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ESTIMATING PAST DIAMETERS OF PONDEROSA PINE IN NORTHERN CALIFORNIA

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ABSTRACT: Past outside bark diameters (d.o.b.) of ponderosa pine in northern California can be estimated from the relation of bark thickness to stem diameter. An equation for estimating past d.o.b.'s has been developed. The relationship appears to be linear between 1 and 20 inches d.o.b. and differs from ratios reported for the species in other areas. Site quality and crown class did not seem to affect the relationship.

RETRIEVAL TERMS: tree diameter measurements; past diameters; *Pinus ponderosa*; California.

OXFORD: 521.1:174.7 (794).

Past diameters outside bark (d.o.b.) of forest trees can be estimated easily and reliably by relating bark thickness to stem diameter. Such estimates are useful in determining the past d.o.b.'s of trees not previously measured—particularly for intensive studies of growth and yield.

Equations of bark thickness for ponderosa pine *(Pinus ponderosa* Laws.*)* have been published for the Black Hills region[1] and for the Pacific Northwest.[2,3] But because of the racial variation within this species,[4] equations useful in one region may not apply to another.

This note reports the bark thickness-diameter relationship of young-growth ponderosa pine growing west of the Sierra Nevada crest and the southerly Cascade range in northern California. An equation for estimating past diameters on the basis of this relationship has been developed.

METHODS

Sampling

Young stands of pure ponderosa pine were examined at 18 sites in Shasta, Tehama, Trinity, and Yuba counties, California, during the fall and winter seasons of 1966-68. All stands were even-aged and of natural origin, with no evidence of previous suppression. Estimated site index for sample stands ranged from 60 to 160 feet at 100 years.[5]

Trees were considered acceptable for sampling if they appeared free of any injury that might affect bark thickness, such as basal wounding or fire scorching. I chose from 9 to 61 measurement trees at random in each stand. The sample size varied with stand density, condition, and area. A total of 498 trees were measured.

Diameter outside bark was measured to the nearest 0.1 inch at breast height for each tree. Diameters ranged from 1 to 20 inches. Single bark thickness was

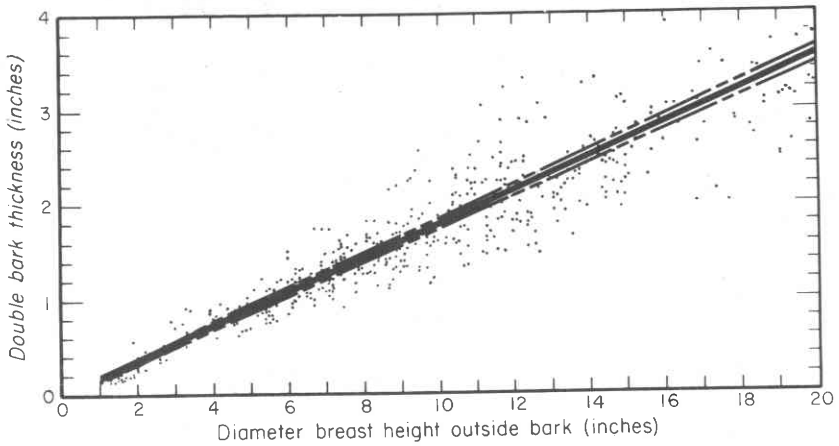

Figure 1.—*Relation of double bark thickness to diameter breast height outside bark for westside ponderosa pine in California. Broken lines indicate 99-percent confidence interval of slope (basis: 498 trees).*

measured to the nearest 0.01 inch with a Swedish bark gauge at three 120° intervals at the point of diameter measurement. Care was taken to prevent the foot of the gauge from penetrating the wood. All measurements were made through the thicker bark ridges—never in fissures. Crown dominance class was estimated for each tree.

Analysis

The three bark measurements for each tree were averaged and doubled to obtain one estimate of double bark thickness. Double bark thickness was then plotted over d.o.b. *(fig. 1)*; results indicated a linear relationship, with the line passing through the origin. Variance in bark thickness was proportional to the square of the diameter. Data were then stratified by site index classes and within-site crown classes to test for their effects on the bark thickness/d.o.b. relationship.

Using the method of weighted ratio estimators,[6] I computed 21 bark thickness/d.o.b. constants for all site and crown class combinations. I converted these constants into equations that expressed past d.o.b. in terms of current d.o.b. and intervening wood increment.[7]

RESULTS AND DISCUSSION

Bark thickness was linearly correlated with d.o.b. for diameters between 1 and 20 inches. Variation in bark thickness increased as stem diameters increased. Comparison of bark thickness/ d.o.b. constants for the 21 site and crown class combinations did not reveal any practical differences. Trees on poorer sites and of lower crown classes tended to have thicker bark than trees on better sites and in upper crown classes, but trends were not consistent.

Pooled data produced the following equation suitable for a d.o.b. range of from 1 to 20 inches:

$\hat{Y} = 0.1765X$

$S_b = 0.0014$

in which

$\hat{Y}$ = estimated double bark thickness in inches

X = d.o.b. in inches

S_b = standard deviation of slope coefficient.

Substitution of the slope coefficient resulted in the following expression for estimating past diameters:

$D_p = D_c - 1.2143\ W_g$

in which

D_p = d.o.b. at some specific time in the past

D_c = current d.o.b.

W_g = double the radial wood growth formed between D_p and D_c as measured from increment cores.

The equation is applied as follows:

1. Measure current d.o.b. (D_c) of the sample tree to the nearest 0.1 inch.

2. Determine the date (d_i) for which you wish a past diameter estimate and the number of annual rings this will include.

3. Extract three equally-spaced increment cores at breast height, each core including the rings formed since d_i.

4. Measure, average, and double the three radial lengths of wood between the outer edge of the ring formed in d_i and the outer edge of the current ring. This becomes "W_g."

5. Substitute D_c and W_g into the equation to estimate D_p.

Table 1.—*Estimated past diameters of ponderosa pine in California from current diameter and double radial wood growth*

Current d.o.b. (inches)	Past diameter outside bark when double radial wood growth, was . . .											
	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
	Inches											
2.0	1.7	1.4	1.1	0.8	0.5	0.2	–	–	–	–	–	–
4.0	3.7	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.3	1.0	0.7	0.4
6.0	5.7	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.0	2.7	2.4
8.0	7.7	7.4	7.1	6.8	6.5	6.2	5.9	5.6	5.3	5.0	4.7	4.4
10.0	9.7	9.4	9.1	8.8	8.5	8.2	7.9	7.6	7.3	7.0	6.7	6.4
12.0	11.7	11.4	11.1	10.8	10.5	10.2	9.9	9.6	9.3	9.0	8.7	8.4
14.0	13.7	13.4	13.1	12.8	12.5	12.2	11.9	11.6	11.3	11.0	10.7	10.4
16.0	15.7	15.4	15.1	14.8	14.5	14.2	13.9	13.6	13.3	13.0	12.7	12.4
18.0	17.7	17.4	17.1	16.8	16.5	16.2	15.9	15.6	15.3	15.0	14.7	14.4
20.0	19.7	19.4	19.1	18.8	18.5	18.2	17.9	17.6	17.3	17.0	16.7	16.4

Estimated past diameters for certain combinations of current diameters and past wood growth of ponderosa pine are listed in table 1. But the equation reported in this note affords more precise estimates. And it should prove especially useful in detecting subtle changes in past growth patterns.

NOTES

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