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Forestry Research West

Forest Service
U.S. Department of Agriculture

May 1979

Trees help keep a forest fertile

Productivity
Nutrient cycling
Erosion
Forest management
Flood control

A scientist may travel a short distance to his field plot in the canopy of an old-growth Douglas-fir, but he climbs straight up.

Scientists gathering information from study plots as varied as the canopies of old-growth trees and the gravels of mountains streams on the Nation's first Experimental Ecological Reserve—the H. J. Andrews Experimental Forest in Oregon—are learning more about the way forest ecosystems function. Their findings will help forest managers make decisions that affect the long-term productivity of western forests.

"What we're doing here," says Ecologist Jerry Franklin of the Pacific Northwest Forest and Range Experiment Station, "is learning how forest ecosystems are put together and how the interrelationships between organisms are affected by variations in environment and by natural and human disturbances." Franklin is in charge of the Andrews Experimental Forest, where scientists from the Pacific Northwest Station, Oregon State University, and the University of Oregon are conducting long-term studies, and other scientists come to do short-term studies.

Franklin is one of the scientists who saw the need for a more intensive look at basic ecological processes after early studies produced valuable information on silvicultural, logging, and road-building methods.

"Information from our research is particularly valuable to forest managers," says Franklin, "because it comes from scientists of several biological and physical disciplines, all looking at different aspects of forest functions on a research site that is representative of the Douglas-fir and hemlock forests on the west slope of the Cascade Range." Scientists are aided in their work by almost 30 years of data collected since the Experimental Forest was established in 1948. They also share data with each other and exchange ideas and points of view.

"The whole point of multi-disciplinary research is to learn how to maintain the productivity of the forest while obtaining goods and services from it," says Franklin. "Forest managers are often under pressure to emphasize products, and they need information to help them account for the long-term impacts. We scientists need to provide them with information to forecast the effects of their management on ecological processes that may take decades or centuries—changes they will not be around to see."

Arthur McKee, botanist and resident manager at the Experimental Forest, agrees on the value of the research to forest managers. "Because we're looking at all the basic forest processes, we're producing information that is definitely in tune with multiple-use management," he says. "As we learn to model these processes we help managers get a clearer picture of the options for influencing the rate and timing of some natural processes and predict the results of their management activities."

As timber harvest moves to steeper slopes at higher elevations, it becomes more important to understand how a forest functions. "Productivity depends on processes that provide nutrients and stability to the soil mantle and to streams," says Franklin. "We're finding new information about the importance of trees in these processes. Alive and dead, standing and down, trees play a series of roles in slowing the movement of nutrients out of the forest and producing and recycling nutrients."

The functions

The functions of trees in the forest ecosystem, now better understood through research at the Experimental Forest, include the following:

1. Logs, root wads, and other large woody debris, which fall or slide into small mountain streams, reduce stream velocity. This debris gradually causes pools and short waterfalls to form. Floating vegetation collects in the pools where invertebrates like beetles, snails, and caddis flies gouge, scrape, and shred needles, twigs, and other organic material. They utilize some of the nutrients and pass them on for reuse by aquatic plants and other invertebrates. The pools also provide places for sediment to settle and gravel beds to form, improving habitat for fish. Large logs cast dark shadows where fish can hide or feed on invertebrates. A log may fill these roles for more than 100 years. During that time, it is gradually broken down by mechanical forces and decomposed to reusable nutrients.

2. Logs on the forest floor contribute nutrients to soil and water through the action of decay fungi, insects, and bacteria. Logs provide habitat and nutrients for tree seedlings. They also provide habitat for birds, amphibians, and small mammals, all of which play important roles. Many small mammals, for example, dig up and eat truffles—fungi that grow underground. The undigested spores of the truffles are distributed as the animals travel from established forest to cut-over areas, providing new sources of the mycorrhizal fungi essential to most plants. Logs are also runways for small animals, and they help stabilize slopes and retard soil erosion.

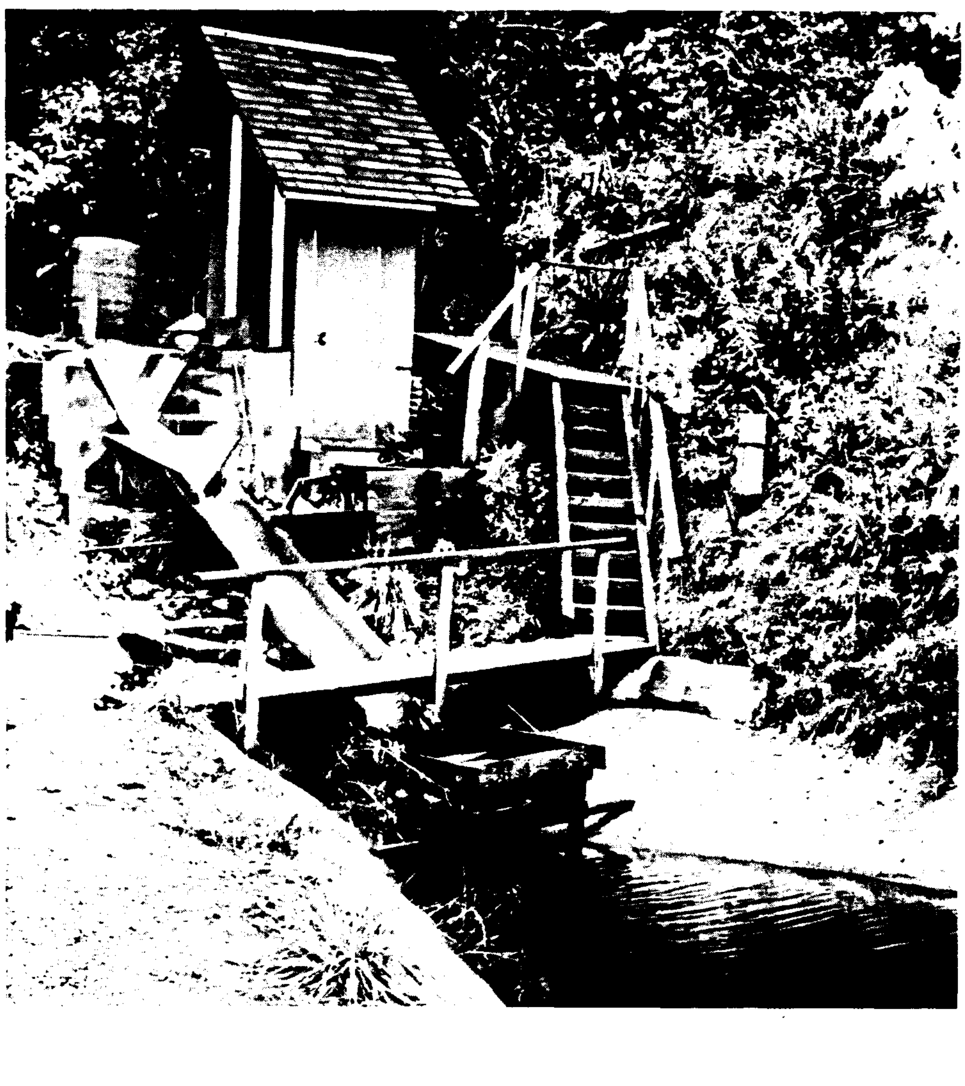
3. Some trees stand for many years as snags. During this time microscopic organisms decompose wood tissue, release nutrients, and fix nitrogen. The larger snags provide perches for birds and homesites for cavity-nesting birds and small mammals, which eat insects that damage live trees.

4. Some trees are habitat for vegetation that contributes new sources of nitrogen to the forest. One of these is the lettuce-like lichen, *Lobaria oregana*. Scientists have found that this lichen is one reason old-growth Douglas-fir trees grow well even after 400 years. The lichen lives in the upper half of tree canopies, often more than 200 feet above the ground. It takes nitrogen from the air for its own growth, and when it falls to the ground, dies, and decomposes, the nutrients are leached into the soil and become available to the old-growth trees and other vegetation. This lichen is one of many organisms that find optimum habitat in the crowns of old-growth trees.

5. Still other trees and shrubs, like red alder and ceanothus, convert nitrogen from the atmosphere to usable nutrients. Scientists are now wondering whether, in the long run, utilizing the ability of these species to replenish the soil under new conifer forests may not be more effective and less costly than using artificial fertilizers.

6. Trees slow down the movement of nutrients from the forest by slowing erosion. They hold soil on hillsides through the anchoring action of their roots. They also reduce the erosive impact of falling raindrops by reducing the amount of water which reaches the soil and by providing a layer of dead needles and twigs on the forest floor which cushions the impact on the soil surface. Plants also take water from the soil and transpire it to the air. The hydrologic impact of these stabilizing functions is especially important if slopes are steep, soils are unstable, ground water levels are high, and it rains a lot—as it does in the Pacific Northwest in fall and winter.

Stream gages monitor hydrologic processes.



New indications of the importance of trees in slowing erosion have come from records kept on the Experimental Forest since the early 1950's. These indicate that clear-cuts have generated nearly as much landslide erosion as roads. Roads cause more landslide erosion from the area they affect than clearcuts do. But clear-cut slopes occur over a much wider area. Geologist Fred Swanson of Oregon State University, who is studying earth movements on the Experimental Forest, says there may be a switch in importance from roads to clearcuts: "Roads have been blamed in the past, and many problems have been corrected. Meanwhile logging is getting into more unstable ground. In parts of the Coast Range over the last ten years, the frequency of slides in clearcuts has gone up, while the frequency of slides from roads has declined. More than 75 percent of the slides which occurred during big storms in 1975 and 1977 were in clearcuts."

7. Trees—or the absence of them—are the key element in a sequence of events that is responsible for

Botanist Bill Denison and Soil Scientist Dick Fredriksen hold an impromptu conference after meeting unexpectedly on the Andrews.

On unvegetated slopes, dry ravel can be an important agent of erosion.

some of the most destructive storms on the west slope of the Cascade Range. It begins after snow has accumulated during a cold spell. Then, as temperatures rise and rain begins, the heat carried to the snowpack by rainwater and condensation of water vapor from the warm, moist air mass on the snow's surface causes rapid melting. Snowmelt water and condensate then combine with rain to produce major runoff. The phenomenon is called "rain-on-snow runoff" according to Hydrologist Dennis Harr of the Pacific Northwest Station. "Only part of the snowmelt is caused by rain itself. At the Andrews, this combination of snowmelt and rain has caused major runoff five times as often as rain alone. We think snowmelt is greater on unforested slopes because the movement of warm, moist air over the snow surface is greater and supplies heat to the snow faster than in forested areas."

Rain-on-snow runoff is most likely on southwest-facing steep slopes because of their orientation to prevailing winter winds. Most landslides on the Experimental Forest have occurred during periods of rapid snowmelt.

The importance of trees in slowing erosion is illustrated dramatically by their absence during rain-on-snow runoff. It is this type of event that accounts for the greatest, swiftest, and most violent loss of soil and nutrients by erosion. Soil Scientist Dick Fredriksen of the Pacific Northwest Station has studied such storm runoff extensively, using data from stream gages that have been recording runoff since 1952. Fredriksen had personal experience with storms when he was resident manager of the Experimental Forest from 1960 to 1965. "You can't believe what happens," he says, "small headwater streams that are only a trickle in summer become raging torrents. Unstable ground that becomes saturated with water slides into streams, carrying debris with it. A tumbling, churning mass of mud, rocks, and logs may go hurtling downstream, gouging stream banks and scouring the stream channel to bedrock. As the moving debris gathers momentum, massive jams of logs slam against road fills and plug culverts too small to let the debris pass. Then streams flow over roads and wash out road fills."

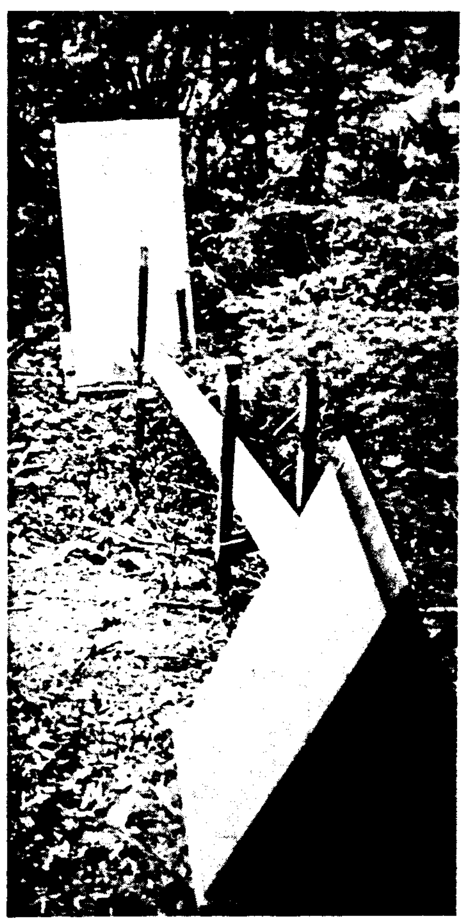
The studies of Fredriksen and others formed the basis for guidelines for building roads, stream crossings, and drainage structures to accommodate the accelerated runoff of severe storms. The scientists also recommended that forest managers send crews out during storms to check conditions and make emergency repairs. Several of the forests in the Pacific Northwest Region of the Forest Service began doing this several years ago. They call the practice FERM (for Flood Emergency Road Maintenance). It has probably saved thousands of dollars in road damage for each major storm, Fredriksen believes.

"Managers can learn a lot if they go out after a big storm," says Swanson. "It is easier then to identify problem areas." On the Mapleton District of the Siuslaw National Forest, which has a good deal of unstable land, the damage from more than 300 slides during a storm in 1975 convinced the staff of the value of a continuing inventory of landslides. "This inventory has been very helpful in identifying unstable slopes which require special management," says Swanson. He points out that an inventory also provides a basis for comparing the cost of slide prevention measures with the benefits of reduced erosion and stream impacts, and lower road repair costs.

Managers are involved

Forest managers and scientists working on the Experimental Forest exchange information in a number of ways. "A dialog between scientists and managers is essential to setting realistic goals and priorities for the rate and directions of research," McKee says. Scientists offer training courses and workshops for managers where they report preliminary findings from research before data collection is complete and papers written. They also answer questions from managers and find out what their problems are. Informal discussions are held on field trips. Individual requests for field trips or help with problems or interpretations of data are an everyday task of the scientists.

A slow-moving earth slide has split a cedar tree. Progress of the slide is being measured by a crack meter and related to factors such as rainfall.



Inquiries about the research program should be directed to Jerry Franklin, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, Oregon 97331 (telephone 503/757-4362 or FTS 420-4362). Scientists who would like information about the Experimental Forest as a research facility can write to Franklin or Arthur McKee, Manager, H. J. Andrews Experimental Ecological Reserve, P. O. Box 300, Blue River, Oregon 97413.

Since 1969 the Experimental Forest has been an intensive study site for the Coniferous Biome of the International Biological Program. It was the high quality of the multi-disciplinary research under this program that led the National Science Foundation to support the Andrews as the first Experimental Ecological Reserve in 1977.

The Experimental Forest is also one of 28 sites that form the U.S. portion of an international system of Biosphere Reserves established under the Man in the Biosphere Program of the United Nations Education, Scientific and Cultural Organization.

Research done on the Experimental Forest is cited in more than 350 scientific papers. A list of these is available from Franklin.

—by Dorothy Bergstrom
Pacific Northwest Station