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INSIDE

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"Science affects the way we think together."
Lewis Thomas

DO CARBON OFFSETS WORK? THE ROLE OF FOREST MANAGEMENT IN GREENHOUSE GAS MITIGATION


Tom Iraci

Sustainably managed forests can mitigate greenhouse gases more effectively than unmanaged forests.

IN SUMMARY

As forest carbon offset projects become more popular, professional foresters are providing their expertise to support them. But when several members of the Society of American Foresters questioned the science and assumptions used to design the projects, the organization decided to convene a task force to examine whether these projects can provide the intended climate benefits. The report details reasons to look for other solutions to greenhouse gas emission challenges.

After synthesizing the latest available science, the authors challenge the underlying assumptions used to establish most carbon-trading mechanisms, including the notion that lightly managed or unmanaged forests will be more effective at sequestering carbon over long periods than would a combination of managed forests and efficiently produced wood products. They take issue with the measurement systems used to determine trading parameters and find validity in the concerns that many market experts have expressed about additionality and leakage.

Energy benefits typically are ignored in forest carbon offset projects, which promotes misunderstandings about overall atmospheric carbon flux. The authors emphasize the carbon-storage benefits of using wood products in place of nonrenewable, energy-intensive materials and using wood-based energy instead of fossil fuels. They recommend sustainable production in forests where it supports primary management objectives and assert that well-managed production forests can promote the goals of reducing carbon emissions and increasing Earth's carbon-storage capacity.

"When we use the tree respectfully and economically, we have one of the greatest resources on the earth."
—Frank Lloyd Wright

Cap-and-trade systems were originally designed to provide incentives to businesses looking for the cheapest way to meet regulatory guidelines for greenhouse gas emissions. Forest carbon offset projects have been added to various voluntary and regional cap-and-trade systems because they were assumed to be an easily verified, low-cost method of achieving global reductions in carbon emissions. As these trading frameworks become more popular, foresters are asked to provide their professional support in the form of forest inventory data, predictive models, measurement protocols, and informed opinions.

After studying carbon trades and their implications in his role as a research forester at the Pacific Northwest Research Station, Jeremy Fried became increasingly concerned that these systems were not supported by the best available science. As a leader of the Society of American Foresters (SAF) Emerging Issues Committee, in 2010 Fried strongly recommended that SAF's membership study the issue in depth, and a multidisciplinary task force was subsequently convened. The task force's findings were compelling enough that the SAF decided to print a special supplement of the *Journal of Forestry* to share the report on their findings.

The comprehensive report, published in fall 2011, summarizes recent research on forest carbon flux, analyzes the assumptions behind carbon trading protocols, and examines the wood–fossil fuel substitution effect. The assessment takes into consideration findings from the fields of forest economics, forest policy, silviculture, ecology, soil science, remote sensing, forest products, forest management, forest engineering, forest policy, and fire science. Perspectives from university researchers, federal agencies, nongovernmental organizations, and the forest products industry were represented on the task force, as was every region of the United States.

More than 200 publications and Forest Inventory Assessment statistics were cited in the report. It reviews forest carbon dynamics and enumerates the barriers to implementing trading protocols intended to reduce atmospheric carbon. Focusing on the United States market, the task force found that offset projects are highly variable and depend on numerous assumptions, most of which are susceptible to bias and "virtually insurmountable" measurement errors.

The task force also reported that carbon offsets typically use partial accounting techniques that don't fully consider the greenhouse gas mitigation benefits occurring outside of the forest. These benefits include the long-term carbon storage available in wood products manufactured in today's highly efficient mills, the life-cycle energy savings that accrue when structures are built with wood, and the renewable aspects of using biomass instead of fossil fuels for energy.

KEY FINDINGS

- Sustainably managed forests can provide greater greenhouse gas mitigation benefits than unmanaged forests while delivering numerous environmental and social benefits.
- Energy derived from burning fossil fuels releases carbon that has resided in Earth for millions of years, whereas energy produced from forest biomass results in no net release of carbon as long as overall forest inventories are stable or increasing.
- Using wood products instead of more energy-intensive materials such as steel, aluminum, plastic, and concrete provides substantial net emissions reductions. Unlike fossil fuel-intensive products that release new atmospheric carbon, wood products can store carbon for centuries.
- Modeled benefits of forest carbon offset projects depend on assumptions, including estimates of forest carbon flux, that are rudimentary and based on limited data. Significant investment would be needed to develop carbon equations for the 542 U.S. tree species that account for both tree size and tree form.

QUESTIONING THE ASSUMPTIONS

A carbon-offset transaction might go something like this: A manufacturer wants to show that it is achieving regulatory standards for carbon emissions, but it doesn't want to invest in new equipment right away or change its production methods. To gain compliance, it pays a forest owner to assume the responsibility for cancelling out a certain portion of the company's greenhouse gas emissions in the form of a carbon credit or offset. In return for a fee that has been established using calculations based on Forest Service inventory data and computer models, the landowner agrees not to cut trees on an identified parcel of forest land for, say, 100 years. Credit for 10 percent of the acreage is held back from the forest owner and goes into an insurance pool intended to cover carbon loss from catastrophic events, such as wildfire, disease, and insect epidemics, during the contract period.

Fried and the task force found several problems with the assumptions underlying this kind of trade.

First, the belief that an unmanaged forest will accumulate and retain an amount of carbon equal to or greater than that which the manufacturer is emitting over time is misguided. Although the nation's protected, unmanaged forests sequester huge amounts of carbon, the additional annual amount is small, largely due to the increasing age of the nation's forests coupled with the fact that insects, disease, and climate change are weakening forest systems, and massive numbers of trees are being killed in wildfires. Disturbances such as these release stored carbon into the atmosphere as the affected trees burn or decay.

Tom Iraci

Under current carbon-offset protocols, thinning to improve forest health or reduce fuel hazards is considered a "reversal," requiring the landowner to return a portion of the carbon-offset payment.

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Tom Iraci

Wildfires release enormous amounts of carbon into the atmosphere, some at the time of the fire, and much more in the decades that follow as fire-killed trees decompose.

"Trees do die, and at a rate that eventually reaches some kind of a stasis at a landscape level," says Fried. "In some stands, up to one hundred percent of the trees will be killed by a fire or insect outbreak; other stands continue to grow, but over the entire forest you'll eventually reach a plateau, after which the net in-forest growth and carbon accumulation rates decline—eventually to zero." Many protected forests on public lands, especially those in parks and wilderness areas, are no longer increasing carbon storage, he says.

The second problem the task force found with many carbon trades is that they may overestimate the global benefits. This is because of the way additionality and leakage are calculated at the individual project scale. Additionality describes the requirement for traders to prove that a particular offset would not have happened in the absence of the trade. "Additionality," states the task force's report "is relatively easy to establish when new trees are planted and maintained, but considerably more difficult to demonstrate when based on what did not or will not happen (e.g., 'I was going to harvest in 10 years but instead will wait 30 years')."

Leakage refers to the situation in which tree harvesting is simply shifted elsewhere. A landowner selling carbon credits may agree not to cut trees, but market demands ensure that the harvest—with its attendant carbon emissions—will be moved to another parcel of forest land owned by someone else around the globe. The task force cited econometric evidence suggesting that leakage is close to 100 percent.

Third, Fried says that the structure of the insurance pool is problematic. "One problem is that the forest credits typically used as insurance against a project failure from wildfires or insects and disease are right next door, so the insurance could burn up or be killed off along with the project," explains Fried. He says that at the current rate that California forests are burning, fire can be expected in any particular stand, on average, about every 50 to 60 years. Increasingly, such fires are stand-replacing events that cover large areas. Wildfires also are becoming more frequent and destructive in the Pacific Northwest's temperate forests.

In other words, no real guarantees can be made that carbon sequestration benefits will be reaped on any particular parcel of land for some defined period of time. Meanwhile, landowners assume considerable risk in any carbon credit deal while relinquishing the right to actively manage their forests using sustainable forestry practices.

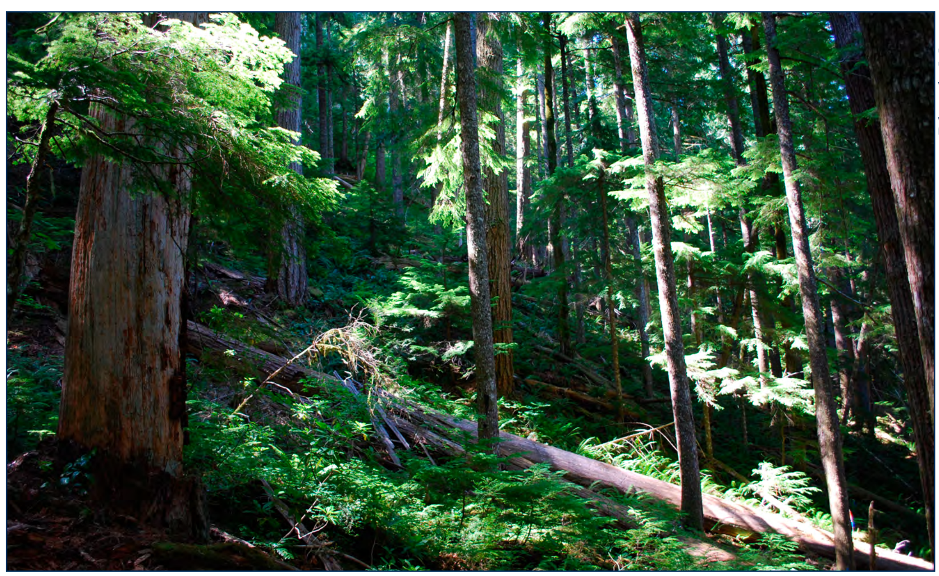
"You can't reduce your stock, even if you're just thinning to reduce your fuel hazards—that's a reduction in inventory stock, and it's considered a reversal. You'd have to pay back at least some of your carbon offset payments," says Fried. "The protocols essentially compensate only projects that reduce harvest levels. If we could make preserves and they would never grow old, blow over, or burn down, that would be great, but that's not the real world. The inescapable conclusion is that offsets really don't work."

Ultimately, the report concludes, carbon trades allow businesses to continue to pollute while providing no real benefit to the environment. "Until we have a full market that accounts for all carbon emissions, the evidence demonstrates that the current system uses biased estimates of true global benefits," says Fried.

MEASUREMENT CHALLENGES

Forest carbon occurs in many forms—in soils; standing dead trees and down logs; litter and duff; understory vegetation; and roots, branches, boles, needles, leaves, and bark of live trees. The amount of carbon in each of these "carbon pools" and the time it resides there depends on stand age, stand density, soil type, site productivity, disturbance, and management history. Climate change, fires, insects and disease, and blowdown also have considerable influence on carbon pools. Depending on the disturbance, live woody carbon is either rapidly or slowly converted to dead woody carbon and decomposition and growth rates can be dramatically influenced. All of these variables ultimately affect carbon flux—the net difference between carbon released and carbon stored in any period of time.

Tallying forest carbon with sufficient accuracy to inform carbon offset transactions would require scientifically sound estimates



Rhonda Mazza

Carbon accumulates in live and dead trees, understory vegetation, forest litter, and soil. It is released through microbial decomposition and soil respiration. Calculating carbon flux—the net difference between carbon accumulation and release—is difficult because it varies with stand age, soil type, climate, and level of management.

of woody biomass for all of the aboveground and belowground forest carbon pools. Forest stand structure, environmental conditions (e.g., topographic aspect), and stand history can profoundly influence tree form. The differences in biomass between two trees of the same species and diameter can be considerable; equations that fail to account for this will be biased (inaccurate) when applied to any particular stand.

Ponderosa pine trees growing in a sparsely stocked stand, for example, will tend to have a greater proportion of their wood in branches than in a closed-canopy stand; they will also be comparatively shorter, which will affect bole biomass. A model developed from trees sampled in closed-canopy stands and applied in an open stand would likely underpredict branch wood and overpredict height, so the landowner might not be fully compensated for the value of the carbon stored in the trees. "If you're getting paid per ton of carbon, being off by even 20 percent is a big deal," explains Fried, "and the discrepancies among the predictions of equations currently in use are often far greater."

That's not to say that today's limited carbon estimation capability isn't useful—even rudimentary estimates are helpful to those working to understand carbon dynamics and the effects of forest management on carbon pools, for example. The problem, the task force found, is that using existing carbon models to account for carbon-offset projects offers an illusion of accuracy and the potential to easily game the system through choice of models. When this occurs, the societal goal of mitigating greenhouse gases becomes secondary to extracting maximum profit from offset transactions.

"Although it is scientifically possible to build better allometric models to accurately predict carbon from tree measurements, the investment required could easily top $100,000,000. Equations would need to be developed for each tree component (bole, branches, bark, belowground) for 542 U.S. tree species, and these would need to account for not only tree size but also tree form, or its proxies: geographic variation, especially for species with large ranges, and stand density" says Fried. "That would likely require felling, drying, and weighing tens of thousands of trees."

Fried points out, however, that other policies that encourage managing forests for carbon benefits do not require such accurate accounting. Policies that encourage use of wood in place of other materials, for example, or discourage waste of wood that could be recovered for energy use, could help move toward the overarching goal of mitigating greenhouse gas emissions.

THE SUBSTITUTION EFFECT

Carbon-trading protocols miss the biggest opportunity available for mitigation because they don't factor in what happens outside the forest. The SAF task force suggests that substituting wood products for materials that require large amounts of fossil fuel to create—steel, aluminum, plastic, concrete, and other nonrenewable materials—and using biomass as a source of energy instead of gas, oil, or coal provide opportunities to reduce greenhouse gas emissions while building Earth's capacity for carbon storage.

"When the full energy benefits of harvested wood products are considered, well-managed forests typically create more total climate benefits than does any scenario intended to reduce the harvest," says Fried.

Burning fossil fuels releases carbon that has been stored in the Earth for millions of years, adding to the atmospheric load with little hope of returning it to a fossil-fuel state for millennia. In contrast, burning wood releases carbon that was stored in the relatively recent past; forests release and absorb carbon in a closed cycle that results in no net release of carbon in sustainably managed ecosystems. Many sawmills and pulp mills, for example, create their own renewable energy by burning biomass fuels—byproducts of the production process.

When trees are cut—as a result of thinning, for example—and used to produce wood products like lumber and furniture, the wood can continue to store carbon for decades or centuries. Recycling wood products increases storage longevity. Meanwhile, in a managed system, more trees can be planted or naturally regenerated to rebuild the carbon-absorption pool, and the land manager can keep the forest healthy by managing for fire, insects, disease, diversity, or other objectives.

Additionally, well-managed forests can build local and national economies, help to ensure sources of clean water, protect wildlife habitat, and provide recreational opportunities. If, on the other hand, millions of trees are killed in a wildfire, not only does the forest become a carbon emitter, the opportunity for long-term carbon storage and other social and environmental benefits is lost.

"Given the substantial carbon storage and substitution benefits that can be derived from forest products and biomass, considering only a trajectory of retaining in-forest carbon leads to inaccurate conclusions," says Fried. "An unmanaged forest is more likely to get to the point where you have catastrophic loss. As long as forests are managed sustainably, we will not be putting new carbon into the atmosphere."

Some scientists are concerned that tree harvesting for biomass production releases carbon stored in forest soils, but research cited in the SAF report found "little long-term effect" if sites are properly managed by leaving surface

Mark Nechodom

Biomass plants burn nonmerchantable harvest and mill wood residues to generate electricity. The carbon released during this process can be recaptured relatively quickly if the harvested area is replanted in trees. In contrast, returning carbon released by burning fossil fuels to its source would require millennia.

soil layers containing organic matter onsite and allowing time for regeneration.

As an active member of the Sierra Club, Fried says he understands the passion people have for forest landscapes, and he empathizes with those who never want to see trees cut. But, based on objective science, he advocates for the middle way, believing that sustainably managing forests simply makes environmental and economic sense.

"It's important to me that science be as objective as we can make it, recognizing that we all bring our own framing biases and belief systems to the table," he says. "But it's incumbent upon us to disclose them, work hard to put them aside as much as we can, and let the science tell the story as it is."

Fried and the task force are not suggesting that solely using wood-based products in place of other more energy-intensive substitutes will be enough to address greenhouse gas emissions. Rather, they suggest that serious consideration be given to the entire carbon cycle and how sustainable forestry can play a role in emissions mitigation.

Nor are they suggesting that all forests be managed.

m.o.daby design llc

Wood products store carbon indefinitely, and far less carbon is emitted during manufacturing compared to similar products made of metal, plastic, or concrete.

"There are all kinds of reasons to not manage forests and to leave them alone," says Fried. "We're recommending that where it makes sense, where objectives for forest land involve managing for products and energy, such management is compatible with carbon and climate benefits. The Europeans figured this out 10 or 15 years ago. Their carbon management is simply sustainable forestry: you grow trees, cut them, use them to make an array of products and produce energy, and grow more trees."

"Offsets are an imaginary commodity created by deducting what you hope happens from what you guess would have happened."

—Dan Welch

FOR FURTHER READING

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LAND MANAGEMENT IMPLICATIONS

- Keep forests as forests and manage appropriate forests to meet landowner objectives including carbon storage.
- Limited or "passive" management may not produce the additional in-forest carbon storage benefits desired.
- Tracking the allocation of forest carbon across live and dead trees, understory shrub and herbaceous vegetation, soils, the forest floor, forest litter, harvested wood products, and energy wood is far more difficult than conducting traditional inventories of commercially valuable wood based on bole size.
- Use objective, science-based analyses to develop climate mitigation policies and pay close attention to the assumptions and models used.
- Significant energy benefits accrue from using wood products, which commonly are underestimated or uncounted in project-based carbon offset accounting rules.
- Acknowledge the substitution effect when developing forest policy instruments; understand that it is immediate, irreversible, and cumulative.

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