

# In Spring, Nature's Cycle Brings a Dead Tree to Life

Ecologists see fallen logs as cradles of forest diversity.

By JANE E. BRODY

**I**F you don't believe there's life after death, look closer some spring day at a dead tree lying on the forest floor. Chances are, if it has been there for a while, it is teeming with more life now, after death, than when it was standing erect lifting its leafy arms to pray.

Though it lacks the spring finery that inspires poets and lovers, a leafless tree is often more valuable to its forest dead than alive, say ecologists working in the old-growth forests of the Pacific Northwest. This fact, they say, has been largely ignored by wood-hungry forest managers in most of the United States and Europe, where overzealous harvesting of

"dead wood" has depleted forests and rendered them highly susceptible to environmental stresses like acid rain.

"Rotten wood was once considered just a fire hazard, a waste, an impediment to travel," remarked Dr. Michael Amaranthus, a soil scientist with the United States Forest Service in Grants Pass, Ore. "More and more we are seeing it as an essential part of the forest system, crucial to its long-term productivity. It provides a reservoir of moisture and nutrients and a variety of habitats and food resources for a wide diversity of organisms. Our understanding of the importance of dead wood has increased a lot in the last 10 years."

When nature cries "timber," countless unseen denizens of the forest rush to take up lodging in the fallen tree. Dead trees serve as warehouses and even factories for essential nutrients that enrich the soil and foster new growth. They store carbon, thus curbing atmospheric carbon dioxide and the pace of global warming. They hold volumes of water that sustain

growing trees in droughts. And they serve as nurseries for new plant life, providing cozy niches where seeds can gain a firm foothold and outgrow other seedlings struggling to capture the light that penetrates where the tree once stood.

The trunk of a dead tree is consumed by a varied succession of microbes, plants and animals, which help to replenish the soil as they break down the wood. A result, say the two forest ecologists, Chris Maser and James M. Trappe, is "an accumulation of life and nutrients that is greater than the sum of its original parts."

"In a forest where the trees are repeatedly cut and removed, the soil becomes depleted, the structures deteriorate and the forest loses its resilience for coping with stress," said Dr. Trappe, a forest mycologist at Oregon State University in Corvallis. This has already happened in Germany, where the forests are being se-

verely damaged by air pollution and acid rain, Dr. Trappe said in an interview last week. "And Germany is the country whose concept of intensive forest management served as a model for our own," he noted.

Fallen trees help to preserve the forest by stemming the erosion of soil from wooded slopes and diverting streams that in straight courses might gouge out soil. In fresh waterways, fallen trees trap nutrient-rich sediments and create pools where fish can spawn and fry develop.

Beyond the forest, dead trees help stabilize beaches and create habitats for wildlife in estuaries and salt marshes. Logs that reach the open sea serve as a major source of carbon

and other foodstuffs for marine life.

"Unfortunately, very little of this is now happening because the oceans are being deprived of this resource," said Mr. Maser, an author and consultant living in Las Vegas, Nev. "We are beginning to starve the oceans as

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## Birth, Death and Renewal in a Tree

When a tree dies, life does not end. In a series of steps (clockwise from here), insects, plants and fungi colonize the decaying tree, and it evolves into a new habitat, teeming with life.

### 1. Opening the tree to the external world

Bark and wood-boring beetles, carpenter ants, and mites initiate the invasion by channeling through the wood. Fungi, insects and roots follow these paths.

### 8. Regenerating soil

Nutrients return to soil in decaying plant and animal material, completing the cycle of life, death and renewal.

### 7. Small mammals arrive

Voles and shrews burrow in soft wood and feed on mushrooms and truffles.

### 2. Mosses and lichens

Mosses and lichens become established on the surface and capture nutrients in rainwater that has passed through the forest canopy.

### 3. Nutrition from fungi and bacteria

Microorganisms proliferate and help decay the wood. Fungi and bacteria are key sources of nutrients, especially nitrogen, for plants and animals that thrive in dead trees.

### 4. Grazing on fungi and microbes

The fungi are foodstuffs for many invertebrates, like beetles and mites.

### 5. Grazing on the grazers

Larger arthropods like spiders feast on invertebrates that dine on fungi and microbes.

### 6. Larger plants colonize

Roots of seedling trees and shrubs, like hemlocks, penetrate log crevices, aided by a symbiotic relationship with the fungi.





# Nature's Spring Cycle Brings Logs Alive With a Teeming Army

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well as the soil because we are not reinvesting the biological capital nature provides into the forest, ocean, air or land."

"The function of dead trees in the ecosystem has rarely received the consideration that it deserves," says Dr. Jerry F. Franklin, an ecosystem analyst at the University of Washington's College of Forest Resources in Seattle. "At the time a tree dies, it has only partially fulfilled its potential ecological function. In its dead form, a tree continues to play numerous roles as it influences surrounding organisms. The woody structure may remain for centuries and influence habitat conditions for millennia."

So, these forest scientists urge, woodsman, woodsman, spare thine ax for fallen as well as standing trees. Think twice before hacking up and carting off those logs dead in name only and dooming them to a brief and limited life as firewood.

## A Long, Rich Afterlife

As scientists with the United States Forest Service in Corvallis in the 1980's, Mr. Maser and Dr. Trappe produced a technical review, "The Seen and Unseen World of the Fallen Tree," that could easily become Exhibit A in the ongoing case to preserve forests. Their publication, number PNW-164, is available for \$5.50 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Using the unmanaged 450-year-old forests of Douglas fir in the Pacific Northwest, Mr. Maser and Dr. Trappe demonstrated that dead wood was far more than mere waste or a fire hazard to be removed as quickly as possible. Rather, they showed that dead trees were very much a part of the living forest.

"A dead or fallen tree is simply an altered state of a live tree and has

hundreds of years of contribution it can make to the earth," Mr. Maser said. "The big question now is how much wood needs to be left in the landscape as a biological reinvestment in the land that supports us all."

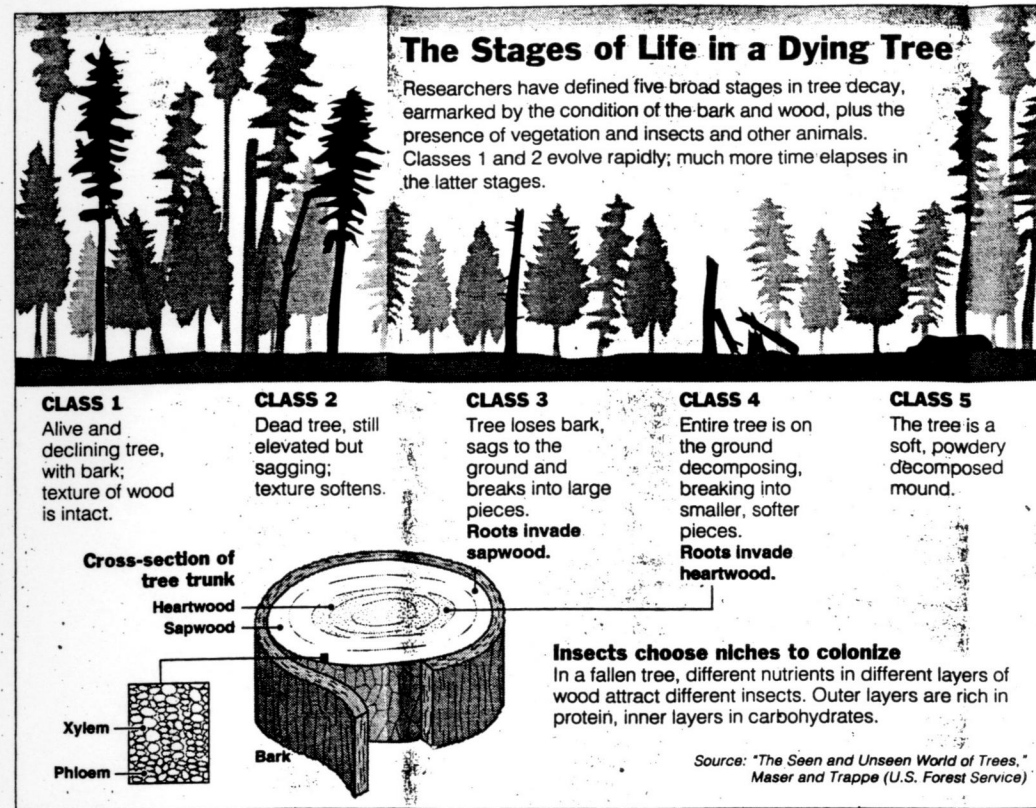
Once a tree falls, it passes through five distinct phases of decay, they wrote. At each stage, the tree supports new life for which it is the sole or principal habitat.

At stage 1 are newly fallen trees with intact bark, a condition soon to be changed as bark and wood-boring beetles tunnel through. These brazen beetles blithely disregard the chemical and mechanical defenses of the conifer's bark that discourage most insect predators. The first beetles create channels for their successors. The beetles also carry in fungi and bacteria that provide food and essential nitrogen for future invaders.

At stage 2, trees still retain bark but as the beetles feast away, the nutritious growing layer of inner bark and the nearby phloem, which transported sugars, become spongy. These tissues are likely to be eaten in a few years. Next in line is the sapwood, which in the living tree housed the water-carrying structures called xylem.

By stage 3 the bark sloughs off. Roots from sprouting seeds now invade the sapwood, and the trunk begins to break into large, solid pieces. In a fallen Douglas fir, the sapwood succumbs to insects and fungi in 10 to 20 years, Dr. Trappe said, although the bark of this tree "probably hangs around for centuries."

At stage 4 the heartwood, composed of the dead xylem that forms the bulk of the tree trunk, is all that remains. It now breaks apart into soft blocks as roots invade this dense, highly resistant and not very nutritious wood. This is the stage, the longest in the decay process, that hosts the most diverse array of wildlife, including mites, centipedes and snails, as well as salamanders,



Nancy Sterngold/The New York Times; Illustration by Baden Copeland

shrews and voles.

Finally, in stage 5, the tree is no more than a soft, powdery mass. Ashes to ashes, dust to dust, soil to soil.

## A Succession of Life

Stocked with nutrients, a fallen tree supports more life than when it was alive. Invading fungi ooze out enzymes that liberate the tree's nitrogen for use by other organisms. More nitrogen is provided by bacteria that extract it from the air. The tiny organisms that inhabit the log fertilize it with their excrement. Leaf litter and rainwater laden with nutrients and lichens from the forest canopy fall on the dead tree, adding further enrichment.

Carpenter ants are most active in stage 2. Their catholic diet includes

butterflies and the honeydew of aphids. Nesting in fallen logs, they carry nutrients into the tree from the outside. Termites take over late in stage 2, importing in their wood-chomping bodies both protozoa that digest cellulose and bacteria that capture atmospheric nitrogen. By the time a termite colony is ready to move on, it has created a labyrinth of passageways in the tree that can be used by other animals and by the roots of invading plants.

As logs reach stage 3, their bark and sapwood is sloughed off and plants have taken root. The logs become ready for occupation by a wide range of animals. As Mr. Maser and Dr. Trappe wrote about the trees when they reach stage 4: "Various mites, insects, slugs and snails feed on the higher plants that become es-

tablished on the rotten wood. These plants also provide cover for the animals, as do the lichens, mosses and liverworts that colonize fallen trees."

In this microenvironment, mites thrive on the dead plant and animal matter that accumulates on fallen trees. The skeletons of dead mites, in turn, serve as incubators for fungal spores, and the fungi provide sustenance for other invading plants and animals.

The folding-door spider is among the many arthropods that thrive in these conditions. It constructs a silky tube in one of the many cracks in the outer layer of a fallen tree that has reached stage 3 or 4 of its decay. The outer edges of the tube are pulled inward to form a slitted cover and the spider waits on the inside for the arrival of suitable prey, which are abundant in the decaying wood.

## Diversity or Monoculture?

Among the ecologically important denizens of fallen Douglas fir is the California red-backed vole. The rodent eats mostly fungi and lichens but has a particular passion for truffles, Mr. Maser has shown. The vole then disperses the spores of the truffle, inoculating decaying trees with this valued foodstuff. This benefits other truffle-eaters, including the squirrels and mice that are the principal foodstuffs of the spotted owl and other carnivores.

"The spotted owl debate is not a case of owls versus people," Dr. Trappe said. "It's a question of whether we want the diversity of organisms that the natural forest provides, or in its place a monoculture in which many organisms will disappear, not just the spotted owl."

If Dr. Mark E. Harmon, a forest ecologist at Oregon State University, has his way, dead trees as well as living forests will become valued as critical elements in containing global

warming. When a tree is cut and processed into paper or a fallen tree turned into firewood, carbon dioxide is ultimately released into the atmosphere. "But a dead tree left on the forest floor holds onto its carbon for decades, even centuries," he explained.

Dr. Harmon is directing a project whose lofty time horizon rivals that of the earthmade plaque sent aboard the spacecraft Pioneer 10 to Jupiter and beyond. More than 500 logs of four different species have been placed throughout the H. J. Andrews Experimental Forest outside Eugene, and their patterns of decomposition are to be studied over the 200 years they will take to decay. Biologists will monitor the insects and microorganisms that colonize the logs, the small plants and large trees that become established on them and the birds, reptiles and mammals that use them as dwellings and food sources.

In a parallel experiment on two sides of the Cascades, 800 large trees were felled in 1987 and 1988 and placed in streams. Dr. James Sedell, an aquatic biologist at Oregon State University, said the project had already restored habitats for juvenile coho salmon and steelhead trout.

## Fallen Logs and Streams

"When a large log falls in a stream, the current scours out a pool around it and other wood gets trapped to form a debris jam," Dr. Sedell said. Fish then go into the pool, which serves as a safe harbor during winter floods and a secure habitat in summer droughts, he explained. The next step is to see if more fish leave the stream and grow up in the sea.

"I'm optimistic," the biologist remarked. "Worldwide there's been much more interest in the role of wood in rivers and streams. The Forest Service and several states have begun to recognize that on forested land they need to allow big fallen logs to remain in streams to protect the fish resources."

Now, he and other scientists say, the question on land and water is: How much dead wood must be kept to bring back the many habitats needed to sustain the diversity of life on earth?

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