Building the Biocarbon Economy: How the Northwest Can Lead

Reinventing Forestry: Growing Ecosystem Services

Diversifying forestry by growing carbon, water services, wildlife habitat and high-value wood products

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A WORLD-CLASS CARBON RESOURCE

The iconic forests of the Pacific Northwest represent the region's greatest carbon storage opportunity, and one that ranks at world-class scale. Westside forests ranging from the coast to just east of the Cascade crest "are capable of sequestering more carbon on some sites than any other terrestrial ecosystem," notes veteran University of Washington forest scientist Jerry Franklin.

A U.S. Forest Service study found **that forests in Oregon, Washington and California store 20.5 billion metric tons of carbon.** That is **39 percent of total forest carbon in the U.S. and close to two percent of carbon stored in world forests**.[1]

Another study places the potential upper bound for carbon storage in westside forests at 671 metric tons CO_2 equivalent ($MTCO_2e$) per acre compared to a current average 330 $MTCO_2e$/acre.[2] **While it is unrealistic to expect that the old forests will be fully restored, it is conceivable to envision far greater carbon storage.**

"We could really do a lot with Northwest forests in the next 50 years to take CO_2 out of the air," Franklin says. "We've drawn down the carbon stocks. There's general agreement that **only 20-25 percent of aboveground carbon remains in coastal forests compared to the amount before European settlement.** That means you have a lot of capacity you could theoretically fulfill."

"We could probably double the store, if that is the only objective," Oregon State University forest scientist Mark Harmon says. "**I'm sure we could easily increase it by 50 percent."**

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[1] Richard A. Birdsley, *Carbon Storage and Accumulation in United States Forest Ecosystems,* USDA Forest Service General Technical Report Wo-59, 1992, p. 3

[2] Erica A.H. Smithwick et al, "Potential Upper Bounds of Carbon Storage in Forests of the Pacific Northwest," *Ecological Applications*, 12(5), 2002, 9.1315

Building up biocarbon in forests involves a set of practice changes centered on one "fairly simple" rule, Harmon says**. "The less frequently you disturb a forest, the more carbon it's going to store."**

"What we could do to really increase carbon sequestration is much longer rotations on managed lands," Franklin says. "We tend to cut at a time when forests are really beginning to sock away a lot of carbon, at 40 years. Douglas fir forests tend to accumulate biomass through the second century."

After a disturbance, whether cutting, disease or fire, **forests accumulate carbon on a steep curve over the first 150 years and do not reach a stable carbon level until around 200 years**.[3] In older forests, carbon gain and loss tend to balance out.

Carbon releases continue years after clearcutting due to decomposition of organic material. Even at 80 years, regenerating forest stands store approximately half the tree carbon of nearby old-growth forests averaging around 500 years in age, "indicating that **conversion of old-growth forests to younger managed forests results in a significant net release of C (carbon) to the atmosphere."**[4]

Not everyone agrees that longer rotations are the prescription for gaining the most carbon storage from forests. Some scientists and forest industry representatives maintain that short-rotation cutting locks large amounts of carbon in wood products. Most forest advocates as well as leading scientists dismiss that argument.

One study found that only 23 percent of carbon in Oregon and Washington wood products harvested from 1900-92 was stored, including 74 percent in structures and 20 percent in landfills. Most carbon is released to the atmosphere during the production phase, 45-60 percent depending on the year.[5] Meanwhile, a trend toward shorter rotations is generating lower-quality wood products that tend to deteriorate more quickly. The thickly grained wood of older trees provides longer-lasting products.

However, the argument that short rotations based on carbon stored in wood products is still influential with both the timber industry and some policymakers. Thus **research must continue on the dynamics of carbon in wood products** with different forest management practices and production practices. **Results and their implications need to be communicated to the public and policymakers** in order to ensure that an accurate picture informs public policy.

Besides longer rotations, **another forest management option that yields high biocarbon performance is selective cutting.** Harmon says cutting 20 percent of a forest

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[3] Ibid

[4] J.E. Janisch and Harmon, M.E., "Successional changes in live and dead wood carbon stores: implications for net ecosystem productivity," *Tree Physiology*, 22, p77-89. 2002.

[5] Mark E. Harmon et al, "Modeling Carbon Stores in Oregon and Washington Forest Products: 1900-1992," *Climatic Change* 33: 521-550, 1996

every 20 years can equal maintaining the whole forest to 200 years. Selective cutting leaves an overall healthier forest better capable of sustaining tree re-growth. Targeting larger, older trees opens spaces for younger trees to grow faster.

"**Frequent partial harvest of forest stands can store as much C in the entire forest system as long intervals between complete harvests** of trees in a stand," writes Harmon and other scientists. "This occurs because with partial harvest in a stand, the live C store is not reduced to zero . . . . With complete harvest of the trees in a stand, the live C store has to accumulate from zero stores."[6]

OPTIMIZING FOR MULTIPLE ECOSYSTEM SERVICES

In general, practices that improve carbon storage in forests tend to enhance other ecosystem services**. Healthy westside forests capture water, beneficial during both droughts and drenching storms, and sustain high levels of biodiversity.** So improving their biocarbon performance not only tamps down global warming – it improves regional capabilities for adapting to the intensified heat and water cycles of global warming.

But there are cases where ecosystem forest carbon storage needs to be balanced with other objectives including wildlife habitat and fire management.

For example, forest researchers and advocates are reaching agreement that careful thinning is needed to improve habitat in some westside forests thickly replanted as tree farms after clearcutting. East of the Cascades forests typically have one-third to one-half the carbon storage of their coastal cousins. In contrast to westside forests where fire is rare, on the eastside light forest fires are key to ecological functions. But a century or so of fire suppression has thickened the forest with overgrowth, threatening genuine old growth trees with stand-replacing fires. So some level of thinning there is also widely regarded as a necessity.

Thinning to improve habitat and reduce fire dangers is not expected to maximize short-term carbon storage. But it will but will prepare forests to better withstand the extremes of climate change, and to build up carbon stocks over the long term.
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"Treating these dense monocultures through variable-density thinning (with stops and gaps in trees to create structural diversity) is likely to help facilitate onset of older forest characteristics," notes Dominick DellaSala, chief scientist for the National Center on Conservation Science and Policy.[7]

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[6] Mark E. Harmon et al, "effects of Partial Harvest on the Carbon Stores in Douglas-fir/Western Hemlock Forests: A Simulation Study," *Ecosystems* (2009) 12: p789

[7] Testimony of Dominick A. DellaSala, Ph.D., Chief Scientist, National Center for Conservation Science & Policy, and President Elect, Society for Conservation Biology, North America Section, House

A bill introduced by Oregon Sen. Ron Wyden in December 2009 reflects an emerging consensus between a wide range of forest advocates and the forest industry on the issue. The *Oregon Eastside Forests Restoration, Old Growth Protection and Jobs Act* would set the stage for thinning on six national forests, while prohibiting logging larger trees. The bill would allocate $50 million to ramp up the effort, and set up a science advisory committee to guide it.

"We need the timber industry to help restore eastside forests. It's no longer zero-sum," comments Andy Kerr, a veteran forest advocate who helped negotiate the deal between the industry and advocates including Oregon Wild and Defenders of Wildlife.

Much Northwest commercial timber land is also planted thickly as industrial tree farms with trees 30-40 years old. From the ecosystem services standpoint, the worst action owners can take apart from clearcutting those lands is to do nothing at all, says Ian Hanna of the Forest Stewardship Council U.S.

"For optimal growth the best thing they can do is thin," Hanna says. "The younger the forest the truer is this notion."

PROVIDING ECOSYSTEM SERVICES ON FEDERAL FORESTS

Northwest federal forest lands represent carbon stores of the first order, a Wilderness Society study found:

- U.S. Forest Service lands store an average of 500 $MTCO_2e$ per acre, and account for nine of the top 10 carbon-storing national forests in the U.S. (the other is the Tongass in the neighboring biome of Southeast Alaska).
- Oregon and Washington national parks store 644 $MTCO_2e$/acre.
- Bureau of Land Management forests in the region average 460 $MTCO_2e$/acre.
- By comparison, tropical rainforests hold 360-460 $MTCO_2e$/acre.[8]

The Wilderness Society notes that "our national forests and other public lands might add carbon storage to the set of multiple uses they provide as a public service to the nation, through practices that accumulate carbon in old-growth forests, large woody debris, and forest soils."[9]

Explicitly **re-purposing federal forests as providers of ecosystem services – climate, water, biodiversity, recreation – is a goal supported by many forest advocates.** This would also ensure that federal forests are available to buffer against climate change.

Subcommittee on National Parks, Forests & Public Lands, Committee on Natural Resources, March 3, 2009 Hearing, :"The Role of Federal Lands In Combating Climate Change"

[8] Ann Ingerson and Anderson, Mike, Top Ten Carbon Storing National Forests in America, Wilderness Society, March 2010

[9] Ann Ingerson, *U.S. Forest Carbon and Climate Change: Controversies and Win-Win Approaches*, The Wilderness Society, 2007, p.9

"Federal lands often contain large blocks of intact and functional ecosystems with viable fish and wildlife populations most capable of adapting to rapid climate change in the coming decades," Dominick DellaSala testified before Congress. "Therefore in an era of increasing climate disruptions, federal lands are our best hope for conserving the ecosystem services upon which society depends. Managing for the restoration and conservation of those ecological systems must become the clear and primary goal of federal agencies." DellaSala asked that the Secretaries of Agriculture and Interior be required "to develop a connected system of lands and waters as a climate change refuge." [10]

For westside old-growth forests, almost all on federal public lands, the clear imperative is preservation of a globally-significant carbon sink. It will take at least 250 years after cutting down an old-growth stand to re-grow the carbon store.[11] Since the forest struggles in the 1980s and 1990s, the trend has been toward preservation. While the Northwest Forest Plan adopted in the mid-'90s allowed cutting some older trees, in effect very little old growth has been cut. But permanent preservation has not yet been enshrined into law. Many forest advocates believe this is a logical step.

Meanwhile restoration forestry will grow young forests into mature and old growth stands. Actions such as thinning and road closings are needed on forests that have been managed for timber harvest. The Wilderness Society estimates that one-third of the Forest Service's 375,000-mile road system could be retired and reseeded for $601 million to $1.26 billion. That would sequester at least 40 million metric tons for CO_2 nationally, half in Northwest and Northern Rockies forests.[12]

Since the "timber wars," the trend in the U.S. Forest Service has been toward forestry oriented to ecosystem services.

"Most timber harvesting we do now has a restoration focus – fire, wildlife, forest health – typically in an integrated approach where timber production is an outcome," notes U.S. Forest Service Region Six Director of Natural Resources Jose Linnares.

An innovative Forest Service research project on the Deschutes National Forest in Oregon aims to describe and quantify the value of ecosystem services provided by the forest including carbon, water, recreation and habitat. These new analytical tools will be used as a framework for forest stewardship, with an initial analysis of trade-offs between thinning to reduce fire dangers and other ecosystem services.

Some make the argument that carbon offset markets could be used to fund reforestation and improved forest management projects on federal lands. Projects on federal lands could potentially be much cheaper to implement than private land

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[10] Testimony of Dominick A. DellaSala

[11] Mark E. Harmon; Ferrell, William K., and Franklin, Jerry F., "Effects on Carbon Storage of Conversion of Old-Growth Forests to Young Forests," *Science*, Feb. 9, 1990, p.669-702

[12] Joe Kerkvliet et al, "Carbon Sequestered When Unneeded National Forest Roads are Revegetated," The Wilderness Society, Feb. 2012

projects. Federal agencies often do not require the same financial returns as private landowners. But this concerns opponents, among whom number many public lands advocacy groups and many who work in the private lands offset market. The large extent of federal lands raises worries that the market could be flooded by cheap offsets that dampen other markets. **Lands advocates maintain that a basic function of federal public lands should be to provide ecosystem services such as carbon accumulation**. So this should not be a marketable, private commodity, but a function supported by public budgets, they argue.

Forest advocates in British Columbia are moving strongly toward climate-based preservation of BC Forest lands, providing a model for work in the U.S. Northwest. Seven BC environmental NGOs have formed Working Group on Biodiversity, Forests and Climate. The group commissioned a scientific study by veteran ecologist Jim Pojar. The report calls for an interconnected climate conservation network managed for carbon and biodiversity covering 50 percent of the provincial landscape. That compares to 15 percent that is now in parks and protected areas. BC groups are working to have one or more climate conservation areas designated in the next four years and for science-based mapping of priority areas around the province.

"Intact, functional, natural ecosystems could be more resilient to climate change than are ecosystems that are fragmented, simplified or degraded by human activities," Pojar writes. These ecosystems contain microclimates that buffer climate change, and make it easier for species to migrate in response to warmer temperatures. "Natural forests in particular play a major role in protecting the quality and quantity of water by buffering the impacts of storms, floods, erosion, drought and rising temperatures."

At the same time, **"There is a strong link between ecosystem conservation and carbon stewardship."** BC forests average 311 $MTCO_2e$/acre, while **BC forests hold an estimated 18 billion metric tons of carbon**.[13]

On the U.S. side **the Sierra Club is assembling the scientific base for climate-based conservation efforts in the Puget Sound and Olympic Peninsula region**. The club's emphasis on climate and energy issues is cross-fertilizing with its traditional focus on lands issues.

"We realized we needed to look through a different lens, resilient habitat," explains Cascade Chapter Public Lands Organizer Benjamin Greuel. The effort is still shaping, and will require a broader alignment, he adds. "To tackle something like this, no one can do it alone."

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[13] Jim Pojar, *A New Climate for Conservation,* Working Group on Biodiversity, Forests and Climate, Jan. 2010.

REINVENTING FORESTRY ON WORKING LANDS

Working forest lands under private, state and tribal ownership forest lands represent a different set of challenges, as well as a far larger portion of U.S. forested lands.

"With 63 percent of our nation's forests privately owned . . . carbon-friendly management of public forestland will not be enough," the Wilderness Society points out."[14]

The biocarbon challenge on working forest lands is to make an economic proposition out of longer rotation harvesting and selective cutting. That entails building bridges to new markets for ecological services and higher quality wood products.

For two decades efforts have been underway to build new economic models for working lands forestry that create value for ecosystem services including wildlife habitat, clean water and carbon storage. Through voluntary efforts and early carbon cap-and-trade programs, small but significant markets for ecosystem services have been created (an extensive discussion on carbon offsetting and ecosystem services markets is carried in the *Working Lands Toolbox* briefing). Much of this work has focused on preventing conversion of working forests to development.

West Coast states have been a global innovation center in economically valuing ecosystem services as a forest product. Work to develop credible forest accounting protocols for increased forest carbon sequestration in California has evolved into the ***Climate Action Reserve.*** Paula Swedeen describes it as "the most rigorous carbon accounting protocol in existence."

Over 50,000 acres of working forest in California, Oregon and Washington have been conserved through the ***Pacific Forest Trust*** since its inception in 1993. That represents $160 million worth of land. Conservation easements (also covered in *Tools & Policies*) cover 38,000 acres of that land. PFT now shares its knowledge nationally, consulting with operations managing more than five million acres of working forests.

One exemplar forest owner with which PFT has worked is the Fred M. Van Eck Foundation in the redwood region of Northern California. The foundation is using carbon money and the sale of a conservation easement to restore second growth forest to its former structurally and functionally complex form through selective harvest. Income to the landowner is coming from sustainable timber harvest – 50 percent of growth per decade – and carbon credits registered by the Climate Action Reserve.

Carbon stocks will be significantly higher on this 2,200-acre property in 100 years than it was when the project started. The land also provides a home to a pair of spotted owls. The permanent conservation easement ensures that the restored forest will

[14] Ingerson, *U.S. Forest Carbon and Climate Change: Controversies and Win-Win Approaches,* p.9

continue to provide ecosystem services for a very long time. Such arrangements provide income that can be crucial to allowing forestland owners to make a transition to longer rotations.

Small, non-industrial forest ownerships offer fertile biocarbon potential. In Washington State, 90,000 landowners hold five million acres mostly in blocks of a few hundred acres or less, notes Mitch Friedman, executive director of Conservation Northwest. Around half of landowners are not managing for timber. "Of those that do, most do so on significantly longer rotations than the 35-45 years now common on industrial lands. The Hamma Tree Farm aims for 77 years on its 3,000 acres; Cowlitz Ridge aims for 80 years on its 1,200 acres."

Court Stanley, president, of Port Blakely Tree Farms, explains the challenges facing timber operators in making the transition to new forestry practices. Once management decisions have been made to harvest at a certain age, companies are financially locked in to that plan.

"Once you reduce a rotation age, it is hard to get back," Stanley says. "It becomes impossible for a company to do, based on cash flow."
"It is hard to make the leap based on the old paradigm," Hanna agrees. "A diversity of income streams is the ultimate solution"

Ecological services payments are an important element of that diversity. They can come from a multiplicity of sources, including private land trusts; ecosystem services markets for water, carbon and biodiversity; and local, state and federal programs. For example a number of USDA conservation programs now support forestry improvements including the Conservation Reserve Program, Wildlife Habitat Incentives Program and Environmental Quality Incentives Program. USDA programs and other ecosystem services supports are covered in the *Working Lands Toolbox* briefing.

"If there were financial incentives to increase rotation age, companies would do it," Stanley says.

BUILDING MARKETS FOR HIGH-QUALITY WOOD PRODUCTS

Port Blakely itself has rotation ages around 60 years, around 20 years longer than on typical Northwest commercial forest lands. The company's model works because it has developed markets for higher-quality logs in Asia. This hearkens to an older strategy which may also map the future for the Northwest timber industry.

The Northwest formerly could achieve market differentiation with high-quality wood products from older trees. One ironic consequence of the Northwest's forest struggles has been to push the industry toward shorter rotations that result in harvesting younger trees. Ecotrust, a group in the lead of developing new models for Northwest forestry, describes the consequences:

"As harvests shifted to smaller trees, the manufacturing technology has adapted. **The region now produces commodity lumber from commodity trees,** much as is done in Canada, the US South, New Zealand, Australia, Brazil, Chile, Russia, the rest of Europe using low-cost Russian logs, and, soon, Uruguay.

"**The difficulty with a commodity log and lumber strategy for Pacific Northwest firms is that competing regions have lower log and labor costs**, and access to the same manufacturing technology as is available elsewhere in the world . . . . One can imagine a 'race to the bottom' as falling costs and expanding market share from lower-cost competitors drive down lumber prices in the US, and eventually timber prices."[15]

While current timber prices in the US might average around $100/cubic meter, competitors in the southern hemisphere and Russia can supply wood at around a fifth of that. "It is difficult to see how a cost-minimization commodity focus will be successful in a world where there is abundant commodity timber available from lower-cost competitors."[16]

So **the Northwest timber industry should build markets for longer rotation forestry producing premium wood products**, Ecotrust says. The region's proximity to the U.S. Southwest and Asia provides additional advantage as energy and transport costs rise: "Japan with its traditional markets for high quality softwood continues to buy high-end products from the region. And the most rapidly growing market in the world – China – is readily accessible . . . ."

Making this model work requires ensuring that the infrastructure to harvest, process and market larger trees will be available at the end of longer rotations.

"To make long-rotation forestry feasible, we need to assure to the satisfaction of thousands of individual landowners that there will be a future market for the big trees, as well as the means – loggers, haulers, mills, people who want to buy the products from big logs – for processing big logs," Mitch Friedman says. "That means we need to sustain enough of an economy in big logs now to keep those things around."

That is going to require policy decisions to make larger trees in the 80-120-year age range available from state and federal lands while stands grow to maturity on private lands, Friedman adds.

Stanley cites another market-building tool for longer rotations: changing LEED green building standards that favor concrete and steel over wood. Current standards eliminate wood products from many government building contracts where LEED standards are required.

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[15] Clark S. Binkley et al, *An Ecosystem-Based Forestry Investment Strategy for the Coastal Temperate Rainforests of North America*, Ecotrust, April 7, 2006, p.9-10

[16] Binkley, p.3

"A push on the benefits of wood would help keep forestry as a viable business on the landscape," Stanley comments.

Conversion of forest lands to development represents a serious threat for releases of forest carbon, and is fed by financial trends.

"The timber industry is in upheaval," Friedman notes. "**Tax and investment policy and trends have driven transformation of the private industrial forest ownership** away from the large vertically-integrated companies that at least pretended to have long-term commitments to forestry, and **toward fractured ownerships** by timber investment management organizations and real estate investment trusts that seek short term profits."

"In short," adds Friedman, "**we can't assume that today's industrial timberlands won't be tomorrow's strip malls.** The closer to town, the higher the risk to those forests and the water, recreation, views, carbon storage and other ecosystem services they provide local communities."

MODELING ECOSYSTEM-BASED FORESTRY MANAGEMENT

Ecotrust is developing a new model for ecosystem-based forestry management that draws together the key elements in reinventing the industry.

The model is based on regular light thinnings aimed at promoting growth of larger, more valuable trees to 60-70 years and beyond. Older trees supply high-quality, high-strength fiber that earns higher prices and is thus more economical to harvest per unit. The model provides steady timber revenues that tend to rise over the life of the rotation. **Revenues from ecosystem services, including carbon payments and conservation easements, provide a bridge in early years when timber revenues are lower.**

Underscoring the vital role of tax policy, **Ecotrust has made creative use of the federal New Markets Tax Credits aimed at promoting economic development in depressed areas.** Most Northwest timber-oriented communities fall in this category. Credits are given to Community Development Enterprises (CDEs), which use them to improve the business case for investments. Winning $50 million in credits, Ecotrust's for-profit CDE, Ecotrust Forest Management, purchased four blocks of timberland on the Olympic Peninsula and Oregon coast. Ecotrust is using those lands to test and refine new forestry models.

"We are trying to look at how ecosystem services can help us move to longer rotations," Ecotrust Forest Carbon Program Manager Steve Dettman says. "In the board market the U.S. is going to be outcompeted by many areas of the world. What can we do in the region that provides competitive advantage? We have forests that sequester more carbon than anyplace else in the world."

"Probably no other region has as much potential to store high quality carbon, while providing other services such as water, biodiversity, scenic resources, recreation and

climate adaptation," says Ecotrust Forest Management CEO Bettina von Hagen. "This is a hugely significant strategy for the Pacific Northwest and the world."

FILLING IN KNOWLEDGE GAPS

While much is known about carbon accumulation in Northwest forests there are still gaps in knowledge that must be filled to realize biocarbon potentials.

"We don't have a good handle on carbon fluxes in many different ages and conditions," Jerry Franklin says. The University of Washington scientist did seminal research on carbon accumulation in old growth forests, but he says less is known about mature forests in the 80-200-year age range. While extensive modeling work has been accomplished, "We have very little field-oriented research looking at carbon. **The most important topics we need to address are productivity and carbon fluxes in mature forests, and the impact of timber harvests on mature stands."**

The region does have a first-class old growth research station at the Wind River experimental forest in the southern Washington Cascades, where carbon flux instruments mounted on a crane provide real-world data. It will be the Northwest core observatory for an unprecedented National Science Foundation (NSF) network of around 20 such centers in the U.S., National Ecological Observatory Network. Franklin had hoped NEON could help fill the mature forests gap, but funding stresses eliminated that option.

Franklin scales the research effort needed to understand mature forests at $200,000-$500,000.

"Most traditional funds for research are drying up," Franklin says. "It is very hard to compete for NSF grants to do the work we're thinking about. The Forest Service Pacific Northwest Research Station doesn't have money. It is even difficult to keep the crane work going."

Mark Harmon cites other research needs.

"We still need to investigate through modeling and field studies which practices are going to pay off the most," the Oregon State University forest scientist says. "It is more complicated than people are portraying."

Harmon adds that **the region could also use more real-time data about forest conditions that could be generated with remote sensing technology.** Matched with understanding of various practices being applied on specific plots, the information could build detailed knowledge on best practices for biocarbon. This would enable better prediction of performance, which could help reduce costs for carbon offset contracts and other ecosystem services payments.

Large-scale data gathering that analyzes carbon performance across the entire landscape would be highly valuable to forest managers as they make decisions, Steve Dettman says.

"Funding would allow agencies to share information, bring in serious data analysis and build a compelling case for best practices, showing where we are doing well and where we are not," he notes. "The data is out there. It is a matter of sharing it and committing time to do analysis."

Such knowledge on forest behavior and practices could have applications beyond the Northwest, and demand will only increase, Dettman says. **"We can be the people to whom everyone turns to provide answers. Getting ahead of the curve would be a smart move for all of us."**