Pure Multi-cohort stands

- These stands have three (3) or more well-defined age classes
- Form when major stand replacing events occur very infrequently; trees die individually or in small groups, creating gaps in which a new cohort initiates
  - Naturally in forests with very tolerant species
  - Naturally in habitats where soil moisture deficiency or small light fires allow only one species to perpetuate and grow
  - Artificially by cutting / harvesting

Pure Multi-cohort stands ...

- Examples: Tolerant species vs. Soil moisture deficiency

Pure Multi-cohort stands ...

- Selection System: Silviculture programs that maintain uneven-aged stands through Selection Method of regeneration
- Administrative definition
  - A watershed / wildlife perspective sees a stand with lots of within stand variation where others may see lots of little stands
- Ecological definition
  - Gap size is no larger than 2 x as wide as the surrounding mature trees are tall
Selection Method

- Mature trees are removed at relatively short intervals to open enough growing space for regeneration
  - Removed singly as scattered trees (single tree)
  - Removed in small groups creating gaps (group)
- Usually associated with natural regen.
- Oldest / largest trees cut and enough smaller trees to ensure adequate trees of desired age classes free to grow

Selection System Purposes

- Land objectives dictate always having some large trees & continuous cover
  - Aesthetic considerations
  - Sustained yield on small holdings
  - Very high value trees
- Juxtaposition of old tree near young often good for wildlife
- Reduce risk of wind-throw / blow-down
- Reduce fire risk - lower temp. in lower canopy
- Good habitat for species requiring later stand stages, including “old growth”
- Abundance of large trees ensures seed source

Selection System Disadvantages

- Not suited for intolerant species
- Must inventory frequently - ea. cutting cycle
- Frequent entry requires careful planning of roads, skid trails
- Need skilled marking crew
- Risk of damage to residual trees high(er)
- Interspersion of age / size classes makes some site prep methods infeasible
- Longer, deeper crowns may sacrifice quality of upper-stem logs
- Poor habitat for species requiring early stand stages

What is the ideal?

- To have ongoing growth equal to what is taken out of the stand as a whole
  - Can be thought of as having equal crown volume in each age class
  - Can be thought of as having equal basal area in each age class
  - Can be thought of as harvesting periodically no more than the average growth of the stand over the same period
## Selection Sub-systems

- Single-Tree Selection System
- Group Selection System
- Strip Selection System

### Single-Tree Selection System

- Theoretically, single mature trees are harvested in short equal intervals, remaining groups thinned
- Size of each even-aged cohort = size of opening created by removal of a single mature individual
- Allows establishment of many seedlings, openings should be enlarged periodically
- Best suited to tolerant species
- The “classic” form of the system - the most common image conjured up in people’s minds
Group Selection System

- The “final” age-class is made up of two or more mature individual trees
- Larger the opening, the more intolerant the species that can be used
- Has advantages over single-tree
  - Less damage to residual trees in larger openings
  - Trees develop in clearly defined “even-aged” aggregates (hardwoods may need “training”)
  - Better for handling irregular stands

Edge effects
- As opening (group) size ↓, total perimeter of edges in forest ↑

Regeneration
- Side shade is provided
- Surrounding older trees take moisture, nutrients

Residual large trees
- Increases “effective” growing space
- If species are phototropic

Openings
- Gaps in canopy, micro-environmental conditions may be suitable for regenerating species over the entire spectrum of local vegetation
- Tend to become hot air pockets by day, and frost / dew pockets at night (esp. if small)

Groups
- No need for same size, shape, arrangement
- Could use shelterwood or seed-tree method as regeneration cut for value accrual or other ecological function

Pure Multi-cohort stands

- Example: Patch Cutting vs. Group Selection Regen. Method
Selection Sub-systems

- Strip Selection System

Strip Selection System

- Geometrically arranged groups
- Enables easy log transport through cut area
- May provide for advance regeneration in side light of strips
- If strips advance against prevailing wind, a wind-firm stand is created

Strip Selection System (cont’d)

Uneven-aged Stand Management

- Balanced (regular) multi-cohort stands
  - All age classes are “equally” represented

- Irregular multi-cohort stands
  - Not all age classes are equally represented – there are gaps

(E.C. Turnblom)
Uneven-aged Stand Management

- Balanced uneven-aged stands
  - “Continuous Equilibrium” – every age class is present on equal area so the stand is a perfect sustained yield unit (rarely occurs in nature)
  - Harvest every year exactly what is grown
  - How many trees of each age class are needed?
  - Best theoretical answer is have each class contain equal foliage surface area (measurement too intricate to be practical)

Uneven-aged Stand Mgt. (cont’d)

- Simplifying assumptions
  - Treat stand periodically (not annually), each period is called the “cutting cycle”
  - Number of cutting cycles in a rotation determines the number of age classes to maintain
    - 50-yr rotation on 5-yr cutting cycle
      - 10 age classes: 0 – 5, 6 – 10, 11 – 15, …, 46 – 50
    - 50-yr rotation on 10-yr cutting cycle
      - 5 age classes: 0 – 10, 11 – 20, 21 – 30, …, 41 – 50
  - Basal area is closely related to crown foliage area
  - Typically use diameter as surrogate for age, though height would be better, it’s too difficult to estimate

Negative Exponential Distributions

- In late 19th century, deLiocourt observed that very old forests in Europe often exhibited DBH distributions where number of trees in one class is common multiple of number in the next larger
- Meyer found this is true in N. American forests, too – called it the “q-factor”
  - q-factor ranges from 1.1 to 2.0 depending on
    - Species
    - Growth rate (mediated by site quality)
    - Mortality rates
    - Stand density (basal area)
    - Maximum size of mature tree to be grown
Determining the growing stock

- We make use of the only mathematical “identity” in forestry to guide construction of appropriate DBH distributions
  - \( BA = 0.005454 \times (DBH)^2 \times (TPA) \)
  - Decide on maximum DBH, q-factor, and stand BA
    - This determines the # of trees in the largest DBH class
- DBH distributions so constructed are best used as guides to determine which classes are deficient, which are surpluses
- Focus should be on keeping up with openings large enough to establish regeneration

Uneven-aged Stand Mgt. (cont’d)

- Regulating cut by DBH-distribution
  - Series of little stands (cohorts) each of same area (same crown area), conforming to a yield table for pure stands is fundamental basis (check method)
  - Essentially converts age distribution to DBH distribution
  - Need to consider how to make changes to DBH distribution through cutting in each cycle
  - Trees chosen to harvest / leave should be based on
    - Age (or size)
    - Quality
    - Vigor (foliage: amt., color, density; crown ratio)

Regulating cut by DBH-distribution

- Set max DBH = \( x \), cut most trees sized \( x \) or larger
- Cut all “surplus” trees unless needed for a larger deficient class
- Thin smaller classes simultaneously
- \( x \) is best thought of as a guide
Regulating cut by DBH-distribution

- Example: Northern hardwoods stand
- Deficiencies in DBH (age) classes may be present
- Leave some surplus trees to “fill in” gaps in DBH distribution

Irregular Uneven-aged Stands

- “Balanced” stands necessary only for even flow of sustained yield
- Other objectives can be satisfied w/out balance
  - Beauty
  - Wildlife habitat
  - Seedling ecology
  - Protection of stand, soil, or site
- Distribution of age & DBH classes can fluctuate, but should remain consistent with Sustained Yield of entire forest

Pure, multi-cohort System Applications

- Restrictive Sites
  - Moisture is so limiting that root competition precludes other species from filling apparent “gaps” in the stand
  - System takes advantage of rare regeneration events
  - Examples
    - Scotch pine (on deep sands, south of Baltic Sea)
    - Ponderosa pine (eastern Washington, interior west)
    - Longleaf pine (southeast U.S.A.)

- Good sites
  - More effort must be expended to control unwanted species
  - Example
    - Loblolly pine / Shortleaf pine (Arkansas)

Pure, multi-cohort System Applications

- Restrictive Sites
  - Longleaf pine (Bainbridge, GA)
Pure, multi-cohort System Applications

- Longleaf pine (*Pinus palustris*)

Pure, multi-cohort System Applications

- Longleaf pine

Pure, multi-cohort System Applications

- Longleaf pine old-growth
Pure, multi-cohort System

- Good sites
  - Loblolly pine / Shortleaf pine (Arkansas)

Concluding Thoughts

- q-factors are “attractive”
  - In some cases, puts too many small trees on the ground
  - Restricts advancement into larger DBH classes
  - Can lead to dependence on the math rather than on the actual conditions in the stand
- How much growth to harvest?
  - Never more than the equivalent MAI in an even-aged stand of same species & site at the chosen rotation age
- Potential Mistakes
  - Not paying attention to initial success / survival of regeneration or other stand conditions can lead to “high grading”
  - Failing to watch the “edges” of the new regeneration patches so that young tree crowns become overly shaded

(E.C. Turnblom)