DIVISION V-A—FOREST AND RANGE SOILS

The Soil-Vegetation Survey in California[1]

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ABSTRACT

This paper deals briefly with procedures and kinds of information currently being obtained in the soil-vegetation survey of wild land in California and some of the problems encountered. The principal objective of the survey is to obtain accurate basic information on the kind and distribution of soils and natural vegetation, their relationships, and their characteristics and uses as an aid in better management of wild lands. The classification and mapping of both soils and vegetation follows a closely integrated procedure in which the skillful stereoscopic interpretation of aerial photographs plays an important part.

SINCE 1947 the California Forest and Range Experiment Station has been engaged in a survey to obtain basic information on the kind and distribution of soils and natural vegetation as an aid to management of wild land. This is a basic survey in that it is not designed for some single specific purpose. Rather, it is designed to obtain information on the characteristics of soils and vegetation, and their relationships, in such a way that the information can be interpreted for a number of land-management purposes. This paper describes briefly the procedures used and the kinds of information obtained in the survey, and relates some of the survey problems encountered.

At present the survey consists essentially of two cooperative projects, with the California Forest and Range Experiment Station responsible for coordinating direction of both. One of these, the larger so-called State Project, deals with the survey of wild land that is mostly privately owned. Work on this project is done in cooperation with the California Division of Forestry, sponsoring agency, and the Departments of Agronomy and of Soils and Plant Nutrition of the University of California. Started in 1947, this State Project was broadened to its present cooperative status in 1953.

The other project deals with soil-vegetation surveys within the national forests of California. This work is in cooperation with the California Region of the U. S. Forest Service, the Department of Soils and Plant Nutrition of the University, and in some areas the Soil Conservation Service. The work of both projects is closely "tied in" with the soil survey program of the University of California.

Soil-Vegetation Survey Procedures and Kinds of Information Obtained

Several articles have discussed the procedures and the type of information needed for surveys of wild land soils and vegetation (1, 3, 6, 7). In general these articles point out the greater effectiveness of combined surveys of soils and vegetation. In the California work, soils and vegetation are classified and mapped in closely integrated procedures that place much reliance on aerial photo interpretation, both in the office and in the field.[3] The surveyors in the field actually work on both parts of the survey at the same time, although the first steps in the survey are concerned mainly with vegetation.

VEGETATION CLASSIFICATION AND MAPPING

Vegetation is classified and mapped at two levels: First, according to major kinds of vegetation, called vegetation cover classes, which can be delineated by stereoscopic interpretation of aerial photographs; second, according to the dominant plant species, called species types, which are delineated by a combination of photo interpretation and ground observation.

The vegetation cover classes follow in the main those described by Jensen (2). Briefly they are:

1. *Broad types of vegetation*: Such as commercial conifer species as a group, noncommercial conifer species as a group, hardwoods, shrubs, bushy herbs, grass, and marsh. These broad types are recognized in mapping either singly or in various combinations in order of abundance.

2. *Total woody vegetation density*: Density classes are based on the percent of ground space covered by the woody vegetation canopy.

3. *Characteristics of commercial conifer stands*: Stands of commercial conifer species are classed according to the age composition of the stand, to the crown density of the stand, and to the crown density of sawlog size trees.

Other information is also obtained through photo interpretation, such as the amount of bare ground or rock, and areas cultivated to crops, intensively pastured, or used for urban-industrial purposes.

Photo interpretation in the office is an important first step in the soil-vegetation survey, even aside from the vegetation information thus obtained. A particularly important point is that natural vegetation-cover boundaries provide a first approximation of the location of possible soil boundaries. Ordinarily in wild lands, the more contrasting the differences in natural vegetation across a boundary, the more probable it is that the vegetation boundary indicates the location of an important soil boundary. This is not to say that a first approximation of the location of all possible soil boundaries is obtained from the vegetation-cover mapping. They are not. Nevertheless, the vegetation-cover boundaries have been found to indicate reliably the location of soil boundaries in so many places that the vegetation-mapping part of the work provides a tremendous aid to the soil-mapping part.

Species-type mapping is done in the field on photo overlays. Each dominant woody plant species within a broad class of woody vegetation is listed in order of

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[3]Detailed procedures are given in a mimeographed "Field Manual, Soil-Vegetation Survey in California," U. S. Forest Service, California Forest and Range Exp. Sta., Oct., 1954.

abundance for each area delineated. Information on species types has important use value. For example, the dominant commercial conifer species present are recorded, which is of importance in connection with timber management and harvest; dominant shrub species are recorded, which, with knowledge of their postfire sprouting or nonsprouting nature, provides information of importance in clearing shrub-covered land for range improvement.

Recently, a procedure for sampling herbaceous vegetation in range areas, has been added to the State Project.[4] This information, along with other information of the survey, is used in characterizing the more important soils of range areas as to their suitability for forage production and range use under extensive management.

SOIL CLASSIFICATION AND MAPPING

The soil classification work of the soil-vegetation survey follows the principles of the natural system of soil classification in the United States. The Soil Survey Manual (4) is the main guide for terminology. The soil series is the principal natural unit of classification used. Standard soil series descriptions and a key to soil series of California (5), coupled with experience and knowledge of the soils of the State and adjacent areas, provide the basis for classification decisions at the soil series level.

At times, the authors have been questioned as to the need of going through the work of classifying soils of wild lands at the series level when simpler classes could serve certain purposes. The answer has been that the natural combination of all soil characteristics serving to differentiate one soil series from another are likely to be involved to some degree in the wide range of interpretive uses of survey information.

The soil series is the soil classification unit usually related most specifically to broad types of vegetation cover, but it is still too broad for some desired use interpretations. Consequently, the soil mapping units used are phases of soil series. These subdivisions or phases of soil series are based most commonly on classes of the following:

1. Soil depth.
2. Slope.
3. Coarse fragments in soils.
4. Rockiness (surface rock).
5. Severe erosion.
6. Character of parent rock, where differences are of hydrologic or other significance.

Other phase separations of soil series may be made where such are of significance in land use and management. One might well ask why phases of soil types are not used rather than phases of soil series. There are two reasons: (*1*) the range in surface texture within soil series so far encountered in upland areas in the State is fairly narrow, usually no more than equivalent to the range of a main textural class, and (*2*) the intensity of survey is more in keeping with soil series differentiation than with soil type differentiation.

Each area delineated on photo overlays in the field, whether differences are due to vegetation, soils, or both, is completely symbolized as to species-type of vegetation, soil phase, and site-index class where applicable. Where soils must be separated within areas of uniform vegetation, landscape features other than vegetation, such as topography or microrelief, are used as guides in placing boundary lines on the map. In places, complexes of both soils and vegetation must be mapped, and in some places groupings of similar soils are mapped where the expense of separation is unwarranted. Mapping is to a minimum of 10 acres for contrasting kinds of soils and vegetation and to a minimum of 40 acres for noncontrasting kinds. Soil samples are collected from soil series for which laboratory and greenhouse fertility studies are desired. These studies on soil samples are made by the University of California and are an important part of the project work.

The practice of mapping vegetation and soils concurrently in the field is important. It provides the chief means of determining the relevance of a particular combination of soil characteristics to natural plant growth. The value of this information is probably best brought out in the determination of site-index class for timber production. Age and height measurements of trees, and the site index determined from these measurements, are referred to the particular kind of soil in which the trees are growing. Such established relationships make it possible to assign a site-index class to any area of a particular kind of soil even though the natural forest growth has been removed. Two sets of site-index classes are used, one for Douglas-fir and one for mixed pine and fir stands (7). A site-index class symbol is placed in each area delineated during field mapping for those soils at all suitable for timber production.

MAPS AND REPORTS

Three kinds of maps are issued (*1*) "Timber Stand-Vegetation Cover" maps, which are uncolored 7½-minute planimetric quadrangles of 2 inches to a mile scale and which show vegetation-cover classes and other information; (*2*) "Soil-Vegetation" maps, which are similar but show species types of vegetation, soil series and phases, and timber site-index classes; and (3) generalized, colored county maps of ½ inch to a mile scale, which show upland soils grouped by color according to normally associated broad kinds of vegetation. Legend sheets accompany the first two kinds of maps and include tables giving preliminary information on vegetation and soils and estimated suitabilities of the soils for timber and range forage production.[5] Examples of methods of symbolization on maps have been given in a previous publication (7).

Reports, both descriptive and statistical, are under preparation for the generalized county maps. Statistical information on extent of soils and vegetation and various combinations of these for a county is obtained by line-transect sampling procedure and IBM punch card sorting.

Some Problems Encountered

In an operation as technically complex as the soil-vegetation survey, some problems are expectable. A few are listed here as a possible help to those undertaking similar work elsewhere.

1. *Training and experience of technical personnel.*—The objective as to personnel has been to maintain a balance in numbers between soil scientists and research foresters or range specialists. Even with the technical and scien-

[4]Detailed procedures are given in a mimeographed "Field Manual, Grassland Sampling," supplement No. 1 to the manual listed in footnote 3, prepared under direction at the Dept. of Agronomy, University of California, Davis.

[5]Some modification in title of these two kinds of maps have been made since earlier issues.

tific training such men already have received, additional training in the concept of soil-vegetation surveys and procedures is essential to do the job satisfactorily. Ordinarily, about a year of experience on the survey is required before a man is fully competent. Consequently, any rapid turnover of men can seriously affect the rate of survey work.

2. *Base maps.*—Adequate base maps for planimetric control of aerial photographs in cartographic work is an essential consideration before survey work is started in an area. In some of the mountainous parts of the state base maps are old, of small scale, and inaccurate in places. In such parts, additional work is required to provide base maps either from aerial photographs, special surveys, or both.

3. *Recency of aerial photography.*—When only old photos are available, vegetation is particularly difficult to map where extensive logging or other changes of vegetation have occurred recently. Consequently, it has been found necessary to re-photograph some areas for the survey. On the other hand, the combination of old photographs for reference and new photographs for mapping is valuable in the soil part of the work.

4. *Field transportation.*—Four-wheel-drive station wagons have been found to be the most satisfactory for field transportation during mapping in rough country, although maintenance costs run fairly high. Other types of cars curtail field work somewhat, since areas passable for a station wagon but not for other vehicles must then be travelled on foot. Even with station wagons, considerable mapping must be done on foot.

5. *Soil classification.*—Where much of the area is essentially unexplored as to soils, new soil series may be expected, in some places in considerable number. These must be studied and dealt with in soil correlation work. Also, some small but mappable areas of soils are occasionally encountered that are quite distinct from known established soil series. They differ in too many characteristics to be handled as variants, and are of such local extent that setting up a new series, at least at the present time, seems unwarranted. Such soils so far have been called "distinctly different soils of very limited extent," certainly an unwieldy handle. They have a special map symbol, remain unnamed, but are described.

6. *Vegetation classification.*—Problems in identification of woody plant species, particularly shrubs, arise from time to time in the species-type mapping. In some cases two species may be extremely difficult to differentiate in the field; in other cases the validity of species separation is questionable. Usually, such difficulties are overcome by grouping the plants in mapping. An opposite problem is encountered in some shrub species where both burl-formers and nonburl-formers are presently classed in one species. Differentiation of such shrubs is important in relation to postfire sprouting or nonsprouting habits and to problems of land clearing. Hybrids or unusual forms of plants also cause occasional difficulties. The project maintains consulting relationships with the Herbarium of the University of California, where plant specimens are submitted for identification and record. Through the years a number of plant species have been established and a more definite range in characteristics and extent determined for others.

Conclusion

The general procedures as outlined here have had a thorough trial and found to be workable, although no doubt some modifications will be made from time to time as more experience and knowledge is gained. The soil-vegetation survey is not an end in itself. It will fail its objective and purpose unless the information obtained is useful and is used. Experiences in putting the information to use have played and will continue to play a major role in the operations of the survey.

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