

Defoliator Modeling

Tracking Outbreaks Through Time

The towering, moss-covered trees of the “Emerald Edge”—the coastal temperate rainforest stretching from northern California to Alaska—are known for their lushness. So it is especially noticeable when those green forests start turning brown. One cause of this browning is outbreaks of defoliator insects, which feed on the needles and leaves of plants. Outbreaks play a major role in shaping forest dynamics across the coastal rainforest ecosystem, but research on defoliator population fluctuations is lacking, especially in terms of how climate influences outbreaks. Without this knowledge, land managers may struggle to predict and plan for future outbreaks.

A recent study fills the gap, using multiple types of data to create models of historical outbreaks of two major defoliator species. This helps researchers understand the conditions that gave rise to defoliator outbreaks from 1901 to 2020 in Pacific coastal temperate rainforests and offers insight into how they might behave in the future.

Western Blackheaded Budworm

Western blackheaded budworms are a defoliator insect native to the Western U.S. and Canada. During the larval stage, they prefer western hemlock. However, they can also target several other conifers, including Sitka spruce, Douglas-fir, Engelmann spruce, mountain hemlock, and true firs.



Photo by Edward H. Holsten, USDA FS



Photo by Elizabeth Graham, USDA FS

Hemlock Sawfly

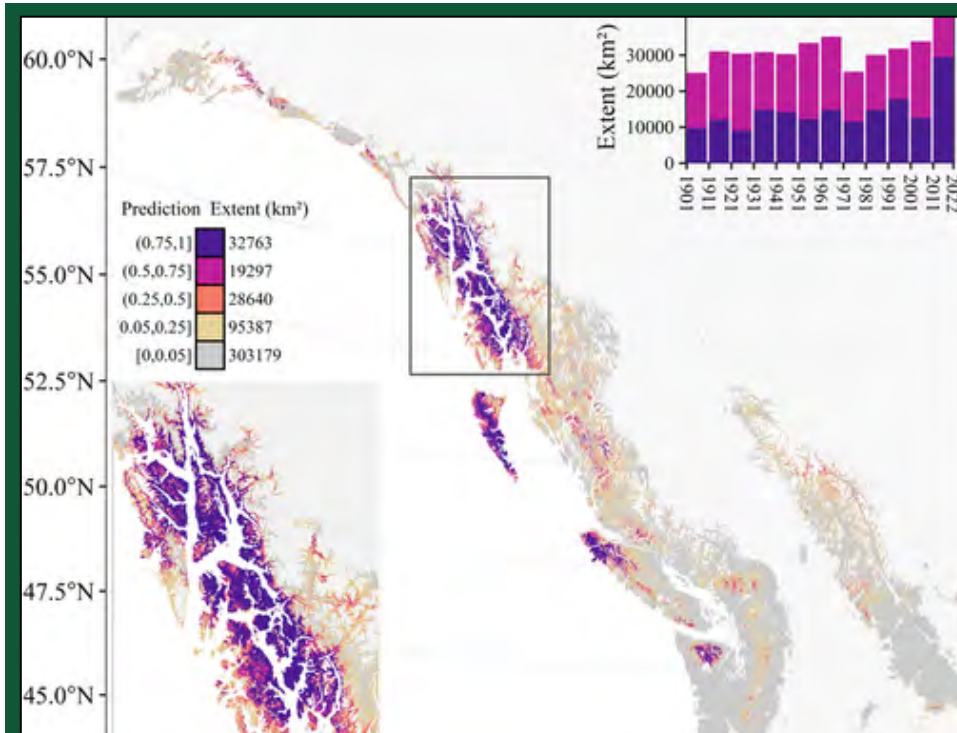
Hemlock sawfly are also a larval defoliator insect with a similar range to the blackheaded budworm in the Western U.S. and Canada. They also prefer western hemlock, but can target other conifer species if they are near infested trees, including Sitka spruce and mountain hemlock.



Defoliator damage in SW Alaska. Photo by of Michael Howe, USDA FS

Defoliator Damage

- Hemlock sawfly feed on mature needles, whereas the western blackheaded budworm feed on current year's growth.
- Damage from defoliators is often less immediately noticeable than that of bark beetles, but intense outbreaks can kill, topkill, or severely weaken host trees.
- Generally, an outbreak of one species does not result in widespread mortality, but impacts can be magnified if outbreaks of more than one defoliator species overlap.
- Defoliator insect damage is visible from the air as reddening or browning of needles, which can progress to a uniform grey coloration as needles die and drop. This is visible in the photo to the left.



Study Area

As an example, this map shows the predicted likelihood that hemlock-spruce forestlands could support outbreaks of western blackheaded budworm between 2011 and 2020 across the Pacific coastal temperate rainforest, with a focus window on Southeast Alaska.

The bar chart shows the predicted amount of hemlock-spruce forestlands that could support outbreaks in each decade. Colors in the bar chart correspond to the predicted ability to support an outbreak, not necessarily whether an outbreak occurred or not.

Figure from Howe et al. 2024

Outcomes

The study provides a baseline understanding of how and where defoliator outbreaks have occurred in the past, which is important information for forest managers.

The study also found that defoliator outbreaks happen in a specific “bioclimatic envelope,” or a set of favorable conditions. These conditions include:

- **Adequate host availability:** Whether or not there are enough of the insects’ preferred host tree species to support a large population.
- **Limited range of spring, summer, and winter temperatures:** Both extremes of hot and cold can inhibit the insects’ success, so outbreaks can only occur when temperatures are favorable throughout their growth.
- **Minimum precipitation:** Cold and wet seasons may encourage disease in the insect populations, including a fungal disease in hemlock sawflies known to act as a biocontrol.

Management Connections

- The study found that outbreaks have been moving northward over time as suitable climate ranges moved north over the last century.
- Of the three main bioclimatic factors influencing outbreak potential, temperature appears to be the most important factor influencing individual insect and population distributions.
- As climate change is projected to cause increases in temperature across this region, land managers should be aware of the potential for changing outbreak distribution, particularly those in the northern extent of these specie’s ranges.

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[Read the full article here](#)

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