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IMPORTANCE OF SOIL TO TREE GROWTH

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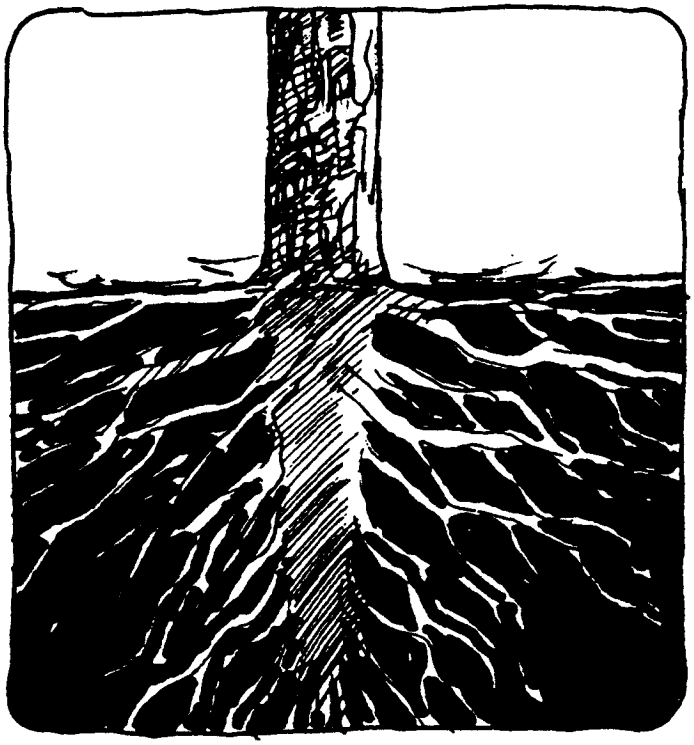

THIS FORESTRY PUBLICATION IS ONE OF A SERIES ON SOUTHERN PINE MANAGEMENT.

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Soil quality is an all important factor in forest management decisions. Soils influence which tree species will grow best and yield the highest timber product volume, the length of time required to grow a timber crop, and the amount of money a landowner can invest to yield an acceptable economic return from forest management.

Trees will grow on many soils, but soils vary greatly in their ability to produce merchantable volumes of pulpwood, sawtimber, veneer, poles, piling, or other wood products in a reasonable amount of time. Past land use greatly affects soil productivity. In the Southeast, land that has been farmed is often eroded and lacking in one or more nutrients. The old saying "plant your sorry, worn out acres to trees" does not yield the highest return to the landowner. Just as with any other crop, the better the land, the more productive the forest. Landowners must be aware of factors limiting forest production when investing in forest regeneration and management.

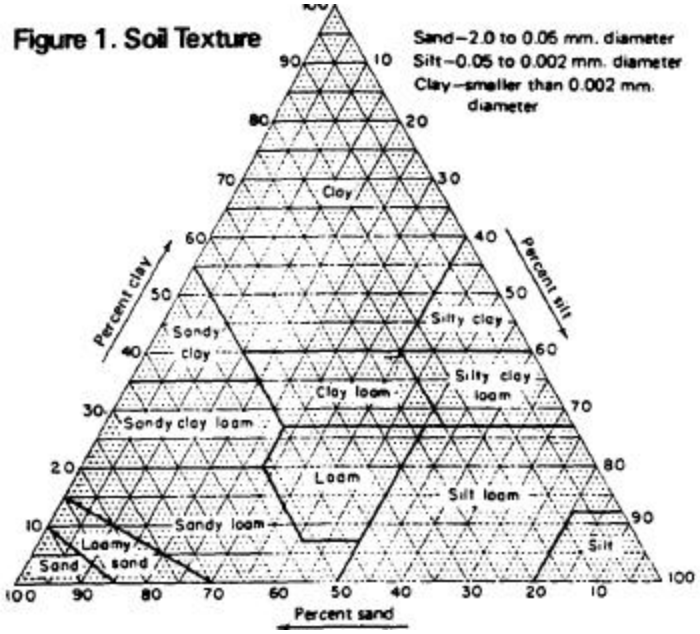
Soil Characteristics

One or more of the southern yellow pines will grow well on many sites. The following factors have a major impact on forest soil productivity.

1. Topsoil Depth - The depth of the uppermost soil layer is the most critical factor affecting the growth of southern pine. This zone is where many of the small "feeder" roots, through which water and nutrients enter the tree, are located. Logically, topsoil is highest in organic matter and nutrients, is usually well aerated and drained, and allows maximum root growth and root penetration. Erosion on many sites has reduced the topsoil depth to a few inches or less. In such cases, the characteristics of the second and third soil layers become increasingly important.

2. Soil Texture - The relative amounts of sand, sift, and day in the topsoil and subsoil layers is called texture. Sandy soils are comprised of large individual sand grains, are normally very well drained, but often lack nutrients through constant loss by leading. On deep pure sands, longleaf pine normally is selected for management since it is best adapted to this low moisture, low nutrient environment. On the other end of the texture spectrum are the pure day soils comprised of very small, fine soil particles. Generally, days exhibit higher water holding capacity, often to the point that soil aeration and root growth is inhibited. Some days contains adequate nutrients and are sufficiently well-drained between the extremes of pure sand and pure day. The combination of particle size along with the physical and chemical properties of each individual particle type in a given soil determine the soil's productivity. (Figure 1)

3. Subsoil Consistence Class - In addition to topsoil depth, consistency of the subsoil layer has been



recognized as an important determining factor in forest soil productivity, particularly for loblolly and shortleaf pine. Consistency is defined as the tendency for soil particles to adhere (dump together) particularly when wet. Consistency affects the ability of feeder roots to grow in the soil and absorb both nutrients and moisture. The following consistency classes will help you understand the productivity of your soil:

Class 1 - Very friable Non-plastic when wet, cannot be molded into a "wire." Loose or non-coherent when dry. Typical of coarse-textured soils (sands, loamy sands, sandy loams). Low to medium productivity.

Class 2 - Friable. Only slightly Plastic when wet. Crushed into aggregates under gentle pressure when moist. Soft when dry. Medium to high productivity.

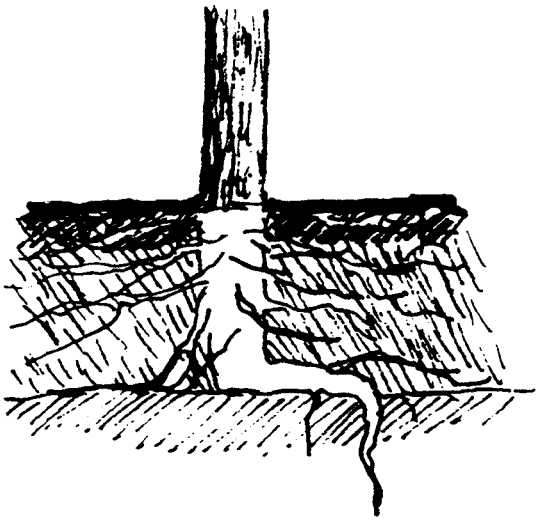
Class 3 - Semi-plastic. Can be deformed and will "ribbon-out" when worked while wet. When moist it will tend to crumble somewhat when ribboned out between the thumb and finger. When relatively dry, the soil is firm. Medium to high productivity.

Class 4 - Plastic. The soil is easily deformed and holds impressions when wet. When it is moist, it can be molded continuously into various shapes without breaking. It is hard when dry. Low to medium productivity.

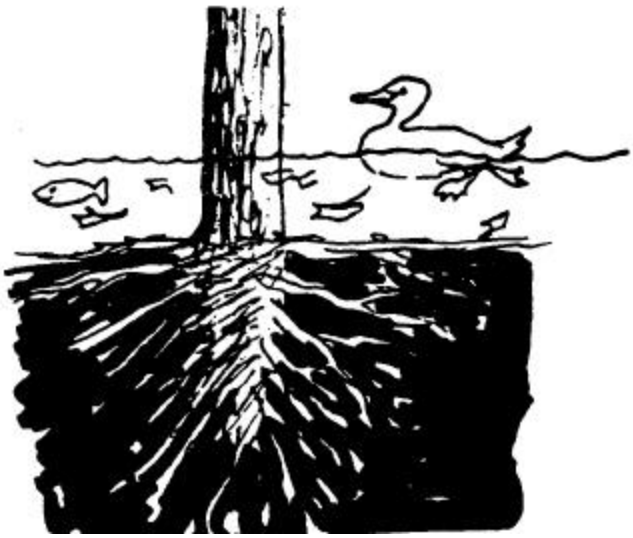
Class 5 - Very plastic. Soil has the properties of putty. When wet it can be molded into various shapes and will form a long ribbon when worked. h is firm but can be molded under moderate pressure at intermediate moisture contends. When dry, it is extremely hard. Usually low in productivity.

Class 2 and 3 soils are considered the best for forest tree growth, followed by Class 4.

4. Limiting layers - Any soil layer which limits the downward penetration of a tree's root system will reduce tree growth. In coastal plain soils, mineral and organic matter particles often form a cement-eke layer below the soil areas. These "hardpans" are typical of poorly drained areas with fluctuating shallow water tables, and they limit the depth to which roots, penetrate. Farmland may be underlain by a than layer of consolidated soil material just below the plow layer. These "plow pans" may be broken up by deep plowing, unlike permanent hardpans, which cannot be broken.



5. Internal Drayage. - Few trees species can grow in sots which are constantly wet. Poor drainage can "drown" tree roots by blocking the exchange of oxygen and carbon dioxide between the soil and roots. Drainage can sometimes be improved by ditching or by using bedding in site prepration. Internal drainage properties can be estimated by measuring the depth to "mottling" in a soil. Mottling refers to the coloration of sod caused



by minerals under poorly drained conditions. Mottled soils are usually red, yellow, or gray in comparison to surrounding soil color. In the very poorly drained soils, the entire soil profile may be ashy gray. (Table 1)

Table 1. Internal Drainage Classes

Class	Depth to Mottling
Well drained	over 36 inches
Moderately wet	24-36 inches
Somewhat poorly	12-24 inches
Poorly	less than 12 inches
Very poorly	Gray soil color

Soils in the first three drainage classes usually are medium to highly productive while the latter two classes are low to medium in productivity.

6. Fertility - The southern pines grow over a wide range of soil fertility levels. Soil fertility is a measure of the nutrients available in the soil for plant growth. Supplemental fertilization is normally not recommended for southern pine species except in cases of major nutrient deficiency. Phosphorous is deficient in some soils, and early tree survival and growth can sometimes be improved by adding phosphorous. A soil test made prig to site preparation will alert a landowner to critical deficiencies. Soil tests are made by the Cooperative Extension Services in each state. Your Extension agent can arrange to have your soils tested. Research has shown conflicting response by forest trees to fertilization with nitrogen fertilizer, particularly early in a rotation. Growth suppression may occur if the fertilizer increases the growth of competing weeds. Best results from early fertilizer use arise from a combination of fertilization with control of competing vegetation by herbicide or mechanical methods, not a usual forestry practice. Late rotation fertilization applied within 5 to 8 years before final harvest has been shown to increase timber yields in some situations. Landowners should have soils tested to determine the nutrient status and consult a forest soils specialist (contacted through the local Extension agent) to determine if the cost of fertilization will yield an acceptable increase in timber growth and yield.

Site Index

Foresters use site index to evaluate a soil's capability to support tree growth. Site index is measured by the total height to which dominant trees of a particular tree species will grow on a given site at some index age, usually 50 or 25 years in the southeast. Dominant trees are those which occupy the uppermost layer of the tree canopy; that is the tallest trees in the stand. The index age muse be stated as well as the tree species when referring to site index. Site index for one tree species will be different from another on the same site. Soil characteristics tend to vary considerably within an area, making it advisable to determine site index stand-by-stand.

If the site index for loblolly pine in a stand is 70 feet at 50 years, then we expect loblolly seedlings planted on that area today to be 70 feet tall in 50 years. There is a close relationship between site index and the volume of merchantable wood produced. Volumes increase rapidly with improvement in site index. When timber yields are estimated, dollar value projections based on site index can be made.

Site index of an area can be determined in several ways. The simplest and most reliable is to measure the height of dominant trees on the site at age 50. This is seldom possible on a given area, since seldom will trees be exactly 50 years old. Site index can be, estimated by measuring dominants at a younger or older age and determining height at site index age from index curves for that species.

A common method for measuring site index is based on physical properties of the soil. Tables giving site index by this system are available for several important species. The information used is the depth of topsoil and plasticity rating of the subsoil. In deep sands, the depth

to a finer-textured horizon and fine particle content of that horizon are used instead of topsoil depth and subsoil plasticity.

Subsoil plasticity, a measure of suitability for root growth depends on the amount of clay present. It indicates water-holding capacity, water availability to roots, and aeration. As plasticity increases, root aeration decreases. Roots of most plants need better aeration for good growth than exists in plastic and very plastic soils. Consequently, in the Piedmont for example, with its shadow topsoils, an increase in plasticity of subsoil means a decrease in site when topsoil depth remains constant. (Figure 2)

Coastal Plain topsoils are coarser-textured and deeper. They have poor water-holding capacity. So we see that an increased plasticity of the subsoil is an advantage in this physiographic region because of different topsoil characteristics. (Figure 3 and 4)

In the mountains, factors such as slope, position on the slope, and aspect (facing direction of the slope) complicate site index determination. Tables to estimate growth and acceptance in the local markets. constructed for these areas.

Landowners should consult professional foresters to evaluate the site index of a property for a particular tree species. Site index information is also included in county soil surveys that are being made throughout the South.

Site index can be determined for virtually any commercial tree species with reasonable accuracy. If a particular species is not present, and direct investigations of soil properties do not apply, some species can be cross-referenced. For instance, by referring to the proper tables, a site index derived for white oak growing on a site can be converted to a site index for one or more of the tern pines with reasonable accuracy

Species Selection

Selecting the proper sues of southern pine to manage on a site requires several decisions:

1. Know your objectives. If timber production is to be the major objective, select a species that will economically produce timber products. If wildlife, recreation, aesthetics, or other uses is the objective, select species accordingly.

2. Know the capabilities of your site; its productive potential.

3. Select species with a proven track record in terms of site index by soil physical characteristics have not been

4. If two or more species could be selected and timber production is the major objective, select the species that will yield the greatest return on your investment.

5. Invest only in those species and on those acres capable of producing an acceptable economic return.

Table 2. Site Index Values for loblolly and Shortleaf fines in the piedmont Plateau as Influenced by Sol (Cole, 1952).

Sub-Soil class	Subsoil Consistence When Moist	Species	Depth to Subsoil (inches)						
			2	4	6	8	10	12	18
1	Very Friable	Loblolly	57	79	82	86	88	89	91
		Shortleaf	51	62	66	68	69	70	71
2	Friable	Loblolly	52	74	77	81	83	84	86
		Shortleaf	47	59	62	64	65	66	67
3	Semi-plastic	Loblolly	46	68	71	75	76	77	79
		Shortleaf	43	54	58	60	61	62	63
4	Plastic	Loblolly	38	60	63	68	69	70	72
		Shortleaf	38	49	53	55	56	57	58
5	Very plastic	Loblolly	32	54	57	61	62	64	66
		Shortleaf	33	44	48	50	51	52	53

Table 3. Site Index (50 years) of Loblolly Pine in the Coastal Plains of Veer, North Carolina, and Northeastern South Carolina as Influenced by Well and Imperfectly Drained Soil.

Subsoil Characteristics		Depth to Subsoil in Inches					
Consistence when moist	Texture	6	12	18	24	30	36
		Site Index					
Very Friable (noncoherent)	Sands	65	70	73	75	77	79
Friable	Loamy sands to light sandy hams	70	75	79	81	83	85
Friable	Sandy hams	73	79	82	85	87	89
Friable	Loams	75	81	85	88	90	92
Semiplastic	Sandy day bums to day hams	77	83	87	90	92	94
Plastic	Sandy Clays	78	85	89	92	94	96

Table 4. Site Index (50 years) of Loblolly Pine in the Coastal Plats of Virginia, North Carolina, and Northeastern South Carolina as Influenced by the Characteristics of Poorly Drained Sol.

Subsoil Characteristics		Depth to Subsoil in Inches						
Consistence	Texture	6	12	18	24	30	36	42
		Site Index						
Friable	Sandy hams to sandy days	75	81	85	88	90	92	93
Semiplastic to plastic	Sandy days	81	88	92	95	97	99	101
Very plastic	Clays	85	92	96	99	102	104	106