**Thinnings** --- Cuttings made in **immature stands** for the purpose of utilizing material which otherwise **might be lost** before the rotation age is reached and/or **redistributing the growth** of the stand to fewer more desirable stems

Immature stands
Anticipated Mortality
Redistribute Growth

**Thinning** is an intermediate operation and **differs** from a regeneration cut because the purpose is better growth on residual trees, **NOT** to obtain reproduction

**Do you have enough trees of appropriate species and form that are capable of increasing in value?**

Yes - intermediate stand management is warranted
No - take measures to regenerate the stand
Thinning in Stand Development

Use of Crown Classes in Thinning

1. Crown classification will be the basis for deciding which trees to remove
2. Other considerations will be vigor, health, and form of the trees and spacing between trees
3. In reality, what we often try to do with thinning is speed up what would naturally happen & this usually means favoring the better trees of high position in the canopy

Effects of Thinning

Stand Growth vs Tree Growth

• Stands tend to grow & expand until they reach full occupancy of the site
• After that stage, rate of fiber production on the site changes little, but diameter growth of individual trees is reduced
• Thinning — reduce competition so that growth that does occur is on fewer stems that continue to grow at a good rate (given site & age)
Effects of Thinning

**How Does Thinning Do That?**

- Alters *environment* of remaining trees
- Crowns and root systems expand
- Changes in sunlight received, carbon dioxide, temperature, crown space, root environment (moisture, nutrients, etc.)

**Thinning Effects**

- Reduced crowding through altering the *environment* (physical space and sunlight received) of the remaining trees
- By redistributing growth potential to the most desirable trees, the overall health, vigor and growth of the stand is increased
Effects of Thinning

Effect on Stem Form

• Thinned stands --- increased DBH growth at base of stem
• Unthinned stands --- increased DBH at base of crown
• Impact on taper of stem --- form class --- gradual thinning preferred, not a drastic cut

Effects of Thinning

Effects on Height & Diameter

• Stand density has little effect on height growth
• DBH growth (usually a good response) but depends on degree of overstocking before release, type of thinning, and age and crown class of tree

Effects of Thinning

Effects on Diameter

• Drastic increases in diameter growth indicates that you have waited too long to thin & may not be desirable due to wood properties
• Objective --- keep trees growing at a good, even rate
• Appearance --- rings will decrease in width from the pith outward, but basal area growth remains almost constant
Methods of Thinning

Classical Thinnings ----
- Low,
- Crown (high),
- Selection or Dominant

Combination of Classical
- Free
- Mechanical or Geometric
  - Row or Strip

Methods & Application of Thinning

Review of Terminology
1. Selection Regeneration Method
2. Selection Thinning – now referred to as dominant thinning
3. Selective Cutting
Methods & Application of Thinning

Low Thinning

- Diagram
- Trees Removed
- Trees Left
- Advantages
- Disadvantages
- $d/D$ ratio < 1

Methods & Application of Thinning

Crown Thinning

- Diagram
- Trees Removed ---- favoring good crop trees and removing immediate competition ---- upper crown classes
- Purpose --- Provide space in canopy for crown expansion
- Use --- developing selected crop trees
- $d/D$ ratio = 1

Methods & Application of Thinning

Crown Thinning compared to Low Thinning

- Takes more skill to apply
- Products of larger size
- Can stimulate growth of selected crop trees much more
- More flexible in terms of what can be done with remaining trees
Methods & Application of Thinning

Selection Thinning

- Terminology
- Diagram
- More difficult to visualize and use properly
- Removing the very trees that are favored in crown or low thinnings.
- What happens if carried too far????
- \( \frac{d}{D} \) ratio > 1

Selection/Dominant Thinning

- Most commonly used when rough dominants are removed to favor better trees from highest possible crown class
- Used to shape the stand
- Usually conducted in young stands and favors tolerant species

Selection/Dominant Thinning ---- USE

- Hardwoods – very little use except in neglected stands to remove coarse dominants
- Tolerant Conifers – Used most in this type. Lower crown classes will respond and give good growth
- Intolerant Conifers – Not appropriate except for first thinning in unmanaged stands
Methods & Application of Thinning

Selection Thinning — Comparison with Low and Crown Thinning

- Main use with any species is for first thin, really an improvement cutting to correct stand structure
- Tendency is to thin too heavily, with low and crown thinning, tendency is to thin too lightly

Methods & Application of Thinning

Free Thinning

- Combination of classical methods
- Free thinning is usually one of the classical methods with modifications, i.e., first thin in pine stand may be a low thin to salvage anticipated mortality, but some large dominants might also be removed because of form, disease or spacing
- Most application in previous unmanaged stands and much less in stands that have been thinned previously
- D / D ratio ???

Methods & Application of Thinning

Mechanical Thinning

- In previous methods, the decision to cut a tree was based on crown class. With mechanical spacing, little or no regards given to crown class. The main consideration is spacing
- Graph
- d / D ratio = 1
Methods & Application of Thinning

**Mechanical/Geometric Thinning**

- 2 Types ---- spacing and row
- Used primarily as first thinning in young, dense stands before crown differentiation has occurred. Otherwise large holes would be created.
- Mostly used in conifer plantations. Could be used in naturally regenerated hardwood stands with a chopper or bush-hog in thin strips.

**Advantages** ---- low cost, little skill, facilitates removal of material from the woods.

**Disadvantages** --- may leave some of poorest trees and cut some of the best trees, lead to lopsided crowns, susceptibility to snow and ice.

**Combination Mechanical Thinning**

- Common Method

Example:
- Thin every 3rd row
- BA = 180 ft$^2$/Acre
- Row = - 60 BA
- Thin in leave rows = 20 to 40 ft
- Leave BA = 80 to 100
Methods & Application of Thinning

Combination Mechanical Thinning

• A good method for 1st thinning in plantations
• It is a tradeoff between purely classical method, which may be the best biologically, and mechanical that may be the most economical.
• Some of the better trees are cut and probably leaving some of those that you prefer not to leave, but opens up the space for crown expansion and will give a good response
Initiating a Thinning Program

**Biological Considerations**

Indications

- Decrease in live-crown ratio
- Decrease in DBH growth rate
- Stocking Considerations (closed canopy)
- Natural Pruning

---

**Economic Considerations**

When is precommercial thinning justified?

- Species stagnation
- Response to later thinning would be reduced to unacceptable levels
- Susceptibility to insects & disease

---

**Economic Considerations**

Whether or not to delay 1st thinning?

Generally, a decision whether thinning will pay for itself. Must decide if reduction in growth (diameter) is offset by greater returns from the thinning

Ramifications of overstocking
Initiating a Thinning Program

**Choice of Method**

- Depends on species, condition of the stand (age, size of trees, density), previous treatment of stands, economics
- 1st thinning in a sawlog rotation is often used to correct undesirable conditions
- If only one thinning can be performed, usually some type of free or combination thinning. Why?

Initiating a Thinning Program

**Frequency**

- Ideally when diameter growth rate begins to decrease
- Usually difficult to determine
- Usually directly related to or controlled by severity of previous cut

Initiating a Thinning Program

**Example of Thinning Schedule**

- Site Index = 90’
- # of trees planted = 680 (8’ x 8’)
- 1st thinning at 15 years, remove about 1/3 of stems based on form, insects, disease --- leaves about 390 trees/acre
- 2nd thinning at age 22, leaves 200 trees/acre (chip & saw)
- 3rd thinning @ age 30, leaves 100 trees/A
- Rotation age of 35 ---- multi-products
Initiating a Thinning Program

**Regulation of Cut**

- Must determine how to measure — # of trees, basal area, volume (board feet, cubic feet, weight). What is problem of each?
- Ideally a measure would be one that gives a measure of utilizing or growing surface, i.e., a photosynthetic area of leaves
- Photosynthetic area or leaf area is constant and what we want is lowest amount utilizing surface/unit of PS area which will give full utilization of the site
- Surrogate ---- leaf area correlated with sapwood area or live conducting tissue

Basal area gives a reasonable approximation

Residual density will depend on objectives of management. If maximizing growth, what stocking will achieve that?

See graph

By thinning back to lowest point (inflection point), where we still get full utilization of occupancy of the site.
### Initiating a Thinning Program

**What to Thin?**
- Unwanted species
- Poor form
- Insects & Disease
- Slow growth
- Spacing considerations

**What is used?**
- Stocking Chart
- Basal area, size, number of trees, average tree diameter
Initiating a Thinning Program

What is used?

Stocking ---- is a relative measure (qualitative)

Density ---- absolute measure (quantitative)

Thinning Summary

Through thinning:

• Salvage material which otherwise would be lost
• Thus, increasing the financial yield of the stand
• At same time redistributing growth to fewer stems so that we get larger, more valuable material from the stand
• Again, increasing financial yield over what might occur without management

Bottom Line

• Creating more space for existing trees to become larger and increase in value
• Bigger Trees, More Growth, In Less Time, More $$$
• Thinning is NOT a Regeneration Method
Thinning on Growth & Yield
Biological Standpoint

- Total Dry Matter Production --- Curves tend to be a constant for a wide range of densities
- WHY? ----

Thinning on Growth & Yield
Biological Standpoint

- Cubic Volume Yield --- generally the same as dry matter production
- Differences in level and shape of curve will occur according to species, site and age
**Thinning on Growth & Yield**

**Rule of Thumb Guidelines**

- Thin to a basal area (BA) that is equal to site index.
- Lighter thinning in older stands, i.e., BA remaining should increase as age increases.
- Rate of production is less on older trees, thus need higher BA to keep stand growth at given rate.

**Thinning on Growth & Yield**

MAI --- Mean Annual Increment  
PAI --- Periodic Annual Increment  
*Refer to graph on page 74 of text*

- Basis for determining sustainable cut.
- MAI is cumulative over a lifetime.
- $\text{MAI} = \text{PAI}$ when MAI culminates at its maximum.
Thinning on Growth & Yield

MAI & PAI

• Peak MAI is the best estimate of the maximum production rate that can be continuously sustained for a given species & site quality. It determines how much can be harvested annually on a sustainable basis and how long the rotations should be to maximize production.

• When PAI exceeds MAI, then stand has not reached culmination of MAI.
• Curves are not at zero --- based on merchantable timber, would be zero if dry matter production.
• PAI becomes negative after the age when decay and mortality becomes equal to growth.

Thinning on Growth & Yield

Gross Production vs Net Production

• Gross Production
• Net Production
• Mortality
• Yield
Thinning on Growth & Yield

Effects on Economic Yield

- Not much effect of thinning on biological yield, so WHY thin?

- Even though dry matter production or cubic foot yield may not be greatly influenced by changes in stocking due to thinning, the merchantable or economic yield may be greatly increased

Thus, in most cases, justification is an increase in the economic yield

Other reasons: health of the stand, water yield, wildlife habitat, etc.
**Thinning on Growth & Yield**

**How May Thinnings Improve Economic Yield**

- Salvage of mortality
- Increase in tree size and improvement in wood quality
- Yields earlier income
- Reduced investment in growing stock
- Improve stand composition
- May reduce cost of future operations

**General Comments on Thinning**

1. Intensity of thinning ---- depends on objectives or product produced
2. Costs incurred ---- spacing vs thinning (density control)
3. Longer rotations vs shorter rotations
4. Natural vs Artificial regenerated stands

**General Comments on Thinning**

5. Considerations other than wood production
   a. Forage production
   b. Wildlife habitat
   c. Aesthetics & recreation
   d. Water Yield & quantity
General Comments on Thinning

6. Spacing

7. Logging damage to residuals and windfirmness (site and species related)