

Comment on *Land Management Plan Direction for Old-Growth Forest Conditions Across the National Forest System #65356*

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Goals in the Executive Order

In Executive Order 14072 (Biden 2022), President Biden wrote (boldface mine)

*My Administration will manage forests on Federal lands, which include many mature and old-growth forests, to promote their continued health and resilience; **retain and enhance carbon storage**; conserve biodiversity; mitigate the risk of wildfires; enhance climate resilience; enable subsistence and cultural uses; provide outdoor recreational opportunities; and promote sustainable local economic development.*

...

(c) Following completion of the inventory, the Secretaries shall:

...

*(iii) develop policies, with robust opportunity for public comment, to **institutionalize climate-smart management and conservation strategies that address threats to mature and old-growth forests on Federal lands.***

It's clear from the text of the Executive Order that the phrase "climate smart" includes the idea that one of the goals of forest management should be to maximize carbon storage, amongst other goals. This is consistent with the Forest Service's Mission Statement,

"The mission of the USDA Forest Service is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations." (USDA 2015)

where it is important to both present and future generations that we slow climate change by removing as much carbon dioxide as possible from the atmosphere.

Forest Management for Carbon Optimization

And that brings us to §7.4.2 **Forest Management for Carbon Optimization**, in the DRAFT Ecological Impacts Analysis Report. The report does not account for the time it takes a forest, especially an old-growth forest to re-grow after it is harvested. It states:

Many management activities may have short-term carbon emissions but yield long-term carbon benefits through enhancing forest resiliency and therefore carbon stabilization. For example, timber harvest aimed at removing hazardous fuels and reducing live tree density can yield short-term carbon emissions but ultimately reduce risk of high severity wildfire, yielding long-term increases to carbon stability (Krofcheck et al. 2019).

While this is literally correct, the words “ultimately” and “long-term” are misleading, because it takes decades to centuries for the forest to re-grow. When the forest is harvested CO₂ is generated and a carbon debt is created. During the payback period, the atmosphere and ocean will have a higher CO₂ concentration and will thus trap more solar energy and raise the Earth’s temperature. As the forest grows back, it will reduce that CO₂ debt, but the temperature increase will remain for a long time in the form of warmer ocean water. This logic is supported by the literature, e.g. in (O’Hare 2009) and (Peng 2023).

The concept of a carbon debt and payback period is standard in the literature, though it is perhaps more often associated with construction projects like wind farms or solar panels, e.g. (NREL 2024), than with forestry. As an example of the use of these concepts in the forest-adjacent literature, (Malcolm et al 2020) describe the computation of a payback period for forest harvest for wood pellets for electricity generation.

A second statement in §7.4.2 that is true but misleading is this:

For projects involving forest harvest, some removed carbon can be stored for long time periods if converted to harvested wood products (HWP).

Certainly, a fraction of harvested wood will be used for building houses and the like, and will be stored for perhaps as long as a century. Other wood products like paper and cardboard end up in landfills within a decade, at which point its global warming potential is largely determined by how well the landfill’s methane production is managed and collected. But a lot of wood is just burned for fuel. A surprising amount of American wood is burned overseas (Chatham House 2017).

Figure 2 in (Peng 2023) shows a flowchart of roundwood use in 2010, and we see that 48% (1.9 billion m³/year) is burned for fuel, and 18% (0.63 billion m³/year) becomes “industrial waste”. A further 9% becomes paper and presumably ends up in a landfill within a few years. The remaining 25% becomes lumber, fiberboard, etc and has a chance of a long lifetime.

Evaluating the lifespan of harvested wood products is complicated, and detailed modeling is necessary to extract precise answers. However, it's clear that part of the harvest turns into CO₂ fairly rapidly. And, typically fossil fuels are used for processing and shipping the wood, adding a bit more CO₂.

The final problematic statement in §7.4.2 is:

Woody biomass for energy production can also decrease greenhouse gas emissions if it is substituted for more fossil fuel-intensive energy sources (Sathre and O'Connor 2010, D'Amato et al. 2011, Oliver et al. 2014).

As before, the statement is -- strictly speaking -- correct, but misleading. It's misleading because coal and gas are no longer the dominant power sources for new electrical generation. Specifically, September 2024 statistics from the US Energy Information Administration show that wind, solar, and battery added 18.7 GW of new capacity, while only 0.4 GW of fossil gas powered generators were added (EIA 2024). Including forecasts for the remainder of 2024, 94% of new generation capacity will be renewables, while only 4% of new generation capacity is powered by fossil fuels.

So, we should be comparing the carbon intensity of burning wood to the average carbon intensity of new generation capacity. And, while electrical power generated from wood may have a smaller carbon footprint than generation from gas, its carbon footprint is higher than an average modern power plant. Estimates of the carbon intensity of wood-burning power plants are available for the Drax plant in the UK (which incidentally gets much of its wood pellets from the USA). A Chatham House report (Brack et al 2017 §3.5) finds that the carbon footprint of the wood pellet supply chain is 19% - 44% of the CO₂ emitted by burning the pellets. So, wood fueled power plants are now dirtier than new US power generation, even neglecting the burning of the wood itself.

So far, we have established three points. First, that Forest Service policies should (amongst other goals) attempt to maximize carbon storage. Second, when trees are harvested, CO₂ is released into the atmosphere, and global warming is accelerated until the forest regrows and pays back the carbon debt. And third, the magnitude of the carbon debt is a substantial fraction of the carbon in the forest. (Peng 2023) shows that the global carbon footprint of forest harvests is 3-4 gigatons of CO₂-equivalent per year.

Appropriate Actions

So, what are the appropriate actions to take that would increase the amount of stored carbon and thereby minimize global warming? To do this, one maximizes the carbon stored in the three main reservoirs:

1. The forest itself, including trees, roots, soil carbon, and downed wood;
2. Long-lived wood products with lifetimes of at least several decades (e.g. houses);
3. Short-lived wood products (e.g. paper) which have reached well-maintained landfills where methane emissions are controlled and the wood products are expected to survive for a time comparable to or larger than the forest regrowth time.

Basically, if some forest carbon isn't stored in #1, #2, or #3, it will be in the atmosphere.

While we cannot dismiss #2 and #3, Figure 2 in (Peng 2023) makes it clear that when a forest is harvested, these reservoirs end up with only a small fraction of the wood. A house, for instance, would primarily be built from sawn wood (10.4% of harvested roundwood), wood based panels (7.9% of harvested roundwood), and poles, pilings etc (3.3% of harvested roundwood). In total, reservoir #2 will accumulate no more than 21.6% of harvested roundwood. And, of course the roundwood is only a part of the total forest: roundwood is basically the vertical tree trunks, leaving out branches.

Similarly for #3. Paper is probably the largest landfill component, and it comprises 20.4% of the harvested roundwood; "industrial waste" is another 17.5%. However, it's not reasonable to consider landfills to be stable storage reservoirs of carbon: the Environmental Protection Agency estimates landfills account for 14% of the US methane emissions (US EPA 2024), and methane is an important greenhouse gas.

Even optimistically, only a modest fraction of the harvested wood will be stored safely for the time it takes for the forest to re-grow, and the USFS has relatively little control over that fraction. So, the handle that the USFS has to control stored carbon is to control the amount of carbon in the forest (i.e. #1 above).

It is well established that the carbon stored in forests increases with the age of the forest, even well into the "old growth" stage (Keeton et al 2011; Moomaw et al 2019; Fraser et al 2023). (Luysaert et al 2008), (Gundersen 2021), and (Luysaert 2021) disagree on the rate at which old-growth forests store carbon, but both agree that old-growth forests continue to capture substantial amounts of carbon.

Carbon keeps accumulating as forests age, so old growth forests store the largest amount of carbon. Consequently, if we were managing just for maximum carbon storage, we should manage to increase the amount of healthy old-growth forest.

In a real situation, where forests face threats from fire, pests, and disease, and where timber production is another goal, the best overall management strategy is going to be a blend of the strategies that are separately optimized for timber production, and carbon capture. However, the optimum blend will put more emphasis on old-growth forests than a strategy that ignores carbon capture.

Specifically, because the *DRAFT Ecological Impacts Analysis Report* dismisses carbon capture in forests, any management strategy that has carbon capture as a goal will include more mature and old-growth forests than the preferred plan proposed in *Land Management Plan Direction for Old-Growth Forest Conditions Across the National Forest System #65356*. Thus, we should prefer **Alternative 3** because it will lead to trees standing longer, giving them more time to store carbon, and increasing the total stored carbon.

To quote (Peng 2023), “These findings are, in a sense, good news because they imply that if people could reduce forest harvests, forest growth could do more to reduce atmospheric carbon, a potential mitigation ‘wedge’ that is rarely identified in climate strategies.”

Summary

- Carbon storage is explicitly listed as a goal in Executive Order 14072.
 - The analysis in §7.4.2 of the *DRAFT Ecological Impacts Analysis Report* is incomplete because it waves away the extra global warming caused by the reduction in carbon storage that happens when trees are harvested.
 - Storage of forest carbon in manufactured wood products is not negligible, but is substantially smaller than carbon storage in the forest itself.
 - Forests continue to accumulate carbon far into the “old growth” regime. For practical purposes, the older a patch of forest is, the more carbon it stores.
 - Therefore any forest management plan that has carbon storage as a goal should minimize harvesting, and especially minimize harvesting of mature and old-growth areas. (Subject to potential compromises with other goals.)
 - Because the flawed analysis in §7.4.2 of the *DRAFT Ecological Impacts Analysis Report* leads to Alternative 2, an analysis that includes carbon storage as a goal would likely lead to a strategy like Alternative 3.
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