

Science

FINDINGS

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“Science affects the way we think together.”

Lewis Thomas

Remember Redcedar! An Overlooked Species Reveals Its Potential



Connie Harrington

Until recently, little was known about how young western redcedar would respond to management. A series of studies, some initiated 30 years ago, have found that the species responds well to thinning and fertilization. Above, an old-growth western redcedar in Olympic National Park, Washington.

“Oh, the cedar tree! If mankind in his infancy had prayed for the perfect substance for all materials and aesthetic needs, an indulgent god could have provided nothing better.”

—Bill Reid

Western redcedar (*Thuja plicata*) is one of the more easily recognized trees growing in Pacific Northwest forests. Look for a tree with reddish fibrous bark and lacy foliage of small, interlocking, scale-like leaves. Indigenous people along the Pacific Coast called cedar the “Tree of Life,”

valuing its beauty, versatility, and durability. Northwest tribes used it for their homes, canoes, baskets, and other daily necessities. Redcedar’s straight wood grain and resistance to rot also have made its wood commercially valuable. Yet, as Don Minore, an ecologist with the Pacific Northwest (PNW) Research Station, observed in 1983, “Much less time, money, and effort have been invested in learning how to grow the species than in studying its products.”

When Connie Harrington, a research forester, moved from the East Coast to the Pacific Northwest more than 30 years ago, she was surprised to find that although old-growth redcedar was considered very valuable and

IN SUMMARY

People have long valued mature western redcedar for its strong, lightweight wood that is rot-resistant. The species has cultural importance for Northwest tribes who use the tree’s bark and roots as well as the wood.

Redcedar is very shade-tolerant and is often found in the understory and midstory of Pacific Northwest forests. It is also very adaptable and can grow on a wide range of site conditions in both single- and mixed-species stands. In contrast to Douglas-fir, the subject of countless studies related to its growth potential and response to management in the region, very little has been reported for redcedar.

A series of studies conducted over 30 years on the responses of young-growth redcedar to a wide range of stand, site, and management conditions has led researchers with the Pacific Northwest Research Station to conclude that redcedar is very responsive to management. For example, the species responded well to both thinning and fertilization on a nutrient-poor site, it didn’t experience thinning shock when released from overtopping competition, and in a range-wide analysis, its growth rates held up better under competition than Douglas-fir. These findings are helping land managers evaluate opportunities for growing redcedar to meet multiple economic and ecological objectives.

was being rapidly harvested, the species was treated as a nonrenewable resource. No system was in place to manage young-growth stands of redcedar. As Harrington dug deeper to determine why redcedar was being neglected, she learned that after old-growth trees were no longer available, researchers and forest managers devoted most of their energy to developing management guidelines in young-growth stands for the most common species, such as Douglas-fir and ponderosa pine.

“Managers thought only old-growth redcedar had value, which was basically true when substantial inventories of old-growth were still available for cutting. But the value of logs from young-growth stands has increased substantially, and redcedar is one of the most valuable species we can grow on many sites,” Harrington notes.

“Another misperception was that red cedar was a very slow-growing species,” she continues. “I think this perception developed because the species sometimes grows in conditions where growth rates are very low, such as on nutrient-poor sites or in deep shade. Also, deer and elk browse young redcedars,

KEY FINDINGS	
	<ul style="list-style-type: none"> Western redcedar is a shade-tolerant species that responds well to thinning and removal of larger trees that overtop it.
	<ul style="list-style-type: none"> Redcedar’s ability to regenerate under both low and high light conditions can result in a substantial number of new trees that are ready to take advantage of the newly available light and nutrients after thinning or other disturbance.
	<ul style="list-style-type: none"> Redcedar’s maximum growth rates are less than those of Douglas-fir, but hold up better under competition, particularly competition from larger trees that may overtop it.
	<ul style="list-style-type: none"> Redcedar tolerates nutrient-poor conditions, but also grows well on nutrient-rich, productive sites. It can be grown in mixed or pure stands.
	<ul style="list-style-type: none"> Redcedar can survive for many years in a forest understory or midstory position. By growing where other trees cannot, it contributes to canopy structure and enhances wildlife habitat and ecological diversity.

which makes it particularly difficult to regenerate. So you have both misperceptions and challenges. For me, redcedar was a species

that was ripe for research to see how it would respond to management practices that favor it in young-growth stands.”

EXPLORING REDCEDAR’S RESPONSE TO MANAGEMENT

Over the past three decades, Harrington has undertaken a series of long-term studies with fellow foresters from the PNW Research Station, focusing on how redcedar responds to different management scenarios. Recognizing the unique opportunity to learn more about the species, private landowners and forest management agencies have provided land and other support for this research.

In one study, research foresters Harrington and Warren Devine examined how redcedar responded to a variety of thinning and fertilization treatments over 25 years. When Harrington initiated the study in 1980, she

established control plots with no treatment, and plots with thinning only, fertilization without thinning, and thinning and several types of fertilizer applications.

Harry Bell, who was then manager of ITT Rayonier’s silviculture research program, provided land for the research and coordinated the management activities needed to implement the thinning and fertilization. Bell recalls, “We were thinking of planting cedar but had no knowledge about how to manage it in an intensive forestry context—how to thin it or whether it responds to fertilizer. We had lots of unanswered questions, so we did the project.”

Devine and Harrington divided their analysis into two segments: Devine examined the taper, height, and diameter measurements of the 250 largest “crop” trees per hectare, and Harrington looked at the data for all of the trees, which included many new young hemlock and redcedar ingrowth developing in the stand. “The major strength of this study was that Connie had the foresight to establish it in 1980, and she included quite a few treatment options,” notes Devine, “So we have the advantage of long-term data on this species for which there’s very little information.”

Another study led by Leslie Brodie, a forester with the PNW Research Station, focused on



A researcher measures the diameter of young redcedar. The tree in the left photo is in a control plot which received no treatment. The tree in the right photo is in a plot that was thinned and fertilized 12 years prior.

Connie Harrington

how redcedar responds to being released from shade to sunlight, and whether fertilization enhances its response. Brodie observes, “There’s an anecdotal belief among foresters that redcedar doesn’t respond well to thinning and experiences shock when released from competition from trees that overtopped it or whose crowns were overlapping. We suspected that wasn’t the case.”

On the study site, managed by the Washington Department of Natural Resources (DNR), root disease was killing the Douglas-fir in a mixed-species stand, but the redcedar was much more tolerant of the disease. The Washington DNR was interested in creating more variation in the future stand, so it removed the Douglas-fir and left the redcedar. The research team selected 74 redcedar trees in a range of sizes, canopy positions, and light conditions. “Some were out in the open after the logging, and others were still under the stand,” Brodie explains. “We applied fertilizer to half of the study trees, and I analyzed several different competition

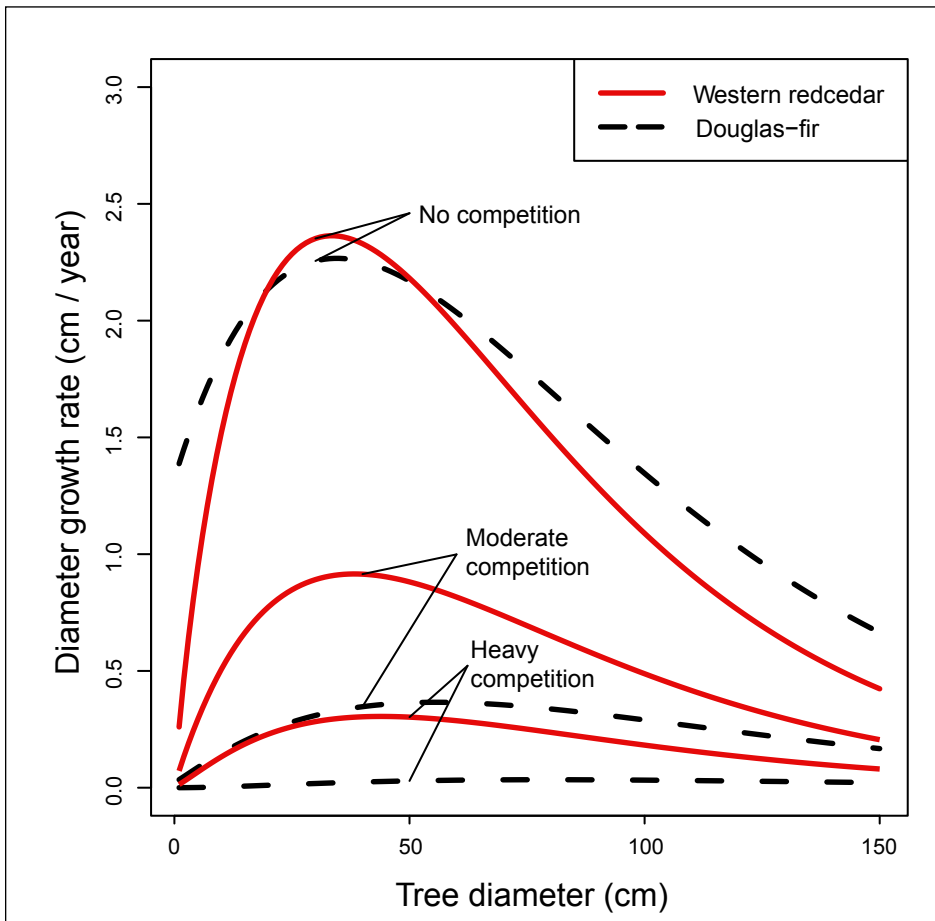
indices to see which had the best statistical ability to predict the response to release.”

In a much broader study, PNW research forester Peter Gould took the lead in assembling and analyzing a redcedar database covering 50,000 trees on more than 3,000 plots in Oregon, Washington, Idaho, Montana, and British Columbia. These trees had been measured at least twice, and in some cases had been remeasured repeatedly over several decades. The research team analyzed growth rates for redcedar under a range of conditions, including tree age, competition, site quality, and type of management. Data came from the above two studies and from the U.S. Forest Service and the British Columbia Ministry of Forests. “Some of the plots were established more than 70 years ago,” says Gould. “We often just look at short, 5-year segments. Having data where trees were measured over long periods is very valuable.”

One objective of the range-wide growth study was to improve the estimate for maximum

stand density index for redcedar. “Basically, the maximum stand density index is a measure of tolerance to crowding and represents the trade-off between tree size and the number of trees,” explains Harrington. “Trees that are more shade-tolerant tend to have higher maximum stand density index values. If you haven’t accurately determined this index, your growth projections will be less accurate, and you’ll make management decisions based on flawed information. If the trees are spaced too widely, they’ll have large branches, which create large knots and reduce their value. But if the spacing is too narrow, the trees will grow very slowly.”

The PNW scientists weren’t alone in their quest to better understand redcedar. In 2010, Harrington worked with others in British Columbia and Alaska to organize an international symposium on western redcedar and yellow-cedar in Victoria, British Columbia. People from federal, state, and provincial agencies, tribes, universities, the forest industry, and consulting firms attended. She recalls, “Several of us thought that rather than having researchers publish their results individually and talk to just a few people, the symposium would create some synergy by getting both researchers and managers together, to talk about a whole range of topics. I think both the symposium and the resulting proceedings raised awareness about cedar and its ecology and how it can be managed.”



This growth model projects that redcedar and Douglas-fir of the same diameter have similar growth rates when growing in open conditions. Growth rate declines for both species under moderate to heavy competition from larger trees. The decline is less for redcedar, however, because it is more tolerant of shade than is Douglas-fir.

Purpose of PNW Science Findings

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REDCEDAR'S SURVIVAL STRATEGY: LIE LOW AND MARK TIME

When analyzing the results of their long-term study, Devine and Harrington noted that thinning created additional space for young redcedar to grow, and fertilizing made the trees more competitive at a younger age, as if they were growing on better soil. The fastest and most growth per acre, however, resulted from fertilization without thinning. “One of the interesting results from this study,” notes Harrington, “was that the response to added nutrients was very substantial and impacted both height and diameter growth.”

“Because of its potentially high timber value, wood quality is an important concern in managing redcedar,” explains Devine. “Higher quality wood comes from trees with fewer branches toward the bottom of the stem. When we fertilized but didn’t thin, many more of the large crop trees were competing for light. This caused the lower branches on the trees to die and be shed. The net effect was that the lowest live branches were higher on the trees in this treatment, which will result in higher value wood.”

Harrington and Devine also found that many of the smaller trees were extremely persistent, despite being very crowded, heavily shaded, and on nutrient-poor soil. Even many of the smallest trees that weren’t fertilized were still alive after 30 years.

“Usually regenerated trees don’t grow well under a canopy of older trees. You wouldn’t find very many young Douglas-fir surviving under a dense Douglas-fir overstory because they aren’t as shade-tolerant as redcedar,” Harrington explains. “For a lot of species, the seeds come down every year and germinate, but the seedlings don’t survive. For redcedar, however, a lot of seedlings survive, and another age class or cohort of trees can become established.”

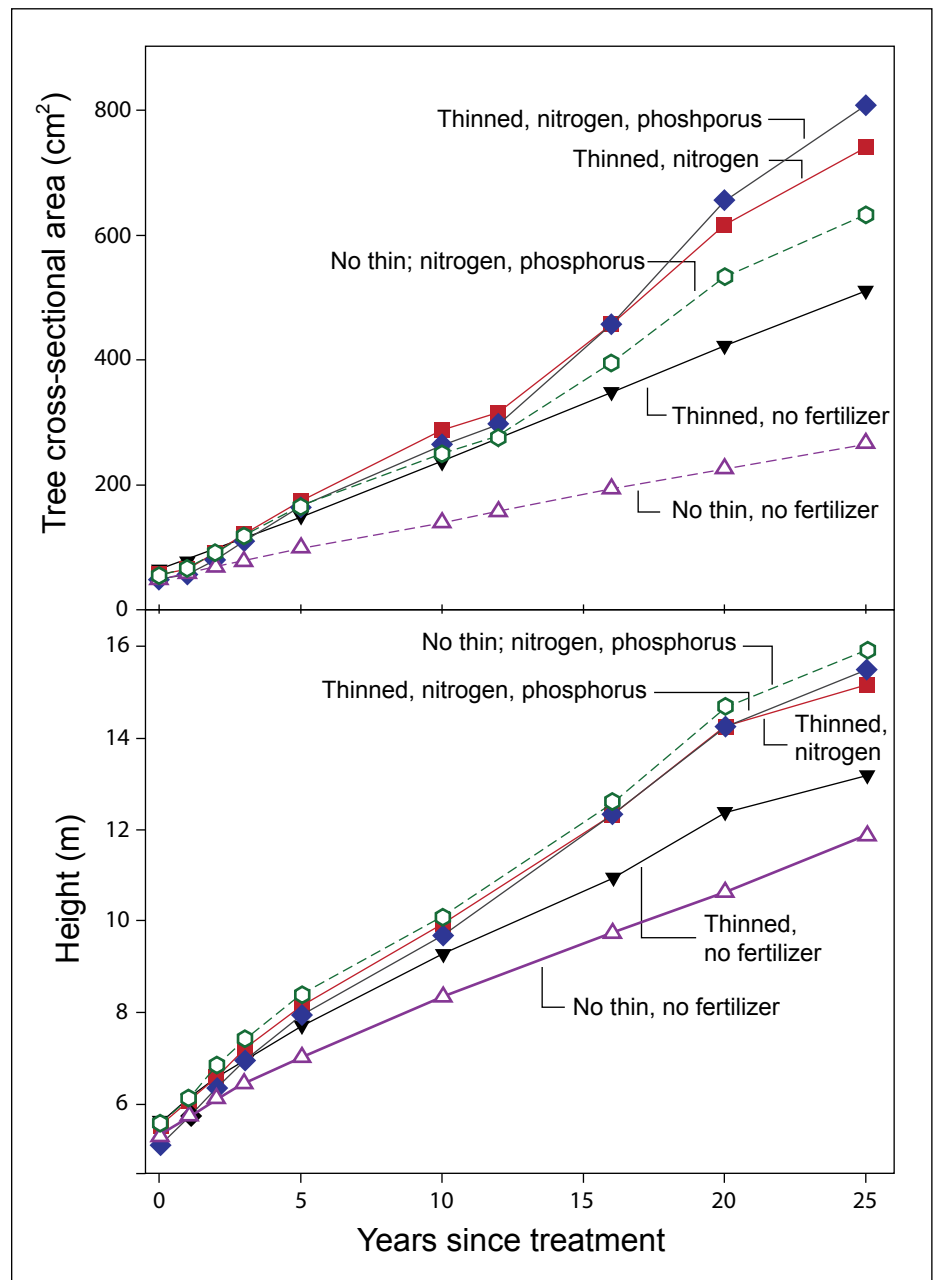
Redcedar also responded well to additional light when overtopping trees were removed and the number of competitors was reduced in the immediate area. This demonstrates that redcedar can be retained when other trees are being logged or thinned. The researchers also learned that although the response to fertilizer was always positive for diameter growth, it was only positive for height growth if the fertilized tree was not overtopped by another tree. And, they found the increased growth rate was temporary.

Brodie recalls, “We expected the cedar to respond well to being released, but I was surprised that the response to the fertilization was only significant for a few years. Then again, fertilization may still be a valuable management tool, depending on your short-

term objectives. All in all, these results look promising for managing cedar, especially because if you can release already established redcedars, you won’t have the deer and elk browsing problem that you have if you plant seedlings. And fertilization may help smaller trees grow out of reach of browsing animals more quickly.”

In analyzing the data related to redcedar’s growth and survival, Gould found that redcedar outperformed Douglas-fir at higher densities. But he was surprised that many trees that had been measured over decades managed to survive, even though they were growing very slowly in deep shade.

“In a forest, the large trees that form the top canopy have the best access to sunlight, and their deep roots give them access to water deep in the soil,” Gould observes. “Living in the forest understory is a difficult life. Redcedar does that well. With many species in the understory, if you tag a small tree, when you come back for a remeasurement, it’s dead. A standout trait of redcedar is it hangs in there and survives. When a large tree falls—or a manager creates an opening—it presents an opportunity, and the redcedar is ready to move up into the overstory. Lying low and marking time in the understory until favorable conditions present themselves may be a good ecological strategy.”



Tree growth on nutrient-poor soil sites can be increased substantially by thinning and fertilization. These results are based on the 250 largest trees per hectare (100 per acre) measured over 25 years.

BRIDGING ECONOMIC AND ECOLOGICAL OBJECTIVES

As a result of this research and its projections of growth under different densities, industry managers are thinning more redcedar stands than previously. “When we initiated the study years ago, there was no market for redcedar. We were doing the research just to gain an understanding of how to optimally grow trees,” recalls Harry Bell, who is currently the chief forester with Green Crow. “Now that young-growth cedar has a high market value, we have more incentive to thin and fertilize, and we have the research that confirms we can get a good return on our investment with these treatments.”



Public forest management agencies are also finding this research useful, according to Florian Deisenhofer, who is a silviculturist for the Washington DNR’s Pacific Cascade Region. “Pacific Cascade Region manages about 500,000 acres of state land,” he explains. “Some of them are reserves, some are multilayered late-successional forests managed for northern spotted owl habitat, and some are used for variable retention harvesting. Cedar is a highly valuable species, but it’s very difficult and expensive to regenerate because of the browsing problem. Typically, 10 to 15 years ago, if you had some understory saplings or midstory trees that had no merchantable value at the time of the harvest, they probably would have been cut down.”

Deisenhofer continues, “In forestry, everything takes so long, that sometimes it’s difficult to know if an approach is working as well as we think it is. Leslie’s and Connie’s research shows that redcedar responds very well to release, as long as the logging damage is minimized. We have many stands with 30- to 50-foot-tall redcedar ready to be released. These trees are hanging out in the midstory, waiting for an opportunity to start growing. This research helps me persuade manag-

FOR FURTHER READING

Brodie, L.C.; Harrington C.A. 2010. [Response of western redcedar to release and fertilization in a mixed-species stand](#). In: A tale of two cedars: International symposium on western redcedar and yellow-cedar. C.A. Harrington, tech. coord. Gen. Tech. Rep. PNW-GTR-828. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 139–144.

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 LAND MANAGEMENT IMPLICATIONS 
<ul style="list-style-type: none">Managers can use the newly defined maximum stand density index (a measure of tolerance to crowding) in growth models to determine the optimal spacing for the trees to achieve both economic and ecological management objectives.
<ul style="list-style-type: none">Redcedar can be managed to develop stands with multilayered canopies that contribute to wildlife habitat and ecological diversity.
<ul style="list-style-type: none">Because redcedar responds well to thinning, it may be a candidate for juvenile spacing or thinning for wood production, or may be retained and managed in mixed-species stands to develop multilayered canopies.
<ul style="list-style-type: none">Redcedar responds to fertilization with increased growth in many situations, as long as it is not directly overtopped by other trees.

ers that we need to do more of this type of release-and-retain management. Because the research was conducted on DNR property, the results are that much more convincing. I can say here’s what they found, it works, and it’s even on DNR land.”

With this information, managers can decide where and how to manage stands to meet multiple objectives, such as creating multilayered tree canopies for wildlife habitat and enhancing redcedar’s market value for timber production.

Says Gould, “There are often tradeoffs between managing for ecological values or timber values, but they’re not mutually exclusive. Redcedar might be a good bridge between the two objectives. Managers can create multistory stands with Douglas-fir in the overstory and redcedar in the understory and midstory and still get a fairly decent growth rate out of the redcedar. Most of the redcedars out on the landscape are there because they naturally regenerated. Letting nature take its

course may be fine. But when you can help it out, why not plant and manage for the species, rather than just rely on the luck of the draw?”



Connie Harrington

A researcher collects foliage samples to examine new growth on this western redcedar.

“The obvious is that which is never seen until someone expresses it simply.”

—Kahlil Gibran

Harrington, C.A., tech. coord. 2010. A tale of two cedars: international symposium on western redcedar and yellow-cedar. Gen. Tech. Rep. PNW-GTR-828. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 177 p. <http://www.treesearch.fs.fed.us/pubs/36731>.

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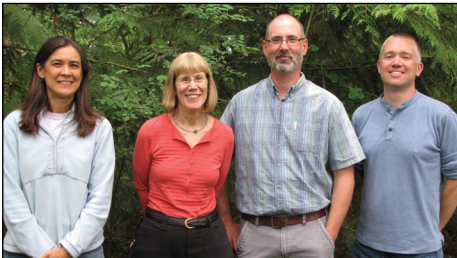
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PETER GOULD is a research forester with the Pacific Northwest Research Station, working on topics related to forest productivity and growth models. He received his Ph.D. in silviculture from Penn State University with a focus on modeling forest regeneration.

WARREN DEVINE is a biological scientist working under contract for the Olympic National Forest on a project that addresses the potential effects of climate change on forest trees. He received his Ph.D. in plant and soil science from the University of Tennessee.

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