

# Science

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*"Science affects the way we think together."*

Lewis Thomas

## MOVE OVER, DOUGLAS-FIR: OREGON WHITE OAKS NEED ROOM TO GROW



D. Peter

Many landowners, conservation groups, and public agencies are interested in retaining the cultural legacy and biodiversity associated with Oregon white oak habitat.

*"Our route has been through what might be called a hilly prairie country, the grass mostly burned off by recent fires, and the whole country sprinkled with oaks, so regularly dispersed as to have the appearance of a continued orchard of oak trees."*

—Henry Eld, Wilkes Expedition, 1841, near Independence, Oregon

It's beginning to look like Oregon white oak will get an 11<sup>th</sup> hour reprieve. Throughout the Pacific Northwest, a fledgling campaign of oak research and restoration is taking root and beginning to

reverse a long-standing trend. And not a moment too soon. Oregon white oak, also called Garry oak, now exists on only a fraction of its former range in many areas, and the woodlands and savannas that remain are largely in poor condition.

Oregon white oak habitats have been in trouble since the mid 1800s. The moist, well-drained soils that are found in valley bottoms and support the best oak habitat also create the most valuable farmland. So, not surprisingly, agricultural development and urbanization have supplanted most of the prime oak habitat. What's more, ever since Native Americans stopped regular burning through the valleys and foothills, conifer

### IN SUMMARY

Oregon white oak savanna and woodland habitat in the Pacific Northwest has declined to less than 10 percent of its former range, and much of what remains is of poor quality. In addition to urbanization and agricultural development, habitat is being lost to conifers that have invaded oak areas, which were once maintained through frequent burning by Native Americans. The conifers eventually overtop and kill the shade-intolerant oaks. Many landowners, conservation groups, and public agencies are interested in restoring the cultural legacy and biodiversity associated with oak habitat. Until recently, however, there has been little specific information available on the effects of management practices to guide their actions.

The Oak Studies Group at the PNW Research Station laboratory in Olympia, Washington, has been building a body of research to aid the restoration of oak habitat. They have shown that the complete removal of overtopping conifers—as opposed to partial removal previously suggested—is the best way to increase stem growth, promote new branches, and bolster acorn production. An updated growth model predicts that many oaks will die unless released from overtopping conifers. By recruiting volunteers from British Columbia to California for an annual acorn count, the researchers have found that the best acorn producing trees have wide crowns, few competitors, and grow in moist, well-drained soils. When planting oak seedlings, the group stresses the importance of initial seedling size and post-planting treatments to control weeds and prevent animal browsing.

trees—primarily Douglas-fir—have been steadily encroaching on the oak’s territory. Without frequent fires to keep them in check, fast-growing conifers eventually overtop and ultimately kill the sun-loving oaks.

Oak habitat is now a rare sight in a landscape replete with conifers. Connie Harrington, a research forester with the PNW Research Station in Olympia, Washington, believes that their scarcity helps explain why so many people have rallied around the oak restoration cause. “I also think people are attracted to the open spaces and the special plants and wildlife that are associated with oaks,” says Harrington.

“Oregon white oak savannas and woodlands represent a biological and cultural legacy in the Pacific Northwest. Many of the plants and animals associated with oaks are not found in conifer forests,” says Harrington. “Therefore, if we allow the oak legacies to disappear we’ll lose critical ecological diversity and wildlife habitat.”

Harrington leads the station’s Oak Studies Group. Their work spans from Vancouver Island to northern California and is focused on practical strategies for restoring and managing Oregon white oak habitat.

“Most of the oak resource is on private land, so it’s important for us to find ways to get the information packaged for landowners and those who work with landowners, not just for other scientists,” she explains.



## KEY FINDINGS



- The effect of releasing oaks from overtopping Douglas-fir was greatest when all nearby conifers were removed. During the 5 years after release, oak stem growth and acorn production increased, and the formation of new branches increased the size of the tree crowns. Oak trees with relatively large crowns prior to release responded most rapidly. There were no symptoms of shock or other negative effects of release on oak trees.
- Oaks are found in many habitats, but the best acorn producers have wide crowns, few competitors, and grow in moist, well-drained soils. High variation in acorn production across years is related to winter temperature and spring and summer precipitation.
- Whether Oregon white oak seedlings are grown in nursery beds and planted bare-root, or grown in containers, it is important to promote a vigorous root system that will allow seedlings to establish quickly after planting, before soils become dry during summertime. Early growth is strongly affected by initial seedling size, and beneficial post planting treatments include weed control and tree shelters.
- The widely used ORGANON growth model has been updated for Oregon white oak. It predicts mortality of oak trees will be high unless overtopping conifers are removed but that growth in response to treatment is better than previously predicted.

Indeed, Oregon white oak woodlands and savannas are among the most endangered ecological communities in the Pacific Northwest, and their future is dependent on the active participation of thousands of private landowners. Over the past 7 years, the Oak Studies Group has partnered with conservation organizations, state and federal agencies, universities, and landowner groups to develop a research program that readily translates into

tools and information for oak restoration-ists on the ground. Other researchers and restorationists are also working with Oregon white oak and associated prairie systems, but as Harrington explains “I think our group’s work is different in that we have emphasized studies specifically designed to learn more about managing the tree component of these ecosystems.”

### *Purpose of PNW Science Findings*

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

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## CONIFER INVASION

**O**regon white oak is shade intolerant, meaning its leaves cannot efficiently photosynthesize unless they receive full sunlight. Oak branches that are in heavy shade will die. If most of the crown becomes shaded, the tree might persist for several decades, but eventually it will succumb. Prior to widespread agricultural settlement, Native Americans favored the oaks by frequently burning the savannas. After regular burning by Native Americans ceased, the invasion of other species—especially Douglas-fir—began. Due to their faster growth and a greater maximum height, the conifers quickly overtopped oaks throughout the Pacific Northwest.

Most of the overtopped oaks have long since died. But there are still many places where oaks are hanging on despite the siege of conifers. These are the high-priority restoration sites. “For many stands, it’s now

or never in terms of management actions having an impact,” says Harrington. “I’ve never worked on a project where I thought the topic was so time critical.”

Recognizing this, many landowners and conservation groups have elevated oak habitat restoration to a priority. One such example is Fort Lewis Military Reservation, near Tacoma, Washington, which is home to the largest oak stands west of the Cascades in Washington, and contains many examples of woodlands and savannas that have been invaded by conifers. Harrington and her colleagues teamed with Fort Lewis’ Forestry Program and initiated a study to examine the effects of releasing Oregon white oak from overtopping conifers.

“We evaluated three levels of release from Douglas-fir competition: a full release where all Douglas-fir within one tree-height were

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removed, a half-release where all Douglas-fir within one-half of a tree height were removed, and a control where only a few trees were removed,” explains Warren Devine, a research forester at the PNW Research Station laboratory in Olympia, who was a lead investigator on the experiment. “We found that the response of oak trees was greatest in the full release. During the first 5 years after the treatment, oak stem growth and acorn production increased and new branches formed, which increased the size of the tree crowns. Oak trees that had relatively large crowns prior to release responded most rapidly.”

Harrington was pleased to see that the full release was so effective. “First of all, we found out that it was possible to remove the large overtopping conifers with very little damage to the smaller oaks,” she says.

“Also, prior to our research, it was unknown whether these oak trees could recover after decades of suppression, or if an abrupt and total release from conifers would adversely affect the oaks. Many people had recommended only doing a partial release as a first step, but our research demonstrated that a staged release was not necessary. Managers can now choose the type of release activity that best fits their management objectives and financial resources.”

“Overall, our findings suggest that release will result in positive changes for overtopped oaks,” says Devine. “Increased acorn production will benefit many wildlife species

that feed upon seeds and will promote natural oak regeneration. And the formation of new branches indicates that the release has increased the oak’s vigor.”



C. Harrington

*Because of the prolonged absence of wildfire, conifers such as Douglas-fir have encroached into thousands of acres of oak habitat, where they eventually overtop and kill the oaks.*

## ANSWERS ABOUT ACORNS

**A**corns are oaks of the future. They are also a rich source of food for many mammals, birds, and insects. For example, the western grey squirrel, a species listed as threatened in the state of Washington, relies heavily on acorns for food during the fall and winter. Unfortunately, the loss of oak habitat has resulted in fewer oak trees, and the small-crowned oaks that remain produce few acorns. As part of developing a comprehensive restoration strategy, Harrington and her colleagues set out to address some fundamental questions about acorns.

For example, how many acorns do Oregon white oaks produce? At what age does an oak first produce acorns? What is the age of maximum acorn production? What controls the variation—from tree to tree and year to year—in acorn production?

According to David Peter, no one really knew the answers to these basic questions. Peter is an ecologist at the Olympia Lab and coordinates the investigation into acorn production. “We started our research by completing several whole-tree acorn counts, where we used binoculars to count every acorn on the

tree,” explains Peter. “We did several surveys from the ground and even rented a lift truck for some trees to ensure we were counting the acorns high in the canopy.”



D. Peter

*Researchers conducted several whole-tree acorn counts to establish accurate estimates of acorn production before switching to a simpler protocol, which was followed by volunteers from throughout the Pacific Northwest.*

Based on these surveys, Peter estimates that an oak with a healthy mushroom-shaped crown can produce from zero to 1,000 acorns in an average year. Factors that affect the size of the crown, such as age and crowding by other trees, influence acorn production by individual trees, while winter temperature and spring or summer precipitation seem to control year-to-year variability.

Peter summed up his experience doing whole-tree acorn surveys in three words: difficult, tedious, and time-consuming. Fortunately, by comparing the whole-tree count data with a previously developed code system, he found that he could still make useful estimates of acorn production by simply categorizing a tree’s acorn production into four codes. The codes ranged from Code 1: No acorns, to Code 4: Clusters of acorns all over the tree with limbs potentially bending under the weight of the fruit. This simple protocol can be followed by anyone interested in oaks, which turned out to be a tremendous asset.

For several years now the group has collaborated with dozens of volunteers for an annual acorn count. "Acorns are best counted during the end of August and beginning of September, before they begin dropping off the tree and while their yellowish color provides contrast against the green leaves," says Harrington. "Without the help of the volunteers, it would be impossible to gather data throughout the range of Oregon white oak during such a short time-span."

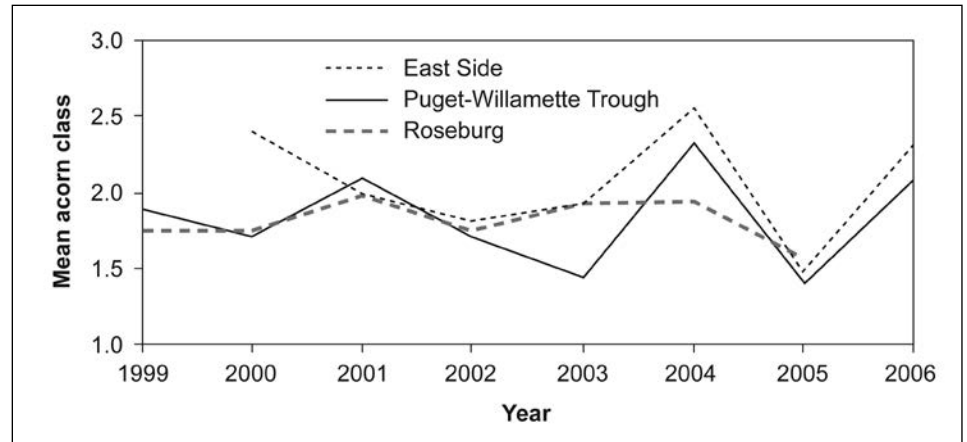
Some of the volunteers are interested landowners with no specific training of any kind, while others work for land management agencies or conservation organizations. "At least 70 people in California, Oregon, Washington, and British Columbia have collected acorn production data since 1999, and 18 government agencies or private institutions have contributed personnel or access to facilitate the study," says Peter.

Thanks to the new acorn data, the researchers now estimate that acorn production begins when an oak is 10 to 20 years old, and that production levels-off around age 80. Open-grown, mushroom-shaped crowns produce more acorns than vase-shaped crowns, which are typical of dense woodlands. Oaks growing in wetlands or on steep, south-facing slopes produce the fewest acorns, while open-grown trees on moist, well-drained soil produce the most.



D. Peter

Oregon white oak acorns are an important wildlife food but acorn production is quite variable. The best acorn producers have wide crowns and few competitors, and grow in moist, well drained soils.



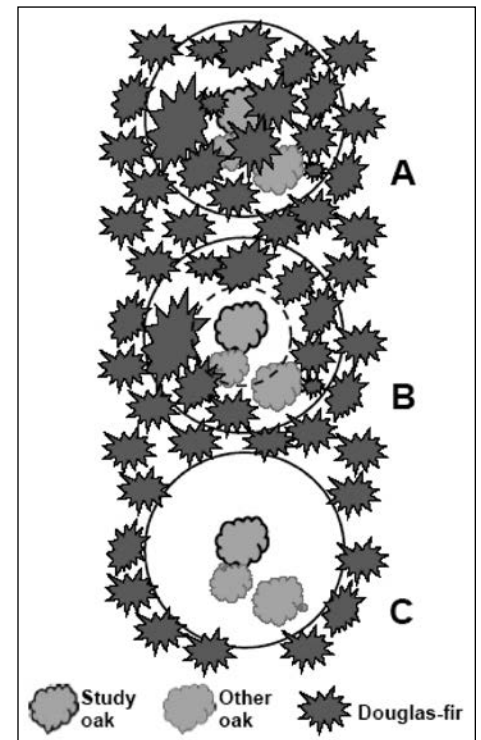
For several years, scientists have been collaborating with volunteers to monitor acorn production across a range of site conditions. High variation across years is related to winter temperature and to spring and summer precipitation.

## OAK REGENERATION

The Oak Studies Group parlayed their success using volunteers for acorn counts into another component of oak restoration: planting oak seedlings. "When we started studying regeneration, there were very few publications with information on establishing Oregon white oak, and most previous plantings could only be considered a modest success," says Devine. "With such

limited information to start from, we needed to explore a wide range of sites and practices." Fortunately, by recruiting volunteers, they were able to do just that.

"People involved with oak habitat restoration tend to be very enthusiastic about their work," says Devine. "They have been quite helpful to us."



The researchers evaluated three levels of release from Douglas-fir competition (A = no release; B = half release; C = full release) and found that the response of oak trees was greatest when all nearby Douglas-fir were removed.

🏠 **LAND MANAGEMENT IMPLICATIONS** 🌲

- Overtopped Oregon white oaks can be restored by removing all the competing trees. Previously, many people had recommended only a partial release as a first step, but new research demonstrates that this is not necessary. Managers can choose the type of release activity that best fits their management objectives and financial resources. Choosing not to release oaks from overtopping competition will result in oak mortality and thus, fewer restoration options for the future.

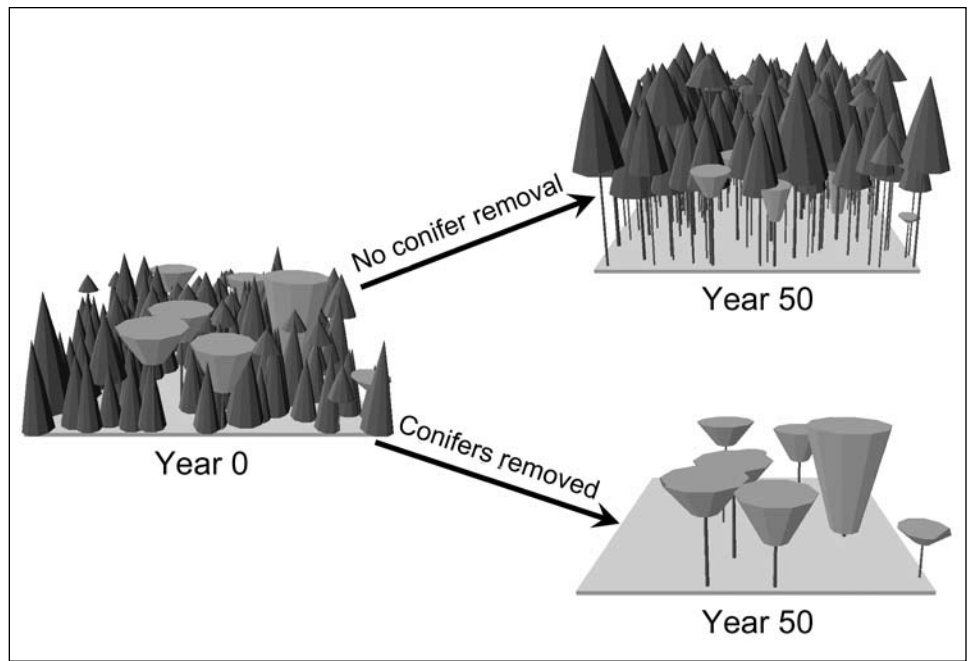
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- Oregon white oak has been eliminated from many of its original locations in the Pacific Northwest, and thus, planting oak seedlings is often the most effective way to reestablish the species. Using high-quality planting stock and post-planting treatments that suppress weed competition and reduce animal damage are the best ways to ensure success.

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- Identification of stand and habitat characteristics associated with varying levels of acorn production allows managers to determine which trees and stands are likely to have the greatest acorn production potential, and if desired, to apply treatments that will increase acorn production.

With the help of more than a dozen volunteers spread throughout the region, Devine has been monitoring oak planting success for the past 4 years. He's found that the quality of planting stock is very important; stout, 2-year-old seedlings have proven to be the best choice. After that, it is a matter of irrigating, preventing animal browsing, and controlling competing vegetation. In a series of trials, he and Harrington found that oak seedlings planted within 4-foot-wide weed-mats had increased growth because otherwise weeds consume most of what little water is available during the summer months. Protecting seedlings from browsing by deer, elk, or cattle is also important, and the researchers have found tall tree shelters to be very effective in getting the seedlings off to a good start.



*ORGANON is a free, publicly available tree growth simulator, which can be used to predict the survival and growth of oaks under different management strategies.*

## PREDICTING OAK'S FUTURE

To help landowners anticipate the effects of different restoration strategies, the researchers have combined their own data with all the other oak growth data they could find throughout the region, including field data from Oregon State University (OSU) and the PNW Research Station's Forest Inventory and Analysis Program.

Peter Gould, who is also a research forester at the Olympia Lab, Harrington, and David Marshall, a former research forester at the lab, have synthesized these data into a suite of growth equations that can be used to predict growth and survival of oak under different stand conditions and management strategies. "The new equations predict long-term survival under a conifer overstory to be much poorer, and growth after release or thinning to be much better, than predicted by previous equations," explains Gould. The team collaborated with Professor David Hann at OSU to incorporate these equations into the newest edition of ORGANON, a widely used, publicly available tree growth model (the model can be downloaded at: <http://www.cof.orst.edu/cof/fr/research/organon/downld.htm>).

"Since the new model predicts substantial benefits of treatments such as removing conifers or spacing out the oaks, managers

may now find oak restoration easier to justify," says Gould. Gould and Harrington used the new model to predict the effects of several alternative scenarios in a 50-year landscape planning exercise that was based on data from real stands. About 60 percent of the oaks in stands with overtopping conifers were predicted to die and many of those that would survive would be in poor vigor. Gould commented "Losing the existing oaks would greatly limit future options for oak restoration."

Previously, the response of oaks to management within the model was based on just 10 to 15 trees—now it incorporates more than 800. This is the same pattern we see for oak information generally. Until recently, there was relatively little known about the biology and management of oaks, but now, thanks to the Oak Studies Group and the enthusiasm of volunteers, landowners, and conservation groups, Oregon white oak restoration is becoming a well-developed science. Hopefully it will be enough to save this important ecosystem from the brink of extinction.

*"The creation of a thousand forests is in one acorn."*

—Ralph Waldo Emerson

## FOR FURTHER READING

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## SCIENTIST PROFILES



*Members of the Oak Studies Group (from left): Dave Peter, Peter Gould, Connie Harrington, and Warren Devine, Resource Management and Productivity Program, PNW Research Station.*

CONNIE HARRINGTON is a research forester interested in silviculture, tree physiology, and plant productivity (and has a special fondness for neglected species). She received her Ph.D. from the University of Washington in 1984.

WARREN DEVINE is a research forester who, in addition to his research on Oregon white oak, also studies conifer regeneration in even- and uneven-age systems. He received his Ph.D. from the University of Tennessee in 2002.

PETER GOULD, also a research forester, is currently working on several projects focusing on the growth of northwestern species; he received a Ph.D. from Pennsylvania State University in 2005.

DAVE PETER is an ecologist who studies Pacific Northwest plant communities, including community structure, composition, and fire history. He received his Ph.D. from the University of Washington in 2005.

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