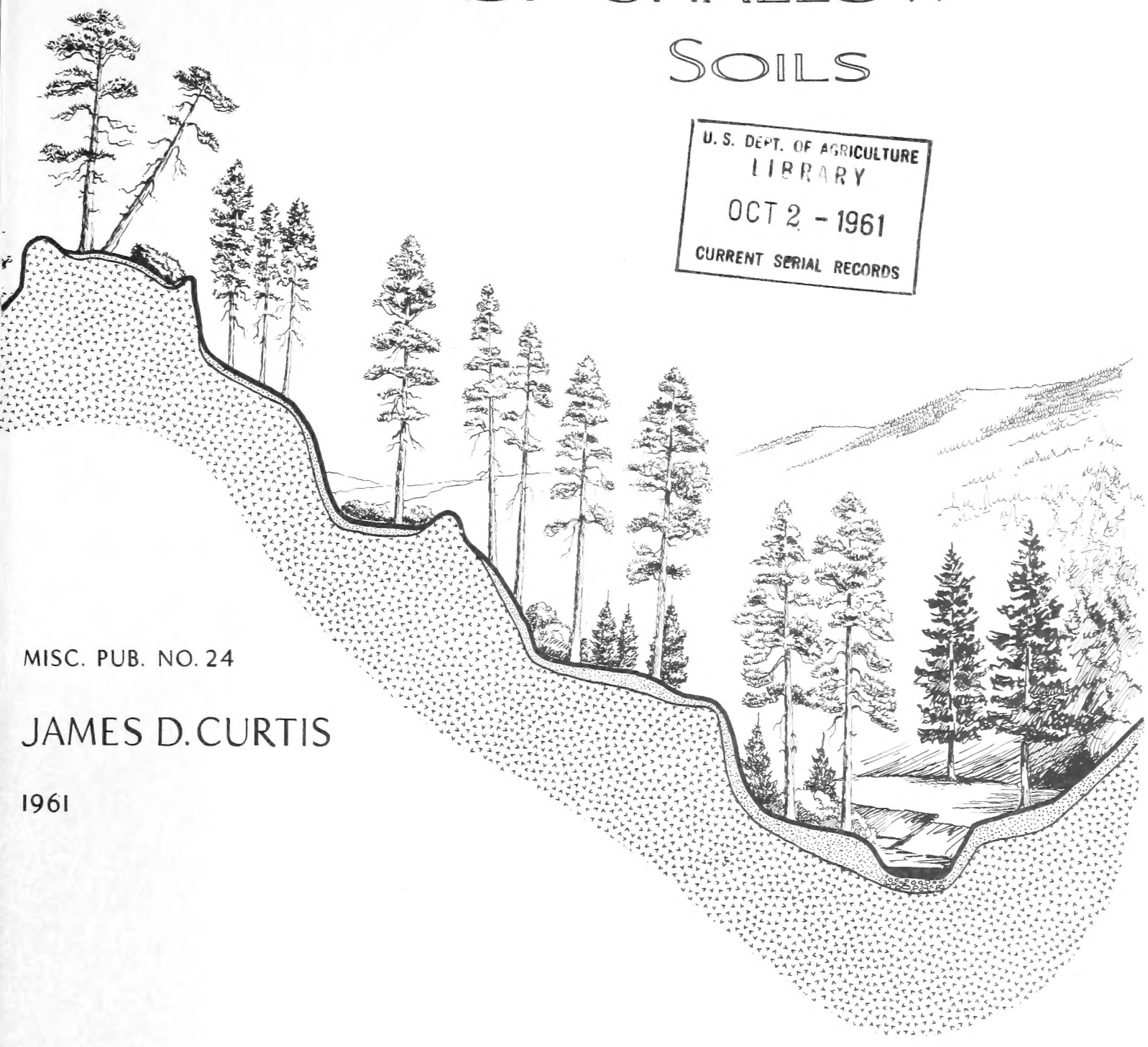
SILVICULTURAL LIMITATIONS OF SHALLOW SOILS



MISC. PUB. NO. 24

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1961

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE
OGDEN, UTAH
REED W. BAILEY, DIRECTOR

Misc. Pub. 24 May 1961

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SILVICAL RESTRICTIONS OF SHALLOW SOILS

Survival and growth of forest trees depend on adequate soil which provides not only mechanical support but a medium to furnish moisture and nutrients. Numerous studies of many tree species have confirmed this silvical axiom throughout the world. The shallower the soil, the lower the survival and the less the growth, other factors being suitable. Survival of seedlings is a critical problem where summer precipitation is low and inadequate to maintain necessary available soil moisture. Deep soils, particularly when they are moist and fertile, eliminate one basic and important problem that confronts every forest manager, namely, regeneration. Within forest zones where there is little or no soil on bedrock, trees become established over a period of many years but are confined to rock crevices or pockets, where soil and moisture are barely sufficient to sustain life. In these locations, stocking is commonly unacceptable and the form of the trees is inferior because of their excessive taper and coarse branching.

Myers and Van Deusen[1/] recently showed that on the two main soil types in the Black Hills ponderosa pine type, soil depth accounted for most of the variance in site index. Cox, McConnell, and Matthews[2/] found that in western Montana, effective depth of soil in which tree roots might develop was the principal factor influencing tree growth. As a result of a survey of 85,593 acres in Utah, Olson[3/] concluded that on shallow soils the physical conditions for plant growth are poor and thus soil erosion is likely to accelerate.

In the Intermountain region, extensive areas of forests are on shallow soils. In some parts of the region, such as central Idaho, the difficulties in the business of growing trees are compounded because the granitic soils are highly dessicative and there is annual summer drought. In other localities, as in central and southern Utah, bedrock is often close to the surface. In all parts of the region, summer temperatures are high and summer relative humidities often low. Topography is varied and pronounced and hence aggravates the effects of both low and high soil surface temperatures. The combination of these edaphic, climatic, and physiographic factors results in severe growing conditions for the seedling during its establishment and for the tree during its lifetime. Soil stability and retention of site quality are more important and valuable than any direct or indirect crop that the site produces. Hence the manipulation of the forest crop is a responsibility of incalculable importance for the land manager to assume. Unless his judgment and practical skill are the highest order, he can damage the site irreparably.

1/ Myers, Clifford A., and James L. Van Deusen. Site index of ponderosa pine in the Black Hills from soil and topography. Jour. Forestry 58: 548-555. 1960.

2/ Cox, G. S., R. C. McConnell, and L. M. Matthews. Ponderosa pine productivity in relation to soil and landform in western Montana. Soil Sci. Soc. Amer. Proc. 24: 139-142. 1960.

3/ Olson, O. C. Relations between soil depth and accelerated erosion on the Wasatch Mountains. Soil Sci. 67: 447-451. 1949.

PROBLEMS IN THE PONDEROSA PINE TYPE

While all forest types in the Intermountain region can be found growing on extremely shallow soils, the ponderosa pine type, which is the most valuable, requires maximum silvicultural knowledge and skill for its successful management. The cutting and extraction of this species is comparatively simple; its replacement can be extremely difficult.

The ponderosa pine type grows on several distinct soil types, on all aspects, on slopes varying from level to more than 100 percent, and from one end of the Intermountain region to the other. Furthermore, soil depth varies from little or none to soil in ample amount. A current study in Idaho[4/] has traced and measured the summer depletion of moisture in forest soils. This study reveals that to a depth of 60 inches a steady loss of moisture occurs annually, that the upper soil horizons dry out faster than the lower horizons, and that particularly in the upper 2 feet of the soil mantle the wilting point is commonly reached and frequently exceeded.

Studies of natural regeneration of ponderosa pine in the Boise Basin[5/] on 7.6 miles of transect show that survival of seedlings increased from 0 on soils 1 foot deep to 22 percent on soils 4 feet deep and, in another location, from 24 percent on soils 1 foot deep to 64 percent on soils 4 feet deep. In a third sample, survival increased from 0 on soils 1 foot deep to 40 percent on soils 4 feet deep. Another study[6/] of 35,000 ponderosa pine stock planted on five aspects, showed that towards the end of September of the first year, survival was in direct ratio to the amount of moisture available in the 6-inch, 10-inch, and 18-inch depth zones. On September 23 soil moisture content in the 18-inch depth zone averaged below the wilting point in 17 of 25 plots. Highest survival was found most frequently where moisture was above the wilting point in the 18-inch depth zone.

Both the natural and artificial regeneration of ponderosa pine require the elimination or at least substantial reduction of competing vegetation by plowing or by scarifying. This operation produces a furrow or other type penetration of about 18 inches by power-propelled teeth, plows, or disks. Even with no site preparation, the shoe of the planting machine digs 15 inches beneath the surface of the ground. On steep slopes (greater than 35 percent) where manual labor replaces machines in the site preparation and planting process, the 10- to 12-inch roots of transplants require much more than an 18-inch soil mantle if they are to survive, let alone grow, at an acceptable rate.

4/ Kidd, Walter J., Jr. Intermountain Forest and Range Expt. Sta. unpub. data, 1960.

5/ McConkie, Andrew R., and Edwin L. Mowat. A preliminary study of factors affecting establishment of ponderosa pine and Douglas-fir seedlings in central Idaho. Intermountain Forest and Range Expt. Sta. unpub. ms. 1936.

6/ Read, Wayne B. Preliminary report on Boise Basin Burn Planting Project, Payette National Forest, Idaho. Intermountain Forest and Range Expt. Sta. unpub. ms. 1935.

CRITERIA FOR HARVEST CUTTINGS

In terms of silvicultural action, what does this mean?

The logical, and perhaps only, conclusion that can be drawn is that where soils less than 20 to 24 inches deep support the ponderosa pine type and in which harvest cuttings are contemplated, cuttings cannot be made, with any prospect of success, in the same way as they are made on deep soils, i.e., 24 to 60 inches. The type of harvest cutting, if indeed it is decided to cut at all, should be altered so that the site is never clear cut and a cover of trees is left on the shallow-soiled areas. No other course of action appears wise.

To forestall the consequences of clear cutting on shallow-soiled sites where the prompt establishment of reproduction is uncertain, the silviculturist, and the forest manager, must be guided primarily by soil depth, and then, and only then, can they decide the appropriate cutting method. Thus, soil depth would be the basic criterion on level ground as well as on steep ground.

How shall the tree marker judge or estimate soil depths?

At present he can rely on the surveys and techniques of professional soil experts[7/] from which surface configuration and the flora upon it provide helpful clues in recognizing soil depth. The reasonable cost of such surveys and the information they furnish leave no doubt that they are an indispensable adjunct of silviculture and should precede decisions on land use of any kind. They provide the silviculturist with a means to judge where it is safe and logical to clear cut and where it is necessary to cut by stemwise selection, or, finally, if a particular area should be left uncut. If shallow soils predominate, it may be prudent to consider the wisdom of designating some forested areas as "off bounds" to logging of any kind. Any plan of cutting mature and overmature timber on shallow soils in summer drought country should be based on soil depth and not solely on economic considerations; the results of any other course of action must be considered a doubtful bequest to posterity.

7/ Olson, O. C. Soils of the Zena Creek Logging Study, Payette National Forest, Region 4 unpub. ms., illus. 1960.