Chapter 1

Regeneration: An Overview of Past Trends and Basic Steps Needed to Ensure Future Success

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Abstract

The forest resource of the 12 states in the south comprises approximately 73.7 million ha of timberland and includes the natural ranges of loblolly *(Pima taeda* L.), slash *(Pinus elliottii* Engelm.), longleaf *(Pinus palustris* Mill), sand *(Pinus clausa* Vasey), and shortleaf *(Pinus echinata* Mill.) pines. Forest growing conditions over this broad geographic area vary considerably because of variations in both climate and soil type. Environmental factors such as drought, excess water, competition for light, insects and diseases, animals, and limited nutrition often make regenerating southern pines a challenge. However, the fact that most of the older pine stands existing today are the result of natural regeneration demonstrates that, overall, conditions in the South are suited to these species. Today, approximately 1.7 million ha of pine are harvested each year. Although over 800,000 ha are regenerated annually with over 1.2 billion seedlings, more than 50% of the harvested area is left to regenerate naturally or revert to other forest types. This means that future demands for timber must be met using fewer and fewer hectares that need to be more intensively managed utilizing many of the forestry practices described in this manual. Initially, the proper selection of a regeneration system and development of an accompanying regeneration plan are critical to long-term success and productivity on these sites. Thirteen steps for developing a plan and a sample regeneration form are included in this chapter and provide an introduction to the 21 chapters which follow.

1.1 The Resource

The forest resource of the 12 states referred to as the South (Fig. 1.1) comprises approximately 73.7 million ha (182 million ac.) of timberland [3], spanning from east Texas to as far north and east as Virginia. The resource includes the natural ranges of loblolly *(Pinus taeda* L.), slash *(Pinus elliottii* Engelm.), longleaf *(Pinus palustris* Mill.), and sand *(Pinus clausa* Vasey) pine. The range of shortleaf *(Pinus echinata* Mill.) pine extends north of the 12 southern states.

Forest growing conditions over this broad geographic area vary considerably because of variations in both climate and soil type (see chapters 9 and 10, this volume). Across the South, average annual rainfall varies from nearly 112 to 165 cm (44 to 65 in.), annual potential evapotranspiration from 71 to 114 cm (28 to 45 in.). The combined difference in annual rainfall inputs and evaporative demand yields a range in mean annual water deficit of 2.5 to 20 cm (1 to 8 inches). Growing season varies from 150 days in Virginia to over 330 days in Texas and Florida. Soils range from deep loessial deposits with > 18 cm (7 in.) of available water holding capacity to coarse-textured, shallow, rocky soils with < 2.5 cm (1 in.) of available water holding capacity. These varied conditions of climate and soil type, in conjunction with environmental factors such as drought, excess water, competition for light, insects and diseases, animals, and, in some cases, limited nutrition, can make regenerating the southern pines a challenge. However, the fact that most of the older pine stands existing today are the result of natural regeneration demonstrates that, overall, conditions in the South are suited to these species.

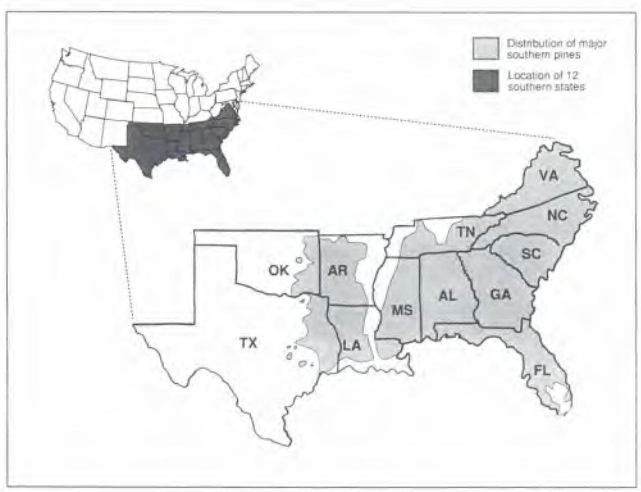

Figure 1.1. Combined distribution map of the major southern pines in the southern United States. Adapted from [2].

M. L. Duryea & P. M. Dougherty (eds), Forest Regeneration Manual, pp. 3–7.

1.2 History of Pine Regeneration in the South

1.2.1 Regeneration in the Past

The early settlers moving into the southern United States found a large timber resource — the South's first forest. As this original timber was harvested, the area was either converted into farmland or left to regenerate by natural means. Most of the South's second forest (early 1900-68) and third forest (1968-2000) originated from natural regeneration. It was not until the 1920s that artificial regeneration began to play a role in re-establishing southern pine [3]. Wakeley [4] reports that a few plantations had been established before 1900, but the total area reforested artificially by 1920 was probably < 202 ha (500 ac.). In the 1920s, the Great Southern Lumber Company in Bogalusa, Louisiana, began a company nursery and an artificial regeneration program [4], triggering the beginning of intensive plantation management in the South. However, it was not until after World War II that artificial regeneration programs contributed significantly to southern pine regeneration. Both government incentives (see chapter 2) and the increased demand for softwood to supply the developing southern plywood and pulpwood industries promoted the increase in plantation management at that time [3].

1.2.2 Regeneration Today And Tomorrow

Today, approximately 1.7 million ha (4.2 million ac.) of pine are harvested each year.1 Although over 800,000 ha (2,000,000 ac.) are regenerated annually (Fig. 1.2), more than 50% of the harvested area is left to regenerate naturally or revert to other forest types. Thus, natural regeneration is still a major means of reforestation in the South, especially on nonindustrial, privately owned land. However, two major aspects of harvesting practices differ today from years past: (1) today, much of the area harvested is clearcut instead of selectively logged because much of the small-diameter wood can now be used for pulp and the large-diameter wood for sawtimber, and (2) fire protection now prevents repeated burns on harvested areas. These two aspects result in naturally regenerated stands that tend to be either mixed hardwood-pine or pure hardwood forests rather than pine forests. Softwood production could be increased on much of the naturally regenerated area by controlling hardwoods to release the pines. McWilliams and Birdsey [1] have suggested that release treatments may represent as big an opportunity for increasing softwood production as greater participation by private landowners in artificial regeneration programs.

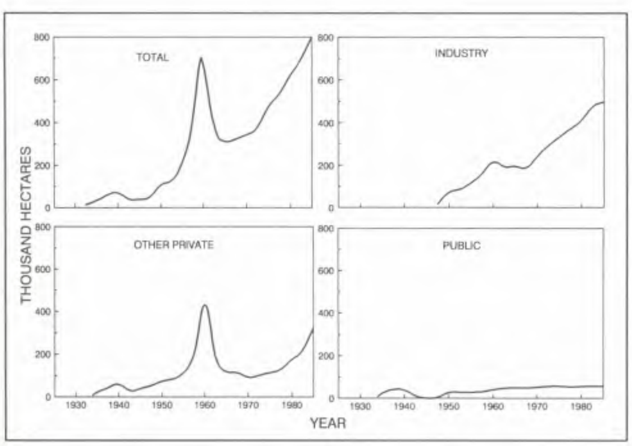

Figure 1.2. Trend in hectares planted or seeded to southern pines over the period from 1930-85. Adapted from [3].

Artificial regeneration (planting and direct seeding) is practiced on about 800 thousand ha annually in the South. Over 1.2 billion seedlings are planted each year. Because most of the seed used to produce these seedlings is from seed-orchard trees subjected to intense breeding and testing programs, no longer are seed costs considered insignificant. Therefore, seed conversion efficiency is of major concern. Nursery, lift and store, and planting programs have been developed to ensure that seedling quality is maintained from the nursery to the planting spot (see chapters 4, 6, 7, 16, and 17).

1.3 Importance of a Successful Regeneration System

Selecting a regeneration system that will succeed is important for three general reasons (see chapter 3):

(1) It determines how quickly an area will return to production.
(2) It determines the opportunities that will be available to the land manager over the entire rotation.
(3) It determines the likelihood of unwanted costs if too few or too many seedlings are established.

Regeneration programs that do not re-establish a pine stand 1 to 2 years following harvest represent a substantial loss in initial investment (see chapter 2). Moreover, the landowner will then have to determine whether to replant or interplant and bear the attendant cost. For example, the impact of poor survival on replant frequency is illustrated in Figure 1.3 for a regeneration program in which nearly 12,146 ha (30,000 ac.) of seedlings were planted annually at 1,482 trees/ha (600 trees/ac.) and for which the replant threshold was 741 trees/ha (300 trees/ac.). If average survival across the area planted was 80%, then the area to be replanted was < 10% of that initially planted. However, if the average survival fell below 80%, the proportion of area requiring replanting increased rapidly. Replanting results in (1) lost production time, (2) decreased efficiency in converting high-value seedlings into established trees, and (3) increased likelihood of thinning because of

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Based on the assumption that 84 m^3 (1200 ft^3) are removed from the average hectare (acre) harvested and that 142.9 million m^3 (5 billion ft^3) are harvested per year.

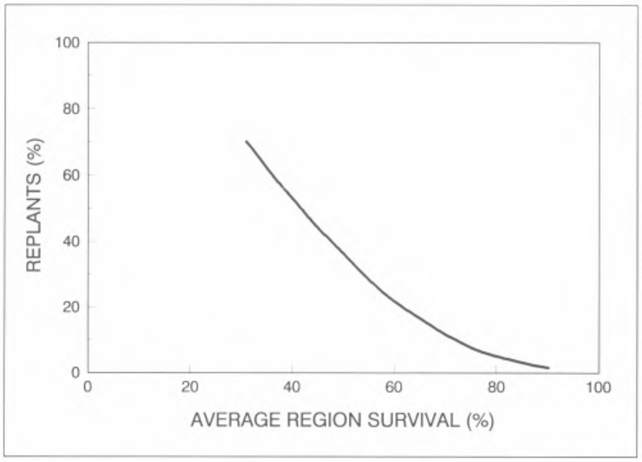

Figure 1.3. Percentage of planted hectares requiring replanting relative to the average survival on all hectares planted.

overplanting to offset anticipated seedling losses. But the alternative is accepting marginally stocked stands. The consequences of poor regeneration demonstrate the need for developing a regeneration plan that maximizes the chances for success.

1.4 Developing a Regeneration Plan

A regeneration plan should (1) define the goals for regeneration and management, and (2) then identify the practices needed to meet those goals. For instance, if the goal is to produce a forest stand for sawlogs, the regeneration decisions will be considerably different from those required to produce a forest stand for pulpwood. Or if the goal is to preserve the habitat of an endangered species, regeneration decisions and practices must be altered. Anticipating and planning result in a close matching of goals with practices and help ensure the success of a regeneration program. Following is a series of 13 steps for developing a regeneration plan and a sample form (Fig. 1.4) illustrating how those steps may be applied.

1.4.1 Step 1: Identify Goals

The first step in regeneration is identifying goals. Why does a landowner want a forest stand on a particular site? To provide income in 20 to 30 years? To restore marginal or unused cropland? To promote wildlife or improve aesthetics? Because many of these goals may be compatible with each other, multiple goals are possible. Defining goals has importance for each one of the steps that follow.

1.4.2 Step 2: Characterize the Site

The site must be characterized before decisions about practices can be made. If the site has not yet been harvested, the present forest ecosystem will help to define the site's biological and physical features (see chapters 9 and 10). Knowledge of the soil and topography will facilitate species selection, site preparation, and fertilization decisions. The presence and frequency of particular tree species might illustrate the possible success of certain species after planting.

1.4.3 Step 3: Identify Special Considerations

Special biological, management, and regulatory considerations should be identified early in the planning process to avoid problems or complications later on. Special considerations might include streamside management zones, wetland regulations, endangered species, erosion control, and societal constraints imposed by neighboring landowners (see chapters 9, 10, 21, and 22).

1.4.4 Step 4: Define the Major Limiting Factors

The major site factors which may limit regeneration success need to be identified. These might include heavy infection of fusiform rust, low levels of phosphorus in the soil, deep sand (which means a droughty site), or intense competition for site resources (such as occurs when pines are planted onto land previously in pastureland grasses) (see chapters 9, 10, 14, 19, 20, 21, and 22).

1.4.5 Step 5: Select the Best Species, Seed Source, and Family

On the basis of goals, site characteristics, special considerations, and limiting factors, a species and seed source most likely to successfully establish and grow must be selected. Some decisions, such as planting Choctawhatchee race (var. *immuginata)* of sand pine on the deep sands of western Florida or rust-resistant families or sources such as Livingston Parish loblolly pine on areas highly susceptible to fusiform rust, are easy to make. However, other decisions may not be so clearcut. Nevertheless, many options are available for ensuring that the best combination of site and genetics is identified to optimize the regeneration goal (see chapter 11).

1.4.6 Step 6: Identify the Best Regeneration Method

Considering the goals, site characteristics, economics, special considerations, major limiting factors, and species, the landowner or manager must determine the best regeneration method. Should the area be allowed to regenerate naturally after harvest? Or should it be seeded with the species of choice, or planted with bareroot or container seedlings (see chapters 3 through 7)?

1.4.7 Step 7: Select the Best Stock Type or Seed Source and Planting Procedures (Artificial Regeneration)

For planting, the stock type must be selected. Most regeneration programs in the South use 1+0 bareroot seedlings (see chapter 6). However, some situations warrant use of container seedlings (see chapter 7); for instance, because longleaf pine is sensitive to handling, Page 1

REGENERATION PLAN

Land To Be Regenerated: *Carson Creek Unit*

Location: *1 mile south of Carson City on Hwy 345 (map included)*

Land Area: *300 acres (121 hectares)*

1. Goals

Harvest revenue from sawlogs
Beauty
Wildlife

2. The Site

75-year-old longleaf pine stand (Site index = 20 m)
Well-drained, sandy soil over 6 feet (1.8 m) deep
Deer abundant on site
Red-cockaded woodpecker nests in NE quarter of unit

3. Special Considerations

Landowner on south edge of property may be sensitive to clearcutting and spraying
Preserve red-cockaded woodpecker nesting habitat

4. Major Limiting Factors

Droughty site
Competition from other vegetation
Logging slash limiting number of plantable spots
Brown spot needle blight on longleaf seedlings?

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REGENERATION PLAN

Carson Creek Unit (continued)

5. Species, Seed Source, and Family

Longleaf
Collect seed from seed-production areas
Seed collection zone #2

6. Regeneration Method

Machine planting

7. Stocktype and Planting Procedures

Container longleaf pine
Check into fungicide dips for brown spot needle disease
Order from Forest Seedlings, Inc. by October, 1989
Pick up seedlings on January 12
Refrigerated shipping of seedlings
Plant immediately
Hand planting using two 2-person crews
700 trees per acre (1730 per hectare)

8. Site Needs

Harvest timber except for woodpecker areas
Pile and burn slash
Spray herbicide for grasses

9. Seedling-Protection Needs

Continue to monitor vegetative competition

Page 3

REGENERATION PLAN

Carson Creek Unit (continued)

10. Site Evaluation

Evaluate survival and growth after first and second years

11. Costs and Economic Returns

Calculate costs and returns for
Timber
Piling and burning slash
Spraying herbicide
Container seedlings
Hand planting

12. Timetable

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989			*Harvest*		*Pile, burn slash*	*Spray herbicide*	*Order seedlings*					
1990	*Pick up seedlings*	*Plant seedlings*									*Evaluate survival growth*	

13. Recordkeeping

Save all invoices and receipts
Visit with EPA for advice

Figure 1.4. Sample form illustrating the 13 steps of a regeneration plan.

container stock may survive these stresses better than bareroot. Although most of the seedlings currently planted in southern regeneration programs are grown from seed, vegetative propagation, especially from rooted cuttings, will become common in the future (see chapters 4 and 5). Regardless of stock type or seedling origin, however, seedling quality can be degraded at any step from nursery to planting hole (see chapter 8). Therefore, handling and planting procedures are critical to successful regeneration (see chapters 16 and 17). Initial stocking decisions should be based on goals and anticipated regeneration success (see chapter 15).

For direct seeding, the purchase or collection of good-quality seed of the desired genetic makeup must be assured and the sowing method selected.

1.4.8 Step 8: Determine Site Needs

If a stand of trees is present, harvesting must be planned. Site-preparation alternatives should be investigated and the need for fertilization assessed (see chapters 12 through 14). For natural regeneration, decisions about seedbed preparation, competition control, and harvesting (cutting method, number of trees to leave, and timing) need to be made many years in advance of cutting (see chapter 3).

1.4.9 Step 9: Determine Seedling Protection Needs

Determining the present and anticipating the future needs for seedling protection are critical to successful regeneration. Effects of insects, disease, animals, and weeds on the survival and growth of newly planted seedlings or sown seed need to be minimized (see chapters 19, 20, 21, and 22).

1.4.10 Step 10: Plan for Site Evaluation

The regeneration process is ongoing. The planting site must be evaluated for up to 5 years to assess regeneration success and the need for site maintenance (continued seedling protection) (see chapter 18).

1.4.11 Step 11: Evaluate Costs and Economic Returns

After listing the options in all the above steps, it is necessary to estimate the costs and economic returns of the different practices (see chapter 2). To do this requires, in part, a good estimate of site index, a decision on the species to be planted, and a clear target of final stand stocking.

1.4.12 Step 12: Develop a Timetable for Regeneration

After selecting the practices to meet identified goals, the landowner or manager should develop a timetable for regeneration. Timing of some practices is firm; for instance, planting must be done in late fall, winter, or early spring. However, that of others can be more flexible in response to, for instance, unexpected delays such as those caused by weather.

1.4.13 Step 13: Keep Good Records

Keeping good records is an essential part of regeneration and land management (see chapter 2). Reliable information on the timing and costs of practices will help during tax preparation. The information may be useful for problem solving on the area currently being regenerated or for planning on another parcel.

1.5 Summary

The southern pine forest represents a resource of major economic importance to the southern U.S. and to the nation as a whole. About 66% of this resource is owned by nonindustrial private landowners who are failing to regenerate > 50% of the area they are harvesting. This means that future demands must be met from fewer hectares managed more intensively. Accelerating the use of genetically improved stock and cultural practices, such as intensive site preparation, fertilization, and competition control, can all help to increase yields from a shrinking land base. Undoubtedly, planned regeneration will be needed to balance utilization and production both now and in the future. The steps outlined in this chapter and expanded on in subsequent chapters provide the framework needed to develop successful regeneration programs for the southern pines.

References

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