Application of Uneven-aged Management

Important Terminology, Concepts & Methodology

What is Uneven-age???

Age Classes

• Uneven-aged stand
• How many age classes must an uneven-aged stand have?

This is the defining characteristic of an uneven-aged stand
Uneven-aged Stands

2 Types
- Balanced
- Irregular

Uneven-aged stand = Intimate mixture of age classes

Balanced Uneven-aged Stands

- All-aged Forest
  - Every age class in the rotation is represented
  - Each age class represents approximately the same area
  - Regeneration of new trees would need to occur every year

Balanced Uneven-aged Stands

- The perfect “All-aged” stand is theoretical, it mostly exists only in the imagination
Balanced Uneven-aged Stands

- Even-spaced age class
  - More attainable
  - 3 or more age-classes evenly spaced over rotation (i.e., over a 5-year cutting cycle)

Irregular Uneven-aged Stands

- 3 or more age classes
- Stems are not evenly distributed throughout age classes

Some Terminology

- Silvicultural System
  - Process by which a forest is tended, harvested & regenerated to achieve management objectives

- Selection Method
  - Regeneration method or technique aimed at the creation and maintenance of uneven-aged stands (i.e., Indiv., Hec., Group, Patch)

- Sustained Yield
  - Even-flow, non-declining, i.e., roughly the same cut every year
**Sustained Yield Unit (SYU)**

- Most commonly the SYU is the FOREST
- It is possible for the SYU to be the STAND
  - However, ABSOLUTELY NECESSARY to have a balanced distribution of age classes
  - You are harvesting the tail of the diameter distribution and creating conditions for progression of smaller size classes

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**Regulation of the Cut**

- Method by which the annual periodic cut is determined in order to attain a Sustained Yield
  - Two ways to look at this
    - Area Regulation
    - Volume Regulation

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**Area Regulation**

- A management scheme to produce sustained yield at the forest level
  - NOT at the STAND level
- Does not create Uneven-Aged STANDS
  - Creates Uneven-aged FORESTS
**Conceptualization**

- 10,000 acre forest
- 50 Year Rotation
- 2,000 acre working unit (compartments)
- Work in 1 unit each year

**Area Regulation**

- The age indicates a 25-year cutting cycle (longer or shorter cycles may be appropriate)
- Aerial view

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**Notes:**

- Comments or additional information regarding the conceptualization and area regulation processes.
Volume Regulation

- Removal of Annual or Periodic Growth
- All age classes grow in an INTIMATE MIXTURE
- Mature stems (Rotation age) harvested each year
  - Financially mature stems harvested

Financial Maturity

- Tree or stand can be seen as an investment
- When growth falls below an alternative rate the stand or tree is said to be financially mature
Uneven-aged management entails:

- Maintaining trees of different age classes in the same area
- Calls for more or less equal, periodic harvests
- Under this practice, trees are removed on an individual basis to leave a desired number of trees in each size class
- Variety of goals can be met
- Each harvest stimulates reproduction of new trees and enhances the growth and yield of older trees.

Diameter Distributions

- Most straightforward & widely understood types of uneven-aged silviculture is single-tree selection
- Many early attempts failed b/c of inadequate regulation
Regulation & Control

- Cutting was concentrated in large size classes w/ little thought given to developing and maintaining a balanced diameter distribution
- High-quality, mature timber was removed first – after repetition this reduced ingrowth into the sawtimber size classes

Result = Diameter-Limit Cutting or High-grading

“High-grading” selective logging
- Poorly planned selective logging results in damaged, poor-quality stands.

Single tree selection system
- Well-planned and well-implemented selection systems can result in high-quality stands with little damage.

Diameter Limit Cut

- Most common practice of harvesting hardwood forests of North America
- High grades the forests by taking only the largest and best trees at every harvest. “Taking the BEST, Leaving the REST”
- Loggers and sawmillers often refer to this as select cutting or selection.
- It is poor forestry!
High-Grading

Definition
- Occurs when the residual stand has less value and potential value as the stand removed.
- Still widespread in Tennessee (Diameter-limit cutting)

High-Grading

- What’s the Harm?
- Most stands in Tennessee are Even-aged
- Favors shade-tolerant species
- Shade-tolerant spp. in the TN tend to be less valuable (economically and sometimes biologically)
- What would happen if Oak spp. were replaced?
• What we have learned is that regulation requires control over:
  - Diameter distribution
  - Growing stock levels

Stocking Control

Stocking Control

• What stocking levels should be retained after the cut?
• Gross growth varies only slightly over a moderate range of stocking levels
  - 60 or 70% of full stocking enhances individual tree growth & stand growth
  - “Optimal” residual stocking varies with species & sizes of trees, diameter distribution, among others.
Control of Diameter Distribution

- Determining the desired number of trees or basal area to be retained in each diameter class
- “q” quotient

“q” quotient

- Expresses number of trees in successive diameter classes as a means of calculating a desired diameter distribution.
- Tends to be fairly constant in many undisturbed, uneven-aged stands.
- Represents the slope of the relationship (slope of the regression) between # of trees/ac and DBH.

“q” quotient (example)

If you had 100 trees in the 6 inch class & a “q” of 1.3 you would have 130 trees in the 5 inch class, 169 trees in the 4 inch class and so on …
“q” quotient

- To set up a Diameter Distribution based on “q” you must decide upon three parameters:
  - Residual stocking
  - Maximum tree size (considering financial maturity and/or landowner objectives)
  - What “q” to use

What “q” to Use

- “q” normally varies between 1.3 and 2.0
- Small “q” tend to have higher proportions of the growing space devoted to larger trees (sawtimber)
- Stands managed with higher “q” values dominated by more trees in the smaller size classes (pulpwood, small product objectives)

Comparison of Stand Attributes with Varying “q” - values

<table>
<thead>
<tr>
<th></th>
<th>Q = 1.2</th>
<th>Q = 1.5</th>
<th>Q = 1.8</th>
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</thead>
<tbody>
<tr>
<td>Stems per acre</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Size of Stems</td>
<td>more sawtimber - less repro</td>
<td>less sawtimber - more repro</td>
<td>least sawtimber - more repro</td>
</tr>
<tr>
<td>Seedling/Mature Tree Ratio</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Wildlife Habitat Cover</td>
<td>low</td>
<td>medium</td>
<td>high</td>
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<tr>
<td>Landowner Goals</td>
<td>more to timber</td>
<td>compromise between timber &amp; aesthetics</td>
<td>least timber</td>
</tr>
</tbody>
</table>
Residual Stand Structure Goals

• Once goals for stocking, max. tree size & “q” have been set, it is simple to calculate stand structure goals.
  – Assign 1 tree to largest DBH – then calculate successive smaller diameter classes with “q”
  – Calculate basal area of each DBH class & total basal area
  – Calculate for both target & actual, then compare

Target vs. Actual

Creation & Maintenance of Balanced Uneven-aged Stands

• Creation from Even-aged stands
  – Can be done, but requires some loss of growth potential
  – Usually takes time (full rotation – removing a portion of the stand each cutting cycle)
Creation from Even-aged stands

- 50-year rotation
- 10-year cutting cycle – enter stand once every 10 years
- Remove 1/5th of the stand each cutting cycle
  - If the decision was made when the stand was 80 yrs old – some 130 year old stems harvested

Creation from Even-aged stands

- If the stand was younger
  - Potentially harvesting immature stems early and overmature stems later in rotation
- In either case – would suffer a financial loss – loss in potential productivity
  - Losses may not be justified

Creation from Irregular Uneven-aged stands

- Can be done much faster
- But potential losses remain a consideration
- Must remove or harvest from all age classes
- Remember “q”
Building an Uneven-aged Forest

Manipulation of Stands

Harvest Cuts – Which trees are removed?

- Largest & usually oldest – either as individuals or small groups
- Harvested trees represent the annual or periodic growth
- Replaced by regenerating stems (reproduction) – this is repeated over time to create or maintain an uneven-aged stand
- Financial maturity – overriding factor
Other Considerations

• Trees at or above largest diameter – may not want to cut if still vigorous and healthy
• High-risk trees – not likely to make it to the next cycle – disease or insects
• Poor form – may want to remove poor genetic material or damaged stems
• Diameter distribution goals – cut more heavily or lightly in a diameter class to obtain proper diameter distribution

What about the Small Trees?

• Thinnings are required to regulate immature age or size classes
• Can not ignore – represent future
• Density needs to be controlled to foster ingrowth and continuous regeneration
  – If ignored – small stems will create a bump in the diameter distribution
  – Can cause loss in productivity & prohibit future regeneration
  – Pay attention to “q”

What Trees to Keep
  (among immature classes)

• Those of the best quality, soundness & vigor
• Offering best probability of survival & growth
• The desired spp.
Modifications of the Selection Method

• Single Tree Selection
• Group Selection
• Strip Selection
• Dauerwald

Single Tree Selection

• Managing Individual stems
• Create openings (removal of mature stems) to regenerate new stems in once occupied space
• Remove sufficient numbers of mature trees to cover area allocated to that age class

Single Tree Selection

• Thin individual immature stems to balance the distribution
  – This redistributes proportional area among fewer stems
  – To optimize growth potential
Single Tree Selection

- Some species adapted:
  - Sugar maple
  - Beech
  - Hemlock
  - Red spruce
  - Grand fir
  - Engelmann spruce

Single Tree Gap

Sunlight able to reach the forest floor
Single Tree Criticisms

- Inability to regenerate shade-intolerant spp.
- Unwillingness to invest in tending of immature stems
- Unwillingness to invest in inventory to determine diameter distribution & needs for tending

Single Tree Criticisms

- Can be difficult with clustering of mature stems
- Difficult to minimize damage to the residual stand
**Group Selection System**

- Stems cut in small groups rather than as individuals
- Identify family groups of mature and immature trees
  - Harvest mature groups to open the canopy for new regeneration
  - Thin the family groups of immature stems to maintain balance

**Group Selection**

**Reasons to Use:**

- Species requirements
  - Intolerants do not regenerate in small openings created by single tree selection
  - By modifying the size and arrangements of the group cuts, create a wider range of environments and conditions most favorable for a particular species

- 1. Species requirements
  - Reproduction – develops in small even-aged groups – gives better form
  - Able to track age class development easier (easier to see)
  - Edge effect – may be beneficial in establishment of some spp. – can cause growth reduction later.
    - Not good for phototropic spp., i.e. hardwoods
Group Selection

- 2. Economics of harvesting
  - More economical to harvest groups – less damage to residuals

- 3. Wildlife
  - More edge, more environmental conditions that produce a greater diversity of plants for cover, food source, etc...

Group Selection System

Not greater than 1.5 to 2 times the height of average of the dominant canopy

Not group selection – Patch clearcut
Group Selection Praise

- Can increase chances for regenerating shade-intolerant species
- Semantics – can turn into patch clearcutting if the size of the group is large – remember area management

Group Selection Criticism

- Inventory ignores spatial distribution of family groups
- Unwillingness to tend immature groups
  - Failure to tend immature groups makes it a mere diameter-limit cut

Strip Selection

- Each age class in the stand is concentrated in long narrow strips
- Harvested on a cutting cycle to include one strip each entry
- Seldom used in the U.S.
- Advantage – harvested material concentrated
**Strip Selection**

- Advantage – less damage to reproduction
- Mostly used for montane watershed management – help increase snowpack
- Difficult to initiate, forces you to cut overmature & immature stems to set up the system

**Dauerwald**

- German – meaning continuous forest
- Each tree receives TLC
- Managing single trees instead of stands
- Used b/c of lack of land base in Europe
- Highly intensive management

**Growth & Production**

- Debate – uneven-aged stands are more efficient in production of volume and value
  - First, Value – may not be the case – species dependent – in the southeast the most valuable species are generally intolerant
Growth & Production
– Second, Volume – Reproduction occurs under mature harvestable trees
  • Less time for harvestable turnover
  • Space for new cohort is not taken by mature stems
  • Better utilization of the site
– Greater volume has not been conclusively demonstrated through scientific investigation
  - Debate continues on.......... 

Economics of Uneven-aged Management
• Uneven-aged management may be appropriate for certain class of ownership
  – Small Private Landowners
    • Some small landowners have a limited land base and wish to obtain periodic returns on investment
    • Especially if stand is already uneven-aged or two-aged – may be too costly to convert to even-age (time lag)

Small Landowner Example
• Situation – small landowner (200 acres), stand has been high-graded by diameter-limit cuts (so it is two-age)
• Alternatives:
  – No management – take what little stand produces
  – Convert to pine
  – Uneven-aged management – proper use
Small Landowner Example

- Landowner has a desire to actively manage – improve production of stand
- Assume a rotation of 30 years
  - Costs – site prep & planting (Even-aged), improvement cuts and added cost of harvesting (Uneven-aged)
  - Returns – value from clearcut (even-aged), value from yearly harvest (Uneven-aged)

Small Landowner Example

- Returns are more for plantation management
- Reasons why uneven-aged management might still be acceptable
  - Large initial investment in plantation
  - Multiple objectives – wildlife, aesthetics, timber

- In the past we have given landowners the alternative of even-aged or nothing
- Maybe we can encourage better tending of private land by promoting uneven-aged management
- Many simply not willing to employ even-aged or plantation management
**Other Partial Cuttings**

**Non-harmful cuttings Do Not:**
- Preclude regeneration
- Upset soils or expose them for long times
- Plug up natural drainages or change landforms

**Cuttings outside this Silvicultural System:**
- Give irregular yields of unpredictable amounts
- Take a chance on spp. composition of regeneration
- Accept non-uniform distribution of growing stock
Selective Cutting not Selection

- Creaming, culling or high-grading
- Diameter-limit cutting
- Exploitation that removes certain trees of high value without regards to regeneration
- Known silvical requirements & sustained yield being wholly or largely ignored

Advantages & Disadvantages as compared to even-aged management

Advantages
- Seed source more assured
- Better protection of site
- Less danger of fire
- Aesthetically more pleasing
- Sawtimber quality could be better – debate
- Less susceptible to insects or pathogens

Disadvantages
- Harvesting is not concentrated – more costly
- More supervision & expertise required
- More damage to reproduction & residuals
- Less chance for selecting for better genotypes
- Difficult to manage & evaluate
Summary

• Favors tolerant spp. — equates to less valuable timber in TN
• Cost of operation is greater — larger area impacted for similar extraction
• Damage to residuals & reproduction
• For method to be effective, must be diligent in cutting in all size/age classes

Summary

• Markets for all materials are needed
• More expertise & time needed for proper implementation
• Danger of method degenerating to highgrading & diameter-limit cutting unless proper care is taken to promote all size/age classes