



# Aerial Surveys for Swiss Needle Cast in Western Oregon



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## Introduction

In the last decade Swiss needle cast, caused by the native fungus *Phaeocryptopus gaeumannii*, has severely damaged Douglas-fir in the coast range of western Oregon. The primary impact of the pathogen on Douglas-fir (which is the only susceptible tree species) is premature loss of foliage, which results in significant reduction in tree growth. Recent reduction in volume growth from Swiss needle cast in western Oregon likely exceeds 100 million board feet per year.

## The Pathogen

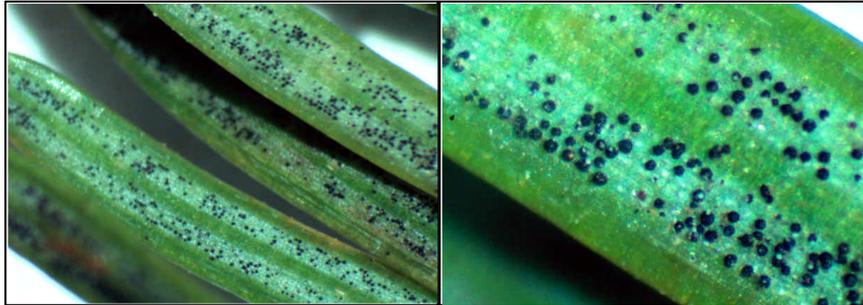


Figure 1. Fruiting bodies of *P. gaeumannii* block stomates on the underside of Douglas-fir needles, interfering with photosynthesis and water regulation

## Diseased

## Foliage Loss

## Healthy



Figure 2. The main effect of Swiss needle cast is premature loss of foliage, which results in growth loss and poor vitality. Before foliage is cast it often becomes very yellow (chlorotic) with irregular necrotic areas.

## Symptoms of Swiss Needle Cast



Figure 3. Trees damaged by Swiss needle cast have sparse transparent crowns and discolored foliage. Both height and diameter growth are reduced by the disease.

## Appearance of Diseased Stands

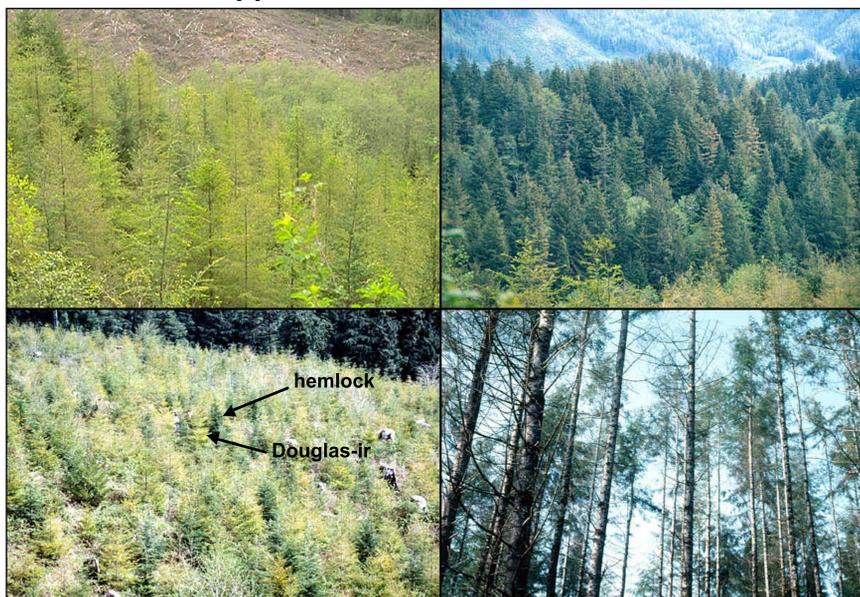


Figure 4. When Swiss needle cast damage is severe, Douglas-fir forests appear yellow to yellow-brown in the spring just before bud-break. This discoloration is the signature mapped by aerial observers. Sometimes crowns are sparse but not yellow, making aerial detection difficult.

## Aerial Survey Procedures

Since 1996, annual aerial surveys have been employed to monitor the amount and distribution of damage. Flights were made in April and May at 1,500 to 2,000 feet above the terrain, following north-south lines separated by two miles. The surveys covered about 2.9 million acres of forest each year. Observers looked for areas of Douglas-fir forest with obvious yellow to yellow-brown foliage, a symptom of Swiss needle cast. Patches of forest with these symptoms (the patches are referred to as polygons) were drawn onto 1:100,000 scale topographic maps. Sketch maps were digitized and the data analyzed using Arcview software.

## Aerial Signature of Swiss Needle Cast

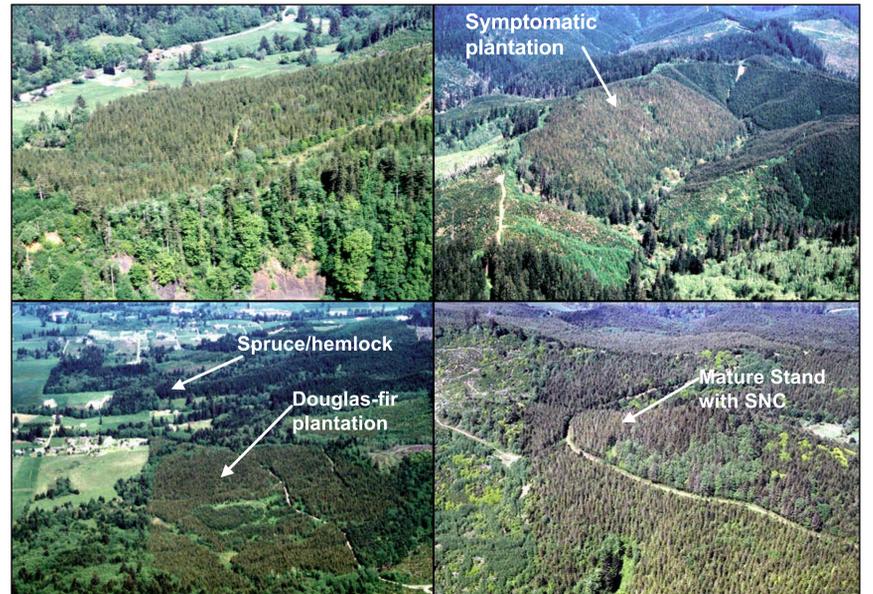


Figure 5. Aerial observers look for patches of Douglas-fir forest with yellow to yellow-brown discoloration.

## Aerial Survey Results

After five years of surveys, we have little doubt that Swiss needle cast symptoms continue to intensify, especially in the northern half of the Coast range. In 2000, 283,000 acres of Douglas-fir forest had obvious symptoms of Swiss needle cast, which was an increase of 100,000 acres compared to the 1998 survey in the same area, but a slight decrease compared to 1999. The slight decrease in 2000 may not be meaningful because of the inherent variability of the survey and the use of computer-based sketchmapping for the first time in 2000. Swiss needle cast symptoms are now detected up to 30 miles inland from the coast. Most areas with symptoms occur within about 18 miles of the coast, often within the Sitka spruce vegetation zone. The widespread planting of Douglas-fir within this vegetation zone, which has a climate favorable to Swiss needle cast, is an important contributing factor to the recent disease increase.

Flights were made over the west slopes of the Cascade range (more than 70 miles inland from the coast), and few areas with obvious Swiss needle cast damage were observed. Swiss needle cast is present in the Cascades, but damage is not severe enough to be detected from the air.

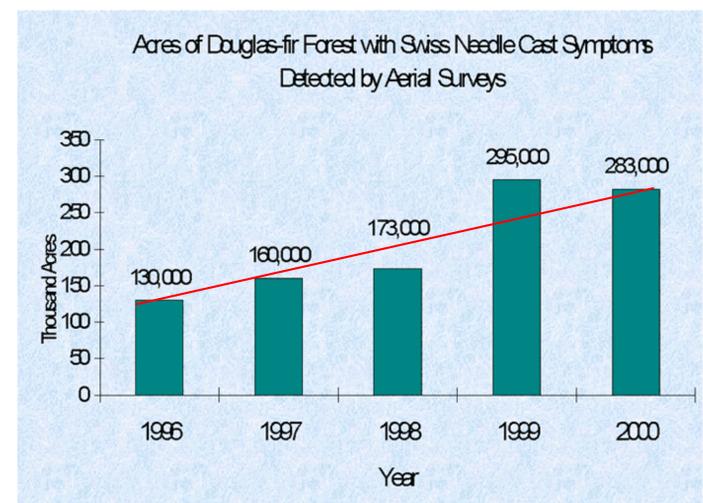


Figure 6. Trend in area of Douglas-fir forest in western Oregon with symptoms of Swiss needle cast detected during aerial surveys in April and May, 1996-2000.

## Did we map the same areas each year?

Areas mapped with symptoms in one year were not always detected the following year. When comparing the 1998 and 1999 surveys, about 55,000 acres were mapped in both years. In other words, about 31 percent of the acres mapped in 1998 also were mapped in 1999. When we superimposed the 1998 and 1999 maps, we found that 1,016 polygons overlapped and likely were attempts to map the same area of damaged forest. This represents about 50 percent of the polygons mapped in the 1998 survey. Failure to map the same areas each year is due to timing of the survey (early or late), conditions at the time of the observation flight (clouds can affect color perception), changes in the forest from harvesting, and errors in sketch-mapping the precise location of the polygon.

## Swiss Needle Cast 1996-2000

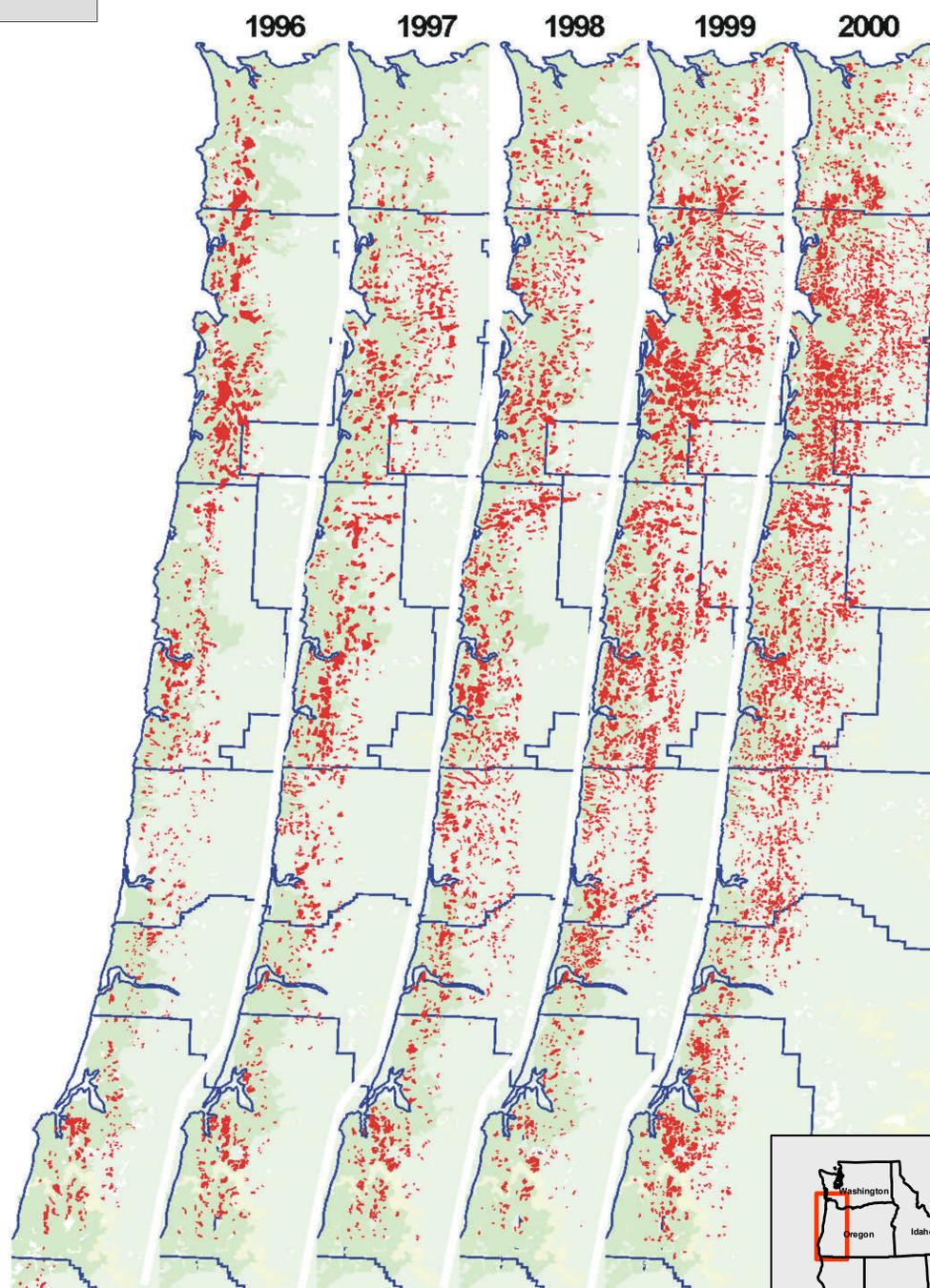
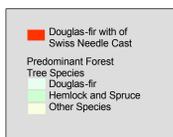


Figure 7. Maps showing patches of Douglas-fir forest with symptoms of Swiss needle cast in western Oregon, 1996-1999.

### Factors Affecting Survey Results

Survey results vary from one year to the next because symptoms change rapidly in response to weather conditions before and during the flight period (mid-April through May). Surveys flown later (close to the time of bud-burst) usually detect more areas with symptoms than those conducted earlier. In 1997, an unusual period of warm sunny weather at the end of May enhanced symptom expression, so we re-surveyed a portion of the northern Coast range. The late survey (May) detected twice as many acres of forest with symptoms as the earlier survey (late April) of the same area. Clear weather is required for flying, but the showery weather typical of April and May prevents precise scheduling of the survey for same time each year.

Factors other than the presence of the pathogen strongly affect disease and symptom development, and these factors remain poorly understood. The shape and distribution of survey polygons and the observer's comments suggest that symptoms are most obvious on southerly aspects and on exposed ridge tops, indicating a strong environmental interaction (Figure 8). Observations on ground plots also confirms this. Extreme weather events such as windstorms and unusually low temperatures appear to affect foliage loss and discoloration.

### Interaction of Environmental factors with symptoms of Swiss Needle cast



Figure 8. Symptoms of Swiss needle cast are most severe on southerly aspects and exposed ridges, and on the exposed upper crown of trees, indicating a strong interaction between disease and the environment.

### Ground Verification

We visited 100 disease monitoring plots located in the northern half of the survey area and compared disease severity ratings of plots that occurred within aerial survey polygons to those that were not in polygons (Figure 9). Swiss needle cast was present and damaging on all plots. Disease severity was slightly greater (significant at the .01 level, students t-test) in plots that occurred within aerial survey polygons than in those outside of polygons (Figure 10).

Many more acres of Douglas-fir forest are affected by Swiss needle cast than indicated on the aerial survey maps. Our maps represent only those areas where disease symptoms have developed enough to be visible from the air. Monitoring plots and other ground checks have shown that even though damage in an area may be severe in terms of needle loss, it might not be mapped by the surveyors, who depend on discoloration as the main indicator of damage.

### Ground Verification Plots

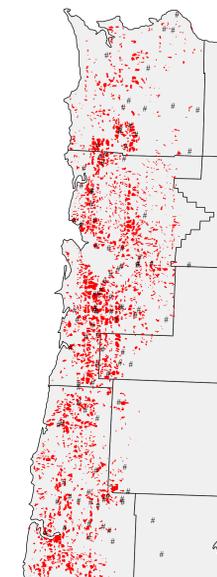


Figure 9. Location of 100 Swiss needle cast monitoring plots in the northern Oregon Coast range, and 1998 and 1999 aerial survey polygons.

### Needle Retention Inside or Outside of Aerial Survey Polygons

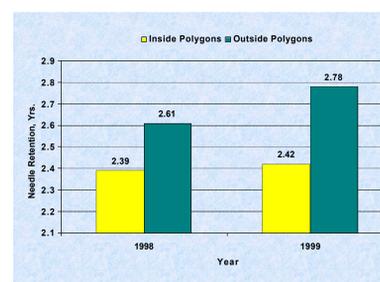


Figure 10. Mean needle retention for plots occurring inside or outside of aerial survey polygons, northern Oregon Coast range, 1998 and 1999. Needle retention is the number of annual compliments of needles present on lateral branches in May, with a range of values from 0.5 (severely damaged tree) to 3.5 or greater (healthy, undamaged tree).

### Conclusions

Aerial survey information is most useful for mapping general areas in which Swiss needle cast is causing significant damage to Douglas-fir forests. It depicts a zone in which Douglas-fir management should take into consideration the effects of the disease. By overlaying the distribution of polygons with vegetation and topographic maps, the survey also provides some insight into factors that affect distribution and severity of the disease. The acreage estimates are useful for documenting trends over time, but they are not an accurate measure of the true amount of forest with Swiss needle cast damage.

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