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Dead Trees and Healthy Forests: Is Fire Always Bad?

Science & Policy Brief

Key Points:

- Fire and other disturbances are essential processes of forest renewal.
- Thinning is not appropriate in all forest types.
- Dead trees are a natural part of a healthy ecosystem.
- Salvage logging is not necessary to prevent future fire.

Fire and other disturbances are essential processes of forest renewal.

Forested landscapes may be thought of as living "crazy quilts," with patches formed occasionally through the action of natural and human-caused disturbances like fire, windstorms, and logging. Prior to the advent of modern logging technology, virtually every North American forest experienced occasional renewal through the action of fire. In some places, fire was a frequent visitor, killing very few large trees as it burned harmlessly through the forest litter and grass. In most places, though, fire burned only occasionally, creating patches of severely burned forest as it raced through the canopy under extreme weather conditions. In these patches, old forests were killed, soon to be replaced by young, rejuvenated stands. This cycle of forest maturation, death, and replacement was critical to maintaining the diversity and vitality of the ecosystem.

Change is the only constant.

As forests recover from major disturbance, they go through a series of changes. During the first stage, seeds germinate and grow into a forest of saplings. Recruitment of new trees into the forest continues until there are so many trees that new seedlings cannot compete for light, water, and nutrients. At that point, the forest enters a period of intense competition during which smaller, weaker trees lose out to larger, more robust trees. Mortality during this "stem exclusion stage" is called "density-dependent mortality" because it is caused by competition rather than by external agents.

Such mortality is often very high, resulting in the death of most of the trees in the stand and can last several decades in some forest types. For example, plantations of radiata pine with initial densities of 1500 trees per hectare will "self thin" to fewer than 250 trees per hectare in the first 50 years of stand development. It is not uncommon in normal, healthy developing stands for more than half of the trees at any one time to be dead from density-dependent mortality.

Eventually, during the development of natural forest stands, trees get so large that their death creates room for new trees, and the forest makes the transition from the stem exclusion stage to the "understory reinitiation" stage. At that point, the stand changes from even-aged to multi-aged, and the causes of mortality switch from density-dependence to a combination of competition and extrinsic forces like insects, disease, and wind. Some late-seral or old-growth forests can be quite dynamic with large numbers of snags and down logs as a prominent feature. Tree mortality is a very important process in older as well as younger forests.

[1] USDA Advance Notice of Proposed Rulemaking, July 10, 2001, 66 Fed. Reg. 35918

[2] USDA Roadless Questions and Answers, June 9, 2003

Thinning is not appropriate in all forest types.

Different forest types may develop differently. For example, high-elevation spruce-fir forests naturally go long periods of time without fire. In such forests, the accumulation of large amounts of woody debris and saplings in an "old-growth" structure is the natural course of stand development. There is nothing abnormal about the amount of woody buildup in these forests or the crown fires that occasionally renew them.

Alternatively, in dry, low-elevation forests, like ponderosa pine, accumulation of woody debris and saplings was unusual historically. Frequent surface fires killed saplings and burned down logs, keeping the forest open (Fig. 1). In the past century, the exclusion of fire from these forests has allowed open forests to fill in and become dense forests that no longer support surface fires.

Recently, a great deal of scientific attention has been given to developing methods of restoring natural structure to these low-elevation forests by thinning the large numbers of saplings that have developed in the absence of frequent fire. Application of the same methods to spruce-fir forests, though, would be inappropriate as it would result in an unnatural forest.

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It is not uncommon in normal, healthy, developing stands for more than half of the trees at any one time to be dead from density-dependent mortality.

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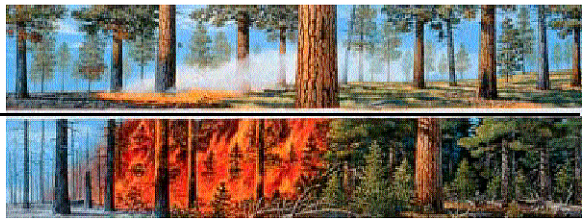
FIGURE 1.



ARTWORK JIM DAWSON © NATIONAL GEOGRAPHIC SOCIETY, 1996

Dead trees are a natural part of a healthy ecosystem.

It is a common misconception that a tree that dies in the forest without being harvested is wasted. Nothing could be further from the truth. Trees have been dying in forest ecosystems for as long as there have been forests, and the function they perform is critical to maintaining the integrity of those ecosystems. Snags and down logs provide animal and plant habitat; build, diversify, and protect soils and aquatic ecosystems; and provide sites for microbial activity critical to forest productivity. In many cases, fire plays an important role in the creation of dead trees.

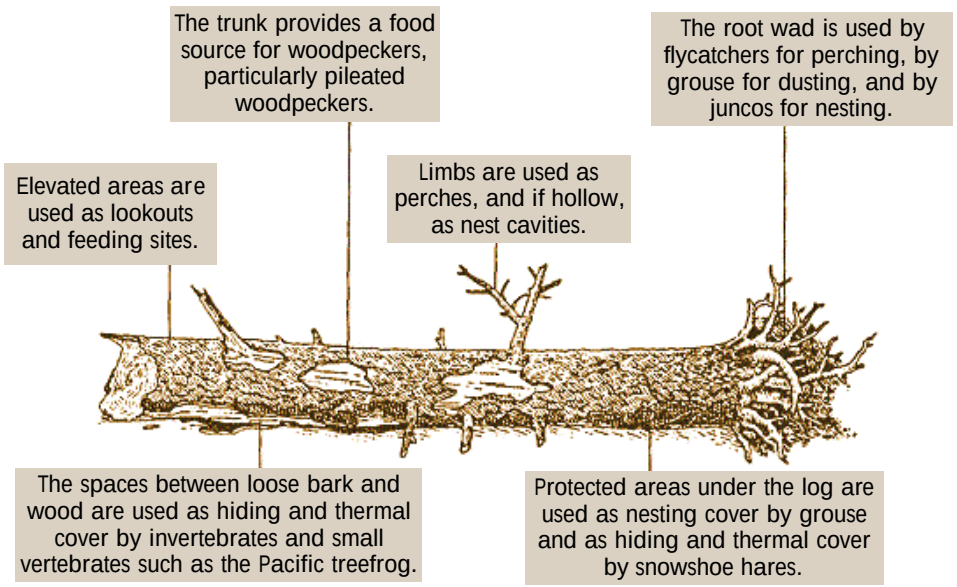
The living dead

When a tree dies, it may remain upright with at least some portion standing as a snag, or it may fall over taking a piece of the forest floor with it. Both processes are important events in forest development. In the case of a snag, the death of a tree is the birth of a new and vital structure. As snags decay, they provide protected sites above the ground that are used by a variety of forest creatures. Young snags, with clinging, curling bark, provide roost sites for a number of bats. Woodpeckers also rely on snags as sites in which to excavate nest cavities, and other "secondary cavity nesters" rely on the woodpeckers to excavate their home sites. At least 42 common North American birds nest in cavities. Many of these snag-dependent bats and birds play an important role in checking insect population outbreaks, thereby protecting remaining trees.

If a tree falls over and takes soil with it, it creates important forest floor diversity. Over centuries, this process of "pit-and-mound formation" and the accumulation of large woody material create a complex soil architecture of organic debris and ridges of mineral soil. The effect is to enhance diversity of microhabitats occupied by small organisms that are important to overall ecosystem

FIGURE 2.

Logs provide habitat for a number of forest creatures



processes. Some species preferentially colonize either mineral soil or organic debris.

Logs on the forest floor fulfill a number of functions. Like snags, logs provide important habitat for vertebrates as diverse as salamanders, shrews, and bears. While working as a research biologist, former Forest Service Chief Jack Ward Thomas identified 179 species that use dead wood in the Blue Mountains of northeastern Oregon, amounting to over half of the vertebrate species in the region. Dead wood also forms the basis of the forest food web, providing substrate for fungi, termites, beetles, and isopods, which in turn feed earthworms, centipedes, flies, ants, and wasps. Ants and wasps, like birds and bats, are important predators of insects that can kill trees at high population densities, and many ant species rely on dead wood for nest sites.

In aquatic ecosystems, logs also form the basis of an intricate web of life. In addition to providing food to a variety of invertebrates, logs provide attachment sites for aquatic insects and hiding cover for predators. Channel features created by logs, notably pools, determine the kinds and amounts of fish that can inhabit a stream.

Slow death offers long life.

The eventual decomposition of logs has effects on the forest site that may last decades or even centuries after the death of the tree. Logs in an advanced state of decay may store and release water, nitrogen, and other nutrients and provide sites for low-level nitrogen fixation. Some tree species appear to regenerate better in decayed wood than on non-wood substrates, and decayed wood often abounds with roots, despite being relatively nutrient poor compared with mineral soil. The ability of soil organic matter, some of which derives from dead wood, to hold nutrients against leaching may play an important role in site productivity. Dead trees are just as important to healthy forests as are live trees.

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Salvage logging is not necessary to prevent future fire.

While dry, dead trees do add to the fuel load in the forest, it does not necessarily follow that they increase the risk of subsequent fire. Most of the fuel that is consumed during forest fires consists of small-diameter "fine fuels" like pine needles and twigs. Standing trees and their large-diameter branches are rarely consumed; thus, their presence does not add significantly to fire danger. Concern about the contribution of dead trees to fire hazard has led some to recommend "salvage logging" of burned timber or trees killed by insects to reduce future fire danger. However, these concerns appear to be unwarranted. If burned or insect-damaged timber were more likely to burn than the surrounding forest, then fire in young, recovering forest would be a commonly observed phenomenon, which it is not.

Additional Reading

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