Reprinted from: Proc., Second Symposium on Southeastern Hardwoods, p. 114-119. 1978.

PLANNING FOR NATURAL REGENERATION OF HARDWOODS IN THE COASTAL PLAIN

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Abstract.--Hardwood species reproduce through seeding and sprouting. Frequent selective cuttings and small, incomplete openings favor tolerant species; the opposite conditions favor intolerants. Factors to be considered in evaluating and predicting reproduction before harvest are listed.

Additional keywords: Silvics, reproduction.

Ninety-five percent of the southern hardwood resource is in natural stands. Plantations will probably be important in the future, but at present their expense makes it necessary to maintain high yields of lumber and wood fiber in natural stands. Careful planning is necessary for obtaining the rapid, complete regeneration that ensures high yields. Many land managers, however, do not fully understand how hardwoods reproduce and for that reason fail to achieve adequate regeneration in their stands. This paper discusses the factors that affect hardwood reproduction and how land managers can control regeneration.

REPRODUCTION OF HARDWOODS

All hardwood stands reproduce in one of, or in a combination of, three ways. First, stands can regenerate after a harvest by widespread establishment of seed. More commonly, new trees are gradually established from seed over the years. Finally, regeneration by sprouts from the stumps and roots of cut trees is a significant part of most stands.

For examining reproduction from seed, hardwoods can be divided into species that have light seeds and those that have heavy seeds. The first group includes sycamore (*Platanus occidentalis* L.), sweetgum (*Liquidambar styraciflua* L.), yellow-poplar (*Liriodendron tulipifera* L.), maple (*Acer* L.), cottonwood (*Populus deltoides* Bartr.), willow (*Salix nigra* Marsh.), boxelder (*Acer negundo* L.), elm (*Ulmus* L.) and ash (*Fraxinus* L.). Species with heavy seeds are primarily the oaks (*Quercus* L.) and hickories (*Carya* Nutt.)

Usually, light-seeded species are more apt to produce a new stand through post-harvest seeding than are heavy seeders. For both groups there must be an abundance of viable seed for new trees to become established in adequate numbers. Most light-seeded species produce fair to good seed crops annually, but on occasion produce no seeds over a broad area, such as was the case with green ash (*Fraxinus pennsylvanica* Marsh.) in the fall of 1976. Species with heavy seeds tend to produce good crops infrequently, every 3 to 5 years for many (Beck and Olson 1968; Burns, Christisen, and Nichols 1954; DeBell and Hook 1969; Goebel and McGregor 1973; Tryon and Carvell 1962).

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Distribution of light seeds, which are moved by wind and water, is usually much wider than distribution of heavy seeds. Wind will move light seeds up to 300 feet, or sometimes farther from the seed tree (Benzie 1959, Engle 1960, Fenton 1964). Water can distribute light seeds even longer distances, depending on species, and whether or not the seeds fall during overflow, and the speed of water movement.

In the South, many species sprout prolifically, but there are significant differences within species, depending on where they grow. For example, stumps and roots of large oaks do not ordinarily sprout in the bottomland but may do so readily on drier upland sites. There is a lack of documented information about the effects of stump size and season of cutting on sprouting. Observations indicate, however, that stumps of green ash, bitter pecan (*Carya aquatica* (Michx. f.) Nutt.), sugarberry (*Celtis laevigata* Willd.), hickory, and tupelo (*Nyssa aquatica* L.) up to 20 inches in diameter will sprout readily on good hardwood sites. Many other species will sprout if stumps are less than 5 inches in diameter. Low-origin stump sprouts, that is, sprouts from stumps less than one foot high, and root sprouts will develop into high quality trees. Many observers would have difficulty recognizing that a stand originated from sprouts once it reached pulpwood size. Probably the most important silvicultural trait of stump and root sprouts is their very rapid early growth (Bruner and Reamer 1971, Johnson 1964, Johnson and Krinard 1976, Nyland and Irish 1971). In later life, sprouts slow to a growth rate that is normal for the species.

ESTABLISHMENT AND DEVELOPMENT OF SEEDLINGS

Many variables affect the species and density of reproduction that become established in an area. Although the combination of factors needed for good seedling establishment occurs, sometimes over a broad geographic area, chances of success in any one year are not good.

In bottomlands, the frequency, depth, and duration of overflow affect the reproduction that becomes established in an area. Water prepares the seedbed by softening the soil and allowing root penetration of the germinating seed. Soils in areas of frequent and prolonged overflow are usually high in clay content, and once the surface soil drys it affords an almost impenetrable layer to the new root. Often rainfall will prepare the soil surface, but usually not as effectively as overflow. Both rainfall and overflow must prepare the seedbed during the germination period or when temperatures are high enough for germination (usually from April through June). Probably the poorest seedbed for hardwood establishment is sod. Usually a sod cover occurs on compacted soil that is often associated with heavy grazing either by cattle or deer and occurs most often in small openings where grazing animals tend to concentrate. Water also appears to provide good natural stratification for seeds of some lowland species.

Due to the uncertainties of surface soil moisture, it is best for heavy seeds to be an inch or two under the soil (Johnson 1967). Sometimes this is accomplished in natural stands by animals burying seeds, but more often it occurs when seeds fall into holes or are covered with sediment. In contrast, seeds of sweetgum have difficulty establishing seedlings if they are covered with one-half inch or more of soil (Bonner 1967). Light seeds of other species probably have similar requirements. Light seeds usually germinate more quickly than heavy seeds, so establishment conditions need be favorable for a shorter time.

The tolerance of species to shade influences their establishment and development. Most species classified as intolerant will germinate and often start growing in limited sunlight but usually die within a few weeks. With an hour or two of direct light daily, seedlings with moderate shade tolerance may persist 1 to 3 years.

There is evidence that even an intolerant species like yellow-poplar can persist for 10 to 15 years in an opening that is too small for the species to develop beyond 10 to 15 feet in height. When yellow-poplar is overtopped by a low overstory, it will cease growth and die rather quickly.

Tolerants can persist many years in nearly complete shade, but their persistence is related to their size as well as to shade from the overstory. New seedlings of even tolerant species usually succumb quickly in complete shade. But if they can begin in a small opening and grow to 5 feet or more in height before the overstory closes, they may die back from the terminal and resprout, but seldon do they die completely, probably because of a well developed root system. Species considered intolerant normally will not die back and resprout. Once they stop height growth, they die.

Oaks usually present a special consideration in regeneration. Occasionally conditions are right to establish dense stands of oak from seed. Seedlings can survive in small openings. Those of Nuttall oak (*Quercus nuttallii* Palmer) will usually die within 5 years unless they receive a couple of hours of daily sunlight (Johnson 1975). Thus, the manager has about that much time to remove the overstory and keep the oaks growing. Unfortunately, unless oaks are 5 feet or taller at time of release, they may not grow rapidly enough to compete with trees of many other species (Sander 1972).

PLANNING AND EVALUATION

To exert control over regeneration of a hardwood stand a manager must know the following about his area:

(1) Frequency and distribution of root and stump sprouters by species.
(2) Frequency and distribution of light-seeded seed trees by species.
(3) Size, density, and distribution of marginal commercial species.
(4) Size, density, and distribution of established reproduction by species.
(5) Condition of seedbed and nature of competing herbaceous plants. Vines, for example, slow stand development and favor slower-growing, sturdier trees, such as the oaks.
(6) Patterns and duration of overflow.

Most of the information can be gotten from sample milacre plots and cruise data. An experienced hardwood forester can do a fair job of estimating conditions by systematically walking the area and taking notes.

Once background information is accumulated, options and objectives of management can be determined. Frequently, due to past silvicultural practices, management options do not exist; the question, then, is simply whether or not the stand is composed of suitable species. Nearly always the species present are suitable to the site, but growth rates and utilization priorities for those species may not be.

Where opportunities for controlling reproduction exist, the manager will probably want to strive for a balance of species. A stand can be harvested in most any manner and tolerant species will survive and grow. Stands that have been selectively cut without regard to reproduction usually revert to more tolerant species, simply because they are favored by the small openings with limited sunlight created by the cutting. The challenge is to reproduce nonsprouting, intolerant species, which usually become established after cutting. Guidelines that should increase the number of trees of intolerant species are:

1. Keep overstory tight before harvest so that full shade will result in a seedbed of mineral soil, or at least one relatively free of herbaceous plants.
2. Leave seed trees of light-seeded species, particularly those within 200 feet of regeneration areas. Although seeds can remain dormant in the duff for many years (Clark 1962), seed trees increase the probability that adequate regeneration will become established.
3. Make openings at least 200 feet in diameter.
4. Cut or deaden all marginal commercial and low quality trees in the regeneration area 2 inches dbh and larger. The purpose is to get all trees started from the same level. Although stumps of most marginally commercial species sprout prolifically, the sprouts are normally outgrown by trees of commercial species.

If the manager can obtain a good species balance in the initial stand, he can form the stand and control the final species mix through a series of thinnings. To favor some species, many of the oaks for example, first thinning or weeding may have to be precommercial (Arend and Scholz 1969, Beck 1970, Johnson 1975, Marquis 1967).

Maximum stocking of reproduction usually occurs 3 to 5 years after an opening is created. In a large opening, most species will remain in the stand for at least 10 years--giving ample time to perform the first thinning or weeding to favor certain species. The first thinning in viny areas should not be done until the stand has developed above the vines, which can take up to 20 years. Otherwise, the stand could regress into another vine stage, slowing remaining stand development. On most hardwood sites, dominants and codominants among reproduction will average 2 to 4 feet of height growth annually during the first 20 years.

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