Woody Debris and Life History Strategies of Understory Plants: Exploring Burial and Clonality in Upland Old-Growth Forests

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INTRODUCTION:

The deposition of large amounts of woody debris is often a hallmark of old growth forest systems. Wood allowed to decay in place (necromass) contributes a unique nutrient and moisture regime to the forest floor (Harmon and Hua, 1991). Itself a source of disturbance, wood deposition can bury plants already vying for access to light in the understory. The slow decay rate of necromass presents a challenging substrate for plant reproduction. Regardless, understory plants continue to persist within the unique woody microtopographies of mature forest systems. Those with effective life history strategies such as the ability to reproduce asexually (clonally) can even thrive in this environment (Halpern, 1989). Clonality is widely seen as a life history strategy that enables plants to resource share, seek more beneficial habitat and **recover from disturbance** (Bittbiere, 2020).

METHODS

The experimental design and long-term monitoring of these plots was born out of the ashes (quite literally) of Mt. St. Helen's 1980 eruption (Antos and Zobel, 1986).

Study Sites: Four **old-growth subalpine forest** sites near Mount St. Helens, WA, USA, were studied.

Experimental Design: Sites were paired by tephra (volcanic ash) depth from the 1980 eruption (Deep: 15 cm, Shallow: 4.5 cm) and by understory diversity (Rich or Poor), creating four site types (DP, DR, SP, SR).

Plot Establishment: In 1980, ~100 **permanent 1m² plots** were established along transects at each site.

Data Collection: Identification and **percent cover of all vascular plants and woody debris** (wood, bark and branches) was recorded in all plots at peak growing season in 2025, adding to data collected using the same method in 1981, 2000, 2016, and 2020.

ANALYSIS

All statistical analyses were performed in R version 4.3.2 (R Core Team 2023). A multi-level approach was employed to examine **relationships between woody debris cover change and plant cover change.**

Occurrence Threshold Justification: A conservative 10% occurrence threshold was applied to focus analysis on **ecologically relevant species** with sufficient data for robust inference, excluding rare species that could produce spurious results due to limited occurrence.

Species-level Regression Analysis: Individual species meeting the 10% occurrence threshold were tested for an **interaction effect with change in woody debris cover**. Linear mixed-effects models were fitted with Site included as a categorical fixed effect (DR, SR, DP, SP) and Transect included as a random intercept term. Models for species indicating negligible variance at the transect level were simplified to ordinary least squares regression without random effects.

RESULTS

Clonal species that met the 10% occurrence threshold for analysis **dominated** both the total community (78.3%) and the analyzed species subset (89.0%), demonstrating their **ecological importance in this system**. (**Figure 1)**

Exploring the relationship between woody debris deposition and understory species cover from 2020 to 2025, **most species (14 of 16) showed no statistically detectable negative response to debris deposition** with effect estimates clustering near zero. Only two species (*Xerophyllum tenax* and *Arnica latifolia*) showed statistically significant negative responses. (**Figure 2)**

Spatial distribution of plant species reveals **differential site occupancy between clonal and non-clonal** groups across the study landscape and adds dimension to the only significant negative response to woody debris deposition on the part of *Xerophyllum tenax* and *Arnica latifolia* who mainly show cover in one site each. (**Figure 3)**

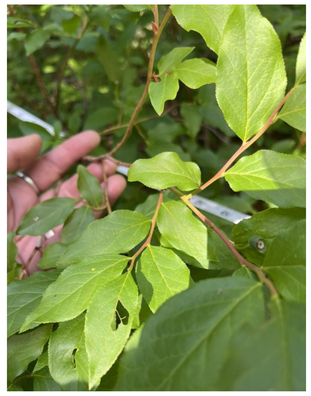

Figure 1

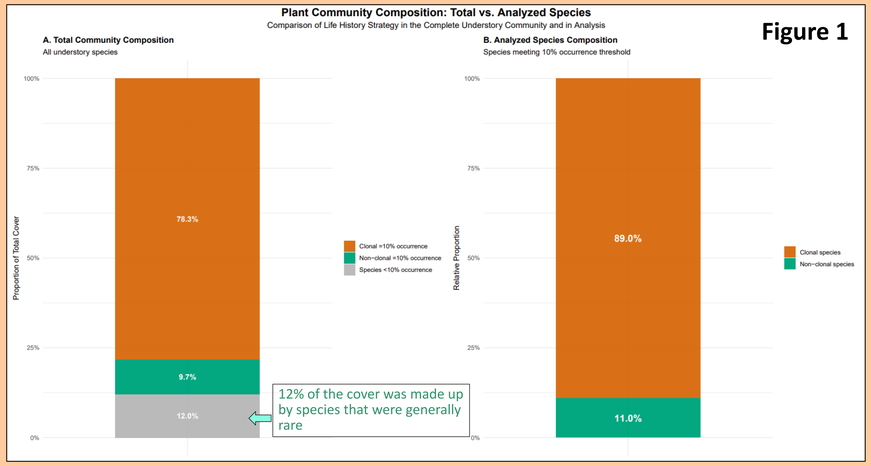

Figure 2

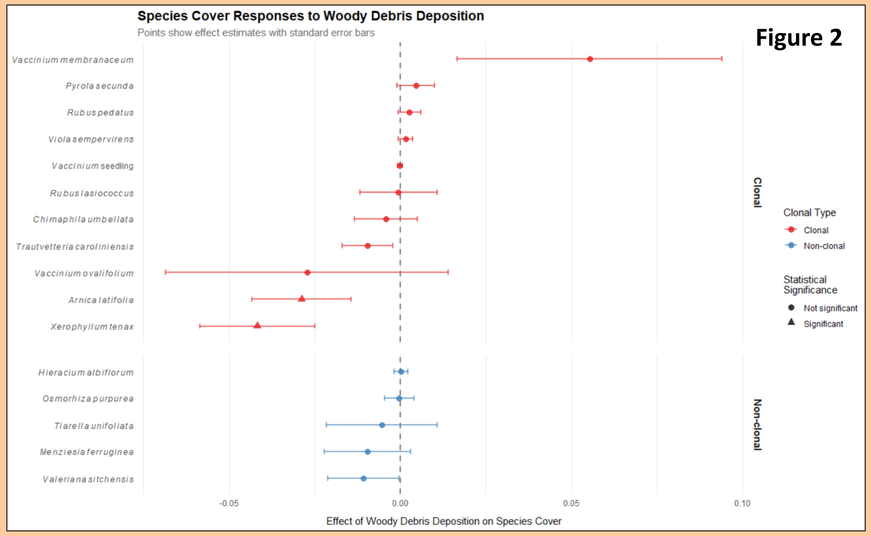

Figure 3

DISCUSSION:

- In the upland old-growth cascades forests, plant communities have a long history of interaction with volcanic disturbance and woody deadfall.
- The current data builds on **45 years of data** looking at plant responses to **burial by volcanic debris**.
- Plant responses to continuous **woody debris burial** were analyzed, which has not been previously examined at the sites.
- **Clonal plants dominated the community across all sites.**
- **14 of 16 widespread species showed no significant negative response to woody debris deposition.**
- This finding points to the idea that old-growth understory species are pre-adapted to disturbance by burial.
- **The plant communities that recovered most robustly after the 1980 eruption and tephra burial may have been those primed for burial through selection pressure provided by woody debris deposition in old-growth stands.**
- This information is pivotal in an era of ever-increasing disturbance where **old-growth forests can act as disturbance refugia.**

REFERENCES: available upon request