

Insect Outbreaks in the Northwest

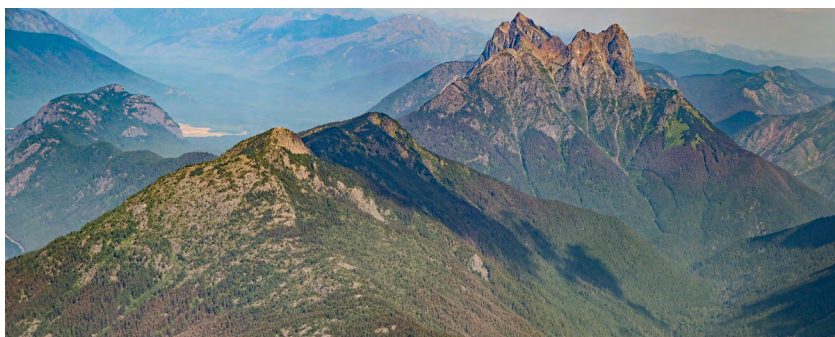
Northwest forests are home to many species of native insects that live in and feed on trees. When insect populations are small, they help thin old, stressed, or sick trees and diversify forest structure.

Forest insects are grouped based on how they feed or what part of a tree they eat. Two of the most common groups (sometimes called “guilds”) of forest insects in Oregon, Washington, and Idaho are bark beetles and defoliators.

Bark beetles and defoliators are found in many Northwest forests, usually in low numbers, and different species prefer different types of trees. However, both bark beetle and defoliator populations can grow in response to changes in environmental conditions.

What Leads to Insect Outbreaks?

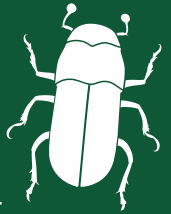
Forest insects can cause widespread tree damage and death when their populations increase quickly and remain large, often for multiple years, creating what is known as an insect outbreak. A quick, marked, increase in **bark beetle** populations is often prompted by disturbance events that weaken host trees, such as wind damage or drought. During large outbreaks, bark beetles can kill even healthy trees. The exact mechanisms that lead to **defoliator** outbreaks are less clear, but outbreaks usually happen when the climate is suitable and there is an abundance of host trees across a large landscape. Fungal diseases such as root rot can also weaken trees and make them more vulnerable to forest insects in any condition.



Western spruce budworm damage in the North Cascades of Washington, 2024. Forest Service photo by Justin Hoff.

Bark Beetles

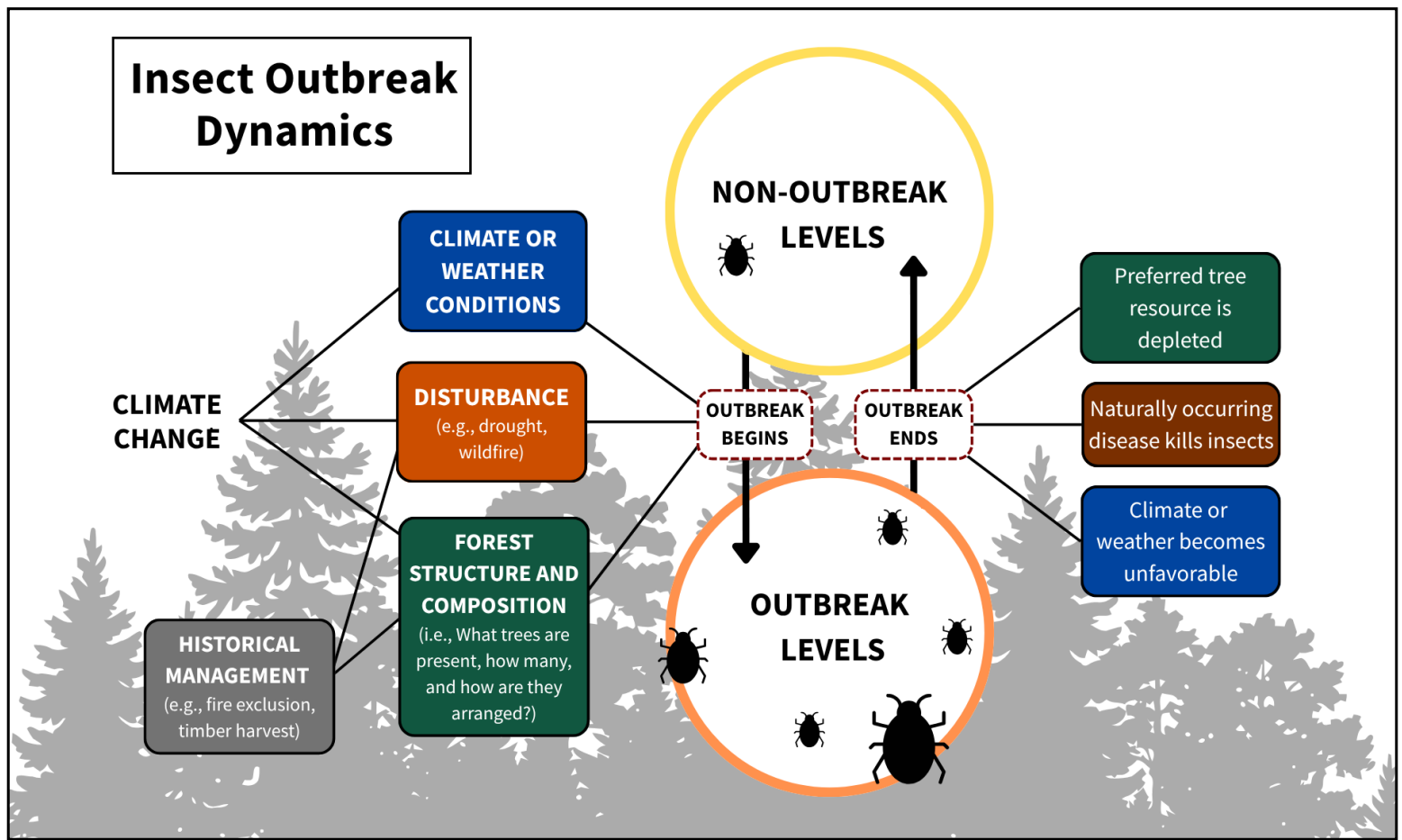
Bark beetles live in and feed under tree bark. When their populations are small, bark beetles generally feed on large, old trees that are already dying or weakened. These trees may be weak due to competition for resources, drought, disease, or some combination of the three. Stressed, dying, or weak trees are attractive to bark beetles because they have less energy to defend against insects. This often happens in crowded (high-density) forests where competition for water, sunlight, and nutrients is high. Disturbances, warmer temperatures, or an overabundance of preferred host trees can all create conditions that contribute to greater bark beetle numbers.



Defoliators

Defoliators eat tree leaves or needles. They eat new or old leaves (or needles) of healthy or weak trees, depending on the species and time of year. They are not known to target a particular tree size or age. Conifers may die from severe defoliation or when defoliation occurs over many successive years, whereas hardwood trees, such as bigleaf maple, rarely die from defoliation alone. Defoliator populations grow with suitable climate conditions and a sufficient number of host trees.





Insect outbreaks begin due to some combination of environmental disturbance, favorable forest structure and composition, and favorable climate or weather conditions. Source: USDA Northwest Climate Hub.

What Role Does Forest Structure and Composition Play?

Forest structure and composition influence susceptibility to insect outbreaks. Forests dominated by one tree species or tree size are especially vulnerable to bark beetles because they provide an abundant and readily available food source. On the other hand, certain defoliators like western spruce budworms prefer forests with trees of many ages. During outbreaks, bark beetles and defoliators can take even greater advantage of high-density forests where trees are stressed due to competition for nutrients and sunlight. Historical land management practices, including fire exclusion, have altered modern insect outbreak patterns by changing which tree species are present, and the number of trees, in certain landscapes.

How Does Climate Influence Insect Outbreaks?

Climate influences the timing and extent of insect outbreaks in forests. **Temperature**, one aspect of climate, directly dictates when some forest insects reproduce, emerge, and feed on trees. Forest insects use temperature to sync their life cycles with food availability. Western spruce budworm, for example, emerge from hibernation around the same time that new conifer needles emerge. Winter temperatures commonly determine the geographic range of some forest insects. Mountain pine beetle larva, for example, cannot survive extreme cold.

In Oregon, Washington, and Idaho, climate primarily affects insect outbreaks through its influence on trees, rather than the insects themselves. Because the region generally experiences milder winter temperatures, most of its native forest insects are already able to survive. While **drought** is a natural part of climate in this region, warming temperatures are increasingly worsening droughts by raising demand for limited water. Drought compromises tree defenses, making drought-stressed trees a common target for some insects.

What About Climate Change and Insect Outbreaks?

Climate change effects may alter outbreak patterns throughout the Northwest. Warmer temperatures are increasing drought severity, which can make forests more vulnerable to insect outbreaks. Other climate-related disturbances such as wildfire and heavy precipitation are becoming increasingly common. These can result in landslides and flooding that injure and kill trees, making forests more susceptible to attack by insects and pathogens.

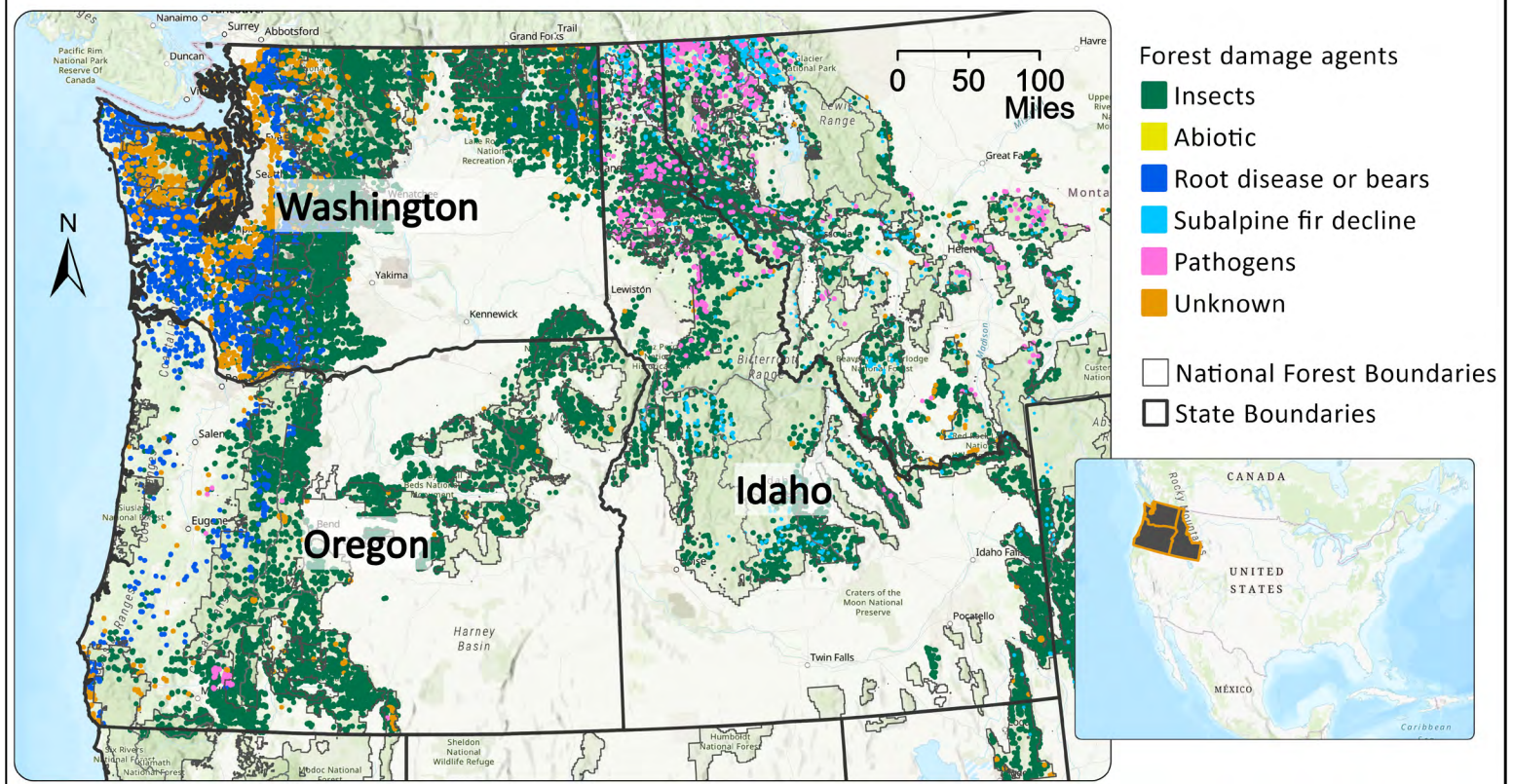
How Do Outbreaks End?

Insect outbreaks generally end when the insect's preferred host trees are depleted, or when climate or weather conditions suddenly change. Freezing temperatures in June, for example, can damage foliage and kill feeding western spruce budworms. Defoliator outbreaks may also end due to naturally occurring diseases within the population.

Insect Monitoring

Damage and mortality from insects can be measured from aircrafts with aerial detection surveys. Aerial detection surveys are generally completed every year in Oregon, Washington, and Idaho, and results are summarized in forest health reports along with ground survey data. These forest health reports summarize insect and disease damage and often include summaries of climate and wildfire for a given year. Satellite remote sensing and forest inventory data are also important sources of data on outbreak damage.

2024 USDA Forest Service Insect and Disease Aerial Detection Survey Results, USDA Northwest Climate Hub Region



2024 aerial detection survey data for Oregon, Washington, and Idaho, grouped by damage causal agent. Fungal diseases are hard to capture via aerial survey. As a result pathogens are greatly underrepresented in this dataset. USDA Northwest Climate Hub map by Analise Sala.

Species Spotlight: Mountain Pine Beetle

Mountain pine beetle is well known for its ability to kill large swaths of trees during outbreaks. In Oregon, mountain pine beetle has killed more trees than any other beetle, averaging 380,000 acres (roughly the size of Mount Rainier National Park) of tree mortality per year between 2007 and 2016.

Tiny but powerful, this native bark beetle lives and feeds underneath the bark of living lodgepole pine, ponderosa pine, sugar pine, whitebark pine, and western white pine trees in the Northwest. The beetles burrow into the tree bark to lay eggs; after hatching, the beetle larvae feed on the tree's living tissue. This disrupts the tree's ability to transport nutrients, which can weaken the tree and lead to death.



Lodgepole pine killed by mountain pine beetle on the Umatilla National Forest in Oregon in 2023. Forest Service Aerial Detection Survey photo.

In the Northwest, outbreaks of mountain pine beetle are most common in dense lodgepole pine forests and dense mixed-conifer forests (which may include Douglas-fir, ponderosa pine, and western larch) with large old pines. Mountain pine beetle outbreaks are also common in high-elevation forests of whitebark pine that have been weakened by white pine blister rust. Outbreaks tend to lessen once the beetles have exhausted the existing nearby supply of vulnerable trees.

Mountain pine beetle killed or damaged 90,200 acres across Washington in 2023, and over 24,000 acres in Idaho in the same year, primarily in lodgepole pine forests. Increases in mountain pine beetle activity are often associated with drought and disturbance events that may increase in frequency with climate change.



Pitch tubes on a ponderosa pine. Pitch is resin mixed with phloem (plant tissue that transports nutrients) boring dust that is produced by some trees in response to mountain pine beetle feeding. Photo by Cameron Nacify, GreenFire Geomatics.

Species Spotlight: Western Spruce Budworm

Western spruce budworm is a well-known cause of tree damage in the Northwest. A native defoliator, western spruce budworm feeds primarily on the needles and buds of Douglas-fir and true firs (*Abies* species). When the larvae first emerge, they begin feeding on old needles and buds, transitioning to new needles and leaves once they develop. Trees often appear reddish in color after western spruce budworm feeding.

Defoliation by western spruce budworm does not normally kill trees. However, if the damage is repeated or severe (greater than 90% needle loss), western spruce budworm can kill trees, primarily smaller trees with less foliage, and make them more susceptible to attacks from other insects such as Douglas-fir beetle or fir engraver.

The last significant outbreak of western spruce budworm in Oregon was in the late 1980s and early 1990s.

In Washington, after 6 years without noticeable defoliation, 63,500 acres of defoliation were detected east of Ross Lake in the North Cascades in 2024. In southern Idaho, western spruce budworm defoliation affected 146,000 acres in 2024, less than 1% of the 21.5 million acres of surveyed forestland. Outbreaks of western spruce budworm can range from a few years to decades, ending when local populations of preferred host trees are consumed or environmental conditions change.



(Left) Western spruce budworm damage on Douglas-fir trees (taller trees in center) and adjacent, undamaged Rocky Mountain juniper (shorter trees in lower center) in the northern Yellowstone region.



(Right) Western spruce budworm larva hangs from a silk fiber. Western spruce budworms produce silk for protection during feeding and can use the silk to drop down in search of a new food source. For this reason, western spruce budworms do well in multi-tiered forests with different age classes where they can eat overstory trees and use their silk to access understory trees below.

Photos by Cameron Naficy, GreenFire Geomatics..

Managing for an Uncertain Future

Much remains to be learned about insect outbreaks in the Northwest and how they may change under future conditions. Nonetheless, management strategies aimed at improving overall forest health can help forests remain resilient to the effects of insect outbreaks. Effective management will vary depending on the forest insect and tree species involved but may include:

- ***Diversifying tree species and tree ages*** to reduce damage for some host tree species during outbreaks.
- ***Managing forest density***, through actions such as prescribed burning or thinning, to reduce competition for resources and decrease tree stress.
- ***Removing weakened trees*** to prevent an outbreak from beginning and protect nearby healthy trees by decreasing the chances of insect population growth.
- ***Considering a site's microclimate, future climate projections, and host tree availability when planting trees*** to minimize future drought stress and improve long-term forest resilience to insects.

Many land managers are already preparing for changes in insect outbreak patterns associated with warmer temperatures. These adaptation efforts are most effective when implemented consistently across large areas and different ownership types.



A Forest Service land manager inspects trees for warning signs of drought and beetle infestation in the Sawtooth National Recreation Area on the Sawtooth National Forest in Idaho. Forest Service photo.

Resources

- **Field Guide to the Common Diseases and Insect Pests of Oregon and Washington Conifers**: A tool for land managers to help quickly identify the most common forest insects and pathogens in Oregon and Washington. It features written descriptions, identification keys, comparative tables, photographs, and line drawings to illustrate and emphasize key characteristics.
- **USDA Forest Service Insect and Disease Leaflets**: Each leaflet provides general information about an insect or disease affecting tree species in the United States. Certain leaflets are outdated and may need to be supplemented with other resources.

The Western Wildland Environmental Threat Assessment Center (WWETAC) develops and communicates the latest scientific understanding of environmental threats to the Western United States. We conduct applied science and provide tools and information to help land managers assess and respond to environmental threats, leading to more resilient landscapes. To learn more, visit <https://research.fs.usda.gov/pnw/centers/wwetac>.

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