

TITLE: Effect of Swiss needle cast on crown structure of Douglas-fir as it relates to fire risk and potential fire behavior in western Oregon

FY2004 WEST COAST REGION

FHM FIRE Evaluation Monitoring Proposal (CONTINUING PROJECT)

LOCATION: Oregon Coast Range and Cascade Mountains

DURATION: Year 3 of 3-year project (2002-2004)

FUNDING SOURCE: Fire

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COOPERATORS:

Simpson Timber
Starker Forests
Oregon Department of Forestry
USDA Forest Service
USDI - BLM

PROJECT OBJECTIVES:

The overall objective of the proposed research is to assess the degree to which stands impacted by Swiss needle cast experience an increased susceptibility to wildfire. Specific objectives include:

- 1) To describe quantitatively the changes in tree morphology (foliage/branch quantity, distribution, and dynamics) resulting from Swiss needle cast;
- 2) To link these changes in tree morphology and dynamics to resulting alterations of fuel loads and potential fire behavior in trees with varying degrees of Swiss needle cast damage;
- 3) To establish the best procedure for rating Swiss needle cast damage (for example, needle retention, live crown to sapwood ratio, crown transparency, etc.) in other stands, and for linking the needle cast rating to implied fire risk and behavior.

JUSTIFICATION:

- 1) Links between FHM sponsored aerial surveys, intensively studied plots, and FHM, CVS, and FIA data will be achieved by ensuring a capacity to estimate crown and stand structure from routinely measured variables, and by making recommendations for alternative plot/tree measurements;
- 2) Swiss needle cast has attracted tremendous attention both within the forestry community of western Oregon and Washington and from the general public due to frequent media coverage. Some of forests at highest risk are in the old Tillamook burn in northwestern Oregon. Future conflagrations on or off the Tillamook State Forest would not only be politically disastrous - it would have severe economic consequences for forest industry, for whom the Coast Range is a prime Douglas-fir timber producing region.
- 3) The project implements sampling, laboratory, and analysis procedures that have been tried and tested at a lower level during previous Swiss needle cast survey work. Although the work is arduous and time-consuming, we do not see any potential pitfalls.

DESCRIPTION:

a. Background: The risk of wildfire in the western U.S. has increased dramatically over the past 50-100 years due to the unique stand structures and landscape patterns that active management (including fire exclusion) and pest outbreaks have produced. Swiss needle cast in western Oregon is rapidly becoming another agent capable of causing increased susceptibility to and severity of wildfire.

Since the 1980's the Swiss needle cast epidemic has become more and more evident in Douglas-fir forests of the Coast Range. Disease incidence and severity have increased dramatically during this time. Recent aerial surveys and permanent monitoring plots show sustained damage in the Coast Range, and there is some evidence that the disease is increasing in parts of the Cascade Mountains. The severity of damage varies greatly, ranging from stands with nearly complete defoliation to those with barely perceptible damage. Nearly a million acres of forest in Oregon are affected by this disease to some degree.

Swiss needle cast alters the morphology of trees and the structure of stands. The main effect on trees is premature loss of foliage, and this loss is greater in the upper crown of trees than in the lower crown. As a result of this crown sparseness, light penetrates deeper into the crown on diseased trees than on healthy trees, which appears to cause at least two major changes in stands: 1) understory vegetation proliferates and persists in stands in which it normally would be inhibited by shade; and 2) light filtering through the defoliated crown allows lower foliage and branches to remain on trees longer, slowing the rate of crown recession that normally occurs in response to shading. In addition, the natural dynamics of fine fuel accumulation, particularly from accelerated foliage loss, appears to be altered, and some evidence indicates that SNC-damaged trees have lower wood moisture content than healthy trees.

These changes to tree and stand structure and fuel accumulation likely affect fire behavior in several ways. First, the slowing of crown recession allows branch to persist longer than normal on trees, providing vertical continuity in ladder fuels. Secondly, the profligate growth of shrub species and subordinate trees provides a tremendous amount of understory fuels that extend well into the canopy of the overstory Douglas-fir. Third, ground fuel accumulation is accelerated

by premature loss of foliage, much of which falls just prior to summer drought rather than just prior to the wet season as normally would occur. Finally, the altered crown bulk density and moisture content likely influence combustion rates and convective air currents.

b. Methods: We will sample stands across a range in Swiss needle cast severity, as well as age and stand density. The sampling matrix will contain three levels of Swiss needle cast severity (severe, moderate, light), two age classes (20-40 and 40-60), and two Douglas-fir stand density levels (relative density 30-50 and 50-70). Selecting two stands in each of these 12 cells will yield 24 study sites.

At each study site we will establish a 0.04-ha circular plot (11.28-m radius) in a representative part of the stand. For all standing trees, we will measure height, dbh, and height to lowest live branch. For non-woody and woody vegetation <1.3m, we will estimate % cover and maximum height for each species on the 0.04-ha plot. Four dominant or codominant Douglas-fir trees will be selected randomly for felling, being sure not to include trees with top breakage or forks. Before felling, we will also determine needle retention, crown density, and crown transparency on the trees selected for felling. Four litter traps will be placed within each plot and emptied and weighed on a monthly basis.

On each felled tree, all live branches will be measured for basal diameter and height to point of insertion on the bole. On one of the felled trees, the live crown length will be divided into thirds and two branches will be selected randomly from each third. On the three other felled trees, one branch will be sampled randomly from both the fifth and tenth whorl. On all felled trees, a stem disk will be cut at breast height and at crown base. We will measure annual radial growth for the last five years, total sapwood width, and number of rings in the sapwood. Height increment for each of the past five years will be recorded.

For each sample branch, we will record the following information: 1) branch basal diameter; 2) total branch length; 3) foliage retention by year, main axis only; 4) foliage retention by year, laterals only; 5) foliage retention rating for entire branch; 6) number of secondary interwhorl branches by year; 7) number of secondary whorl branches by year. The branch will then be bagged, labeled, and transported to the lab to determine distribution of leaf mass and branch mass by age class.

Vertical distribution of needle and foliage biomass will be characterized across the gradient in Swiss needle cast intensity by fitting β -distributions to needle and branch data from each tree. Existing equations and the measured height data will be used to estimate amount and distribution of understory vegetation. Stand-level biomass distribution will be constructed as the composite of individual trees and understory vegetation, as well as litterfall rates. Implications for fire risk and fire behavior will be analyzed with components of existing fire models. Relationships among these results and sapwood area, foliage mass, crown length, foliage retention, crown density, and crown transparency will be quantified to allow extension of the results to conventional plot data, including FHM, CVS, and FIA data.

c. Products:

- 1) Report quantifying effects of Swiss needle cast on crown structure;
- 2) Report quantifying effects of Swiss needle cast on stand structure and litter dynamics;
- 3) Report on changes in fire risk and expected fire behavior induced by varying levels of Swiss needle cast;
- 4) Report documenting recommended field procedure for assessing Swiss needle cast severity and system for estimating associated stand attributes that are salient features of fire risk and/or fire behavior assessments.

d. Schedule of Activities:

2002	June-Sept	Plot location
	Sept-Dec	Plot establishment, tree measurements, foliage sampling; begin branch lab work
2003	Dec-March	Finish plot establishment, tree measurement, foliage sampling
	March-June	Branch lab work; data entry/editing
	June-Sept	Plot location; initial phase of data analysis; preliminary reporting
	Sept-Dec	Plot establishment, tree measurements, foliage sampling; begin branch lab work
2004	Dec-March	Finish plot establishment, tree measurement, foliage sampling; branch lab work
	March-June	Branch lab work; data entry/editing
	June-Dec	Data analysis, final reports

e. Progress/Accomplishments

Project is on schedule. All plots have been established and foliage and branches collected. Litter sampling has been completed. Eighty percent of data analysis is complete, and interim results have been reported to cooperators. A poster was presented at the annual forest health monitoring meeting in January 2003.

Results from the litterfall analysis indicate that after eight months, total Douglas-fir needle litterfall varied between 1578.0 to 3775.1 kg/ha, while total Douglas-fir fine woody material litterfall ranged from 55.0 to 619.2 kg/ha. After accounting for other species' total litterfall and basal area, a significant relationship between total Douglas-fir litterfall and needle retention, a measure of SNC, exists ($p < 0.05$). A one-year decrease in needle retention is associated with a 2012.5 kg/ha increase in total Douglas-fir litterfall.

COSTS:

In-kind contributions will be provided by cooperating landowners and agencies in the form of study sites and destructively sampled trees. Cooperating landowners will include the Oregon Department of Forestry and private landowners. The 2002 award was for approximately \$30,000, which was \$12,000 less than requested. The methods and scope of project were adjusted to reflect the reduced budget. The award for 2003 was \$37,000.

	Item	Requested FHM EM Funding	Other- Source Funding	Source
2004				
Administration	Salary	6,000	\$2,000	Landowners, in-kind service
	Overhead	1,000		
	Travel	1,000		
Procurements	Contracting			
	Equipment			
	Supplies			
TOTAL REQUEST - 2004		8,000		