SILVICS OF LOBLOLLY-BAY, GORDONIA LASIANTHUS[1]

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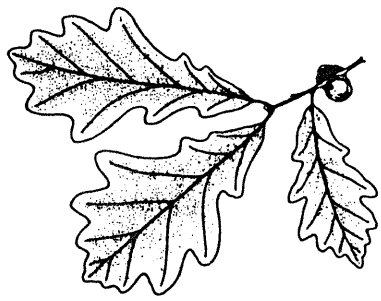

ABSTRACT.--Loblolly-bay (Gordonia lasianthus (L.) Ellis) is a hardwood commonly found in pocosin areas of the Atlantic Coastal plain. The soils of loblolly-bay sites are sandy, acidic, poorly drained and infertile. Average growth rates, determined by stem analysis, were 0.58cm/yr stem diameter growth at 1.3m and 0.38m/yr total height growth. Loblolly-bay sprouts readily from both stumps and the base of burned stems. Flower formation began during April with flower opening during July and August. Seed-fall occurred during November and December and ranges from 2.6 x 10^3 to 25.9 x 10^3 seed per tree.

INTRODUCTION

The coastal plain of the southeastern United States contains many hectares of pocosins, which are characterized by poor drainage, infertile sandy soil and a vegetative cover of broadleaf evergreen shrubs. A sparse canopy of pond pine (Pinus serotina Michx.) and loblolly-bay (Gordonia lasianthus (L.) Ellis) may also be present. The 1978 U.S. Forest Service Forest Survey of South Carolina and the 1983 Survey of North Carolina indicated that there were about 571,000 hectares of commercial forest land in the two states that were classified as bays and wet pocosins. These surveys also indicated that about 53 percent of this land is in the farmer and miscellaneous private ownership class.

Loblolly-bay is an angiospermous, evergreen hardwood of pocosin sites which may have potential for tree management. However there is little known about the species. In this paper we will describe some of the silvical characteristics of loblolly-bay as obtained from our field work in coastal South Carolina.

FIELD METHODS

Hobcaw Barony, a 7,000 ha research forest in Georgetown county, South Carolina and the 101,000 ha Francis Marion National Forest (FMNF) in Berkeley and Charleston counties, South Carolina were the study areas. Both areas are on the lower coastal plain and consist of level uplands and depressions underlain with clayey or sandy sediments (Smith and Hallbick 1979).

During 1979 and 1980, 21 sites containing at least one loblolly-bay tree each were sampled on Hobcaw and 29 sampled on the FMNF. Sites were located from aerial photographs and soil maps, and were subjectively selected after field checks. Trees (woody stems at least 3.0cm DBH) were inventoried within 15m of a loblolly-bay tree, which served as the center of the single plot sampled in each site. Tree diameter (to the nearest 0.1cm) and species were recorded during the tree inventory. Shrubs (woody stems less than 3.0cm DBH but greater than one meter tall) were tallied by species in a circular plot of 5m radius with the same center as the 15m plot. Meter square quadrats were located 5m from the central loblolly-bay stem in the cardinal directions, and loblolly-bay stems less than one meter tall were tallied in the quadrats. Finally, a soil core was taken at each site to a depth of one meter or to the water table, whichever came first.

Phenologic changes of three loblolly-bay trees located on Hobcaw were monitored by weekly measurements on five branches located in the upper canopy of each tree. Access to the canopy was from a tower of construction scaffolding carefully erected around each tree.

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Seedfall was measured around five loblolly-bay trees located on Hobcaw with fifteen wooden $0.26m^2$ seedtraps arranged in three lines radiating from each tree. Traps were place at distances equal to 1/8, 1/4, 1/2, 1.0 and 1.5 of the central tree height, and were emptied weekly during the time of seedfall.

Seed germination was measured by placing loblolly-bay seeds collected on Hobcaw and stratified at 4^oC for two weeks, on METRO MIX 300, and kept moist by a mist propagation system. Fifteen days later the seedlings were potted in 7.6cm plastic pots with the same METRO MIX 300. At 56 days from germination the seedlings were repotted and planted in the field 184 days after germination. Periodic total height measurements were made on the planted seedlings.

During the first spring of field work we observed several loblolly-bay seedlings in recently plowed fire lines, and few on the adjacent forest floor. To test the hypothesis that successful establishment of loblolly-bay is enhanced by exposed mineral soil, we mechanically removed the litter layer of a 0.02ha portion of a loblolly-bay site. A 3 x 3m wire fence exclosure was installed in the cleared area. Seedling density and height were periodically measured both inside and outside of the exclosure.

Growth and biomass data were obtained by destructively sampling a total of 71 loblolly-bay trees from the 50 sites inventoried on Hobcaw and FMNF. Pre-felling measurements were DBH and two crown widths, as estimated by a downward vertical projection of the crown at right angles. Then the tree was carefully felled into a cleared area. Once on the ground the following were measured; stump height, stump diameter, stump age, age at 1.3m above the ground, bole length, height to base of live crown, and diameter at the base of live crown. The bole was then severed at 1m intervals and the diameter at both ends and fresh weight were measured for each bole section. Unfoliated branches, foliated branches, and leaves were then separated and a green weight determined for each component. Samples of each component of each tree were weighed in the field, returned to the laboratory and dried at 60^oC until a constant weight was reached. Dry weight of the bole and total aboveground dry weight of each tree was calculated and used as response variables in simple linear regressions.

Fifty-two stumps of trees cut during the gathering of biomass data were tagged and the number and height of large sprouts (stump sprouts with a basal diameter greater than 0.5cm) and the number of small sprouts (stump sprouts with a basal diameter less than 0.5cm) were periodically recorded. Sprouting was monitored on seven tagged trees in a pocosin on Hobcaw that was burned in early December.

RESULTS AND DISCUSSION

Site Description

The characteristic soil of loblolly-bay sites has a sandy texture (75-98 percent), a surface peat layer 3 to 14cm thick, and has poor or very poor drainage. The groundwater level is often above the peat surface during the winter and has a pH of 3.2 to 4.8. Soil surveys of Georgetown county (Stuckey 1982) Berkeley county (Long 1980) and Charleston county (Miller 1971) indicated that typical soil series of the loblolly-bay sites include Leon sand, Lynn Haven fine sand, Rutlege loamy sand and Pickney loamy fine sand. Topographically, the sites were either between pine "ridges" and hardwood drainage areas or sites were the broad flat pocosins and Carolina Bays. Carolina Bays are elliptical landforms of varing size, with a sand ridge surrounding a flat poorly drained interior.

Loblolly-bay is most commonly found in the Pond pine and Sweetbay-Swamp tupelo-Redbay Society of American Foresters forest cover types, however it can be a minor component of the Pondcypress, Loblolly pine-Hardwood and Atlantic White-Cedar types.

The basal area of loblolly-bay, redbay (Persea borbonia (L.) Spreng.), blackgum (Nyssa sylvatica Marsh.), loblolly pine (Pinus taeda L.), and pond pine accounted for 84 percent of the average site tree basal area of $24.8m^2$/ha (SE 1.67)[1]. Tree density averaged 1,912 (SE 172) stems per hectare. Sweet pepperbush (Clethra alnifolia L.) or fetterbush (Lyonia lucida (Lam.) K. Koch) were the most abundant shrub species and accounted for 73 percent of the average 46,278 (SE 6,077) stems/ha stocking.

Flowering and Seed Production

Flower formation began around the third week of April and continued until the first of August. The buds were fully formed and started to open during July and the flowering reached a peak during the first part of August. We observed that an individual flower was open for only one or two days before the sepals and petals would fall off. The remaining seed capsules would begin opening during October and seedfall would commence then and continue until March of the following calendar year. Seedfall was the highest during the last of November and first of December.

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[1]SE is standard error

Annual seedfall rates ranged from 2.6 x 10^3 to 25.9 x 10^3 seed per tree. Seed production per tree increased rapidly with tree size for trees 20cm DBH and greater, which corresponds to an approximate age at the stump of 35 years. The five trees selected for seedfall measurement produced 368.1 x 10^3 seed the first growing season and 360.0 x 10^3 seed the second season, indicating small annual variation. Seed dissemination was poor, with an estimated 63 percent of the source tree.

Seed germination was observed in the mechanically cleared area during the first half of April for two growing seasons. The first spring after clearing there were 9 (SE 5.0) seedlings/m^2 and the second spring there were 62 seedlings/m^2. Also during the second spring we tallied an average of 8.8 (SE 5.1) one-year-old seedlings/m^2. These results coupled with the observation of seelings on fire lines indicated to us that seedling establishment is greatly enhanced by exposed mineral soil.

Seedling and Sprout Growth

Growth of seedlings established on mineral soil averaged 4.2cm (SE 0.2) from germination to August of the first growing season. By June of the second growing season these seedlings were 11.1cm (SE 0.4) tall. Seedlings started in the greenhouse were 35.2cm (SE 1.4) tall when they were outplanted in the early winter, and grew to 48.6cm (SE 3.5) tall by the end of their first growing season in the field.

Our data on sprouting from stumps of trees cut for biomass estimation and sprouting from trees in a control-burned pocosin indicated that loblolly-bay sprouts readily and the sprouts grew rapidly. One-year-old stumps of trees cut for biomass estimation had an average of 4.5 (SE 1.4) sprouts with a basal diameter greater than 0.5cm and these sprouts averaged 63.3cm (SE 3.7) high. Sprouts less than 0.5cm basal diameter averaged 10.5 (SE 1.4) sprouts per stump. Two-year-old stumps had sprouts with a basal diameter greater than 0.5cm which averaged 47.1cm (SE 1.7) in height. There was no apparent relationship between stump height and stump diameter and number and size of stump sprouts.

Six of the seven tagged trees in the burned pocosin sprouted with an average of 9.2 large (SE 4.3) (basal diameter greater than 0.5cm) sprouts and 10.2 (SE 3.7) small sprouts/tree. The large sprouts averaged 70.9cm (SE 3.8) high and 0.75cm (SE 0.04) diameter at their base.

Root suckers were not observed in either disturbed or undisturbed areas.

Tree Growth and Yield

The results of our destructive sampling 71 loblolly-bay trees are summarized in Tables 1 and 2.

Table 1.--Descriptive statistics of biomass data for loblolly-bay.

Parameter (units)	Number of Observations	Mean	Minimum	Maximum
DBH (cm)	71	14.0	1.0	61.2
Total Height (m)	71	11.0	2.3	25.9
Age at Stump (years)	69	25.4	6	112
Bole Dry Weight (kg)	71	62.3	0.1	559.8
Total Above-ground Dry Weight (kg)	70	85.5	0.3	647.8

Simple linear regressions were calculated to predict height and DBH from age at the stump. Diameter growth was estimated from the regression to be 0.58cm/yr and diameter growth rates for trees from Hobcaw and the FMNF were similar. The relationship between age at the stump and the total height was also linear, but the height of the oldest tree, which was considerably older than the remainder of the trees sampled, appeared to deviate significantly. Therefore the oldest tree was considered an outlier and was not included in height and biomass regression.

Height growth of all sampled trees, except the oldest, was constant and the growth rates were different for each site. The growth rates were estimated to be 0.30m/yr for Hobcaw and 0.36 m/yr for the FMNF and are relatively slow, especially when compared to loblolly pine growing on an upland site. Trousdell, Beck and Lloyd (1974) estimated that loblolly pine growing on upland sites in the Atlantic coastal plain with a 25 year site index of 60 would be 21m tall at 30 years. A 30 year old loblolly-bay would be 13m tall.

Oven dry biomass of the bole (and bark) and the entire above ground portion of loblolly-bay trees were estimated as a linear function of diameter squared times height and these estimates are presented in Table 2. The estimates are presented separately for each site because the prediction equations were different for each site.

The national champion loblolly-bay is located in northern Florida and is 25.6m tall with a DBH of 122cm.

Table 2. Growth and yield estimates of loblolly-bay at Hobcaw and the Francis Marion National Forest. Biomass estimates are on a oven dry weight basis.

Age	DBH		Total Height		Stem Biomass		Aboveground Biomass	
	Hobcaw	FMNF	Hobcaw	FMNF	Hobcaw	FMNF	Hobcaw	FMNF
years	-----cm----		------m-----		----kg/tree----		------kg/tree------	
10	5.1	5.1	6.6	6.0	13.1	3.8	16.9	5.8
20	10.9	10.9	9.6	9.7	25.0	17.6	32.4	23.6
30	16.7	16.7	12.6	13.3	54.3	53.2	70.4	69.3
40	22.6	22.6	15.7	16.9	108.4	120.9	140.6	156.1
50	28.4	28.4	18.7	20.5	194.8	230.8	252.7	297.2
60	34.2	34.2	21.7	24.1	321.1	393.1	416.7	505.5

MANAGEMENT IMPLICATIONS

This research did not identify any silvical characteristics of loblolly-bay which would prevent management specifically for the species on appropriate sites. The following scenario combines the results of this study into an outline for the management of loblolly-bay.

The site description data indicates that sandy, acidic, poorly drained soils with a peat layer will probably be suitable for loblolly-bay. The presence of redbay and pond pine should aid identification of such sites.

A stand of loblolly-bay could be established by planting containerized seedlings grown in a greenhouse, or the area could have the litter layer removed, either mechanically or by one or more hot fires and be direct seeded. If there are loblolly-bay stems present on the site, a seedtree form of regeneration may be possible after appropriate seedbed preparation. The sprouting ability of loblolly-bay and the rapid growth of the shoots indicate that coppice management may be appropriate.

Finally, the growth and yield of the species will be less than that of southern yellow pines growing on upland sites or bottomland hardwoods in alluvial swamps. This is most likely a function of the site and not the species because pond pine, which is often found in association with loblolly-bay, also grows slowly in pocosin sites (Kaufman et al. 1954).

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