THE GREAT AMERICAN STAND

US FORESTS AND THE CLIMATE EMERGENCY

Why the United States needs an aggressive forest protection agenda focused in its own backyard

DOGWOOD ALLIANCE

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EXECUTIVE SUMMARY

Standing forests are the **only proven system** that can remove and store vast amounts of carbon dioxide from the atmosphere at the scale necessary to keep global temperature rise below 1.5 degrees Celsius this century. It is therefore essential to not only prevent further emissions from fossil fuels, deforestation, forest degradation, and bioenergy, but also to expand our forests' capacity to remove carbon from the atmosphere and store it long-term.

If we halted deforestation, protected existing forests, and expanded and restored degraded forests, we could reduce annual emissions by 75 percent in the next half a century. If fossil fuels were rapidly phased out during this same time period, we could reduce the amount of carbon in the atmosphere, meet the goals of the Paris Agreement and avoid catastrophic climate change. But, we cannot solve the climate crisis without a major scale-up in forest protection and restoration across the planet. We must not only protect remnant primary, intact forests, but also conserve and restore less pristine landscapes. Yet, to date, forest protection commitments and funding are too narrowly focused on tropical forests.

The United States is home to some of the world's greatest forests. Spanning from the temperate rainforests of Alaska and the ancient redwoods of California, to the mixed-mesophytic forests of Appalachia and the cypress tupelo forests of the coastal South, American forests are among our nation's most valuable natural assets. From removing carbon from the atmosphere and storing it to providing natural flood control, stabilizing fresh water supplies, and protecting the greatest diversity of wildlife and plants on the planet, our health and well-being are integrally tied to the ecological health of our forests.

Over the span of more than a century, an estimated 99 percent of the nation's "frontier forests"—large, contiguous virgin forests with all species intact— have been lost across the lower forty-eight states. During the same period, the United States has emerged as the world leader in commercial logging, currently producing and consuming more wood products than any other country. Though trees can live to be hundreds, even thousands, of years old, less than 15 percent of U.S. forests are older than one hundred years. Tens of millions of acres of natural forests have been replaced with monoculture commercial tree plantations. Meanwhile, as the threat of catastrophic climate change grows, the value of old, intact, standing natural forests and the climate-stabilizing services they provide are more critical than ever.

In spite of the growing need to accelerate protection and restoration of forests, government policies and forest markets are still largely stuck in the past, driving the replacement of diverse natural forests with single-species tree plantations, characterizing non-merchantable trees as "low value" or "waste wood" and measuring sustainability largely in terms of a continuous supply of forest products to commercial markets. The United States has yet to acknowledge forest degradation from logging, nor has it stepped up to protect and restore forests' diminished ecological functioning across large landscapes.

Since the Industrial Revolution, society's energy use has pumped increasing amounts of carbon dioxide into the atmosphere. At the same time, destroying forests for development and agriculture, and consuming ever-increasing amounts of wood products has contributed to the high concentrations of carbon dioxide currently in the atmosphere. Equally as important, but often overlooked, forest loss and degradation continue to significantly compromise the ability of our forests to help stabilize the climate. Yet, climate strategies in the United States ignore this important function of forests, and policies are too narrowly focused on only one important aspect of the climate equation—reducing emissions from fossil fuels.

The rate and scale of commercial logging for wood, pulp and paper, and fuel in the United States is preventing critical progress toward solving the climate crisis. Our current national greenhouse gas reporting system perpetuates the status quo by failing to provide information necessary to assess the impacts of forestry practices on the climate. As a result, forest protection and restoration in the United States has been largely ignored as a climate imperative while accelerated logging is often proposed as a climate solution. For example, in just the past several years, the U.S. South has become the world's largest exporter of wood pellets to Europe, where they are burned to generate electricity in place of coal. This new market is driving increased logging of ecologically important forests. Meanwhile, burning wood for electricity releases up to 50 percent more carbon dioxide than burning coal per unit of electricity generated.

Forest protection in the United States has been largely ignored as a climate imperative while acelerated logging is often proposed as a climate solution.

Failing to acknowledge the need to scale up forest protection will thwart our ability to effectively avoid catastrophic climate change. Simply put, we cannot "log" our way out of the climate crisis, and substituting wood in place of fossil fuels for energy will move us away from a climate solution. Key findings of this report include:

- The United States reports that our nation's forests are removing an estimated amount of carbon dioxide out of the atmosphere equivalent to roughly 13% of annual emissions, far less than global average of 25%.
- Though the EPA does not report emissions from logging in its annual greenhouse gases inventory, a study published in 2016 calculated that **carbon emissions from logging from 2006 to 2010 averaged 162 +/- 10 Tg/year (equal to 584 MMT of CO2), an amount greater than fossil fuel emissions from the residential and commercial sectors combined** as reported in the latest EPA Greenhouse Gas Inventory Report: 1990-2014.
- Logging accounts for 85% of emissions from U.S. forests, more than five times the emissions from conversion, fire, wind, insects and tree mortality combined.
- Logging is diminishing the net U.S. forest carbon sink by at least 35%. If soil emissions associated with logging were counted, this number would be significantly higher as many forests would shift from being characterized as net carbon sinks to net emitters.

The international framework used by the United States for reporting carbon emissions from forests is masking emissions from logging, over-representing the extent of U.S. forest climate mitigation benefits and enabling the world's largest forest industry to avoid accountability for climate impacts.

- Burning trees in place of fossil fuels for energy will accelerate, not reduce, carbon emissions while also degrading forests' ability to provide critical climate mitigation and other ecosystem services.
- Efforts to characterize bioenergy or other wood products as "carbon neutral" are not only inaccurate, but irrelevant. "Carbon neutrality" is not good enough because concentrations of carbon dioxide in the atmosphere must decrease rather than remain constant over time.
- More than half of the carbon lost through deforestation and harvesting in the United States from 1700 to 1935 has yet to be recovered from the atmosphere. Reports that forests are "offsetting" fossil fuel emissions are therefore misleading since forests are not, nor can they, offset emissions from fossil fuels when they have yet to offset past emissions from forest loss and degradation.

- Carbon dioxide emissions from logging are not measured or reported the same as other sources of emissions. Instead, all forest emissions are essentially reported as "offset" by annual forest growth, masking critical information necessary to inform climate policy.
- Reports that U.S. carbon stocks have grown in the past several years rely in part on tree plantations and wood products, neither of which are capable of storing carbon long-term. Combining short-term and long-term carbon stores as if they were comparable is misleading and overestimates the role of forests in keeping carbon out of the atmosphere.
- Ongoing degradation of forests from logging compromises critical ecological functions, such as water storage and natural flood control, which buffer our most vulnerable communities against the worst effects of natural disasters.
- Natural disasters, which threaten the well-being of our communities, cost billions of dollars annually, with the Unites States suffering two of the most costly disasters in the world in 2016. These are threats that could be mitigated and costs that could be reduced by expanding protection for forests along rivers.
- Government incentives for bioenergy and other forest products must be replaced with payment for the ecosystem services provided by standing forests. This will require new government and corporate policies that incentivize and help to fund the protection of forests.

We need to invest in protecting and restoring intact, old forests across large landscapes for carbon storage, flood control, water purification, and biodiversity. Treating forests as an unlimited, renewable, extractable commodity that can support infinite growth in the forest products industry is an outdated business model that must yield to a new way of doing business that values standing forests. A major transformation in the forest economy is necessary so our consumption of wood products is brought into alignment with the ecological limits of forests, and the critical climate stabilization and other life-supporting functions they provide.

We can solve the climate crisis by scaling up forest protection while we rapidly drive down emissions from fossil fuels and transition toward clean, renewable energy sources, such as solar and wind. Achieving the scale of forest protection and restoration needed over the coming decades may be a challenging concept to embrace politically; however, forests provide a proven means for atmospheric carbon removal and sequestration that can operate at the necessary scale and time frame to keep the world from going over the climate precipice. Forest protection, restoration and expansion must therefore become a top priority in America's climate agenda.

Treating forests as an unlimited, renewable, extractable commodity that can support infinite growth in the forest products industry is an outdated business model.

BACKGROUND AND CONTEXT

The primary driver of global climate change is increasing levels of heat-trapping gases present in our atmosphere.[1] Human activities, including combustion of fossil fuels and bioenergy, forest loss and degradation, other land use changes, and industrial processes, have contributed to increasing atmospheric carbon dioxide, the largest contributor to global warming, which will cause temperatures to rise and stay high into the next millennium or longer.

The most recent measurements show the level of atmospheric carbon dioxide has reached 400 parts per million and will likely to remain at that level for millennia to come.[2] This makes meeting the temperature limiting goal of 1.5 degrees Celsius in the historic Paris Climate Agreement even more challenging. Even if all fossil fuel emissions were to cease and all other heat-trapping gases were no longer emitted to the atmosphere, temperatures close to those achieved at the emissions peak would persist for the next millennium or longer.[3]

It is therefore essential to prevent greenhouse gas emissions from deforestation, forest and soil degradation, as well as from warming soils and thawing permafrost. In addition, we must simultaneously increase Earth's natural capacity to remove and store carbon. In fact, meeting the goals of the Paris Agreement now requires the implementation of strategies that result in negative emissions, i.e., extraction of carbon dioxide from the atmosphere.[4] In other words, we need to annually remove more carbon dioxide from the atmosphere than we are emitting and store it long-term.

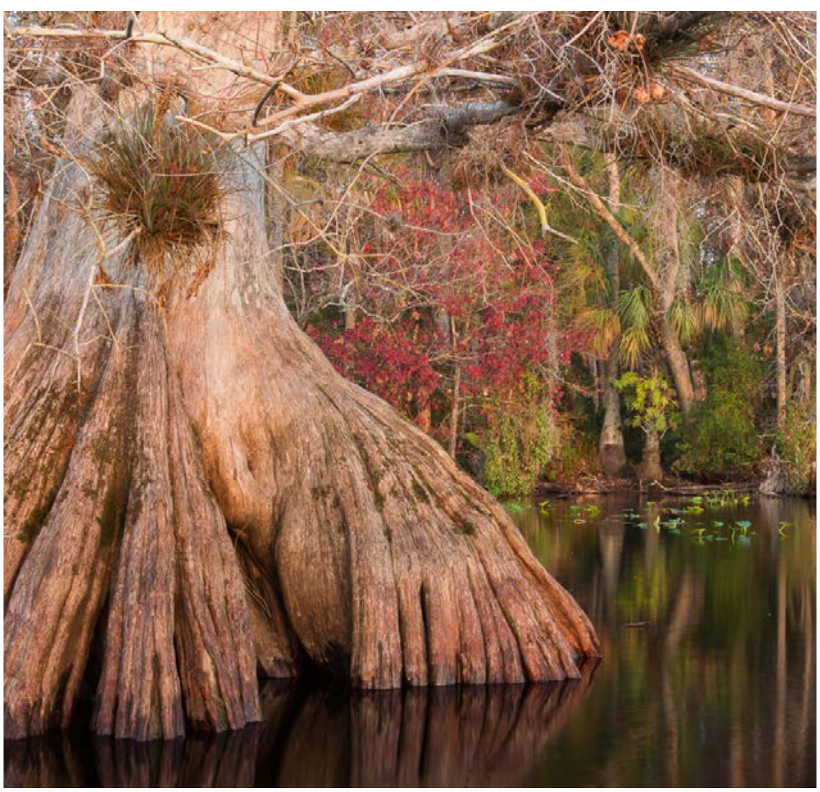
Forests and soils are the only proven techniques that can pull vast amounts of carbon dioxide out of the atmosphere and store it at the scale necessary to meet the Paris goal. Failure to reduce biospheric emissions and to restore Earth's natural climate stabilization systems will doom any attempt to meet the Paris (COP21) global temperature stabilization goals.

This means we must go well beyond protecting what is left of the world's remaining intact forests. Solving the climate crisis will require a major forest protection and restoration effort focused on leaving significantly more forests across the planet standing. This includes forests in the United States, which are the largest producers of industrial timber and some of Earth's most carbon-dense forests.[5,6]

Although, understandably, much of the focus around climate change in the United States has been placed on reducing fossil fuel emissions, anthropogenic forest destruction and degradation here at home continue to disrupt forests' ability to pull significantly greater amounts of carbon out of the atmosphere and store it long-term. Conserving and restoring forests, an essential piece of the climate solution puzzle, is often misconstrued or ignored in the United States.

The most recent U.S. report of greenhouse gas emissions states that our forests currently "offset" 11 to 13 percent of total U.S. annual emissions. That figure is half that of the global average of 25% and only a fraction of what is needed to avoid climate catastrophe. And while the U.S. government and industry continue to argue that we need to increase markets for wood, paper, and biofuel as climate solutions, as this report lays out in more detail, the rate, scale, and methods of logging in the United States are having significant, negative climate impacts, which are largely being ignored in climate policies at the international, national, state, and local levels.

The United States has yet to acknowledge the extent of forest loss and degradation here at home or to fully integrate an aggressive forest protection, restoration, and sustainable management agenda into its climate strategy. We must come to terms with the fact that continued loss and degradation of U.S. forests will make it impossible to meet internationally agreed upon temperature and climate goals. We must change course.



Conserving and restoring forests, an essential piece of the climate solution puzzle, is often misconstrued or ignored in the United States.

FORESTS AS A CLIMATE SOLUTION

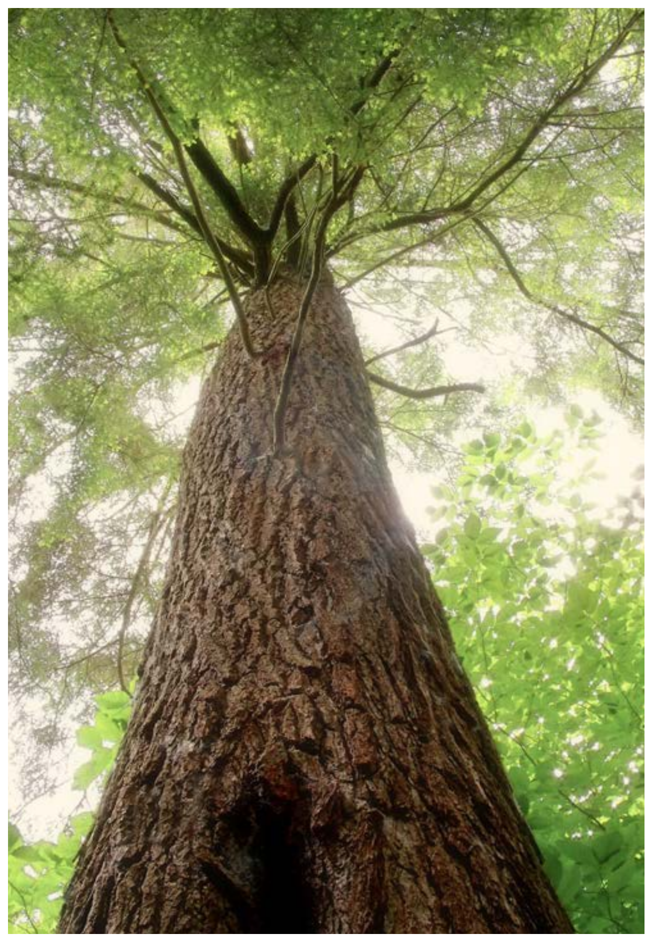
In 2011, the amount of carbon in the atmosphere totaled 828 BMtC (billion metric tons of carbon), or 390 ppm. Today concentrations exceed 850 BMtC and 400 ppm. Concentrations of carbon dioxide have increased 45 percent since preindustrial times. It is estimated two-thirds of the emissions since 1750 came from fossil fuel combustion, while one-third came from land and forests.

An estimated 7.8 BMtC (billion tons of carbon per year) come from fossil fuels and cement manufacturing, and 1.1 BMtC come from land use changes, mostly deforestation for agriculture.[7] Forests and other ecosystems have been removing carbon dioxide from the atmosphere for over 300 million years. Forests and other plant communities currently remove an estimated 2.6 BMtC and store it in plants and soils. Oceans remove another 2.3 BMtC. These natural systems are tried and true. Since human society emits approximately 8.9 BMtC, this means that net additions are roughly 4.0 BMtC.[7] Globally, if we halted deforestation and land degradation, this figure would drop to just 2.9 BMtC.[7] Protecting and expanding forests and restoring degraded forests and soils could pull an additional amount of carbon out of the atmosphere that could reduce this number to just 1 BMtC/yr over the next half a century.[8] Depending on how aggressively fossil fuel emissions are also phased out, it could be possible to decrease this number to zero or actually reduce the concentrations of carbon in the atmosphere over the next half century.[8] Were we to do so, concentrations of carbon dioxide in the atmosphere would decrease significantly, and we might have a chance of meeting the Paris temperature goals.

Forest protection and restoration emerged as a key strategy in the Paris Agreement for addressing climate change. Article 5 in the Paris Agreement identifies the importance of forests.[9] However, to date, global efforts are too narrowly focused on targeting tropical forests for protection and restoration. Moreover, the models developed pursuant to the Paris Agreement for achieving negative emissions do not emphasize protecting existing forests and restoring lost and damaged ones. Instead the models used to forecast future emissions assume the replacement of coal with bioenergy from forests to fuel electric power stations and to capture and store the carbon dioxide underground (aka Bioenergy Carbon Capture and Storage, or BECCS).

Multiple scientific reports have thus concluded that a scale up in the removal and storage of carbon by forests around the world, including in temperate and boreal forests, is critical to achieving the goals as set forth in the Paris Agreement.

First of all, this technology does not exist today, and even if it did, the large amount of energy needed to remove, capture, and store carbon dioxide from the power station would require building an additional power plant for every two or three existing ones. This would require the cutting and burning of 33 to 50 percent more trees, further diminishing our forests. As recent research demonstrates, this technology is highly unlikely to be economical and at scale by the time it is needed in 2030.[10, 11]



Standing forests, on the other hand, have proven potential to remove and store vast amounts of carbon. Multiple scientific reports have thus concluded that a scale up in the removal and storage of carbon by forests around the world, including in temperate and boreal forests, is critical to achieving the goals as set forth in the Paris Agreement.[12]

In addition to removing carbon from the atmosphere, increasing forest protection has also been widely acknowledged as critical to ensuring climate resiliency for forests and people. In fact, Earth's climate, flood control, and water supplies are all regulated to a large extent by the planet's vast forests. At a time when droughts and floods are becoming more frequent and intense, protecting our forests is one of the smartest investments we can make to become more resilient to the irreversible effects associated with current levels of carbon dioxide in our atmosphere.

Yet, to date, the forest protection commitments, funding, and policies developed in response to climate change have been largely focused on reducing emissions from deforestation and forest degradation (e.g., "REDD+," New York Declaration on Forests) in the tropics. And while vast amounts of carbon are stored in tropical rainforests annually and they are under tremendous threat, it is critical that we broaden our efforts by accelerating forest protection across the world, including here in the United States. Second, while we must stop deforestation, we must also significantly reduce the degradation of forests from industrial-scale logging for paper, lumber, and fuel. In fact, a recent report found that in tropical forests, degradation could be as severe a problem as deforestation when it comes to carbon emissions.[13] No similar analysis has been conducted relative to the degradation of forests in the United States, though logging rates in the United States are the highest in the world.

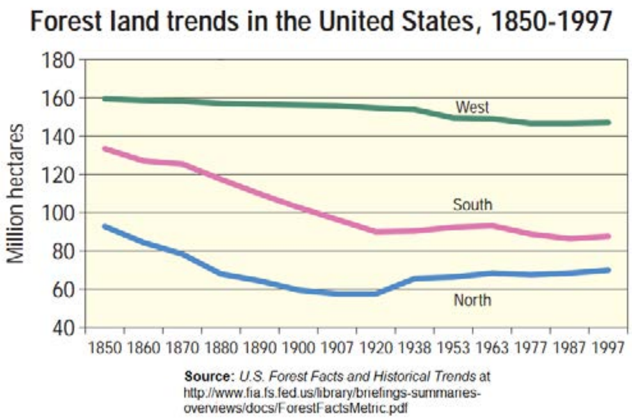
FOREST LOSS AND DEGRADATION IN THE UNITED STATES

For eons, natural forests have played a significant role in regulating our atmosphere and stabilizing Earth's climate by removing massive amounts of carbon dioxide from the air. Exploding human populations combined with new technologies that have enabled the industrial-scale production and consumption of forest resources have destroyed and degraded vast amounts of Earth's forests, releasing billions of tons of carbon dioxide into the air while simultaneously reducing forests' climate stabilization capacity. Around the world, only about 32 percent of Earth's original, primary forests remain undisturbed by humans.[14, 15]

Since the Neolithic revolution reached forested Europe, humans have been cutting forests for agriculture and other needs. When Europeans reached North America, forests stretched unbroken from the East Coast to Kansas. It is claimed that a squirrel could travel through the trees from Boston to the Mississippi River without once touching the ground. Between 1607 and 1910, virtually the entire eastern United States was converted from forest to farmland, denuded for timber and forest products, and cleared for new homes and forts. Human expansion out West had similar impacts on forests.

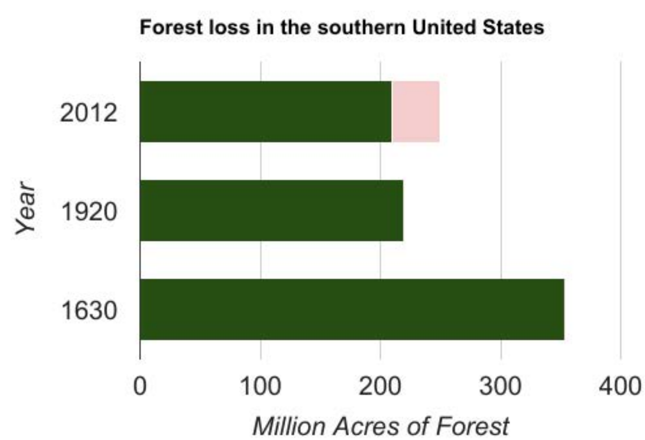
In the continental United States, estimates of the loss of primary, original forests range from 85 to 90 percent with as little as 1 percent remaining in the southeastern region.[16 - 18] Only about 5 percent of California's original coastal redwood forests remain.[19] According to the World Resources Institute, less than 1 percent of "Frontier Forests"—large, contiguous virgin forests with all the species intact—still exist in the lower forty-eight states.[20]

Though many acres of forests in the United States have regenerated and for the last one hundred years forest acres have been relatively stable, the extent of forests is only 70 percent of what it once was, (62% if tree plantations are not counted[21]) and our remaining forests do not possess the same degree of ecological integrity they once had.[22] As a result, U.S. forests are no longer the vast, complex, highly-functioning climate-regulating systems they once were, having lost significant climate stabilization capacity. In fact, in the United States, 60 percent of the carbon lost through deforestation and harvesting from 1700 to 1935 has not yet been recovered.[23 - 26]



Recent reports state that U.S. forests remove an amount of carbon dioxide from the atmosphere equivalent to about 13 percent of the nation's human-made carbon dioxide each year. Often this figure is used to underscore the positive role the nation's forests play in addressing climate change. However, globally, it is estimated that forests pull an amount of carbon from the atmosphere equivalent to 25 percent of anthropogenic emissions, almost double that of U.S. forests. It is also frequently reported that U.S. forests are "offsetting" roughly 13% of fossil fuel emissions.[14, 27] However, the reality is that forests in the United States are still operating at a carbon deficit, as forest growth has yet to absorb emissions from past forest loss and degradation.

Threats to U.S. forests have not yet ceased. Forests are threatened by the changing climate, which in some regions is producing drought and increasing tree mortality. Industrial-scale utilization and land use change continue to destroy and degrade forests and their multiple ecosystem services. U.S. forests produce about 28 percent of the world's wood pulp and 17 percent of roundwood, more than any other country in the world.[28] The United States is also now the world's largest manufacturer and exporter of wood pellets as an alternative to coal for generating electricity in Europe, placing added demands on a resource already under stress. Yet, ironically, government and industry in the United States often promote the logging of forests on both public and private land as a climate solution, ignoring the imperative to accelerate forest protection and restore degraded ecosystems.



Though many point to recent gains in forest acreage as promising, the truth is that plantations make up much of those gains in the Southern US (pink represents plantations/ green natural forests)

FOREST EMISSIONS ACCOUNTING AND REPORTING

According to the latest IPCC Assessment Report, humans currently emit about 9.9 BMtC of carbon as carbon dioxide each year. This includes an estimated 1.1 BtC/y from land degradation including deforestation. However, as set forth in more detail below, current accounting for forest carbon is masking emissions from the forestry sector and perpetuating the idea that markets for wood are helping to solve the climate crisis.

There are several significant issues with the current global forest carbon calculation protocols associated with Land Use and Land Use Change (LULUC) as defined by the U.N. Framework Convention on Climate Change (UNFCC) and used by the U.S. government in reporting national greenhouse gas emissions from forestry. This report is not intended to be a thorough critique of the details of IPCC LULUC standards as implemented by the United States in its annual greenhouse gas inventory. However, issues with the overarching framework raise some important questions about whether current reports on emissions from land use are missing important climate impacts from logging and in doing so are presenting an inflated view of the positive role that U.S. forests are playing in mitigating climate change.

The first issue lies in the lack of consistent definitions and approaches that can be applied by policy makers. According to an IPCC guidance document for governments, flexibility related to choosing an approach, the baseline year against which to report and how a country decides to define "deforestation" and "regeneration" are variables that can yield very different results.[29] This flexibility has operated to the benefit of countries (such as the United States) that have already destroyed and degraded much of their primary and intact forests and replaced them with large areas of fast growing plantations and even natural forests dedicated to supplying commercial forest markets. For example, the net-net approach used by the United States to calculate and report emissions from the land sector under UNFCC framework and IPCC guidance has been criticized as:

"…favoring a country whose forests are young and growing, due to for example, intense harvesting prior to the commitment period, net-net accounting will deliver a better outcome. These countries can increase their number of accounted credits during the commitment period from removals by their young growing forests. A country that has large areas of primary or mature forest would suffer under net-net method, as any harvesting will produce debits with few credits generated until subsequent commitment periods."[30]

For example, the United States is currently reporting land use emissions based on annual change in carbon stocks against a 1990 and 2005 baseline. The effect is to completely ignore over a century of deforestation and degradation in the United States that resulted in massive quantities of carbon dioxide emissions while taking credit for any gains in forest growth as well as for the rapid annual rate of uptake from fast growing younger stands that have replaced large stores of carbon in old forests.

This results in a double standard where the United States is not accountable for significant, past emissions from forest loss and degradation, which contributed to the high concentrations of carbon currently in the atmosphere. Meanwhile, Indonesia, for example, which is undergoing the conversion of tropical forests to fast-growing palm oil plantations, is held accountable. The United States counts the conversion of natural forests to plantations as "reforestation" and "forests remaining in forests." Meanwhile, in Indonesia, the replacement of rainforests with palm oil plantations is often referred to as "deforestation."[31]

The United States reports a net growth in carbon stocks for the past several years. Many erroneously point to this as evidence that U.S. forests are increasing their capacity to remove carbon dioxide from the atmosphere and store it long-term. However, long-term and short-term carbon storage is not adequately delineated in the accounting process.

THE GLOBAL DOUBLE STANDARD

When farmers burn forests for palm plantations in Indonesia, it is deforestation -- but when landowners clearcut forests in the US for pine plantations, it is sustainable? Somehow, crossing country lines changes the meaning of landscape-wide degradation.

For example, no distinction is made between fast-growing plantations even though these forests are not actually going to store carbon long-term, and the total stored per acre is, in many cases, less than in the native forests that were displaced. This is important because measuring Earth's natural capacity to not only absorb carbon dioxide from the atmosphere, but also to store it long-term, is as critical as measuring annual emissions or annual changes in carbon stocks.

Yet, the current accounting system fails to account adequately for differences in the longevity and resilience of carbon stocks, focusing instead on estimating carbon stored on an annual basis and the annual rate of atmospheric carbon dioxide removal. This approach fails to adequately reflect the climate impacts associated with the conversion of natural forest to highly managed plantations.[32, 33] Though the rate of carbon accumulation is high with fast-growing, young plantation trees, the total stock of stored carbon is significantly lower than in an older natural forest.[32] In addition, plantations and even fast-growing trees in natural forests for commercial production do not store carbon long-term since the majority of the carbon in a forest managed for commercial production will be re-released into the atmosphere if a substantial amount of the forest biomass is removed during harvest (i.e.,clear-cut).

One study found that in the United States, on average, 40 percent of the carbon stored in trees is lost as residuals left behind after harvest. Of the 60 percent of the trees that end up in wood products, only a portion of that ends up in a product, with the remainder lost as mill waste. Of the remaining portion of the trees ending up in wood products, only 1 percent of carbon remains in forest products in use, and only 13 percent of the carbon is contained in landfills 100 years after harvest.[34]

Thus, the actual carbon stored long-term in harvested wood products represents less than 10 percent of that originally stored in the standing trees and other forest biomass. If the trees had been left to grow, the amount of carbon stored would have been even greater than it was 100 years prior. Therefore, from a climate perspective, the atmosphere would be better off if the forest had not been harvested at all. In addition, when wood losses and fossil fuels for processing and transportation are accounted for, carbon emissions can actually exceed carbon stored in wood products.[34] While there is nothing inherently wrong with counting the carbon stored in wood products on an annual basis, it is important to recognize that wood products represent a depreciating climate asset versus a standing tree that appreciates in climate value over time.

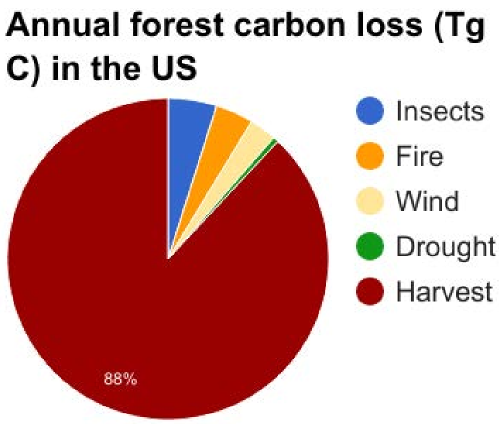
Failure to recognize the difference between long-term carbon stocks that will continue to increase the amount of carbon absorbed and stored and those that are short-lived is analogous to a company presenting short-term, expendable and depreciating assets as evidence of its long-term financial health. Presenting accounting in this way makes it impossible to ascertain the actual growth in long-term wealth versus growth in income that will be offset by future expenses or assets that will depreciate over time. This is critical as we need to focus on both increasing carbon uptake through forests and keeping it out of the atmosphere long-term.

It is also frequently asserted that as long as carbon stocks are expanding, there is no cause for concern. Earlier this year, Professors Mark Harmon and Bev Law of Oregon State University wrote the following in a letter to members of the U.S. Senate in response to a bill introduced that would essentially designate the burning of trees as carbon neutral:

"The [carbon neutrality] bills' assumption that emissions do not increase atmospheric concentrations when forest carbon stocks are stable or increasing is clearly not true scientifically. It ignores the cause and effect basis of modern science. Even if forest carbon stocks are increasing, the use of forest biomass energy can reduce the rate at which forest carbon is increasing. Conservation of mass, a law of physics, means that atmospheric carbon would have to become higher as a result of this action than would have occurred otherwise. One cannot legislate that the laws of physics cease to exist, as this legislation suggests."[35]

A recent study, published in 2016, underscored this point, finding that carbon emissions from logging from 2006 to 2010 averaged 162 +/- 10 Tg/year (equal to 584 MMT of CO2), an amount greater than fossil fuel emissions from the residential and commercial sectors combined as reported in the latest EPA Greenhouse Gas Inventory Report: 1990-2014. This same study found that carbon loss from forests reduced the potential forest carbon sink in U.S. forests by 42 percent. Logging accounted for 85 percent of carbon lost from forests, more than five times conversion, natural disturbances and tree mortality combined. Logging forests therefore actually reduced the potential of the U.S. forest carbon sink by over one-third or approximately 35 percent.[12] Though already significant, this number as well as the numbers above related to emissions, would be substantially higher if soil emissions from harvests were counted.

Across all forest products, from 2006 to 2010 the production of pulpwood resulted in the highest forest carbon losses12. In addition, the processing of wood into paper is energy-intensive, resulting in significant, additional carbon and other greenhouse gas emissions.



Multiple studies warn that carbon emissions from soil due to logging are significant, yet under-reported. One study found that logging or clear-cutting a forest can cause carbon emissions from soil disturbance for up to fifty years.[36, 37] Ongoing research by an N.C. State University scientist studying soil emissions from logging on Weyerhaeuser land in North Carolina suggests that "logging, whether for biofuels or lumber, is eating away at the carbon stored beneath the forest floor."[38] If soil emissions were accounted for based on measuring carbon inputs and outputs versus change in stocks, it could significantly magnify the amount emissions reported by the United States from logging and fundamentally shift the status of many acres of forests from a net sink to a net emitter.

The process of net accounting also assumes emissions from logging are "offset" by carbon being absorbed by forest growth. Yet, forests would be absorbing carbon regardless of logging activity and do not selectively remove carbon dioxide that was released from forest harvesting and burning. They remove carbon dioxide from all sources in proportion to their size. Forest growth in one place does not therefore negate emissions in another.

Forest-based "offsets" of carbon emissions in current accounting protocols focused on regulating land-based offsets are active processes requiring independent verification and documentation that forest growth is "additional," meaning that it would not have occurred otherwise, and "permanent," meaning measures are in place to ensure that the carbon will remain in the forest and not be lost through subsequent conversion to another use or through degradation. For example, carbon offsets from forestry projects under REDD+ (Reducing Emissions from Deforestation and Degradation) require action to protect forests above and beyond "business as usual." The same is true for forest-based offsets under the California Global Warming Solutions Act.

Reporting that forest emissions are de facto offset by forest growth without the kind of verification and validation required for forest-based offset projects has the effect of giving the forest industry a free pass on emissions. That there are emissions associated with logging is indisputable; yet, in the United States annual greenhouse gas inventory report of annual emissions, these emissions are not transparent and instead are masked by net reporting. Meanwhile, a recent study of carbon emissions from logging in Oregon documented that the state's faulty net carbon accounting resulted in millions of tons of carbon emissions left unaccounted for, several times greater than the emissions from the state's coal burning power plant.[39]

MASKING EMISSIONS FROM BIOENERGY

Currently, carbon emissions from burning wood pellets to produce electricity in are counted as zero under E.U. climate policy, even though burning wood releases more carbon dioxide into the atmosphere per kilowatt hour than burning coal.[40 - 43] This policy flaw, which relies on emissions to be calculated as a land-use change (as per the section above), has resulted in the accelerated destruction and degradation of forests in the U.S. South as large power plants in Europe transition away from coal to wood. Forests, including mature, coastal wetland forests in the U.S. South, are being cleared to produce wood pellets for European power plants. The International Energy Agency predicts that there will be a threefold increase in global forest-based bioenergy by 2050.[44]

There are many preferable energy alternatives to fossil fuels that can reduce carbon emissions and other pollutants and that are much more energy efficient, including solar and wind. There are several scientific reasons why bioenergy is neither carbon neutral nor climate friendly:

1. A tree will burn in a matter of minutes to produce electricity. But it takes up to a century for a new tree to absorb a comparable amount of carbon. During this regrowth period, there is more carbon in the atmosphere, which contributes to increased warming, melting of glaciers, release of greenhouse gases from thawing permafrost, and increased ocean acidification. The added warming from burning trees occurs instantly, but the effects do not reverse themselves for centuries, if ever.

2. All plant material releases slightly more carbon per unit of heat produced than coal. Because plants produce heat at a lower temperature than coal, wood used to produce electricity produces up to 50 percent more carbon than coal per unit of electricity.[40]

3. Some argue that the absorption of emitted carbon dioxide upon burning wood as a fuel is instantaneous when measured over a "landscape." In other words, if one draws a sufficiently large boundary around a forested area, other growing trees absorb an equal amount of carbon. But, these trees do not selectively recognize the molecules released from burning wood, which would be a remarkable achievement!

4. This argument is extended to state that as long as trees absorb more carbon somewhere on the landscape than is being emitted from forest losses, the emission from burning wood are carbon negative. In fact, a major power station in the U.K. makes the claim that as it burns wood releasing vast amounts of carbon dioxide, it is somehow simultaneously removing this gas from the atmosphere.[45]

5. Carbon is either in trees and soils, or in the ocean or the atmosphere. It does not magically vanish because a tree somewhere else is growing. Other trees are already absorbing carbon dioxide from the atmosphere. Whenever more carbon dioxide enters the atmosphere, it immediately begins absorbing heat. This leads to real consequences including melting glaciers and ice caps, sea level rise, and feedback emissions of carbon dioxide and methane from permafrost thawing. Glaciers do not reform, and gases released from thawed permafrost are not immediately reabsorbed by soils just because a tree has regrown after many decades. It takes a long time for the consequences of warming to be reversed.

6. Forests do not absorb carbon from "new" emissions. They absorb carbon from the large reservoir of past emissions both natural and manmade, including past forest loss, and soil degradation from land use change for agriculture, logging, wildfires, etc. This is just like a bank account where the money you withdraw is from the balance on hand, not from the most recent deposit or just from the deposit from accumulated interest or a paycheck or birthday gift.

7. Once living trees are removed, new saplings do not absorb as much carbon as the older trees until many decades pass.[46] Since there is no requirement that trees be replanted and allowed to mature, there is no guarantee that the carbon released will ever actually be reabsorbed and stored.

8. An additional amount of carbon dioxide is released from soils when trees are harvested, and more soil carbon may be lost from erosion.[36]

9. Trees are harvested, dried, and transported using fossil fuels. These emissions add about 20 percent or more to the carbon dioxide emissions associated with combustion.[47, 48]

10. The IPCC recommends that emissions from bioenergy (life-cycle analysis accounting for "upstream" and "downstream" emissions) be listed as land use changes rather than from the energy sector. This limitation results in emissions disappearing from the ledgers, especially when the fuel is from forests in one country, but it is burned in another.

11. It takes a forest to fuel a power plant. An analysis done for the U.S. Forest Service on the amount of wood required to replace coal for a 500 MW coal plant in the Pacific Northwest would require clear-cutting 100,000 acres of poplar each year. Even these fast-growing trees would be unable to keep up a replacement rotation on 1 million acres that would need to be cut to fuel the plant for ten years.[37, 49]

12. The COP21 agreement in Paris identified Bioenergy Carbon Capture and Storage (BECCS) as a potential pathway for emissions reductions from bioenergy. Hypothetically, BECCS captures some fraction of the emitted carbon dioxide from wood combustion, creating a net decrease in atmospheric emissions. This technology only exists in pilot stages and is so inefficient that it requires an additional power plant for every two or three producing electricity. On the other hand, standing forests are a proven, efficient, and cost-effective technology for capturing and storing carbon.[10]

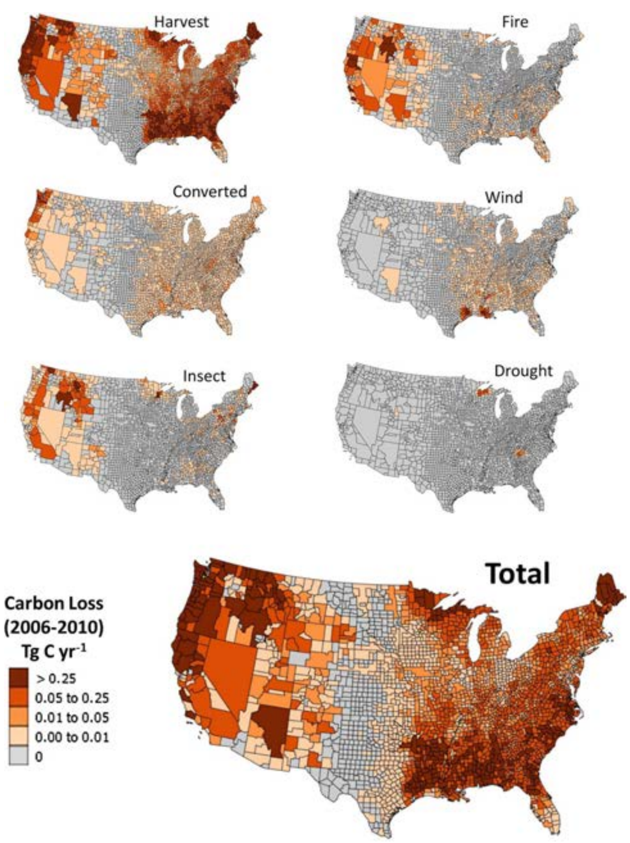
Each of the reasons listed above refute the notion that burning wood to generate electricity is a sound strategy for solving the climate crisis. Yet, this has not stopped policymakers from continuing to count emissions from burning wood as zero as in the E.U., nor has it prevented attempts to do the same in many U.S. states and by the U.S. Congress. The E.U. Commission's proposed new biomass policy, while limiting some subsidies, extends the policy of counting biomass carbon emissions as zero to 2030, despite a commissioned report that documents the negative forest and climate impacts resulting from current policies. Many scientists are concerned that lawmakers are trying to repeal the laws of physics and chemistry by attempting to legislate forest biomass as essentially a carbon neutral energy source.

THE DOUBLE STANDARD: When someone burns wood to cook in a developing country it is considered a climate problem but when a developed country burns trees to generate electricity it is deemed a climate solution.

OTHER WOOD PRODUCTS

As the controversy around claims of carbon neutrality and landscape-level net-carbon accounting for the bioenergy industry grows, we must begin to ask ourselves: Do some of the same concerns apply when it comes to emissions from traditional forest products? The simple answer is yes. Carbon emissions from logging forests for paper, pulp, and timber are not "offset" by natural (passive) carbon sequestration. Simply put, the forestry sector as a whole is not de facto carbon neutral.

Not all forest products create the same amount of carbon emissions. Burning a tree to generate electricity has the highest carbon footprint as stored carbon in trees is immediately transferred to the atmosphere. By contrast, solid wood products store carbon for varying lengths of time, with long-lasting wood products, such as high-quality flooring and some building materials, having a lower carbon footprint than less durable products. Short-lived paper products have a higher carbon footprint than solid wood products. Across all forest products, from 2006 to 2010 the production of pulpwood resulted in the highest forest carbon losses[12]. In addition, the processing of wood into paper is energy-intensive, resulting in significant, additional carbon and other greenhouse gas emissions.



Attribution of Forest carbon loss fron 2006-2010 shows harvests accounted for 85 percent of forest emissions. Spatial figure and data for pie chart reproduced from Harris et al. (2016).

Though most forest products of today are not capable of storing significant amounts of carbon for long periods of time that hasn't prevented the promotion of wood products expansion as a strategy for increasing carbon stocks in the United States. For example, former president Obama proclaimed October 16–22, 2016, as National Wood Products Week in announcing $7 million in federal grants to "promote the use of wood energy and wood products" as one of the ten "building blocks" in USDA's Building Blocks for Climate Smart Agriculture and Forestry.[50]

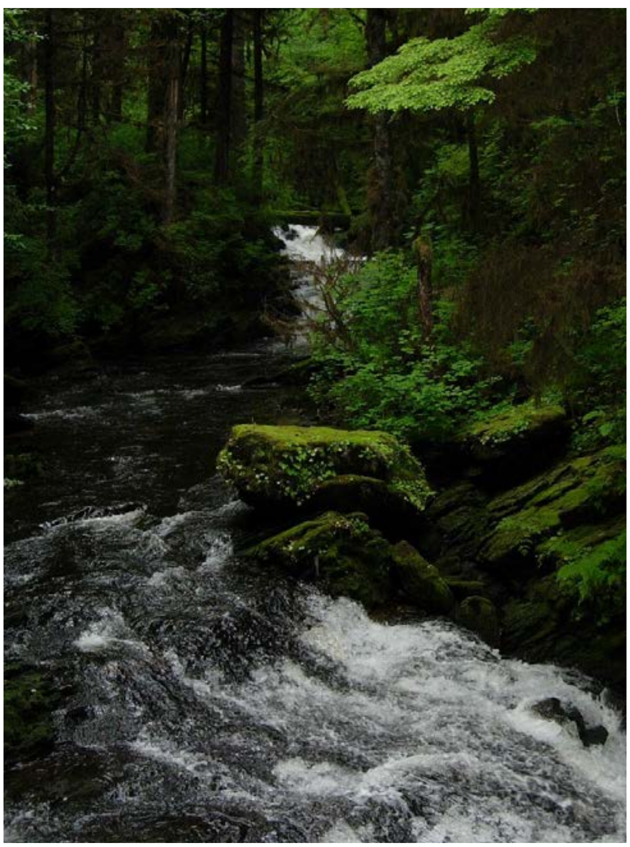
Recently, some in government and the wood products industry have started advocating for a wholesale shift in the use of steel in skyscrapers and other commercial structures to wood as a climate solution. Recent studies suggest that the benefits of replacing steel with wood to make ever taller buildings are overstated.[51] Whether wood has a lower carbon footprint than steel when the entire life cycle of the product is considered is debatable, especially when steel is recycled. Moreover, the impact such a substitution would have on the ability to accelerate forest protection at a scale needed to meet the goals of the Paris Agreement must be considered. Shifting from steel to wood for construction could take 40 percent of global annual forest growth and result in a tripling of current global timber harvest.[38]

Perhaps we have ignored carbon emissions from logging to supply wood to the forest products sector because of industry maturity. Paper, pulp, and timber industries were working in U.S. forests well before greenhouse gases were a concern. In contrast, the wood pellet industry is growing at a time when we are very concerned about additional emissions prompting many scientists to come out against the flawed landscape-scale, net-carbon accounting arguments frequently used to justify the expansion in wood-based bioenergy as an alternative to fossil fuels.[52 - 54] At the end of the day, the faulty accounting may be zeroing out these emissions in our reporting, but it is not fooling the atmosphere or helping us solve the climate crisis.

Shifting from steel to wood for construction could take 40 percent of global annual forest growth and result in a tripling of current global timber harvest.

RETHINKING FORESTRY IN THE UNITED STATES

Protecting mature, high-biomass forests and remaining old forests, allowing young forests to mature, and halting the conversion of natural forests to plantations may solve many of our current forest carbon problems. First, we need to protect mature, high-biomass forests that already store large amounts of carbon. Many old-growth forests in the United States, which hold the highest densities of carbon, are vulnerable to logging.



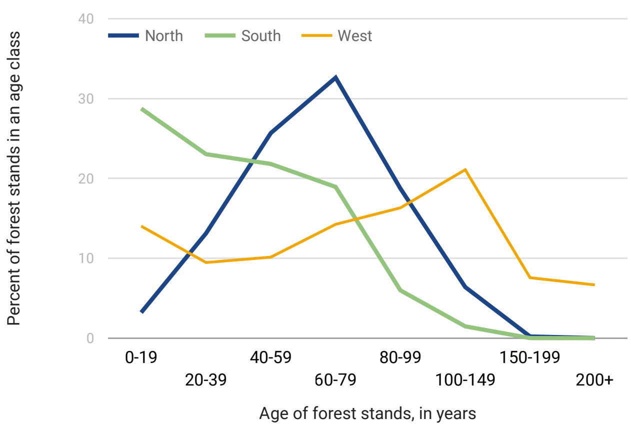
The Tongass National Forest is a national treasure, currently vulnerable to logging.

In Alaska, the U.S. Forest Service is currently embroiled in litigation with several environmental groups over the decision to log old growth in the Tongass National Forest, one of the most carbon-dense forests in the world.[55 - 56] Similar fights have occurred across the United States as the Forest Service attempts to log rare ecosystems critical to the survival of endemic flora and fauna. In the Rockies, organizations fight off regular attempts to log old growth and habitats critical to large carnivores.[57] Older forests on private lands also lack protection. The clear-cutting of mature wetland forests in the Southeast for wood pellets to fuel power stations in the E.U. has recently been the subject of national and international headlines.

Second, allowing young trees across the globe to grow and mature could remove up to 2 BMtC from the atmosphere each year.[8] Anytime a forest is cleared, it is converted to a younger stand, taking many decades to mature. Large-scale, clear-cut logging across a landscape results in a corresponding increase in acres of younger stands. When forests are converted from older to younger stands, a carbon debt is accumulated for decades to a century, depending on the age at harvest.[46]

Forests in the United States are currently very young and very fragmented.[58] The potential lifespan of a tree is several hundred to thousands of years old. Yet, only 15 percent of the nation's forests average more than one hundred years (figure 1). One study found that ending commercial logging on U.S. national forests and allowing forests to mature instead would remove an additional amount of carbon from the atmosphere equivalent to 6 percent of the U.S. 2025 climate target of 28 percent emission reductions.[59] Yet, the U.S. Forest Service is proposing to increase logging on national forests to 1980 levels, which by some accounts would increase emissions by 6 percent.

Figure 1. Ages of Tree Stands by Region, USA



Satellite images of global forest cover loss documented that from 2000 to 2012, the rate of disturbance of southern U.S. forests from logging was four times the rate of South American rainforests.

In fact, the U.S. government promotes logging on public lands under the auspices of forest "restoration" as a climate solution. In 2014 the United States signed onto the Bonn Challenge, a nonbinding global agreement to "restore" 500 million hectares of forests by 2030. Pursuant to its restoration agenda, the Forest Service has increased timber production on national forests from 2.5 billion board feet (bbf) in 2011 to 2.8 bbf in 2014 and has plans to increase this number further in 2015 and 2016 with targets of 2.9 and 3.2 bbf respectively, based on funding levels in the president's budget request.[60] Fire hazard is often used as justification for "restoration" logging of national forests in the West; yet, countless scientific studies reiterate the importance of fire for ecosystem health and expose the numerous negative impacts that U.S. Forest Service post-fire and fire prevention logging projects actually have on fire-dependent ecosystems and species as well as on carbon emissions.[61]

In the U.S. South—the world's largest wood producing region—half of the forests are less than forty years old (figure 1). The intensity of logging in the U.S. South is visible from space. Satellite images of global forest cover loss documented that from 2000 to 2012, the rate of disturbance of southern U.S. forests from logging was four times the rate of South American rainforests.[62]

Converting older stands to younger stands releases carbon because young forests do not store as much carbon.[46] In contrast, allowing forests to grow old increases the amount of carbon removed and stored long-term. Countless studies have shown that old-growth forests are more valuable than young-growth forests for long-term carbon sequestration.[32,46,63]

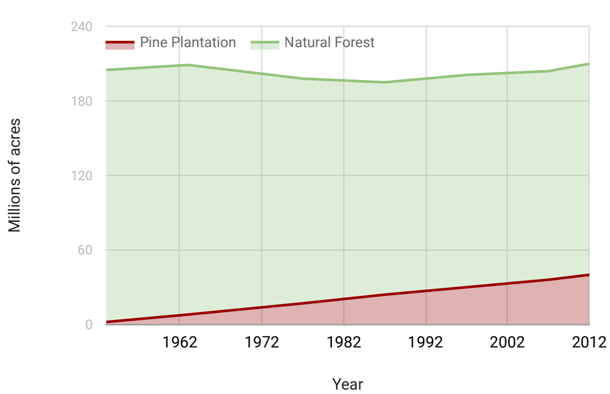
Since the establishment of the U.S. Forest Service, logging and subsequent loss of forests to other uses have been replaced with utilitarian harvesting practices, known as the principle of "sustainable forest management." This principle asserts that as long as trees are not harvested at a rate that exceeds regrowth, there is a "sustained yield." On private lands, where the lion's share of industrial logging occurs in the United States, "sustainable management" has largely been reduced to measuring acres and growth-to-harvest ratios. Many point to a relatively stable acreage of forests in the United States over the past one hundred years and a positive growth-to-harvest ratio as evidence of "sustainable" forestry. This measure of "sustainability" fails to consider many other important factors such as age-class distribution, fragmentation, long-term carbon storage and biodiversity that affect the ecological functioning of forests across large landscapes.

Pine plantations have replaced tens of millions of acres of natural forests across the Southeastern US.

Natural forests are more biodiverse and provide more ecosystem services than pine plantations.

One consequence of this narrow "sustainability" focus is that only trees with commercial value are desirable in a forest. In many cases, this has led forest managers to focus on fast-growing, early successional species that regenerate well in large openings (i.e., clear-cuts). This can result in greatly reduced tree, plant, and animal biodiversity. The ultimate direction of this market-driven mindset is to establish monoculture tree plantations in the place of natural forests, which retain few ecological functions. Simply put, plantations are not forests but are rather simply a monoculture crop, like corn. The species themselves are selected or genetically engineered for rapid growth and uniformity. We can grow a crop of uniform trees much faster than a natural forest, but it requires many energy- and resource-intensive inputs to maintain, including pesticides, fertilizers, and forest thinnings that create carbon emissions. The emissions of nitrous oxide emissions from the fertilizer adds significantly to the heat-trapping greenhouse gas intensity of this type of forest management.

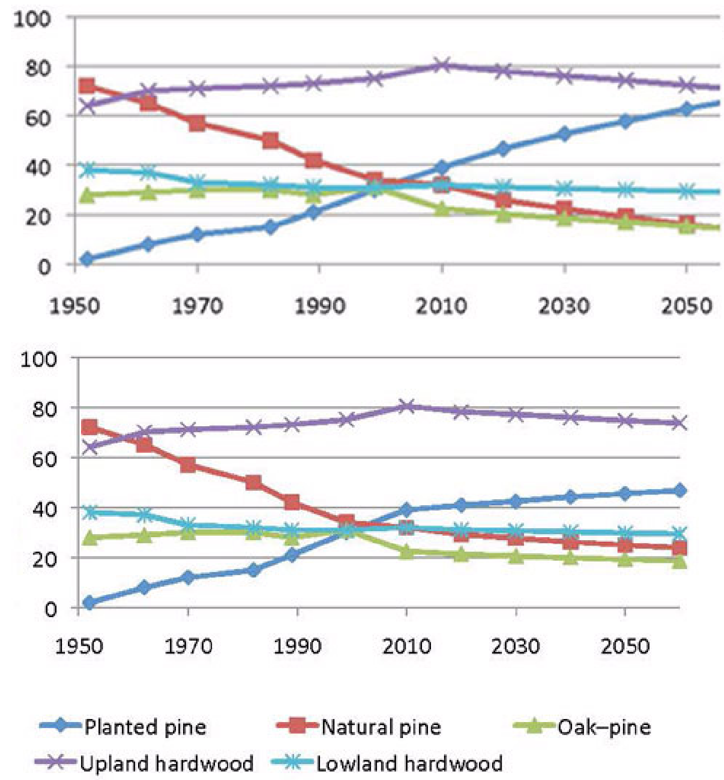
Figure 1. Since 1953, pine plantations have increased while natural forest has decreased in the US South.



In the United States, favorable tax policies, government subsidies, and cost-share programs have made planting tree plantations economical on private land.[64] As a result, tens of millions of acres of some of the nation's most diverse natural forests in the U.S. South have been converted into highly managed monocultures. In the last sixty years, pine plantations in the South have grown from zero to over 40 million acres.[65] In the same time span, the South lost over 30 million acres of natural forests (figure 1). Though globally, tree plantations make up 7 percent of the world's forests, in the coastal plain of the southeastern United States, plantations make up 27 percent of the "forest," more than one in every four acres.[66,67]

Scientific studies show that when natural forests are converted to plantations, a carbon debt is accumulated. One study showed that converting natural forests to pine plantations emitted carbon and reduced the yearly carbon storage for that area by up to 68 percent.[68, 69] Though no one has yet calculated the figures for the entire United States, a recent study found that European forests likely released 3.1 BMtC into the atmosphere since 1750 as a result of converting natural forests to plantations.[70]

According to the U.S. Forest Service, the loss of natural forests to plantations is projected to continue even under a scenario of moderate growth in wood products markets, with most natural forest types declining while the area of plantations continues to expand.[71]



Planted pine (blue dots) is forecasted to increase in the future to the detriment of natural forest (all other lines) in both moderate (above) and high (below) wood product market predictions.

RETHINKING FOREST PRODUCTS: USE AND WASTE

As we begin to recognize the tradeoffs between our use of forests and our need to restore ecological functions across large landscapes, we must acknowledge the impacts of our current consumption of wood products. This is a challenging concept within an economic system that depends on growth in markets to deliver increasing returns to shareholders and investors. In fact, the idea of reducing consumption hits a sensitive nerve, given that our current economic system is dependent on ever-increasing consumption of products.

Change is difficult, but we can shift the politics and the policies. Unlike fossil fuels, we actually do need some wood products for building and sanitation. At the same time, many forest products on the market are wasteful and/or designed to be short-lived. In 2013, over one-third of municipal waste was forest products, with 6.2 percent being wood and 27 percent paper products.[72]

Reducing consumption and increasing recycling could reduce the carbon footprint of the United States' wood products consumption while also creating opportunity for forest restoration.[28] In fact the Multiple-Use Sustained Yield Act of 1976 encourages the Forest Service to promote recycling and reuse of wood and paper products, but this has not been a high priority.

Reducing consumption could also reduce the release of other greenhouse gases. Methane emitted from decomposing organic material in landfills has long been identified as a significant contributor to greenhouse gas emissions. Products such as disposable cups, packaging, and business documents become mummified alongside food waste for decades and contribute to methane release.[73] Short-rotation tree plantations require nitrogen fertilizer that releases nitrous oxide, which is the third most significant greenhouse gas and now the largest human contribution to stratospheric ozone depletion.

While we can easily turn to solar and wind power as sustainable, low-carbon alternatives to wood pellets to provide electricity, alternatives for other wood products are more complicated. As a first step, we should prioritize the necessary wood products over the convenient wood products.

CARBON STORAGE, CLEAN WATER, FLOOD CONTROL

FOREST FOCUS OF THE TWENTY-FIRST CENTURY

Our natural forests are not just carbon sinks, although that has been our focus so far. A forest, when left standing, provides a whole host of "ecosystem services" beyond carbon storage, including wildlife habitat, recreational value, water and air purification, flood control, and pollination that support human resiliency in the wake of climate change. Some of these, especially flood control and water stabilization, will be increasingly important as climate change continues to exacerbate droughts and floods. Weather-related disasters are also costly, with annual costs in the United States rising into the billions over the past decade.

Many argue that we need to increase markets for wood products to prevent the loss of forest to another use. But, the logic that we must degrade forests to protect them is not sound given the impacts of forest degradation on our economy, climate, water, biodiversity, and other ecological services. Forests don't only have value when logged for wood, pulp, mulch, or pellets. They also have tremendous economic value when left standing; yet, these values are not fully recognized in current government policies or by our economic system. Our economic system and associated government policies must begin to recognize both the value of forest ecosystem services as well as the costs of forest degradation.

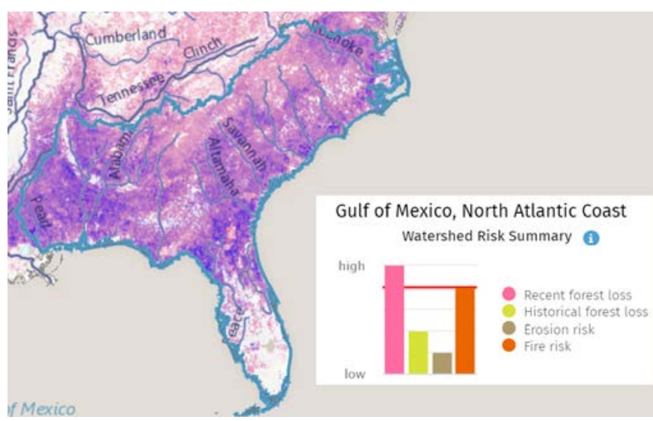
Permanently protecting forests with high conservation values and restoring degraded forests will not only help remove additional carbon from the atmosphere, but will also lessen the harshest effects of climate change, such as more frequent and severe flooding and droughts. Severe storms and associated flooding in the United States are among the most costly impacts of climate change, resulting $115 billion in direct costs from 1960 to 2005. Flooding disproportionately impacts cities, towns, agriculture, and transportation networks located along rivers and in floodplains.[74]

Standing natural forests mean less frequent and less intense flooding for low-lying flood-prone areas, like the Mississippi valley and Southeastern Coastal Plain.[75] Increased protection of forested wetlands and forests along rivers needs to be a national priority. In coastal areas, planting mangroves instead of using traditional erosion control saves up to 28 times more money—a strategy that could be used effectively throughout the nation.[76]

Deforestation and clearcut logging has also caused massive landslides with heavy losses of property and life. One of the most damaging case occurred near Oso, Washington, in 2014 where a denuded hillside collapsed, and the ensuing mudslide killed forty-three people and destroyed over forty homes and buildings.

Much of the western and southeastern United States are already experiencing more frequent droughts. Intact forests not only help to stabilize water supplies, but also act as filters, ensuring clean, fresh drinking water.[55] Over half of the variation in water treatment costs can be attributed to the state of surrounding watershed forests.[77] **Two-thirds of America's fresh water supply filters through forests.[5]** Forests can store large amounts of water, preventing or lessening the harsh effects of drought.[78] These water benefits, in addition to carbon benefits, are more than enough reason to protect and restore our natural landscape.

Yet, according to a recent analysis by the World Resources Institute, the degradation of forests across the United States has put many watersheds at high risk.[79] (figure 3)



The World Resources Institute shows high watershed risk in the southeastern United States, primarily from recent forest loss and fire risk.

CLIMATE JUSTICE

Climate change is already happening, disproportionately affecting our most vulnerable populations including people of color. The year 2016 was documented to be the hottest globally on record, the third record-breaking year in a row to achieve that distinction. Even unnamed storms have had catastrophic effects in the United States.[80, 81] These extreme weather events affect all Americans, but especially those who live along our coasts in economically depressed areas and where industrial logging is concentrated.

A community member stands for forests, 2016, Charlotte, NC.

Two of five of the world's most costly natural disasters of 2016 resulted from flooding in the Southern United States, disproportionately impacting coastal rural communities located along rivers.

The Southeast has had more billion-dollar weather and climate disasters than other parts of the country, disproportionately impacting large populations of African Americans and economically disadvantaged communities.[74] In fact, two of the five most expensive natural disasters in the world in 2016 were due to storms that caused severe flooding along rivers in the rural southeastern United States.[82] Restoring degraded forests in communities most vulnerable to the effects of climate change will ensure equitable access to clean water, flood control, and the myriad of other benefits that forests provide. As it currently stands, rural communities in the coastal plain of the U.S. South bear the brunt of the impacts of industrial logging, yet protected areas are few, regulation is lacking, and economic opportunities are restricted. Other economically disadvantaged communities in other heavily logged regions of the United States are also impacted. For these reasons, forest management in the United States is not only an issue of climate science but also climate justice.

IMPORTANCE OF BIODIVERSITY

The critically endangered red wolf relies on healthy southern forests to survive.

Biodiversity supports ecosystem functioning and reduces the risk of natural disasters.[83] Yet, the world is undergoing the sixth mass extinction event, on par with dinosaur extinctions, and globally, biodiversity has fallen below a "safe" level—indicating that many species are endangered or extinct.[81] The great biologist E. O. Wilson argues that half the land area of the planet needs to be set aside to maintain global ecosystem function.[85]

The U.N. Convention on Biological Diversity issued a press release on October 21, 2015, preceding the Paris negotiations, underscoring the need for governments to consider the protection of biodiversity as a climate disaster reduction strategy because functional ecosystems provide "safety nets to communities in times of climate shocks and natural disasters."

"Biodiversity is a critical resource, not only for climate change adaptation and mitigation, but as a tool to make countries more resilient and help reduce the risk and damages associated with natural disasters."[86]

In the United States, we are failing to protect the nation's most biologically diverse forests. A recent study by the National Academy of Sciences documents that most of the protected lands are in the West, but most of the biodiversity is found in the Southeast.[87] Though the forests of the Southeast are among the most biologically diverse on the continent, they are experiencing the highest rates of logging anywhere on Earth and regulations are virtually nonexistent.[62, 88] The number of extinct or extirpated species in just this one region of the United States doubled from thirty-two in 2002 to sixty-five in 2011.[5, 71] Over the next ten years, the southeast region of the U.S. Fish and Wildlife Service is implementing a conservation strategy to prevent the extinction of more than four hundred fish, wildlife, and plant species. [89]

Measuring success in valuing our forests is not as easy as counting acres. Rather, this is an active process that emphasizes quality, not just quantity. It is common sense that large, protected forests like the Great Smoky Mountains National Park and Sequoia National Park are of higher quality than small woodlots scattered throughout the United States, broken by roads and houses, large clear-cuts, and pine plantations. Across the landscape, fragmentation is so pervasive that "edge effects" characterize most forests in the United States today.[90] Restoring forests and connectivity is key to not only reducing carbon emissions but also protecting communities and wildlife from the effects of climate change.

THE PATH FORWARD

While in the last century the market and policy focus emphasized commercial forestry, the sustainability challenges of the twenty-first century require a greater emphasis on conservation and protection. Standing forests play a critical role in stabilizing Earth's climate. When left undisturbed, forests have the potential to pull vast and increasing amounts of carbon out of the air and store it. When left alone, forests can do their best work, protecting freshwater supplies and preventing floods during heavy storms. Large expanses of undisturbed forests are also critical to reversing the rapid rate of global species extinction and loss. In addition, well-managed forests where structural diversity is maintained through retention during harvest cycles can also play an important role in improving ecosystem function in working forests.

Because of losses that have already occurred, it is essential that forests and soils be rehabilitated so forest ecosystems are *expanded in scale and enhanced in terms of quality*. This work needs to be done so human needs are satisfied through the expansion of ecosystem services. We refer to this process as "restorative development."

It is time for the United States to embrace a forest economy that addresses the ecological sustainability challenges of the twenty-first century. There is nothing more important than ensuring a safe, habitable world for the children of today and tomorrow. Yet, as of today, forest management is largely influenced by the outdated policies and market approaches of the early twentieth century.

We must align government and corporate policies behind a forest economy that is restoration-based and one that promotes the highest and best use of limited forest resources. **A recent study published by the University of North Carolina found that for every million dollars spent on restoration, up to thirty-three jobs were created, an amount comparable to other industries.**[91] In addition to jobs, other economic benefits associated with ecosystem protection include higher property values and tax revenues, increased revenue from tourism and recreation, and cost savings associated with improving ecosystem services.

We must start measuring and quantifying forest degradation and setting ambitious targets to protect and restore forests. This will require a transformation in the way we think about the forest-based economy, forest industry and government policies related to forests, climate change, and land use. With a concerted effort, a willingness to change, and an innovative mind-set, we can restore ecological function across large landscapes in the United States. Over the next two decades, we must:

- permanently protect carbon-rich, old-growth stands on both public and private lands;
- set and achieve aggressive targets for restoring degraded natural forests to older, more complex, and connected ecosystems, especially biodiverse forests and those that provide critical ecosystem services, such as wetland forests and forests along rivers;
- halt the conversion of natural forests to plantations and restore some of these lands to a mix of native species;
- prioritze forest restoration and protection efforts in economically disadvantaged communities most vulnerable to climate change in ways that ensure livable-wage jobs for those who need it most in the community;
- implement a transparent accounting system that accurately measures the actual dynamics of carbon flows and long-term carbon storage that are taking place within the natural world.

Aligning corporate and government policies behind these five principles would go a long way toward ensuring the United States is doing its part to hit the ambitious temperature-limiting goals of the Paris Agreement. It would also have the added benefits of reducing the costs and impacts of natural disasters for communities most vulnerable to the effects of climate change, while providing equitable access to life-supporting ecological services and jobs. In addition, a transformation in public and private sector policies will drive business innovation and create new economic opportunities, as has been the case in the energy sector.

There are many potential pathways for achieving an aggressive scale-up in forest protection in the United States. Over the next decade it will be important to focus on global climate change policy, domestic energy policy, state and federal forest policies, economic development, strategic land acquisition, technical support and training, corporate action, and addressing consumption and waste.

There are many potential pathways for achieving an aggressive scale-up in forest protection in the United States.

GLOBAL CLIMATE POLICY

The IPCC, the Paris Agreement, and other (future) climate agreements and research need to include all forests, including boreal and temperate forests. The United States and other developed nations must be held accountable for past and ongoing forest loss and degradation. As the world's largest producer and consumer of wood products, the United States must not only acknowledge emissions from the forestry sector but set aggressive targets for reducing emissions from logging and associated forest degradation on the one hand, and for restoring U.S. forests climate stabilization capacity on the other. The United States must go beyond merely committing to continue to account for forest emissions using a net-net approach consistent with UNFCCC and IPCC protocols as outlined in its Nationally Determined Contributions (NDC) submitted pursuant to COP21. The United States must commit to scale-up forest protection and restoration as a core strategy, setting ambitious targets aligned with the five principles above. As a signatory to the New York Declaration on Forests, which is aimed at stopping deforestation, halting the loss of natural forests, and increasing restoration, the United States should not only maintain its commitments to support tropical forest protection but also expand its commitment to include U.S. forests. In addition, the requirements for global carbon accounting of Land Use Change need to expanded so relevant information necessary to make sound climate policy is required including:

- annual disclosure of gross carbon emissions from logging attributed to specific forest products (i.e., wood, paper, and fuel) as separate categories;
- carbon input-output calculations that measure and calculate soil emissions associated with logging;
- segregation of accounting and reporting of the carbon stock changes in plantations, in intensively managed forests, and in unmanaged forests so progress toward improving long-term storage can be measured;
- carbon emissions from bioenergy emissions counted as part of the energy sector when the fuel is burned just as fossil fuel emissions, including emissions from harvest, transportation, and processing. No country should be able to count bioenergy emissions as zero. The practice of counting emissions from bioenergy as "net emissions" at the land use level, makes it difficult to compare bioenergy emissions with alternative fuels and technology to ensure the replacement of fossil fuels with low-carbon clean sources of fuel.
- Growing forests do not absorb carbon dioxide released only from bioenergy combustion, but instead draw it from the reservoir of carbon dioxide from all sources in the atmosphere. Removal rates for the uptake of carbon dioxide by managed forests and soils should be counted separately from

unmanaged forests and only be credited as they occur over time. It is inappropriate to claim credit for carbon dioxide removal that occurs in a forest that is unrelated to the source of the biofuel.

- The practice of counting "net carbon emissions" as zero should be abandoned. This would align carbon accounting with standard financial accounting practices. No person is allowed to "offset" his or her income with expenses and only report the net as income. All income is accounted and totaled, and all expenses are treated the same way. Any income or expenditures that qualify for special treatment (i.e., as a valid, verifiable, additional, permanent forest carbon offset) are noted separately and treated accordingly.

The practice of counting "net carbon emissions" as zero should be abandoned. This would align carbon accounting with standard financial accounting practices.

DOMESTIC ENERGY POLICY

Federal, state, and local energy policies must focus on transitioning from fossil fuels to clean, low-carbon technology, such as solar, wind, and geothermal, while simultaneously improving energy productivity, i.e. using energy more efficiently. Logging forests as a fuel replacement for fossil fuels is not a sound climate strategy. Accounting for bioenergy should follow the recommendations as set forth above.

Reducing fossil fuel emissions is a must to reach our climate goals as soon as possible. Therefore, the United States should not adopt policies intended to use forests to offset emissions from the fossil fuel industry. Climate policy related to forests should be developed outside of energy policy and focus instead on reducing emissions from deforestation and degradation and restoring U.S. forests' ability to remove and store carbon long-term.

STATE AND FEDERAL FOREST POLICIES

Management of publicly owned forests should immediately shift away from commercial logging and toward the restoration of ecosystem functions including long-term carbon storage, biodiversity protection, water stabilization and purification, and flood control. Immediate priority should be to prevent the logging of carbon-rich, mature forests.

Tax policies and cost-share programs should be revised to encourage private landowners in areas identified as conservation priorities to leave forests standing. Currently federal and state cost-share programs provide government assistance for planting trees after harvest but no similar cost-share programs exist to help landowners keep trees standing. Some tax policies also give lucrative tax credits and breaks to landowners whose "primary objective is commercial logging"; yet, landowners who wish to leave their trees standing have to commit to legally encumbering their property in order to receive tax benefits. Through providing incentives and cost-share payments for ecosystem services targeting high priority conservation areas, **governments can provide the right mix of policy incentives that can influence private landowners to manage forests for their ecological values.**

In the absence of strong voluntary leadership from the forest sector, a resource-use or carbon tax and/or regulation may be required to achieve conservation results at the scale needed to ensure a stable climate. Such regulations (i.e., requiring industry to meet carbon emission reduction requirements) could spark new markets for private landowners such as markets for long-term carbon storage or other Payments for Ecosystem Services (PES), while also creating new types of jobs in the forest industry.

Allowing large consumers and producers of forest products to use forest protection, improved forest management and restoration to offset emissions associated with logging may be an appropriate solution, but only if such offsets meet rigorous standards that abide by internationally recognized land-based offset protocols. Such an approach would create new markets for landowners consistent with climate goals.

ECONOMIC DEVELOPMENT

Federal, state, and local governments will need to embrace forest protection as an economic development strategy in rural forested communities, prioritizing grants and tax incentives for communities and businesses whose practices align with forest stewardship over those focused solely on forest extraction. Tax incentives should also only be given to businesses that prioritize training and hiring people from the community.

STRATEGIC LAND ACQUISITION

To secure a new generation of forests managed for ecosystem function, significant government investment will be required. Such an investment, if strategically focused, can result in cost savings into the billions of dollars. For example, the City of New York's public purchase of a forested watershed to improve water supply and quality saved the city billions of dollars that otherwise would have had to be spent building and managing water treatment plants. Multiple initiatives in the United States, such as the Sustainable Rivers project in Savannah, Georgia, are focused on protecting and restoring forests around rivers to protect freshwater supplies.

Given the "social cost" of inaction at up to $220 per ton of carbon released into our atmosphere, it makes sense to focus on investing in forest carbon sequestration and long-term storage as well. Just as we dedicate funds to fix degrading infrastructure, such as roads and highways, we must invest in restoring our degraded natural infrastructure.

TECHNICAL SUPPORT AND TRAINING

The government infrastructure necessary to achieve large-scale forest protection and the restoration of ecosystem function already exists through numerous state and federal agencies including the U.S. Fish and Wildlife Service, U.S. Forest Service, EPA, and state forest and wildlife agencies. Yet managing for large-scale ecosystem function will require strong leadership, new policy directives, and new technical skills and knowledge.

State and federal forestry agencies must broaden their services and expertise in the fields of measuring ecosystem health across large landscapes, restoration of ecosystem function, and managing for ecosystem services. Forestry schools also have an important role to play, building a pipeline of future foresters trained and skilled at managing carbon projects, supporting large-scale, landscape conservation efforts, and helping landowners derive value from standing forests.

CORPORATE ACTION

Over the past decade, some leaders in the U.S. forest industry have embraced new supply chain management practices aimed at improving forest conservation. From ramping up the use of recycled materials, to mapping critical forests to target for protection, to scaling up Forest Stewardship Council (FSC) certification, to discouraging the continued conversion of natural forests to plantations, to providing funding for land conservation, and to pilot-testing forest carbon projects, numerous corporate consumers and a handful of large paper and forest products producers have stepped up to lead and embraced change. These efforts are encouraging. At the same time, continued transformation in the forest products sector is critical. Not all companies that have committed to changes have embraced all aspects of improved supply chain management, focusing on one or two elements but not others. Leadership in all areas is necessary. In addition, many companies have yet to step up. Significant continued innovation, investments, and improvements in the following areas is imperative:

- Large corporate consumers of forest products must consume less, while also taking responsibility for the impacts of their operations on forests. Corporate consumers need to continue to play a leading role in eliminating wasteful use, recovering discarded products, and holding suppliers accountable to continued improvements on the ground, in forests.

- Forest products companies must integrate conservation mapping into their supply chain management practices, avoiding sourcing from areas identified as high priority for permanent protection, and working with landowners to manage other conservation targets for large-scale ecosystem services through retaining more forest cover and allowing forests to mature.

- FSC certification is the forest certification system most closely aligned with the types of improvements needed in managed forests, providing some protection for forests with high conservation values, requiring retention during harvests and discouraging the conversion of natural forests to plantations. As a leading-edge forest certification system globally, FSC is already contemplating its role in certifying ecosystem services, such as carbon storage, but it needs to move more quickly into this area. Other certification systems, such as SFI and PEFC, have yet to deliver standards with enough rigor to leverage meaningful, positive conservation outcomes.

- Corporate investments in forest protection will be critical. Government alone cannot afford to foot the entire bill for the level of conservation necessary to solve the climate crisis. The mobilization of private capital is important as current global estimates show a gap of $200 to $300 billion annually in the amount of money needed to protect nature at a scale to ensure an inhabitable planet into the future. Forest products companies have a responsibility to support a scale-up in forest protection as a cost of doing business in light of their reliance on forests as a raw material. In addition, innovation in the finance sector is also critical to provide much-needed capital for projects that protect and restore forests. Known as conservation financing, this new field of investing is beginning to gain traction, with some promising results. However, investments in the private sector must not result in the privatization of public assets, such as water.

ADDRESSING CONSUMPTION AND WASTE

Our current rate and scale of consumption of wood products is not sustainable, given it is in direct competition for land needed for life-supporting services. In addition to promoting a restoration-based forest economy, we need to also align corporate and government policies with emerging the concepts of "Cascading Use," "Zero Waste," and the "Circular Economy." These concepts, focused on using limited natural resources efficiently and on the highest and best uses, stand in stark contrast to the "extract, make, use, and discard" linear economy that exists in most places today.

CONCLUSION

With the serious adverse consequences of a changing climate already occurring, it is important to broaden our view of sustainable forestry to see forests not merely as a commodity to be extracted and sold, but as complex ecosystems that provide valuable, multiple life-supporting services like clean water, air, flood control, and carbon storage. We have ample policy mechanisms, resources, and funding to support conservation and protection if we prioritize correctly.

U.S. forests will continue to provide wood and paper products, but cannot become a fuel source for commercial scale electric power production. We must commit to a profound transformation, rebuilding forested landscapes that sequester carbon in long-lived trees and permanent soils. Forests that protect the climate also allow a multitude of species to thrive, manage water quality and quantity and protect our most vulnerable communities from the harshest effects of a changing climate.

Protecting and expanding forests is not an "offset" for fossil fuel emissions. To avoid serious climate disruption, it is essential that we simultaneously reduce emissions of carbon dioxide from burning fossil fuels and bioenergy along with other heat trapping gases and accelerate the removal of carbon dioxide from the atmosphere by protecting and expanding forests. It is not one or the other. It is both!

Achieving the scale of forest protection and restoration needed over the coming decades may be a challenging concept to embrace politically; however, forests are the only option that can operate at the necessary scale and within the necessary time frame to keep the world from going over the climate precipice. Unlike the fossil fuel companies, whose industry must be replaced, the wood products industry will still have an important role to play in providing the wood products that we need while working together to keep more forests standing for their climate, water, storm protection, and biodiversity benefits.

It may be asking a lot to "rethink the forest economy" and to "invest in forest stewardship," but tabulating the multiple benefits of doing so will demonstrate that often a forest is worth much more standing than logged. Instead of subsidizing the logging of forests for lumber, paper and fuel, society should pay for the multiple benefits of standing forests. It is time to value U.S. forests differently in the twenty-first century. We have a long way to go, but there is not a lot of time to get there.

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