

ESTIMATING FOLIAGE AND TWIG WEIGHT OF SPRUCE AND FIR

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Estimating spruce (*Picea* spp.) and balsam fir (*Abies balsamea*) available as browse in dense spruce-fir stands by 100% clipping or twig counts is tedious, time-consuming, and expensive. Techniques have been devised to reduce these problems. Peek (1970) correlated the weight of current growth of 3 deciduous species with plant height, which can be measured rapidly. Crawford et al. (1975) and Stutzman et al. (1979) used rapid electronic techniques to estimate weight of small twigs and needles on Virginia pine (*Pinus virginiana*). Brown (1976) related shrub aboveground weight and leaf weight to basal stem diameter. King (1975) related available browse weight to basal diameter of Canada yew (*Taxus canadensis*).

We suspected a close relationship of twig and needle weight to height and diameter at root collar of unbrowsed regenerating balsam fir and spruce in stands that had been clear-cut 4–15 years previously. We measured height and diameter at root collar to the nearest 0.1 cm and 0.01 cm, respectively, of 46 balsam fir and 49 spruce trees to evaluate this relationship. White and red spruces (*P. glauca* and *P. rubens*) were not separated by species. Heights of sample trees ranged 11.0–523.0 cm for balsam fir and 10.0–295.7 cm for spruce. Diameter at root collar ranged 0.26–11.84 cm for balsam fir and 0.20–7.05 cm for spruce. A wide range of sizes was selected, from

the smallest to the largest known to occur on the study areas, to obtain a representative sample. Twigs and needles on the portions of trees below 2.29 m in height—the effective browsing zone—were clipped and oven-dried for 24 hours at 100 C. Fir twigs were clipped to a diameter of 0.30 cm, the average diameter of browsed twigs. The current annual growth of spruce twigs was clipped because browsing of spruce was minimal. Browsing of balsam fir by deer (*Odocoileus virginianus*) and moose (*Alces alces*) occurred in patches, and was heavy in those areas, but the total percentage of available fir browsed was low in all the clear-cuts studied. Only unbrowsed trees were selected because we wanted to determine the theoretical maximum amount of available browse.

For spruce and balsam fir, we determined the relationship of twig and needle dry weight to tree height (H), diameter of root collar (DRC), $H \times (DRC)$, and $(DRC)^2$ in a multiple regression with a forced zero intercept. Dry weights of twigs and needles correlated ($P < 0.05$) with tree height (H) $\times$ stem diameter at the root collar (DRC) and provided the best-fit regression equation of all possible combinations of variables (Table 1).

This method offers a rapid technique for measuring twig and needle weight for species that have many branches. After the initial regression equations have been established, an investigator needs only to measure tree heights and root-collar diameters on additional plots. The technique avoids destructive sampling and allows repeated measurements on permanent plots.

We conducted our study on formerly

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Table 1. Equations for estimating weight of spruce and fir twigs and needles. Dry weight (W) in grams, both height (H) and diameter at root collar (DRC) in centimeters.

Type of browse	N	Regression equation	r^2
Balsam fir	46	$W = 0.336(H)(DRC)$	0.97
Spruce	49	$W = 0.882(H)(DRC)$	0.95

logged sites on the Moosehead Plateau in northwestern Maine and would not attempt to extrapolate our coefficients to other areas. Additionally, annual growth of spruce and browsing intensity on balsam fir may differ by year, requiring different coefficients. However, the parameter height $\times$ diameter at root collar should serve equally well in determining appropriate coefficients for estimator equations for spruce and fir in other areas and other years.

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