# COMPARATIVE SNOW DEPTHS IN 40-YEAR-OLD, VARIABLE-SPACED CONIFER PLANTATIONS NEAR THUNDER BAY ONTARIO

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ABSTRACT: January snow depths were measured in randomized, 40 yr old, red pine (*Pinus resinosa* Ait), white spruce (*Picea glauca* (Moench) Voss.) and black spruce (*Picea mariana* (Mill.) B.S.P.) plantations established at 1.8, 2.7 and 3.6 m spacing. Relative ability of the tree species to intercept snow, varied with spacing. Attributes of managed conifer stands may influence value as winter habitat for moose (*Alces alces*).

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Conifer plantations are a common product of contemporary timber management. However, the value of conifer stands as components of moose habitat in managed forests has not been explored in the scientific literature. This note describes the influence of species selection and spacing on snow interception capability of conifer plantations.

Conifer stands provide late winter habitat for moose (*Alces alces*) by providing refuge from deep snow, or crusting conditions(Peek 1971, Coady 1974, Allen *et al.* 1987, Todesco 1988). Snow begins to restrict moose movement when it reaches depths of 65 cm (Thompson and Vukelich 1981) to 75 cm (Des Meules 1964, Hamilton *et al.* 1980). Moose become confined to conifer stands if snow depths exceed 90 cm (Thompson and Vukelich 1981), 107-122 cm (Des Meules 1964) or 113 cm (Telfer 1970). Late winter habitat quality is primarily related to the ability of the stand to prevent the accumulation of deep snow (Table 1).

Quantifiable relationships between stand attributes and habitat quality are essential for calibrating management planning tools. Such tools include Habitat Supply Analysis (HSA) (Thomas 1979, Patch 1987) that permits forest-scale evaluation of wood supply and wildlife habitat, Habitat Suitability Index (Allen *et al.* 1987) or Crop Planning models (Willcocks *et al.* 1990).

Table 1. Relative values of coniferous species in relation to their influence on winter cover for moose. Species with a high index value are believed to provide the greatest amount of interception of snowfall and thermal protection (from Allen *et al.* 1987).

| Species | Index |
|---|---|
| cedar | 1.0 |
| hemlock | 0.9 |
| balsam fir | 0.8 |
| white spruce | 0.7 |
| jack pine | 0.3 |
| black spruce | 0.3 |

Among other things, crop planning includes economic evaluation of silvicultural decisions of which species selection, tree density and age of harvest are important variables. These variables influence sawlog to pulpwood ratio, total merchantable volume and net return on investment. Crop planning has greatest value in forest planning if it is integrated with non-timber models. For example, an integrated model could be used to evaluate the impact of silvicultural decisions such as species selection and tree spacing on parameters important to moose in winter, such as snow depth.

## METHODS

On January 12, 1991, snow depth was measured in each of the experimental blocks of the Thunder Bay Spacing Trial (OMNR

1989), near Thunder Bay, Ontario. Red pine (*Pinus resinosa* Ait), white spruce (*Picea glauca* (Moench) Voss.) and black spruce (*Picea mariana* (Mill.) B.S.P.) were planted in perfect lattice outplantings replicated three times each at 1.8 m, 2.7 m, and 3.6 m spacing in 1951. The entire experimental area was surrounded by jack pine (*Pinus banksiana* Lamb.) operationally planted at a nominal 1.8 m spacing to reduce edge effects. The plantation is now 40 years old and most of the plots have experienced crown closure for many years. Snow depths were measured at 15 randomly selected locations within each plot. Each measurement was taken at the midpoint between four trees where minimum crown closure and maximum snow depth could be expected. Due to plantation establishment failures of two black spruce plots at the 1.8 spacing, 45 measurements were made in the single remaining black spruce plot at the 1.8 m spacing. In addition, 15 randomly positioned snow depth measurements were made in the neighbouring jack pine. Snow depths were also measured on unplanted control plots, equal in size to the planted plots and located throughout the spacing trial.

Snow depth data were analysed using a one-way Analysis of Variance, and the means were compared using Duncan's New Multiple Range Test.

## RESULTS AND DISCUSSION

The results of the statistical analysis show that there were significant differences in snow depth among tree species and plantation densities (Table 2). The plots planted at a 1.8 m spacing were most effective at intercepting snow with black spruce plots having significantly less snow accumulation than the red pine plots. At the wide spacing (3.6 m), red pine was most effective at intercepting snow, but was not significantly different from the white spruce. Black spruce at the 3.6m spacing had poor snow interception capability. This interaction between tree species and spacing is significant because it implies that knowledge of tree species alone in a managed forest plantation is not sufficient to assign a relative value of snow interception capability, as implied by Allen *et al.* (1987).

The nature of this interaction between tree species and spacing is evident when relative snow depths are calculated as a percent of

Table 2. Mean snow depths and percent snow depths (% of control) under red pine, white spruce and black spruce planted at 1.8 m, 2.7 m and 3.6 m spacing. Jack pine were only planted at an operational 1.8 m nominal spacing. Ranking refers to the relative ability to intercept snow. Complete snow interception has a value of 1.0 and no snow interception has a value of 0.0.

| Species | Spacing (m) | Mean Snow Depth (cm) | Snow Depth as Percent of Control | Ranking |
|---|---|---|---|---|
| black spruce | 1.8 | 18.54 a[+] | 35 | .65 |
| white spruce | 1.8 | 20.25 ab | 38 | .62 |
| red pine | 1.8 | 22.07 bc | 41 | .59 |
| white spruce | 2.7 | 25.07 cd | 47 | .53 |
| red pine | 2.7 | 28.34 de | 53 | .47 |
| red pine | 3.6 | 29.34 ef | 55 | .45 |
| black spruce | 2.7 | 31.40 efg | 58 | .42 |
| white spruce | 3.6 | 32.14 fg | 60 | 40 |
| jack pine | 1.8 | 34.14 g | 63 | .37 |
| black spruce | 3.6 | 47.67 h | 88 | .22 |
| control | | 54.20 i | 100 | |

[+]Numbers followed by similar letters are not significantly different at the 95% level.

the snow depths measured on the control plots (Fig. 1). Red pine and white spruce crowns apparently expand to fill the space produced by the lower tree density. On the other hand, black spruce crowns do not expand the same way, even on this fresh, upland site (OMNR 1989). We also observed a great difference between the snow interception capability of white or black spruce at the 1.8 m spacing compared to the operationally planted jack pine which had snow depths almost twice as deep as the spruce.

Crop planning initiatives, where the economic impact of species selection or tree spacing in plantations are determined, should consider the changing value of conifer stands for moose late-winter habitat, based on snow interception capability. Thesame implication applies to HSA, where wood-supply models are linked to habitat values for moose. Allen *et al.* (1987) proposed a relative ranking of tree species for their ability to intercept snow (Table 1). We suggest that rankings of snow interception capability must also consider the relative density of trees in the stand (Table 2). These ranks not only vary with spacing but the relative value of each species in relation to one another also varies with spacing. In addition, there are significant implications to how moose winter habitat is interpreted in Ontario. Conifer stands are assumed to provide winter habitat when they reach 6m in height (OMNR 1988). These data suggest that black spruce stands, even at 40 years of age and greater than 12 m in height, do not provide adequate protection from deep snow when planted or thinned to a 3.6 m spacing. On the other hand, most species probably provide sufficient protection from deep snow at 1.8 m spacing. Traditionally, conifer plantations in Ontario are planted at 2 m spacing but wider spacing at time of planting, or thinning later may reduce plantation density and alter growth form, yield or age of first operability.

This investigation dealt only with snow depth, although we recognize that species selection and spacing in conifer plantations may also influence other moose habitat values such as thermal protection, snow hardness or density. We hope these results stimulate interest in the study of habitat values of the "new" forest. As yet, there are very few examples of randomized plantations the age

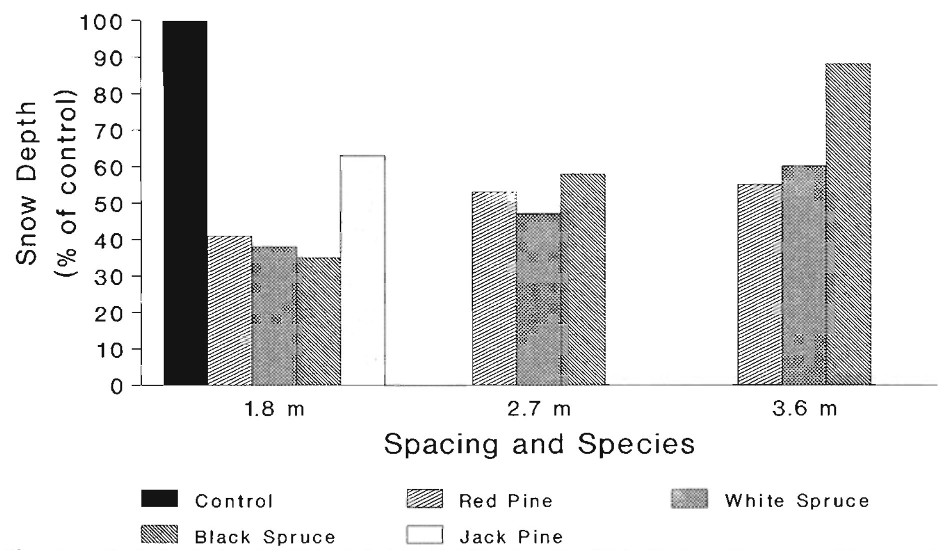


Fig. 1. Percent snow depth, compared to the snow depths on the control plots, in relation to tree species and planting spacing. Red pine (Pr), white spruce (Sw) and black spruce (Sb) were planted in perfect lattice outplantings; the jack pine (Pj) was operationally planted in rows.

of the Thunder Bay Spacing Trial, and wherever possible the value of these components of the "new forest" should be examined to try to forecast their value as wildlife habitat.

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