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Understanding Forest Soils

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INTRODUCTION

Trees need water, nutrients, and sunlight to grow. Soil is the medium supplying two of these three necessities. Basic understanding of a few soil characteristics can greatly improve the ability to make sound and beneficial forest management decisions, whether one's priorities are to improve timber production, wildlife habitat, water quality, or aesthetics and recreation.

Forest soils knowledge informs forest management decisions including land acquisition, species selection for planting, site preparation requirements, fertilization prescriptions, stand density/composition, and harvest timing. Soils are separated into soil series based on concepts with relatively unique characteristics. Soil series with similar characteristics and productivity/site quality can be combined into soil groups. Important characteristics include (1) drainage class, which describes how quickly water is naturally removed from the soil, (2) depth class, which influences rooting depth, (3) surface soil texture (% sand, silt, and clay) and thickness, and (4) parent material. Each soil group has a potential range of site productivity for growing a pine or hardwood species. Productivity is further influenced by (1) land use history, (2) management inputs, and (3) tree species genetic improvement. Forest landowners can use a soil map to guide forest management decisions on their land holdings.

Not all forest soils are conducive to growing timber in a reasonable time frame. Very poorly drained soils are best left as their native vegetation communities. Excessively drained, deep sandy soils are not well suited to loblolly, shortleaf, or slash pine or hardwood planting. Species such as longleaf or sand pine are better adapted to these soil conditions. Forest management inputs (competition control and/or fertilization) can make some marginal soils very productive. It pays to get to know your forest soils.

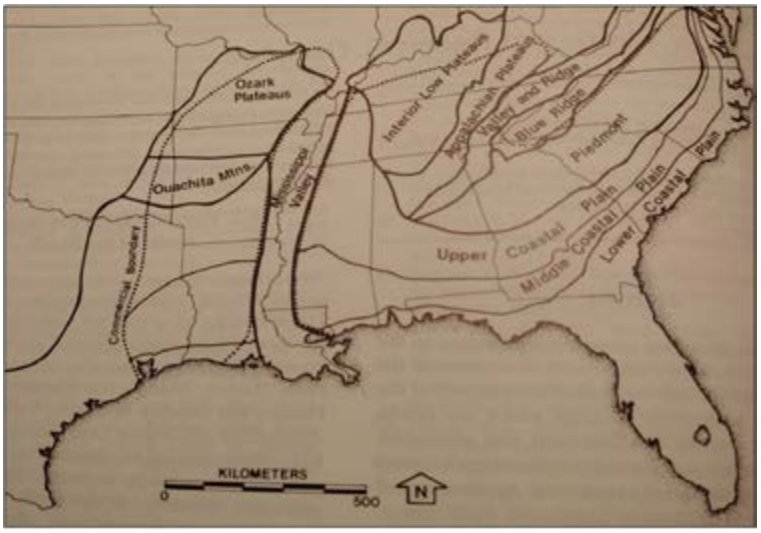

Figure 1: *Physiographic Regions/Provinces of the Southeastern United States.*

Mature trees, whether pines or hardwoods, tend to tell how good or poor the soils are on one's property. Site index, an estimate of site productivity, is the height of the tallest trees for a given pine or hardwood species (codominant and dominant trees; the trees in the uppermost stand canopy position) at a given age. Site index is referenced in terms of a base age, typically either 25 years for planted stands or 50 years for natural stands. Site index is used as an estimation of site productivity because heights are less influenced by stocking (number of trees per acre) and other woody or shrub competition than diameters which are greatly influenced by woody competition.

This paper addresses key components of soils for the Southeastern United States Coastal Plain and Piedmont physiographic regions (Figure 1) and includes the following topics: (1) Coastal Plain soils and soil grouping, (2) Piedmont soil series important characteristics, and (3) where to obtain a soil map. Remember that the soil properties listed in the following sections are important factors influencing water and nutrient availability.

COASTAL PLAIN SOILS

Coastal Plain soils were combined into "soil groups" by the University of Florida Cooperative Research in Forest Fertilization (CRIFF) faculty and staff. The CRIFF classes work well for forest management decisions in the Coastal Plain, especially in Florida and Georgia. Figure 2 shows the CRIFF classes, which are grouped by drainage class and subsoil characteristics including presence/depth to clay accumulation (argillic; Bt), and presence/depth of a spodic horizon (Bh; a subsurface organic horizon) with or without an underlying increase in clay (argillic; Bt).

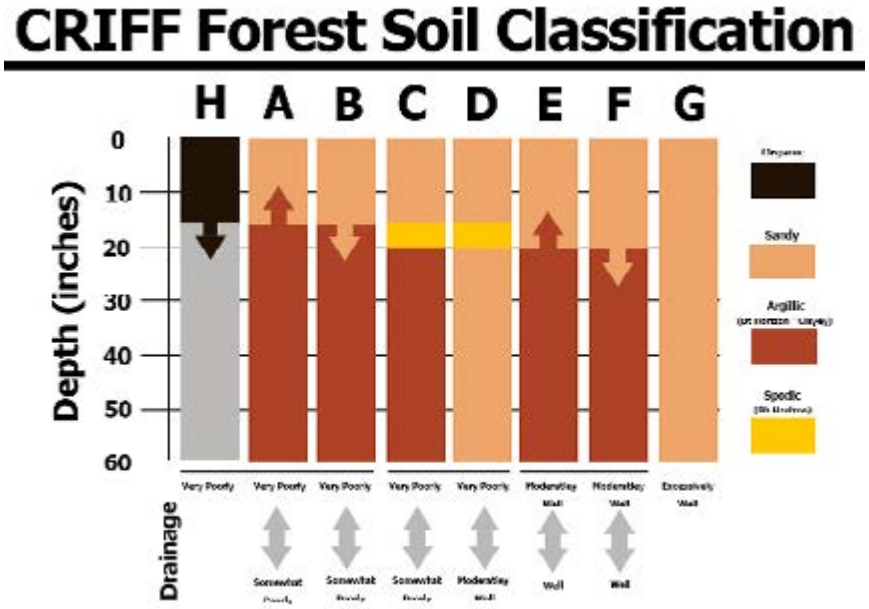

Figure 2: *A soil classification system developed by the University of Florida Cooperative Research in Forest Fertilization (CRIFF) used as an aid in determining forest management decisions in the Coastal Plain.*

CRIFF H soils are very poorly drained soils formed from organic material, not suited for pine plantations.

CRIFF soil groups A and B are very poorly, poorly or somewhat poorly drained (shallow water table most of the year) mineral soils. CRIFF A soils depth to the Bt horizon is within 20 inches and CRIFF B soils depth to a Bt horizon is greater than 20 inches or not present. CRIFF A and B soils have water close to the surface most of the year and typically need mechanical bedding to raise the soil surface for planted seedlings above the water table. Loblolly or slash pine often respond to phosphorus fertilization at planting. Common soil series in CRIFF A are Rains, Bladen and Leaf and in CRIFF B Rutledge, Plummer and Leefield.

CRIFF C and D soils have a spodic horizon (Bh) ranging in color from chocolate brown (most common), to reddish brown, to black. This Bh horizon is a zone of accumulation of iron, aluminum, and organic matter and can become cemented when dry impeding root growth. CRIFF C soils are very poorly to somewhat poorly drained with an underlying Bt horizon. CRIFF D soils are very poorly to moderately well drained soils and do not have an underlying Bt horizon. Common CRIFF C soils are Mascotte and Sapelo. Common CRIFF D soils are Leon and Ridgeland.

CRIFF E and F soils are moderately well or well drained. CRIFF E soils have a Bt horizon within 20 inches while CRIFF F soils have a Bt horizon starting at greater than 20 inches. Common CRIFF E soils are Goldsboro, Norfolk and Orangeburg. Common CRIFF F soils are Fuquay, Wagram, Bonneau, and Blanton. These better drained soils are mostly found on higher ground than CRIFF A through D soils.

CRIFF G soils are sandy, excessively drained soils that are not suitable for planting loblolly, shortleaf or slash pine, but are suited for longleaf or sand pine due to the lack of an accumulation of clay (Bt) horizon to slow down water and nutrient movement through the soil profile. Common CRIFF G soils are Lakeland, Foxworth, and Kershaw.

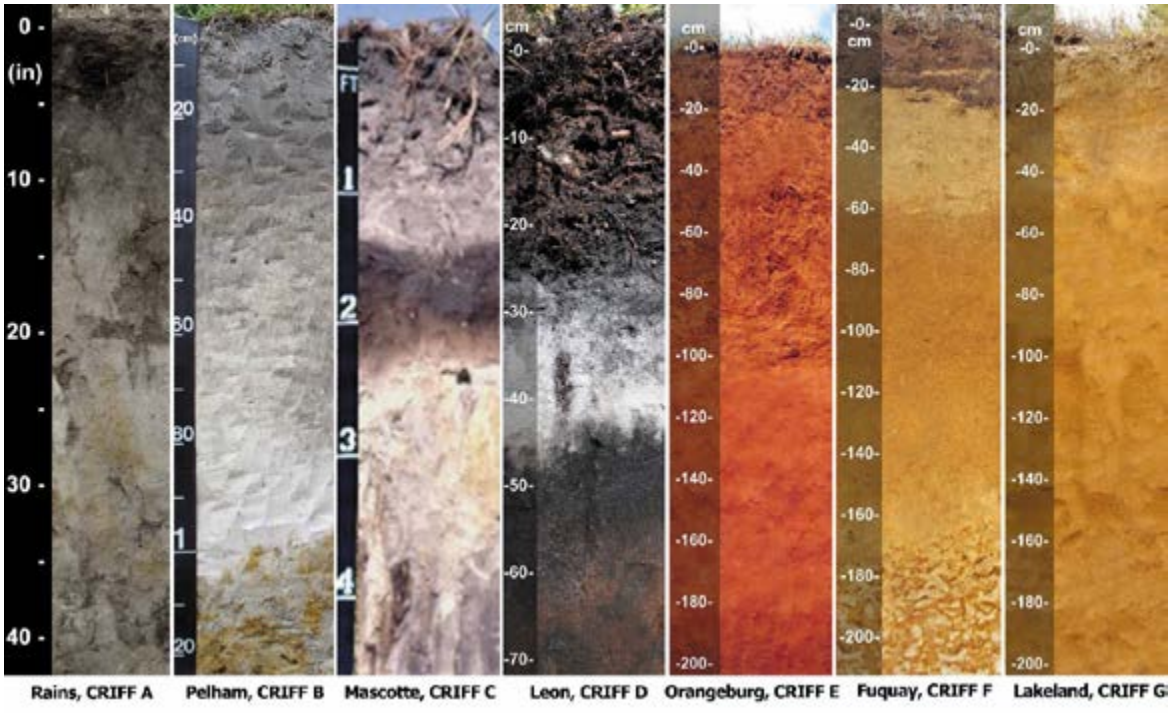

Figure 3: *Soil profiles of Coastal Plain soil series representing CRIFF groups. Rains and Pelham are poorly drained (PD) soil series; Rains has an increase in clay within 20 inches, and Pelham has an increase in clay greater than 20 and 40 inches. The Mascotte and Leon series are very poorly (VPD) or poorly drained, and have a spodic horizon. Mascotte has an increase in clay within the profile, but Leon does not. The Orangeburg series is well drained (WD) and has an increase in clay within 20 inches. The Fuquay series is well drained and has an increase in clay between 20 to 40 inches. The Lakeland series is excessively drained (XD) and sandy throughout. Note that the measurement depth of the profiles is not consistent (inches for Rains, feet for Mascotte, and centimeters for Pelham, Leon, Orangeburg, Fuquay, and Lakeland).*

CRIFF G soils are the poorest soils from a forest productivity standpoint, while CRIFF A soils tend to be the most productive due to the high-water table (available water to trees most of the growing season) and relatively high soil organic matter with proper management (bedding and phosphorus fertilization at planting). Common CRIFF soil series soil profiles are found in Figure 3 and illustrates the drainage classes from high soil-water availability to low soil-water availability from left to right.

Photo 1 shows a mixed pine-hardwood stand on an excessively drained, sandy, very low fertility CRIFF G soil with a site index (base age 25 years) of 40 feet. Photo 2 is an example of a poorly drained, bedded, thinned slash pine stand on CRIFF B soils (Leefield and Pelham) with a site index (base age 25 years) of 80 feet. Photo 3 is an example of a poorly drained, bedded, thinned loblolly pine stand on a CRIFF A soil with a site index (base age 25 years) of 80-85 feet.

PIEDMONT SOILS

Soils of the Piedmont can be first separated based on parent material. Alluvial soils developed from water-transported parent material and generally occur on lower parts of the landscape. Residual soils developed in place from bedrock and occur in more upland parts of the landscape. Important soil characteristics for forest management decisions and potential productivity are: (1) soil surface texture and thickness, (2) depth to a clay accumulation (Figure 4), (3) drainage class (excessively, poorly, and very poorly drained soils tend to be less productive than the moderately well to well-drained soils), and (4) parent material for residual soils. Percent slope (lower percent slopes are easier to manage than

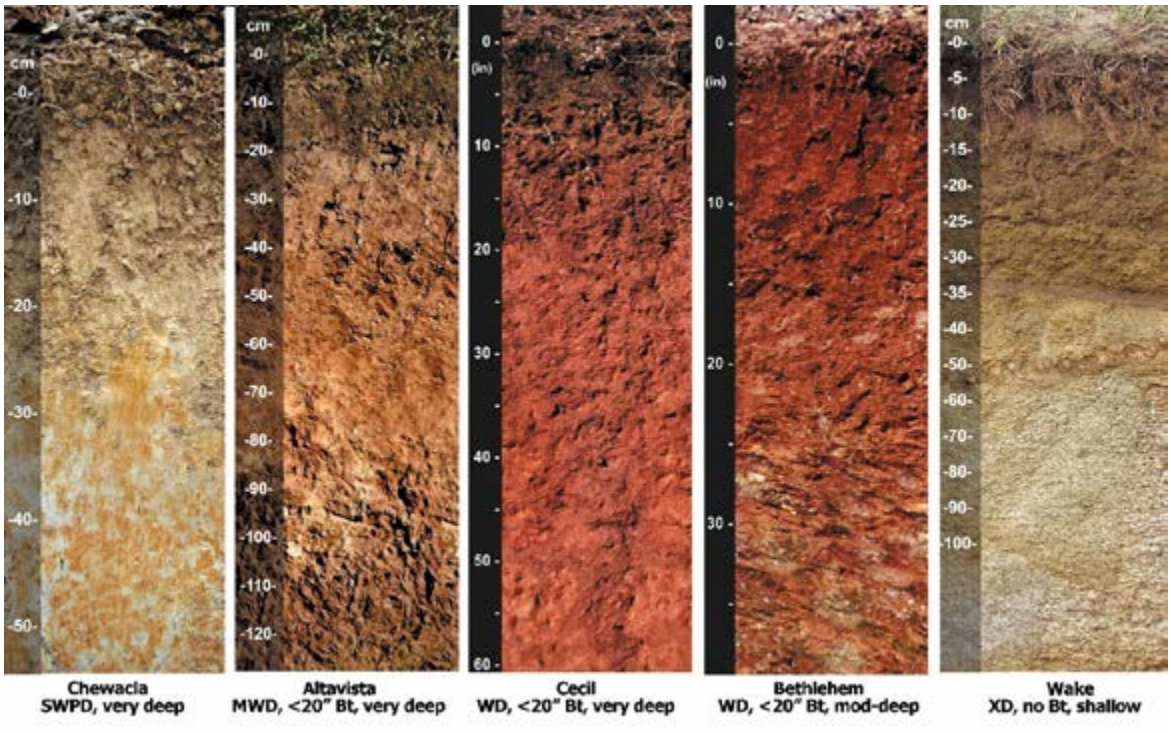

Figure 4: *Soil profiles of Southern Piedmont soil series. Chewacla is somewhat poorly drained (SWPD) and found in floodplain areas. Altavista is moderately well drained (MWD), has an increase in clay within 20", and is found on terraces. Cecil and Bethlehem are well drained (WD) and have an increase in clay within 20". In addition, Bethlehem soils have weathered bedrock between 20 and 40 inches. Wake soils are excessively drained (XD) and shallow to bedrock. Note that the profile measurements are not consistent (Chewacla, Altavista, and Wake in centimeters and Cecil and Bethlehem in inches).*

steeper slopes) and aspect (north to northeast facing stands tend to be more productive than south to southwest facing stands) are also important factors in site productivity and management decisions. Generally, soils with thick, loamy (a mixture of sand, silt and clay with organic matter) textured surface horizons, are very deep to a clay accumulation, and are able to provide adequate water to roots for growth are the most productive. Soils that are eroded, have a restriction within the normal rooting depth, and/or are either too wet or too dry are the least productive.

FINDING SOIL MAPS FOR YOUR PROPERTY

In most cases, a soil map can be found on Web Soil Survey (WSS, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) provided by the Natural Resources Conservation Service (NRCS). It can be found by searching for "web soil survey" in a web browser. The simplest ways to find one's property are either by entering latitude and longitude coordinates to a property gate or entering a street address. Instructions for generating the soil map and associated interpretations are found on the website. Landowners can also contact NRCS for additional information and support.

SUMMARY

Plant species mix and tree species heights at a given age tend to tell the landowner how good, fair, or poor the soils are in a given forest stand. The soil properties mentioned in this paper influence water and nutrient availability, hence the potential of a site for growing timber in a reasonable timeframe. Gaining a better understanding of forest soils will greatly aid a forest landowner and manager's ability to match appropriate tree species to the site properly. Some commercial pine or hardwood species are better suited for some soils than others. Planting the tree species appropriate to the site also allows for improved prescribed site preparation treatments based on seasonal soil conditions. Continued management actions such as competition control and fertilization are affected directly by soil drainage class and depth to a water table. Thinning timing and intensity decisions and general assessment of stand growth and yield during a rotation can be better understood by knowing the important characteristics that influence water and nutrient availability of the soils supporting the trees.

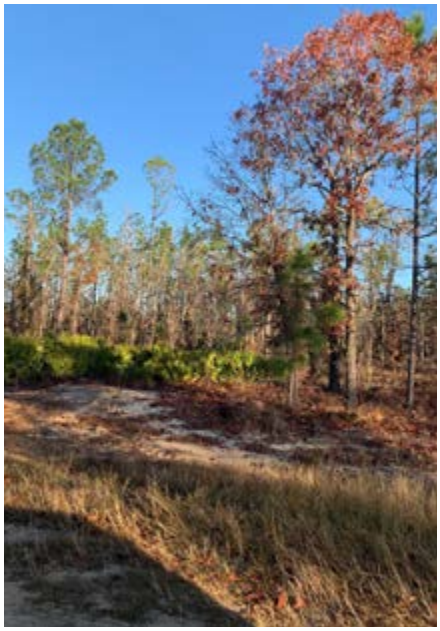

Photo 1: *Coastal Plain CRIFF soil group G, an excessively drained deep sand (Lakeland soil series) with very low native fertility has a site index (base age 25 years) for longleaf pine of 40 feet in Liberty County, Georgia.*

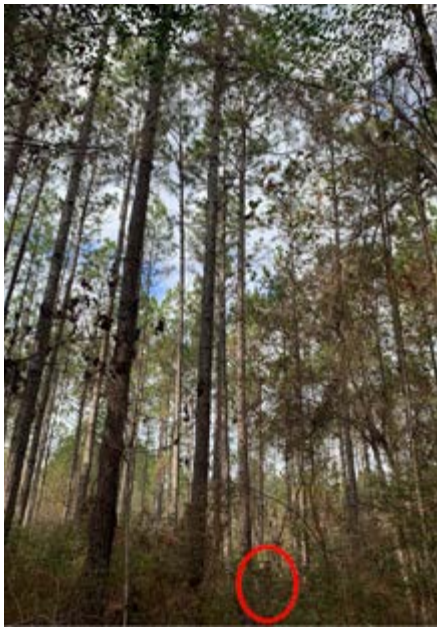

Photo 2: *A 27-year-old planted, thinned slash pine stand on CRIFF B soils (Leefield and Pelham; poorly drained, Bt>20 inches) with an estimated site index of 80 feet for slash pine (base age 25 years) in Bulloch County, Georgia. A 5 ft 9" UGA County Agent is circled for scale.*

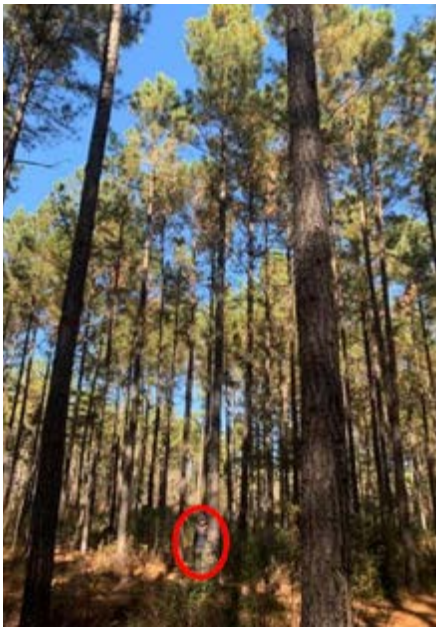

Photo 3: *A 25-year-old loblolly pine stand on a CRIFF A (poorly drained, bedded with Bt<20 inches) soil series (Rains) with a site index (base age 25 years) = 80-85 feet in Screven County, Georgia. The circled UGA County Agent is 6 feet tall for scale.*