

EXTENDING THE RANGE OF LOBLOLLY PINE IN THE MISSISSIPPI
RIVER VALLEY: FACTORS RELATING TO GROWTH AND LONGEVITY

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Abstract.--Factors such as soils, snow, ice, cold weather, insects, diseases, rainfall and initial tree spacing that affect growth of loblolly pine north of its natural range in the Mississippi River Valley are discussed. The most important environmental factor to influence growth is rainfall. As rainfall decreases northward in Illinois, site index and wood specific gravity also decrease, which results in a decrease in biomass production. The southwestern Arkansas and Maryland sources of loblolly pine are recommended for planting in Illinois as they are the only strains that have been shown to be resistant to ice and cold weather damage in the area. Planting loblolly north of highway US 40 in Illinois is not recommended.

Additional keywords: Loblolly pine, growth, environmental factors, seed source.

Loblolly pine (*Pinus taeda* L.) has been extensively planted in the Mississippi River Valley during the past 50 years. Some of these plantations are well beyond the northernmost natural range of this species in the Valley, which is northern Mississippi and western Tennessee, about 125 miles south of Paducah, Kentucky.

The areas planted to trees in the Mississippi River Valley that encompass Tennessee, Kentucky, and Illinois have been mostly old fields where the quality of the site has been reduced to the point that native hardwood cannot be successfully grown. Hence it was necessary to find less demanding tree species to reforest these degraded sites. After planting numerous coniferous species over a period of years, foresters now select loblolly pine as the most desirable tree species to plant in the area. In this part of the Valley, loblolly is relatively easy to plant, makes rapid early growth so that weeds and brush are usually not a serious problem, does not have severe insect and disease problems and produces a large mass of stemwood per year.

There are limitations to the northern extension of loblolly's range in the Valley as various environmental and other factors affect its performance. In this paper are discussed the most important factors found to be related to growth and longevity of loblolly pine north of its natural range in the Mississippi Valley.

FACTORS RELATED TO GROWTH

There is a dearth of published reports on growth of loblolly pine in the middle and upper Mississippi Valley. The few reports that are available pertain to plantations growing in Illinois. Therefore, examples and conclusions

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in this paper are based mainly on these reports and accepted principles or proven facts.

Soils

Soils influence the growth of loblolly pine in Illinois by regulating the amount of available moisture in the soil during the growing season. When moisture is deficient or excessive, growth slows or ceases. Factors that influence the availability of soil moisture for loblolly pine growth in Illinois are (1) the amount of space occupied by roots above an impervious layer, (2) the water-holding capacity of this space (sand, silt and clay content) and (3) the susceptibility of the soil to water-logging (surface drainage).

Most soils in Illinois where loblolly pine has been planted have a loessal cap with the top soil being a silt loam. Nitrogen is usually the nutrient that is most limiting for tree growth on these areas. A soil test should be made before planting an old field as those areas that have been previously limed might result in reduced height growth for loblolly pine (Gilmore 1975).

Soils in the western Kentucky-Tennessee area are composed of loessal and cherty materials. The latter soils are not as highly productive in the natural state as the loessal ones.

Snow and Ice

Accumulation of snow and ice on limbs and needles of loblolly can result in bent and broken limbs and tops of trees destroyed. Trees from six geographic sources of seed of loblolly pine (Table 1) have been tested in Illinois

Table 1. Survival, Growth And Damage By Snow To Loblolly Pine From Six Regions Of Origin. 1/

Region of Origin	Survival (Percent)	Height (Feet)	Diameter (Inches)	Basal Area (Ft ² /Acre)	Volume (Ft ³ /Acre)	Trees Damaged (Percent)
Maryland	57	61	6.6	173	4,418	1.9
Virginia	55	62	6.7	171	4,473	2.7
Arkansas	62	63	6.9	203	5,535	3.7
North Carolina	41	62	7.2	155	4,078	11.3
South Carolina	43	59	7.1	151	3,812	7.4
Mississippi	42	61	7.4	156	4,254	12.4

1/ Percent trees damaged is at age 10 years; all other data are 27 years results.

for 27 years. Results to date indicate that the northerly sources are better adapted to withstand the snow and ice conditions in Illinois than the most

southerly sources (Gilmore and Funk 1977). The southwestern Arkansas source was the least damaged and is the source recommended for planting in Illinois at this time. The second choice is the Maryland source,

Insects and Diseases

Loblolly pine is relatively free from insect problems in Illinois and Kentucky-Tennessee. There are occasional outbreaks of pine sawfly larvae and shoot or tip moth, but damage is not great.

Disease is active in older pine stands. Much of the mortality is attributable to Fomes annosus, an indigenous root rot fungus. The incidence of this fungus in Illinois is increasing and may become great enough to make thinning undesirable silviculturally because of the predisposition of the uncut trees to infection.

Climate

The most striking feature of climate in the area is rainfall, which is rather uniformly distributed throughout the year in Illinois. It ranges from about 38 inches per year in central Illinois to 46 inches in the extreme south. Because of high temperatures during the summer months, there is usually a drought period of one to three weeks duration, beginning in the early part of July. This period of moisture deficit coincides with latewood production in loblolly pine for that region. Consequently, latewood percentage is lowered, which results in a lowering of wood specific gravity. As shown later in this paper, under these conditions biomass production is reduced.

Total height of loblolly pine can be shown to be related to rainfall. For example, Gilmore et al. (1966) found a high correlation between latitude and site index (height at base age of 40 years) ranging from 46 in Central Illinois to 80 north of the Ohio River near Paducah, Kentucky. This information can be translated to show that the low site index occurs in the area of 38 inches of rainfall with the high site index occurring in the 46 inches rainfall area.

It has been shown that wood specific gravity of loblolly pine gradually decreases from the southern to the northern part of its range in the Mississippi Valley (Gilmore 1967). Also, that wood specific gravity is related to warm season rainfall in Mississippi (Wheeler and Mitchell 1962) and available moisture during the summer in Illinois. This increase or decrease in wood specific gravity is directly related to latewood percentages which is correlated with available moisture during the summer months -- higher the summer rainfall, higher the latewood percentage, and higher the wood specific gravity.

When we think of yield we should be thinking of biomass production. That is, the total volume of wood produced times the weight per volume (wood specific gravity) of that wood. Table 2 illustrates the importance of wood specific gravity and stem wood yield for loblolly pine in the Valley. A comparison of the average wood specific gravities for loblolly pine in Illinois, Kentucky-Tennessee and Mississippi demonstrates that the pulpwood yield per unit volume for the species is considerably lower in Illinois than in Kentucky-Tennessee or Mississippi. The greater wood yield per cord in Mississippi a-

Table 2. Wood Specific Gravity, Percent Latewood And Yield Per Cord Of Loblolly Pine In The Mississippi Valley. 1/

	Illinois	Kentucky-Tenn.	Mississippi
Specific Gravity	.403	.424	.479
Percent Latewood	21	28	----
Lbs/ft ³	25	27	30
Lbs/90 ft ³	2,250	2,430	2,700
Diff. Lbs/cd	180	270	

1/Median age of 20 years.

mounts to a considerable quantity of pulp for a mill that uses a large volume of wood. Assuming that a cord and a half per acre per year is produced in all areas of the Valley, approximately 7 tons less wood (dry weight base) per acre is produced at pulpwood age (20 years) in Illinois than on a comparable acre in Mississippi and about 3 tons less than in Kentucky-Tennessee. Even if wood is bought by weight, the cost of handling and pulping the wood of lower specific gravity will result in less profit for the pulp company and more than likely a lower price to the grower for stumpage. These computations demonstrate how yields are lowered as loblolly pine is planted outside its natural range in the Valley.

Site Index

There is more stem wood produced at a given age on sites in southern Illinois than in central Illinois. This fact is easy to demonstrate by considering the previous site index figures given for the two areas (80 vs 46 for southern and central Illinois respectively). If these site index figures are equated to the number of cords produced per acre in 25 years we find that for a site index of 80 we will grow approximately 50 cords per acre and for a site index of 46 the production will be approximately 35 cords.

Not only must we look at volume production but also biomass production. Gilmore et al. (1966) showed a positive correlation between wood specific gravity and latitude. Their findings equates to a wood specific gravity of approximately .415 in southern Illinois and .390 in central Illinois. When the weight of the two yields (50 and 35 cords) are computed we find that the southern area will yield 21 more tons of dry wood in 25 years than a similar area in central Illinois.

Spacing

One of the most difficult forest management problems to solve is to determine the optimum growing space needed for each age and site so as to obtain

the desired wood products most rapidly. Twenty-five years data shows that for an unthinned loblolly pine plantation growing on a medium quality site in southern Illinois, a spacing of 8 x 8 feet is superior to a 4 x 4, 6 x 6 or 10 x 10 feet spacing (Arnold 1978). This spacing will yield more cubic feet volume and cords than the other spacings. Thirty years data for this unthinned plantation shows that the 8 x 8 feet spacing is still superior to the other spacings, yielding 58 cords as compared to 26, 45, and 56 cords for the 4 x 4, 6 x 6, and 10 x 10 feet spacings respectively. ^{1/}

Initial spacing in a plantation will affect total height of loblolly pine after the crowns close. In the above plantation, total heights of all trees at thirty years averaged 73 feet in the 10 x 10 and 8 x 8 feet spacings, 69 feet in the 6 x 6 spacing and 61 feet in the 4 x 4 spacing. These reduced heights will result in reduced yields.

Yield Comparison

While loblolly pines growth and yield in southern Illinois are encouraging, it is less than that reported in its natural range. For example, in Louisiana, 18-year-old loblolly pine planted at 8 x 8 feet spacing averaged 1.9 cords per acre per year (Hansbrough 1968). In Illinois, the growth at this spacing has been 1.7 cords per acre per year (Gilmore and Gregory 1974). The best yield in the Louisiana plantation was 40 cords per acre in 18 years planted at 10 x 10 feet, whereas in southern Illinois loblolly produced only 26 cords per acre at 10 x 10 feet in 18 years.

FACTORS AFFECTING LONGEVITY

Loblolly pines of southern origin are adapted to longer frost-free seasons and are inherently capable of greater growth than those from more northerly sources. But if loblolly pine grown from southern seed are moved too far north, they may grow too long in the year and be subject to late spring or early autumn frosts or may be so poorly adapted as to suffer cold damage during the dormant season. This condition prevailed in a loblolly seed source study in southern Illinois (Gilmore and Funk 1977). The most southerly sources of loblolly were seriously injured by frost and cold so that survival was less than half of the original stand. The northerly sources such as Maryland and Arkansas were less damaged and survival averaged 60 percent.

There is an axiom in plant ecology that the range of a species is not governed by the average conditions (competition, climatic, etc.) that exist in the area but by the extremes which might occur once in 25 to 100 years. This axiom was substantiated during the late 1970's in central Illinois. A plantation of loblolly pine of Maryland seed source was established in 1948 near Champaign which is about 325 miles north of its natural range (Lorenz and Jokela 1965). The trees made adequate growth during their first 30 years, attaining a height of 56 feet, which is above the average for loblolly through-

^{1/} Adapted from file report, "Growth of loblolly pine after 30 years at different initial spacings", by L. E. Arnold, July 18, 1980.