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Robert W. Lange

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School of Forestry/University of Montana/Missoula

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BARK THICKNESS, k. FACTORS FOR FOUR MONTANA CONIFEROUS TREE SPECIES

By Robert W. Lange[1]

Introduction

Diameter breast high (D.b.h.) outside the bark is one of the simplest and most convenient measurements to make and is the one most often used to determine standing tree parameters. The inside-bark diameter, however, is more important than D.b.h. in calculating wood and bark volume and in predicting stem and volume growth.

Meyer (1946) found that, within the normal range of diameters, the relationship of inside-bark and outside-bark measurements can be expressed by the simple linear regression equation:

$$d = k \cdot D$$

and therefore:

$$k = \frac{\Sigma d}{\Sigma D} = \frac{\Sigma D - 2B}{\Sigma D}$$

where D is the diameter outside the bark, d is the diameter inside the bark, B is single bark thickness, and k is the linear regression coefficient. Thus the coefficient k, or bark "k factor," if known, can be extremely useful in determining inside bark diameter and bark thickness from a D.b.h. measurement.

Stayton and Hoffman (1970), in estimating bark thickness for sugar maple (*Acer saccharum* Marsh.), found Meyer's bark k factor equation as accurate as the equation they had developed using six independent tree-stem variables.

A number of other authors have reported on the relationships between diameter, bark volume, and bark thickness in both hardwood and coniferous species. Smith (1969), in Vermont, also worked with sugar maple; Minor (1953) and Miller (1961) studied two southern pine species; and Krier and River (1968) investigated log bark volume in three western species. Gevorkiantz and Olsen (1951) determined the percentage of bark in each of 25 trees native to the Lake States. Meyers (1964) was concerned with lodgepole pine in Colorado and Wyoming; and Johnson (1966) developed several bark-factor equations for Douglas-fir. To date, however, no researcher has established the bark k factors of the major timber species in Montana.

Consequently, the purpose of this study was to determine the average bark k factors of four important commercial species in Montana generally and particularly in the Lubrecht Experimental Forest[2] where research in mensuration, silviculture, and ecology is currently in progress.

Method

Five hundred trees were randomly chosen on Lubrecht Experimental Forest for the sample. Species selected for measurement were:

Ponderosa pine	(*Pinus ponderosa* Laws.)
Lodgepole pine	(*Pinus contorta* var. *latifolia* S. Watts)
Western larch	(*Larix occidentalis* Nutt.)
Douglas-fir	(*Pseudotsuga menziesii* var. *glauca* (Mirb.) Franco.)

Outside diameter and bark thickness were measured[3] at three points on the uphill side of each tree. Wick (1969) concluded that no apparent bias is introduced by using only uphill-side measurements. A 7-foot aluminum tube (½-inch dia.) with linear marks at 1 foot (stump), 4½ feet (breast height) and 6 feet was used to locate the three measurement points on all stems. In order to insure uniformity, all measurements were made by the same two men using the same instruments.

Percent slope, exposure, and stand crown closure were noted, but these factors had no significant effect on the bark k factors. Although the influences of site quality and tree age on bark thickness were not specifically considered in this study, the bark k fac-

[1]Associate professor of forestry, University of Montana, Missoula.

[2]Located 35 miles east of Missoula, Montana, this 27,000-acre forest is managed by the Montana Forest and Conservation Experiment Station.

[3]These measurements were made with a diameter tape (1/10-inch calibrations) and a Swedish bark gauge (1/20-inch calibrations).

tors presented below are averages representing a cross section of site and age classes within Lubrecht Forest.

Results

The plotted data for each species showed a straight-line linear relationship as expected. When substituted in Meyer's formula they yielded the bark k factors shown in Table 1.

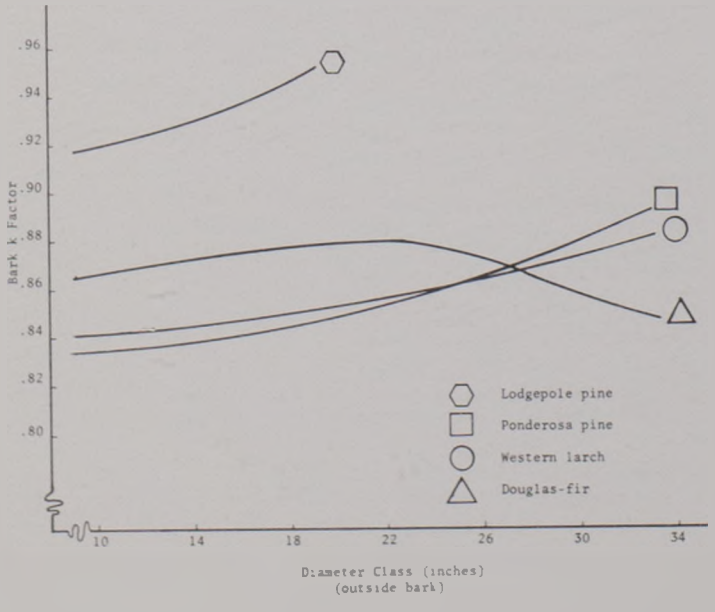
TABLE 1. Average bark k factors.

Species	Trees Sampled	Stump (1 ft.) k	Breast height k	6 ft. on Stem k
Ponderosa pine	200	.8395	.8516	.8575
Lodgepole pine	100	.9122	.9252	.9299
Douglas-fir	100	.8571	.8731	.8745
Western larch	100	.8142	.8482	.8546

Brickell (1970) reported an initial increase in the ratio of inside-bark to outside-bark diameters as measurements progress up the stem. Consistent with his findings, Table 1 reflects a definite increase in bark k factors between the stump and the six-foot mark on the tree.

Smith (1969) found a positive correlation between bark thickness and D.b.h. in sugar maple. The present study reveals a similar relationship in ponderosa and lodgepole pine and in western larch, but the bark k factor of Douglas-fir appears to decline in the larger diameter classes (Figure 1). This trend, however, may be attributable to insufficient or nonrepresentative sampling of large trees.

FIGURE 1. Bark k factors by species and diameter class.



In addition to the measurements taken on Lubrecht Forest I analyzed some tree-stem data previously collected at two other western Montana locations by University of Montana forestry students. Although these data were probably not as accurate as those from Lubrecht, they do suggest the effect of locality on bark k factors (Table 2).

TABLE 2. Comparison of bark k factors (at breast height) from three locations in western Montana.

Species	Lubrecht Forest Trees Sampled	Lubrecht Forest k Factor	Libby, Mont. Trees Sampled	Libby, Mont. k Factor	Nine-Mile* Trees Sampled	Nine-Mile* k Factor
Ponderosa pine	200	.8516	62	.8764	150	.8565
Lodgepole pine	100	.9252	41	.9378	5	.9243
Douglas-fir	100	.8731	230	.8694	25	.8890
Western larch	100	.8482	116	.8962	—	—

*Lolo National Forest, 15 miles northwest of Missoula.

The bark k factors calculated for ponderosa and lodgepole pine, western larch, and Douglas-fir on Lubrecht Experimental Forest should provide reliable estimates of inside-bark diameters when applied to D.b.h. measurements in that forest. However, if the inside-bark diameter of an individual tree must be determined more precisely, it should be computed from the actual D.b.h. and bark-thickness measurements of that tree.

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