificial regeneration
- Less control over genetics, spacing, and density
- Less intensive site preparation often used
- Lower cost than artificial regeneration

Natural vs Artificial Regeneration

Artificial Regeneration

- Seed source should be adapted to climate and soils of the planting site
- Usually bare root or containerized nursery seedlings
- Spacing dictated by objectives
- Timing depends on location, best when seedlings are dormant during rainy periods
- Proper planting technique important
- Better genetics

Question

Which method of regeneration (natural or artificial) is considered more reliable from a spacing and performance standpoint?

Stand Establishment: Fertilization

- Added cost to increase seedling growth rates and pine straw production
- May be needed when straw is raked regularly
- May not be economical on all sites—past land use history
  - Usually not needed on old fields, cutover sites often benefit
- Conduct soil and foliage tests to make decisions
- Nitrogen (N) and phosphorus (P) are two most limiting nutrients for growth
- Applied together, or as P alone at stand establishment

Post-Planting Operations

Herbaceous Weed Control

- Improves seedling survival and early growth
- Herbicides that are safe to apply over pine seedlings at recommended rates
  - Rates can vary by pine species and weeds treated—CHECK LABEL
- Applied first or second spring after planting
  - After weeds first emerge (<1 ft tall)
- Usually banded application (4-6 ft) around seedling
  - As effective as broadcast application

Post-Planting Operations

Pine Straw Production

- Begin at canopy closure—sooner for loblolly<slash<longleaf—to first thinning
- Intermediate income source--$1 for every $6 of wood income
- Check to see if contractors are in your area
- Per acre or bale value greatest with longleaf>slash>loblolly pine
- Usually completed annually—spring and summer
- Productivity depends on species, site productivity, stand density, competition control (herbicides, fire (early), and mowing), rakeable stand area, fertilizer use, and raking frequency

Thinning—The Premise

- Differences in height growth between individual stems occurs over time—vigor declines
- Results in some smaller, weaker stems
- Affected by species, site productivity, tree spacing, and growth rate
- Growth rate slows over time as growing space and resources become limited

Thinning

- Thinning reduces stand density to improve growth rates, improve health and vigor, and recover potential mortality of individual trees
- Necessary to maintain growth rates
- Frequency--spacing and desired product classes—done 1 or possibly 2 times before final harvest
- Opportunity for intermediate income

Thinning

- Basal area and live crown ratio as easy indicators
- Methods
  - Pine plantations-row thinning with operator's choice or free thinning on adjacent rows
  - Remove suppressed, poorly formed, and diseased trees
  - Depending on stand health and target structure, some better trees may be removed too
- Minimum size for merchantability is pulpwood size class—sold by weight

Question

Why is thinning important for pine plantations managed on longer rotations (sawtimber, poles, and chip-n-saw)?

Other Management Options

- After thinning, other objectives such as wildlife habitat improvement may take precedence
- Periodic prescribed burning in thinned pine plantations (e.g. 3-5 years)
  - Improve plant and insect diversity and richness
  - Valuable wildlife habitat for a variety of species
  - Timber production may be a secondary objective for some landowners

Pine Product Classes

Price reported per ton or per cord (4' x 4' x 8')

Based on 1. defects/form and 2. diameter class to a given length

Stumpage prices vary locally so consult a local forester or timber buyer

Increasing Value ($)

4. Pulpwood
Dimensions: 4.5-9.5" dbh to a 3" top
Price: $7-18/ton

3. Chip-n-saw
Dimensions: 9.6" to 12.5" dbh to a 5-6" top diameter and good form
Price: $14-19/ton

2. Sawtimber
Dimensions: >12.5" dbh to 8-10" top and good form
Price: $20-27/ton

1. Poles
Dimensions: >8" dbh to 6" top diameter and no defects to ≥32'
Price: $43-55/ton

Final Harvest Considerations

- Timber product type and value affected by site conditions, disturbances, management decisions over the life of the stand and timber markets at harvest
- Higher value products (poles, sawtimber) take longer to grow than less valuable products (chip-n-saw, pulpwood)
  - More risk of damage with longer rotations (insects, diseases, storms, fires, etc.)
  - Shorter rotations usually have a higher rate of return
  - Monitor timber markets regularly—sell high

Final Harvest Considerations

- Work with a consulting forester or natural resource professional
- Express your objectives or goals for your land
- Create a timber contract
- Timber harvests can take months to plan and execute
- Be aware of your state's rules and regulations (environmental, taxes, etc.)
  - Best Management Practices (BMPs)

Summary

- Southern pines are suited to a variety of sites throughout the Southeast and can be a valuable economic commodity
- Regeneration decisions (species, spacing, site prep, fertilization, and release) should be tailored to your location and objectives
- Active management is necessary to realize potential yields and maintain healthy stands—work with a forester

Photo Citations

1. Photo by David Clabo

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Questions?

1. Would mechanical or chemical site preparation offer better long term control of small hardwood stems (<1”diameter) on a site that is scheduled to be planted with pine?

2. Which method of regeneration (natural or artificial) is considered more reliable from a spacing and performance standpoint?

3. Why is thinning important for pine plantations managed on longer rotations (sawtimber, poles, and chip-n-saw)?

Hardwood Management

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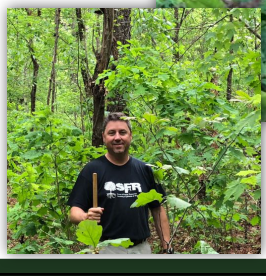
WOODLAND STEWARDS

A Regional Extension Program for Landowners

Overview

- The hardwood resource
- Factors that impact hardwood management
- Components of a hardwood stand evaluation
- Tools that will benefit you as a resource manager
- Plan is to look at the forest and not delve into the trees just yet…



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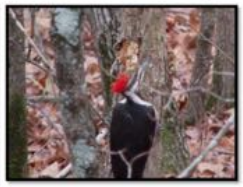
Why do we manage hardwoods?

- Timber
- Wildlife
- Recreation
- Aesthetics
- Water and air quality



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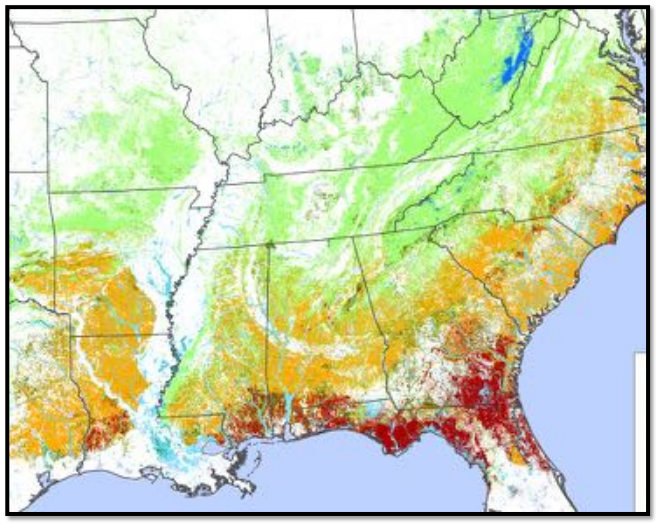
Hardwood Forests in the Eastern US

Source: USDA Forest Service



Why are oak species desirable for management?

- Studies have shown the importance of oak species to woodland value for multiple objectives.
- Timber
  - High utilization
  - Relatively fast growing
- Wildlife
  - Hard mast production key component of diet for many wildlife species
  - Squirrel, ducks, blue jays, woodpeckers, rodents, deer and many other consumers
  - Several studies have indicated positive correlations between animal populations and hard mast production
- Aesthetics
  - Open woodlands are often viewed as aesthetically desirable
- Water and air quality
  - Long lived
  - Large root systems and crown area

Tree ID Resources:

- Silvics of North America: Volume 2. Hardwoods
  http://www.srs.fs.usda.gov/pubs/1548
- Virginia Tech Dendro:
  http://dendro.cnre.vt.edu/dendrology/factsheets.cfm
- Smart Device Apps:
  Vtree, Leafsnap, Treebook, and more

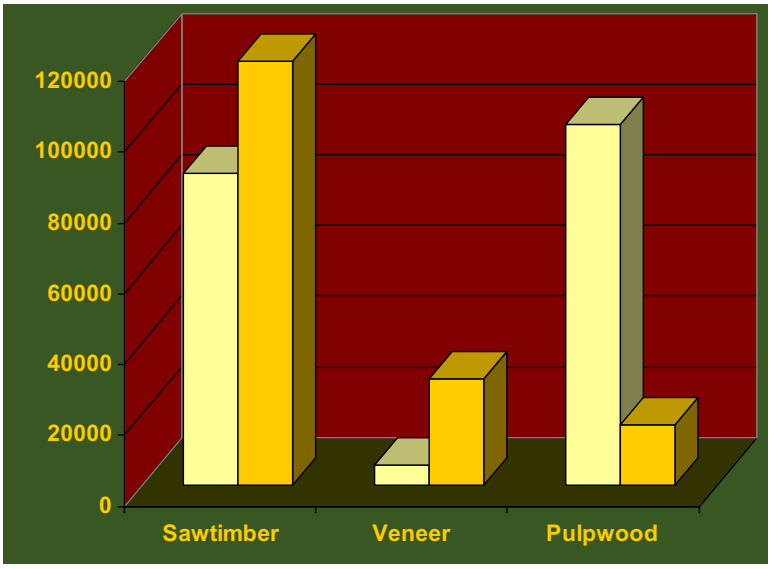
Hardwood Quality

- Not only is species important but tree quality is important
- This is especially true for a timber management objective

Photos by: Kyle Cunningham

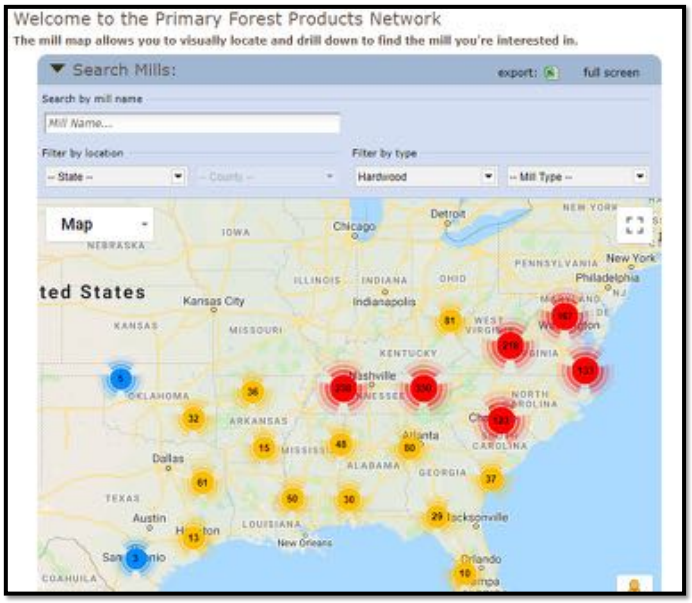
Volume vs Value for Hardwood Timber

- Arkansas Example:
  - Pulpwood: Very low value to volume ratio
  - Sawtimber: Good value to volume ratio
  - Veneer and other specialty products: High value to volume ratio
    - e.g. white oak stave log market



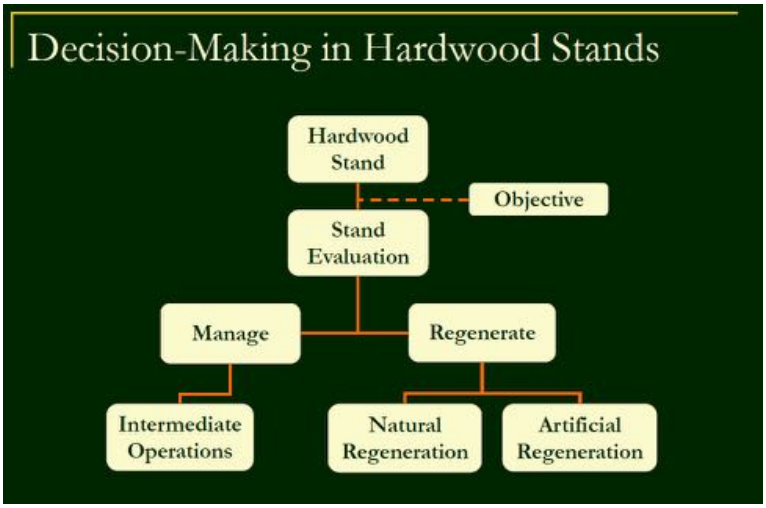
Mills Near You?

- The ability to harvest and remove trees is an essential element to managing hardwoods for health and productivity.
- **Primary Forest Products Network**
- http://primary.forestproductslocator.org/



Evaluating hardwood stands is a difficult challenge

- A large number of species
- Specific site requirements
- Different levels of stem quality and value



Species Groups

- Desirability of hardwood species may differ based on a specific management objective and/or landowner preferences
  - e.g. managing for non-game wildlife
  - Or, personal preference on aesthetic qualities of various species

Examples of desirable species groups for management in the Southeast

- Desirable species
  - Red oaks
  - White oaks
  - Ash
  - Black walnut
- Acceptable species
  - Sweetgum
  - Yellow poplar
  - Hackberry
- Unacceptable species
  - Hickories
  - Red maple
  - Elms
  - Hornbeam
  - Blackgum
  - Some oak species

Important Considerations

- Stand location?
  - Bottomland
  - Terrace
  - Upland
- Desired Species?
  - Timber, wildlife, other
- Desired timber product goals?
  - Veneer
  - Sawtimber
  - Pulpwood

Establish Objectives

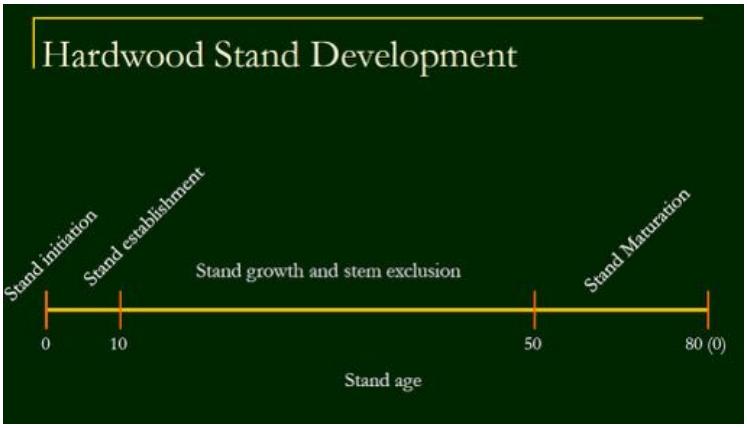
- What is more important?
  - Timber, wildlife, other?
- Specific goals?
  - Species that are important
- How much investment can I afford?
  - Time and Money
- What final product am I looking for?

Analyze Current Conditions

- Timber inventory
  - Develop a stand table
- Wildlife evaluation
  - Numbers
  - Habitat (surrounding properties)
- Site considerations
  - Species site relationships
- Revisit management objectives

Stand Age

- Two fallacies about tree size and age
  - Large trees = old trees
  - Small trees = young trees
- Remember for the most part hardwood stands in the Southeast are even aged.



Tree Vigor

- High vigor trees
  - Better quality
  - More disease and insect resistance
- Components of Tree Vigor
  - Full Crown
  - Signs of limb dieback or decay
  - Condition of tree bole
  - Signs of damage or decay

Photo by: Kyle Cunningham

Stem Quality
(Log Grade)

- Helps determine merchantability
  - Types of products
- Helps determine economic value
  - Higher grade = higher value
- Used when marking a stand for thinning
  - Base concept to remove lower grade trees and leave higher grade trees

Photos by: Kyle Cunningham

Stocking

- The number of trees per acre is important to know to assist in management decisions
- In hardwoods it is even more important to have a feel for the number of "manageable"trees per acre.
  - Helps meet goals
  - Helps provide trees with value to manage

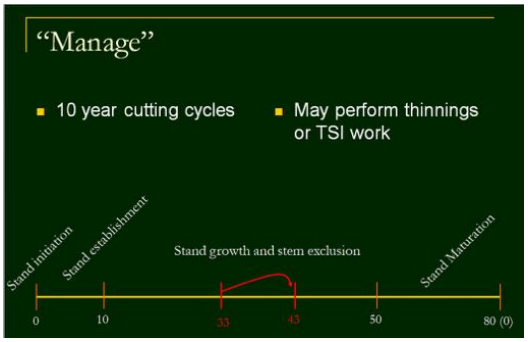
Stocking Levels for Upland Hardwood Stands

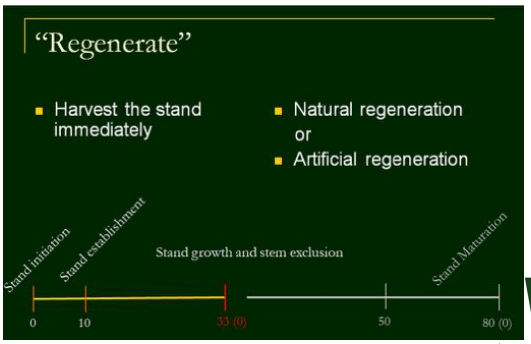
Stocking level	Average DBH	Trees per acre	Basal area	Stocking percent
Understocked	8	130	46	40%
	10	95	52	40%
	14	58	62	40%
Fully stocked	8	177	62	60%
	10	125	68	60%
	14	70	75	60%
Overstocked	8	305	106	100%
	10	215	117	100%
	14	118	126	100%

Adapted from: Gingrich, 1967

Tree Management Categories

- Ultimate goal of a stand evaluation
- Categorize trees as:
  - Manageable trees – The trees that will help meet LO objectives.
  - Unmanageable trees – Trees incapable of assisting to meet goals.
  - Cull trees – Trees of proper species, but do not meet other requirements for management (e.g. non-merchantable).
- Remember these concepts are for even-aged oak forest types of the Southeast
  - Shade tolerant forest types such as those in parts of West Virginia and in the NE could be managed differently.





Make A Plan

- Establish objectives
- Analyze current conditions
- Make decisions to keep costs low
- Develop a schedule of activities
- Seek professional help

Photos by: Kyle Cunningham

	2019	2020	2021
Stand 1	Thinning	Wildlife plots	
Stand 2	Final harvest	Site prep	Plant trees

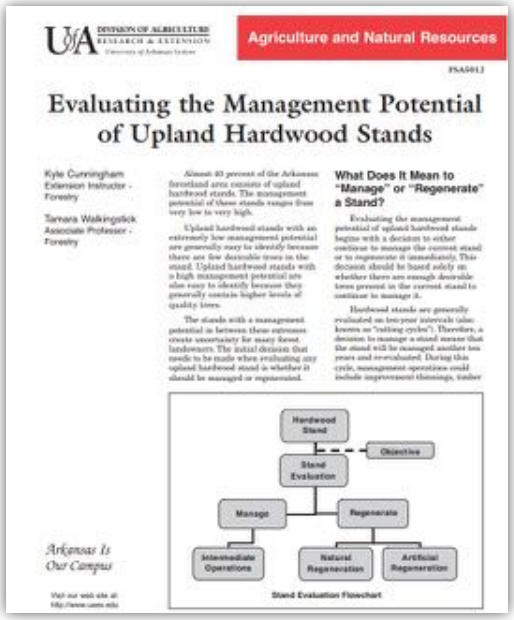
Seek Professional Help

- County Extension Office
- Forestry Commission
- Game and Fish Biologists
- Natural Resources Conservation Service Office
- Private Consultants

Photo by: Kyle Cunningham

Decision Support Tools for Hardwood Management

- Publications
  - Stand Evaluation Publication FSA5012
- Websites and apps
  - Tree ID (Vtree)
  - Soils (WGS Soils Mapper)
  - Mapping (Google Earth)
  - Timber Price Reports
    - Local and regional sources



U/A DIVISION OF AGRICULTURE RESEARCH & EXTENSION

Agriculture and Natural Resources

FSA5012

Evaluating the Management Potential of Upland Hardwood Stands

Kyle Cunningham
Extension Instructor - Forestry

Tamara Walkingstick
Associate Professor - Forestry

What Does It Mean to "Manage" or "Regenerate" a Stand?

Hardwood Stand
Objective
Stand Evaluation
Manage
Regenerate
Intermediate Operations
Natural Regeneration
Artificial Regeneration

Stand Evaluation Flowchart

Arkansas Is Our Campus

WOODLAND STEWARDS

Time to take a break!

WOODLAND STEWARDS
A Regional Extension Program for Landowners

Assessing and Prescribing Treatments for Degraded Stands

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WOODLAND STEWARDS
A Regional Extension Program for Landowners

Presentation Outline

- About Clatterbuck
- What is a Degraded Stand?
- Causes
- Determining ACS --- Acceptable Growing Stock
- Assessment Procedures
- Prescription Protocols:
- **DECISION-making** ---- Regenerate or Rehabilitate?
- Recommendations

Difference in Degraded and Low Quality Stands

- Degraded ---- Caused by cutting practices and/or disturbances

- Low Quality ---- Caused by poor or low site productivity

Degraded Stands

Definition:

1. Absence of merchantability in the sawtimber class
2. Absence of Acceptable Growing Stock (**ACS**) --- Must build ACS from improvement of the current stand **or** through regeneration

Underlying Premises

- All degraded conditions cannot be corrected in one treatment
- Foresters working with landowners often have only one opportunity to provide silvicultural corrections --- often times associated with a timber harvest

Degraded Stands

Causes:

1. Repeated cutting without regard to the future stand
   - --- Reduces stem quality
   - --- Reduces *merchantable* volume
   - --- Changes species composition
   - --- Little or no consideration of regeneration
   - --- Canopy discontinuity

Degraded Stands

Causes (continued)**:**

2. Fire and Grazing
3. Repeated entries with logging damage
4. Pests (insects and disease)
5. Poor site quality ---- Inherent low quality, not degraded

Degraded Stands

Overall:

- Repeated harvesting **usually leads to:**
- Increase in undesirable mid-story and understory --- lack of markets for small dbh material
- Reduction in vigorous advance reproduction
- Reduction in butt log quality
- Trees are **not** left with the potential to increase in value

Timber Goal

- Increase Acceptable Growing Stock to a level that ultimately allows and sustains commercial harvest ------ sometimes called ***Desired Future Condition***

- Some degree of movement towards desired future condition should be considered a **SUCCESS**

Was Your Prescription Successful?

Does the next forester encounter a condition that is better than what you are faced with now?

Degraded Stands
Procedures

1. Assess Stand
2. Perform an inventory
3. Determine: **Species**
   Vigor
   Quality
   of *Acceptable Growing Stock (ACS)*

Tree Vigor

<u>Function of</u>:

- Age
- Live Crown Ratio (LCR)
- Crown structure and form ---
  flat-topped, spindly crowns are poor candidates
- No branch dieback in crowns

Degraded Stands
Procedures
Consider:

a. Site quality potential
b. Stocking of desirable trees
c. Tree form & quality
d. Species composition
e. Regeneration potential
f. Landowner preferences

Prescription Protocol

The primary question to be assessed:

Rehabilitate Current Stand

or

Regenerate New Stand

Acceptable Growing Stock (AGS)

Defined: **Desirable SPECIES** with potential to increase in value

- Adequate number and distribution of AGS knowing that stocking of these trees is less than optimal.

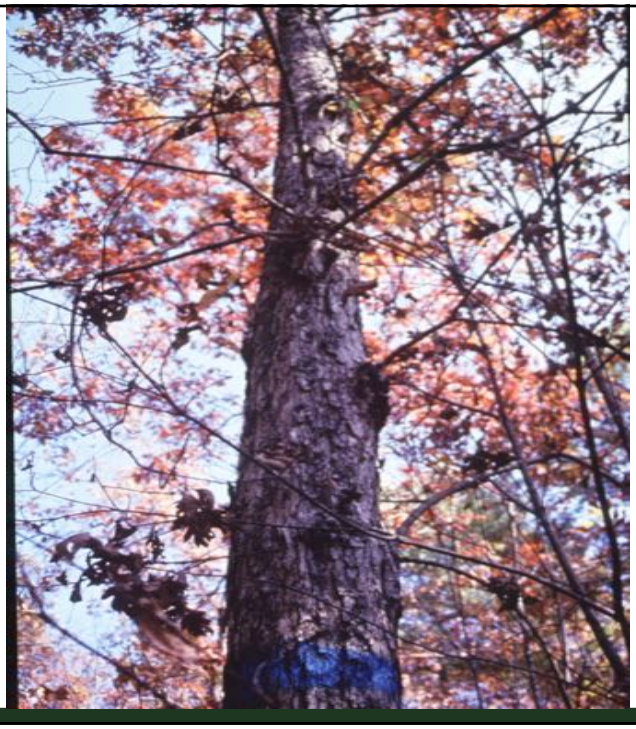
Acceptable Growing Stock (AGS)

QUALITY

Assessing quality potential in degraded stands

- **Target butt log**
  - -- 80 % of value is in the butt log
  - -- Degraded or low quality sites will naturally be short-logged

Enough quality (value) to carry stand forward ???



Acceptable Growing Stock (AGS)

Assessing VIGOR

- Normally accomplished using crown class determinations --- however ----
- Degraded stands tend to have discontinuous canopies
- Should rely on tree condition (visual) to determine response rather than crown class in these situations. **Function of age, live-crown ratio, and crown condition**

Prescription Protocol

Rehabilitate Current Stand

Regenerate New Stand

Regeneration

When complete clearcutting is not an option

- What size of opening is required to initiate and maintain growth of shade intolerants/intermediates?
- What are harvesting constraints to opening size?

Regeneration

When complete clearcutting is not an option

- 150 ft. opening changes species composition
- However, long-term sustainable growth of shade intolerant / intermediate species occurs when gaps are 1.5 acres and larger
- 1.25 acre opening size or greater tend to minimize effects on harvesting efficiencies
- *Work of LeDoux in WV, Lhotka in KY*

Regeneration

When complete clearcutting is not an option

Two-age Systems

Perpetuates 2 age classes composed of

1. Younger regenerating class
2. Older reserve trees (<15ft^2/acre)

Two-Aged System

- Known in literature as

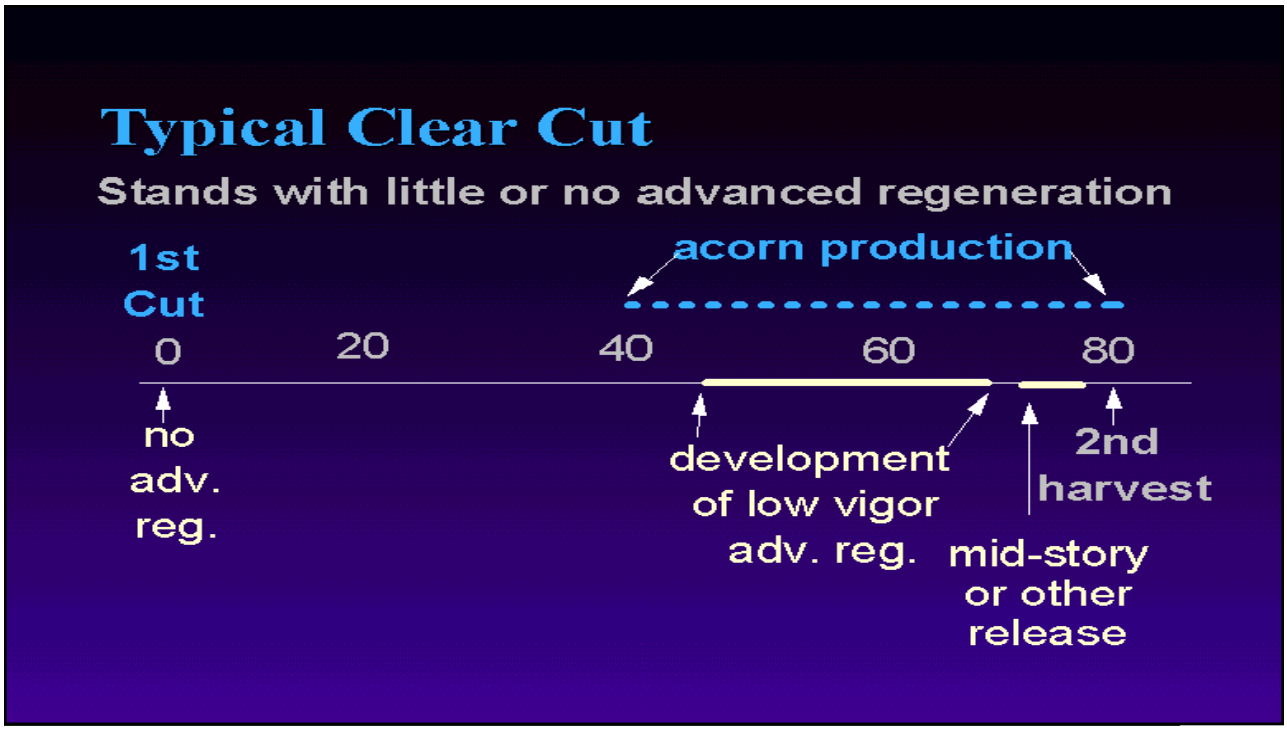
1. Deferment cuts
2. Irregular shelterwoods
3. Shelterwood with reserves

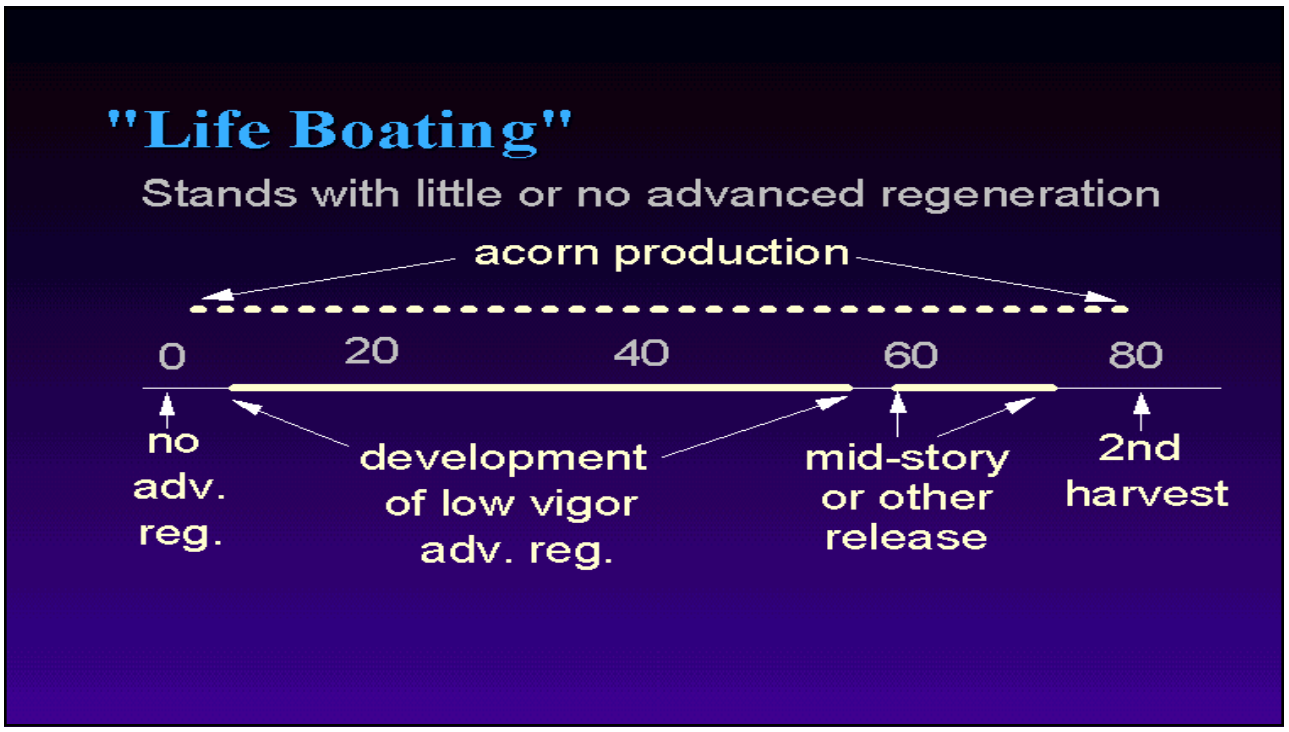
Two-Aged System --- Advantages

- Aesthetics --- first & primary use in the US as an alternative to clearcutting
- Ability to regenerate intolerant/intermediate species
- Provide structural diversity
- Develop large, high-value stems (*potentially*)
- Maintain some sexual reproduction
- Less fiscal hardship than traditional shelterwood

Two-Age System --- Disadvantages

- Reserve tree candidates may not be present
- Potential Tree Grade decline of reserve trees
- Aspects of forest fragmentation
- Ability of timber harvesting operators
- Impact on mating system (*relatively unknown*)

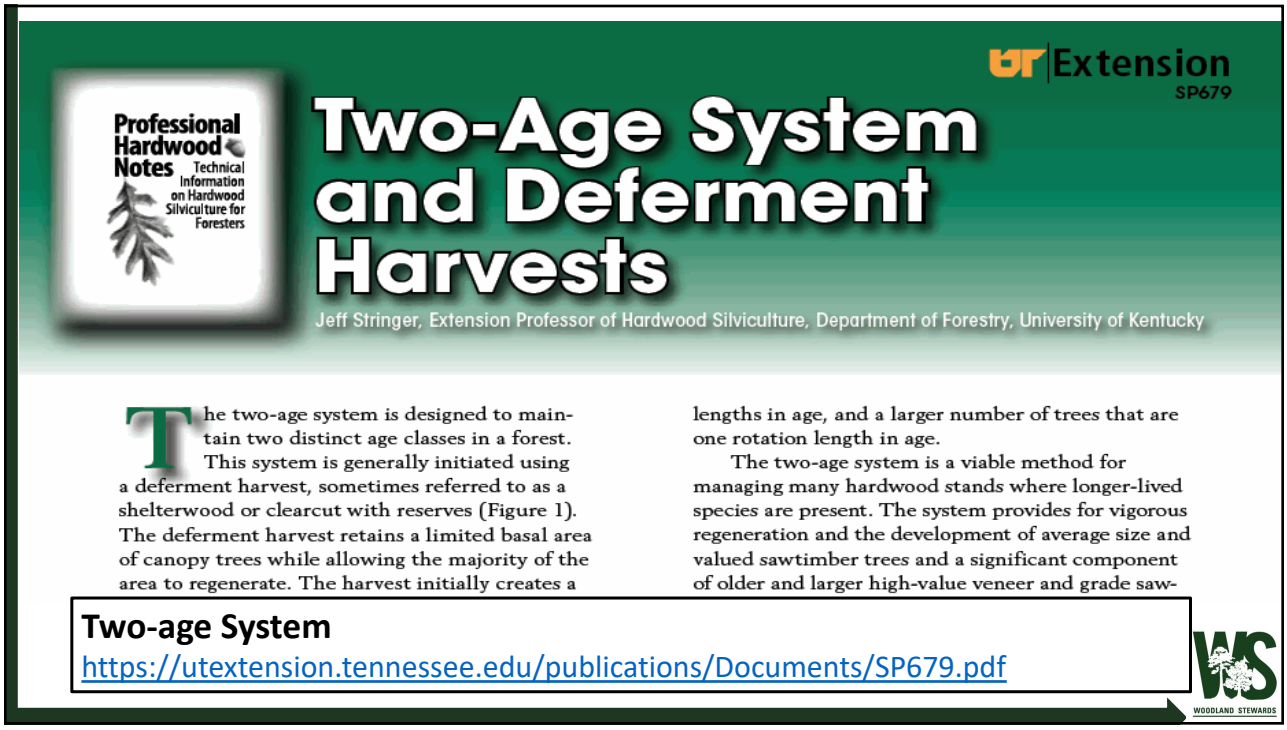




Two-Age System

Summary

- Two-age system could be used to lifeboat species (oaks) in stands where advance regeneration is not present at time of harvest, i.e. oaks!
- Reasonable regeneration treatment for landowners when clearcutting is not an option or disfavored



Example
Improving Degraded Stands

1. Commercial clearcut removed 3000 bd ft/acre in sawtimber-sized trees. No further treatments implemented.

Height	Initial = 22 ft;	At 22 yrs = 49 ft
Diameter	Initial = 3.3 in;	At 22 yrs = 4.4 in
Desired Species	7%	
AGS	18%	mean dbh = 7.6 in at 22 yrs

WOODLAND STEWARDS

Example
Improving Degraded Stands

2. Remaining residuals are clear-felled. No other treatments or herbicides used

Height	Initial = 5.6 ft;	At 22 yrs = 52 ft
Diameter	Initial = 0 in;	At 22 yrs = 3.9 in
Desired Species	18%	
AGS	36%	mean dbh = 5.1 in at 22 yrs

Example
Improving Degraded Stands

3. Remaining residuals were clear-felled. Crop trees of desired species released at age 10 and sprout clumps were thinned to 1 stem/clump.

Height	Initial = 6 ft;	At 22 yrs = 62 ft
Diameter	Initial = 0 in;	At 22 yrs = 3.9 in
Desired Species	38%	
AGS	72%	mean dbh = 5.7 in at 22 yrs

Example Comparison
Improving Degraded Stands

	Com. CC	Clear-fell	Release @10 yrs
Height (ft)			
Initial	22.0	5.6	6.3
22 yrs	49.2	52.3	62.4
Diameter (in)			
Initial	3.3	0.0	0.0
22 yrs	4.4	3.9	3.9
22 yrs AGS	7.6	5.1	5.7
Desired species (%)	7.0	18.0	38.0
AGS (%)	18.0	36.0	72.0

Management of desired species and acceptable growing stock during intermediate and regeneration processes make a **huge difference** in future value of the future stand!!!

Otherwise, degraded, low-value stands will prevail

Data Courtesy of Dr. Jeff Stringer, University of Kentucky

Degraded Stands
Recommendations

1. Stands with more than 50 ft^2 of basal area per acre in acceptable growing stock (AGS) are not generally considered as degraded.

2. Prioritize higher quality sites over poor quality sites

Degraded Stands
Recommendations

3. Thinning is generally not practical in degraded stands. Stocking is not sufficient to allow thinning.

4. Some positive improvement or treatment of the stand is considered a success.

Degraded Stands
Recommendations

5. Manage or Regenerate???

Heterogeneous stands may have both ---- areas to regenerate and areas that can be managed to increase value ---- perhaps work strategically in groups/patches

Degraded Stands
Recommendations

6. Regenerating the stand may have better potential for increasing value than culturing existing trees

7. On lower quality sites, may consider mixed harddwood-pine stands

Degraded Stands
Recommendations

8. Two-age system is viable for increasing success for degraded stands --- establishing viable and desirable regeneration as well as capturing some value of retention trees

9. Some treatment of a tolerant, undesirable midstory and understory is usually required.

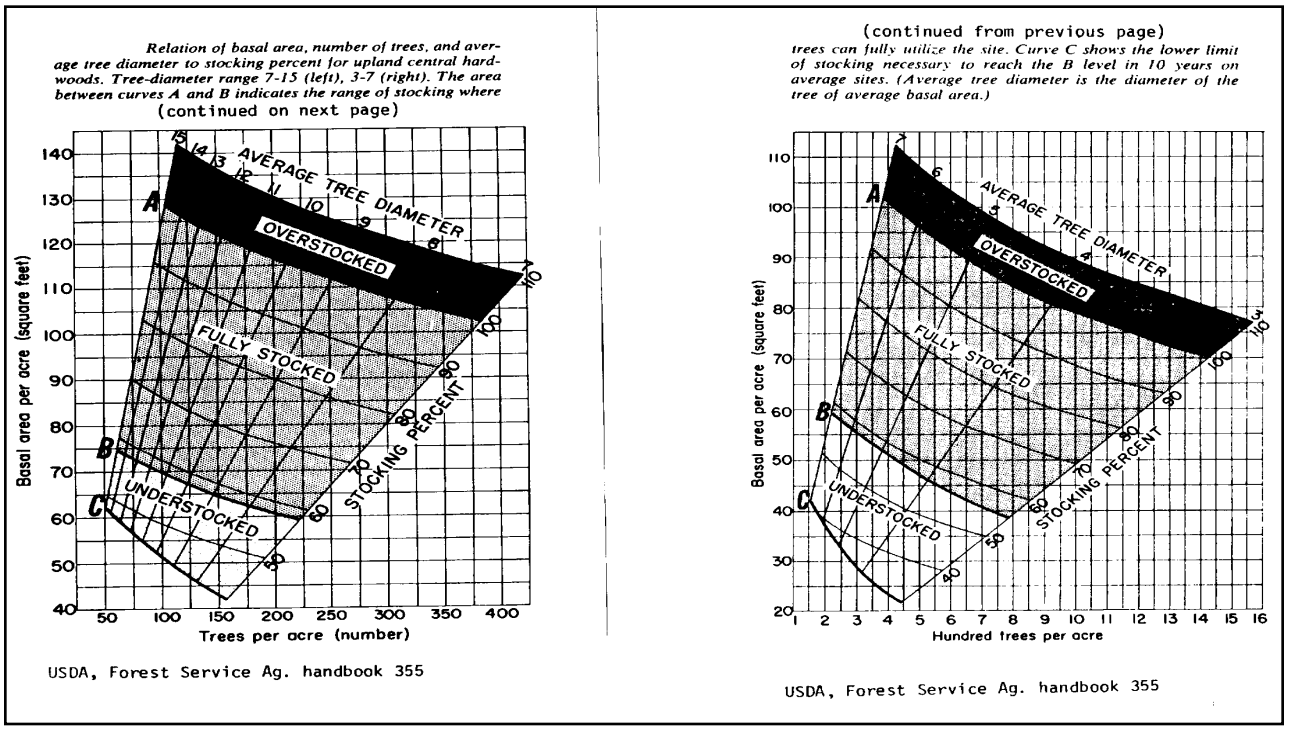
Summary
Treatments in Degraded Stands

- Do something positive somewhere versus something wrong everywhere
- Give up some silvicultural control in some stands to assure that proper treatment occurs on more promising stands. Prioritize
- Carefully assess site preparation needs. Post- vs. Pre-harvest site preparation

Summary

Treatments in Degraded Stands

- Select higher productive sites over lower productive sites
- Regenerate if overstory is below C-line
  - Reduce to 15-20 sq ft
  - Conduct regeneration surveys
  - Prescribe site preparation



Relation of basal area, number of trees, and average tree diameter to stocking percent for upland central hardwoods. Tree-diameter range 7-15 (left), 3-7 (right). The area between curves A and B indicates the range of stocking where

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trees can fully utilize the site. Curve C shows the lower limit of stocking necessary to reach the B level in 10 years on average sites. (Average tree diameter is the diameter of the tree of average basal area.)

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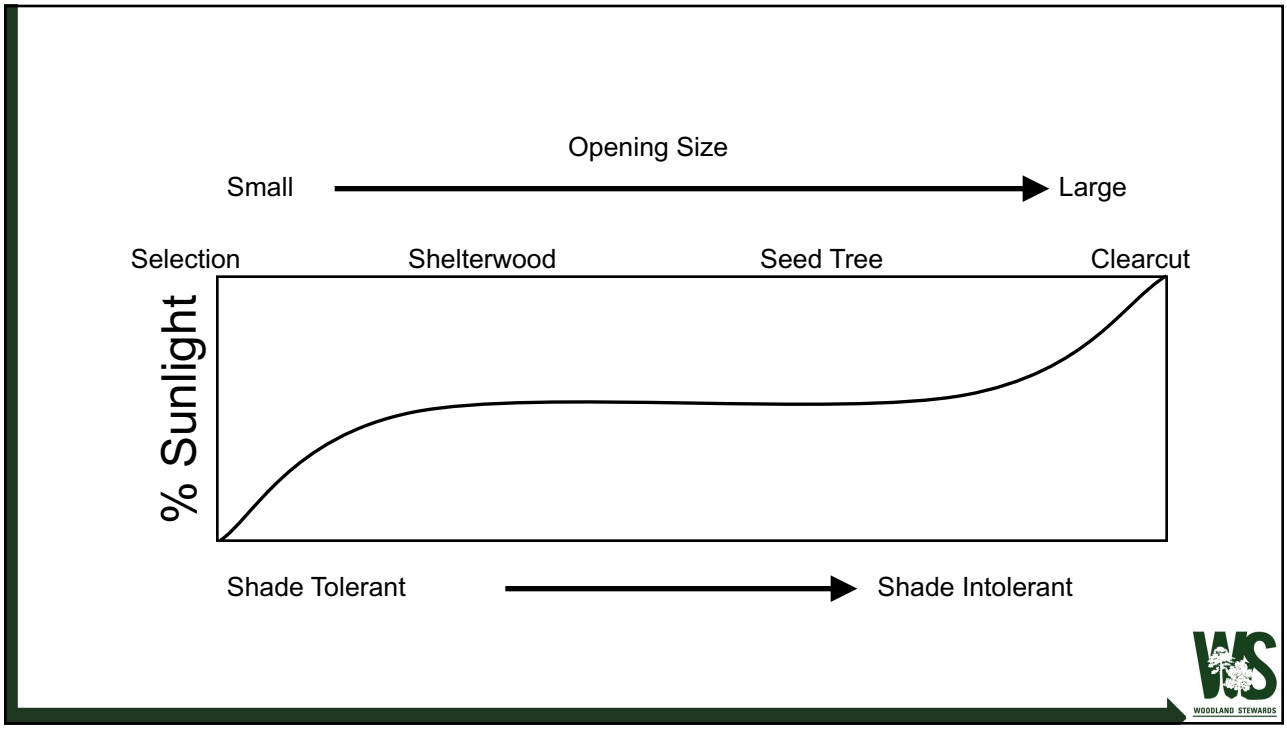
Summary
Treatments in Degraded Stands

- Control unwanted midstory/understory development
- Consider mixed pine-hardwood stands on lower quality sites (Research in progress)

Summary
Treatments in Degraded Stands

- Two-age system (sparse tree mgmt)
  - Develop better quality butt logs
  - Allow for regeneration without clearcutting
  - Lifeboat species
  - Single trees or groups?



What Are We Managing?

- **Sunlight** ----- Determines species composition
- **Space/Density** -----
  - Determines growth by influencing crown size
  - Influences stem quality

Improving Degraded Stands

https://utextension.tennessee.edu/publications/Documents/SP680.pdf