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Conifer Foliage Mass Related to Sapwood Area

Note by Charles C. Grier and Richard H. Waring

Abstract. Investigation of 52 trees suggests that foliage mass (kg dry weight) of individual Douglas-fir, noble fir, and ponderosa pine trees can be estimated from regressions on sapwood cross-sectional area (cm²) at dbh (1.3 m). Equations are respectively $y = 0.072 \times -1.34$, $y = 0.51 \times -4.63$, and $y = 0.043 \times +7.13$. Correlation coefficients (*r*) were 0.98 or greater. Similar relations may exist for other species having clearly defined sapwood. *Forest Sci.* 20:205-206.

Additional key words. Biomass, *Pseudotsuga menziesii*, *Abies procera*, *Pinus ponderosa*.

CURRENT METHODS of estimating tree foliage mass rely on regressions involving external tree dimensions such as dbh. These methods are adequate for stands of relatively small or young trees where crown dimensions are fairly regular, but not for individual large or old trees. We report here an alternative for individual Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), noble fir (*Abies procera* Rehd.) and ponderosa pine (*Pinus ponderosa* Laws.), using regressions of foliage mass on sapwood cross-sectional area at dbh.

Fifty-two study trees were obtained from four locations in western Oregon and from one in Northern Arizona: twelve from a 20-year-old Douglas-fir stand at 365 m elevation in the Oregon Coast Range; nine from a 95-year-old Douglas-fir stand at 365 m elevation in the Cascade Range; twelve from a 20-year-old Douglas-fir stand at 914 m in the Cascade Range; ten from a 130-year-old, mixed stand

of noble fir and Douglas-fir at 1,200 m in the Oregon Cascade Mountains; and nine from a mixed age ponderosa pine stand on the Fort Valley Experimental Forest, Arizona. Study trees were selected to represent the range of diameter and crown dominance classes present.

Study trees ranged in diameter from 4 to 112 cm dbh (1.3 m) and 2 to 65 m tall. Because of this wide range, foliage mass of individual trees was determined in two ways according to tree size. Small trees (< 15 cm dbh) were cut, treated with a leaf-killing defoliant (cacodylic acid), and hung indoors until needles dropped. Foliage was then dried at 70°C and weighed to the nearest gram. Foliage of these trees was dead within 10 days of treatment and thus its weight is subject to whatever respiration weight loss took

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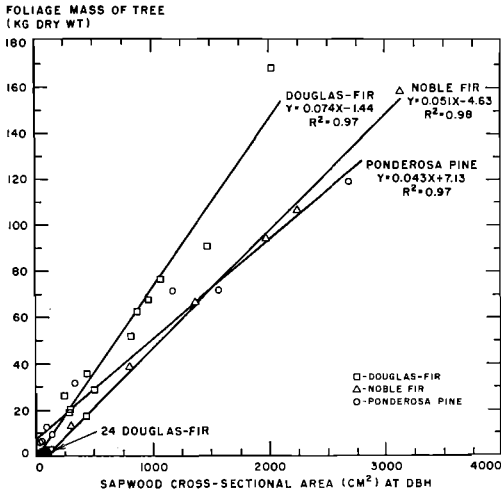


FIGURE 1. Relation between sapwood cross-sectional area (cm^2) and total foliage mass (kg) for Douglas-fir, noble fir and ponderosa pine.

place during that period (Forrest 1968). Foliage mass of large trees was determined as follows. After felling, crowns were cut into 3 m sections along the main stem and all foliage-bearing twigs in each section clipped and weighed. A 1 to 2 kg subsample from each section was taken, weighed, dried at 70°C , reweighed, separated into twigs and foliage, and these components weighed. Foliage mass was computed from the field weight of each section adjusted for water and twig content and then summed for each tree crown. Fresh weights were obtained the day the trees were felled and subsamples were heat-killed within five days of sampling.

Sapwood area was computed from the av-

erage of four right-angle measurements at dbh. Sapwood was distinguished from heartwood by color; this boundary could be established to ± 1 mm.

Figure 1 shows the linear relations between foliage mass and sapwood cross-sectional area for Douglas-fir, noble fir, and ponderosa pine. For larger trees, sapwood area seems a better estimator of foliage mass than diameter. For example, two Douglas-firs plotted in Figure 1 have diameters of 66 and 78 cm, sapwood areas of 1072 and 961 cm^2 , and foliage mass of 76.6 and 67.6 kg, respectively. Sapwood area in these examples is obviously more closely related than diameter to foliage mass.

A similar relation exists for one other coniferous species, at least in smaller trees. Ovington *et al.* (1968) report a high correlation ($r^2 = 0.94$) between foliage mass and bole cross-sectional area in 8-year-old *Pinus radiata*. This correlation is actually against sapwood and bark, since heartwood in *Pinus radiata* begins forming only after 19 to 20 years (Nicholls and Dadswell 1965).

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