

# Development of Seven Hardwood Species in Small Forest Openings

## 22-Year Results

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**ABSTRACT.** *Small forest openings planted with seven leading commercial tree species were completely dominated by yellow-poplar (Liriodendron tulipifera) that averaged 90 feet tall after 22 years. Of the other planted species, swamp chestnut oak (Quercus michauxii) was most shade tolerant while Shumard oaks (Q. shumardii), water oaks (Q. nigra), and sweetgum (Liquidambar styraciflua) showed little tolerance.*

There is little detailed information of how preferred southern hardwood species compete in developing regeneration stands. This is especially true in forest openings created by small group selection cuts where growth of inherently faster-growing, shade-intolerant species may have been slowed.

Inter-species competition can be studied in natural regeneration stands, but the number of highly desirable species is usually limited and relative development among species is confounded by inherent growth differences due to tree origin, whether sprout, advance reproduction, or new seedling. In 1960, one-year-old seedlings of seven leading commercial species, water oak (*Quercus nigra* L.), Shumard oak (*Q. shumardii* Buckl. var. *shumardii*), cherrybark oak (*Q. falcata* var. *pagodifolia* Ell.), southern red oak (*Q. falcata* Michx. var. *falcata*), swamp chestnut oak (*Q. michauxii* Nutt.), sweetgum (*Liquidambar styraciflua* L.), and yellow-poplar (*Liriodendron tulipifera* L.), were planted in forest openings between 1/4- and 1/2-acre in size. Surrounding overstory trees were about 100 feet tall. All plantings were on the Bluff Experimental Forest near Vicksburg, Mississippi. The forest is representative of the silty uplands (loess soil) with short, steep slopes, narrow ridges and

bottoms. More than 50 percent of the overstory trees are red oaks, but there is a great diversity of species, including but not restricted to ash (*Fraxinus*), hickory (*Carya*), sweetgum, Carolina basswood (*Tilia caroliniana* Mill.), yellow-poplar, and large sassafras (*Sassafras albidum* (Nutt.) Nees) (Johnson and Little 1967).

Except where the top soil has severely eroded, sites are excellent for nearly all hardwood species that grow in the bottomlands and uplands of the South and Southeast. Minor differences in site quality are related to degree of slope, so plantings were established on three sites: in bottoms with 0 to 5 percent slope; on gradual, 15 to 22 percent slopes; and on steep, 29 to 35 percent slopes.

Openings were made by cutting and utilizing all merchantable trees down to 6 inches d.b.h., while other stems down to 1 inch d.b.h. were either deadened or cut and the stumps deadened. Plots were laid out in rows of 7 or 14 planting spots along the contour. One tree of each species was planted at random in each of seven consecutive planting spots with spots and rows 2 feet apart. There were 20 seedlings per species in each planting. Sites were replicated three times.

All trees were measured for height and diameter after 1, 2, and 22 years. At no time during the study was there any attempt at weed control.

## RESULTS AND DISCUSSION

When two-year results were reported (Johnson and Krinard 1963), survival was 89 percent or

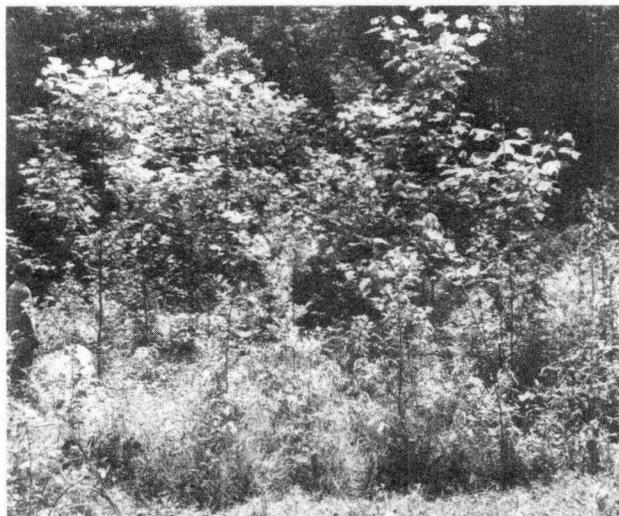


Figure 1. A bottom plot showing: (A) planted seedlings and typical slope sites in background; (B) start of growth in the second year in April 1961; and (C) mid-third-year growth in June 1962.



Figure 2. A 22-year-old stand (same bottom plot as Figure 1 but viewed from the opposite end) prior to 1982 growing season. Yellow-poplar in center foreground is 9.3 inches d.b.h. and 94 feet tall;

**Table 1. Survival, diameter, and height by species after 22 years.**

| Species            | Survival | Diameter  |        |          | Height    |       |        |
|--------------------|----------|-----------|--------|----------|-----------|-------|--------|
|                    |          | $\bar{D}$ | $S_d$  | Range    | $\bar{H}$ | $S_d$ | Range  |
|                    |          | Percent   | Inches | Feet     |           |       |        |
| Yellow-poplar      | 50       | 6.5       | 2.9    | 1.9-14.0 | 70        | 21    | 26-106 |
| Sweetgum           | 29       | 2.3       | 1.1    | 0.8- 6.3 | 28        | 12    | 11- 67 |
| Swamp chestnut oak | 52       | 1.3       | 0.5    | 0.3- 2.6 | 17        | 5     | 7- 30  |
| Water oak          | 9        | 1.4       | 0.6    | 0.7- 2.8 | 19        | 8     | 11- 34 |
| Shumard oak        | 7        | 1.1       | 0.3    | 0.6- 1.6 | 19        | 4     | 13- 26 |
| Cherrybark oak     | 2        | 1.5       | 0.5    | 1.1- 2.3 | 25        | 6     | 22- 34 |

higher for all species except southern red oak, which averaged 69 percent. The tallest trees were yellow-poplar, averaging 8.5 feet. Trees of all other species averaged 4.9 feet or less. Tallest of the red oaks was Shumard, averaging 4.7 feet. Trees had developed above most herbaceous plants; vines were not prevalent on any plot (Figure 1).

After 22 years, only yellow-poplars were in a free-to-grow position, *i.e.*, in an intermediate or better crown class (Figure 2). Half of those planted were still alive, and 39 percent of the survivors were dominant or codominants that, as a group, averaged 9.3 inches d.b.h. with a range of 6.3 to 14.0 inches, and 90 feet tall with a range of 72 to 106 feet. The best two-thirds of the dominant/codominant component, or what would be considered crop trees, averaged 10.0 inches d.b.h. and 92 feet tall. Limb-free boles averaged 40 feet.

Other species had survival rates ranging from 0 (southern red oak) to 52 percent (swamp chestnut oak) (Table 1). Not one tree was in a dominant or codominant position. Tallest oaks, mainly swamp chestnut oak, were between 20 and 40 feet (Figure 3). These trees had relatively fast early growth but ultimately became suppressed by the faster-grow-

ing yellow-poplar. For sweetgum particularly, the larger size attained in earlier years probably accounts for the higher than expected survival for a shade-intolerant species. Aside from their crown position, larger suppressed trees probably have developed larger root systems that contribute to survival.

Considering only trees that have been suppressed most of their life, those <20 feet tall after 22 years, swamp chestnut oak is the most tolerant of shade and side competition, while Shumard oak, water oak, and sweetgum show slight tolerance. Usually swamp chestnut oak is considered a tolerant species, the others intolerant or moderately tolerant. Tolerance of the understory swamp chestnut oaks was typified by a flat, but full, crown.

There appeared to be little inter- or intra-species growth difference by degree of slope.

Natural regeneration did not develop within the plantings. Among trees growing outside, a few sycamore (*Platanus occidentalis* L.) and sassafras were nearly as large as planted yellow-poplar. Trees of both species originated from seed in the same year as the planting.

Due to overwhelming growth of yellow-poplar, comparative development rates of the other species could not be evaluated. Of importance, though, is that some trees of all species except southern red oak were able to persist. Such trees obviously had been suppressed for many of the 22 years, but few showed any sign of dieback and resprouting.

The study shows that in the silty uplands, yellow-poplar will outgrow the other species tested, even in small openings that approximate those made by group selection harvest. Where there is a seed source, yellow-poplar natural reproduction should dominate such openings, and the futility of spot planting red oaks or even expecting natural seedlings of such to compete is obvious. Longevity of some of the oaks, however, indicates an opportunity for releasing them through commercial thinning when yellow-poplars reach minimum pulpwood size. Where a yellow-poplar seed source is lacking, spot planting of oaks may be a regeneration option.

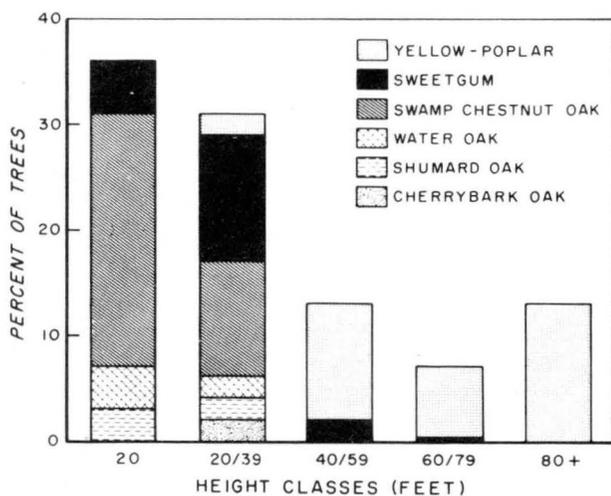


Figure 3. Height distribution by species after 22 years.

### Literature Cited

- JOHNSON, R. L., and R. M. KRINARD. 1963. Planted yellow-poplar outperforms six other species on loess sites. USDA For. Serv., Tree Planters' Notes 61:11-12.
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