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Plant Diversity in Old-Growth and Second-Growth Stands in the Coastal Rainforests of British Columbia

Introduction

One of the human activities impacting biodiversity is the cutting of old-growth forests. In response to the controversy surrounding the cutting of old-growth in the coastal rainforest of BC, the Ministries of the Environment and Forests have produced biodiversity guidelines that are to be applied when manipulating stands in the provincial forest.

This study augments these guidelines by investigating the diversity differences between second-growth and old-growth forests in relation to site quality. We demonstrate how stand-level plant diversity differs between 40-year-old and old-growth stands in the Very Wet Coastal Western Hemlock subzone (CWHvm) on Vancouver Island. This information is intended to provide foresters with an understanding of the effects of age, disturbance and site quality on stand-level plant diversity, thereby allowing for informed professional management decisions.

What is biodiversity and how is it measured?

Biodiversity, a short-form for biological diversity, can be organized at three principal levels: genetic, species and ecosystem. This study examined plant diversity at the species level and targeted understory vascular plants which comprise the majority of plant species in coastal temperate forests. Alpha (α) diversity is a measure of species diversity within an area or ecosystem. The most commonly used measure of α diversity is species richness (S), a simple count of the number of species present within an area. In contrast, beta (β) diversity describes the diversity differences between areas or ecosystems. Beta diversity can be measured by a similarity index, such as the Sørenson index, where an index of 1 would indicate areas identical in terms of species composition.

Alpha diversity (α)

Species richness = number of species per area

Beta diversity (β)

$$\text{Sørenson index} = \frac{2\ (\text{no. of species common to areas A and B})}{(\text{no. of species in area A}) + (\text{no. of species in area B})}$$

Does alpha diversity change over time?

All levels of diversity are subject to temporal variation. Following a stand-destroying event, whether by natural or anthropogenic disturbance, the forest will pass through a series of predictable developmental or successional stages. As it progresses through the stages there is a shift in species diversity (Figure 1). The most dramatic shift in understory plant diversity (when the species diversity declines) occurs shortly after an old-growth stand is removed. Diversity will then increase during the stand initiation stage as early successional species colonize the site. When canopy closure occurs, most if not all, of the pioneer species may disappear causing another decrease in diversity during the stem exclusion stage. Species diversity will gradually increase again as the forest moves into the old-growth stage and the late successional species reappear.

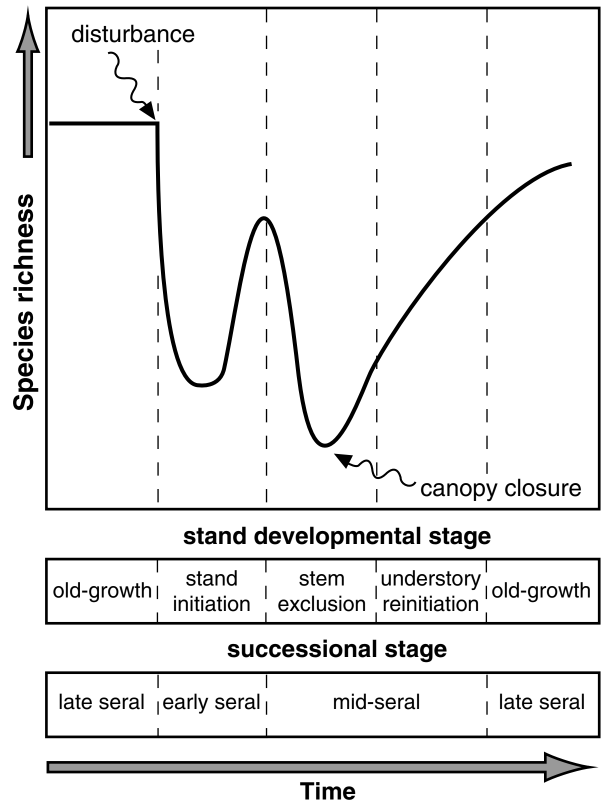

Figure 1. Generalized model of stand-level diversity change over time.

Does alpha diversity vary with age and site quality?

Since all species grow, reproduce, and thrive only under a limited range of ecological conditions, the diversity of understory vegetation will also vary with site quality. In this study, the immature and old-growth stands were segregated into a series of site associations, where each site association represents sites within a relatively narrow range of environments that are capable of supporting a certain biotic community. The five site associations identified in this study were named after the major understory indicator plant species: Salal, Blueberry, Deer fern, Foamflower and Salmonberry. In general, along the edaphic gradient from Salal to Salmonberry, there is a change from slightly dry to very moist soil moisture conditions and a change from poor to rich nutrient conditions.

Our immature study stands were in the mid-seral stage of succession, and the presence of partly open canopies indicates the onset of the understory reinitiation stage. As expected, species richness was lower in immature stands than in old-growth stands with similar site quality (Figure 2).

Trends in species richness were also examined across the site associations. The effects of site quality on diversity differed for immature and old-growth stands. The old-growth stands showed a clear trend of increasing diversity with increasing soil moisture and nutrient levels. Species richness was lowest on water-deficient and/or nitrogen-poor sites (Salal, Blueberry and Deer fern), and highest on moist and nitrogen-rich sites (Salmonberry). In 40-year-old stands this trend was not found.

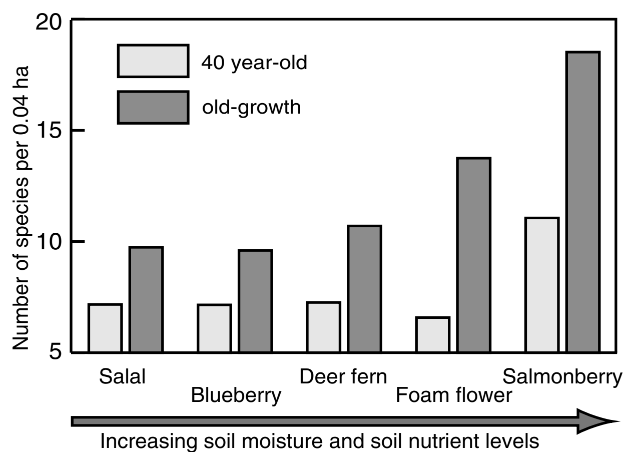

Figure 2. Average species richness in 40 year-old and old-growth stands across the five site associations.

Does beta diversity vary with age and site quality?

When the β diversity of immature and old-growth was compared, the understory vegetation in the old growth stands was found to vary more from stand to stand (*i.e.* they had a lower Sørenson similarity index) (Figure 3). In terms of change in b diversity from the old-growth to immature, the least change or loss in stand to stand variation was on the Deer fern sites.

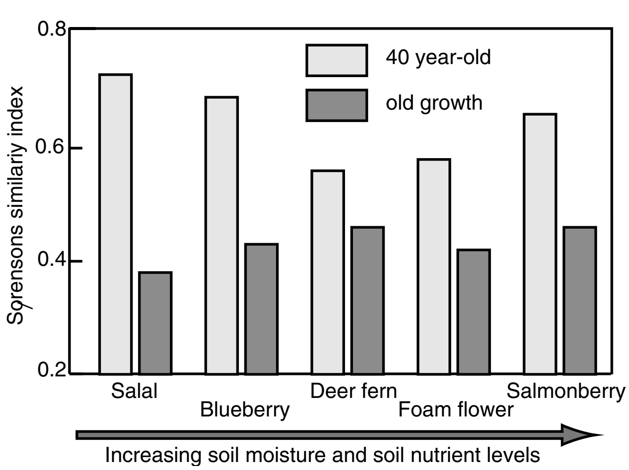

Figure 3. Beta diversity in 40 year-old and old-growth stands across the five site associations.

Why is diversity higher in old-growth stands?

Old-growth stands are more structurally diverse than immature stands. In the absence of major stand destroying disturbances, this increased structural complexity is a natural consequence of aging and, in fact, is the cardinal feature of old-growth. A higher microsite diversity offers more habitats and greater opportunities for species with different niche requirements to co-exist. The link between high structural diversity and high understory vegetation diversity is supported by the greater species richness (α diversity) and higher between-stand variation (β diversity) found in the old-growth stands. This study only investigated understory vegetation; had bryophytes and lichens been examined the differences between old-growth and immature stands would likely have been greater.

Preserving stand-level biodiversity

To minimize the impacts of logging on plant species diversity, as well as improving the chances for its recovery to the pre-harvest level, it is wise to maintain as much structural complexity as possible, and manage on a site specific basis. The measures recommended in the biodiversity guidebook will help preserve both structural complexity and plant diversity at the stand-level:

- retaining snags, individual trees and/or clumps of the original old-growth stands
- establishing mixed-species stands with trees distributed in a random-group pattern and with tree species that will naturally develop a stratified stand structure (*e.g.,* HwCw, HwBa)
- establishing and maintaining irregular canopy cover
- retaining coarse woody debris
- lengthening tree harvest cycles

Based on the results of this study we suggest that in the CWHvm subzone the above recommendations should be carefully considered on sites which have shown the greatest loss in α diversity (*i.e.* the rich sites). On poorer sites, where there is the greatest loss in β diversity, more attention should be given to the plant species composition of the stands prior to harvest to ensure the maintenance of β (stand to stand) diversity.

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