



Institut de recherche sur les feuillus nordiques Inc.
Northern Hardwoods Research Institute Inc.



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Technical Note

Silviculture

Stand Basal Area – Canopy Cover Relationship for Northern Tolerant Hardwoods

Introduction

Canopy cover and stand basal area are two common measures of stand characteristics. Since basal area is directly related to volume and biomass of a stand, mostly tree diameter and/or stand basal area are measured during forest survey. Although canopy cover is important for several forestry applications, it is not measured very often, since its precise measurement is complex and time consuming. On the other hand, remote sensing applications need to predict stand basal area from canopy cover information. Therefore, it is important to establish stand basal area-crown cover relationship for northern tolerant hardwoods in northwest New Brunswick.

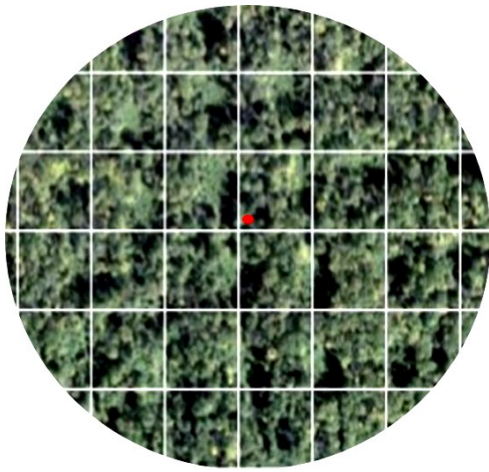
Highlights

- ◆ *There is a moderate correlation between stand basal area and canopy cover (%) in the northern tolerant hardwoods of northwest New Brunswick.*
- ◆ *This tool could help predict information about canopy cover using basal area stand information that is easier to obtain.*
- ◆ *A species and site specific model that takes into account the effects of the site would improve the prediction ability.*

Methodology

Data was obtained from 34 selected plots (hardwood and mixed wood stands containing tolerant hardwoods) in the northwestern part of New Brunswick. Plots in this study are: 1) located in east-west direction from 67° 1' 16.4'' W to 68° 8' 31.7'' W longitudes and in south-north direction from 47°28'14'' N to 47° 42' 25'' N latitudes, 2) have an average altitude of 356m (245m to 520m), 3) an average slope of 13% (0 to 45%), and 4) an average water depth of 22.6cm (0 to 90 cm).

Stand basal area of the plots was measured using a 3 M BAF prism in 2012 by NHRI forest survey team. Then, a satellite image of 10.16 m spatial resolution taken October 2nd, 2012 from Digital globe WV2 satellite was used for canopy cover estimation. The geo-referenced image was used to locate the point of basal area measurement. A circle of radius 30 m was created for the measurement of canopy cover. A systematic grid (10×10 m²) was laid out on the circle (Figure 1). Intersection points falling on tree canopy and on the ground were computed and then equation (1) was used to compute canopy cover (%) (Equation 1). Summary of the data used for analysis presented in Table (1).



$$CC\% = \frac{n}{N} \times 100 \quad (1)$$

Where:

$CC\%$ = Canopy cover, in percentage.

n = number of intersections points falling on tree canopy

N = Total number of intersections points in the circle.

Figure 1: Systematic grid layout for canopy cover estimation.

Table 1: Summary of the data used in modeling (N = 34 plots)

Variables	Mean	Minimum	Maximum
Stand basal area (m ² /ha)	22.63	9	42
Canopy Cover (%)	80.18	35	98
Hardwood proportions	0.89	0.33	1

Section title

Figure 2: Predicting Canopy Cover (%) from stand basal area.

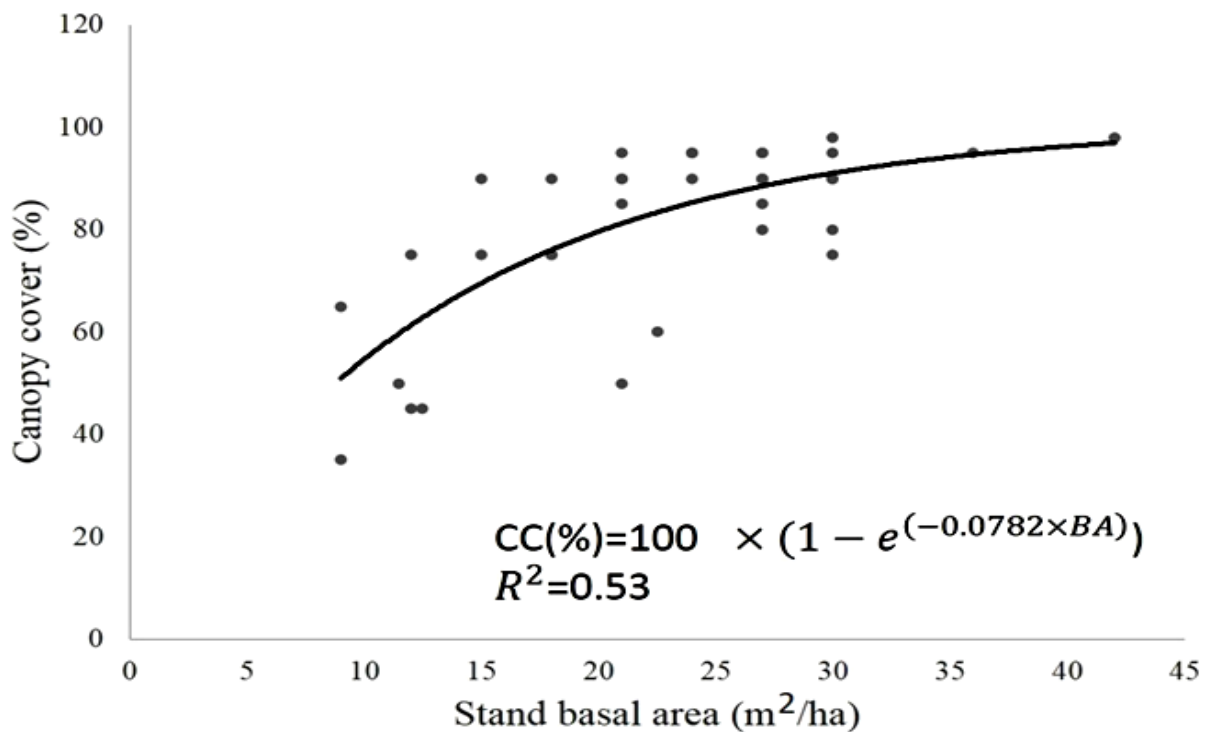
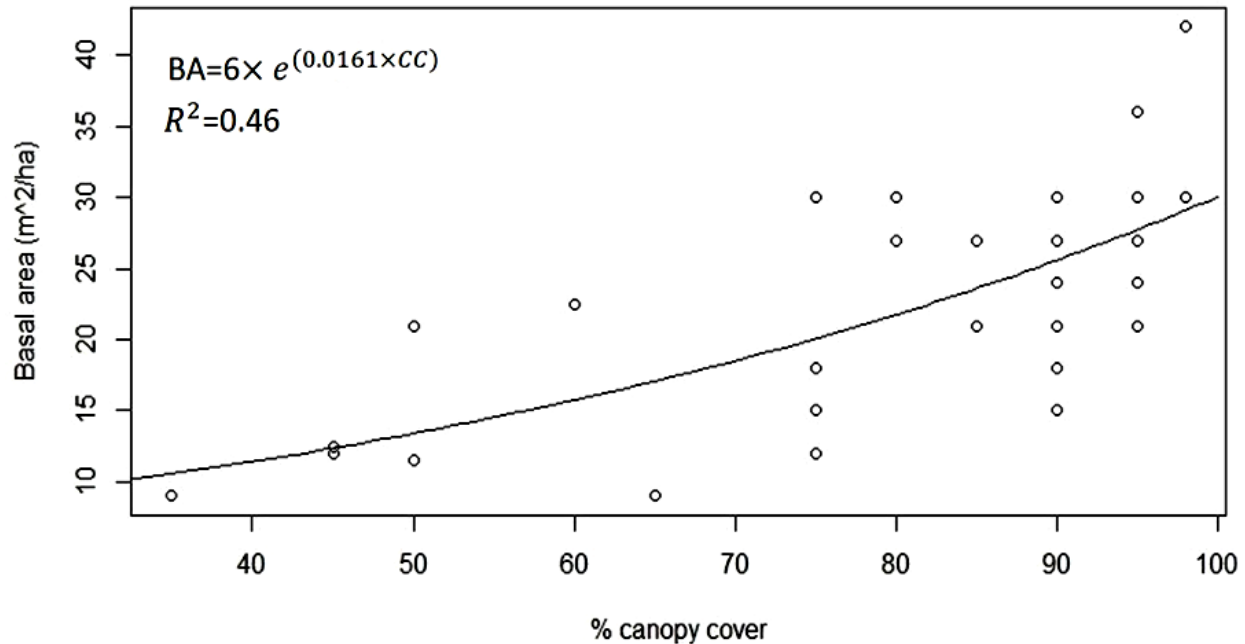


Figure 3: Predicting stand basal area from canopy cover (%).



A good correlation (Pearson correlation: $r = 0.68$, p -value < 0.01) between stand basal area and percent canopy cover was observed in second-growth mixed wood stands where hardwood proportions ranges between 33 to 100 % and stand basal area ranges between 9 to 42 m²/ha (Table 1). Canopy cover (%) was found to decrease from 100 as stand basal area decreases. Percent canopy cover declines marginally with stand basal area in denser stands (SBA > 20 m²/ha) but it declines rapidly with stand basal area in sparse stands (SBA = 10 m²/ha to 20 m²/ha) (Figure 2 and 3).

Conclusion

Although the proposed models give fairly accurate prediction of canopy cover, it indicates that stand basal area is one of the good predictors for estimating a canopy cover percent, and vice versa. As basal area crown diameter relationship varies between species (Russell and Weiskittel, 2011), a species specific model (based on species dominance in a plot) that takes into account the effects of site would improve the prediction ability. Broader category of species composition (softwood and hardwood proportions) used in this study did not show significant effect of species composition on basal area-canopy cover relationship. Proposed model is suitable for northern temperate hardwood and mixed wood stands where hardwood proportions are greater than 30% and stand basal area is between 9 and 42 m²/ha. We recommend to re-calibrate the proposed equations before using these equations in other sites. As canopy cover was assessed measuring the outer or upper canopy surface using satellite imageries, it may underestimate forest canopy in multi-layered or high foliage density forest (Van Pelt and Nadkarni, 2004).

References

- Russell, M.B., Weiskittel, A.R., 2011. Maximum and Largest Crown Width Equations for 15 Tree Species in Maine. *North. J. Appl. For.* 28, 84–92.
- Van Pelt, R., Nadkarni, N.M., 2004. Development of canopy structure in *Pseudotsuga menziesii* forests in the southern Washington Cascades. *For. Sci.* 50, 326–341.

Parameter estimates and associated uncertainties

$$CC\% = 100 \times (1 - e^{(-a \times BA)}) \quad (2)$$

$$BA = a_0 \times e^{(a_1 \times CC\%)} \quad (3)$$

Where:

CC% = Canopy cover (%)

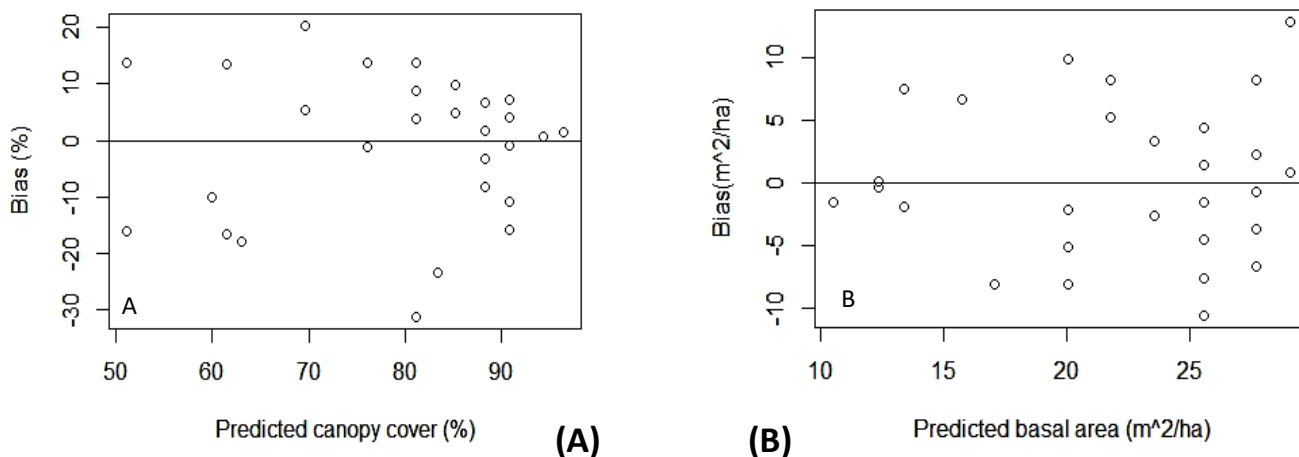
BA = Stand Basal Area (m²/ha)

a, *a*₀ and *a*₁ = parameters to be estimated.

Table 2: Parameter estimates and associated uncertainties.

Equation	Parameter	Estimates	Standard Error	P-value
2	<i>a</i>	0.0782	0.0055	< 0.001
3	<i>a</i> ₀	5.9928	1.8771	0.003
3	<i>a</i> ₁	0.0161	0.0036	< 0.001

Figure 4: Bias (observed-predicted) in predicting (A) canopy cover (%) and (B) stand basal area.



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