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Tree Basal Area as an Index of Thermal Cover for Elk

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Abstract

The relationship of basal area to crown closure was studied in five major forest types of the Blue Mountains of Oregon and Washington. The regressions developed give wildlife and forest managers a tool for estimating the amount of crown closure if data are not available from stand examinations. Information is used in determining quantity and quality of elk thermal cover.

Keywords: Basal area, crown closure, thermal cover, wildlife habitat, Cervidae.

Introduction

Thermal cover for elk is a habitat feature, such as a stand of conifer trees, that provides protection against changes in an animal's body temperature above and below critical tolerances (thermoregulation). Generally, as crown closure increases, the effectiveness of a stand to provide thermal cover improves. Optimum thermal cover is determined by the animal as well as by the habitat. Changes in season, temperature, wind, and radiation create different thermoregulation demands on the animal. Crown closures that provide optimum thermal cover under one set of weather conditions may not be optimum under others. Variability among and within conifer stands often provides a wide range of crown closure and thermal cover characteristics that correspond to animals' changing needs.

For summer ranges in the Blue Mountains region of Oregon and Washington, the optimum level of elk thermal cover for management purposes is defined as a stand of coniferous trees at least 12 m (40 ft) tall and exceeding an average of 70 percent crown closure (Thomas and others 1979). Use varies with the animals' needs and the amount of cover; for example, during summer high temperature periods, elk need clumps of trees that provide dense shade (often 90 to 100 percent crown closure and multitiered crowns) for maximum cooling (Leckenby and Adams 1981), whereas on a winter range the best available thermal cover may be less than optimum for protection.

A better understanding of optimum thermal cover under a variety of weather, site, and seasonal conditions will help managers to appropriately manipulate forest stands to provide this component of elk habitat.

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The objective of this study was to determine if crown closure of conifers in unmanaged natural stands in the Blue Mountains of Oregon and Washington could be predicted from tree basal area measurements. If so, stand basal area, which is usually available, could be used to estimate crown closure and in turn to help managers manipulate stands to achieve optimum thermal cover.

Methods

Plots were located in six geographical areas of the Blue Mountains region of Oregon and Washington: (1) the north portion of the Umatilla National Forest (Walla Walla District); (2) the north portion of the Wallowa-Whitman National Forest (Wallowa Valley District and Hells Canyon National Recreation Area); (3) the southeastern portion of the Umatilla National Forest (Ukiah and Dale Districts plus part of the Baker District of the Wallowa-Whitman National Forest); (4) the southwest portion of the Umatilla National Forest (Heppner District); (5) the Malheur National Forest (Prairie City and John Day Districts); and (6) the Ochoco National Forest (Paulina District).

Plots were established by Oregon State Department of Fish and Wildlife research scientists at specific locations used by elk during all seasons (Leckenby and Adams 1981); 609 plots were stratified into five Society of American Foresters cover types (Eyre 1980) and were identified by symbols (Hall 1976) (referred to as "formation-associations"):

Cover type (SAF)	No.	Symbol (Hall 1976)
Interior Ponderosa Pine	237	CP
Interior Douglas-Fir	210	CD
Grand Fir	213	CW
Lodgepole Pine	218	CL
Engelmann Spruce-Subalpine Fir	206	CE

All plots sampled were in unmanaged stands (there was no evidence of tree removal). A single sample of basal area, using a basal area factor of 10 (Dilworth and Bell 1967) was taken at each plot with a prism. Four readings of crown closure were taken at cardinal directions and 15 feet from the plot center with a type A densiometer (Lemmon 1956) and were averaged.

For each cover type, crown closure and basal area (BA) were related by use of regression analysis. An empirical fit of the data was made by using the models of Y as a function of $\text{Log}_{10}(X + 1)$, and Y as a function of various powers of x (x^1, x^2, and x^3).

From this analysis the equation model percent crown cover $= a + b[\text{LOG}_{10}(\text{BA}+1)]$ was found to be the best fit.

Results and Discussion

For 70 percent crown closure in CP, CD, CW, SL, and CE formation-associations, the corresponding basal area values are 190, 80, 64, 145, and 70 square feet per acre, respectively (figs. 1-5). The percentage of variation in crown closure associated with basal area (r^2) ranged from 0.21 for CE to 0.49 for CW (table 1). These regressions are best used in cases where crown closure data are not available. It should be noted that, whatever the basal area, when 70 percent crown closure is approached on most curves (figs. 2-4), reliability is relatively high (confidence limits are narrow). F tests for all the regressions presented for formation-associations were significant ($p < 0.01$).

These regressions apply only to unthinned stands. Use of these regressions to judge the level of thermal cover that will remain after a stand is thinned is not appropriate. Crown characteristics of remnant trees after cutting in a dense stand are different from crown characteristics of an open stand that developed naturally to the same level of closure. Use of the crown closure-basal area relationships described here would overestimate crown closure—sometimes dramatically.

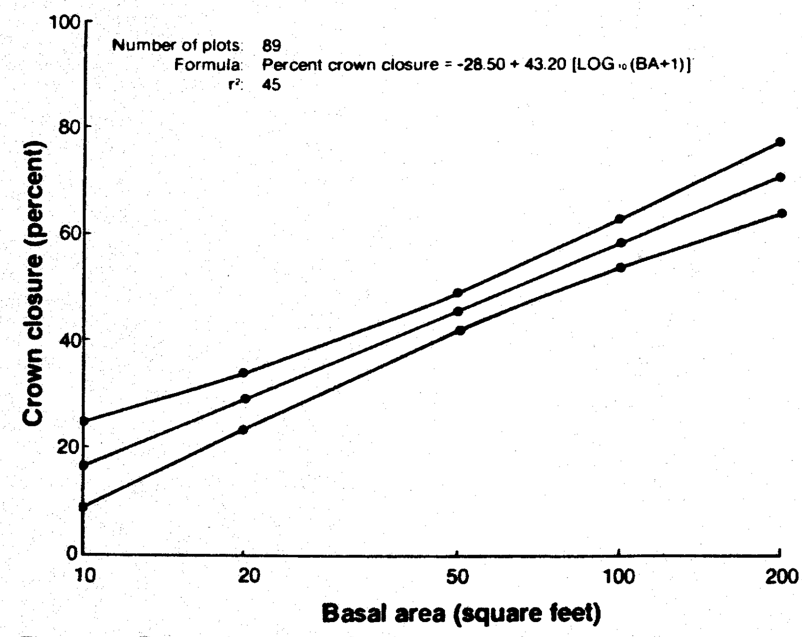

Figure 1.—Regression curve showing crown closure as a function of basal area for the Ponderosa Pine (CP) formation-association.

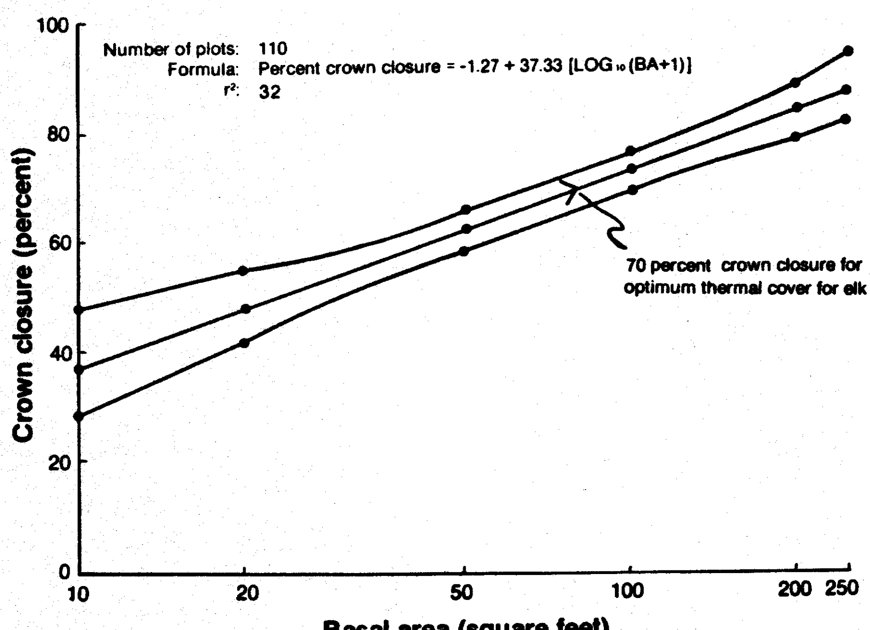

Figure 2.—Regression curve showing crown closure as a function of basal area for the Douglas-Fir (CD) formation-association.

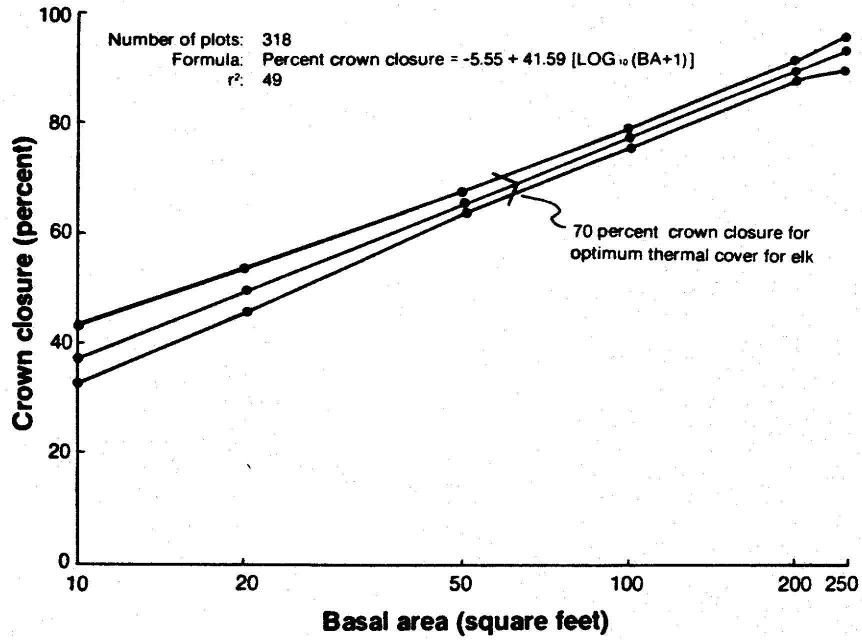

Figure 3.—Regression curve showing crown closure as a function of basal area for the White Fir (CW) formation-association.

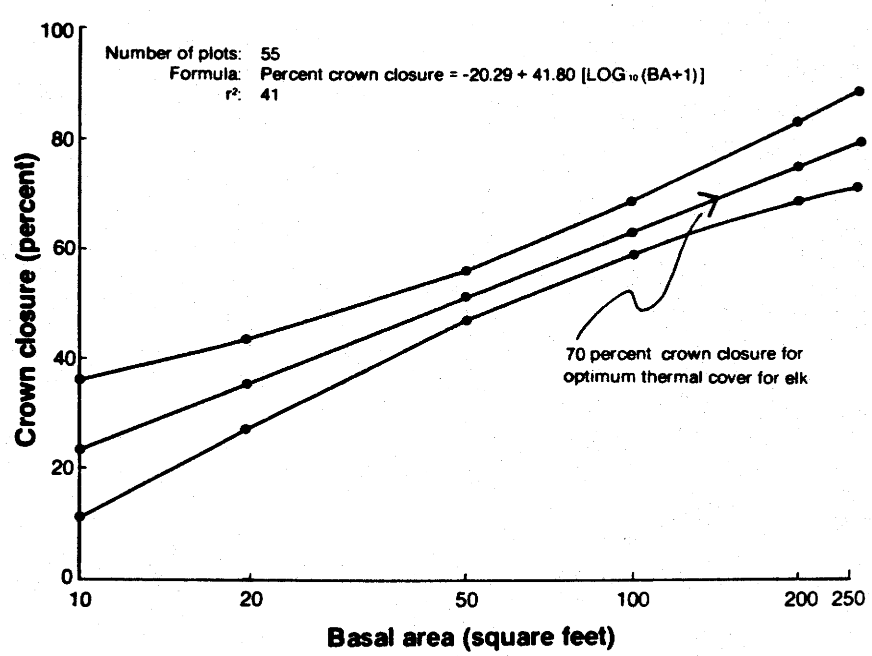

Figure 4.—Regression curve showing crown closure as a function of basal area for the Lodgepole Pine (CL) formation-association.

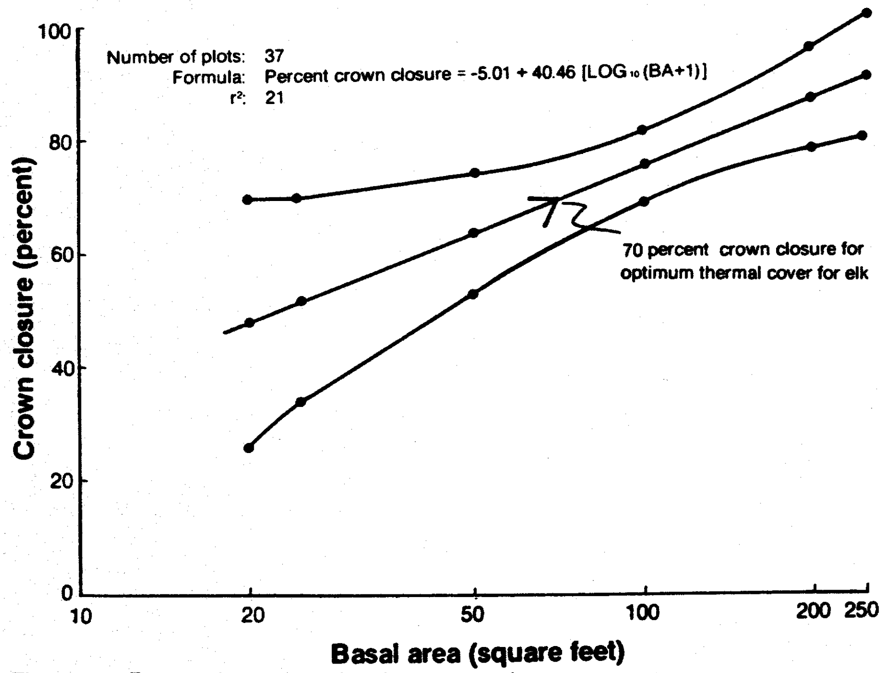

Figure 5.—Regression curve showing crown closure as a function of basal area for the Engelmann Spruce-Subalpine Fir (CE) formation-association.

Table 1—Values by formation-association for regression coefficients a and b in the formula percent crown cover = a + b[LOG_{10}(BA+1)], plus information for evaluating reliability of the crown closure-basal area correlations[1/]

Formation-association	Number of plots	Sampled basal area		Significance of			
		Maximum	Minimum	a	b	F	r^2
CP	89	220	10	−28.50	43.20	0.01	0.45
CD	110	280	10	− 1.27	37.33	.01	.32
CW	318	320	10	− 5.55	41.59	.01	.49
CL	55	270	10	−20.29	41.80	.01	.41
CE	37	270	20	− 5.01	40.46	.01	.21

[1/] Symbols are from Hall (1976), cover types from Eyre (1980): "C" designates a stand of conifers; P, Ponderosa Pine; D, Douglas-Fir; W, White (or Grand) fir; L, Lodgepole Pine; and E, Engelmann Spruce-Subalpine Fir; r^2, coefficient of determination.

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