**Learning Objective:** Following this lab students will create a prescription to successfully naturally regenerate an even-aged pine stand in the southern US.

**Introduction**

*Field observations*

Before preparing a silvicultural prescription it is important to make field observations of the site. While maps and aerial imagery are valuable sources of information, they do not give all the necessary details. Site or stand factors such as disturbances, woody debris abundance, insects or disease outbreaks, mortality due to fire or drought, understory vegetation composition and density, litter layer structure, and estimates of site productivity are often difficult or impossible to obtain from maps or internet resources. Additionally, maps and aerial imagery may be dated, and thus can contain inaccurate information. There is no substitute for the information obtained from field observations by an experienced silviculturist when designing a prescription for a stand.

*Natural regen*

It is possible to naturally regenerate even-aged stands of southern yellow pines via clearcut, seed-tree, or shelterwood silvicultural systems. Compared to artificial regeneration (planting) there are advantages and disadvantages of natural regeneration (modified from Beaufait et al. 1984):

Advantages

- Establishment costs are lower
- Less labor and equipment required
- Provenance of seed is known and more likely locally adapted
- Reduced frequency of tip moth damage
- Better early root system development, no J-rooting or shallow rooting
- Less potential for erosion
- Slash remains well distributed

Disadvantages

- Less control over density, stocking, spacing
- Risk of seed tree loss
- No improved genetics
- Natural seedlings usually start from age 0 vs. age 1 for most planted seedlings
- Precommercial thinning is often necessary
- Short rotations less likely due to low seed production in excessively dense stands
- More difficult to harvest mechanically
- Limited access for fire equipment

When determining the size of clearcuts, or the number of seed-trees or overwood to retain, several aspects of the silvics of southern yellow pines will constrain what may be done silviculturally (modified from Beaufait et al. 1984):

- Most southern yellow pines produce reliable seed crops every 2-3 years, with some seed production every year.
- Longleaf pine does not produce seed prolifically, produces seed on 3-5 year intervals, and produces seed that is subject to a greater incidence of predation than other southern yellow pines.
- Pine pollen is rarely carried in excess of 300 feet by the wind in effective quantities.

- Seed rarely travels further than 200 feet for loblolly and shortleaf.
- Seed rarely travels further than 1.5 times the dominant total tree height in longleaf.
- It usually takes 3 years to produce a good seed crop following seed-tree release. Usually seed-trees or overwood are retained for 3-5 years in southern yellow pines.

In seed-tree or shelterwood systems, selecting the seed-trees or overwood to retain is critical to obtaining successful regeneration. Guidelines on seed tree selection (from Grano 1957) include:

- Trees should be 12 inches dbh or larger.
- Trees that show evidence of producing cones in the past yield 3 times as many cones as those with no evidence of past production.
- Trees with larger crowns will produce more cones than trees with small crowns.
- Trees with dense crowns will produce more cones than trees with sparse crowns.

**Table 1.** Recommended stand density for establishment cuts of seed-tree & shelterwood methods of regeneration for southern yellow pines (modified from Beaufait et al. 1984).

| | | SEED-TREE | | SHELTERWOOD |
|---|---|---|---|---|
| **Species** | **DBH** (inches) | **Density** (TPA) | **Basal Area** ($ft^2$/acre) | **Basal Area** ($ft^2$/acre) |
| **loblolly** | 10 | 12 | 6.5 | 20-60 |
| | 12 | 9 | 7.1 | 20-60 |
| | 14 | 6 | 6.4 | 20-60 |
| | 16+ | 4 | 5.6+ | 20-60 |
| **shortleaf** | 10 | 20 | 10.9 | 30-60 |
| | 12 | 14 | 11.0 | 30-60 |
| | 14 | 12 | 12.8 | 30-60 |
| | 16+ | 12 | 16.8+ | 30-60 |
| **slash** | 10 | 12 | 6.5 | 20-60 |
| | 12 | 9 | 7.1 | 20-60 |
| | 14 | 6 | 6.4 | 20-60 |
| | 16+ | 4 | 5.6+ | 20-60 |

*Cone counting*

Cones of southern yellow pines take approximately 2 years (24 – 26 months) to develop and release their seed (Table 2). To accurately estimate the potential of a stand or a number of retained seed-trees to establish a new cohort in the next year or two, it is possible to count cones as they form (Croker and Boyer 1975). Cone counting is of particular importance in longleaf pine due to its infrequent and unreliable seed crops (Beaufait et al. 1984), but may be done in any of the other southern yellow pines. There are two key periods during a rotation of a naturally regenerated even-aged stand when it may be desirable to count cones:

- Prior to implementing the establishment cut in a seed-tree or shelterwood regeneration method.
- Following the establishment cut and prior to final cut in either regeneration method.

The best time of year to count 6-month-old cones at end of branches is when they are exposed in April – May (Croker and Boyer 1975). These cones will not release seed to regenerate the stand until after the second growing season (approximately 18 months later). Thus, these counts tend to be highly unreliable, but may be used to indicate a future crop failure. Counting 18-month-old cones among the foliage of previous year's growth yields reliable estimates of seeding more than 90% of the time (Croker and Boyer 1975). These are cones that will release seed over the coming winter to regenerate the stand the following growing season.

**Table 2.** Cone development of loblolly pine as modified from Trousdell (1950).

| **Timeline** | | **Seed Cones** | **Pollen Cones** |
|---|---|---|---|
| Year 1 | September | Ovulate buds | Staminate buds |
| | February | Female cones produced | Male cones produced |
| | March | Pollination | Release pollen |
| | April – October | Early growth | Abscission |
| Year 2 | October – February | Dormant | Same cycle as year 1 |
| | March – April | Fertilization | |
| | April – October | Rapid growth | |
| Year 3 | October – May | Cones mature, seeds released | Same cycle as year 1 |

The general procedure for cone counting is:

1. Select a sample tree (seed-tree that will be or has been retained).
2. Standing approximately one tree height away from the tree, use 8-power binoculars to systematically count all 18-month-old cones on the tree. Do not move while doing this.
3. Record the data and repeat this procedure on approximately 50 trees to achieve adequate accuracy.
4. Double the cone count on each tree to account for underestimation of cones obscured by branches, foliage, and the bole (Croker and Boyer 1975).

Data above will be in the units of cones/tree. The desired data that needs to be calculated is either 1) trees / acre to be retained, or 2) seeds / acre to determine if an establishment cut should be made in the next year. Calculate each of these as follows:

1) To estimate how many seed trees to leave: $$\frac{Trees}{Acre} = \frac{Seeds}{Acre} \times \frac{1}{Cones/_{Tree}} \times \frac{1}{Seeds/_{Cone}}$$

2) To estimate seeding rate before a harvest: $$\frac{Trees}{Acre} \times \frac{Cones}{Tree} \times \frac{Seeds}{Cone} = \frac{Seeds}{Acre}$$

To adequately regenerate a fully-stocked stand, **50,000 seeds per acre** are required for longleaf pine (Beaufait et al. 1984). Use the following guidelines from Croker and Boyer (1975) to estimate seeds / cone:

- 50 seeds / cone in good year (risky estimate, can result in failed regeneration)
- 35 seeds / cone in average year (typical estimate)
- 15 seeds / cone in bad year (conservative estimate)

*Precommercial thinning*

Stands regenerated from seed often establish at high densities, ranging from 2,000 – 50,000 trees per acre early in the stand initiation and stem exclusion phases of stand development. Without appropriately timed precommercial thinning stands will be unhealthy and characterized by small-diameter, highly stressed trees prone to damage by insects, disease, and windthrow (if released too late). Typically precommercial thinning is recommended if density exceeds 800 TPA 3 – 5 years after establishment (Beaufait et al. 1984).

**Procedure**

*Equipment for Each Group*

1. BAF 10 Prism (1)
2. Loggers Tape (1)
3. Clinometer (1)
4. Increment borer (1)
5. Binoculars (2 sets per crew)

*Methods*

Begin by determining the acreage of the stand. This will be discussed in lab. In the field, walk the stand to ground-truth the provided map and examine stand conditions that may affect future operations. Make notes on your stand map.

At one representative location we will stop to do a cone count and determine site index using the attached data sheet. Work up your data in the field to be sure you understand how cone counting can be used to inform management recommendations (seed-trees / acre, establishment cut timing).

**Literature Cited**

Beaufait, W., P. P. Laird, M. Newton, D. M. Smith, C. H. Tubbs, C. A. Wellner, and H. L. Williston. 1984. Silviculture. Pages 413-455 *in* K. F. Wenger, editor. Forestry Handbook. John Wiley & Sons, New York, NY.

Croker, T. C., Jr. and W. D. Boyer. 1975. Regenerating longleaf pine naturally. USDA Forest Service, Southern Forest Experiment Station, Research Paper SO-105.

Grano, C. X. 1957. Indices to Potential Cone Production of Loblolly Pine. Journal of Forestry **55**:890-891.

Trousdell, K. B. 1950. A Method of Forecasting Annual Variations In Seed Crop for Loblolly Pine. Journal of Forestry **48**:345-348.

**Cone Counting Data Sheet**

Group Names:_____ Date:_____

Species:_____ DBH:_____ Total Height:_____ Age:_____

Site Index with units and base age:_____

Basal area with units:_____

18-Month-Cone Count (Cones / Tree) :_____ x 2 = _____

*- Remember to double your count as described in intro -*

Estimated Seeds / Cone (assume bad year):_____ Desired Seeds / Acre:_____

Calculated Trees / Acre Required:

Recommendation for timing next harvest based on cone count data:

1) To estimate how many seed trees to leave: $\frac{Trees}{Acre} = \frac{Seeds}{Acre} \times \frac{1}{Cones/Tree} \times \frac{1}{Seeds/Cone}$

2) To estimate seeding rate before a harvest: $\frac{Trees}{Acre} \times \frac{Cones}{Tree} \times \frac{Seeds}{Cone} = \frac{Seeds}{Acre}$

To adequately regenerate a fully-stocked stand, **50,000 seeds per acre** are required for longleaf pine (Beaufait et al. 1984). Use the following guidelines from Croker and Boyer (1975) to estimate seeds / cone:

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Your Name: Stand Name: Date:

Stand Description

Timeline for silvicultural prescription with narrative notes

| Year | Age | Action | Narrative Notes |
|---|---|---|---|
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# Silvicultural Prescriptions Grading Key

| Annotation | Explanation |
|---|---|
| 1 | **Terminology** is incorrect or imprecise. Be sure to use correct silvicultural terminology in all prescriptions. |
| 2 | Prescribed action is too **vague**. You need more detail (e.g. marking instructions, removal percentage). |
| 3 | Prescribed action does not meet **landowner objectives**, or some of the constraints we discussed for this stand. |
| 4 | Prescribed action is **incorrectly timed**. Is your rotation is too short or long based on growth rates of your species or landowner objectives? Are you applying herbicide too late compared to planting (herbaceous control spring after planting, hardwood control fall before planting)? |
| 5 | Prescribed action is not **ecologically** feasible. Does your regeneration method match with the shade tolerance of your crop species? Did you prescribe a burn that will likely kill all your crop trees? |
| 6 | Prescribed action is not **operationally** feasible. Is the stand too small? Are you removing too little volume per acre for a logger to take the contract? Are you operating when the site is too wet? |
| 7 | Prescribed action is **unnecessary**. Are you fixing something that is not actually a problem (e.g. mechanical site preparation on a site with no soil limitations, herbicide on a site with no competition problems, fertilizer on a droughty site, thinning a stand that's at an appropriate density)? |
| 8 | An additional prescribed **action needed**. Did you forget to apply herbicides when planting? Was slash management not prescribed on a high-slash site? Was bedding not prescribed on a wet site? |
| 9 | Prescribed action will not achieve the **density** you state. Did your planting spacing and density match? Did your row thinning intensity and post-thinning density match? |
| 10 | More than one treatments are **combined** on a single line. Be particularly careful with this for establishment of stands, when multiple treatments may be used in within one or two years. Each should go on its own line. |