Forest Management Concepts
Stocking

- Description of trees occupying the site
  - Trees per acre: Planting and survival of seedlings
  - Basal area: Represents the total living tree biomass,
  - Stand density index: Integrates measures of density

- Total tree volume per acre can be maximized by increasing stocking

- Mortality increases with stocking

- Tree size can be increased by maintaining lower stocking
Pine Stocking Chart

A. Current stand
B. After thinning
C. Future stand

Dean and Baldwin
Stand

- Area of forest of similar composition and/or age that will be managed as a unit
- Smallest size is usually a practical decision
Artificial and Natural Regeneration

- Natural regeneration
  - Tree establishment from seeds and sprouts on site
  - Species and density of regeneration can be influenced by treatments

- Artificial regeneration
  - Addition of seeds or seedlings for tree establishment
  - Plantation management
# Regeneration Comparison

<table>
<thead>
<tr>
<th></th>
<th><strong>Natural</strong></th>
<th><strong>Artificial</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocking control</td>
<td>Limited since conditions dictate density</td>
<td>Optimal of seedlings, less of seeds since over seeding is possible</td>
</tr>
<tr>
<td>Genetics</td>
<td>Native material, adapted to site, selection of seed tree phenotypes</td>
<td>Seeds/seedlings selected for specific traits</td>
</tr>
<tr>
<td>Growth</td>
<td>Rapid growth of sprouts, slow growth of new seedlings</td>
<td>Competition minimized for seedling growth, seedlings well rooted and fertilized from nursery</td>
</tr>
<tr>
<td>Cost</td>
<td>Low initial costs, later costs for density management</td>
<td>Costs for planting/seeding, even more for treatments that enhance seedling survival/growth</td>
</tr>
<tr>
<td>Rotation (years)</td>
<td>Longer</td>
<td>Shorter</td>
</tr>
</tbody>
</table>
Integrated Pest Management

- Pesticides are relatively ineffective for controlling pests in forests as compared to agriculture
- Manage tree health and pest populations to minimize economic damage
  - Identify conditions that limit management of some species (Littleleaf disease)
  - Manage to minimize or avoid pest populations (Pales weevil)
  - Improve or maintain tree vigor or health (pine beetle)
Intensive vs Extensive Management

- Intensive management aims to improve financial returns by investing in treatments that:
  - Improve site fertility (fertilization, tillage)
  - Control density and competition (Herbicides and thinning)
  - Improve seedling growth through selection of genetics

- Extensive management aims to minimize investment while producing fully stocked stands of crop trees
  - Natural regeneration and commercial thinning for density control
Forest Plantations

- Stands created by planting seedlings
- Use of agricultural techniques
  - Density control
  - Tillage
  - Fertilization
  - Herbicide application
  - Genetic Improvement
- Implication is often that plantations have lower ecological value than natural stands
  - Genetic similarity
  - Reduction in diversity
Short Rotation Woody Crops

- Dense stands of fast growing hardwoods for pulp or fuel products
- **Species:** Cottonwood, aspen, willow, eucalyptus, and gmelina
- Managed on agricultural land with intensive treatments
- May supplement lower cost supplies from traditional management
- [www.woodycrops.org/](http://www.woodycrops.org/)
Even-Aged Management

- Whole stands managed as cohorts, cut and regenerated at the same time
- Some variation in age (20% of rotation age) to account for sources of regeneration:
  - Older seedlings or new sprouts

[Images: Clearcutting, Seed Tree Cut]
Rotation Age

- The length of time needed for a stand of trees to reach maturity

- Rotation length is determined by the specific stand objectives expressed in biological or financial terms
  - Biological maturity – Year or years that the growth rate has peaked
  - Financial maturity – Year where the interest rate applied equals or exceeds the value growth in the stand
Uneven-aged Management

- Multiple age classes (at least 3) are managed in the within one stand.
- In each treatment cycle, Create conditions for regeneration, thin crop trees, and remove non crop trees.

Single tree or Group selection
Cutting Cycle

- Period of time between harvesting activities in an uneven-aged stand
- Activities are meant to:
  - Harvest mature trees/create regeneration sites
  - Thin pole sized trees
  - Remove damaged/noncrop trees

**FIGURE 10-7**
Comparison of precut stand structure with the residual diameter distribution recommended by Arbogast (1957) for the uneven-aged northern hardwood stand described in notation 10-2.

Nyland, 2002
## Even-aged vs Uneven-aged

<table>
<thead>
<tr>
<th></th>
<th>Even-aged</th>
<th>Uneven-aged</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mgmt costs</strong></td>
<td>Lower since treatments applied to whole stands</td>
<td>Higher since treatments applied to groups of trees</td>
</tr>
<tr>
<td><strong>Stand growth</strong></td>
<td>Faster</td>
<td>Slower</td>
</tr>
<tr>
<td><strong>Appearance</strong></td>
<td>Poor during harvest and regeneration</td>
<td>About the same</td>
</tr>
<tr>
<td><strong>Mgmt period</strong></td>
<td>Rotation</td>
<td>Cutting cycle</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td>Sporadic</td>
<td>Periodic</td>
</tr>
</tbody>
</table>
Discounting, NPV, and SEV

- To put revenue and income spent in different years on the same scale, owners discount (charge interest) both costs and revenue to the present.
  - Discounted Revenues – Costs = Net Present Value
- Each rotation yields a value (NPV) so an infinite series of the value of one rotation is the value of the land, Soil Expectation Value (SEV)
### NPV

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year</th>
<th>Cash flow ($/ac)</th>
<th>Discounted (CF), 7% interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical site prep</td>
<td>1</td>
<td>-80</td>
<td>(-80/(1.07)^1 = - 74.76)</td>
</tr>
<tr>
<td>Planting</td>
<td>2</td>
<td>-75</td>
<td>-65.51</td>
</tr>
<tr>
<td>Herbicide release</td>
<td>7</td>
<td>-65</td>
<td>-40.48</td>
</tr>
<tr>
<td>Thinning</td>
<td>17</td>
<td>450</td>
<td>142.46</td>
</tr>
<tr>
<td>Fertilization</td>
<td>18</td>
<td>-200</td>
<td>-59.17</td>
</tr>
<tr>
<td>Thinning</td>
<td>24</td>
<td>1000</td>
<td>197.15</td>
</tr>
<tr>
<td>Final harvest</td>
<td>30</td>
<td>2000</td>
<td>262.73</td>
</tr>
<tr>
<td>Mgmt costs</td>
<td>1-30</td>
<td>-8</td>
<td>-99.27</td>
</tr>
<tr>
<td>Hunting lease</td>
<td>1-30</td>
<td>2</td>
<td>24.82</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>+287.96</strong></td>
</tr>
</tbody>
</table>
NPV, IRR, and SEV

- If the cost of money was 7% investor is $288 ahead
- The rate of return (IRR) is greater than 7%,
  - Value determined by trial and error
  - NPV @ 10% = 44.57, @11% -1.53
  - IRR is almost 11%
- The value of the acre for perpetually growing trees in this scenario is Soil Expectation Value:
  - $288 + 288/((1.07)^{30} - 1) = 331.51$
Forestry Financial Decisions

- Determine the hurdle rate (interest rate)
  - Alternative rate of return, inflation, risk
- Determine the financial effect of practices by applying growth models
- Determine the cash budget available
- Allocate cash to projects prioritized by rate of return until all the cash is gone
- If there are ties:
  - Cheaper ones first
  - Shorter ones first
Old-Growth

- Old forests relatively free of disturbance
  - Namely human disturbance

- Characteristics
  - Some old, large trees
  - Standing dead trees
  - Multi-layered canopy
  - Uneven-aged

- www.forestencyclopedia.net/p/p1854/
Allowable Cut and Sustained Yield

- Sustained Yield Management develops harvest or use levels that produce a stable annual supply
  - For timber the allowable cut (AC) for each year defines the pathway toward sustained yield
  - The AC changes as forest conditions change (age, health, growth, species)
  - The AC calculated for any year may not be sustainable since managers are expected to recalculate periodically
Growth and Drain

- For large inventories the change in growing stock (potential harvestable trees) level from one inventory period to the next may be:
  - Growth: Size of trees, new trees in inventory
  - Removals: Harvest of growing stock trees
  - Mortality: Death of whole trees or loss of volume (breakage, rot)
- Ratio of Growth to Removals > 1 is though to be “sustainable”
Alabama Growth and Drain 2008

![Graph showing growth and drain for softwood and hardwood with G/D ratios of 1.25 and 1.49 respectively.](image-url)
Sustainability

- Refers to people, not nature
- Ecologic, social, and economic aspects
- Generational equity
  - Will our descendents be as well off?
Sustainability

- Dynamic
  - Solutions must change with knowledge and changing present and future needs
- Sustainability is like driving a really wide road, it’s not necessary to be in the center, just stay out of the ditches.