

RESEARCH ABSTRACT

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Study Title: Effects of airfall tephra on forests northeast of Mount St. Helens

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volcanic ash soil oxygen physiological *Abies amabilis* Pacific silver fir archives

Abstract: The May 18th, 1980 eruption of Mount St. Helens deposited tephra over a very large area of forest land in Southwest Washington. Tephra affected forest stands primarily by covering the foliage. Most tephra originally deposited is now on the forest floor; however, much of the finest deposits were retained by the foliage and still persist in the crowns of many trees.

Branch and foliage morphology of Pacific silver fir (*Abies amabilis*) results in its ability to intercept and retain tephra for the longest periods. Significant damage to the pre-1980 eruption foliage occurred after the eruption and continued through the summer. The amount of damage seen on the needles was significantly related to the amount of ash on the foliage. Foliar damage appeared to be related to elevated needle temperatures. The increase in needle temperature was not related to the temperature of the ash when it fell but was related to the ability of the needles to dissipate energy absorbed from the sun.

Seven sites ranging from 15 to 135 km from Mount St Helens were selected to study the impact of airfall tephra on the growth of *Abies amabilis*, *A. procera*, *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *T. mertensiana*. As tephra depth increased, there was a corresponding increase in visible foliar damage and associated decreases in diameter and height growth. Reduction in diameter growth was greater than reduction in height growth. The reduction in diameter growth approached 50% in both trees and saplings of *A. amabilis*. Growth reduction in true firs was greater than in associated species. This difference was related to their greater capacity for interception and retention of airfall tephra. Damage to trees, and resulting growth reductions, were due to tephra coverage of both the foliage and the soil. Coverage of the foliage resulted in foliar damage, foliage abscission and reduction of total tree foliar area, and increased fine root mortality. Tephra coverage of the soil had the potential to restrict oxygen diffusion into the soil. However, soil oxygen concentrations less than 10% were measured only once over a 2-year period.

Although Pacific silver fir seedlings and small trees recovered within two years after the eruption, mature and old-growth trees throughout the deposition zone began to show symptoms of advanced decline and mortality in 1986. In late 1988, nine growing seasons after the tephra deposition many mature and old-growth

mid-elevation conifer stands within the tephra deposition area are still showing substantial growth losses, decline, and mortality. Preliminary studies of the effects of the tephra deposition have revealed that in some areas virtually all Pacific silver fir trees are succumbing, probably as a result of the effects of tephra deposition, lack of subsequent recovery, or related insect or disease attacks. In other areas, Pacific silver fir recovered to some extent, ranging from slight to complete recovery. Within stands, the recovery of this species also varied widely. Presently, we are assessing the extent of growth loss within the tephra deposition zone. Preliminary results indicate growth losses are limited to Pacific silver fir, but are quite variable within the tephra deposition zone. The ongoing study is investigating the recovery of this species by relating its vigor to stand age, species composition, stand canopy structure, and other site variables.

Type of Measurement(s): We have set up 36 clusters of 3 circular plots each (0.05 hectares) in the areas impacted by ash deposition on the districts of Randle, Packwood and St. Helens. Measurements taken in each plot consist of: diameters of all trees, radial increments of selected trees, depth of 5 different textural layers of tephra in the soil, selected tree heights, and visual assessment of the severity of damage to Pacific silver fir trees.

Frequency of Measurement(s): Measurements began in July 1980 and continue through the present. Research plots were set up on a semi-permanent basis and their location has been precisely recorded. For the objectives of our project, repeated yearly measurements will only be taken on some representative sites.

Data Storage: Most of our data is still in the process of being analyzed. Data has been stored into conventional computer ASCII files and is available for analysis with any statistical package. Data concerning the effects of airfall tephra on physiological processes in true firs and on growth of sapling and full-size trees and on soil oxygen levels has been published. Data concerning effects of airfall tephra on forest decline, especially *Abies amabilis* is in data files in LOTUS 1,2,3 and will be published in Gerardo Segura's PhD dissertation.

Long-term plans: Data available for collaborative efforts: Seeking funding to further investigate effects of airfall tephra on mature trees in forests northeast of the volcano. We are very interested in maintaining our plot system for future reevaluations of general declining conditions. Our data and plot location information is available for any future collaborative research.