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PRELIMINARY SOIL-SITE STUDIES IN THE WESTERN WHITE PINE TYPE 1/

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A guide for estimating site quality on bare, cut-over, or burned-over lands in the western white pine type is needed for planning the management of these lands. On many areas trees may be entirely lacking or an insufficient number in the proper crown classes remain on which reliable site index determinations can be based. Therefore, reliance must be placed on some method other than tree measurement to provide an insight into the probable growth potential of a given area. This paper presents results of a limited study of the relationships of soil characteristics to site index of western white pine in an effort to establish a tentative site quality rating system based on soil characteristics. Relationships of site indices of white pine and associated species are also presented. These relationships must necessarily be confined to the white pine type in which they were determined.

PROCEDURES

Age and height measurements were obtained for various species in the 60- to 80-year-age class on the following number of plots: western white pine, 29; western larch, 18; grand fir, 16; lodgepole pine, 14; and Douglas-fir, 12. White pine site curves were used to determine the site index for white pine and grand fir. Site index determinations for larch and Douglas-fir were based on the site curves for larch. The lack of suitable site index curves for lodgepole pine precluded its use in this analysis. For all site index determinations, the average height of codominant and dominant trees was used for stand height, and the age of the oldest tree in the stand was taken as stand age provided the age of this tree did not differ by more than 3 years from that of the next oldest tree.

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Soil measurements consisted of horizon depth, effective depth, moisture equivalent, and available water-holding capacity of the top 3 feet of soil. Available water-holding capacity was determined as the difference between the moisture equivalent and the wilting percentage and converted to inches on a volume basis.

Effective depth as used in equation 1 (table 1) represents the depth in inches to a hardpan having a bulk density of 1.60 or more, or as the rock-free depth in the top 3 feet of soil. In equation 2, this factor was determined in the field by inspection. It represents either the depth to a pronounced zone of compaction or hardpan, or to the soil layer containing an abnormal and noticeably high rock or gravel content of 30 percent or more.

Site index of white pine on 29 plots is significantly and positively correlated with effective soil depth, depth to the zone of greatly reduced permeability, and the available water-holding capacity of the top 3 feet of soil (equations 1, 2, 3, and 4, table 1).

When equation 1 is used to predict site index of white pine, the estimated site index of 23 of the 29 plots falls within one 10-foot class. The average deviation of the estimated from the actual site index is 7.3 feet. Equation 2 estimated the site index of 22 of the 29 plots within 10 feet of the actual, with an average deviation from the actual of 6.4 feet. Equation 3 estimated the site index of 21 plots within 10 feet of the actual. Of the 8 plots not estimated within 10 feet, 3 of them missed by 1 foot and 3 missed by only 2 feet. Average deviation of the estimated site index from the actual is 7.2 feet. Equation 4, based on laboratory determinations of the available water-holding capacity of the upper 3 feet of soil, estimated the site index of 21 plots within 10 feet of the actual, with an average deviation of 7.2 feet.

All 4 equations representing different soil characteristics show uniformity as a means of estimating the site index of western white pine. Effective depth, obtained by field observation, is the more easily determined factor and when used for estimating purposes results in the lowest average deviation of the estimated from the actual site index. Thus this factor is considered preferable for use based on this limited study.

Site indices of white pine and several associated species are significantly correlated. The relative efficacy of equations 5, 6, and 7 for estimating white pine site index is presented in table 2.

Table 1.--Statistical correlations derived from soil-site data analyses

Equation number	Variables		Regression equation	Regression coefficient significance
	Independent	Dependent		
1	Effective depth (inches) (laboratory determination)	Site index of white pine	$Y = 45.99 + 0.632 X$	$< .02 > .01$
2	Effective depth (inches) (field determination)	do.	$Y = 48.06 + 0.685 X$	$< .01$
3	Depth to zone of greatly reduced permeability (field and laboratory)	do.	$Y = 44.65 + 0.826 X$	$< .01$
4	Available water-holding capacity	do.	$Y = 51.71 + 2.405 X$	$< .02 > .01$
5	Site index of western larch	do.	$Y = 0.941 X - 2.27$	$< .01$
6	Site index of Douglas-fir	do.	$Y = 13.76 + 0.749 X$	$< .01$
7	Site index of grand fir	do.	$Y = 4.32 + 0.968 X$	$< .01$

Table 2.--Summary of estimated versus actual white pine site indices based on actual site indices of other species

Species	Total plots	Plots estimated within 10 feet of actual	Average deviation (estimated minus actual)
	Number	Number	Feet
Larch	18	18	3.3
Grand fir	16	15	4.8
Douglas-fir	12	11	5.5

These comparisons suggest that the site index of western white pine may be estimated reasonably well from the site index of other species (equations 5, 6, and 7).

The relationships enumerated in this report are based on a limited number of plots. Nevertheless, they are well distributed throughout the western white pine type. The results suggest a strong relationship between certain easily determined soil characteristics and site index. The significant relationships between site index of commonly associated species in the white pine forest type provide means for estimating the probable site index of other species on the same site. It appears that an extension of this study may result in the establishment of a sound means of estimating site indices based upon soil characteristics alone.