PNW
Pacific Northwest
Research Station

Science
FINDINGS

INSIDE

issue thirty-six / august 2001

"Science affects the way we think together."
Lewis Thomas

BENEFITS OF HINDSIGHT: REESTABLISHING FIRE ON THE LANDSCAPE

Dense ponderosa pine forests along the lower eastern slope of the Cascade Range, and in interior forests in general, have developed without the influence of fire during the past 100 years.

Experimental thinning and burning treatments can restore dense ponderosa pine forests to historical conditions and natural fire disturbance regimes.

IN SUMMARY

Well-intentioned fire suppression efforts during the last 80 to 100 years have altered the structure of low-elevation forests in the interior Northwest. Historically, nondestructive, frequent, low-intensity fires have given way to larger, infrequent, severe, high-intensity fires. Because of altered fire behavior, forests now have increased fuel and, consequently, are more vulnerable to fire.

Fire science and its application in land management are needed to work with —rather than against—nature to develop sustainable forests and restore our technological capability to manage fires in these forested ecosystems.

The situation is becoming acute as more people occupy the urban-wildland interface and resources that are used to protect forest ecosystems and human structures are stretched to the breaking point.

"There's a lot you can do with fire suppression dollars and not end up with a black forest."
John Lehmkuhl

1855. Botanical section of the "The Stevens Report" on railroad surveys through the northern Cascade Range:

> There is so little underbrush in these forests that a wagon may be drawn through them without difficulty, forming a striking contrast to the dense thickets of the western slopes…the level terraces, covered everywhere with good grass and shaded by fine symmetrical trees of great size, through whose open foliage the sun's rays penetrate with agreeable mildness, give to these forests the appearance of an immense ornamental park.

A century and a half later, it is difficult to imagine drawing a wagon, or in some places even a backpack, through the dog-hair forests that have become the norm in many east-side locations. What has made such a dramatic difference in the landscape?

Fire exclusion.

Before European settlement, large forest fires at low elevations were common, as noted in "The Stevens Report." Since that time, many research reports document frequent fire disturbances in dry east-side forests as the norm before the 20th century.

"Our analysis of fire scars shows that during the presettlement period (1700-1860), the 'mean fire-free interval'—the approximate time between successive fires at any one location—was about 7 years," says John Lehmkuhl, a research wildlife biologist with the Pacific Northwest Research Station in Wenatchee, Washington. "However, other ground fires were occurring across the landscape during that 7-year period, so that fire was almost always present."

Well-intentioned fire suppression efforts during the past 80 years have so altered the landscape that we now face a crisis in fire management. Some stands and landscapes are 10 or 12 fire-free intervals removed from historical conditions on the east slope of the Cascade Range in Washington. The mean fire-free interval has been stretched to 40 years or more. The buildup of fuels without regular burning has given us the massive conflagrations of recent summers, while Washington population growth in the interior West has brought the issue of "what to do next" into focus for many people.

"The truth is, current forest conditions are so far out of sync with inherent disturbance regimes that we lack the technological capability to manage fire disturbance. The public is just beginning to understand that the forests they grew up with, may not be sustainable into the future," explains Lehmkuhl.

KEY FINDINGS

- Before European settlement, the average period between successive fires in any one location was 7 years. Fire suppression has stretched the fire-free interval to 40 years, and many areas have remained unburned for the entire period.
- Current forest understories have grown dense with fire-susceptible species, and crowded growing conditions make them more susceptible to death from insects and diseases. Today's fires are more likely to be large and hotter than historical fires, and more likely to kill whole stands of trees over an extensive area.
- Frequent overlapping low-intensity fires in the presettlement period reduced ground fuels on 50 to 60 percent of an area during a 6- to 7-year period and created a patchwork of different forest conditions across the landscape.
- Closed-canopy forests, such as those used by the northern spotted owl, would not have been supported by the frequent fires of dry east-side forests. Certain areas of the landscape, however, had topographical conditions preventing frequent fires; they became old-growth, dense-canopy refugia but covered less than 20 percent of the landscape.

CHANGING THE SCENE

By studying old fire scars and tree cores, researchers have constructed a picture of the landscape before Europeans arrived in any significant numbers. Fire scars are generally found on the uphill side of trees; with fire moving uphill, a peculiar chimney effect burns that side more intensely, through the bark and cambium layers, leaving a readable history of fire events. Coring scarred trees allows researchers to date fire intervals quite precisely.

Before fire exclusion, ground fires spreading through continuous understory fuels could be extensive. The cumulative effect of multiple burns was a reduction of ground fuels on about 50 to 60 percent of an area during any 6- to 7-year period. These overlapping fires, Lehmkuhl explains, created a patchwork of different forest stand conditions, maintained low fuel loadings, and broke up the continuity of any heavy fuel buildup across the landscape. Historically, in dry east-side forests, a stand might contain an average density of 21 trees per acre with an average diameter of 25 inches, 92 percent ponderosa pine, and the remainder Douglas-fir.

Today's forest stands are vastly different, typically growing 200 ponderosa pine per acre, or as many as 600 Douglas-fir, and most of the trees are smaller than 12 inches in diameter. Current forest understories have grown dense with fire-susceptible species, and fire can now climb "fuel ladders" from the ground to the tree canopy. Continuity in fuels across the landscape is found in the canopy rather than on the ground.

"Today, when a fire occurs, it has an increased probability of being a very severe, stand-replacing event that kills a majority of the trees over an extensive area. The loss of vegetation cover alters current and future wildlife habitat,

Check out our web site at:

http://www.fs.fed.us/pnw

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208
(503) 808-2137

Sherri Richardson Dodge, Editor
srichardsondodge@fs.fed.us

United States Department of Agriculture

Forest Service

changes stream hydrology, and brings high risks of flooding and mass wasting." Furthermore, the spread of such catastrophic fires tends to be affected more by weather conditions than existing vegetation structure, removing control even further from our grasp.

In the past, the large trees survived because their crowns were well above the ground fires, crowns of individual trees were well spaced and their thick bark made them fire resistant. Thus, big trees in open, parklike conditions were the norm. These forests were sustainable over long periods, Lehmkuhl explains, because their structure was maintained by the fire disturbance regime of the area.

In turn, the forests provided habitat for species that preferred those conditions, such as the flammulated owl, now a species of concern. The closed-canopy conditions that favor northern spotted owl habitat would have been less widespread.

LAND MANAGEMENT IMPLICATIONS

- Presettlement conditions are likely to be more stable in the long term than overstocked forests.
- Maintaining current forest conditions is risky. Lightning strikes often in the Cascade Range, and probability is high that the resulting fires will be large with severe impacts on vegetation, soils, and water resources.
- Thinning and frequent low-intensity fires can help recreate a more sustainable set of forest conditions, with open stands of large fire-resistant trees.
- Current forest conditions are so far out of sync with inherent disturbance regimes that we lack the technological capability to eliminate severe fire effects. The expanding wildland-urban interface draws fire fighting resources away from protecting forest systems toward safeguarding human structures.

FIRE AND SPECIES MANAGEMENT

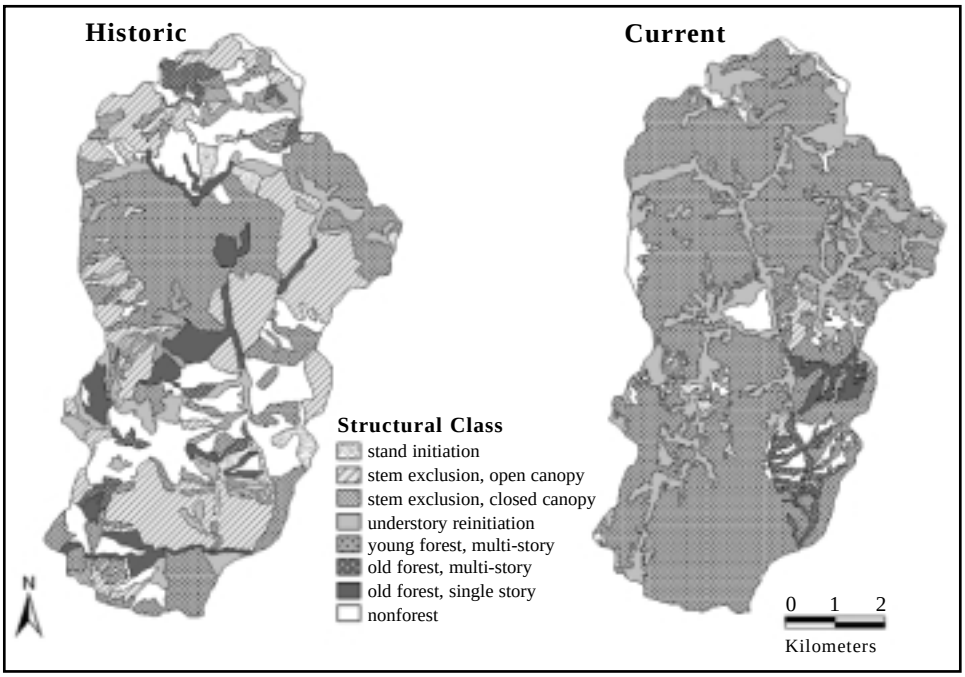
Not only has the fire interval changed since European settlement, tree densities and species compositions have changed dramatically.

After European settlement, fire exclusion and preferential harvest of early-seral conifers, such as ponderosa pine and western larch, allowed many stands to develop further along their successional pathways than in the past. This gave an advantage to species more tolerant of shade but far less tolerant of fire, such as Douglas, grand, and white fir, and western hemlock. They created dense, multilayered canopies across a larger proportion of the landscape and brought with them their propensity for hosting several defoliating insects.

In this way, old closed-canopy forests that may support high numbers of associated species have increased, whereas old open-canopy forests and associated species like flammulated owls are likely to have decreased.

But this outcome questions the wisdom of current management goals to increase amounts and connectivity of older forest for the benefit of species associated with late-successional habitat, Lehmkuhl notes. Current fire research on the east-side suggests that such habitat may be created but at greatly elevated risks of insect outbreaks, tree-killing pathogens, and catastrophic wildfires.

"The Northwest Forest Plan recognizes that the reserve network idea would require different approaches on the east and west sides of the Cascade Range," he says. "Managed reserves and connectivity present a much greater problem on the east side, forcing us to find new ways to



The 1938 historical condition of the La Grande watershed in the Blue Mountains shows a typical mosaic of forest conditions maintained by fire and other disturbances. The current landscape pattern shows a landscape dominated by contiguous fire-prone young forest that developed under fire exclusion and other management practices.

WRITER'S PROFILE

Sally Duncan is a science communications planner and writer specializing in forest resource issues. She lives in Corvallis, Oregon.

manage late-successional reserves." He believes it may be necessary to look more closely at the ecology of species for answers. For example, for the northern spotted owl, we may find that if we provide perhaps 60 percent of its home range habitat intact, it could accommodate itself to the fragmented nature of the remainder.

"However, these benefits to closed-forest species may be short-lived," he notes. "The dense forest structure is not supported by the fire disturbance regime, and the greater propensity for large stand-replacing fires results in high risk of long-term habitat loss. But the question of whether the northern spotted owl will lose out in the long term if we go back to the historical fire regime is really not clear; a workable balance may be struck between closed- and open-canopy forests."

INTERACTING DISTURBANCE CYCLES

Because of topography, soils, aspect, and elevation, some areas habitually escaped the effects of fire. Such "refugia" became islands of older forest in a younger forest matrix and supported species often absent from the rest of the landscape. But contrary to prevailing notions of what used to be, dense forest covered less than 20 percent of the landscape and was connected only by the younger surrounding forests. The cycle of insects and pathogens, fuels buildup, and fire most likely moved the location of refugia across the landscape over time.

"Note that these 'old-growth, dense-forest refugia' were restricted to less than 20 percent of the landscape where topographical conditions prevented frequent fires," Lehmkuhl says. "The inherent fire disturbance regime would not have supported the amounts of dense canopy forests that currently occur with fire suppression efforts."

Fire, of course, was never the only disturbance to the parklike conditions early explorers described. Insects and pathogens have always been present and active in molding the landscape. The dramatic increase in tree density tends to produce growing conditions that make trees susceptible to death from insects and diseases. When species composition changes and encourages proliferation of such insects as the western spruce budworm and the Douglas-fir tussock moth, along with diseases such as dwarf mistletoe and laminated root rot, the potential for tree mortality rises dramatically.

And what do dead and dying, standing and fallen, trees offer? Increased fuel loads, both vertical and horizontal.

Fires with the intensity and magnitude of those that burned the Wenatchee National Forest in 1994, tend to destroy both historical fire refugia and areas of late-successional forest that are not necessarily refugia. Across the landscape, Lehmkuhl says, these fires are less conducive to maintaining biodiversity and are in sharp contrast with the historically shifting mosaic of different-aged stands.

MOVING FIRE INTO MANAGEMENT

Given a relatively clear picture of fire history under natural presettlement conditions, Lehmkuhl believes it is now possible to harness fire science and its application in land management to work with rather than against nature in developing sustainable forests.

"We also need to restore our technological capability to manage fire in these forested ecosystems. The situation is becoming acute as more people occupy the urban-wildland interface and resources are stretched to the breaking point in trying to protect both forest ecosystems and human structures."

A first major attempt by managers to put theory into practice is the "Strategy for Management of Dry Forest Vegetation" of the Okanogan and Wenatchee National Forests in eastern Washington. This document is a work in progress that has been subjected to scientific review and is now being implemented. The objective of the strategy is to provide a framework for management of dense, dry forest vegetation. The framework is meant to illustrate vegetation and fuel treatments potentially appropriate under various dry forest conditions. Research on establishing past fire regimes will be baseline information for developing hypotheses around restoring original landscape conditions, Lehmkuhl explains.

The strategy also incorporates lessons from recent fires. In the catastrophic fires across the Wenatchee National Forests in 1994, 186,000 acres burned severely and rapidly, causing complete stand mortality, with two notable exceptions. Within the Tyee Fire, a 500- to 600-acre dry forest stand survived. It had been commercially thinned and underburned several years before the Tyee Fire. The second example occurred within the Hatchery/Rat Fire, where another stand had not been logged previously, but was in a low-density condition because of the harsh and rocky nature of the site. Most of the larger trees present on this site survived the fire with limited crown scorch, according to the strategy document.

Lower density sites such as these, Lehmkuhl points out, can mediate fire intensities, just as they would have historically. Thus such areas could be designated as anchor points for prescribed burning or to reduce the "size, intensity, and effects of wildland fires."

The strategy document has been thoroughly reviewed and adjusted for science content and also has been the subject of 14 public meetings with stakeholders including national forest staff, the Yakama Nation, the North Central Washington Farm Forestry Association, and the Eastern Washington and Yakima Provincial Advisory Committees. Issues arising out of these meetings have been incorporated into the proposed strategy. Some of these include public understanding and support, information gaps, ecosystem approach, adjacent properties, economic feasibility, endangered species, prescribed fire and smoke, soils, water quality, and snag management.

MANAGEMENT AND SCIENCE AT WORK

The Okanogan and Wenatchee National Forests' strategy is an example of how replicable science and management trials on the ground can be combined with suitable levels of acceptance by the public. The development of the strategy has been a team effort between PNW Research Station, university researchers, and national forest managers since the beginning of background research, according to Richy Harrod, forest fire ecologist with the Okanogan and Wenatchee National Forests.

"Our previous dry forest management strategy was not a single, stand-alone document, so the process of getting this down on paper, collecting and using the information in the right way, required close work with the scientists from which we all benefited enormously," Harrod says. "In the arena of monitoring, we are undertaking a much more rigorous program as a result of putting together this plan, which will significantly improve our ability to learn as we go along."

He points out that the strategy is a departure from management approaches of a decade ago, in which work was planned on a project-by-project basis, with no overriding strategy for the forest that was used as a guide and checkpoint. Each activity is now given a priority on the landscape, with better coordination on where it will be implemented, with what vegetation type, and how. As the strategy document notes, the effects of stand-scale management are often cumulative over time and space and, therefore, influence vegetation at the landscape scale

To test management strategies and develop knowledge of fire ecology on the east side of the Washington Cascade Range, scientists at the Wenatchee Forestry Sciences Laboratory and the University of Washington and the staff at the Okanogan and Wenatchee National Forests are involved with the Fire and Fire Surrogate study. This is a national research project investigating tools for fuels and fire management. Thinning, burning, and combinations of both are being tested, with experiments designed locally at sites across the country and with data combined nationally to learn about effects on vegetation, wildlife, soils, belowground biodiversity, and fuel quantities.

"With the knowledge that we have from both research and on-the-ground experience, we feel we are ready to significantly change some fire management approaches," Lehmkuhl says.

With other fire researchers, Lehmkuhl believes that a more sustainable approach to forest management, rather than continued fire exclusion, is to attempt to reconstruct forest conditions with open stands of large fire-resistant trees by thinning and frequent low-intensity fires. "Instead of only reacting to fire, we need to plan on its occurrence and be proactive by managing forests in ways that decrease the chance of large fires and increase landscape stability."

This would also restore habitat for species that require that particular landscape type, which currently is in short supply.

He notes two important caveats: the need to go slowly as ideas are applied to the landscape and the need to closely monitor, research, and adapt to what we're learning. "In other words, we must minimize the risk relative to the uncertainty, because there is a great deal at stake ecologically, not to mention with public values and public trust."

Private landowners are beginning to look at partnership roles, particularly as incentives become available under the National Fire Plan. Under the new National Fire Plan, Congress has shifted funding from fire suppression into the areas of forest health, fuels management, and fire research. In the foreseeable future, it may be possible to drag a wagon through a dry east-side forest once again.

Because of the 1994 fires... the public expects the Forest to take bold but reasonable steps to protect local communities and forests from catastrophic fires, and they want to participate in this effort.

Strategy for Management of Dry Forest Vegetation, Okanogan and Wenatchee National Forests

FOR FURTHER READING

U.S. Department of Agriculture. 2000. *Strategy for management of dry forest vegetation, Okanogan and Wenatchee National Forests.* www.fs.fed.us/r6/wenatchee/ news/news-main.htm. (July 18, 2001).

Camp, A. [and others]. 1997. *Predicting late-successional fire refugia pre-dating European settlement in the Wenatchee Mountains.* Forest Ecology and Management. 95: 63-77.

Everett, R.L. [and others] 1999. *Fire history in the ponderosa pine/Douglas-fir forests on the east slope of the Washington Cascades.* Forest Ecology and Management. 129: 207-225.

Science
FINDINGS

U.S. Department of Agriculture
Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, OR 97208-3890

Official Business
Penalty for Private Use, $300

PRSRT STD
US POSTAGE
PAID
PORTLAND OR
PERMIT N0 G-40

SCIENTIST PROFILES

JOHN LEHMKUHL is a research wildlife biologist and former team leader for the Eastside Forest Health Restoration Team with the Pacific Northwest Research Station, Wenatchee Forestry Sciences Lab. He has a Ph.D. in forest resources from the University of Washington and has worked in various professional and technical positions for the Forest Service, the National Park Service, the Smithsonian/Peace Corps Environmental Program, and in private consulting. His current research interests are in landscape and disturbance ecology of Pacific Northwest forests and their influences on the ecology and management of wildlife.

LEHMKUHL can be reached at:

Pacific Northwest Research Station/USDA Forest Service
Forestry Sciences Laboratory
1133 N. Western Avenue
Wenatchee, Washington 98801
Phone: (509) 662-4315 ext. 235
E-mail: jlehmkuhl@fs.fed.us

ANN CAMP was a research forester on the Eastside Forest Health Restoration Team with the Pacific Northwest Research Station, Wenatchee Forestry Sciences Lab. She has a Ph.D. in forest resources from the University of Washington and is now on the faculty of the Yale School of Forestry and Environmental Science.

RICHARD EVERETT (retired) was the research plant ecologist and team leader for the Eastside Forest Health Restoration Team with the Pacific Northwest Research Station, Wenatchee Forestry Sciences Lab. He has a Ph.D. in range science from Oregon State University.

COLLABORATORS

Richard Schellhaas, Don Spurbeck, Peter Ohlson, David Keenum, and Richy Harrod, Okanogan and Wenatchee National Forests

James Agee and Chadwick Oliver, University of Washington