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Regeneration Patterns in the Mountain Hemlock Zone

Introduction

The Mountain Hemlock (MH) zone includes all subalpine forests along British Columbia's coast. It occurs at elevations where most precipitation falls as snow and the growing season is less than 4 months long. The zone includes the continuous forest of the *forested subzones* and the tree islands of the *parkland subzones* (Figure 1). Old-growth stands are populated by mountain hemlock, Pacific silver fir, and Alaska yellow-cedar, and are among the least-disturbed ecosystems in the world. Canopy trees grow slowly and are commonly older than 600 years, while some Alaska yellow-cedars may be up to 2000 years old.

Understanding regeneration patterns in the MH zone has become increasingly important as logging continues towards higher elevations of the zone where snowpacks are deeper.

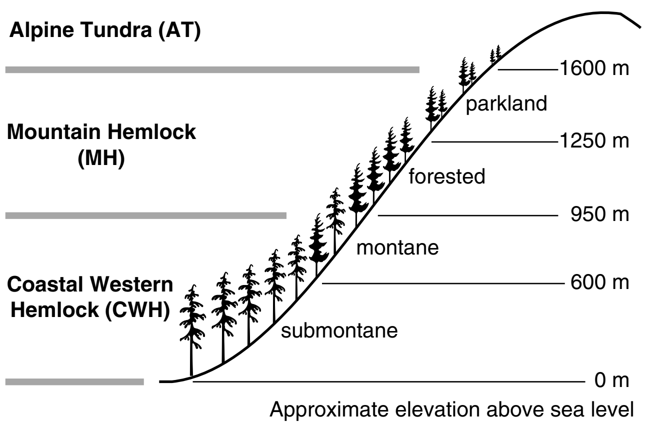

Figure 1. Elevation sequence of biogeoclimatic zones and subzones in southern coastal British Columbia.

Regeneration patterns in adjacent forests

Regeneration patterns on the BC coast change with elevation. At lower elevations, within the Coastal Western Hemlock (CWH) zone, regeneration matches the *gap model*: trees are most likely to regenerate in gaps in the forest canopy caused by the death of one or more trees (Figure 2). While the gap model favours regeneration far from other trees, snow at high elevations inverts the pattern to favour regeneration close to other trees (the *tree-island model*, Figure 3) and results in the tree islands that define the parkland MH subzones. Tree islands are usually on raised ridges or mounds that are first to emerge from snow and are the only microsites with a long enough growing season to support tree establishment and survival.

This study examines regeneration patterns at elevations that are intermediate between these two systems, those within the forested MH subzones. It is based on results from 6 old-growth stands in Tetrahedron Provincial Park, near Sechelt, at elevations ranging from 1080-1195 m.

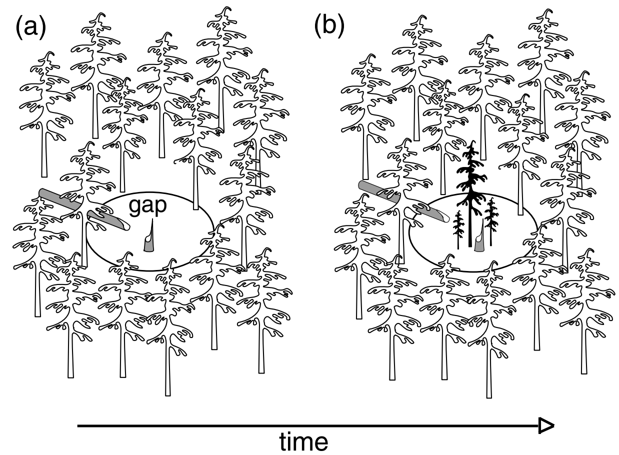

Figure 2. The gap model. (a) A canopy gap is formed by the death of one or more canopy trees. (b) With the passage of decades or centuries, the gap is eventually filled by a new canopy tree. Trees are most likely to reach the canopy layer far from other trees.

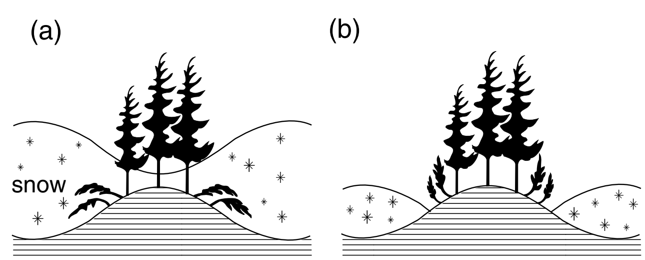

Figure 3. The tree island model. (a) Snow blankets the ground in winter. (b) With the onset of warmer weather, snow melts first near trees and on mounds. Trees are most likely to establish and survive close to other trees.

Where does regeneration grow?

As expected, we found less snow and earlier snow melt on mounds, under the forest canopy, and near canopy trees. Late-snowmelt sites had a more open canopy than early-snowmelt sites, and were more likely to be north-facing and flat than south-facing and steep. Most trees died standing and singly so there were no large canopy openings created by multiple treefalls as are common in low-elevation stands. Though there were many large (up to 600 m²), late-snowmelt gaps, especially on flat sites, they did not support the vigorous colonization that would be expected if such gaps were required for regeneration. Most such gaps had not supported canopy trees for many centuries (if ever) since stumps were seldom present, and, since most regeneration was <2 m tall and buried by snow well into June, they are unlikely to support canopy trees in the near future.

Regeneration was most successful on mounds and near canopy trees. It was unaffected by overhead canopy cover (*i.e.*, the presence or absence of a canopy gap), apparently because of the prevalence of low-angle, diffuse light. In contrast to most forested ecosystems, almost all seedlings and understory trees established on undisturbed forest floor rather than on decaying wood or mineral soil (Figure 4).

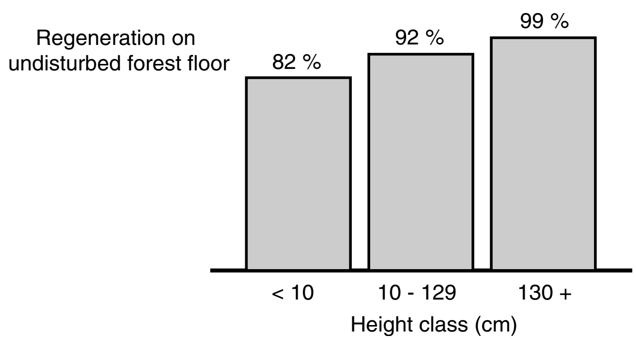

Figure 4. Most regeneration grows on undisturbed forest floor, and the proportion increases with tree height.

Do regeneration patterns match the gap or the tree-island model?

Regeneration patterns are more consistent with the tree-island model than the gap model since trees are most likely to survive on mounds and close to a canopy tree. Still, the presence of some regeneration in gaps show that the study sites supply a transition between gap and tree-island models. The tree-island model is best expressed on flat, north-aspect sites that retain snow the longest and so are most similar to high-elevation sites. It is also more apparent in the regeneration of Alaska yellow-cedar than of mountain hemlock. While both species regenerate successfully beside other canopy trees, mountain hemlock is much more common in canopy gaps, especially on steep, south-facing sites. The different regeneration patterns of these species may be related to their ecological niches in that, snow may more strongly restrict the regeneration of a species near the upper limit of its elevational range (like Alaska yellow-cedar) than that of a species in the middle of its range (like mountain hemlock).

Management Implications

This study shows that regeneration patterns reflect the impacts of elevation and snow and hence, indicate potential regeneration problems. For example, regeneration patterns that match the tree-island model indicate high snowpacks and severe growing conditions. As growing conditions become more severe, we expect that regeneration problems will increase. Simple measures could be developed as indicators of the severity of growing conditions, especially the date of snowmelt and the proportion of understory and sub-canopy trees growing on mounds and close to canopy trees. Other useful measures are already recorded during standard site diagnosis.

Some indicators of the tree-island model

- snow on the ground in late May
- regeneration that is mostly on mounds or close to other trees, particularly where there are distinct tree islands
- a change in species composition that excludes lower-elevation tree species (like western hemlock and Pacific silver fir), especially if subalpine fir is present
- an open-canopy stand with short (<25 m), heavily-tapered canopy trees, and a poorly-developed sub-canopy layer
- a predominance of standing dead trees (snags) rather than windthrown trees
- treeless gaps without standing water or stumps (late-snowmelt gaps)
- large gaps containing only mountain hemlock and Alaska yellow-cedar understory trees, especially when they are almost prostrate and covered by moss
- species that are indicators of high-elevation growing conditions such as heathers, crowberry, partridgefoot, and white rhododendron

Reference

Brett, R.B. and K. Klinka. 1998. A transition from gap to tree-island regeneration patterns in the subalpine forest of south-coastal British Columbia. Can. J. For. Res. 28: 1825-1831.

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