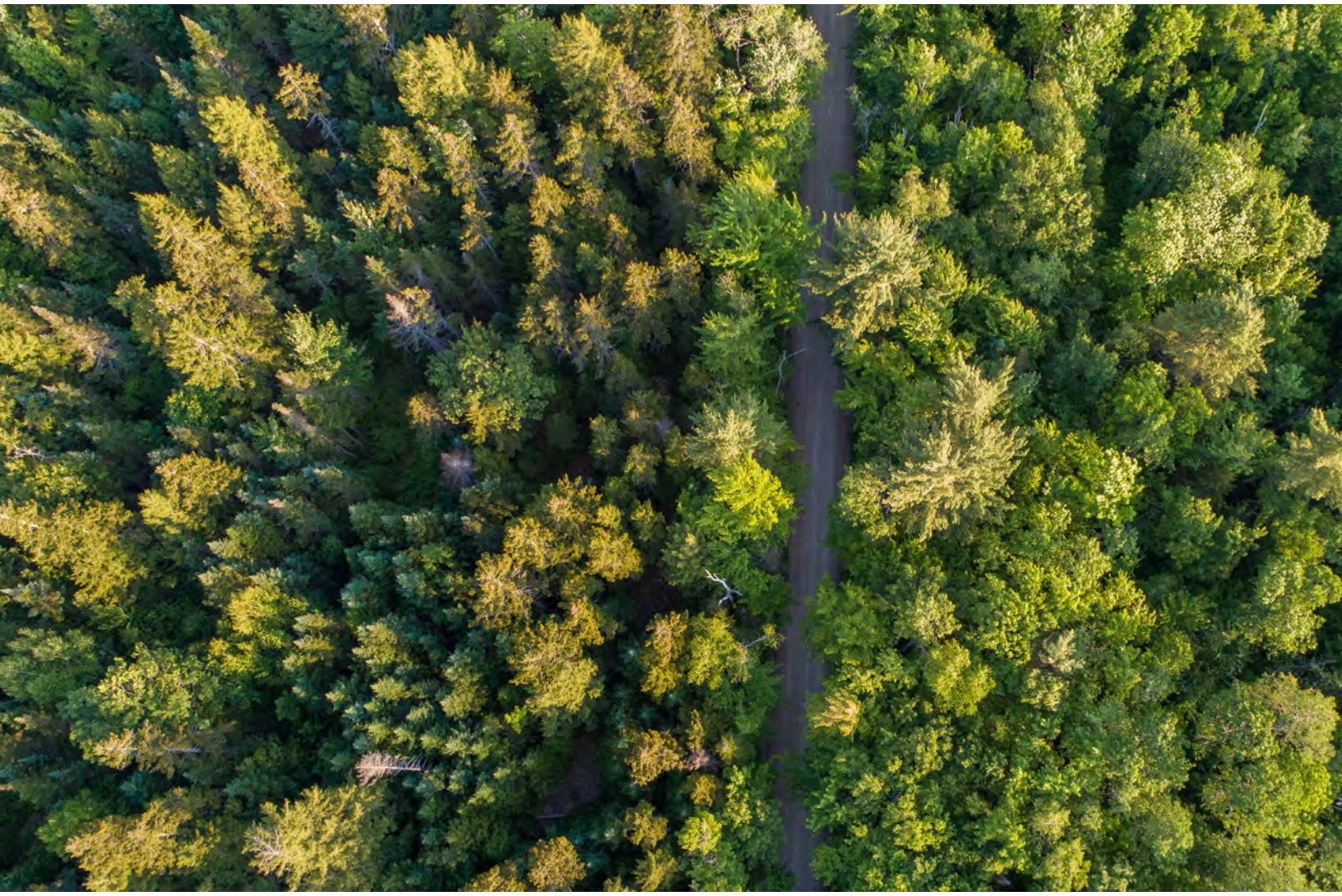
TRUST FOR PUBLIC LAND®

Enhanced Carbon Easement

A NEW APPROACH TO ADDRESSING CLIMATE CHANGE WITH WORKING FORESTS



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Trust for Public Land (TPL) is sincerely grateful to the following advisory committee members, all of whom made this report possible.

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Our thanks to many colleagues across TPL and external partners for their contributions and input.

COVER: An aerial view of the forest in Jackson, NH. © Jerry and Marcy Monkman/EcoPhotography

ACKNOWLEDGEMENT

Since 1972, TPL has been a leader in conservation efforts, safeguarding more than 4 million acres of land. This vast conservation effort not only protects valuable recreation and natural habitats but also serves as a crucial means of addressing the impacts of climate change. TPL takes pride in its ongoing commitment to delivering innovative solutions that tackle our most pressing challenges head-on.

This report is the culmination of a tremendous and thoughtful effort by all of those on our committee, advisors, and the consultants, to whom TPL is immensely grateful. This group worked for over a year identifying the elements necessary to deploy this enhanced carbon easement concept. TPL is pleased to present the results of such work.

This report would not have been possible without the financial support of the U.S. Endowment for Forestry, U.S. Department of Defense, and U.S. Forest Service Cooperative Forestry.

TPL staff managing this report include: David Patton, Vice President of the Center of Strategic Leadership and National Lands Initiative; Richard Corff, Washington State Director of Land Conservation; and Taj Schottland, Associate Director for Climate.

Conservation easements are governed by state law, and, the guidelines associated with specific conservation easement programs. This report outlines recommendations to utilize existing easement programs to address climate change with working forests. TPL projects conform to Land Trust Standards and Practices applicable to the creation and management of conservation easements. TPL does not promote or endorse any specific easement structure, method or tool recommendation presented in this report.

The findings, conclusions, and recommendations presented in this report are those of the authors alone, as are any errors in the report.

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TRUST FOR PUBLIC LAND GREEN PAPER SERIES

Each Green Paper represents a rigorous analysis of a topic in support of TPL's mission to create parks and protect land for people, ensuring healthy, livable communities for generations to come. Collectively, these papers advance TPL's goals and strategic commitments, namely that parks and green spaces deliver healthier outcomes, stronger communities, greater equity, and more effective climate solutions. They are not an end-product; they are a starting point for change.

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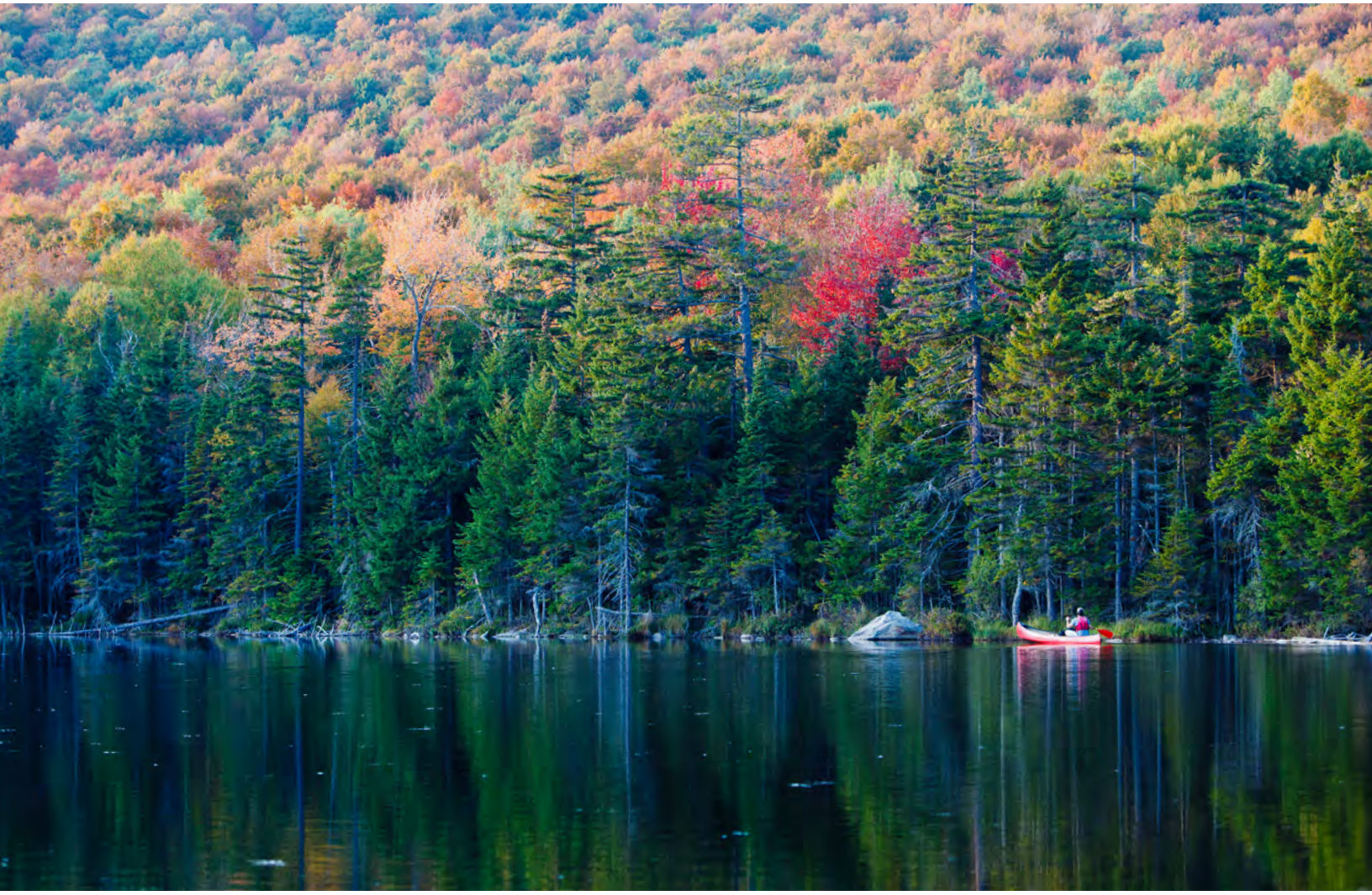
LEFT: McVickers Brook Preserve, an addition to the Schiff Nature Preserve in Morris County, NJ. © Marni Horowitz

Executive Summary



Randolph Community Forest in the Town of Randolph, NH. © Jerry and Marcy Monkman/EcoPhotography

Communities across the United States are increasingly impacted by climate-related disasters such as wildfires, megastorms, floods, and extreme heatwaves, the latter now causing more deaths than any other weather-related event. These events are exacerbated by rising global temperatures, driven in large part by carbon dioxide (CO_2) emissions. Carbon sequestration by trees—nature's solution for capturing and storing CO_2—plays a crucial role in mitigating these climate impacts. Forests act as carbon

sinks, absorbing enough CO_2 to offset approximately 12% of the nation's greenhouse gas emissions, according to the Environmental Protection Agency (EPA).[1]

However, forest carbon sequestration is under threat. From 1990 to 2018, carbon sequestration rates declined by 7%, largely due to the loss of forestland and management practices focused on short-term gains. The U.S. loses 6,000 acres of open space each day, much of it in forestland.[2] Moreover, many working forests are managed on rotation cycles that prioritize short-term financial return over carbon capture and ecosystem health.

While carbon markets were developed to incentivize carbon storage, their effectiveness has been limited by issues like low valuation, transparency and trust concerns, and the risk of double counting. To address these limitations, new approaches are essential to maintain resilient, productive, and sustainable forests.

Innovative Conservation Strategies

While several efforts are underway to expand the availability of landowner incentives aimed at extending harvest rotations, few yield transparency, public trust, and scalability. In addition, few opportunities exist for public investment. Here, Trust for Public Land (TPL) proposes an additional approach that would enhance the application of a traditional working forest conservation easement by adding longer harvesting cycles as a purchasable component. We call this an enhanced carbon easement, and it is a win-win for climate action.

Enhanced carbon easements offer a promising alternative to carbon-market approaches. These easements are legal agreements that compensate landowners for extending the timeline between timber harvests, thereby incentivizing longer forest growth cycles. By delaying harvests, these easements enable forests to retain existing carbon stores and capture additional CO_2 as trees mature, increasing overall carbon sequestration as a result.

Compensation is determined based on the value of the timber and the discounted cash flow resulting from the delayed harvest, ensuring that landowners receive fair market value for the environmental benefits their forestlands provide. This approach not only enhances carbon storage but also promotes forest health, biodiversity, and resilience to climate change impacts.

And studies underscore the multiple benefits. Research by the Northwest Natural Resource Group reveals that doubling harvest cycles for Douglas Fir forests can increase timber yields by 52% and sequester 53% more carbon.[3] This approach not only contributes to climate mitigation but also enhances forest health, biodiversity, and long-term productivity, offering a sustainable path forward for working forests in the face of climate change.

Developing Enhanced Carbon Easement

This report outlines a comprehensive framework for implementing enhanced carbon easements, a transformative approach to addressing climate change and bolstering forest resilience. The model includes three key components: fair market valuation through appraisal practices, carefully designed easement options, and methods for calculating carbon benefits. Now is the time to harness the potential of working forests with this straightforward, cost-effective and transparent solution, offering immediate incentives for landowners to extend harvest cycles.

This approach maximizes carbon sequestration, enhances forest age, and delivers multiple co-benefits, including improved habitat, biodiversity, water and air quality, soil health, and valuable social and economic gains for local communities. With clear guidance on structuring enhanced carbon easements, TPL recommends moving forward with pilot projects across diverse landscapes to validate and establish this approach as a new national standard for climate conservation and sustainable forestry.

Hiking on the Cross-Rivendell Trail in West Fairlee, VT.

Introduction

As climate change tightens its grip on communities across the United States, extreme heat, wildfires and flooding are growing more frequent and severe. Land conservation offers powerful opportunities to mitigate against the consequences of global warming. Almost every acre of preserved outdoor space, particularly forested areas, sequesters carbon, playing a significant role in climate change mitigation. This sequestration helps offset carbon emissions from various sources, including deforestation, wildfires, and fossil fuel use.

Forests absorb CO_2 through photosynthesis, storing it as carbon in their biomass and soils. Sustainable forestry practices, such as reforestation and improving forest management, further enhance this sequestration capacity while delivering essential ecosystem services, including soil stabilization, water quality improvement, flood mitigation, and wildfire buffering. According to the U.S. Forest Service, such practices can be optimized to expand forests' contributions to climate adaptation and resilience.

Despite these benefits, forest loss remains a significant threat. Between 2001 and 2022, the United States lost approximately 113 million acres of tree cover—a 17% reduction, according to Global Forest Watch. Without strategic interventions, an additional 23 million acres of forests could be lost by 2050 to development, logging, and fires—an area equivalent to the state of Indiana.[4] The U.S. Geological Survey emphasizes that land conservation is an effective climate strategy that can be implemented quickly and at low cost. Compared to newly restored forestlands, mature trees are stable and store large amounts of carbon.

While carbon markets were initially developed to incentivize carbon storage on working forestlands, their impact has been limited due to persistent issues like low valuation, lack of transparency and trust, and concerns about double counting. These challenges undermine the potential for carbon markets to drive meaningful, long-term climate benefits. To truly leverage forests as a powerful climate solution, we need new, innovative approaches that secure reliable carbon storage and create sustainable economic incentives for landowners. Without such improvements, carbon markets alone are unlikely to generate the level of forest conservation and carbon sequestration required to meet global and U.S. climate goals.

This report introduces a novel approach to forest conservation: *enhanced carbon easements*, which provide incentives for landowners to lengthen the growing periods of their forests, known as extended rotations. By merging the established tool of conservation easements with targeted incentives for extending harvests, enhanced carbon easements offer a straightforward, transparent way to promote long-term carbon sequestration and effective sustainable management practices on private forestlands.

NAVIGATING SOLUTIONS: A COMPARISON OF CARBON STRATEGIES	
Forest Carbon Market	**Enhanced Carbon Easement**
• Limited transparency & trust • Concerns of double counting • Low valuation • Lack of public agency participation • Two existing markets – California Protocol – Voluntary markets	• Focus on timber market values vs. carbon value • Trusted real estate tool—purchase • Transparent appraisal process • Incentives that encourage extending harvest rotations • Can be publicly funded

This approach offers the benefit of using a trusted, transparent, and straightforward alternative to traditional carbon markets, addressing their key shortcomings. By grounding values in tangible timber markets and leveraging proven legal agreements, enhanced carbon easements tackle dual goals: strengthening forest health and maximizing long-term carbon capture and storage.

The following sections outline the enhanced carbon easement concept, along with the scientific basis and key recommendations for implementing this idea. The aim is to establish a viable framework that can be replicated nationwide and at different scales.

A Novel Approach

This concept is simple. Use a traditional working forest conservation easement, which typically purchases rights to permanently conserve or protect privately-owned land, and enhance the easement by including restricted timber rights that will extend harvest timelines with an additional purchase. By layering this additional component onto an easement, landowners will be compensated fairly while they increase the amount of the carbon their trees capture over time.

A conservation easement is a legal agreement between a landowner and an eligible organization that restricts the activities that may take place on a property in order to protect the land's conservation values. Each easement's restrictions are tailored to the particular property, to the interests of the individual owner, and to the policies and mission of the easement purchaser.

To understand the easement concept, think of owning land as holding a bundle of rights. A landowner may sell or give away the whole bundle of rights, or just one or two of those rights. The rights given away, sold, or otherwise transferred to the easement purchaser may include, for example, the right to construct buildings, to subdivide the land, to restrict access, or to harvest timber. By selling or donating a conservation easement, a landowner retains some rights—such as continued ownership--and gives up others by deeding them to a qualified purchaser or easement holder.

Forestland conservation easements are diverse in their restrictions and often allow for a range of management practices geared to the specific goals of the conservation program, the landowner's objectives, and the regional or state silvicultural standards. These traditional easements can vary significantly, with some permitting active forest management, such as selective harvesting, while others may impose stricter limitations to preserve specific ecological values. It's important to recognize that traditional easements already provide significant carbon sequestration benefits.

The enhanced carbon easement builds on this flexibility by placing a stronger emphasis on the purchase of restricted timber rights. The easement will introduce incentives that encourage practices aimed at extending harvest rotations, thereby maximizing the carbon sequestration potential of forested lands. This approach not only upholds the conservation values typically associated with easements but also advances additional benefits by enhancing the capacity of these lands to

serve as long-term carbon sinks, contributing more effectively to climate change mitigation efforts.

While this report focuses on the technique of purchasing restricted timber rights to enhance carbon storage capacity, it also acknowledges that this approach doesn't capture the full spectrum of nature-based solutions achieved by extending rotations. Increasing the harvest age of working forestlands yields other significant ecosystem values, such as improved water quality, soil health, wildlife habitat, and cultural heritage.

To fully understand the broader implications of an enhanced carbon easement on forest ecosystems, further evaluation and research is needed. This research should explore how longer harvest intervals impact the diverse ecological, social, and cultural services forests provide. By doing so, we can better appreciate the comprehensive benefits this conservation strategy achieves, and the multifaceted roles forests play in mitigating climate impacts.

The Power of a Forest

Natural climate solutions in the U.S. have the power to absorb 21% of our annual net greenhouse gas emissions, and land conservation, in particular, stands tall as one of the most cost-effective means of doing so.[5]

The Environmental Protection Agency's (EPA) 2018 Inventory of U.S. Greenhouse Gas Emissions and Sinks found that American forests absorbed 800 million metric tonnes of carbon dioxide equivalent between 1990 and 2018. That sequestration offset 12% of our total greenhouse gas emissions. Unfortunately, the EPA also found that total carbon sequestration in forests decreased by 7% across that same period, due to forestland conversion and a slowing rate of sequestration.[6]

Contributing to this decrease is the short rotation cycles of many working forests, which is intended to maximize near-term profits. This new Enhanced Carbon Easement provides an opportunity to offer incentives to landowners to extend the length of harvest cycles and potentially shift this trend.

Tree age plays a critical role in carbon sequestration, and evidence supporting the benefits of enhanced carbon easements and sustainable forestry underscores the urgency of protecting working forests as part of a national climate strategy.

Mature forests, with their larger and denser biomass, are much more effective at sequestering carbon than younger forests. This scientific understanding of forest ecosystems highlights the importance of optimizing tree age for carbon sequestration.

Forests in the later stages of seral development and the large trees within them play an outsized role in the accumulation and long-term storage of atmospheric carbon, and consequently enabling their protection where lacking has been recognized as an effective nature-based climate solution.[7]

By lengthening harvest cycles, forests can thus sequester carbon at much higher rates. For instance, research by the Sightline Institute suggests that in the states of Washington and Oregon, extending rotations from 45 to 75 years on just 40% of current private timberland would sequester almost 11 million metric tons of CO_2. That is equal to 10% of Oregon's annual emissions reduction goal for 2050 and 7% of Washington's goal.[8] Lengthening harvest cycles offers one of the greatest potential carbon gains of any natural carbon solution.

Another U.S. Forest Service study showed that Southeastern forests, especially those consisting of fast-growing species like loblolly pine, can store 30% to 50% more carbon by extending rotations from 25-to-30 years to 40-to-50 years.[9]

What we know is simple: Extending forest harvest rotations provides a straightforward, yet powerful climate solution. The longer the harvest cycle, the more carbon the forest sequesters, and the greater its resilience to future climate impacts. But the benefits of mature forests extend far beyond just carbon absorption. These ecosystems play a crucial role in addressing climate change, while simultaneously offering a host of environmental and community advantages.

For example, U.S. forests and forest products currently offset about 13% of national greenhouse gas emissions. Additionally, mature forests enhance air quality, filter pollutants from waterways—benefiting the 37% of Americans who rely on forested areas for drinking water—and provide essential habitats for wildlife species at risk. The benefits are equally significant for human communities, as working forests support local economies by supplying timber and non-timber products, such as foraging resources, hunting and fishing opportunities, and other economic activities.[10]

Moreover, these forests contribute to cultural and recreational values, promote public health and scientific research, and provide clean air and water, reinforcing their multifaceted importance. This comprehensive approach to forest management demonstrates that investing in longer harvest rotations supports not just the climate, but also the economic and social well-being of communities.

Concept Development

While several attempts are underway to expand the availability of landowner incentives aimed at extending harvest rotations, few command transparency, public trust, and scalability. The enhanced carbon easement effectively bolsters a traditional working forest conservation easement by adding longer harvesting cycles as a purchasable component.

TPL convened an advisory committee to research and evaluate the potential for an enhanced carbon easement and to identify the necessary elements to successfully deploy this concept. The diverse committee members included experts in easement valuations, forest carbon valuations, ecosystem functions, natural resource management, and timberland appraisals, as well as timberland owners. It was important to include timberland owners that represented multiple forest types and sizes, to ensure scalability of our work and

Volunteers working at the August 2017 Day on the Land in Waimea Valley, HI. © TPL Staff/Laura Kaakua

to engage with representatives in natural resource management to gather feedback and ensure viability.

TPL hired consultant Plauché & Carr to help facilitate an objective and inclusive process. TPL also contracted with Mason, Bruce & Girard, Inc and Natalia Hasler Consulting to assist in the development of our recommendations. TPL hosted five meetings of the full committee over the course of a year and formed subcommittees that focused on each of the areas we sought to address, carefully considering all aspects.

The outcome of our work is captured in this report, which provides approaches to three things:

- **Appraisal Valuation:** Outlines a scalable and versatile appraisal approach to consider in order to determine the fair market value of specific timber rights associated with extending harvest rotations.
- **Easement Language:** Offers provisions to help guide enhanced carbon easement development as either a stand-alone easement, new easement or add-on to an existing easement.
- **Carbon Assessment:** Provides a series of resources that can support assessment of the additional carbon sequestration that may be achieved by adopting an enhanced carbon easement.

Making use of the following tested and proven concepts and processes around the traditional conservation easement, and adapting them to take on the challenges of climate change, will add this powerful mechanism to the tool chests of public and private funders as well as timberland owners to make a real and sustainable impact.

Sequestering and capturing ambient carbon does not have to be complicated or difficult. Carbon easements have the potential to make trees—one of the most critical avenues for storing carbon—sequester even more, for even longer. The recommendations outlined in this report make it possible to begin testing the enhanced carbon easement across the country.

Other Considerations

TPL recognizes that there are other factors that should be taken into consideration when pursuing an enhanced carbon easement. While this report provides guidance on how to implement such an easement, TPL recognizes there are questions that remain, including:

- **Stewardship:** Who will be eligible to hold the easement? Can we follow current guidelines established by existing programs. Stewardship monitoring will be required with this vehicle. Every conservation property should be inspected to ensure the goals of the management plan are met, with a special focus on forest management and harvest schedules. As with traditional easements, the monitoring process should include both legal and practical guidelines to ensure the landowner adheres to the easement restrictions, while allowing for permissible activities.
- **Monitoring:** What requirements are needed to ensure costs are kept low without losing the values of the easement over time? Monitoring is a critical aspect of ensuring that easements remain effective in meeting their terms and conditions, including the aspects of an enhanced easement.
- **Management Plan:** Developing a forest management plan will be a key part of any easement process to ensure that forest resources are managed in adherence to the easement goals. This will influence the ultimate appraisal value of the property.
- **Community impact:** What are the long-term implications for communities, and best transition strategies. Better understanding the impacts on markets, economies and jobs will be an important aspect to consider.
- **Leakage:** A commonly used, but sometimes misunderstood term used to describe upstream market forces that may negate some of the intended benefits associated with improved forest management or avoided conversion projects. This report does not attempt to answer this question, but does recognize this issue deserves further research as it impacts the broader field of compliance and voluntary carbon markets.

CASE STUDY

AN ENHANCED-CARBON FORESTLAND CONSERVATION EASEMENT AT CHIMACUM RIDGE COMMUNITY FOREST

On Pacific Northwest's Olympic Peninsula, rising between Center and Beaver Valleys in Chimacum, Washington is a forested landform locally referred to as Chimacum Ridge. Located near the main population centers of the county, home to headwater tributaries of Chimacum Creek, prominently seen from regional vantage points, and surrounded by productive farmland and other forests, Chimacum Ridge holds enormous consequences for the people and wildlife of east Jefferson County.

Jefferson Land Trust has worked with partners and the local community since 2010 to help protect this iconic property. It has successfully ensured it will always remain undeveloped and managed as healthy timberland. As part of the acquisition of this property, the partners were able to deploy both a traditional easement and an innovative Forestland Conservation Easement, which replicates several areas outlined in this report including improved forest management practices that extend rotation ages.

Starting in 2011, Jefferson Land Trust and Trust for Public Land worked with partners to complete the following transactions:

- Traditional Development Easement. In 2016, the landowner sold a Restrictive Easement on the entire property to the U.S. Navy, through the military branch's Readiness and Environmental Protection Integration (REPI) program, permanently removing the development rights on the property, and preserving it for its forestry values. The value of the easement acquisition was $1.2 million.

Chimacum Ridge WA. © Tegra Stone Nuess

- Enhanced Forestland Conservation Easement. In 2018, the Washington State Legislature allocated $3.4 million to this conservation project, allowing Jefferson Land Trust to acquire a Forestland Conservation Easement designed to protect certain ecological conditions of the property, and to promote improved forest harvest practices.

With the partnership achieving these important acquisitions, the Land Trust then purchased the remaining underlying deed in 2023 and is now managing it as a community forest designed to provide ecological, social, and economic benefits to the region forever.

The Forestland Conservation easement helps protect several key ecosystem and conservation values, including carbon sequestration. Listing carbon storage within the conservation values helps ensure that the ongoing management of the forest favors that function of the forest. In other words, forest management that reduces the overall sequestration function of the forest is prohibited.

The Forestland Conservation Easement also includes within the Purpose section the following language, which emphasizes the carbon sequestration role of the protected forest, along with several co-benefits:

- Owner and Grantee agree that this Easement will support increased forest carbon sequestration through the implementation of forest management practices that may also promote landscape-scale ecological functions to protect water, soils, and habitat for fish, wildlife, and plants.

Specific limitations on the scale and scope of forestry activities, included within the Forestland Conservation Easement terms, are designed in part to increase the carbon sequestration potential of the forest over time, and support the other ecological features and values of the forest. In particular, it limits the size of any future clear-cuts to 10 acres and requires the minimum rotation age of any regeneration cuts to be 50 years.

The Miles Mountain project is about climate resiliency, core working forest, wildlife habitat, hunting, watershed quality, and motorized recreation (snowmobiles and ATVs). This area comprises 13,000 acres of rural forestland, and is primarily used for hiking, fly fishing on Moose River, bird watching, ATV use, and hunting. Miles Mountain is TPL's biggest landscape project to date. © Chris Bennett

All activities on the property are further required to be conducted in accordance with a Stewardship Plan, which more specifically addresses the silviculture intended to achieve the desired future conditions.

In the case of the Chimacum Ridge Community Forest, the forest is intended to produce economic, ecological, and social benefits in perpetuity. The economic benefits derive from a continuous supply of timber that will be harvested in a way that is compatible with the ecological and social benefits of the Community Forest, including carbon sequestration. So while the property will continue to produce timber, the harvest will be limited by the enhanced Forestland Conservation Easement.

Formal Recommendations

The following section highlights three areas of focus for this report: appraisal valuation, easement language, and carbon assessment. Each section provides recommendations for practitioners on advancing these concepts. However, TPL acknowledges that there are multiple methods and approaches to these topics, and many details will need to be tailored to meet the specific goals and objectives of individual projects and practitioners. Simply put, there is not a single, standard approach, but rather a framework for implementation.

Valuation of Conservation Easements

Appraising the value of conservation easements is a complex, but well-established process. An enhanced carbon easement—as TPL proposes—can be valued using the very same methodologies. This also allows appraisers and landowners to use existing, long-standing timber markets to reflect the actual impact to landowners of extending timber harvest cycles, an important component to any incentive-based system. Leveraging tools already in use greatly reduces any hurdles to implementation of this idea.

This report offers a transparent and versatile process for evaluating the true fair market value of extending harvest rotations by focusing on timber assessments. It is not limited in scale or geography. The process can be applied to different forest sizes and forest types across the country.

Purpose

This section of the report lays out the recommendations for determining the compensatory value for the acquisition of specific timber rights from a landowner. The specific rights to be acquired would be spelled out in a conservation easement document with the purpose of increasing forest carbon sequestration by extending rotation lengths or making other modifications to the management of the forest to increase carbon stocks. (Other property interests may be acquired as well, but those are not addressed in this report.)

A conservation easement[11] is defined as, "An interest in real estate restricting future land use to preservation, conservation, wildlife habitat, or some combination of those uses. A conservation easement may permit farming, timber harvesting, or other uses of a rural nature as well as some types of conservation-oriented development to continue, subject to the easement."[12]

An enhanced carbon easement is a term coined by TPL aimed at utilizing easements to increase carbon increasing carbon capture and storage on working forestlands. The decision to execute any type of easement will be determined at the project level. The approach outlined herein is applicable to all easements.

Although carbon sequestration may be a new twist on the traditional goals of an easement, conservation easements have been used to acquire partial interests in real estate for over a half century, and there is a well-developed body of work around their valuation. An excellent reference is a text produced by the Appraisal Institute in conjunction with the Land Trust Alliance.[13] Enhanced carbon easements can be valued using the same methodology used for traditional conservation easements.

Valuation of Conservation Easements

Two competing federal appraisal standards are at odds as to how conservation easements should be valued. The disagreement hinges on whether actual sales of easements should be used as direct evidence of the market value of the easement being appraised:

- Internal Revenue Service regulations, which relate to voluntary charitable donations of a full or partial interest in property, state that the use of actual easement sales serve as the preferred valuation method if there is a "substantial record of sales of easements comparable to the donated easement."

- The Uniform Appraisal Standards for Federal Land Acquisitions, on the other hand, stipulates that sales of easements cannot typically be used and that only the "before and after" method can be used to value an easement.[14] UASFLA ("Yellow Book") appraisal standards were developed in the context of involuntary condemnation where the focus is ensuring that the property owner is fairly compensated or the impact of the taking on the value of the remaining interest in the land. However, UASFLA is also applied to voluntary sales of easements and other property types when federal funding is involved. Some states and municipalities also require UASFLA-compliant appraisals.

It is beyond the scope of this report to discuss the advantages and disadvantages of the two approaches. Readers interested in such a discussion are referred to the Appraisal Institute's text referenced in footnote 2. Instead, we make the following observations:

- In most areas, a "substantial record of sales" of easements that are comparable to the proposed easement does not exist. This is particularly true with respect to enhanced carbon easements, which are a new concept without a track record of application (as of this writing).
- The issue of "comparability" of sales is complex when applied to forested properties. The exact same easement language applied to different forestlands could have drastically different effects on market value depending on the specific property characteristics, such as current age class distribution, species composition, site productivity, etc. Thus, it would be difficult to "prove" comparability or adjust for property differences.
- Most "sales" of conservation easements do not meet many of the conditions of a market transaction. For example, they are not exposed to the market or subject to multiple competing offers, and the motivation of the buyer is not typical of most real

Students of Brewster Pierce Memorial School attend class in the outdoor classroom in Huntington Community Forest, in Huntington, VT.
© Peter Cirilli

estate transactions. Furthermore, there aren't multiple conservation easements listed for sale and competing for buyers. Instead, they are most often negotiated between one buyer (such as a land trust or government agency) and one seller (the landowner), usually based on an appraisal. Public funding or funds obtained through fund-raising campaigns are frequently involved. For all these reasons, their usefulness as indicators of market value—if that term is even applicable in this situation—is questionable.

Finally, it seems likely that many, if not most, enhanced carbon easements will be funded by federal grants, which will require the application of the UASFLA standards. As discussed, UASFLA requires the "before and after" methodology in nearly all situations. From a pragmatic perspective, therefore, it is recognized that a "before and after" appraisal will likely be necessary in many enhanced carbon easement acquisitions.

- Note that federally funded easements often must include provisions granting rights to the federal government that make the related carbon project ineligible for the California compliance market.

Overview of the Before and After Methodology

As noted in the previous section, voluntary conservation easement acquisitions financed by federal (and often state) funding sources may be valued using a "before & after" appraisal. In the "Before Case," the property is appraised "as is" based on its Highest and Best Use (HBU) prior to encumbrance with the proposed conservation easement. In the "After Case," the property is appraised under the Hypothetical Condition that the proposed easement is encumbering the property as of the date of the appraisal. The difference between the before and after values is the compensation for the conservation easement.

The "before & after" appraisal methodology has several advantages:

- It is a recognized and accepted approach to valuing conservation easements that will be familiar to appraisers, federal and state funding agencies, land trusts, and many landowners.
- There are appraisal standards to ensure quality and consistency.
- It is applicable across all geographic regions and forest types.
- It is scalable across the entire range of property sizes.
  - It is a framework that can be applied to a one-acre or a 100,000-acre property.
  - The specific analytical tools may vary but the methodology is consistent.
- It is also adaptable:
  - It can be applied to even-aged plantation forests, multi-age and uneven-aged natural forests, or mixes of all the above.
  - It can be applied to more complex easements that convey development rights, public recreational access, and other rights in addition to enhanced carbon forest management.

Standards

APPRAISER QUALIFICATIONS

Appraisal services in the U.S. are regulated by the federal and state governments. Appraisals of conservation easements are real property appraisals and fall under these regulations. One aspect of the federal regulations is national standards for real property appraiser qualifications, which are set by The Appraisal Foundation. Most states require that real estate appraisals be conducted by state-licensed appraisers who meet the federal qualifications for training and experience. Licensing is required for appraisers involved in federally related transactions.

For projects subject to federal review, the federal review appraiser must approve any appraiser selection, regardless of their education and credentials, and that for FLP work (and other federal work) the appraiser should have a demonstrated experience in this property type, appraisal methodology, etc.

Some states allow professional foresters to appraise timber or forestland in some situations. In Oregon, for example, an exception to the appraiser licensing regulations allows professional foresters to appraise timber or forestland as part of services provided as a forest management consultant, but only where the use of the land is limited to forestland and only in non-federally-related transactions. In California, state appraiser licensing is required only for federally related transactions.

Since conservation easements are complex transactions involving conveyance of partial interests in real property, it is advisable to obtain the services of a state licensed (certified) general commercial appraiser to lead the work, even if exceptions may permit other options. State licensing requires the appraiser to adhere to applicable appraisal standards, normally the Uniform Standards of Professional Appraisal Practice (USPAP). Compliance with these legally enforceable standards takes care of many aspects of the appraisal service, including assurance of ethical conduct and competency.

Beyond basic appraisal qualifications, the appraiser selected for the work should have experience in timber and forestland valuation or should engage a forestry professional to assist in aspects of the assignment in which they lack adequate competency. This is especially true for larger properties where modeling of future forest management and cash flows will be more complex. The appraiser should also have training and experience appraising conservation easements. The Appraisal Institute and American Society of Farm Managers and Rural Appraisers both offer educational courses in easement appraisal. If federal (or sometimes state) funding is involved, the appraiser should also have training and experience in the current UASFLA standards.

USPAP

The Uniform Standards of Professional Appraisal Practice is the generally recognized ethical and performance standard for the appraisal profession in the United States. The Appraisal Standards Board of The Appraisal Foundation is responsible for writing, maintaining, and interpreting USPAP. They contain standards for all types of appraisal services, including real estate, personal property, business, and mass appraisal. States have adopted USPAP as law and state licensing boards regulate compliance. Compliance is required for state-licensed and state-certified appraisers involved in federally related real estate transactions. Most states also require compliance with the standards even in assignments that are not federally related.

UASFLA

The Uniform Appraisal Standards for Federal Land Acquisitions, also known as "Yellow Book," are a set of appraisal standards promulgated by the Interagency Land Acquisition Conference. They are considered "Supplemental Standards" to USPAP and are required to bolster the minimum level of documentation and yield compliance with the unique and applicable appraisal methods and procedures that have evolved from federal case law, mostly in the context of eminent domain takings. However, they are applied to most appraisals involving federal funding for real property acquisitions. Many states also require UASFLA compliant appraisals for similar projects. UASFLA introduces the concept of the Larger Parcel in which the estate to be appraised may be different than the property to be encumbered by the easement.

IRS-QUALIFIED APPRAISALS

IRS-Qualified appraisals are usually required to substantiate the value of a tax deduction for a non-cash charitable contribution. This includes donations of perpetual conservation easements that meet the definition of a Qualified Conservation Contribution. It is beyond the scope of this paper to discuss IRS-Qualified appraisals of conservation easements.

SCOPE OF WORK

For each appraisal assignment, the appraiser must identify the problem to be solved; determine and perform the scope of work necessary to develop credible assignment results; and disclose the scope of work in the report.[15] Assignment elements necessary for determining the scope of work include:

- Client and any other Intended Users
- Intended Use of the appraiser's opinions and conclusions

The northern Presidentials in New Hampshire's White Mountains as seen from a field in the Randolph Community Forest in Randolph, NH. © Jerry and Marcy Monkman/EcoPhotography

- Type and definition of value
- Effective date of the appraiser's opinions and conclusions
- Subject of the assignment and its relevant characteristics
- Assignment conditions

The appraiser works with the client to identify the assignment elements and from there develops the scope of work. In many UASFLA assignments, elements of the scope of work are provided to the appraiser in the assignment instructions written by the government agency requesting the work.

There are three scenarios under which we can envision enhanced carbon easements being acquired:

1. An enhanced carbon easement is being placed on a forestland property that has an HBU of commercial timber production and no pre-existing conservation easements.
2. An enhanced carbon easement is being placed on a forestland property that is already encumbered by a pre-existing conservation easement that limits the economic use of the property to commercial timber management.
3. A broader conservation easement is being placed on a property, which may or may not have an HBU of commercial timber production, that simultaneously acquires or extinguishes development, subdivision, and/or other rights and also includes elements of an enhanced carbon easement.

These range from simple to more complex. However, each of these scenarios can be handled by the "before and after" methodology and the applicable appraisal standards. Under scenario 3, the value of the easement will come from the combination of rights acquired, which includes rights unrelated to the enhanced carbon components of the easement. If the client needs to know how much of the easement value is attributable to the enhanced carbon elements, this need should be communicated to the appraiser in advance so that the

additional work required to allocate the value can be incorporated into the fee quote and scope of work.

Property Data

As for any appraisal, the appraiser will need access to all relevant data and information about the subject property, including preliminary title commitment(s) and exceptions documents, property tax records, and ownership history. Additional documentation should be provided to the appraiser as well: environmental assessments; mineral evaluations; water rights information; copies of existing leases and permits; management plans; prior offers of purchase; current option agreements; maps; geographic information system data, etc.

Reliable timber inventory data is essential to the appraiser and will be used in all appraisal approaches. A determination will need to be made as to the credibility of any current inventory for the purposes of the project, and/or the need for collection of new inventory data.

A woman squats in the shade picking huckleberries in the Swan Valley, MT. © Deb Love

Conservation Easement Document

The appraiser must be provided with a copy of the proposed deed of conservation easement that will encumber the property. It is critical that the document be in final form because material changes to the terms and conditions of the conservation easement document after the appraisal has been completed may necessitate a new appraisal.

Highest and Best Use

BEFORE CASE

The appraiser must develop an opinion of the Highest and Best Use of the subject property in the Before Case, prior to the encumbrance by the conservation easement. This involves an identification of the legally permissible, physically possible, and economically feasible uses of the subject property and then determining which of these uses is maximally productive and results in the highest value.

The degree of analysis necessary to reach this conclusion will vary with the subject property. The analysis must be well supported by market data. The Before Case HBU conclusion should not be a speculative use. It should be reasonable and probable as of the effective date of value.

In the context of enhanced carbon easements, we assume the property is forested and it is likely that the current use is commercial timber production. However, it is important that the appraiser considers whether there are alternative economic uses for all or part of the property that have a higher value and appraise it accordingly. For example, if the property could be subdivided into rural residential lots and developed for that purpose, and if there is market evidence of demand for residential lots, the appraiser must determine if this is the HBU. If so, it should be appraised on that premise.

If commercial timber production is identified as the HBU, the appraiser should describe the approach to timber management that would maximize financial returns to contrast the Before Case management with

After Case management under the enhanced carbon easement. Maximizing financial returns is usually equated to maximizing the net present value (NPV) of expected future cash flows considering only regulatory and operational constraints on management.

The appraiser should interview the current landowner and/or land manager to document the current business objectives, silvicultural practices, rotation lengths, planned harvest volume targets over time, etc. The appraiser should form an opinion as to whether the current management approach reasonably aligns with maximally productive use. If so, that approach should be the basis for income approach modeling in the Before Case. If not, the appraiser should describe how the maximally productive management approach would differ from the current practice. This may require research into typical management regimes followed in the market, perhaps through consultations with an independent consulting forester.

AFTER CASE

The HBU is reconsidered in the After Case in light of the terms of the enhanced carbon easement and how it restricts and directs the use of the property. In the analysis, the appraiser should summarize the terms and conditions of the proposed easement document and describe how it modifies the management of the property compared to the Before Case.

Income Capitalization Approach

While developing the scope of work, the appraiser determines whether the income capitalization approach to value is applicable to the appraisal problem. This is partly dependent on the HBU of the property.

The income capitalization approach is applicable to commercial forestland because it is an income-producing property type. The approach is based on the Principal of Anticipation, which holds that a property's market value is the present value of the sum of anticipated future benefits. Most knowledgeable forestland investors rely primarily on the income approach and use discounted cash flow analysis to value these more complex properties that often have highly variable income flows. Appraisers use the same techniques to mimic the actions of the market.

Discounted cash flow (DCF) is a form of income capitalization that calculates the present worth of the expected costs and income stream over the projection period and includes a reversion value at the end of the term. In DCF analysis, future costs and revenues are estimated based on expected future harvests and management activities. This future cash flow is then discounted to the present using an appropriate discount rate to estimate an NPV.

Appraisers use a variety of software tools and analytical approaches to forestland appraisal. These range from spreadsheets (from simple to complex) to sophisticated linear programming or simulation-based forest planning systems such as Woodstock (Remsoft), TigerMoth (TigerMoth), Patchworks (Spatial Planning Systems), and Forest Projection System (Forest Biometrics Institute). This protocol does not specify any particular platform as long as the platform used by the appraiser incorporates the essential elements of a discounted cash flow model.

Components of a DCF model, outlined below, include holding period, initial property inventory, silvicultural regimes, growth and yield modeling, harvest forecast, projected costs and revenues, discount rate, and reversion.

Holding Period: The number of years that the property is held for investment; or, in other words, the time period between the hypothetical purchase and sale of the property. It is also the length of time for which the costs and revenues are forecasted. The holding period may differ between the Before and After analyses and should reflect market behavior—that is, the typical actions of buyers and sellers.

Reversion: The reversion value is an estimate of the market value of the property at the end of the holding period. It is discounted back to the present using an appropriate reversion discount rate and added to the NPV of the net cash flows over the holding period. There are alternative methods of estimating a reversion

value that vary by region and/or appraiser. These include direct capitalization of an average stabilized annual income, discounting the cash flows of a model projection that extends beyond the end of the holding period, and an application of unit values to the land and timber inventory present at the end of the holding period.

Regardless of the approach used, it is critical that the appraiser take into account the impact of the easement on the market value of the property as of the reversion date, if the easement extends beyond the holding period.

Initial Property Inventory: The initial condition of the forest can be represented in the model in a number of ways, including individual trees, stands, or stratum.

Silvicultural Regimes: The silvicultural regimes describe how timber will be managed from stand establishment through final harvesting. These may include site preparation, artificial or natural regeneration, competition control and other intermediate treatments, and sequences of partial harvests and regeneration harvests. In appraisals, the range of silvicultural regimes is often simplified. In the context of appraising enhanced carbon easements, the regimes modeled should reasonably represent those typically adopted by market participants in the Before Case and regimes as modified by the easement terms in the After Case.

Growth & Yield Modeling: This is a forecast of the future biological growth of the initial timber inventory and the estimated yield (production) of various timber products over time under the silvicultural regimes included in the model. Yields are expressed in whatever units are appropriate for regional markets. There are several approaches to growth and yield modeling, including published tables, separate tree or stand-based growth modeling software, or growth equations within the planning model platform. To be credible, the approach used by the appraiser should be one that is widely accepted and embraced by market participants. Ultimately, what matters is that the growth rates used are in line with market participant expectations for the region.

Although not normally part of an appraisal assignment, to the extent that the appraiser or their forestry technical support is able, the growth and yield modeling could include estimates of carbon tons or CO_2-equivalent tons of inventory in the yield forecasts using accepted definitions and processes.

For example, the Forest Service's Forest Vegetation Simulator (FVS) has an extension that estimates both the stand-level carbon stock and harvested carbon using calculation methods consistent with the U.S. Carbon Accounting Rules and Guidelines for the 1605(b) Voluntary Greenhouse Gas Reporting Program and the Intergovernmental Panel on Climate Change's Good Practice guidance for national greenhouse gas inventories. There are about 20 geographic variants of the modeling system covering all of the major forest types in the U.S.[16]

If possible, outputs of the discounted cash flow modeling of the subject property should include inventory and harvest in terms of carbon tons or CO_2-equivalent tons. This will facilitate modeling of forest carbon balances and carbon sequestration in harvested wood products and allow comparison of the Before and After Cases in the context of effects of carbon sequestration.

Harvest Forecast: The harvest forecast is a projection of future harvest volume over time, dictated by the silvicultural regimes, projected growth, regulatory constraints, and operational considerations such as workforce and markets. A linear programming-based harvest scheduling model will mathematically solve for the harvest schedule that optimizes the objective function, usually maximization of the NPV. Simulation models will approximate an optimal solution by some form of heuristic algorithm. Other models may require the appraiser or analyst to manually test scenarios to identify a schedule that maximizes the NPV. The forecast should provide detail of the harvest volume by species and product to allow for assignment of prices to convert the harvest volume to a revenue stream. As mentioned above, harvest volumes should also be expressed in units of carbon.

Costs: The DCF model should include all expected future expenses. A complete set of management costs includes the more or less fixed costs such as property taxes, certain administrative expenses, road maintenance, fire protection, etc.; variable costs associated with silvicultural (e.g., tree planting) and other land management activities (e.g., timber sale preparation and administration); and expected capital costs for roads and bridges, if applicable. Depending on the common practices of the region, timber may be sold as standing trees ("stumpage") or delivered logs. Production costs such as logging and hauling are included if the model is based on delivered log sales, but not included in stumpage sale models. The appraiser should try to obtain historical cost data from the subject property.

Revenues: The DCF should include expected revenue streams from both timber and non-timber sources. Timber revenue projections are a product of the projected harvest volumes and a forecast of timber prices (stumpage or delivered prices). Appraisers have various approaches to timber price forecasting including in-house forecasts, third-party forecasts, market surveys, or a hybrid of two or three approaches. Ultimately, price forecasts should reflect market expectations as of the appraisal date. Non-timber revenues (hunting leases, rock sales, cell tower leases, etc.) should be included for completeness when material to the property value, even if they won't be affected by the easement.

Discount Rate: The discount rate represents the rate of return expected by the market for a given property. In DCF analysis, the discount rate is the interest rate used to determine the present value of future cash flows. Appraisers should base the discount rate on market evidence. It should be a real rate if real dollars are used for costs and revenues, or a nominal rate, if inflation is "built in" to future costs and revenues. As noted below, the discount rate may vary between the Before and After Case. Further, the discount rate applied during the holding period may be the same or different than the discount rate applied to the reversion value described next.

A man and woman hike in the new Bethel Community Forest in Bethel, ME. © Jerry and Marcy Monkman/EcoPhotography

BEFORE CASE

In the Before Case, the property is modeled as a typical buyer would envision its future management. Assuming the HBU has been determined to be commercial timber production, a maximally productive approach to management, as was outlined in the HBU analysis, is the appropriate basis for review. This approach, however, may not be simply limited to the cash flows from timber harvests during the holding period, but may also need to consider market behaviors such as intermediate land sales, capital appreciation expressed as in the reversion value, and/or other market-derived considerations.

AFTER CASE

In the After Case, the property is modeled as a typical buyer would envision its future management under the terms and conditions imposed by the enhanced carbon easement. The valuation model is modified to meet the easement's requirements with regard to silvicultural systems and restrictions on rotation lengths, rate of harvest, maintenance of inventory, etc.

The appraiser should also consider how other elements of the model should be modified. For example, the appraiser should consider how the easement will affect:

- **Future management costs**—are there added costs imposed by the easement for compliance monitoring, reporting, and periodic site inspections by the enhanced carbon easement holder? Will production costs (logging and haul) be affected?
- **Future log prices**—is the timber produced in the After Case more or less valuable than the timber produced in the Before Case; for example, due to larger size or an improved grade mix?
- **Marketability**—how will the encumbrance by the enhanced carbon easement affect the marketability of the property in the After Case? For example, should the discount rate be adjusted to account for additional risks related to the easement or account for effects on marketability?

Adjustments should be made to the model to address these factors. As always, the adjustments should be supported with market evidence.

Sales Comparison Approach

The sales comparison approach is based on the principle of substitution, which holds that a prudent buyer will pay no more for a property than it would cost to acquire a comparable substitute property with similar utility. The approach recognizes that typical buyers will compare asking prices and seek to acquire a property that meets their needs at the lowest price.

In developing the sales comparison approach, the appraiser identifies and analyzes transactions of comparable properties. Sale prices for each comparable are adjusted to account for differences in market conditions and property characteristics that affect value. The results are then used to derive an indication of value for the property being appraised.

As noted in Section B, UASFLA requires a "Before and After" approach to the appraisal and does not allow for use of direct sales of conservation easements in the sales comparison approach.

BEFORE CASE

The Before Case should be straightforward assuming the market for properties like the subject forestland is relatively active. The appraiser follows the normal process of completing a pre-easement highest and best use analysis of the property and then finishes the analysis using standard sales comparison techniques.

The appraiser identifies, researches, and verifies several market transactions (or listings or pending sales) of properties similar to the subject property prior to the encumbrance by the enhanced carbon easement. The comparable sales should have the same HBU as the subject, or at least an HBU that is similar in terms of the market value it creates. Research into each sale should verify the property's legal description, relevant property characteristics, interest conveyed, sale price, identities of buyer and seller, conditions of sale such as financing and motivations of the parties, and any other relevant information on the transaction.

The analysis will vary with property type but generally the appraiser identifies the relevant unit of comparison (e.g., price per acre) and elements of comparison that drive value. The appraiser then adjusts each sale for transactional characteristics (e.g., property rights conveyed, financing terms, conditions of sale, expenditures made after purchase, and market conditions) and property characteristics (e.g., location, physical, and economic characteristics) to "make the sale like the subject." The result is a value indication for the subject property from each of the comparable sales. The final step is reconciling these values into a single value indication.

AFTER CASE

Successful application of the sales comparison approach in the After Case is contingent upon the availability of sales of similar easement-encumbered properties where those easements have a similar effect on the market value of their underlying sale property as the proposed enhanced carbon easement will have on the

subject property. Comparable sales should have the same HBU as the subject property in the After Case, should have similar physical and locational attributes, and similar limitations to use as the subject property in the After Case.

Such encumbered sales are often difficult to find for traditional conservation easements. Sales of conservation easement-encumbered properties occur relatively infrequently even in areas where large numbers of properties have been placed under conservation easements. However, local and regional land trusts can be a good source of sale leads at least in some states.[17] Conservation easements that place limits on timber management practices as enhanced carbon easements are much less common, and transactions of such conservation easement-encumbered properties are even more rare. This may require a search over a broader geographic area and/or a more extensive time period. The Appraisal Institute's Valuation of Conservation Easements course recommends the following process for researching After Case sales:[18]

1. Search the subject property's market area for recent sales first.
2. Older sales in the subject's market area.
3. Markets that are competitive with the subject property's market area.
4. Markets that are comparable to, but not necessarily competitive with, the subject property's market area.
5. A sufficient number of sales must be used to support conclusions.

Lacking enough conservation easement-encumbered property sales, the appraiser may need to consider sales of unencumbered properties where other factors essentially mimic the effects of the proposed enhanced carbon easement. For a typical conservation easement that extinguishes development rights, the appraiser can consider transactions of properties where development is not legally permitted under current zoning and/or identify sales where development is unlikely because of remoteness or physical limitations of the site. The point of including these sales, even though they are not encumbered by a conservation easement, is that the transaction value would not have been influenced by any future development potential.

In considering enhanced carbon easements, the appraiser might think about how such an easement would affect the "intensity of use" of the property and draw parallels in searching for unencumbered sales that will have a similar intensity of use due to physical conditions. Intensity of use could be measured in terms of timber productivity or income-producing potential. For example, if the subject property is a highly productive forest in the Before Case it might produce an average harvest of 800 board feet per acre per year over a 50-year period (this figure can come from the income approach modeling). Thus, its intensity of use would be 800 bd.ft./acre/year in the Before Case. The appraiser might then assess the property's board foot productivity as encumbered in the After Case as having a lower intensity of use. Perhaps over the same 50-year period, the income approach model shows the property will only produce an average harvest of 600 bd.ft./acre/year in the After Case because of a requirement for longer rotations and other constraints imposed by the easement. Given that, good After Case comparable sales would be those of unencumbered lower site properties that biologically can only produce about 600 bd.ft./acre/year. One could also make a similar analysis using average annual income per acre rather than timber volume production.

Cost Approach

Like the sales comparison approach, the cost approach is based on the principle of substitution. In this context, the principle is that no rational investor will pay more for a property than the cost of constructing an equivalent substitute. The cost approach is typically used to value improved properties in which a substantial portion of the market value is contributed by built structures and other improvements.

A natural question arises as to whether the approach is applicable to properties like vacant forestlands that have no built improvements. USPAP Standards Rule 1–4(b) requires that appraisers apply the cost approach when it is necessary for credible assignment results but

does not specify when it is or is not necessary. However, Frequently Asked Question 187, in a supplement to USPAP, addresses this question stating that the cost approach is not necessary when appraising land without improvements.

UASFLA is consistent with USPAP, stating that, "this approach to value is most useful in developing the value of a property in which the improvements are new (and actual costs are known) and there is no evidence of depreciation." Further, it "is also used as a check on the opinion of market value indicated by the sales comparison approach and for appraising highly improved properties with no known comparable sales."[19]

Therefore, in most cases appraisals of conservation easements do not require the cost approach unless there are substantial built improvements on the property. In that case, the improvements must be considered in the conservation easement valuation but may not have to be valued. Primary factors to consider are whether the contributory value of the improvements will be affected by the conservation easement and whether the improvements will have an effect on the HBU. The Appraisal Institute conservation easement appraisal course has some advice on when improvements must, should, or don't need to be appraised.[20]

That said, some forestland appraisers employ an approach that is referred to as a "modified" cost approach in which the existing timber on the property is appraised based on unit values akin to replacement costs and added to a land value extracted from comparable land sales.

If the appraiser determines that a modified cost approach is required for a credible assignment result for an enhanced carbon easement, the same "Before and After" approach applies. In the After Case, the appraiser must consider how the proposed enhanced carbon easement affects the various components of value.

Reconciliation

The final step in the appraisal process is the reconciliation of the value indications from the approaches employed in the analysis to a final opinion of value. In a Before and After appraisal, there are two reconciliations: one for the Before Case and one for the After Case. The difference between the reconciled value conclusions represents the compensatory value of the easement. UASFLA standard 2.3.6.1 states that the appraiser must report the difference by deducting the after value from its before value.

Glossary

Unless otherwise footnoted, all definitions are from: The Appraisal Institute, *The Dictionary of Real Estate Appraisal, 7th Ed.*

Conservation easement: An interest in real estate restricting future land use to preservation, conservation, wildlife habitat, or some combination of those uses. A conservation easement may permit farming, timber harvesting, or other uses of a rural nature as well as some types of conservation-oriented development to continue, subject to the easement.

Federally related transaction: In the United States, under Title XI of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA), any real estate-related financial transaction that a Federal Financial Institutions Regulatory Agency (FFIRA) engages in, contracts for, or regulates, and that requires the services of an appraiser.

Highest and Best Use (HBU): The reasonably probable use of property that results in the highest value. The four criteria that the highest and best use must meet are legal permissibility, physical possibility, financial feasibility, and maximum productivity.

Hypothetical condition: 1. A condition that is presumed to be true when it is known to be false. 2. A condition, directly related to a specific assignment, which is contrary to what is known by the appraiser to exist on the effective date of the assignment results but is used for the purpose of analysis.

IRS-qualified appraisal[21]**:** an appraisal that is (1) treated as a qualified appraisal under regulations or other

The Wolcott Community Forest is primarily used for hunting, fishing, hiking, mountain biking, and bird watching. Children and classes frequent the area since it's adjacent to Wolcott Elementary School. © Chris Bennett

guidance prescribed by the Secretary, and (2) conducted by a qualified appraiser in accordance with generally accepted appraisal standards and any regulations or other guidance prescribed by the Secretary.

Larger parcel: In governmental land acquisitions and in valuation of charitable donations of partial interests in property such as easements, the tract or tracts of land that are under the beneficial control of a single individual or entity and have the same, or an integrated, highest and best use. Elements for consideration by the appraiser in making a determination in this regard are contiguity, or proximity, as it bears on the highest and best use of the property, unity of ownership, and unity of highest and best use. In most states, unity of ownership, contiguity, and unity of use are the three conditions that establish the larger parcel for the consideration of severance damages. In federal and some state cases, however, contiguity is sometimes subordinated to unitary use.

Net present value (NPV): The difference between the present value of all expected investment benefits (PV) and the present value of the capital outlays (CO), i.e., NPV = PV – CO.

Timber cruise[22]**:** the process of measuring forest stands to determine stand characteristics such as average tree sizes, volume, and quality.

Easement Language

Bringing an enhanced carbon easement to fruition requires not only the means to calculate carbon additionality and conduct an appraisal, but also the easement language necessary to appropriately encumber the land.

Below you will find easement language that creates flexibility to meet the needs of landowners, funding agencies, and easement. It can be used for three types of transactions: (1) a stand-alone enhanced carbon easement, (2) one that is developed in conjunction with a traditional conservation easement, and (3) one that is layered on top of an existing conservation easement. This is a menu of various recommended conservation easement provisions that can be used as a resource when drafting enhanced carbon easements. Conservation easement language must also meet state legal requirements and requirements of applicable funding sources and programs (e.g., Forest Legacy Program), including but not limited to provisions related to: prohibition or limitation on subdivision; limits on compatible nonforest use; linear nonforest corridors and other easements; right to enter the property for monitoring; valuation; assignment; transfer, amendment, and extinguishment; no merger; duties of owners; and enforcement provisions.

A. CONSERVATION VALUES

The conservation values defined in the conservation easement should include commercial timber forest resource production and forest carbon storage and sequestration. Conservation values may also include ecosystem services, climate change resiliency, and other conservation values that do not conflict with the continuation of commercial timber forest resource production, extension in rotation age, and forest carbon and sequestration.

Recommended Conservation Easement Language

i. WHEREAS, the Property possesses significant forest resource values of great importance to Grantor, Grantee, the people of [County], the people of the State of [STATE], and the people of the United States, including: commercial timber and non-timber forest resource production; forest cover; forest carbon storage and sequestration; ecosystem services; climate change resiliency; open-space; wildlife habitat; water quality and retention, and aquifer recharge; educational opportunities; recreational opportunities; and scenic values (collectively, the "Conservation Values"). Grantor intends that the Conservation Values of the Property be preserved, and that the Property continue to be used primarily for forestry and related activities that are associated with, compatible with, and complementary to, such Conservation Values for the length of the Easement;

B. PURPOSE AND AUTHORITY

The purpose and authority provision in the conservation easement should specify that the acquisition of the conservation easement supports increased forest carbon storage and sequestration and may also reference the extension in rotation age that contributes to the increased forest carbon storage and sequestration.

Recommended Conservation Easement Language

i. WHEREAS, the Property is predominantly forested, providing carbon storage and sequestration potential, and has been and continues to be managed for commercial production of timber products; and this Easement contains specific provisions designed to increase the capacity of the Property to sequester and store forest carbon;

ii. The purpose of this Easement is to protect the Conservation Values of the Property by defining certain Permitted Uses and certain Prohibited Uses of the Property, and by providing to Grantee rights to monitor and enforce compliance with the terms of this Easement (the "Purpose"). The Parties intend to help the land remain healthy and viable in the face of future changes to the climate or the ecology of the region within which the Property is located.

iii. The Parties agree that this Easement will support increased forest carbon sequestration through the implementation of forest management practices, including an extension in rotation age that may also promote landscape-scale ecological functions to protect water, soils, and habitat for fish, wildlife, and plants.

C. TERM

The term of the conservation easement should be perpetual where required by an applicable funding source or program, or if otherwise desired. The minimum term of the Enhanced Carbon Easement component should be the number of years required for all existing timber stands on the property to reach the minimum rotation length or harvest age.

Recommended Language for an Enhanced Carbon Easement:

i. The term of this easement requirement is XX years from the Effective Date of this Enhanced Carbon Easement as defined in Section YY ("Term").

D. MULTI-RESOURCE MANAGEMENT PLAN

The conservation easement should include a provision outlining the requirements for a property-specific Multi-Resource Management Plan that shall govern management of the property. The provision should be clear that management activities on the land must be done in accordance with and be consistent with the Multi-Resource Management Plan and must require that the Multi-Resource Management Plan contain provisions that will ensure an increase in carbon storage and sequestration on the subject property.

Recommended Conservation Easement Language:

i. The Parties agree that this Easement will support increased forest carbon storage and sequestration through the development and implementation of a Multi-Resource Management Plan that includes an extension in rotation age and that may also promote landscape-scale ecological functions to protect water, soils and habitat for fish, wildlife and plants.

ii. Compliance with the elements of an approved Multi-Resource Management Plan is a requirement of this easement. The Multi-Resource Management Plan and any Amended Multi-Resource Management Plan shall be consistent with the Purposes of this Grant. The Multi-Resource Management Plan shall be based on the most current science and strive to improve stand quality and maintain important wildlife habitats consistent with current stand conditions and site quality and shall include at least the following elements:

   a. Landowner's forest management objectives, including carbon storage and sequestration objectives;

   b. An appropriately scaled, accurate map indicating such items as forest stands, streams and wetlands, and major access routes (truck roads, landings, and major skid trails);

   c. Forest stand (treatment unit) descriptions (forest types, stocking levels before and after harvesting, soils topography, stand quality, site class, insect and disease occurrence, previous management history, and prescribed silvicultural treatment;

   d. A feasible strategy and timeline for practice and activity implementation;

   e. Plant and wildlife considerations (identification of known significant habitats and management recommendations, and Grantor's plan with regard to retaining snag trees, den trees, and downed trees);

   f. Recreational considerations;

   g. Historic and cultural resource considerations (identification of known resources and associated management recommendations); and

   h. Description of how management prescriptions will affect forest carbon pools and climate

resilience and ensure increased carbon storage and sequestration on the property, including through an extension in rotation age.

The Multi-Resource Management Plan shall be updated at least once every 10 years. Amendments to the Multi-Resource Management Plan shall be required in the event that Grantor proposes a treatment not included in the Multi-Resource Management Plan, but no such amendment shall be required for any change in timing or sequence of treatments if such change does not vary more than 3 years from the prescription schedule set forth in the Multi-Resource Management Plan as approved by the Grantee. Grantee may rely upon the advice and recommendations of such foresters, wildlife experts, conservation biologists, or other experts as Grantee may select to determine whether the Multi-Resource Management Plan or Amended Multi-Resource Management Plan would be detrimental to the Purposes of this Grant.

iii. Grantor shall undertake Forestry Activities on the Property in accordance with a Multi-Resource Management Plan to ensure increased carbon storage and sequestration. It is the intent of each party to ensure forest management that is undertaken on the Property increases carbon sequestration and storage on site. It is not the intent of either party to preclude forest management on the Property in order to achieve the Purpose of this Easement, but rather to achieve the Purpose through and by use of active forest management consistent with this Easement. Progress toward achieving the Purpose will be monitored by Grantor and Grantee using inventory and other field data, assessing change on at least a decadal basis. The Multi-Resource Management Plan shall be consistent with the Purposes of this Easement and shall include at least the following elements:
    a. Grantor forest management objectives.
    b. Forest stand (treatment unit) descriptions (forest types, stocking levels before and after harvesting, soils, topography, stand quality, site class, insect and disease occurrence, previous management history, and prescribed silvicultural treatment including harvest schedules).
    c. Description of how management prescriptions will affect forest carbon pools and climate resilience and ensure increased carbon storage and sequestration on the property, including through an extension in rotation age.

E. BASELINE DOCUMENTATION

The conservation easement must refer to the baseline documentation report (BDR). The BDR should describe the current and recent timber management practices, including parameters such as typical silvicultural practices and rotation lengths for the subject property.

Recommended Conservation Easement Language:

i. WHEREAS, the specific Conservation Values of the Property are documented in an inventory of relevant features of the Property, including a description of current and recent silvicultural practices such as clear cut, patch cut, seed tree, continuous thinning or group selection forest management techniques. The data and explanatory text are presented in the Baseline Documentation Report, dated [Insert date], which consists of reports, maps, photographs, and other documentation that the parties agree to provide.

ii. WHEREAS, Grantor and Grantee have assembled an inventory of relevant features of and past and current forest management of the Property, which is maintained on file at the offices of Grantee and incorporated herein by this reference (the "Baseline Documentation"). The Baseline Documentation consists of reports, maps, photographs, management plans, forest inventories and assessments, and other documentation including a description of current and recent silvicultural practices such as clear cut, patch cut, seed tree, continuous thinning or group selection forest management techniques, that to the best of the Parties' knowledge provide, collectively, an accurate representation of the Property as of the date of the information contained in the Baseline Documentation, as further described therein, and which is intended to serve as an objective nonexclusive information baseline for monitoring compliance with the terms of this Easement. The Parties have signed the Baseline Documentation to

indicate each party's review and approval as to its accuracy to the best of their knowledge.

F. SIGNAGE

The conservation easement should allow for the use of signage to provide information about the enhanced carbon easement.

Recommended Conservation Easement Language:

i. Upon the prior written consent of Grantor, Grantee may erect and maintain a sign or other appropriate marker on the Property, visible from a public road, bearing information indicating that the Property is protected by this Easement and held by Grantee, and describing the carbon storage and sequestration taking place pursuant to the Easement. The sign may also name the funding sources for the acquisition of the Easement. The location and design of the sign shall be determined by mutual consent of Grantor and Grantee, which consent shall not be unreasonably withheld. Grantee shall be responsible for the costs of erecting and maintaining such sign or marker.

G. GRANTOR'S GENERAL RESERVATION OF RIGHTS

A provision reserving Grantor's rights that are not otherwise conveyed to Grantee and uses and activities on the property not inconsistent with the easement terms should be included in the easement.

Recommended Conservation Easement Language:

i. Grantor reserves for itself and its successors and assigns any and all rights accruing from its ownership of the Property that are not otherwise conveyed to Grantee under this Easement or prohibited hereunder and any and all uses of or activities on the Property that are not inconsistent with the terms of this Easement. Without limiting the generality of the foregoing, Grantor specifically reserves for itself and its successors and assigns the following uses and activities (together with all reserved rights, the "Permitted Uses") under this Easement.

H. FORESTRY ACTIVITIES

In addition to a general reservation of rights, the conservation easement's description of permitted uses should include a section addressing forestry activities that allows forestry activities subject to certain limitations, including requiring that forestry activities are undertaken in accordance with the Multi-Resource Management Plan. This provision should also outline required elements of the Multi-Resource Management Plan.

Recommended Conservation Easement Language:

i. Grantor may engage in, and allow others to engage in, Forestry Activities on the Property, subject to the provisions and limitations below.
   a. As used herein, "Forestry Activities" shall mean the production and harvest of timber and other forest products and all conditions and activities occurring on the Property in connection with such production, including without limitation: noise; odors; dust; fumes; operation of machinery; employment and use of labor; chemical or mechanical silvicultural treatments; the use of surface rock for road construction and maintenance activities; roadway movement of equipment and products; protection from damage by wildlife; prevention of trespass; and construction, maintenance, removal and relocation of fences, roads, bridges, culverts, ponds, drains, waterways, equipment storage sheds, landings, and similar features, provided such activities are done in full compliance with all applicable local, state, and federal laws and regulations.
   b. In undertaking Forestry Activities on the Property, Grantor shall undertake Forestry Activities on the Property in accordance with an Enhanced Carbon Easement Management Plan to ensure increased carbon storage and sequestration. It is the intent of each party to ensure forest management that is undertaken on the Property increases carbon sequestration and storage on site. It is not the intent of either party to preclude forest management on the Property in order to achieve the Purpose of this Easement, but rather to achieve the Purpose through and by use of

active forest management consistent with this Easement. Progress toward achieving the Purpose will be monitored by Grantor and Grantee using inventory and other field data, assessing change on at least a decadal basis. The Enhanced Carbon Easement Management Plan shall be consistent with the Purposes of this Easement and shall include at least the following elements:

(1) Grantor forest management objectives.

(2) Forest stand (treatment unit) descriptions (forest types, stocking levels before and after harvesting, soils, topography, stand quality, site class, insect and disease occurrence, previous management history and prescribed silvicultural treatment including harvest schedules.

(3) Description of how management prescriptions will affect forest carbon pools and climate resilience and ensure increased carbon storage and sequestration on the Property, including through an extension in rotation age.

c. Grantor shall give Grantee written notice of any timber harvest requiring a local, state or federal permit upon submittal of a permit application for such harvest, provided that failure to provide such notice shall not be a breach of this Easement.

I. STEWARDSHIP ACTIVITIES

The Permitted Uses section of the conservation easement should also include a provision allowing stewardship activities to monitor, protect and maintain the Conservation Values.

Recommended Conservation Easement Language:

i. Grantor may engage in, and allow others to engage in, any activity to monitor, protect, and maintain the Conservation Values, including but not limited to habitat restoration, enhancement, and management activities.

J. GENERAL PROHIBITED USES

The conservation easement should address prohibited uses, and include a provision addressing prohibited uses generally that includes a prohibition on uses and activities that are incompatible with the purposes of the easement. This general language should be followed by express prohibitions on certain defined activities.

Recommended Conservation Easement Language:

Grantor shall not conduct or engage in any use of or activity on the Property that materially violates any term of this Easement, and Grantor shall not permit any such use or activity by third parties except as provided in this Easement (the "Prohibited Uses"). In addition to a general prohibition against any use of the Property incompatible with the purposes of this Easement, the following uses and activities are expressly prohibited:

K. INDUSTRIAL, COMMERCIAL, AND RESIDENTIAL DEVELOPMENT AND ACTIVITIES

The conservation easement should make clear that the property must be dedicated to forest cover and prohibit inconsistent uses including industrial, commercial and suburban/residential development or activities.

Recommended Conservation Easement Language:

i. The Property shall be dedicated to forest cover. Unless allowed under Permitted Uses in Section [X], Grantor may not use the Property for industrial, commercial or suburban/residential development or activities, or for any other use that is inconsistent with the terms of this Easement.

L. DEVELOPMENT RIGHTS

The conservation easement should include a provision restricting development rights on the property, as well as restricting the transfer of those development rights to another property or used for the purpose of calculating permissible lot yield or density.

Recommended Language for a Fixed Term Conservation Easement:

i. Grantor hereby grants to Grantee for the Term of the Easement all development rights in the Property held by Grantor, except as specifically reserved herein, and the Parties agree that such rights may not be used on or transferred off of the Property, or to any other property adjacent or otherwise, or

(except as expressly permitted herein) used for the purpose of calculating permissible lot yield or density of the Property or any other property. The non-transferability of the associated development rights shall be binding on Grantor, Grantor's successors, heirs and/or assigns for the Term of the Easement.

Recommended Language for a Perpetual Conservation Easement:

ii. The development rights associated with the Property are hereby extinguished and, as a result of such extinguishment, shall not be used on or transferred off of the Property, or to any other property adjacent or otherwise, or (except as expressly permitted herein) used for the purpose of calculating permissible lot yield or density of the Property or any other property. The non-transferability of the associated development rights shall be binding on Grantor, Grantor's successors, heirs and/or assigns.

M. PROHIBITION ON SURFACE DISTURBANCE

The conservation easement should prohibit surface disturbance activities that are incompatible with the purposes of the easement. Limited mining and extraction activities, such as those that do not impact the surface, may be permitted.

Recommended Conservation Easement Language:

i. Except as otherwise permitted under this Easement, Grantor shall not conduct, engage in, or permit the commercial mining or commercial extraction of soil, sand, gravel, oil, natural gas, fuel, or any other mineral substance on the Property, using any surface mining method. Grantor may conduct or engage in mineral extraction on the Property if such extraction is not accomplished by any surface mining method and the method of extraction has a limited, localized impact on the land that does not damage, impair, or endanger the Conservation Values of the Property. No extraction permitted pursuant to this Section may occur without prior written notice to and consent of Grantee as provided for in Section [X]. Notice shall include a description of the type of extraction, the areas within which such extraction shall occur, and the anticipated impact thereof.

N. ECOSYSTEM SERVICE MARKETS ALLOWANCE/PROHIBITION

To ensure that the Grantor does not engage in double counting of generated credits, the conservation easement should limit the sale or exchange of ecosystem market credits (including carbon, wetland, species and habitat, and other ecosystem services credits) generated from the carbon sequestration or ecosystem service values associated with the enhanced carbon easement.

Recommended Conservation Easement Language:

i. For the Term of the Easement, Grantor may not sell, exchange, or otherwise participate in transactions of ecosystem market credits under other programs, including the transaction of carbon, wetland, species and habitat, and other ecosystem services credits generated from the carbon sequestration and ecosystem service values associated with the Easement.

McVickers Brook Preserve, an addition to the Schiff Nature Preserve in Morris County, NJ. © Marni Horowitz

Carbon Assessment

Extending timber harvest rotations is a widely recognized strategy for increasing carbon storage and sequestration. It is one of several strategies that together make up a suite of "Improved Forest Management" and "Sustainable Forest Management" practices recognized by voluntary and compliance carbon markets in the U.S. and globally through the United Nations Framework Convention on Climate Change[23] Allowing trees to grow longer before harvesting leads to greater biomass accumulation, which in turn stores more carbon.

Carbon accounting research from Penn State notes that delaying that delaying harvest by just five years can increase total carbon stored by up to 10%.[24] This approach is particularly beneficial in young and middle-aged forests, where trees are still growing rapidly and absorbing carbon efficiently. However, as trees mature, their rate of carbon uptake may slow, so incorporating all the biomass components is important, as well as timing extended rotations to balance carbon benefits with timber yields.

And the benefits can be found in regions across the US. Work by Mississippi State University Extension provides guidelines for estimating carbon sequestration in loblolly pines, showing how longer growth periods yield higher biomass and carbon storage. These findings show longer rotation cycles, often extending from 40 to 60 years, further increase carbon storage, especially when intermediate thinning is conducted.[25]

In the Northeast, a study analyzed different rotation lengths (40, 60, and 80 years) in Northern Hardwood Forests and found that extending the rotation from 40 to 80 years significantly increased both carbon storage in biomass and soil carbon sequestration. Forest stands with longer rotations exhibited increased biomass growth, with 80-year rotations storing up to 30% more carbon compared to 40-year rotations.[26]

Similarly, in the Pacific Northwest, a study by Ecotrust showed that lengthening harvest rotations from 40 years (a common practice) to 75 years resulted in 20–26% greater carbon storage in Washington forests and 18–25% more in Oregon forests.[27] This increase results from older trees accumulating more biomass. However, the slowing rate of carbon uptake in mature trees and the importance of soil carbon sequestration and harvested wood products should be factored into management decisions.

Forests in moisture-rich regions like the Pacific Northwest, particularly in Cascadia, have high potential for carbon storage. Research indicates that longer rotations in these areas not only enhance timber yields but also provide significant climate benefits, maximizing the region's natural carbon-storing capacity.

These findings underscore the importance of extended harvest rotations as a key strategy in forest management, playing a vital role in climate change mitigation by maximizing carbon sequestration. However, evaluating the carbon benefits of longer rotations is complex and varies across different forest types and management practices. The following section offers insights and resources available for assessing the carbon benefits linked to an Enhanced Carbon Easement.

Principles for Calculating Net Carbon Benefit

A carbon additionality assessment is a critical component in evaluating the public benefits of implementing an Enhanced Carbon Easement. Although the easement itself does not directly monetize carbon, understanding and estimating the carbon additionality achieved by purchasing restricted timber rights and expanding improved forest management practices will provide an additional assessment of value. This involves assessing how much additional carbon sequestration occurs due to extending tree growth periods beyond current market-driven harvest schedules.

As outlined by researchers, foresters, and carbon market protocols, this section identifies the key components and criteria for determining whether the carbon reductions or sequestration activities are truly "additional"—that is, whether they would not have occurred without the implementation of the project. In other words, Additionality refers to the idea that carbon sequestration or emission reductions must be beyond what would occur under business-as-usual (BAU) scenarios.

When calculating net carbon benefits of extending forest rotation lengths, multiple interconnected dynamics should be assessed to determine if additionality is occurring as a result of an extended harvest rotation. Ideally, one should consider the full carbon cycle, including wood products and post-harvest regeneration, to determine the sustainability of the carbon benefits. Carbon stored in wood products can continue to hold carbon after harvest, and forest regrowth can replenish carbon stocks. Proper accounting ensures that these dynamics are included in long-term carbon benefit assessments (US GAO).

The framework below outlines the methodology for assessing the carbon benefits of extending forest rotation periods compared to traditional timber harvest practices. Ultimately the inputs will be determined by the management protocols defined by the individual Enhanced Carbon Easement. This approach is grounded in key principles from carbon market standards and scientific research on forest carbon dynamics.

These principles provide validation for the methods used in determining additional carbon sequestration, leakage assessment, and long-term carbon storage outcomes.

1. **Baseline Scenario Modeling:** Establishing a reference scenario based on current market trends and typical forest management practices, including expected carbon sequestration without any intervention.
2. **Extended Rotation Impact:** Assessing how the lengthened harvest rotations contribute to increased carbon storage in both above-ground biomass (trees) and below-ground carbon pools (roots and soil).
3. **Additionality Criteria:** Applying rigorous standards to determine if the carbon benefits observed are directly attributable to the Enhanced Carbon Easement and not to other external factors or pre-existing conditions.
4. **Leakage and Market Effects:** Evaluating potential unintended consequences, such as increased harvesting in other areas (leakage) or market shifts that could offset the carbon benefits gained.
5. **Long-term Carbon Dynamics:** Considering the overall carbon balance over time, including post-harvest carbon storage in wood products and the regeneration of the forest, to ensure that the carbon benefits are sustained.

The baseline carbon stock assessment is a foundational step in determining the carbon sequestration potential of delaying a timber harvest. By accurately measuring the existing carbon in the forest's biomass, soil, and deadwood, and using sophisticated growth models to project future carbon stock under a BAU scenario, land managers can make informed decisions about the potential carbon benefits of changing harvest practices. This assessment ensures that any additional carbon sequestration resulting from delayed harvests is well-documented and scientifically validated.

Resources

There are several carbon analysis tools designed to help land managers, conservation planners, and forest owners assess carbon storage, sequestration potential, and emissions in forests and other ecosystems. These

tools are widely used in both voluntary and compliance carbon markets and are essential for informed decision-making. Multiple public and private tools, protocols, and resources exist for calculating net impact. These resources vary in complexity, sophistication, ease of use, and accuracy, ranging from desktop analysis and generalized projections to site-specific field verification protocols. We are not promoting a chosen/preferred methodology, but rather providing resources for users to consider when assessing the carbon benefits of an Enhanced Carbon Easement.

While each tool has its own unique modeling, there is commonality among carbon analysis tools. Each provides the ability to model and estimate carbon sequestration and greenhouse gas (GHG) emissions in relation to forest and land management practices. Here are key shared characteristics:

1. **Carbon Stock Estimation:** All three tools noted below assess the amount of carbon stored in ecosystems, particularly in forests and soils. They focus on different carbon pools, such as above-ground biomass (trees and vegetation), below-ground biomass (roots), and sometimes deadwood and litter.
2. **Scenario Analysis:** Each tool allows users to simulate various land management or forest management scenarios, such as extending harvest rotations, changing land use, or implementing conservation strategies. This helps project the potential carbon outcomes of different decisions over time.
3. **Baseline Comparison:** These tools establish baseline conditions (business-as-usual scenarios) to compare the carbon impact of new interventions or management practices. For example, COLE provides estimates based on typical forest growth, while LUCAS and FVS project how deviations from typical practices (like afforestation or delayed harvests) impact carbon sequestration.
4. **Geospatial and Regional Specificity:** They all factor in geographic variation. For instance, FVS has regional variants that tailor the model to specific forest ecosystems, and LUCAS incorporates large-scale land use changes at regional or global scales. COLE uses FIA data to ensure regionally accurate estimates.
5. **Decision Support for Policy and Management:** Many tools are designed to assist forest managers, policymakers, and conservation planners in evaluating the carbon benefits or greenhouse gas (GHG) impacts of land use decisions. By providing quantifiable carbon data, these tools help integrate climate mitigation strategies into land and resource management.

Each tool serves its purpose in slightly different contexts, but they share the overarching goal of promoting sustainable land use and forest management by evaluating carbon sequestration and GHG emissions.

Below are some of the most widely recognized carbon analysis tools:

1. FOREST VEGETATION SIMULATOR (FVS)

The Forest Vegetation Simulator (FVS) is a widely used growth and yield modeling tool developed by the U.S. Forest Service. It simulates forest growth over time based on current stand conditions, management actions, and natural processes. FVS allows users to model the effects of various forest management practices (thinning, harvesting, and planting) and natural disturbances (wildfires and insect infestations) on forest ecosystems.

2. CARBON ONLINE ESTIMATOR (COLE)

The Carbon Online Estimator (COLE) is a user-friendly, web-based tool developed by the U.S. Forest Service to help landowners, foresters, and conservationists estimate the amount of carbon stored in forest biomass. The tool utilizes data from the Forest Inventory and Analysis (FIA) program, which collects detailed information about U.S. forests. COLE is particularly useful for quick, approximate carbon assessments for specific regions or forest types.

3. LAND USE AND CARBON SCENARIO SIMULATOR (LUCAS)

The Land Use and Carbon Scenario Simulator (LUCAS) is a modeling tool designed to simulate land use changes and their impacts on carbon stocks and GHG emissions. LUCAS helps researchers, land managers,

and policymakers understand how different land management strategies affect carbon dynamics, particularly in forests, agricultural lands, and urban areas. By integrating various land use scenarios, it can project how carbon sequestration or emissions evolve over time under different policies or management actions.

In addition to these three tools, there are several others designed to be simple and adaptable for a wide range of projects related to land use and forestry.

- *EX-ACT (Ex-Ante Carbon-balance Tool)*
- *i-Tree*
- *MC2 Dynamic Global Vegetation Model (MC2)*
- *GHGenius*
- *CARBON-ERA*

For further detailed methodologies, resources such as the IPCC Guidelines for National Greenhouse Gas Inventories and the U.S. Forest Service Carbon Accounting Models can be consulted.

These tools can assist in forest management decisions, project planning, and carbon market participation by providing accurate carbon estimates and projections.

Conclusion

Carbon calculator tools are crucial for assessing the additionality of adopting enhanced carbon easements because they help quantify the incremental carbon sequestration or emission reductions that result from specific conservation actions.

A benefit of adopting an Enhanced Carbon Easement includes a less complex carbon verification process while amending business-as-usual forest practices to deliver tangible climate benefits that would not occur without the easement. This means practitioners can use existing methodologies and tools for calculating forest management benefits that are met by extending harvest rotations. This may include the use of one of the many publicly available tools or a customized analysis using site verified data, akin to how carbon credits are measured and verified. However, there is recognition of the drawbacks associated with these current tools. For example, the practical tools and methodologies for calculating these benefits are often not accessible or user-friendly to the people who would apply them in real-world scenarios, such as small forest landowners, conservation organizations, or local governments.

Several issues contribute to this challenge:

1. **Technical Complexity:** Calculating the net benefits of extended harvest rotations requires a deep understanding of forest growth models, carbon accounting, and ecosystem service valuation. Many landowners or community managers may not have the technical expertise to apply these models or interpret their results accurately.
2. **Data Availability:** Accurate calculations depend on site-specific data, such as soil type, species composition, and climate conditions. This information may not be readily available to landowners or conservation planners, making it difficult to develop precise estimates of the benefits.
3. **Tool Accessibility:** While sophisticated tools for modeling forest growth and ecosystem services exist, they are often developed for academic or governmental use, requiring specialized knowledge to deploy. Even when user-friendly tools are available, they may lack the granularity needed for specific regions or forest types, or they may not be well-publicized within the broader conservation community.
4. **Education and Outreach:** There is often a gap in outreach efforts to train landowners and managers in the use of available tools. Without sufficient technical assistance or educational programs, the benefits of extended harvest rotations may go unrealized because stakeholders are unaware of the potential or unsure how to quantify it.

Addressing these barriers will require developing more user-friendly, accessible tools, ensuring the availability of high-quality, localized data, and providing training and outreach to help landowners and managers make more informed decisions.

While the science behind the net benefits of extending harvest rotations—such as improved carbon sequestration, enhanced biodiversity, and better water quality—is well-established, the ability to translate this data into user-friendly information is still needed. This report recommends that end users consult with public agencies or carbon-modeling experts to ensure best practices are used when evaluating forest management strategies, particularly those related to carbon sequestration, ecosystem services, and economic return.

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