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Uses and Limitations of Soil Surveys for Forestry [1]

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Introduction

As forest management practices intensify, the need for quality soil maps of forest land increases. Several forest industries in the southeastern U.S. have found soil survey information helpful in both planning and implementing land management prescriptions (Table 1).

Soil survey traditionally has been oriented toward agricultural and, recently, urban needs. The need for quality soil resource maps of large holdings of forested land has also become evident.

Foresters sometimes express concern or even distrust regarding the utility of soil surveys. There are two major reasons for this problem. Foresters do not always interpret soil map delineations as well as they might, and the soils often have not been mapped with sufficient concern for forestry interpretations.

In discussing these two problems we will use the policies and procedures of the National Cooperative Soil Survey (NCSS). The standards and procedures of NCSS are best reflected in standard county surveys published by the USDA Natural Resources Conservation Service, but generally our discussion is applicable to any type of soil resource map.

Concepts of Soil Series and Phases of Soil Series

The soil series is the most refined unit in the system of soil classification known as Soil Taxonomy (Table 2). One soil series differs from another in kind, thickness, and arrangement of soil horizons, color, texture, structure, carbonate content, humus content, mineralogy, and other characteristics (Soil Survey Staff, 1975). Particular emphasis is placed on characteristics that affect the use and management of soils. The series is not, however, the unit most often mapped. The map unit is commonly a phase of a soil series. A soil series is divided into phases based on any mappable property that will affect management or productivity (Table 3). One should not expect, as many land managers often do, that series will have a narrow range of productivity, because a series is not always defined as such. Only the phase of a soil series should be expected to have a narrow productivity or management interpretation.

Practical Aspects of Mapping Soils

An understanding of soil mapping procedures is required to ensure proper interpretation of soil maps. In the NCSS system a soil is usually not recognized as a series unless there are at least 2000 known acres

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of that soil (Soil Survey Staff, 1996). If a soil's extent is less than 2000 acres, one of two things can happen. If the soil has properties outside the range of existing recognized series, it may be mapped under the name of a known series and referred to by the mappers as a **taxadjunct** of that series. A taxadjunct differs from the series after which it is named in so few properties and to such a small degree that its interpretations for use and management are almost identical to those of the named series.

If, on the other hand, a soil is different in properties and behavior from any existing series and is again less than 2000 acres in extent, it is mapped as a variant of an associated, existing soil series. The soil description in a soil survey report explains how the variant differs from the soil after which it is named.

The scale at which a survey is mapped is not always the same scale at which it is published. It is common for a soil mapper to map at 1:15,840(4" = 1 mi.), but many surveys are published at 1:20,000 (3.16" = 1 mi.) or at 1:31,680 (2" = 1 mi.). Some field detail is lost in the transfer to a smaller scale. Surveyors have minimum-sized delineations that they can map. This minimum-sized delineation can range in area depending on the type of soil survey. At a 1:15,840 map scale, areas no smaller than 2 to 2.5 acres can be delineated. A 2.5 acre area depicted on a 1:15,840 map would be approximately 0.25 inches on a side.

This is the smallest area that can be delineated and labeled while remaining readily discernible. The same size square would represent approximately 4 acres on a 1:20,000 map. These constraints are similar to those that foresters encounter when mapping forest or vegetation types. Soil surveyors may see a soil difference in the field but not map it because of its small size. They may delineate a small unit and have it eliminated if the scale of the map is reduced for publication. Certain small areas of strongly contrasting soils, such as swamps, disturbed lands or stoney areas, can be identified and located on a map by using special spot symbols. Each spot symbol represents an area of a certain size. On a 1:20,000 soil map each wetspot symbol might represent approximately a 1-acre area of wet soils.

It is often physically and cartographically more difficult to map soils in forested areas. Agricultural lands provide the mapper with a relatively unobstructed view of the landscape. Small differences in topography are easier to see than in a forest stand. Similarly, locating soil boundary lines on the aerial photograph is often easier on agricultural land where there are more landmarks to help the mappers locate themselves. A soil map can be no more accurate or precise than the mapper's ability to locate the soil boundary lines accurately on the soil map.

Composition of a Field Map Unit

The previous section dealt with certain limitations a soil mapper faces when drawing a soil boundary around an area and assigning the delineation a map unit name. The fact that an area is given a map unit designation and delineated on a map does not mean that everything within those boundaries is the named map unit. A distinction should be made between the concept of a map unit and the field reality of a map unit. A soil map unit that bears the name of a phase of a soil series consists dominantly of that phase, but also includes other components. Soils exist on a landscape not in pure units, but in mixtures dominated by one or more components.

The dominant soil in a soil map unit, together with included areas (inclusions) of similar soils, should comprise 75% or more of the area of that map unit. About three-quarters of a map unit should have similar interpretations for management and productivity. Up to one-quarter of the area of the map unit is allowed to consist of inclusions of soils that are quite different. These guidelines are goals toward which a mapper strives. Any individual map unit may or may not meet these limitations depending on the complexity of the landscape and the mapper's ability to note soil differences. In a check of map unit purity for three soil series in Walton County, Georgia, for example, Powell and Springer (1965) found that soil series had been mapped correctly at about 74% of 518 sites, and soil phase was mapped correctly at about 59% of the sites. Inclusions comprised from 17 to over 40% of the areas of the map units checked. Powell and Springer judged the mapping to be highly reliable, however, from the standpoint of grouping soils that could be interpreted similarly. The proportion of included soils that would require interpretations different from those of the dominant soil in each map unit was generally less than 15%.

Interpretations of Soil Mapping Units

The final product of a soil survey is often regarded as the base map with map units delineated on it. This, in fact, is not the end product. For a map to be meaningful to forest management, interpretive maps for management activities should be considered the final product. A forester looking at a soil map often cannot find individual soil map units that are large enough to manage as an entity. Fortunately for the forester, soils are classified, distinguished from each other, and mapped using criteria that are not always related to forest productivity or other management considerations. Therefore many contiguous map units often have the same interpretation.

Such units can be combined on an interpretive map into larger, manageable units. For example, soils as mapped in a standard NCSS soil survey report can be lumped for forest management purposes into CRIFF (Cooperative Research in Forest Fertilization) soil groups (Munson, 1984; Kushla and Fisher, 1980) (Figure 1, Table 4, and Table 5). Soils of the A and B groups would be candidates for young plantation fertilization while the D group soils would be better candidates for established stand fertilization (Fisher, 1981). Interpretative maps such as these are potent tools in forest management and can be constructed for other forest practices. But keep in mind that these interpretive maps have the same limitations built into them that soil map units have. A certain percentage of the area will not react as anticipated because of inclusions and other variability inherent in the mapping and in interpretive guidelines. For example, not every CRIFF B soil will produce a response to fertilization. A very large percentage will, however, and the probability of response is very high.

A strong argument can be made for mapping at the more detailed scale of the map units and not at the scale of the interpretations. By mapping soils as finely as possible one maps a rather stable resource.

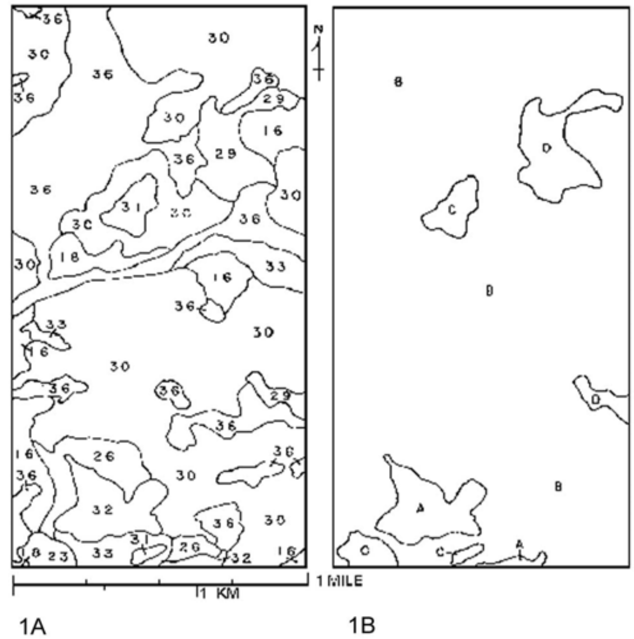

Figure 1.

Interpretations and practices usually change more rapidly than soil properties. By having detailed soil maps a land manager will have the basic resource information needed to change interpetive maps as forest management practices evolve.

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Table 1. Some uses of soil surveys in forestry.

Designating areas of easy or difficult road construction
Estimating potential productivity of forest land
Proper species selection for a given site
Locating areas with potential for fertilization
Locating areas sensitive to logging hazards
Locating areas suitable for specific site preparation practices
Locating sources of fill or surfacing material

Table 2. The heirarchy of Soil Taxonomy from highest (Order) to lowest, most refined (Series) level.

Category E	**Examples**	
Order	Spodosol	Ultisol
Suborder	Aquod	Udult
Great Group	Alaquod	Kandiudult
Subgroup	Aeric Alaquod	Typic Kandiudult
Family	Sandy, siliceous, thermic Aeric Alaquod	Fine-loamy, siliceous, thermic Typic Kandiudult
Series	Leon	Norfolk

Table 3. Examples of phases of soil series.

Series	**Phases**
Lakeland	Lakeland sand
	Lakeland loamy fine sand
	Lakeland sand, 0 to 5% slopes
	Lakeland sand, 5% to 8% slopes
Leon	Leon sand
	Leon fine sand

Table 4. Map legend for Figure 1A.

Symbol	Map Unit
16	Leon fine sand
1	Lynn Haven fine sand
23	Olustee fine sand
26	Pelham fine sand
29	Pottsburg fine sand
30	Ridgeland fine sand
31	Sapelo fine sand
32	Stockade fine sandy loam
33	Surrency fine sand
36	Wesconnett fine sand

Table 5. Map legend for Figure 1B.

Symbol	CRIFF Soil category for Forest Management Purposes (Kushla and Fisher, 1980)
A	Very poorly to somewhat poorly drained soils with sandy loam or finer textured horizons within 20 inches of the soil surface.
B	Very poorly to somewhat poorly drained non-Spodosols with sandy loam or finer textured horizons deeper than 20 inches below the soil surface (some without argillic horizons).
C	Very poorly to somewhat poorly drained Spodosols with sandy loam or finer textured horizons below the spodic horizon.
D	Very poorly to moderately well drained Spodosols without sandy loam or finer textured horizons in the profile