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Crown shyness in maturing boreal forest stands

Highlights

- Tree crowns may collide frequently and violently in storms, breaking off foliage, buds and twigs. This creates empty space between the crowns of trees, known as crown shyness. This loss of leaves may cause a loss in stand productivity of older stands.
- Tall and slender trees such as lodgepole or jack pine sway widely in wind storms. Trees with stout boles resist the force of the wind and remain rigid.
- Experiments show that if older stands with crown shyness are artificially prevented from colliding in the wind, they gradually fill in the empty space in the canopy.
- Thinning may be a mechanism to reduce crown shyness and maintain productivity in older conifer stands.

Crown shyness is the empty space between crowns of trees in maturing, fully-stocked conifer stands. This empty space is thought to be caused by breakage of twigs and branches during collisions of crowns during wind. This loss of leaf area decreases productivity of the tree, and the onset of crown shyness in older/taller stand signals the decline in overall stand productivity.

This research note presents information on the cause of crown shyness, its pattern of development and what it means for stand dynamics and forest productivity.

Tall pine trees sway widely in the wind

Figure 1 depicts the movement of the crowns of ten 15m tall lodgepole pine trees in a moderate wind storm (mean wind speeds of 18 km/h). Electronic levels and a data logger recorded the position of each tree every 1/10 of a second. Polygons represent the size and shapes of crowns at 12m height. Colouring and shading are used to display the different positions of the crowns over five - 1/10-of-a-second intervals.

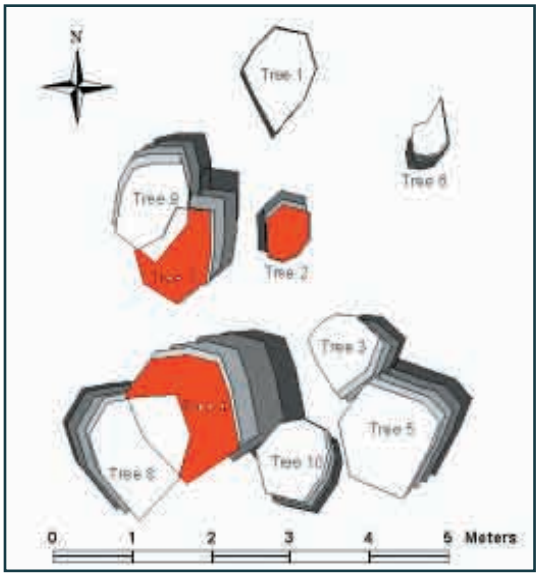

Figure 1. Movement of crowns in a moderate wind storm.

In this moderate wind storm, tree crowns collided hundreds of times per hour and individual crowns oscillated more than 2.5 m from vertical. Dominant and co-dominant trees moved in different directions, with varying frequency in the wind and often collided violently. For example, note the overlap in the crowns of Tree 4 and 8.

A wind storm can act like a barber shaping the crowns of trees

In the photo on the left, the movement and collisions of two trees from wind wore away the foliage and buds between neighbouring trees.

The photo on the right illustrates that twigs of conifers are very brittle in cold conditions. Collisions during cold periods are more likely to break twigs and branches. This may explain why crown shyness is a larger issue in boreal and montane forests than in warmer temperate regions.

Photo courtesy of Uldis Silins.

Photo courtesy of Victor Lieffers.

The sky becomes more open as stands grow in height

These photos of two lodgepole pine stands show the lack of crown shyness in short stands (left) and the gradual increase in crown shyness as stands grow in height (right). In unthinned lodgepole pine stands, more than half the sky is open (shy) in 20m tall stands.

Photos courtesy of Victor Lieffers.

Surprisingly, the length of crown does not increase in stands with greater crown shyness. This is the natural progression of stand development in unmanaged stands. The crown shyness phase corresponds with the understory re-initiation phase of stand development and decline in stand-level growth.

A forested webbed-site: crowns can recover from abrasion

In the photo to the right, groups of 12-15 trees in 16m tall lodgepole pine stands were webbed together to prevent them from colliding with each other in the wind. The canopies were photographed and then photographed again 6 years later. After webbing, the crowns filled in 15% of the empty space and they held more leaf area. This suggests that stands can recover their productivity if crown abrasion is decreased.

Lodgepole pine stands webbed together.
Photo courtesy of Mark Rudnicki.

Some trees stand solid–others bend with the wind

Trees with slender boles have relatively small crowns but they have even less ability to resist deflection in wind. They therefore sway widely in wind and are more likely to collide violently with neighbours.

Trees with slender boles are therefore likely to have greater levels of crown shyness. Stands that are grown at high density are more likely to have slender trees (Figure 2).

Thinning and crown shyness

The two photos below show two 16 m tall white spruce stands in New Brunswick. The stand on the left is unthinned, and is showing initiation of crown shyness. The stand on the right has been thinned from below. The gaps between crowns have refilled.

The unthinned spruce stands were developing crown shyness while commercially-thinned stands appeared to occupy more of the canopy area. More complete occupancy of the overstory is likely to increase overall productivity.

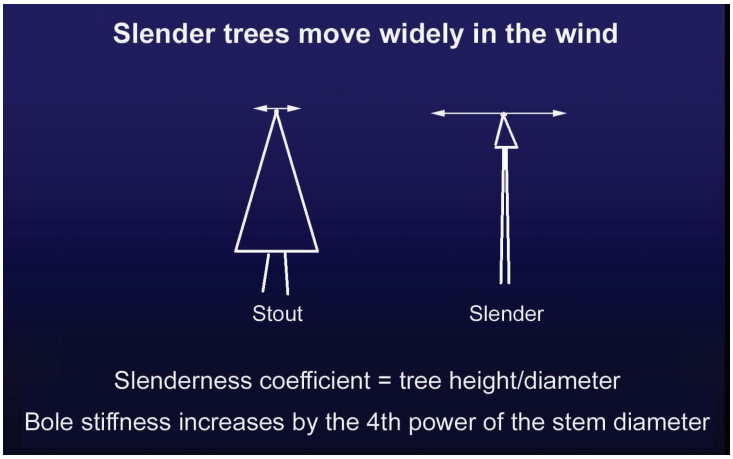

Figure 2. Trees with slender boles sway widely in wind.

Photos courtesy of Victor Lieffers.

Further reading

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Management Implications

- Stand productivity is thought to decline at the onset of crown shyness.
- Onset of crown shyness is also the time of increased light transmission to understory layers of the forest thereby allowing recruitment of trees and understory plants.
- Genetics selection for stiffer and stouter trees could delay the onset of crown shyness.
- A careful commercial thinning regime of even-aged stands could develop trees with stouter stems that delay the onset of crown shyness.
- Understanding the processes in the development of crown shyness will give managers opportunities to influence stand productivity and yield, carbon storage, light transmission to the understory and forest biodiversity.
- Crown shyness should be considered in individual-tree growth and yield models.

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