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Grouping Sites by Soil Management Areas and Topography

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An area can be managed more efficiently when there is adequate information on the growth potentials of the products involved. Because productivity varies with site, sampling efficiency to determine productivity can be increased by stratification -- dividing an area into groups of similar sites (Cochran 1963).

Land strata related to herbage production on areas cleared of timber, and to site index on areas supporting timber, are described. These strata were designed for use on the volcanic soils in the ponderosa pine type on the Beaver Creek watersheds in north-central Arizona. Land strata based on criteria similar to those described here could easily be developed for application on other areas.

Background

Total soil depth has been commonly used as an indicator of site quality (Klemmedson and Murray 1963), but determination of total soil depth is time consuming. Total soil depth did not provide appreciable additional information when Trimble (1964) measured slope position and slope percent to estimate oak site index. Furthermore, slope position and slope percent can be measured easier than total soil depth. Slope position has been shown to relate to herbage production on areas cleared of timber on Beaver Creek (Clary 1964) and to site index of ponderosa pine in the Black Hills (Myers and Van Deusen 1960). Concavity of the slope has been found to be important in estimating Douglas-fir site index (Tarrant 1950). The growth of ponderosa pine has been shown to be related to depth to clay or silty clay (Leven and Dregne 1963).

Soil survey information can be useful in predicting site productivity, particularly where topography is not too rough (Doolittle 1963). Stratification of paper birch productivity with the aid of soil and topographic maps reduces variation within management units and is an aid to silvicultural prescriptions (Cooley 1962).

Development of the Strata

The soils on the Beaver Creek watersheds have been described and grouped

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into soil management areas. [3] These areas consist of two or more soil types arranged in a pattern related to the shape of the land surface and the nature of the soil materials. The two major soil management areas in the ponderosa pine type on Beaver Creek area are (1) Siesta-Sponseller and (2) Stoneman. [3]

The Siesta-Sponseller soil management area is characterized by soils 20 to 60 inches deep derived from basalt and volcanic cinders. These soils occur on rolling uplands and cinder cones, and have exposed basalt outcrops and cobbles or stone on the surface. Slopes range from 2 to 40 percent. The soils often become clayey in the subsoil, though they are loamy on the surface. General productivity of this soil management area is considered "high." [3]

The Stoneman [4] soil management area is characterized by soils 12 to 36 inches deep derived principally from basalt. The soils are clayey, usually with stony surfaces. Slopes are predominantly moderate. Productivity of this soil management area is rated as "medium." [3]

The value of these two soil management areas as a basis for stratification was studied on 23 herbage production sample areas and on 42 ponderosa pine site index plots.

Herbage sample areas were limited to areas that had previously been clear cut of timber or burned over by wildfire. These areas were permanently fenced, deferred from grazing the year of sample, or inaccessible to livestock. Total herbage production was estimated on five systematically located 9.6-square-foot plots on each sample area.

Total height and age at breast height were measured on four to six dominant or codominant trees on the site index plots. Site index was determined from Meyer's (1938) curves. Age at breast height was used to be consistent with local Forest Service practices.

Herbage production and site index were determined on the two soil management areas (table 1). The Siesta-Sponseller management area produced 733 pounds more herbage per acre than the Stoneman management area, and the Siesta-Sponseller site index was 9 feet more than the site index on the Stoneman management area. It is apparent that soil management areas provide a basis for stratification for herbage and timber productivity on Beaver Creek.

Topographic position also influenced productivities (table 1). The swales produced

[3] Anderson, T.C., Jr., Williams, J.A., and Crezee, D.B. Soil management report for Beaver Creek watersheds of Coconino National Forest, Region 3. U.S. Forest Serv., 1960, 66 pp. (Mimeographed report on file at Region 3 Office, U.S. Forest Serv., Albuquerque, N. Mex.)

[4] The Stoneman soils and Stoneman soil management area is correlated as Brolliar in a USDA publication, "Soil Survey, Beaver Creek, Arizona," now in press.

Figure 1.--Soil types and topographic positions of two soil management areas studied, Beaver Creek watershed, Arizona.
A. Siesta-Sponseller; swale
B. Siesta-Sponseller; upland
C. Stoneman; swale
D. Stoneman; upland.

521 pounds more herbage per acre or site indexes 11 feet higher than upland situations did. Therefore, the soil management areas were subdivided by topographic positions when uniform strata were delineated.

Some of the soils within a soil management area tend to be associated with particular topographic positions, but this is not a sufficiently reliable criterion for mapping of swales and upland situations. Aerial photographs or topographic maps can be used, but for intensive sampling these initial mappings should be checked in the field. The criteria used for field checks are listed below and illustrated in fig 1.

Soil Management Areas

1. Siesta-Sponseller
   a. Depth to clay or silty clay: 7 to 12 inches or more.
   b. Surface rockiness: relatively rockfree to cobbly or stony surface. Cinders, volcanic bombs, and basalt cobbles and stones may be apparent on the surface.
   c. Surface color: reddish gray, reddish brown, brown, or grayish brown.
2. Stoneman
   a. Depth to clay or silty clay: 0 to 6 inches.
   b. Surface rockiness: usually a cobbly or stony surface.
   c. Surface color: brown or grayish brown.

Topographic position

1. Swale
   Concave swales and lower slope positions of up to 10-percent slope not dominated by stones and rock outcrops.
2. Upland
   Rolling areas, including steep slopes and stone-littered areas.

Benefits of Stratification

The standard error of herbage production for the sample was reduced by 43 percent compared with simple random sampling. The actual amount of reduction depends upon the weights of each strata on a given area (Cochran 1963). In most situations on Beaver Creek, one or two strata will dominate, and the actual reduction in standard error will be less than that obtained in this sample.

A sample of herbage production on 54 areas supporting timber indicated no differences between the strata under existing timber stocking conditions (fig 2).

The reduction in the standard error of timber site index by subdividing the timber sample into the four strata was 30 percent. It should be reemphasized, however, that the actual reduction in standard error for an area depends on the distribution or weighting of the strata. The reduction usually obtained may be less than that found in this sample.

Summary

Land strata, useful for reducing the sampling variance for both herbage production on areas cleared of timber and site index on areas supporting timber, were designed for use on the Beaver Creek watersheds. Areas are divided into four strata based on soil management areas and topography. The different strata can be delineated by use of soil maps, aerial photographs or topographic maps, and limited ground checks. Guides are presented for identification of the strata in the field.

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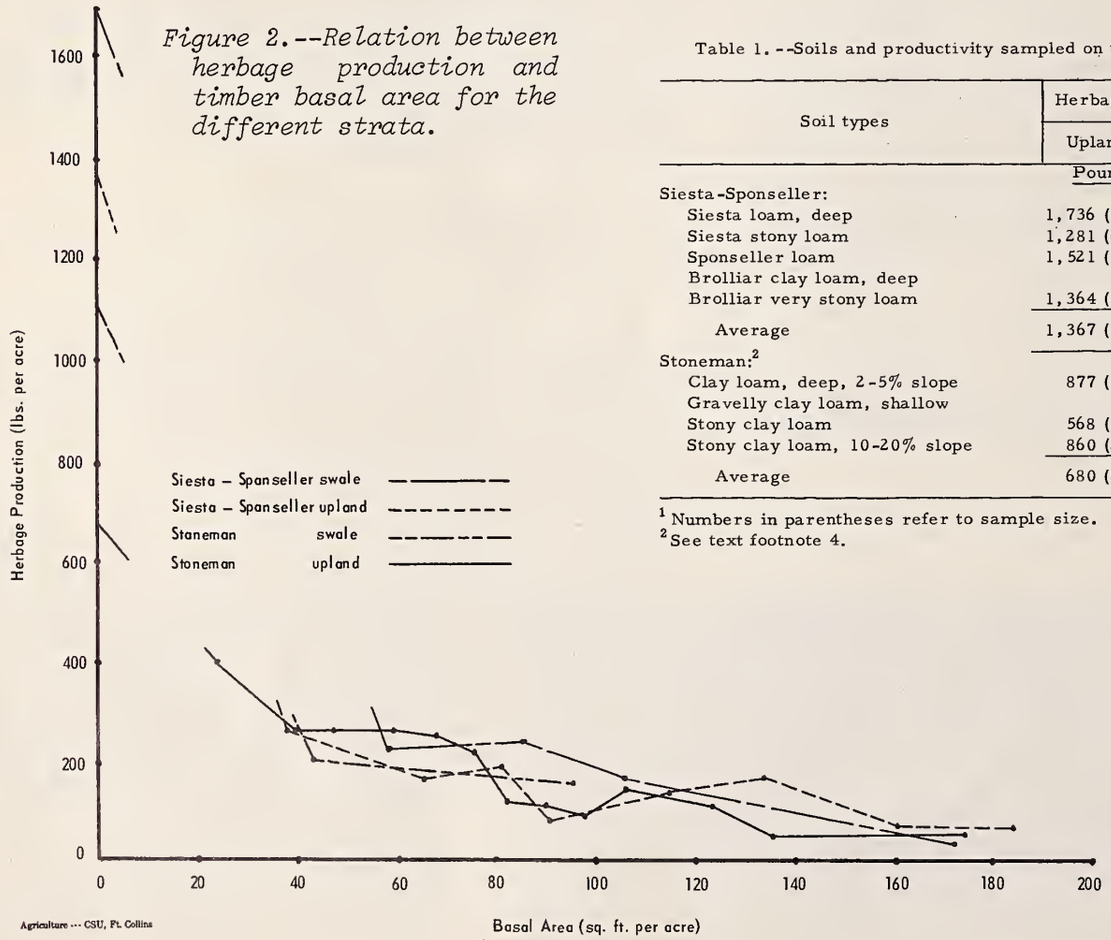

Figure 2.--Relation between herbage production and timber basal area for the different strata.

Table 1.--Soils and productivity sampled on the two soil management areas

Soil types	Herbage production[1]		Site index[1]	
	Upland	Swale	Upland	Swale
	Pounds per acre			
Siesta-Sponseller:				
Siesta loam, deep	1,736 (1)	1,818 (2)	62 (3)	70 (2)
Siesta stony loam	1,281 (6)		63 (2)	66 (2)
Sponseller loam	1,521 (1)		62 (3)	
Brolliar clay loam, deep		1,699 (1)		68 (2)
Brolliar very stony loam	1,364 (2)	1,463 (1)	58 (6)	
Average	1,367 (10)	1,700 (4)	60 (14)	68 (6)
Stoneman:[2]				
Clay loam, deep, 2-5% slope	877 (1)			69 (1)
Gravelly clay loam, shallow			46 (2)	
Stony clay loam	568 (5)	1,117 (1)	52 (16)	61 (3)
Stony clay loam, 10-20% slope	860 (2)			
Average	680 (8)	1,117 (1)	51 (18)	63 (4)

[1] Numbers in parentheses refer to sample size.
[2] See text footnote 4.