U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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Research Note

Number 181 Portland, Oregon January 1960

ESTIMATING PAST DIAMETERS OF SEVERAL SPECIES IN THE PONDEROSA PINE SUBREGION OF OREGON AND WASHINGTON

by

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In certain kinds of forest growth studies, an estimate of diameter outside bark is required for trees as of some previous date. Previously, papers were published by this Station regarding estimation of past diameters of Douglas-fir and ponderosa pine.[1/] Since they were issued, new and more complete data have been collected for most of the major species in the ponderosa pine subregion as part of the Forest Survey inventory program.

Tree diameters as of some past date may be found by subtracting total diameter growth from known present diameters. Total diameter growth is the sum of wood growth and bark growth. Wood growth may be easily obtained from increment cores; since bark growth cannot be measured directly, however, some procedure like the one to be described is necessary.

1/ Johnson, F. A. Estimating past diameters of Douglas-fir trees. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Res. Note 112, 3 pp., illus. (Processed.) 1955.

_____ Use of a bark thickness–tree diameter relationship for estimating past diameters of ponderosa pine trees. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Res. Note 126, 3 pp., illus. (Processed.) 1956.

ESTIMATING TOTAL DIAMETER GROWTH

Bark growth is the change in bark thickness that occurs as a result of diameter growth. If the relation between bark thickness and diameter is linear, then the slope of the regression is an estimate of bark growth in terms of diameter growth outside bark. Furthermore, total diameter growth can be expressed as a proportion of wood growth.

The trees used in this study were selected to provide a representative sample of all trees from the following areas: Stevens, Ferry, Okanogan, Chelan, Asotin, Garfield, Walla Walla, and Columbia Counties in eastern Washington; and Wallowa, Union, Umatilla, and Grant Counties in eastern Oregon. Bark thickness–tree diameter relationships were studied using the following data from these areas:

Species	Number of trees	Range of d.b.h. (Inches)
Douglas-fir	2,259	5.0 - 46.0
Ponderosa pine	1,845	5.0 - 46.0
Lodgepole pine	743	5.0 - 22.0
White fir	764	5.0 - 46.0
Subalpine fir	400	5.0 - 37.0
Engelmann spruce	585	5.0 - 37.0
Western larch	1,058	5.0 - 48.0

For all species included in this report, the relation between bark thickness and diameter is apparently linear for diameters over 5 inches. For all species except ponderosa pine and lodgepole pine the linear least squares regression passes very near both zero coordinates. The relationship logically should show zero bark thickness for zero diameter. Data below 5 inches for ponderosa pine and lodgepole pine probably would approach zero and therefore require curvilinear regressions. However, in this case it is more convenient to use linear relationships for all species. If an estimate is needed below 5 inches, a line can be drawn from the lower end of each regression to the origin.

The procedure for estimating diameter growth using the bark thickness–tree diameter relationship is illustrated for Douglas-fir:

Douglas-fir

$$B_t = 0.0704+0.1176D$$

where B_t = double bark thickness 4.5 feet aboveground

D = tree diameter outside bark 4.5 feet aboveground

where 0.1176 = least squares regression coefficient

The regression coefficient, 0.1176, can be regarded as an indirect estimate of bark growth. It indicates change in bark thickness per unit change in outside bark diameter.

Thus, $B_g = 0.1176D_g$

where B_g = bark growth

D_g = total diameter growth

And, $D_g = W_g+0.1176D_g$

where W_g = wood growth (twice radial growth)

Therefore, $D_g = W_g(1.133)$

For the other species the same procedure gave the following results:

Ponderosa pine

$$B_t = 0.5661+0.0976D$$

$$D_g = W_g(1.108)$$

Lodgepole pine

$$B_t = 0.3147+0.0274D$$

$$D_g = W_g(1.028)$$

White fir

$$B_t = -0.0122+0.1047D$$

$$D_g = W_g(1.117)$$

Subalpine fir

$$B_t = 0.0539+0.0633D$$

$$D_g = W_g(1.068)$$

Engelmann spruce

$$B_t = 0.2113+0.0445D$$

$$D_g = W_g(1.047)$$

Western larch

$$B_t = 0.1231+0.1306D$$

$$D_g = W_g(1.150)$$

CALCULATING PAST DIAMETERS

The foregoing equations give an estimate of the diameter growth for any period of years. The number of years can be controlled by measuring wood growth for that number of growth rings and substituting in the appropriate equation. The estimated diameter growth is then subtracted from the present outside bark diameter to get an estimate of the outside bark diameter at the desired time in the past.