USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE
Western Wildland Environmental Threat Assessment Center

Drought in the West

Interactions with Insects

Drought is a major influence on rangelands and forests in the Western U.S. The direct effects of drought are difficult to identify because they occur in conjunction with other disturbances, including outbreaks of insects, that vary widely by species and location on the landscape.

The effects of forest insects are often magnified under drought conditions. The exact relationship between drought, specific insects, and tree species is complex and still being studied. However, insects cause substantial damage to forests across the West. Of all insect types in the Western U.S., bark beetles cause the most damage and recent outbreaks have effected more forest acreage than wildfires.

The term “outbreak” is often used when discussing forest insect damage; many forest insects become harmful only when multiple biophysical conditions are met and negative feedbacks no longer limit population growth. Depending on the specific tree or insect species and landscape, drought, and especially the heat often associated with drought, can affect these conditions and make outbreaks more likely.

While drought is only one factor in complex ecosystems, there are a few general patterns noted below, such as signs of water stress and increases in insect population, that land managers can look out for when monitoring insect effects on forests.

Water stress reduces natural defenses

Droughts that last longer than a growing season can make trees more vulnerable to insect outbreaks by limiting their ability to use their natural defenses. For example, conifers that dominate Western U.S. forests produce pitch, which traps insects and seals small wounds in the tree’s bark. Water-stressed trees may produce less pitch in their response to attacks from insects like bark beetles. Their pitch may also contain fewer insect-repellent compounds like aromatic terpenes, which serve as an additional defense.

The combination of drought stress and insect damage can be particularly harmful, like this die-off of trees in Shasta Trinity National Forest. USDA Forest Service photo.

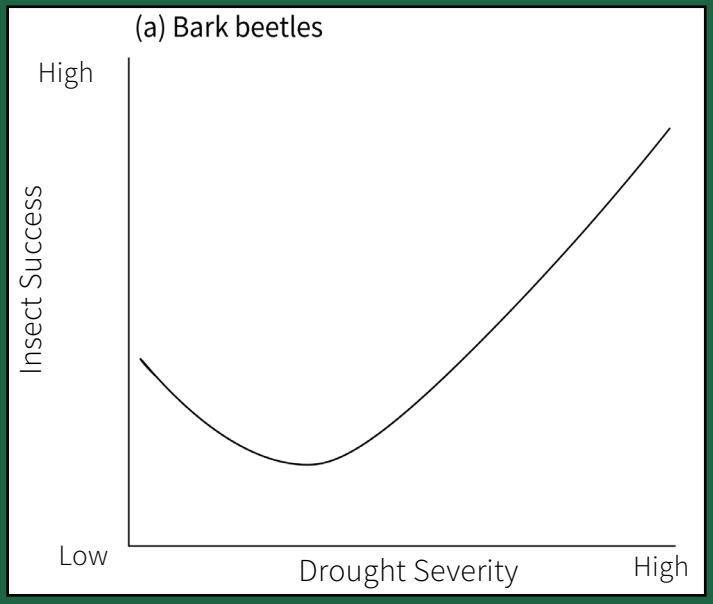
Overall tree stress increases vulnerability

Many forest insects attack already stressed trees. Often, insects are able to take advantage of an increased number of water- and heat-stressed host trees, which allows insect populations to grow large enough to damage less-stressed trees and affect larger areas. Damage from insects to already-stressed trees can tip them from surviving to dying.

Insects are also affected

The length and repetition of drought can have a significant effect on the pattern of insect disturbance. Some insect outbreaks, especially bark beetle outbreaks, may be more severe and widespread during short or intermittent drought because trees are stressed but still retain enough nutrients and moisture to feed an insect population. Recently, droughts have occurred with higher temperatures that can help insects survive through winter, magnifying outbreaks.

Multi-season droughts, however, may reduce the prevalence of some forest insects like defoliators because some do not prefer drier, more leathery foliage that results from plants that are water-stressed for a long period.



This conceptual figure shows how bark beetles generally respond to drought as it intensifies. Low- to moderate-severity drought can reduce bark beetle success as trees have low levels of carbohydrates and nitrogen and reduced moisture content of phloem which may negatively affect development of bark beetles. However, severe drought may inhibit most of a host tree's remaining biotic defenses, and the warm temperatures often associated with severe drought can have a positive effect on beetle populations. It is important to note that the effects of drought on forest insects is not straightforward and is still being studied. Adapted from Kolb et al. 2016. (https://research.fs.usda.gov/treesearch/52328)

Monitoring and management

Knowing when drought is occurring and for how long can inform forest health monitoring and planning. For example, aggressive species like mountain pine beetle and spruce beetle can cause widespread mortality for several years after a drought has ceased, whereas other beetle species like pinyon ips depend on water-stressed trees for success and quickly decline when wetter conditions return.

Resources

- "Observed and anticipated impacts of drought on forest insects and diseases in the U.S." provides a good overview of how drought and insect types interact throughout the U.S.
- USDA Forest Service Forest Insect & Disease Leaflets (FIDLs) have specific profiles for many forest insects and diseases.
- Use this link for more information about drought interactions and updates.

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.