STAFF REPORT

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Topic:	Sightline Institute: Long Rotational Forestry Discussion
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SUMMARY

The Board of Forestry will hear from Dr. Kate Anderson, Senior Researcher at Sightline Institute, about the theory and practice of long rotation forestry in the Pacific Northwest. This is an informational item with time reserved for questions and discussion.

CONTEXT

Dr. Anderson will discuss the present theory and future outlook for longer rotation forest management in Oregon. The presentation will explore multiple objectives for Oregon's forests, including carbon sequestration, and highlight the ecological, economic, and carbon benefits of long rotation management in the Pacific Northwest. Key topics include the following:

1. Summarize how long rotations can help Oregon meet its commitments to a competitive timber economy, public revenue, jobs, climate, and conservation.
2. Define long rotations and explain the biology behind why extending rotations yields both volume and carbon gains.
3. Clarify some confusion and misinformation regarding these results, where the science is clear, and where there are uncertainties.
4. Identify the major hurdles to extending rotations on private land: the short "financial rotation age," limited large-log mill infrastructure, concern that the Endangered Species Act will prevent logging mature trees, and the potential impact on timber supply.
5. Consider possible transition pathways that avoid reductions in timber supply.

ATTACHMENT

(1) Sightline Institute Research on Long Rotations for Cascadian Forests

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Long Timber Harvest Rotations

Methodology, Results, and Policy Considerations

By Kate Anderson, PhD, Sightline Institute | February 2023

The below materials were prepared for the Oregon Board of Forestry's Public Meeting on March 8, 2023.

Included are four articles reporting on Sightline Institute's research investigating whether extending timber harvest rotations can or cannot help Oregon and Washington meet their commitments to a competitive timber economy, jobs, climate, and forest health.

Contents

YES, LONG ROTATIONS CAN YIELD REAL CLIMATE GAINS FOR CASCADIA

Harvesting trees at 80 years, instead of 40, stores more carbon and yields more timber.

This stand of western hemlock on the Olympic Peninsula was thinned over a decade ago by EFM. Source: EFM.

March 17, 2022 | By Kate Anderson, PhD

Forest owners want to know: Will extending my forest harvest rotation produce real climate gains? Timberland owner Richard Pine says, "I'm not entirely convinced." And he's not alone.

"Long rotations" refers to delaying logging[1] and growing forests past a short life, letting them reach something closer to what's sometimes called the biological growth maximum, the age that yields the greatest volume of timber from the land over time. Experts, like Court Stanley, who managed Port Blakely's long rotations for over 30 years, estimate that the biological growth maximum for Pacific Northwest forests west of the Cascades is between 80-100 years.

Applied to football quarterbacks, short rotation forestry is like retiring Patrick Mahomes at his current age of 26 because he's no longer improving as fast as he used to. He's still a superb quarterback, and based on NFL averages, he's still got 10 winning years left in him.

[1] For simplicity, this article narrowly focuses on extending rotations in clear-cut (even-aged) harvests. Timberland owners can harvest uneven-aged, multi-story stands on longer rotations too. The rotation age is defined as when the oldest trees get cut.

Long-rotation forestry could mean replacing two typical 40-year harvest cycles with one 80-year cycle.[2] The long-lived moist forests of the Pacific Northwest offer some of the greatest returns for longer rotations. In NFL terms, they are the Tom Brady, Brett Favre, and Warren Moons of the world's forests—older, wiser, and winners.

As a strategy to coax more and higher-quality timber from a forest, long rotations have been the gold standard. As a tool to fight climate change, delaying harvest was enshrined in action plans all the way back to the Kyoto protocol. Today, extending rotations is an acceptable activity for banking carbon offset credits, including by the strict standards of California's carbon market.

As far as ecosystem modelers are concerned, extended rotations as a top climate priority for Cascadia is settled science. In California, Oregon, and Washington, extending forest harvest rotations on industrial forestlands offers the highest potential carbon gains of any natural carbon solution.[3]

How much carbon storage are we talking about? Extending rotations from 45 to 75 years on just 40 percent of private timberland would sequester up to 5.6 million metric tons of CO_2 per year by 2050 in Oregon and up to 5.2 million metric tons in Washington. These amounts equal 10 percent of Oregon's annual emissions reduction goal for 2050 and 7 percent of Washington's target for 2050.

Measuring wood characteristics. Source: Marcus Kauffman, Oregon Dept. of Forestry.

For about a quarter of all forestland west of the Cascades in Oregon and Washington, extending rotations could also produce enough additional timber to pay for itself, even considering the financial costs of letting trees stand for another 35-40 years.

These financial costs, often alluded to with expressions such as "the time value of money" or "the discount rate," are what drive down harvest age from a "biological rotation age" that maximizes timber yield to a "financial rotation age" that maximizes return on investment.

Dave Walters, Vice President of Acquisitions and Business Development at timber company Green Diamond, explained: "If you look back, forests were managed to hit the peak of biological growth. As the business became more financially motivated, peaking biological growth adjusted to be peaking financial maturity of the forest. The rotation age declined and we got to this financial rotation age."

In future articles, I will explain these and other challenges to transitioning back to long rotations—especially for the many people whose livelihoods depend on the timber industry—and I will explore possible solutions.

[2] The age that maximizes sustained yield varies tremendously by region, species, and even by site. It's much older for slow-growing lodgepole pine in Eastern Washington, and younger for loblolly pine in the Southeastern United States.
[3] Natural carbon solutions are land management strategies that increase carbon storage or avoid greenhouse gas emissions.

Long rotations in practice: It's already working

Debra Pine on a log loader during harvest near Centralia, WA. Source: Richard Pine.

Mason, Bruce & Girard (MB&G), one of the oldest and largest consulting forestry firms in the United States, manages several forests on long rotations. For a 12,500-acre family forest in Linn County, Oregon, for example, its goal is a rotation of 80 years or more. According to MB&G's field data, an 80-year rotation that includes commercial thinning yields 70 percent more timber than two 40-year rotations on the same land.

Edie Dooley, the MB&G forester managing this forest, is passionate about these results. "Everyone's proposing this 80-year rotation, but they just say, 'wouldn't that be cool?' And I want to tell them, 'Hey, we're already doing it, and it works!' It works because you have a really healthy forest and you're still making revenue, and you have healthy communities."

MB&G is not alone. The Confederated Tribes of the Grand Ronde harvest on a rotation cycle of at least 70 years in stands where they use clear-cutting and replanting.

Some large timber companies harvest on long rotations too. Mike Warjone, President of US Forestry at Port Blakely told me about its *minimum* 60-year rotation on 45,000 acres in southwest Washington. Green Diamond, which has invested in learning about carbon offsets and supported a carbon tax in Washington, is also considering extending its rotations. According to Dave Walters, "It's not an easy thing to model, for sure. But we are taking a swing at it and trying to figure out where it may make the most sense.

Some doubt long rotations' benefits

Columbia spotted frog in Desolation Creek, central Oregon. Source: EFM.

Recently, the carbon gains of long rotations have been called into question. For example, timberland owner Richard Pine has heard that harvesting on *shorter* rotations might actually be better for the climate.

This misconception is rampant because representatives of the timber industry are propagating it. Even some professional foresters have been convinced. A Washington State University extension forester told me, "I've read some literature suggesting that it's not necessarily any different to grow two short rotations instead of one long one. You have to think about how long that carbon is going to be stored in a product. If growing trees on an 80-year rotation produced more volume, then we'd see companies do it."

No one questions that longer rotations sequester more carbon in living forests. What's debated is whether shorter rotations store more carbon in *timber products* and reduce *net* emissions. Pine calls it "the ongoing debate between carbon in the forest versus carbon in products."

A side-by-side comparison: 40- vs. 80-year rotations

So, does extending forest harvest rotations produce real climate gains?

Yes, absolutely—even when considering soil carbon, the entire supply chain, carbon in timber products, and potential substitution effects.

Chanterelles harvested near Onion Peak on the northern Oregon coast. Source: EFM.

Richard Pine, who typically aims to harvest his trees around age 65, is *already* harvesting on an extended rotation that is about 20-25 years longer than typical industry practice.

Could he sequester even more carbon by extending his rotations further, say, to 80 years? Yes. Because of their location and species, at 80 years old, his forests are likely still bulking up towards their biological growth maximum, storing more carbon and producing more merchantable timber.

The Northwest Natural Resource Group (NNRG) modeled carbon sequestration and timber production for a 40-year versus 80-year rotation for a forest near Centralia, Washington, that is close to Pine's own timber lands. It found that over a 100-year time period, doubling the rotation age increased timber production by 52 percent and kept an average of 53 percent more carbon out of the atmosphere.

Specifically, an 80-year rotation, including commercial thinnings, produced 82,000 board feet of timber per acre while a 40-year rotation produced only 54,000 in total over the course of two rotations.

For carbon, over the same 100 years, the 80-year rotation sequestered 319 tons of CO_2 per acre in an average year in wood products, landfills, and forest. The 40-year rotation sequestered only 209 tons of CO_2 per acre over two rotations.

To answer Pine's question of whether short rotations store more carbon in wood products: **The longer rotation stored 13 percent more carbon *in wood products* compared with two short rotations.**

For more details and a visualization of these numbers, see Appendix 1.

Seeding doubt about long rotations

So why is there speculation that harvesting on *shorter* rotations might actually be better for our climate?

Game camera wolf siting in central Oregon. Source: EFM.

First, the idea of extended rotations is sometimes confused with the idea of reduced harvest, eliminating harvest, or old growth. Those are completely different ideas. Long rotation simply means growing trees longer, before harvesting them, to allow a forest to reach its biological growth maximum and produce more total timber, not less.

Second, some studies make short rotations look better through bait-and-switch. They associate short rotations with vague terms like "business as usual," but, in their analyses, their business-as-usual forest stands are older forests whose age qualifies them as a long rotation.

Third, misapplying a "substitution effects" argument camouflages short rotations' larger carbon footprint. Falsely assuming that long rotations *decrease* wood supply[4] and unrealistic assumptions about how much energy-intensive concrete and steel would make up the alleged shortage, gives the illusion that short rotations decrease emissions.

Finally, some arguments against long rotations are actually arguments against an abrupt *transition* from short to long rotations. Any transition to long rotations must be carefully planned, not only to support timber jobs and profits, but also to avoid indirect carbon emissions from a temporary dip in lumber supply. I will explore potential strategies to do this in a future article.

Understanding a forest's biological growth maximum

A tree planter with a sack full of seedlings. Source: Marcus Kauffman, Oregon Dept. of Forestry.

The biological growth maximum is the harvest age that yields the greatest volume of timber from the land over successive harvests, or what foresters call "maximum sustained yield." This "biological rotation age" aims to maximize timber yield and is typically higher than the "financial rotation age," which aims to maximize return on investment.

To understand how extending rotations sequesters more carbon and produces more timber, it helps to think of a tree, in the words of Seth Zuckerman of NNRG, as a photosynthetic factory. As the tree matures, the factory hums along, sequestering more carbon and producing more wood each year.

The key to the biological growth maximum is not wasting the sunshine. After a clear-cut, the sun pours down its photons, but they fall on stumps and seedlings. There are hardly any tree leaves or needles to

[4] See appendix 2 for an explanation of the harvest age that maximizes timber volume.

photosynthesize sunlight and carbon into wood and oxygen. As a result, the photons are wasted, and the land's capacity to grow timber and store carbon is squandered.

In round numbers, it takes at least ten years for a replanted clear-cut to green up and begin to look like a forest again. A 40-year rotation, driven more by a financial rotation age, means that 25 percent of the rotation is spent in the factory rebuilding stage, with timber production and carbon storage on hold.

The biological rotation age, in contrast, accounts for this green-up period. Even though a tree's annual growth rate peaks during adolescence, growth still remains strong long after this peak. Because of the first ten years of snail-paced growth, a tree's *average* annual growth continues to increase well past its age of *peak* annual growth. To reach the age that maximizes sustained timber yield over time, you wait until this average annual growth rate plateaus. (Foresters call this biological maximum the "culmination of mean annual increment" or CMAI.)

For each year that passes between a young financial rotation age and the biological rotation age, we're better capturing the land's ability to produce wood and store carbon.

For more explanation and a visualization of why longer rotations yield more timber, see Appendix 2.

Long rotations also benefit water retention, soil health, and more

Carbon storage is just one of the myriad benefits from long rotations.

A salmon swims upstream to spawn. Source: Marcus Kauffman, Oregon Dept. of Forestry.

Back in the 1980s and 1990s, when conservationists began trumpeting long rotations, it was not for the carbon benefits but for all of the other forest ecosystem functions, from water retention to soil fertility. At a time when clear-cuts had taken center stage in the US conscience, long rotations were proposed as a way to avoid conflicts between timber communities and environmentalists.

If you double a short rotation, you can cut half as much forestland and produce the same amount of timber. And while those trees are growing to a ripe middle age of 80, for example, the long-rotation forests are better habitat for creatures like the Olive-sided Flycatcher and the red tree vole and a host of plants that can't thrive on short-rotation plantations. There will still be plenty of younger, more open forests for species that prefer it.

MB&G forester, Edie Dooley, who manages her client's forestlands on an 80-year rotation, sees this up close. "When you harvest half as often, you get less soil disturbance. If you choose to use herbicides and kill everything that first year, with longer rotations you do that half as much, so you have a more intact understory and a better microbial community. When I'm in that forest, I just see a huge diversity of mushrooms, and I don't see that on the short-rotation forests next door. Bigger trees make bigger root systems, your 'leave trees' are bigger, your snags are bigger, your down material is bigger."

Forestry's future: Getting from short to long rotations

Given all the rewards of extended rotations, why don't more timberland owners adopt the practice?

A litany of challenges bedevils long-rotation forestry. For Richard Pine, a major hurdle is the absence of a mill within economic trucking distance that can process the larger logs that longer rotations produce. Mike Warjone has endured a contraction in Port Blakely's large log market. Edie Dooley worries about potential community impacts from reduced employment during a transition period to longer rotations.

In my next articles, I'll lay out some of the key challenges for transitioning the landscape to long rotations, and some potential solutions.

For now, it's clear that harvesting at a forest's biological growth maximum is a core tenet of carbon-informed forestry. Logging at the biological maximum is how to lock up the most carbon in wood products (in addition to living forests) and is the point at which land owners get the most timber per year per acre.

Yes, long rotations can yield real climate gains for Cascadia… and healthier forests, too.

Richard, Debra, and Kerry Pine after a long day in the woods. Source: Debra Pine.

Appendix 1: A closer look at the carbon numbers

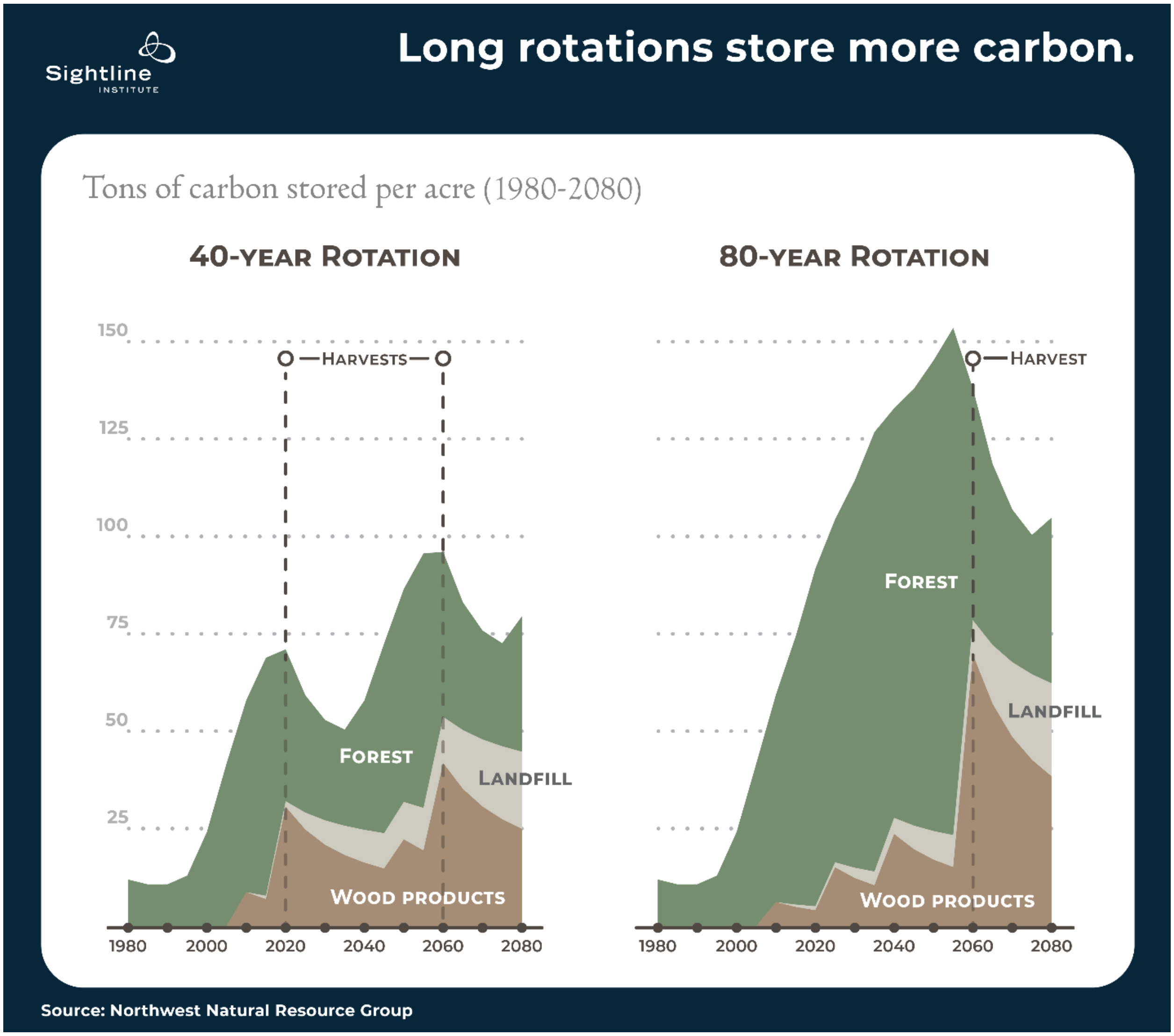
The model: To model carbon sequestration for a 40-year versus 80-year rotation in southwest Washington, NNRG used the Forest Vegetation Simulator and conservatively calibrated this model to avoid overpredicting growth in older forests.[5]

Management: Both rotations are pre-commercially thinned at 10 years and commercially thinned at 30 years. (Thinning yields merchantable timber while making room for the remaining trees to grow more vigorously.) The 40-year rotation is then harvested and replanted at 40 years. The 80-year rotation is commercially thinned at 45 and 60 years, and harvested and replanted at 80 years.

Results: Over 100 years, if you add the total amount of carbon stored in the wood products, landfill, and standing forest, each acre in the 80-year rotation stores 87 tons of carbon (sequestering 319 tons of CO_2) in an average year, ranging from 11 tons of carbon stored in a year during the early days of forest growth to 154 tons just before harvest. On a 40-year rotation, the same acre of forest sequesters only 57 tons of carbon (209 tons of CO_2) in an average year, ranging, over the 100 years, from 11 to 96 tons.

Specifically, the 80-year rotation stores an annual average of 18 tons of carbon in timber products, 6 tons of carbon in landfills (after the wood products have been used and discarded), and 63 tons of carbon in the forest. The 40-year rotation stores 16 tons of carbon in timber products, 7 tons of carbon in landfills, and 34 tons of carbon in the forest (over two-plus rotations).

[5] Under default parameters, the US Forest Service's Forest Vegetation Simulator-Pacific Northwest (FVS-PN) projects unrealistic growth. NNRG controlled for this by using David Diaz's calibrations based on historical yield tables, permanent plots, and forest inventory data (Diaz et al. 2018). This conservative approach captures the rapid growth of intensively managed young stands without allowing the fast growth to persist into older age, thus forcing older stands back towards the median observed ranges for older forests. This calibration almost certainly under-estimates potential timber yield of older forests managed intensively.



Carbon storage from a southwest Washington Douglas-fir forest. Source: Northwest Natural Resource Group

The figure above illustrates these results. The two graphs indicate where carbon is stored, each year, over the course of a century in a 40-year and an 80-year rotation for a Douglas-fir forest in southwest Washington.

Each color indicates a specific carbon storage category. The green area tracks carbon in the forest (above- and below-ground). The brown tracks the carbon stored in wood products. And the gray tracks carbon stored in landfills.

The silhouette of the green area shows the **total carbon added together** from wood products, landfills, and forest. The locations where the brown area spikes up—for example, in 2060 on both graphs—indicate when the forest is harvested or commercially thinned. At the harvest years, the silhouette shrinks, even though trees are converted to wood products that store carbon, because the branches and tree tops are burned or start to decay. Over the next few years, the silhouette continues to decline as a portion of the carbon stored in wood products returns to the atmosphere.

These graphs show that growing forests closer to their biological growth maximum not only stores more carbon in the living forest, but also in the timber products this forest produces.

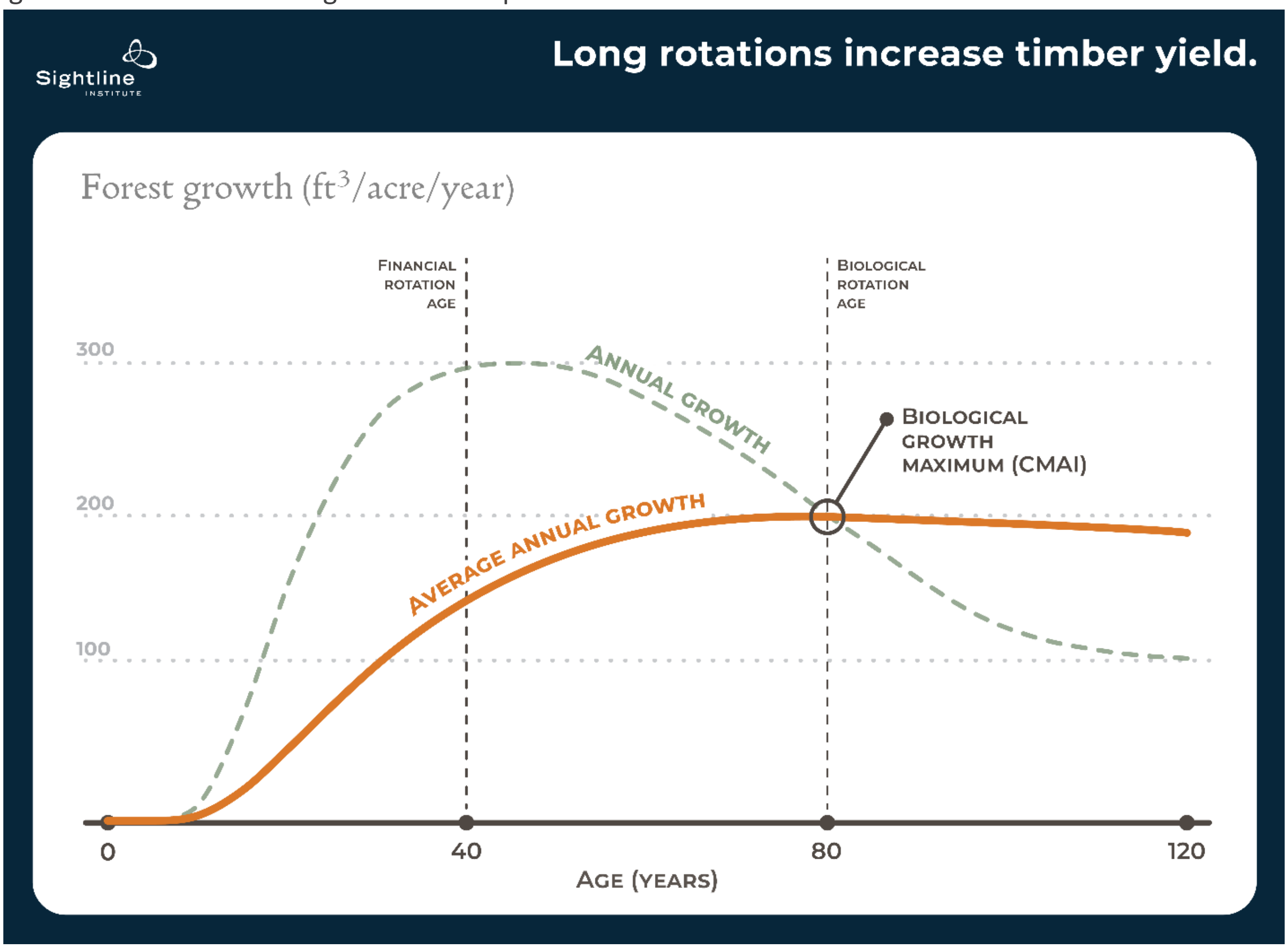
Appendix 2: A closer look at the biological growth maximum

The figure below illustrates *annual* growth and *average annual* growth for a Douglas-fir forest west of the Cascades. This forest's biological growth maximum occurs around 80 years.

The "*annual* growth rate" curve (called the "periodic annual increment," or PAI, in forestry jargon) peaks during the forest's adolescence. However, the forest continues growing steadily long after this peak.

Because it takes at least ten years for a replanted clear-cut to green up and begin vigorously producing wood, a tree's "*average* annual growth rate" (called the "mean annual increment," or MAI, in forestry jargon) continues to increase, even past its age of *maximum* annual growth. That is, the tree's total growth divided by its age is still increasing. To reach the biological maximum, you wait until this average annual growth plateaus. (Foresters call this biological maximum the "culmination of mean annual increment," or CMAI.)

The figure shows that the average annual forest growth continues to increase well past a financial rotation age when forest owners log to maximize profits.



Every forest has a different biological maximum age, depending on tree species, water availability, temperature, soil nutrients, sunlight, and silvicultural management. A lodgepole pine forest in eastern Washington would grow more slowly than the forest illustrated above, and its biological maximum would be older. A loblolly pine forest in the southeastern United States would grow more quickly, with a younger biological maximum.

Managing for longer rotations (for example, harvesting intermediate commercial thinnings) can substantially increase the maximum sustained yield and the biological maximum, for example, from 75 to 105 years, according to one study.

One challenge in trying to agree on the carbon footprint of different rotation lengths is the uncertainty in predicting a forest's biological maximum. Different modeling and calculation methods have always produced different results, but recent intensification of silvicultural practices (such as multi-year use of herbicide, fertilization, and genetically improved seedlings) has increased annual growth. Because these intensively managed forests are essentially never allowed to grow past a short rotation of 35-45 years, foresters can only speculate on the long-term growth potential as these trees age and the consequent rotation age that maximizes yield. What's more, we have little data on long-rotation forests that are well managed for timber yield. The data on older forests come almost entirely from forests that were minimally managed, hindering any short-versus-long-rotation comparison due to the non-comparability of the available data. The bottom line: Regardless of a particular forest's growth curve, the principle of long rotation forestry remains the same. Growing a forest closer to its biological growth maximum produces more timber and stores more carbon.

Why Do We Choose Short Rotation Forestry Over Carbon Storage, Timber Supply, and Forest Health?

The discount rate, vanishing large-log mills, and fear of the spotted owl.

Three stands meet in the foothills of the Cascade Mountains in Oregon: a fresh cut, a young stand, and an adolescent stand (Source: Marcus Kauffman, OR Dept. of Forestry).

May 26 2022 | By Kate Anderson, PhD

Take-aways

There are four main hurdles to long rotations:

1. **A short "financial rotation age"**: Long rotations produce sustained value over time, but not the short-term return on investment sought especially by investor-driven companies that bought up US forestlands starting in the 1980s.
2. **Limited mill infrastructure**: Long rotations grow large, typically higher-quality logs, but most mills today specialize in small logs and either refuse large-diameter logs or pay less for them.
3. **Endangered Species Act**: The historic loss of Pacific Northwest old-growth means long rotation forests provide rare habitat. Forest landowners worry that inviting in the spotted owl could mean they can't log their trees.
4. **Supply**: Long rotations produce more timber per year than short rotations, but how can timberland owners extend their rotations without causing a 15- to 30-year supply shortage that threatens jobs and raises lumber prices?

Extending timber harvest rotations is on the table as a triple bottom line solution—actually a sextuple bottom line solution. But is it really a good idea, and is it even possible? If so, how do we do it?

In my last article, I posed the question: *do long rotations really boost carbon storage and produce more timber?* The answer is a resounding "Yes." This article investigates why today's forest landowners log on short rotations and what stands in the way of extending rotations. In a future article, I will examine how, through careful planning and public investment, we can overcome these hurdles and transform Cascadia's forest landscape to long rotations in a way that works for timber-dependent communities.

Brief review: The six bottom-line benefits of harvesting timber on longer rotations

(For an extended definition and discussion of long rotations, see my prior article. But here's a brief review before we dig in on their challenges.)

A "forest rotation" is the number of years that a crop of trees is grown before the forest is logged and replanted.[6] Long rotations mean growing trees longer before logging.

In the past, timberland owners cut their trees at a "biological rotation age." A biological rotation age maximizes the amount of timber that the land can sustainably produce per year over time.[7] For instance, the biological rotation age for Douglas-fir west of the Cascades might be 80–100 years. Today, most timber companies log their forests at a much shorter "financial rotation age," often less than half the biological rotation age. By doing so, they maximize short-term profits at the expense of long-term timber volume, forest health, and carbon sequestration.

Why are long rotations a *sextuple* bottom line solution? First, they have garnered the most attention for being the best "natural carbon solution" for California, Oregon, and Washington (that's #1 of 6). Modelers also show that long rotations produce more total timber as well as higher quality and more valuable lumber for building homes (that's #2).

And, at a time when Washington and Oregon are scrambling to plan for wildfires (and pay for them), it turns out that long rotations likely mitigate fire severity (#3). Long rotations also improve water quantity and quality and serve as habitat for rare wildlife (#4 and #5). Finally, if history is a guide, extending rotations could help return stability to timber markets and flourishing economies to rural timber communities, if we can get past a transitional supply dip (and that's #6).

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[6] Or, in a mixed-age forest, it is the age when the oldest trees are cut.
[7] Using the term "biological rotation age" to describe the age that maximizes sustained yield (MSY) is a useful shorthand, but it does risk creating the belief that the MSY age also maximizes forest biological integrity and ecological health.

If long rotations are so much better, why aren't they more common?

#1. The time value of money

As mills sold off timberlands starting in the 1980s, the new owners changed from long rotations that maximize a steady supply of timber for the mill to management that maximizes their return on timberland investments (ROI).[8] This is especially true for investor-owned Real Estate Investment Trusts (REITs)[9] and Timberland Investment Management Organizations (TIMOs),[10,11] which currently own a majority of private US timberlands. Large, family-owned timber companies also need short-term profits, especially if they want to invest in complementary businesses or grow their landholdings. It's more lucrative to log short rotations on more land than long rotations on less land.

TIMOs and REITs have raked in windfall profits. From 1990 through 2007, TIMOs averaged a whopping 13 percent return on investment,[12] exceeding the 11 percent averaged by the S&P 500 over the same period, with far less volatility (i.e., making them less risky).

When forestland is held as a financial investment, it must appreciate as fast as Apple or Tesla stock, or other competing investments. Investors want *compounding growth,*[13] which means that value increases exponentially over time.

The *opportunity cost* of not cashing in the trees now and investing in lucrative land deals or Tesla stock means that income received in the future from long rotations is essentially worth less than the same income received today. This is why selling a smaller volume of timber today can be worth a lot more than selling a bigger volume in the future. To find out how much a future timber sale is worth in today's dollars (called *net present value*, or NPV), companies reduce future income by a *discount rate*[14] equal to the rate of return that they can expect on alternative investments.

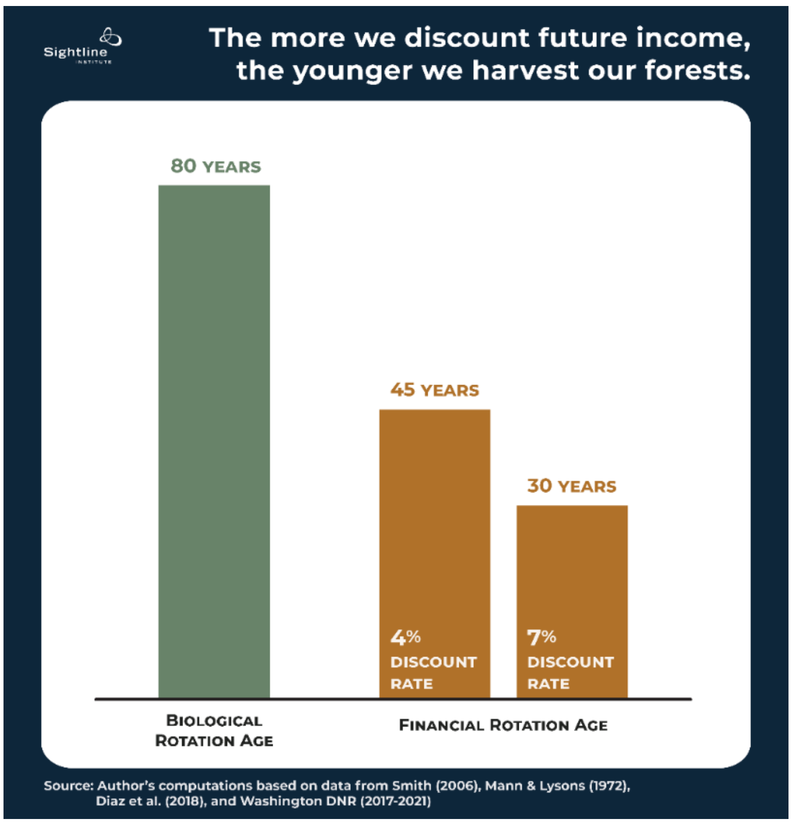
8 The narrow focus on ROI is most extreme in investor-owned companies. According to Elaine Oneil, PhD forest scientist: "As soon as it goes public, everything changes. It's no longer based in the objectives of the company owner, which often include a lot besides money." Most executives at investor-owned companies are now paid overwhelmingly through stock options and bonuses tied to stock performance. While some investors include the retirement funds of regular Cascadians like you and me, that only highlights the problem: most people choose their savings portfolio solely to maximize their rate of return, knowing nothing of the forest ecosystem supporting their timber investment.
9 The main driver for REITs, as codified in a 1960 tax law, is that they do not pay taxes on their income; only shareholders pay taxes on dividends received and capital gains.
10 TIMOs, originally codified in a 1974 tax law, accelerated when a 1986 tax law barred forest product companies from using the lower capital gains tax rate for timber harvests, precipitating the sale of timberlands to tax-exempt investors like pension funds, foundations, and endowments.
11 REITs and TIMOs exacerbate the focus on shareholder value. According to Oneil, "Weyerhaeuser went public before they became a REIT, but the real changes came after they re-organized the business model."
12 TIMO returns were negative for a year after the financial crisis of 2008 but have since been increasing. For the western states of California, Idaho, Oregon, and Washington, the 2021 ROI was 14.42%, but has since declined.
13 Compounding growth means that the interest paid on each year's investment becomes part of the following year's capital. For example: If you invest $1 at a 7 percent interest rate, you'll get $1.07 over the first year. The extra 7 cents are then added to your capital. So, over the second year, instead of making 7 cents again, you will make 7.5 cents. In year three, your capital starts at $1.15, and you'll earn 8 cents. Your investment has now grown to $1.23, which at 7 percent, will yield 8.6 cents in year four. Your annual return on investment grows larger each year. By year 40, your $1 investment will grow to $15, and it will shoot up to $224 in 80 years. With compounding growth, doubling the investment period from 40 to 80 years returns 15 times more money.
14 The discount rate is the rate of return by which you expect or need your investment to grow to compete with alternative investments. To find out the net present value (NPV) of future revenue, we reduce the future earnings by a discount rate, compounded annually. You can think of

The value of a forest grows as the trees mature. Through a forest's adolescence, trees grow faster than the rate of return on Tesla stock—so they're still increasing in today's dollars, as calculated with a discount rate equal to the rate of return on Tesla stock, for example.

Eventually, two things happen. First (and most importantly), because of the compounding rate of return, the Tesla investment grows by more and more each year, soon outpacing tree growth. Second, the trees' annual growth begins to slow down. The forest continues strong average annual growth, but it is not accelerating as it did in its youth.

Companies calculate when to harvest—the financial rotation age—based on a discount rate they set at their needed rate of return. They harvest at the age that maximizes the value of the future timber harvest discounted into today's dollars.In the figure below, the gold bars indicate the financial rotation ages that result from using a 4 percent discount rate (which roughly corresponds with some states' forest management) or a 7 percent discount rate (closer to TIMO or REIT management).

You can see how small changes in the chosen discount rate cause big changes in the age when forests are logged. Compared with the biological rotation age (the green bar in the figure), discounting future harvest income, even with a low 4 percent discount rate, slashes the rotation age by 35 years. Using a 7 percent discount rate shrinks rotation age by 50 years (see the methods section below for more details).



Biological rotation age versus financial rotation age for a Douglas-fir forest west of the Cascades. Numbers will vary for different forests and market conditions.

discount rates as the reverse of interest rates. A company's financial team considers multiple factors when deciding what discount rate to use in their business planning, such as their goals, their debt burden, timber prices, risk, and interest rates. Franklin, Johnson, and Johnson's *Ecological Forest Management* textbook (2018) has an excellent primer on classical investment analysis.

Getting their money upfront means more profits for timber companies and investors, but less value for everyone else. One long 80-year rotation yields more lumber than two short 40-year rotations, as well as more carbon savings, a better home for the many species that prefer old forests, and more cool and clean water. These are the opportunity costs of short-rotation forestry.

Rotation length is one of many ethical controversies stemming from the discounting of future values and ecological benefits, from habitat to mitigating climate change.[15] But don't despair! In my next article, I will discuss ways to bridge the gap between financial and biological rotation ages and incentivize landowners to grow older forests.

#2. Mills and engineered wood

A second, related hurdle for long rotations is a lack of mills tooled to process the large-diameter logs from older trees. Most mills today do not accept large logs (i.e., over 20 to 28 inches in diameter), and if they do, they typically discount them 10 to 30 percent because they are more labor-intensive to cut.

For Richard Pine, who owns timberlands in the southwest corner of Washington, there is not one mill within economical trucking distance set up for his large logs. Pine said, "Because our trees are too big, even at 65, for mills in this area, we long-butt them: we leave 10–15 feet on the bottom, and then start cutting our logs above that. Or we're selling them as cheap wood for firewood and pulp."

The narrow opening of a mill's small-diameter "ring debarker" is just one part that limits log size (Source: Eric Simmons, US Forest Service).

Since the 1980s, the mill infrastructure has shrunk in number from many small-capacity mills tooled for large logs, scattered across the landscape, to a much smaller pool of high-capacity mills that are extremely efficient and highly specialized for small logs (i.e., 7 to 11 inches in diameter).

In the past, mills paid a premium for large logs. Older trees mean wider and longer boards that can serve a greater range of purposes. The denser and stiffer wood makes stronger lumber and, if managed well, contains more premium knot-free and straight-grained "clear wood." Large logs also mean more lumber out per volume in (i.e., less wasted wood) as round logs are sawed into rectangular boards. On average, the *value* of older trees is up to 55 percent higher per board foot compared with younger trees. But today, this value typically doesn't translate into log price.

Older trees still produce superior wood, so why don't mills want them anymore? The answer lies in a perfect storm of insufficient large-log supply, corporate restructuring, mill automation, and engineered wood product technology. (But, ultimately, the main culprit is the financial rotation age.)

[15] For example, the discount rate discourages coastal restoration and wetlands protection projects because the costs are borne now, so they aren't discounted, but the benefits are enjoyed in a discounted future. Similarly, discounting future value also means a low price for carbon offsets because the future damage of climate change is so steeply discounted, but the costs of mitigation are counted in today's non-discounted dollars. So, even if markets were to account for non-timber forest functions, the discount rate reduces their value relative to the present-day costs of protecting them.

When old-growth forest was plentiful in the US West, the timber sector hummed along processing large old-growth logs and large logs from long rotations. Gradually, the old growth was used up, and, as an outcome of tremendous conflict, in 1994, the Northwest Forest Plan drastically restricted logging in the remaining supply to protect the northern spotted owl. In response, private lands increased their harvest rate and logged on shorter rotations.

The contraction in large-log supply coincided with breakneck corporate restructuring, consolidation, and automation across the entire US economy during the 1980s and 1990s. Mergers and acquisitions in the wood products sector—just like the retail grocery market, airlines, and almost every other sector—aligned CEO compensation with shareholder return on investment. This forced companies to focus on short-term profits and high efficiency. Fewer but larger mills, located near highways or railroads, yield higher profits than scattered smaller mills. Smaller and more uniform logs jibe with the automation of mills, which lowers labor costs (by up to two-thirds) and propels profits.


A construction crew installs a cross-laminated timber panel (Source: Marcus Kauffman, Oregon Dept. of Forestry)

Around the same time, the rise of engineered wood product technology decoupled the construction sector from its reliance on large lumber. According to Dr. Kent Wheiler, who directs the Center for International Trade in Forest Products (CINTRAFOR), “What used to be a solid piece of lumber, now it’s an I-joist, glulam, OSB, or CLT.” Oriented strand board (OSB), cross-laminated timber (CLT), and these other products are made by gluing together sawdust, wood fiber, chips, or small-dimension lumber. Today, the construction sector has fully integrated the new technologies. People know how to use them, and building practices have adapted. Now that these alternatives are available, builders won’t necessarily pay a premium price for solid wood to replace an I-joist that will be hidden from view behind drywall.

Port Blakely, a timber company known for its long rotations, witnessed its large-log premium go from standard, to niche market, to practically nil, as engineered product proliferated. Back in 1996, when Port Blakely’s large-log market was booming, it negotiated a 50-year habitat conservation plan (HCP) as insurance in case its long rotation habitat invited in the spotted owl. Part of the deal was maintaining the company’s 60-year rotations.[16] (More on HCPs below.)

Twenty-five years later, despite their efforts at creating flight corridors, understory canopy, and habitat for flying squirrels and other owl pray, the spotted owl still hasn’t moved in. But Port Blakely’s Asian large-log market has evaporated. According to Mike Warjone, President of its US forestry operations, without this market, the 60-year rotations required by its HCP cost the company somewhere in the realm of 7–8 percent in revenues on those stands. Plus, it’s now forced to manage for high density (and thus lower quality habitat) in order to grow skinny 60-year old trees to fit into small-log mills. Without a premium market for large logs, Port Blakely has shifted to shorter rotations on its other forests, and it did not include long rotations in its recently negotiated HCP in Oregon.

[16] According to Warjone, no spotted owls ever moved in, despite their efforts at creating flight corridors, understory habitat, and habitat for owl pray, such as flying squirrels, lichen, and rodents.

Is competition from engineered wood responsible for today's short-rotation forestry? Or is engineered wood the market's response to a chronic shortage of large logs? According to Dr. Wheiler , "There's always a market [for large logs]. It's the mills; that is the question."

But are the mills really the bottleneck? Nathan Nystrom of Hull-Oakes says, "Yes and no. In the 1990s, when they started cutting smaller trees, the mills re-tooled. If larger trees will start coming out of forests, mills can re-tool again."

One forest owner, even a large one like Pork Blakely, cannot revive a large-log mill infrastructure. It's a tough chicken-and-egg problem to solve. But it seems that ultimately the decisive factor limiting mill demand for large logs is the financial rotation age. Wheiler sums it up: "Markets respond to the resource that's available." If larger logs were abundant, would is still be cheaper to create a glulam beam? If there was a reliable supply of large logs, then mills, engineered wood technology, and construction practices would adapt.

It's crucial that the transition back to larger-diameter logs be less devastating and divisive than the upheaval of the 1990s. If done well, it could reverse job loss and revitalize timber-dependent communities. Reinventing large-log manufacturing and a dispersed mill infrastructure, sited closer to forests, could offer more economic opportunities for otherwise isolated woodland owners and communities and would lower the financial and carbon costs of trucking logs to faraway mills. Our mill infrastructure has 40 years to make the transition. At current profit margins, that is plenty of time for today's mills to recover their capital investments and plan for the future.

#3. The Endangered Species Act: Fear of the spotted owl

Perversely, another obstacle to long rotations is the Endangered Species Act (ESA).

A century of intense logging of Pacific Northwest old-growth forests threatened extinction for the spotted owl, marbled murrelet, and other species dependent on old-growth habitat. Now, the Endangered Species Act (ESA) prohibits the "take" of these species, including harassing or harming them, or destroying habitat needed for breeding, feeding, or sheltering.

Especially when managed for habitat, long rotations can support certain aspects of old-growth habitat, such as large trees, rich food webs (including lichen, insects, rodents, and flying squirrels), high canopy layers, standing dead trees (called snags), and open spaces for flying underneath and between trees.

A spotted owl swoops down to catch a mouse (source: Emily Brouwer, National Park Service).

Many forest managers worry that extending their harvest rotation might welcome in an endangered species, triggering ESA protections that prevent logging. Richard Pine told me, "We don't want to invite the spotted owl in… We want to do our part for the environment, but also to make sure we have trees that are harvestable." In one area of Washington, for example, if a spotted owl nest is found on private land, state regulations prohibit logging on 70 acres around the nest.

According to Mark Rasmussen, a forest economist and principal at Mason, Bruce & Girard, it is standard industry practice for landowners, as company policy, to never let their forests get old enough to become suitable habitat. If a landowner does want to grow older and larger trees, they might avoid creating habitat by isolating the older stands from Forest Service land or other protected habitat and by either planting too densely for animals to thrive or spreading the trees far apart from each other.

An increasingly common way to manage these perverse incentives is for landowners to negotiate a deal with federal agencies to get a degree of immunity from ESA liability. Under a Habitat Conservation Plan (HCP) or Safe Harbor Agreement, landowners agree to specific habitat-promoting forest management practices—such as riparian buffers for salmon or minimum 65-year rotations and flight corridors for spotted owls—in exchange for an "incidental take permit" that allows unintentional but not unexpected harm to some habitat or some individuals.

One problem is that HCPs are expensive. According to Warjone, negotiating an HCP similar to the one it recently negotiated on 30,000 acres in Oregon could cost a landowner over $1 million. Port Blakely's land holdings are large enough to make this a reasonable cost of business. But small forest landowners, who tend to value provision of wildlife habitat and environmental benefits above production of timber products, typically cannot afford HCPs. ESA administration has and must continue to adapt.

It's unclear just how much risk the ESA poses to private landowners. Under industrial timber management, it's rare for a spotted owl to move into a private forest; they are listed as threatened for a reason. But that could change with long rotations.

#4. The supply paradox: how do we get back to long rotations?

A huge challenge in extending rotations is how to bridge the supply gap during the transition. The irony is that longer rotations produce more timber per year. But today's timber industry is trapped in a short rotation equilibrium, where extending rotations could jeopardize near-term profits, jobs, and supply.

Malheur Lumber in John Day, OR (Source: Marcus Kauffman, OR Dept. of Forestry).

"Before, you could just see how it would all work," explained Edie Dooley, a forester with Mason, Bruce & Girard. "Long rotations kept the mills supplied." But when harvest increased on private lands and rotation age decreased, "it derailed the whole thing," Dooley said. "Now, how do we get back there? That is the big struggle. It will take a while. We need to do it incrementally and spread it over geography. Otherwise, you're just going to kill your industry, communities will suffer and all the logging firms, and we're not producing renewable resources."

Court Stanley, former president at Port Blakely, said, "Once a company decides to reduce the rotation age, it's almost impossible to go back up. Because you have to stop cutting, and cash flow stops. It's possible, but revenues would drop dramatically."

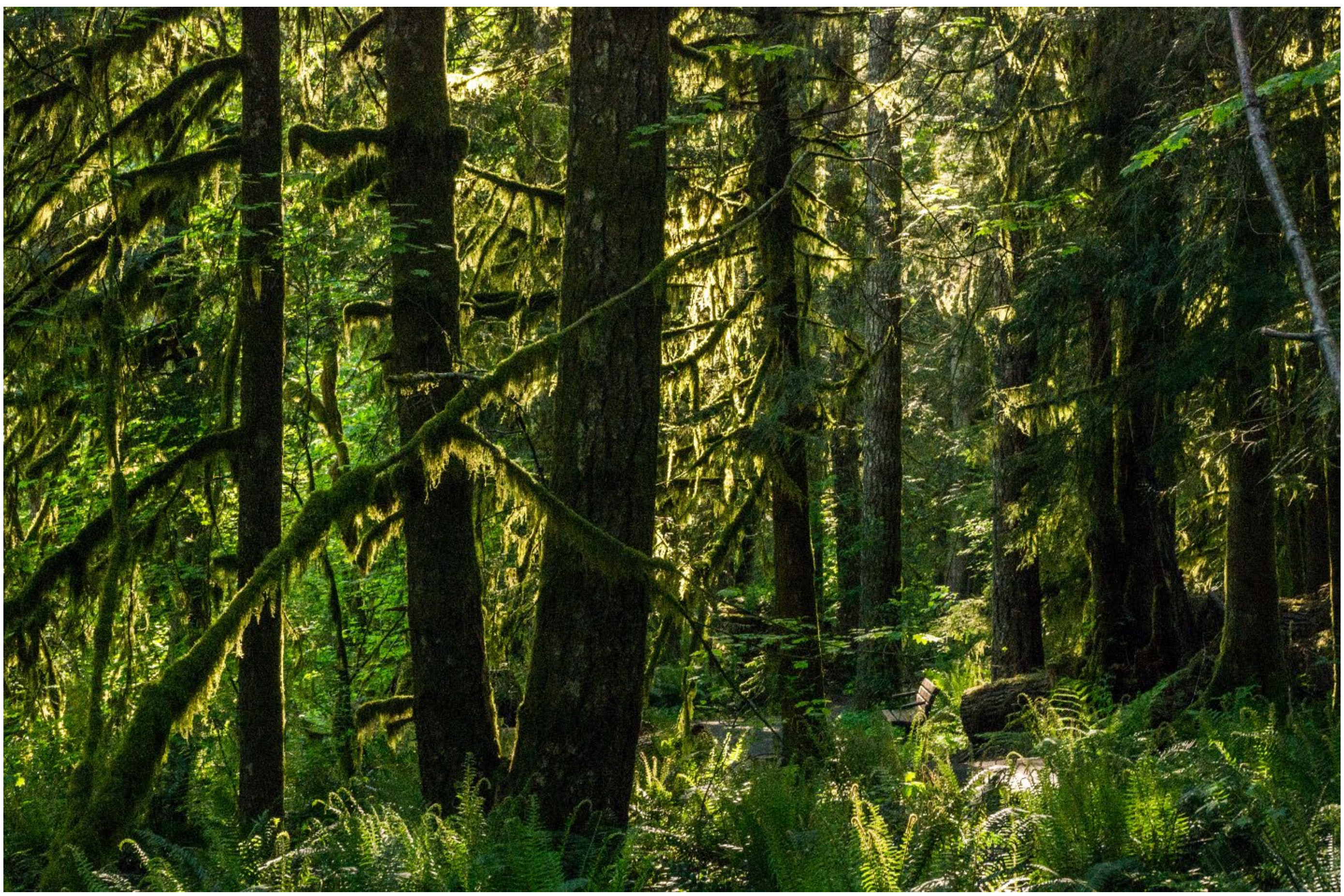
Climate change only makes the supply challenge worse. Today, floods, mudslides, fires, drought, and pests are voraciously eating into timber supply. Long rotations extend the period that timber is exposed to these risks. However, another irony is that older forests experience lower fire severity compared with younger, intensively managed forests, even during extreme weather conditions.

Growing out of short rotations

Off the record, an Oregon forester confided, “I’ve flown all over the state, a lot. I tell you, the footprint of bare ground in the Oregon Coast Range is astronomical. It’s just not sustainable. We need to figure out some way to keep the trees on the landscape longer. At this point, we’re growing corn.”

Longer rotation forests are more functional forests, both economically and ecologically. They nurture the land’s capacity to grow timber, a high and stable supply of quality logs, reliable timber jobs, and a plethora of ecosystem services. But with so many challenges, it feels like the timber industry is trapped.

Is there a way out? Perhaps. Efforts are already underway to unlock this short rotation equilibrium. Ecological investment strategies could reduce management costs and capture alternative revenues. Public support could buoy a decentralized infrastructure of versatile mills, and research on where to site large-diameter mills has already begun. An “all lands” approach, including a gradual patchwork strategy on specific parcels, could bridge the supply gap.



Clackamas County, OR (Source: David Prasad).

Methods

To calculate how the discount rate changes rotation age, shown in the bar graph, I first estimated the net present value (NPV) function of future timber harvests using the discount rates of 4 percent and 7 percent. Next, for each discount rate, I found the rotation age that maximizes net present value.

I chose the discount rates to illustrate a realistic spread: 4 percent is an approximation for state forest management (although many state agencies realize that sustained cash flow over time is more useful than targeting a specified rate of return); 7 percent is an approximation for TIMOs and REITs and likely a ceiling for private forests. In reality, different companies choose their specific discount rate based on their particular goals, opportunities, and market conditions. In the recent past, TIMOs have used discount rates as high as 13 percent, but they are typically lower. Federal forests are not managed for ROI, and the goals of small woodland owners are too diverse to capture with a discount rate exercise.

Seven Ways to Pay for Long Rotations

Public investment is the key to sustainable forestry.

Once on the verge of intensive logging and development, former SDS Lumber Company lands in southwest Washington are now protected by working forest conservation easements. Source: @ianshivephoto / @tandemstock

September 12, 2022 | By Kate Anderson, PhD

Take-aways

The tools needed to fix the short-rotations market failure already exist.

- Short rotations are what economists call a "market failure."
- The (public) ecological benefits from long rotations are often worth double the (private landowners') costs of delaying harvest.
- Creating new markets to pay landowners for extending their rotations, such as carbon markets and sustainability certifications like FSC, can help, but they suffer market failure as well.
- Federal and state programs to pay landowners are already in place and can be scaled up if the U.S. Congress were to appropriate sufficient funds.
- Funding working forest conservation easements (WFCEs) may be the most affordable and scalable tool, while sustainable sourcing and other market tools help build awareness and supply chain capacity.
- At scale, extending rotations on millions of private timberland acres will likely require complementary tax code modifications and new protective policies.

This is the fourth installment in a six-part series discussing how to increase the age when trees are harvested. "Long rotations" refers to delaying logging and growing forests past a short "financial rotation age" to an older "biological rotation age" that stores more carbon, produces more timber, and improves forest health, water quality, and wildlife habitat. View the full series here.

Where timber plantations were once logged intensively on short rotations, older and more complex forests now stand on the 9,400 acres owned by the van Eck Trust in Oregon and California. The new practices store more carbon and offer ideal stream conditions for salmon as well as habitat for marbled murrelets and northern spotted owls. Legal agreements called working forest conservation easements (WFCEs) protect these forests from conversion to agriculture or development, and the van Eck easements include prescriptions that also guarantee improved forest management, including growing older trees, into the future.

In defiance of the false jobs-versus-environment dichotomy, these forests produce millions of board feet of timber each year, supporting loggers, truck drivers, mill workers, foresters, and biologists. Selling carbon credits from its California forests adds another income stream for the Van Eck Trust.

The practice of "long rotations" means growing trees longer before logging them. It extends the length of a harvest cycle from a short "financial rotation age" that maximizes net present value to a longer "biological rotation age" that maximizes timber production as well as carbon storage, habitat, and water quality.

Economists call the ecological harm of intensive short-rotation logging a market failure. That is, when the environmental benefits are accounted for, long rotations increase the wealth of society as a whole by more than enough to pay landowners to delay harvest. Of course, though, without countervailing action, such payment does not occur.

Meanwhile, timber companies do not have to pay the environmental costs of short rotations. These are often unseen "environmental externalities." And long rotations' ecological benefits, because they are public goods that everyone can enjoy whether or not they cut a check to the landowners and investors, suffer from a lack of adequate voluntary funding: the free rider problem. This means that timberland owners, for whom delaying harvest comes at a steep cost, can't get paid for their work of stewarding these trees through long rotations. It's a cycle that cheats the foresters, society, and the environment.

In ballpark figures, fixing the short-rotation market failure on the 8 million acres of private industrial forest in western Oregon and Washington would cost around $16 billion.[17] That sounds steep, until one learns that it would generate around $40 billion in carbon storage benefits alone.[18] That is over 100 percent return on investment.

Is there a way to fix this market failure? Economists have traditionally recommended two kinds of solutions: regulate companies or privatize benefits. Starting with the second option, Sightline examined seven existing mechanisms that Cascadians could use to pay landowners what it costs them to grow older forests, incentivizing those landowners to do so while also supporting the ecological benefits regional residents and people around the globe so appreciate about their forestlands. While we did not perform a robust

[17] $16 billion is a rough estimate of the cost to purchase a working forest conservation easement that specifies older forests, typically between $1,000 to $3,000 per acre, on all 8 million industrial acres.
[18] Multiplying the social cost of carbon, $51 to $100 per ton CO2e, by the additional 110 tons of CO2e sequestered per acre in long rotation forestry over 8 million acres yields over $40 billion.

quantitative analysis that accounts for feedback and equilibrium effects, we did examine the current size and shape of these mechanisms and we compared them with both the carbon storage benefits of long rotations and their costs to landowners.

Following the terms of a working forest conservation easement (WFCE), selective logging creates a small patch opening for canopy diversity, leaving a healthy amount of older trees in the Van Eck Forests of Lincoln County, Oregon. Source: *Pacific Forest Trust staff*.

Because forest health and carbon storage are public goods that are vulnerable to free-riding, voluntary mechanisms alone—carbon markets, sustainable sourcing, sustainability certifications, and impact investing—cannot meet the scale needed to fix the short-rotation market failure. (In other words, these voluntary markets also suffer from market failure.)

But two existing and time-tested US federal programs could. The Forest Legacy Program (FLP) and the Healthy Forest Reserve Program (HFRP) could pay landowners for long rotations at the scale needed to fix the short rotation market failure. FLP appears to be more cost-effective than HFRP because it funds ecological working forest conservation easements (WFCEs) that ensure older forests in perpetuity. For either program to fund older forests at scale, what is required are minor modifications to their current rules and an adequate appropriations bill in Congress.

Congress likely will not pass such an appropriations bill until the widespread belief that "wood is wood" (and that "it's all renewable so it's all good") is replaced with an understanding of the climate and ecological benefits of older forests. Nearly all ways of paying for long rotations can promote this shift. For example, even though it may not sufficiently scale, sustainable wood sourcing policies may be the most effective of the tools that Sightline examined at spreading sustainable wood literacy among the general public, builders, engineers, mill personnel, and foresters. Consciousness-raising is one way that these seven mechanisms to pay for long rotations are more complementary and synergistic than simply additive.

1. Fund ecological working forest conservation easements (WFCEs)

When it comes to storing carbon in forests, perpetuity is the gold standard, and working forest conservation easements (WFCEs) offer a versatile and effective tool to restore and then permanently maintain older forests. Conservation easements are legally binding agreements that stay with the land in perpetuity, even when the land is sold or passed on to heirs. WFCEs most commonly protect a working forest from conversion to development, but many also require additional prescriptions for improved forest management.

While these additional prescriptive terms could explicitly specify long rotations, they tend to be more flexible and to focus on a broad suite of ecological functions that end up yielding older trees anyway. For example, the WFCE on the Mountcrest Forest at the California-Oregon border, does not specify long rotations per se, but its harvest limit of no more than 25 percent of the mature trees in any decade leads to 80-plus-year rotations.

When I asked Laurie Wayburn, co-founder and president of Pacific Forest Trust, if monitoring this kind of prescriptive conservation easement is tricky or cost-intensive, she assured me that it's not. "It's straightforward and simple," she said. "It's based on standard forestry practices and measurements." Land trusts and landowners agree on clear metrics, such as the percentage of trees retained in the forest after a harvest or the size of any openings that are clear-cut. Wayburn explained, "You're not standing behind a tree and saying, 'Don't cut this.' That's all left to the forester's art and science. But you are monitoring a few simple, clear metrics that everybody can identify."

Landowner, Jud Parsons (right); Pacific Forest Trust (PFT) Board Member, Stuart Bewley (middle); and PFT President, Laurie Wayburn (left) tour Mr. Parsons's Mountcrest Forest property, protected by a working forest conservation easement. Photo Credit: PFT

For a landowner, selling an easement generates immediate revenue while allowing continued use of the land. An ecological WFCE usually costs about half the market price of buying the land outright. In today's timberland market, this could easily be $1,000 to $3,000 per acre. And forestland with development potential would be more expensive.

That amounts to a lot of money, but it can be a very good deal. The break-even cost of paying industrial forest owners to delay logging for a contract period of 40 years can quickly approach the cost of buying long rotations in perpetuity or even just buying the land. For example, the Pacific Forest Trust recently orchestrated the purchase of a perpetual easement worth about $1,630 per acre on the Mountcrest Working Forest near Ashland, Oregon. For comparison, according to their own calculations, it may cost Port Blakely over $6,000 per acre, in net present value, to delay harvest by 20 years as part of its Winston Creek Forest Carbon Project. Paying upfront for a WFCE is cheaper because the public doesn't discount the future benefits of protecting our ecosystems and our climate nearly as steeply as the market discounts future harvest revenue. Plus, land will only get more expensive, so now is a good time to buy WFCEs.

But is there funding to pay for WFCEs? In short, not even close. Funding long-rotation conservation easements on all 8 million acres of western Oregon and Washington forests currently logged on short rotations would cost on the order of $16 billion.[19] And that's not considering the higher prices for timberland at risk of development.

WFCEs are funded by a diverse array of local, state, philanthropic, and "transfer of development rights" programs. The single largest funding source is the United States Department of Agriculture (USDA) Forest Legacy Program (FLP), which funds WFCEs on ecologically valuable land at risk of development. In 2021, Oregon and Washington together received $14.2 million in FLP funding.[20] Assuming state matching at 25 percent, this comes to about $18 million. So even if the entire budget focused on extending rotations, current funding levels could only finance easements on about one-tenth of one percent of the timberlands currently logged on short rotations west of the Cascade Mountains.

The beauty of the FLP, though, is that it already exists. No new laws have to be passed. The USDA, Washington DNR, Oregon Department of Forestry, local Forest Service districts, and local land trusts already have experience with FLP. To fund older forests at scale, all that is required are minor modifications to current FLP rules[21] and a historic appropriations bill in Congress, which could theoretically happen as early as the 2023 Farm Bill.

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[19] Again, $16 billion is a rough estimate of the cost to purchase working forest conservation easements that specify older forests on all 8 million industrial acres.

[20] This 2021 amount was dispersed after the FLP budget increase of nearly 50 percent, beginning in 2021.

[21] Needed modifications include: covering parcels not at risk of development and allowing easement appraisals to account for land appreciation (the full "speculative value"), which is often the main reason Timberland Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs) hold timberland.

2. Expand the Healthy Forests Reserve Program

Protecting forests in perpetuity is both the advantage of WFCEs and also a hurdle for landowners. As Arne Hultgren of Roseburg Resources cautioned, easements do reduce an owner's options. "It's like getting married," he said. "You give up certain things but you gain certain things."

For timberland owners not ready to say "I do" forever, could federal incentive payments that induce landowners to delay their harvest by 20 or 40 years be effective? This would essentially be renting an extended rotation: storing carbon for a contractual period, after which the owner is free to develop the land or return to short rotations (both of which would release the extra carbon stored during the contract period back to the atmosphere), or they could sign up for another contract period once the initial one ends.

This is the basic model of USDA's long-standing and well-funded Conservation Reserve Program (CRP). Started in the 1950s to prevent erosion and protect native habitat, the CRP now pays farmers on 10- to 15-year contracts to remove marginal farmland from production. In 2022 about 25.5 million acres are enrolled in CRP across the United States. For timberlands, the CRP counterpart is the much smaller and unevenly implemented USDA Healthy Forests Reserve Program (HFRP).

Bruce Pantzke's CRP-enrolled land enhances pollinator habitat and provides nesting cover for upland game and waterfowl. Source: USDA photostream.

Farmers that enroll in CRP receive an annual per-acre payment ranging from $10 per acre to nearly $300 per acre. In Lewis County, Washington, for example, the 2020 CRP payment was $64 per acre. Total CRP payments to farmers in Oregon and Washington average about $120 million each year (or $4.8 billion over 40 years). If an equal amount went to the HFRP, forests could live an extra 40 years on somewhere around 10 percent of timberlands that are currently managed on short rotations.

It is an unresolved question just how effective such a program would be at changing forest owners' logging plans as opposed to mainly attracting forest owners who weren't planning to log anyway. Plus, as with carbon markets, the public would need to keep paying landowners for short-term carbon storage in perpetuity in order to maintain the climate gains. As a result, this short-term rental approach may do more harm than good by diverting money and political will away from more long-lasting and cost-effective investments.

3. Establish long rotation certification

We've heard that we can "vote with our forks," but can we "vote with our hammers"? A growing movement is saying we can. The idea is that if we are troubled by the timber sector's practices, we can change the system by spending our dollars on wood products that align with our values.

This is only possible if products that meet our values exist and if we can identify them. With the plethora of food labels today (local, grass-fed, organic, humanely raised, and so on), it is hard to remember a time when food was just food.

In the timber sector, groups like the Forest Stewardship Council® (FSC) are trying to chip away at the notion that "wood is wood." The idea is that certification can change how commercial forestry is practiced by giving consumers the information they need to vote with their dollars. When you see the FSC label on a package of toilet paper or a bin of Douglas-fir boards, you know the forests of origin were managed sustainably (for example, without herbicides). To recoup the extra cost of FSC practices, landowners would need to receive a premium of around 3 to 10 percent.

Like the food sector, wood products could host a variety of labels to differentiate the ways wood products meet our values. "Long Rotation-Certified" or "Older Forest-Certified" could be one of them. Long rotations could fill a small niche left vacant by FSC because they are more profitable for landowners and can store more carbon than FSC-certified timberlands, giving them a high carbon-per-dollar value. (This is not to discount the fact that FSC-certified forests are older and store substantially more carbon than conventional timberlands due to healthy forest practices like greater green tree retention and riparian buffers.)

FSC-certified. Source: Giles Douglas

As far as accomplishing industry-wide transformations, voting with your hammer will suffer from the same inherent shortcomings as voting with your fork: prices (not ethics) will continue to drive wood purchases. Just as a "farm fresh" or "all-natural" label on a carton of eggs literally means nothing, it will be difficult for customers to differentiate "long rotation-certified" wood from wood that's simply branded as sustainable. And voting with your hammer may diffuse energy from policy changes that require real votes. Nevertheless, it may be an important component in educating voters to support healthy forest policies at the ballot box.

4. Adopt sustainable wood sourcing policies, both public and private

At the airport in Portland, Oregon (PDX), you can witness another strategy to differentiate sustainable wood products and encourage older forests: sustainable wood sourcing. Not only does the airport's new roof give the feel of walking through the filtered light of a forest, but its recent remodel also emphasized purchasing Douglas-fir lumber from long-rotation forests. For example, PDX was willing to pay a premium for wood from the Coquille Tribal Forest's 80- to 100-year rotations.

Sustainable procurement policies set standards for sourcing goods and services that go beyond the typical values of quality, price, and timing. This strategy uses public policies and private initiatives to move markets.

Emulating farm-to-table but applying it to wood, the nonprofit Sustainable Northwest managed the sustainable procurement of more than 2.2 million board feet of wood products for the PDX remodel. That's about 200 homes' worth of wood. Large projects like this one have the market muscle to build new supply chains and to advance the transparency of existing ones.

On a daily basis, 55,000 people walk through PDX. By investing in such a public and visible project, Portland is also spreading sustainable wood literacy. According to Sustainable Northwest's Micah Stanovsky, "People don't recognize that this thing they're using comes from a forest, and not all forests are the same." Travelers passing through PDX learn about sustainable forestry from informative signs and from labels naming the origin of a particular beam or panel. Raising awareness is the first step towards making “voting with your hammer” possible and even towards congressional expansion of the Forest Legacy Program.

The Glulam beams for the wooden roof in PDX’s new terminal were sourced from the FSC-certified Coquille Tribal Forest. Source: USDA, Oregon NRCS (left), PDXNext (right)

With today’s opaque supply chains, the amount of work that goes into sustainable sourcing is astonishing. Aside from FSC-type certifications, today’s supply chains do not differentiate wood products that are produced ecologically, locally, or equitably. To deliver a “sustainable” beam to the customer, a supplier must take unusual efforts to track that wood from the forest and separate out the tracked boards at the mill and possibly a glulam or window manufacturer as well, and then at the warehouse. Plus, investors, developers, architects, and construction engineers all must learn new skills and adapt their designs to work with the different kinds of products (and delivery schedules) that can be procured sustainably. For example, it’s difficult today to find tight-ringed clear cedar, prized for its resistance to water, rot, and insects, that didn’t come from logging Canadian or Alaskan old growth.

The bureaucratic ring of “procurement policies” may not stir excitement, but even without private initiatives, the reach of local, state, and federal government purchasing is staggering. In the United States, state and local governments purchase around $1.5 trillion in goods and services each year, with the federal government adding an additional $665 billion. This is more than 10 percent of US GDP. Presidents Clinton, Bush, Obama, and Biden all issued executive orders for various degrees of sustainable procurement at the federal level, and multiple states have green procurement policies. Imagine the market for long rotation-certified wood if all public procurement policies required sustainably grown wood. This 10 percent could be multiplied if procurement policies extended sustainable sourcing requirements to contracting purchasers, such as for housing construction.

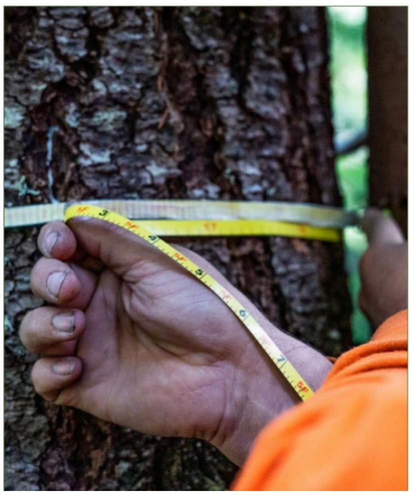
So far, though, neither the federal government nor any state has implemented a sustainable wood sourcing policy. But Portland, Oregon, is leading the way. First, it was a national first-mover in sustainable procurement, and in 2022 it became the first city to explicitly institute a sustainably sourced wood program, following the Sustainable Wood for Cities guidelines.

5. Discipline the forest carbon market

Extending rotations in western Oregon and Washington offers $40 billion worth of climate benefits. Is the global public willing to pay for this carbon sequestration? Could carbon offset markets mainstream long rotations?

The Biden Administration puts the social cost of carbon at $51 per ton of CO2e. (Nobel economist Joseph Stiglitz recommends that the price rise to $100 per ton by 2030.) At 110 tons of additional CO2e stored per acre, extending rotations on 8 million acres of industrial timberland gives you $40 billion.

Unfortunately, as I wrote in a previous article, the carbon market hasn't caught up, and it probably won't. In Oregon and Washington, all of the current offset projects combined store less than one million tons of CO2e each year—only about one-tenth of one percent of the additional storage from extending rotations. The carbon market is growing, but will it grow by 1,000 percent?


Source: OR Dept of Forestry

Plus, the market price for carbon is far too low to spur real change in logging practices. To compensate landowners for the full cost of extending rotations (plus a 20 to 40 percent commission to carbon project developers), the price of carbon needs to be around $58 per ton for a 20-year extension[22] and double that for a 40-year extension. But the market price for carbon has hovered around $7.47 per ton in the voluntary market and around $18 to $30 per ton in California's compliance market. It would take more than a 1,000 percent increase to hit the break-even carbon price needed to attract real change from timber companies.

Fundamentally, carbon market growth is limited by a major free-rider problem. Whether or not we do our part and pay for our own emissions has no bearing on the fate of the climate, but it does bear on our own finances. Unless we are required to pay, as some California industries are, most of us won't ("why should I if nobody else is?").

The carbon market suffers from other problems as well. Offsets do not always add carbon storage that would not have otherwise happened (the "non-additionality" problem). And offset projects often store carbon for only 40 years, not nearly long enough to compensate for the hundreds or thousands of years carbon emissions linger in the atmosphere (the "impermanence" problem).

The carbon market has helped advocates conserve valuable forest acres. But for the task of extending rotations on commercial timberlands, its efficacy is limited.

[22] The actual price varies substantially from forest to forest, depending on species, prices, site productivity, logging difficulty, and haul distance. Accounting for inflation, the estimated break-even price of $49.87 per credit in 2017 equals $58.82 per credit in 2022.

6. Explore "impact investing" opportunities for long rotations

Conventional timber investment funds make money from selling trees and land that have appreciated in value. As a group, timber investment management organizations (TIMOs) have been vilified for accelerating the contraction in rotation age and generally degrading forest health and community wealth.

But there is a new type of timber investor on the block that is bringing private equity capital into the conservation neighborhood. The mission of forestry "impact investors" is to generate a financial return while measurably restoring forest health.

As a financial asset, timber offers predictable cash flows, "countercyclical" returns that tend not to rise and fall with the market, and a hedge against inflation. Impact investors also hope to capture value from selling non-timber ecological services that are becoming more fully monetized, such as water, habitat, aesthetics, recreation, and carbon values. Along with selling timber and carbon offsets, revenue comes from leasing use rights to hunting and fishing groups, selling non-timber forest products such as forest-foraged berries, and selling conservation easements (often paid for by government and philanthropic grants).

In Cascadia, EFM Investments & Advisory (formerly Ecotrust Forest Management) has been an early innovator in the impact forestry sector. EFM is a for-profit TIMO that is restoring forests and practicing FSC-certified timber production on the roughly 130,000 acres it owns and manages in California, Oregon, and Washington. "Rotation" is one of EFM's "5Rs™ of climate-smart forestry," along with retention, reserves, resilience, and relationships, which together result in older forests and double the carbon storage compared with industrially managed forests.

Former SDS Lands, outside Trout Lake, WA now protected under working forest conservation easements and managed by Green Diamond Resource Company. @ianshivephoto / @tandemstock

Also in Cascadia, The Conservation Fund, a nonprofit impact forestry asset manager, recently facilitated the purchase and permanent conservation of more than 96,000 acres of ecologically valuable lands near the Oregon–Washington border about an hour east of Portland. Regional conservationists were alarmed when the SDS Lumber Company announced the land sale. Without the impact investment capital previously raised from selling more than $100 million in "green bonds," an industrial timber company would almost certainly have purchased these highly productive timberlands close to Portland and several growing towns, heavily logged them, and eventually sold them for development.

Part of the deal involved purchasing WFCEs on 61,000 commercial acres managed by Green Diamond Resource Company. Project developers say they likely will not pursue carbon offset funding. Had the market price of carbon been higher, these easements might have additionally specified long-rotation forestry in order to qualify as carbon offsets. As it stands, Green Diamond is free to log on short rotations.

Not all "impact funds" are equally virtuous. Many funds, across sectors, not only yield lower financial returns but also often have *worse* than average social and environmental impacts. It is hard for investors who are not sustainable forestry experts to distinguish funds that restore forests from those managed by charlatans or by ethical managers who still believe wood is wood.

Ultimately, how much impact investors will have largely depends on the public's investment. Timber and land are still the main sources of revenue for impact forest investors. To capture income from clean water, wildlife habitat, carbon, or aesthetics, those investors largely rely on the government programs or private philanthropy that many worthy projects covet.

7. Pursue carbon storage through re-localizing forest ownership

One last "buying long rotations" idea is more of a thought experiment at this point, although the agencies and policy infrastructure to implement it are already in place—they have been ready to go since the Dust Bowl.

The Coast Range Association (CRA) took on the challenge of how to achieve an increase in forest carbon storage that responds to the severity of the climate emergency while supporting local economies in forested rural Oregon. The solution hinges on CRA's (and many others') analysis that carbon storage (and forest management more broadly) is largely driven by *who* owns the forests. For the majority of investor-owned timber companies, timberland is an "asset" that delivers "return." The ratio of asset value to return drives the timber enterprise. It turns out that a low-carbon plantation forest delivers the best ratio of asset value to return.

The CRA reasons that state-sponsored market incentives or outright regulation are politically infeasible in Oregon and a carbon transition could harm forestry workers. But buying private industrial timberlands at fair market value could avoid political resistance from the timber sector and redirect cash flow into local economies.

Chanterelles harvested near Onion Peak on the northern Oregon coast. Source: EFM.

In CRA's vision, locally owned social benefit enterprises that agree to increase forest carbon through a WFCE would qualify for a mix of federal grants and low- or no-interest loans to buy timberlands. In this way, land ownership would be re-localized in the hands of rural Oregonians, and forests would store more carbon.

In today's political climate, though, CRA's proposal is a long shot. Chuck Willer, CRA's director, admits that "implementing the CRA proposal depends on a national mobilization." But pushing boundaries has always been vital for progress; after all, it was Einstein's "elevator thought experiment" that freed him from the scientific limitations of the time, leading to his crowning theory of gravity. As Willer noted, "if we had a national mobilization, we should be prepared with a proposal to respond adequately to it."

Even without a national mobilization, CRA's proposal offers some guideposts. It takes as its starting point the full problem to be solved. It takes the unusual step of jointly addressing climate *and* rural economic justice. And it proposes a solution that directly addresses the underlying drivers of the low-carbon private forest: investor-driven forest management.

The seedlings of long rotation change

The first step to growing long rotations is understanding the roots of the problem: in today's system, timber companies don't have to pay the climate and ecological costs of short rotations. And, as public goods that all can enjoy whether or not we pay, there will never be adequate *voluntary* funding to pay for the benefits of long rotations.

Fixing the short-rotation market failure is both worth it—at roughly a 100 percent return on investment—and possible, if not easy. The first step is raising awareness that some ways of growing trees deliver a lot more value than others (updating the "wood is wood" narrative). Loud grassroots advocacy is important. But so are market tools that connect directly with the public, such as PDX's educational and visible sustainable wood sourcing remodel project or certification labels like FSC or "long rotation-certified."

Ultimately, though, by acting individually in atomistic markets (i.e., voting with their hammers or their carbon dollars), the people who could benefit from long rotations on the roughly eight million acres of private industrial forest in Oregon and Washington simply cannot muster sufficient funds to pay, because these market solutions to the short-rotation market failure suffer their own market failures. Only by joining together and casting votes for elected officials who will invest public dollars in long rotations can we solve the short-rotation market failure.

Luckily, the public programs are already in place to fully pay landowners their cost to delay harvest. What's needed are a few modifications to the federal Forest Legacy Program and the Healthy Forest Reserve Program and a sufficient appropriations bill to scale these programs.

Public dollars would stretch further if they were coupled with tools that directly addressed the negative externalities of short rotations. In a future article, I will explore modifications to the tax code, policy protections, and other tools that require timber companies to shoulder some of the ecological burden of short-rotation forestry—and level the playing field for those that already do.

Northwest Carbon Markets Can't Support Longer Timber Harvest Rotations

That would take a New Zealand-style, all-forests cap-and-trade system

A third-party carbon verifier measures tree girth for a Northern California carbon project. Source: California Air Resources Board

July 11, 2022 | By Kate Anderson, PhD

Take-aways:

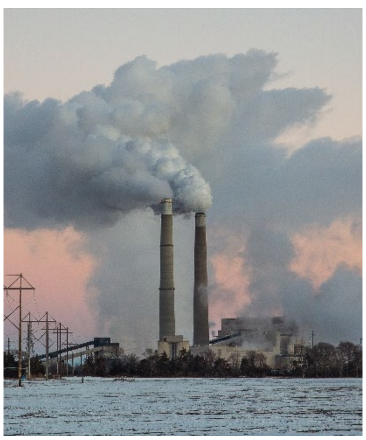
- Despite proponents' optimism, carbon markets can finance only a tiny fraction of the climate gains offered by extending timber harvest rotations in Oregon and Washington.
- Short-term carbon projects don't offset emissions that damage the climate for thousands of years. Guaranteeing long rotations in perpetuity through prescriptive working forest conservation easements is a better deal.
- To weed out "ghost credits" that lower the price of carbon and provide no real carbon gain, forest carbon markets need reform.
- A national cap-and-trade program with mandatory forest enrollment, like New Zealand's, could solve the problems of scale, impermanence, and ghost credits.
- Relying on carbon to fund habitat, water quality, and biodiversity is risky.

Nestled in the southwest corner of Washington, home to coho salmon and the occasional spotted owl, the Winston Creek carbon project is extending rotations on 10,000 acres of forest. By delaying harvest from 40 years to 60 years and letting these trees continue to grow during their carbon sequestration prime, Port Blakely, the forest owner, hopes to double the biomass of its forest.

Port Blakely's Winston Creek carbon project in Lewis County, WA. Source: Port Blakeley

According to American Carbon Registry (ACR) documents, this extension will sequester about 850,000 metric tons of carbon dioxide equivalent (CO2e) above and beyond what a 40-year rotation would sequester. One ton of CO2 is about what a gas-powered car emits on a trip from Klamath Falls, Oregon, to Anchorage, Alaska (about 2,500 miles); therefore, this forest carbon project offsets the emissions from about 850,000 road trips to see moose and hear glaciers crack and rumble.

As part of its Carbon Balance program, Puget Sound Energy (PSE) purchased many of these credits on the "voluntary" carbon market. REI, Avocado Mattress, Boeing, Direct Wines, and the City of Eugene are only a few of the other groups to have bought Winston Creek carbon offset credits. The voluntary market includes all transactions outside of the dozen or so global "compliance" markets that result from mandatory government regulations to reduce greenhouse gas emissions, such as California's cap-and-trade program.



An Xcel Energy coal-fired power plant. Source: Tony Webster

Globally, the entire voluntary carbon market is projected to grow from about $320 million in 2019 to between $5 billion and $30 billion by 2030. Even though only a tiny fraction of carbon market dollars will go to forest projects in the Pacific Northwest,[23] excitement is brewing among conservationists and savvy wood products companies alike.

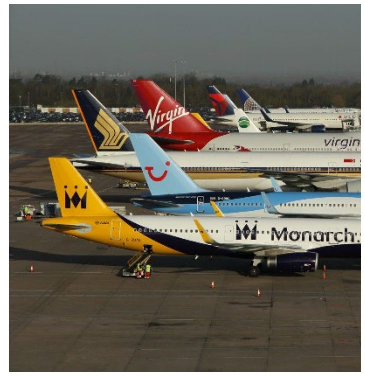
Tom Tuchmann, who's worked in forest conservation for 30 years and is now president of US Forest Capital, is excited about carbon market growth. "It's the first time that a true market price has been created to incentivize private landowners to invest in conservation at scale," he said. "Hundreds of millions of dollars are being raised and spent on carbon credit."

On the ground in Oregon and Washington, carbon offsets have financed innovative forest conservation that protects clean drinking water and salmon habitat as well as jobs for loggers, mills, and mountain bike guides. Native American tribes that have logged less aggressively have sold offset credits from their carbon-rich forests and used the income to reacquire ancestral territory. But how much of forests' "natural climate solution" potential can the carbon market actually fund?

This article is part of a series investigating the potential of long rotations to increase carbon storage and improve forest health in the "wet" forests of western Oregon and Washington. The first article in the series explained why long rotations store more carbon. The second article outlined the four main hurdles

[23] As direct-air carbon capture and other techniques to permanently remove carbon improve, forest projects will face increasing competition for carbon dollars. Plus, much of the voluntary market growth will go to poorer countries with rich forests, where lower wages and lower costs of business make carbon less expensive.

landowners face in extending rotations. This article and the next several ones explore how to overcome these hurdles, starting with market mechanisms to compensate landowners. The goal is a landscape-level shift to long rotations on private timberlands.



Line-up of aircraft at Manchester Airport, UK. Source: Flo Weiss

By themselves, carbon markets cannot solve our climate problem, and they pose some environmental justice dilemmas. Even New Zealand's full-enrollment Emissions Trading Scheme has shown little progress in decarbonizing that country's economy. But it has been effective at reforestation, extending rotations, and preventing deforestation (if not without some hiccups that I will discuss below).

Could carbon markets help incentivize long-rotation forestry in western Oregon and Washington?

Forest carbon markets show promise. But they have severe limits: insufficient market demand and price, impermanence, and ghost credits (offset credits for carbon that would have been stored in forests even without any carbon market payment). To confront these limits, forest carbon markets need more rigorous standards and oversight. But the best solution to remove these limits may be to include all forests in a mandatory nationwide cap-and-trade program.

The climate potential of forests

To keep warming under 1.5 degrees Celsius, we need net-zero global emissions by 2050. For Oregon and Washington together, net-zero emissions means a reduction of 170 million metric tons of CO2e in annual emissions. It's hard to imagine reaching this goal without boosting forest carbon storage. Scientists have pointed to extending forest harvest rotations (long rotations) on private land as the most effective (and cost-effective) land-based carbon sequestration strategy in Oregon and Washington.


Oregon Timberlands. Source: Marcus Kauffman, OR Dept of Forestry

Different kinds of carbon projects have different comparative advantages. Long rotations can store a lot of carbon while also producing a lot of timber. A steady supply of timber supports local economies—not only forest jobs but also those of restaurant owners and teachers, and revenue for county services. Plus, the question of leakage (any increase in logging elsewhere associated with a carbon project's supply reduction) becomes moot because long rotations can beat short rotations on timber volume.

Western Oregon and Washington have more than 12 million acres of privately owned forestland, of which around 8 million acres are owned by large commercial timber companies and likely harvested on short rotations (see Methods section for calculation details). For the productive Douglas-fir forests west of the Cascades, extending rotations from 40 years to 80 years can store roughly an additional 110 metric tons of CO2 per acre in an average year (including the carbon in long-lived wood products).

By extending rotations on these 8 million acres, forests could sequester and store about 880 million additional metric tons of CO2. That is more than five years' worth of Washington and Oregon's current combined emissions from all sources.

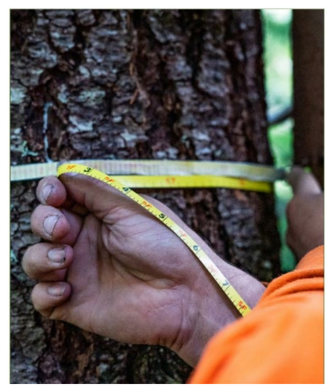
Growing out all the trees at once is not a realistic option. But even a gradual transition would impact the finances of forest landowners. In a previous article, I explained why landowners make more money logging on short financial rotations. Long rotations yield more timber and more value, but delaying harvest means forgoing lucrative investment opportunities in the short term.

A hard look at the numbers: Carbon finance fizzles at scale

How much of landowners' costs could forest carbon markets pay for?

Forest carbon markets suffer from a scale problem. The price of carbon and the intensity of market demand both fall far short of what's needed. The median break-even price of carbon to finance extending rotations by 20 years (including paying the project development costs) is around about $58 per ton of CO2e.[24] To finance a full 40-year extension, from 40 to 80 years, would cost more than double this price (more than $120 per ton).

What is today's market price for carbon? Recently it has hovered around $7.47 per ton in the voluntary market ($9.79 for direct sales), which is not nearly enough to compensate Port Blakely's 20-year rotation extension. The compliance market, which is typically higher, was around $18 in 2021 and recently jumped to about $30. To spark real action on long rotations, the voluntary market price needs to grow about twelvefold.



Source: OR Dept of Forestry

In terms of demand, all up-and-running forest carbon projects in Oregon and Washington currently store around one million tons of CO2e per year (see Methods for calculation details), and buyers seem to be snapping up these credits, which is not surprising at today's bargain prices. Many of these carbon project acres are east of the Cascades.

To reach western Oregon and Washington's carbon potential of 880 million tons from long rotations, the current market would need to grow somewhere in the ballpark of 880 times its current size, and a greater share of investment would need to go to long-rotation carbon projects.

Is this growth in price and market demand inconceivable? Not necessarily. Just this past April, Regen Network Development paid between $34 and $45 per metric ton (among the highest prices ever paid for forest carbon credits) for 31,000 tons of CO2e on the voluntary market. A small share of this carbon is being

[24] The actual price varies substantially from forest to forest, depending on species, prices, site productivity, logging difficulty, and haul distance. Accounting for inflation, the estimated break-even price of $49.87 per credit in 2017 equals $58.82 per credit in 2022.

stored in forests around Issaquah, Washington, as part of a grassroots effort to save a beloved forest from development. While this unusually high purchase price may partly reflect the buyer's desire for positive brand recognition to boost its blockchain venture, the purchase may be a harbinger of market momentum to come.

If the market price could increase twelvefold to around $120 per ton, if the market demand increased 100 times to around 100 million tons of CO2e stored per year, and if more of the investment went to long rotations on commercial timberlands), then the carbon market could finance somewhere in the ballpark of 12 percent of western Oregon and Washington's carbon potential from long rotations.


Roosevelt Elk. Source: Linda Tanner

That's a lot of ifs to get to 12 percent, but it's possible. Financing 12 percent means extending rotations on roughly 960,000 acres—a considerable area of cooler streams and better habitat for Roosevelt elk, black bears, and Northern spotted owls.

Unfortunately, new rules in California mean that future growth will depend on the voluntary market. In the past, California's compliance market purchased the majority of the credits from Oregon and Washington's forest carbon projects. As of 2021, California requires that at least one-half of offset credits be sourced from projects that provide direct environmental benefits in California. Plus, regulated entities can now only offset 4 percent of their emissions (down from 8 percent).

Impermanence

When United Airlines, Amazon, or Puget Sound Energy (PSE) burns fossil fuels, the carbon emitted stays in the atmosphere and harms the climate for centuries to millennia. If these companies buy forest carbon credits to offset these emissions, that carbon may only get stored in trees for 40 years before it is re-released into the atmosphere. The Winston Creek long rotations carbon project is one example of the emissions–offset time mismatch. After the one-time 20-year rotation extension, nothing prevents Port Blakely from logging the property on short 40-year rotations. Projects like this are essentially renting out carbon storage to emitters. It would be different if the project included a conservation easement guaranteeing long rotations in perpetuity.


Airplane contrails. Source: Creative Commons

In light of this impermanence, for some PSE customers, even today's low carbon offset price seems wasteful. One customer wrote, "I fail to see how much good this will do, if you're only just delaying harvesting the trees by 20 years."

Carbon market proponents believe these customers are missing the point. The income stream from selling carbon can continually incentivize landowners to delay harvest. On the other hand, these PSE customers are pointing out a real problem. To truly "offset" their emissions, PSE would need to continually finance Port Blakely's long rotations for one thousand years.

Other credits come from projects that will likely store the carbon permanently. For example, when an Issaquah–King County coalition purchased 15 acres of old forest in western Washington in order to block a planned development that would have logged most of those trees, the carbon became permanently protected, subject only to natural disturbance.

Carbon market standards could be amended to require permanent storage. For example, when the van Eck Trust donated a working forest conservation easement to the Pacific Forest Trust, it guaranteed increased carbon storage on 9,400 acres of forest in Oregon and California in perpetuity. The van Eck carbon project, covering 2,200 acres of these forests, has sold more than $2 million in carbon credits in its first reporting period alone.


Source: Marcus Kauffman, OR Dept of Forestry

A working forest conservation easement protects against the deforestation that accompanies development while allowing continued timber production. Some easements further require particular forestry practices, such as maintaining wide riparian buffers, multi-storied stands, and a minimum amount of older trees (e.g., greater than 30 inches in diameter), or long rotations. By guaranteeing older trees, the stock of carbon stored in the forest gets a permanent boost.

Given the immediacy of the climate crisis, there is a strategic tension between attracting the most participation now and securing the most cost-effective and long-term public benefit. The permanence of conservation easements is more expensive up front but more cost-effective in the long run.

"Ghost credits" haunt our climate's future

What if the scarce carbon dollars aren't even buying real carbon sequestration? The forest carbon market has come under intense criticism for essentially selling "ghost" credits that fail the "additionality" test. Greenhouse gas reductions are only additional if they would not have happened without the prospect of carbon market payment. For example, Laurie Goodrich, director of conservation science at Hawk Mountain Sanctuary, said that even without the carbon payments, "we'd still be managing the land the same way." Some projects have even sold offsets for forests that were already legally protected or, worse, credits for planting trees that were already growing.

The compliance market is typically stricter than the voluntary market, but even with California's gold-standard oversight, researchers found that nearly one in three credits (about 8.5 million cars' worth of emissions) have zero effect on actual forest carbon stores (which the California Air Resources Board refutes).

Hawk Mountain Sanctuary, Pennsylvania. Source: Wikimedia

If forest carbon projects are to remain competitive against a growing market in technologies that remove and permanently store carbon, such as direct-air carbon capture, forest carbon markets need more rigorous standards and oversight. Already some offset buyers are having second thoughts about forest carbon.

Numerous proposals for tighter standards and more oversight of the voluntary carbon market are being debated. California nearly passed two voluntary market reform bills that together would have mandated uniform standards and "truth in advertising," and Pacific Forest Trust is collaborating with several US senators on a bill that would create a federal rating system for voluntary carbon offsets. "Just like you have ENERGY STAR when you buy a refrigerator, or a standard EPA mileage rating for a car," explained Laurie Wayburn, co-founder and president of Pacific Forest Trust.

How effective this new oversight might be is an open question. It's expensive to verify the carbon condition of a forest and whether this carbon is at risk. In a competitive market, developers, who take a 20–40 percent cut of the offset sale, would still be tempted to cherry-pick projects and measurements to inflate carbon gains, as would landowners. Registries and third-party verifiers would still be tempted to cut corners to reduce their oversight and verification costs. Those companies who buy offsets simply to greenwash their brand could still purchase cheaper offsets that don't carry the contemplated "CARBON STAR" label.

In time, these shortcomings may prove to be no more than bumps along the carbon market's road to fulfilling its potential. For example, new technology that uses remote sensing data to measure forest carbon is being developed. This could potentially reduce the burden of oversight by automating verification and monitoring, and it might help small forest owners participate in the market.

Measuring diameter at breast height (DBH). Source: Project Learning Tree

Bettina von Hagen, co-founder of EFM, a forest investment company that manages its land according to the "5Rs™ of climate-smart forestry," attests to recent improvements in the forest carbon market. "In the last two years, there's just been a huge evolution in the quality of standards, pricing, increased rigor," she said. "I just think it's a whole new ballgame."

If you took Econ 101, you might remember that prices go up when supply goes down, as long as demand stays the same. Thus, weeding out ghost credits from the carbon offset supply could potentially raise the market price of carbon high enough to attract meaningful management changes on commercial timberlands. For example, at the right price, Weyerhaeuser might be convinced to grow its trees to 80 years old in a forest it truly had planned to log at 40.

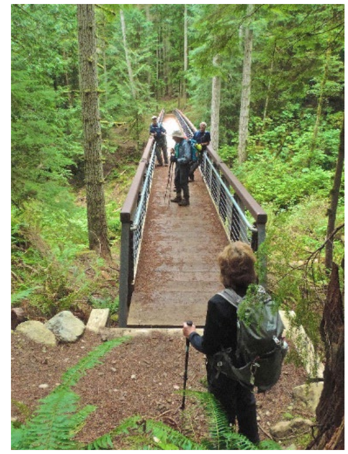
But that's the forest carbon catch-22. Supporters of forest offsets say that focusing solely on the carbon math overlooks the incentives offsets create for protecting forests.

Carbon does not guarantee habitat, water, or biodiversity

The fear is that the carbon market will actually do exactly what it is intended to do—but nothing more. In New Zealand, high carbon prices have led to dense plantations of exotic, short-lived tree species (such as radiata pine) that offer poor habitat and that can displace slow-growing native forests.

Restored forests and long rotations that are managed for habitat provide a whole suite of ecosystem services. But the only ones that have a market are carbon and timber, so conservationists have relied on the carbon market to pay for other forest values.

For example, when Save Cougar Mountain, the Issaquah Alps Trails Club, and community members fought to prevent conversion of their beloved forest near Issaquah, Washington, they did it to prevent habitat fragmentation and to protect the ecological integrity of the forest, streams, and wetlands. The resulting land purchase will also result in substantial carbon storage, and the extra funding from selling carbon credits will help pay back the loan and could help fund future land acquisitions. But carbon was not the coalition's main concern. Because the project would have proceeded with or without the carbon offset dollars, the carbon credits Regen Network Development purchased technically correspond with zero additional carbon storage. If market standards are tightened to avoid non-additionality, worthy projects like this one would become ineligible.



Hikers in the Issaquah Alps. Source: Peter Stevens

In fact, a majority of forest offset credits sold in the California compliance market have come from "conservation" forests and not from "timber" forests. While any conservation forest not legally protected (for example, by a conservation easement) could theoretically be logged at any time, and sometimes they are logged, these forests are not meant for harvest and therefore offer limited "additionality."

Clearly, projects that are essentially fraudulent should be weeded out, but many so-called ghost credits are funding real conservation efforts, such as King County's Land Conservation Initiative. How can the voluntary carbon market be fixed without stranding important conservation efforts?

And is it wrong to pay carbon stewards for doing something the rest of us benefit from, even if they would have done it anyway? As Peter Hayes of Hyla Woods put it, "Do you reward the people who were already doing the good thing? Or do you save your offset dollars to get a 'bad actor' to change their ways? There's a genuine dilemma between the ethical and the strategic."[25]

A coho salmon swims upstream to spawn. Source: Wikimedia

Since a disproportionate number of "good actors" are small forest owners, limiting the forest carbon market to landowners who clear-cut on short rotations would exclude many of them. Small forest owners already struggle to access the carbon market because project development costs can quickly outweigh carbon revenues on their small acreage. One proposal to reform the voluntary market would explicitly *exclude* small projects.

If the price of carbon climbed high enough to attract commercial timberlands, the tie between carbon and other forest ecosystem benefits could be severed. For example, instead of growing a portion of its forests to 80 years old, which improves habitat and protects stream flows, Weyerhaeuser could generate the same carbon credits for less cost by extending its rotations by just one year over a larger acreage, which would yield almost no ecological co-benefits.

But is that a bad thing? The residents of planet Earth are relying on the carbon market for one very important purpose: to reduce the concentration of greenhouse gas in the atmosphere. You don't need to be

[25] Disclosure: Peter Hayes is a contributor to Sightline Institute.

a carbon essentialist to ask whether the carbon market shouldn't focus solely on carbon math while other tools protect forest ecosystems.

Learning from New Zealand

Across the Pacific Ocean, a thriving forest carbon market may offer some lessons for the United States.[26] Since 2008, New Zealand has had the world's only national cap-and-trade program that mandates the participation of forest owners.

The program is complicated, but the basic gist is that forest owners who increase their carbon get paid and those who decrease their carbon have to pay. As long as its carbon price is high enough, the program effectively deters forest conversion, stimulates reforestation, and indirectly incentivizes long rotations. New Zealand's price for a metric ton of carbon has risen steadily since 2013, hitting US$16.50 in 2021 and more than US$52.65 in February 2022.

According to Phil Taylor, who manages Washington-based Port Blakely's New Zealand forests, "the higher the price of carbon, the greater the incentive to plant new forests and extend rotations." For example, Port Blakely has made more than $100 million by extending its rotations in New Zealand, for example from 45 years to 70 years in its Douglas-fir forests.

Radiata pine, a popular tree for carbon storage in New Zealand. Source: North Sullivan Photography

Port Blakely's Mike Warjone supports a New Zealand–style policy in the United States because he has seen it work. "We make more money selling carbon than trees from New Zealand in some years," he said. Warjone notes the New Zealand program works because everyone has to be in it. Mandatory forest enrollment could help even the playing field for the Pacific Northwest timber industry, which has been losing market share to the US Southeast, in some part due to looser environmental regulations.[27] Warjone emphasizes that "whatever we do here should take account of the yellow pine plantations in the Southeast."

If the United States enacted a national cap-and-trade program with mandatory forest enrollment, it could altogether avoid many shortcomings of the current project-based crediting system: scale, impermanence, ghost credits, and the moral hazards of excluding small forest owners and "good actors." Plus, nearly all the money that currently goes to carbon project developers, third-party verifiers, and registries (often more than 50 percent of offset revenues) would go directly to forest owners.

There are more advantages: The automatic inclusion of small-scale forest owners could dampen the systematic transfer of forestlands from family forests to Timber Investment Management Organizations

[26] Because the commercial forests of British Columbia are largely government-owned, this article does not consider the effectiveness of carbon markets in Canada.
[27] The shift is largely due to an increase in Southeastern timber supply caused by federal policies that have long encouraged Southern farmers to plant trees on marginal agricultural lands, resulting in a surplus of inexpensive pine logs for the region's sawmills.

(TIMOs) and Real Estate Investment Trusts (REITs). And making forest owners pay to deforest would likely reduce the profitability of development, calming land speculation and land prices and reining in sprawl.

Unfortunately, New Zealand's national program has not avoided the forest carbon market's catch-22: the potential decoupling of carbon storage from a holistic suite of forest benefits. In fact, high carbon prices have incentivized planting exotic species such as radiata pine, whose superpower is vacuuming carbon two to three times faster than indigenous forests. These species come with ecological problems: fire risk, disease, and inferior habitat. They also sacrifice higher long-term carbon storage for short-term carbon gains.

Improving on New Zealand's model

The world owes many thanks to New Zealanders for 14 years of experimentation and reform. At least four phases of program-wide review have each provided extensive data and analysis and precipitated substantial changes to their system.

New Zealand's native kauri trees are slow-growing behemoths. Source: Wikimedia

Still, there is room for improvement. A national cap-and-trade system that covers Cascadia could preferentially target land based on its carbon potential. To help secure forest carbon against increasing disturbance as the climate changes, land at lower risk of fires, disease, and drought could receive higher payments. The same goes for forests identified as especially promising for natural carbon solutions. This includes the staggering carbon reserves in old growth and other high-carbon forest ecosystems, which New Zealand is struggling to protect.

At the same time, forests that sequester carbon more slowly but offer important co-benefits would need protection. This includes slower growing native species and forests with diverse tree species, multilayered canopies, open flight corridors, and wide stream buffers. When long rotations are narrowly managed for financial returns from timber and carbon, they are planted in dense plantations that largely negate their potential as habitat.

Ultimately, the success of a cap-and-trade system is measured by its progress toward net-zero emissions. Outside of the forestry sector, New Zealand has not made substantial progress toward decarbonization. In its defense, net emissions did not increase as New Zealand's population increased by 18 percent and its GDP increased by 77 percent from 2008 to 2019.

In Cascadia we can learn from New Zealand's diagnosis of this failure and require low and declining emissions caps, policy certainty, sustained high carbon prices, and a closed system that only transacts credits from other entities regulated within the same system.

Now for the main act

"So, will carbon credits single-handedly take down climate change? Not exactly." So concedes Evergreen Carbon, an offset portfolio management company brokering credits from more than 800 carbon projects worldwide.

But can carbon markets (voluntary and compliance) play a valuable role as one of many tools to help societies decarbonize? Quite possibly.

Extending forest harvest rotations on private lands in western Oregon and Washington offers the chance to sequester an additional 880 million tons of CO_2e (more than five years' worth of the two states' emissions from all sources). On their current trajectory, carbon markets can finance only a fraction of this potential.

The first generations of carbon markets have been helpful as warm-ups for the main act. They face some big challenges, though: scale, impermanence, ghost credits, and the potential de-coupling of carbon storage from overall forest health. For the forests of the Pacific Northwest, the best solution to those problems is to replace voluntary project-based carbon crediting with a nationwide cap-and-trade program that enrolls all forests. In the United States, this might sound like a pipe dream, but developing a plan now prepares for the day when rising costs from heat waves, hurricanes, and drought push Congress (and the Supreme Court) to act.

At the same time, it's vital to start looking for other ways to incentivize long rotations and other forest carbon solutions through a combination of market transparency, public financing, and carbon protection policies.

Methods

Acres harvested on short rotations in western Oregon and Washington: 8 million

To estimate the acreage under short rotations, I subtracted out all small forestland ownerships (fewer than 5,000 acres). Although there are exceptions, large commercial businesses tend to harvest on short rotations while small ownerships are more heterogenous. Western Washington has about 5.5 million private forestland acres, 3.7 million of which are owned by large commercial businesses. Western Oregon has about 7.3 million acres of private forestlands, 4.4 million of which are owned by large commercial companies. The total for both states is 12.7 million acres of private forestlands west of the Cascades, 8.1 million of which are owned by large commercial businesses and thus likely to be harvested on short rotations.

Currently active forest offset credits from Washington and Oregon: 1 million per year

There are currently 20 carbon projects in Oregon and Washington that are registered with the American Carbon Registry, Carbon Action Reserve, Verra Verified Carbon Standard, or City Forest Credits registries, and that have been issued at least some credits. There are additional projects in the pipeline, and there may be some whose application has recently been completed/accepted but are not yet registered and have not been issued credits. While the market experts I checked with believe that these potentially uncounted projects are unlikely to add substantially to the total, to be conservative I adjusted the total for this possibility.

Some of these projects will likely continue “in perpetuity” (for example those covered by a conservation easement), while others may or may not last past the minimum required project length. American Carbon Registry requires carbon sequestration and/or storage for at least 40 years, whereas 100 years is the minimum for California Air Resources Board (CARB)-eligible projects.

To convert different types of projects into comparable units, regardless of their ultimate length, I calculated the amount of carbon each project stores in an average year. For example, the Colville Confederation of Tribes was issued 12,336,210 credits for the first 25-year project period, or 493,448 credits per year. This annual credit value reflects the total amount of CO_2e stored in a given year due to carbon projects.

Adding up the annual carbon credited from forest offset projects returned a value of 861,000 tons of carbon stored each year in Oregon and Washington. To account for soon-to-be-credited and potentially uncounted projects, I rounded up this annual credit total to 1 million per year.

Because all compliance projects forfeit a proportion of their credits to a buffer pool in case of natural disturbance or intentional reversal by the landowner, I did not subtract out any canceled credits. (Of the Oregon and Washington forest projects registered in the American Carbon Registry, 538,847 credits have been canceled.)

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