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INSIDE

Four Mixed-Conifer Forest Types.....2
Priorities and Tradeoffs.....3
Consensus Building in Central Oregon.....5

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

Reality Check: Shedding New Light on the Restoration Needs of Mixed-Conifer Forests

The tree is a slow, enduring force straining to win the sky.
—Antoine de Saint-Exupery

Vanessa Petro

A researcher marks a fire scar sample taken from the stump of a tree harvested decades earlier. Evidence of fires and droughts that the tree survived are revealed in its growth rings.

More than a century of human intervention has inadvertently created conditions that have put mixed-conifer forests in the Pacific Northwest at considerable risk. Fire exclusion and past logging and grazing practices have contributed to this problem, as have uncharacteristically large insect outbreaks and severe wildfires.

Land managers now recognize the need to restore resilience to these forests. But for various reasons, they lack social license to engage in restoration activities. A major stumbling block in coming to consensus about how to restore resilience has been the lack of scientific knowledge about the history and ecology of what is broadly defined as "mixed-conifer forest."

One bone of contention has been the role that fire historically played in these forests, and, by inference, what role it should play today. "There has been more social acceptance of the idea that ponderosa pine forests have been altered through fire exclusion, grazing and so forth, whereas the role of fire in the mixed-conifer forest type has been less well understood," says Tom Spies, research forester with the Pacific Northwest Research Station. "Some people feel like we don't know enough to do any management in these forests."

When fire is excluded in semi-arid climates, downed wood, standing snags, and litter on

IN SUMMARY

Until recently, scientific understanding of the history and ecology of the Pacific Northwest's mixed-conifer forests east of the Cascade Range was minimal. As a result, forest managers have had limited ability to restore the health of publicly owned forests that show signs of acute stress caused by insects, disease, grazing, logging, and wildfire.

A recent study co-authored by a Pacific Northwest Research Station research forester revealed that the traditionally used term "mixed-conifer forest" is too broad for ecological management. The study fills a knowledge gap by providing evidence about how the pattern and timing of land-use effects in mixed-conifer forests vary with regard to topography, elevation, and climate. It specifies four major types of mixed-conifer forests in central Oregon and provides an ecological foundation for restoring each type.

The study reveals that all mixed-conifer types are considerably denser than they were prior to the onset of fire exclusion in the late 1800s and suggests that the effects of fire suppression on composition and structure are most evident in the types found in warm, moist environments. It provides evidence that selective harvesting in the 20th century halved the density of large, fire-resistant pines in older forests.

Findings are helping stakeholder groups come together on a shared vision for restoring mixed-conifer forests in central Oregon.

the forest floor combine to create conditions that promote intense wildfire. Add dense understories with lots of small trees, and flames can move rapidly from the ground into the canopy, making forests prone to high-severity fire. In a warming climate, forests could be further threatened by competition for moisture. "It's not just fire, but a whole host of things that can make a dense forest in a dry environment more susceptible to other disturbances," says Spies.

A few years ago, staff at the Deschutes National Forest contacted Spies to conduct a study on the status of old-growth trees on the Deschutes. He and Andrew Merschel, who was working with Spies as an Oregon State University undergraduate student at the time, began conducting a survey in 2009. Spies and Merschel soon noticed some strikingly consistent patterns in structure and species distribution relative to topography, elevation, and climate.

As they looked at the data, what began as a straightforward survey to aid management planning for the Deschutes evolved into a pivotal study that formed the basis for Merchel's graduate thesis and a co-authored article on mixed-conifer forests published by the Ecological Society of America. The study is beginning to answer some of the questions managers and stakeholders have had about how to restore resilience to these forests. By bridging a knowledge gap about the history and growth patterns in these forests, it is helping stakeholders from widely different interest groups reach consensus about restoration activities.

In a nutshell, the study provides solid evidence that not all mixed-conifer forests should be managed using the same approach when resilience is the goal. "The findings are really about taking this amorphous thing called the mixed-conifer forest and bringing more definition to it—putting it in a framework that allows people to better understand how it varies," says Spies.

KEY FINDINGS

- The effects of logging and fire exclusion in mixed-conifer forests vary with environment in central Oregon.
- The effects of fire suppression on composition and structure are greater in warm, moist environments compared to warm, dry environments. Effects are minimal in cool, moist forests that historically were dense and composed of a high proportion of shade-tolerant trees.
- Selective harvesting in the 20th century halved the density of large, fire-resistant pines in what have become older mixed-conifer forests. Densification and lack of lower severity fire may limit the regeneration and development of these ecologically important trees.
- The study identifies four mixed-conifer forest types that managers and stakeholders can use to prioritize restoration activities in the Deschutes and Ochoco National Forests.

FOUR MIXED-CONIFER FOREST TYPES

After redefining the survey project to encompass a more far-reaching agenda, Merschel and Emily Heyerdahl from the Forest Service's Rocky Mountain Research Station began the labor-intensive task of coring and cross-dating thousands of trees. They sampled 171 sites encompassing 34 environmental settings in the Ochoco Mountains and the eastern slope of the Cascade Range—including the Ochoco and Deschutes National Forests. The sites varied widely in topography, elevation, precipitation, and temperature, thus providing a rich data set that represents diverse mixed-conifer forests over a broad swath of land in central Oregon.

The study revealed that these forests changed considerably during the 20th century, and the effects of logging and fire exclusion vary with the environment. Change has happened rapidly in some environments and more slowly in others. "The rate of alteration has been slowest in relatively dry environments, faster in relatively warm, moist environments, and slower in the wettest and coolest mixed-conifer environments," says Spies. "This knowledge helps us to see the forest not as a static phenomenon but as a dynamic and variable process."

Specifically, the study enabled the team to classify four mixed-conifer forest types, differentiating them by environment and current status of species composition. The four types tend to transition from one to another from lower to higher elevation across the landscape.

The *Persistent Ponderosa Pine* type is found in relatively hot, dry environments. It is dominated by large and small ponderosa pine with some Douglas-fir and grand fir and, depending on the location, might be interspersed with a smattering of lodgepole pine or juniper. Its composition suggests that it is the most resilient to compositional change resulting from the exclusion of frequent fire, but the type is much denser than it was prior to fire exclusion in the 20th century. Increased density can negatively affect germination of ponderosa pine seeds and inhibit the ability of the trees to fully mature into old growth.

The *Recent Douglas-fir* type is also found in relatively hot, dry environments. It historically resembled the *Persistent Ponderosa Pine* type, but is now dominated by Douglas-fir, a shade-tolerant species. Douglas-fir has populated the understory, preventing successful regeneration of ponderosa pine.

Purpose of PNW Science Findings

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The *Recent Grand Fir* type is found in warm, moist environments. In this case, the ponderosa pine understory was filled in by grand fir, another shade-tolerant species. This infill occurred earlier than the *Recent Douglas-fir* type. Now the overstory is co-dominated by ponderosa pine and grand fir in more productive sites. As with the *Recent Douglas-fir* type, *Recent Grand Fir* is much denser than it was prior to fire exclusion.

Recent Douglas-fir and *Recent Grand Fir* are usually adjacent to the fourth type, *Persistent Shade Tolerant*, which provides an ongoing seed source for shade-tolerant species. The *Persistent Shade Tolerant* mixed-conifer type is found in cold, wet environments and is least altered from its historical condition, probably because fire has always been less frequent in wetter climates. Even so, these forests are somewhat denser than they used to be.

"One thing the types have in common is that after about 1900 the stands started getting much denser, and some started developing continuous understories," says Merschel. "This began happening right about the time fire exclusion began. Depending on where you are in the environment, they developed very different species compositions."

Andrew Merschel

Persistent Ponderosa Pine: *This mixed-conifer forest type is denser than it was prior to fire exclusion in the 20th century, but its composition is similar.*

Andrew Merschel

Recent Douglas-fir: *Historically, this resembled the* Persistent Ponderosa Pine *type, but shade-tolerant Douglas-fir now dominates, shading out sun-loving pine seedlings.*

Andrew Merschel

Recent Grand Fir: *Ponderosa pine historically dominated this type, but shade-tolerant grand fir has flourished with the exclusion of fire, developing dense understory and midstory canopies.*

Andrew Merschel

Persistent Shade Tolerant: *This is the least altered mixed-conifer forest type, compared to its historical condition.*

PRIORITIES AND TRADEOFFS

In developing its management plans for public lands, the Forest Service is guided by federal regulations and must consider the needs of distinct and historically divergent interests. Some of these include government officials at all levels, Native American tribes, recreationists, homeowners, community wildfire protection groups, the forest products industry, and environmental and wildlife protection groups. The availability of solid scientific evidence showing that mixed-conifer forests are not a one-size-fits-all landscape is helping these various stakeholders see with more clarity the range of possible restoration strategies for the different forest types and examine priorities and potential tradeoffs for individual landscapes.

"We'll want to keep some areas in dense condition," says Spies. "And we've identified places in the landscape where denser forests would have been natural—even in the pre-Euro-American period—and places where the forest would have been more open. So it might help managers prioritize restoration—to identify places where you want to keep spotted owl habitat as a core area, for example. It just provides a little bit more flexibility, and gives us information that could be used to manage a particular landscape."

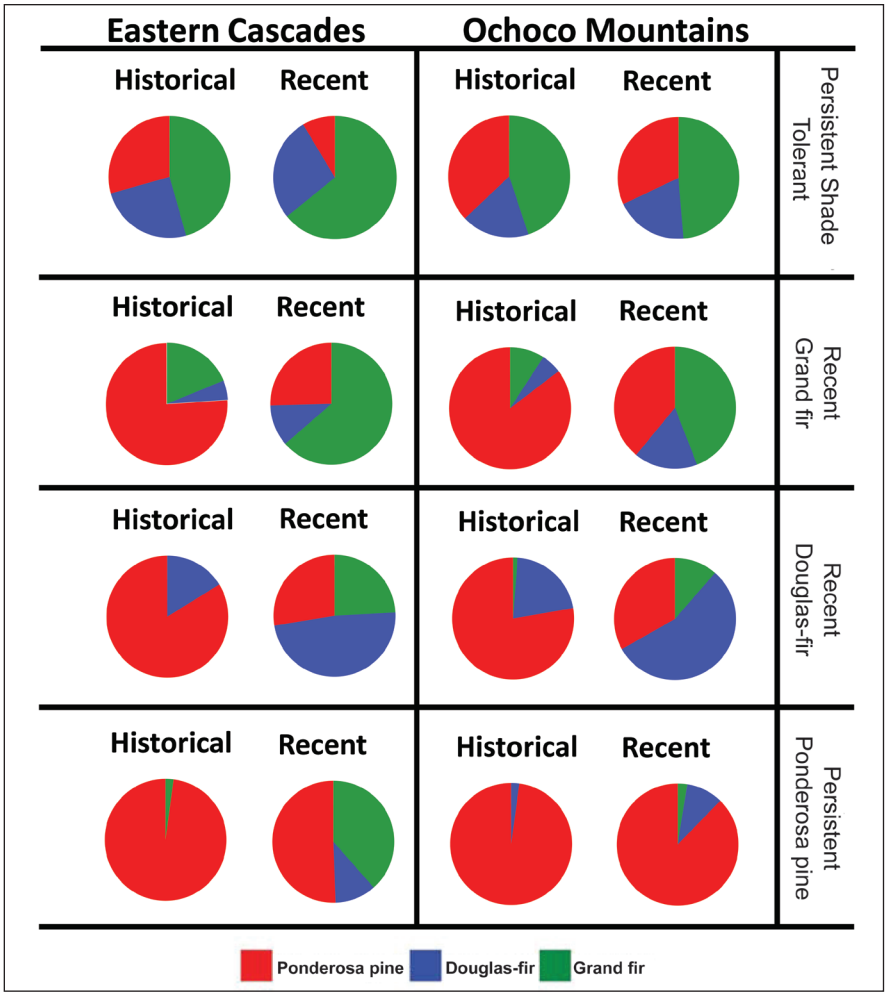
The on-the-ground nature of the study also provides solid evidence about the logging methods used early in the 20th century. "It was not clearcutting," says Spies. "They just went in and removed probably half of the big trees." This selective harvesting reduced the density of large, fire-resistant ponderosa pines in older forests and paved the way for shade-tolerant species to move in.

Knowledge about the structure and composition of ponderosa pine forests before Euro-American settlement can inform current density benchmarks. "If we're using the current density of big old trees to define old growth, we will underestimate the potential relative to what it was in the past," says Spies. "This new knowledge might give managers some targets, or impetus, for doing what's necessary to promote the growth and development of big old trees, particularly pine and Douglas-fir."

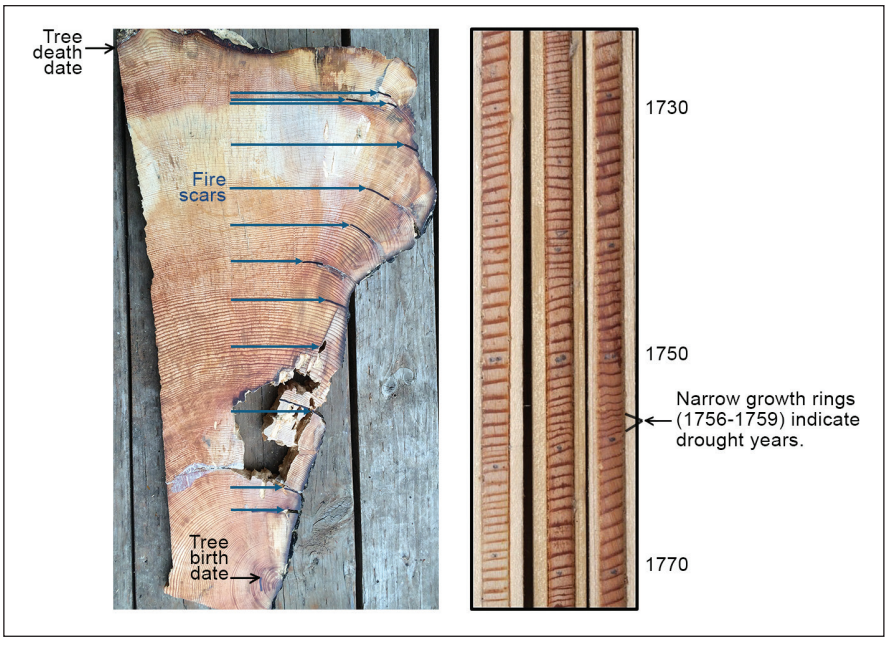
Changes in species composition can be just as important as density, the study concludes. "A change in composition of the forest will change its resilience, and that provides some basis for talking about where you might want to do restoration, or the type of restoration that's needed," says Spies. "In addition to reducing density, maybe we need to remove certain species from certain areas."

For example, grand fir is not as fire-resistant as pine and is more susceptible to drought, insects, and disease. Prior research has shown that as the climate warms and wildfire becomes more frequent, it is unlikely that grand fir will have a chance to develop into healthy, productive old growth.

The study also suggests that the *Persistent Shade Tolerant* type may be a lower priority for restoration because it is least altered from historical conditions.



Composition of trees established in the historical (prior to 1890) vs recent (after 1890) period by type and subregion.



The three tree cores on the right are arranged to show the years 1730 to 1770. Drought years that are consistent across all samples are clearly visible in these three samples especially those in the late 1750s. Cross-dating core samples from a study site reveals precisely how the stand developed through time as well as the structure and species composition of the stand.

CONSENSUS BUILDING IN CENTRAL OREGON

When word got out about Spies and Merchel's study, people wanted to hear about the results right away. "There are some very passionate stakeholders in Central Oregon, and they want to understand this information and the implications of it," says Spies.

Merschel and Spies have been working closely with the Deschutes Collaborative Forest Project and the Ochoco Forest Restoration Collaborative, two strong, local stakeholder groups consisting of people representing assorted interest groups. These collaboratives are taking field trips together, learning about the latest in forest science, and working together to make restoration recommendations to the Forest Service—essentially to provide social license for restoration activities. Both groups have been keenly interested in the mixed-conifer study.

For Pete Caligiuri, a forest ecologist with The Nature Conservancy in Central Oregon, the fact that these diverse stakeholders are working together productively is a hopeful sign that stakeholders will be able to come together on a shared vision for restoring mixed-conifer forests in Central Oregon.

"If you were to turn back the clock a few decades, you'd most likely see some of those groups meeting each other in a courtroom over Forest Service planning," says Caligiuri. "Now we're doing a lot more shared learning around the ecology of these forests, and discovering how stakeholder and community values can be integrated into restoration. That shared learning provides a foundation for us to begin building recommendations that we're forwarding on to the Forest Service. In our quest for the best available science, Andrew and Tom's work rose up quickly on our radar screen as something that we could learn from."

As a seasoned old-growth researcher, Spies is happy to see this movement toward consensus. "There are so many values at stake in these forest debates," he says. "Without studies like these, people fill in the blanks with their own biases and assumptions, so we always like it when a little bit of science can add some clarity."

Merschel says that the value of the study is that it helps to provide context for appropriate management actions. "There have been lots of arguments over what mixed-conifer forests used to look like and how they should look in the future," he says. "The goal is to try and stop some of those arguments and say, 'there's a place for all of this.' It's important to pay attention to where you are on the landscape and the history, and then you can make good, defensible decisions about the management actions you want to take."

The Nature Conservancy's interst in the study's results prompted it to help secure funding through the State of Oregon to support Merschel's work on another study in the area that will further refine the findings. "Now we're trying to drill in at a much finer scale and think about a connected landscape, where each of the plots are connected to each other and influencing each other," says Merschel.

This land is your land,
this land is my land.
—Woody Guthrie

LAND MANAGEMENT IMPLICATIONS

- New classification of mixed-conifer forests can help managers set priorities for effective and appropriate treatments to restore resilience.
- Environments where grand fir and Douglas-fir were always components of the overstory in the last four centuries may be a lower priority for restoration than sites where these species have become established in high densities since the practice of fire exclusion began.
- Compositional changes resulting from land use may be just as ecologically important as density changes. The shift toward shade-tolerant species limits the establishment and development of large fire- and drought-resistant pines, and shifts stands toward less fire- and drought-resistant species.
- Managers can use estimates of past densities of large fire-resistant trees to set restoration targets for various environments.

FOR FURTHER READING

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