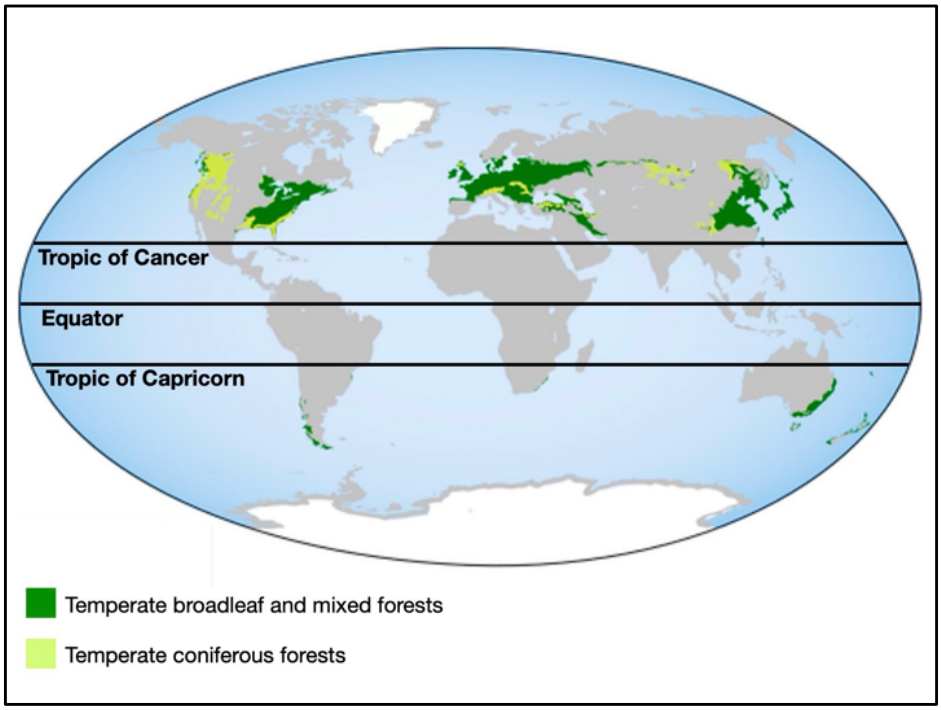
Carbon Sequestration in the Watershed Forests

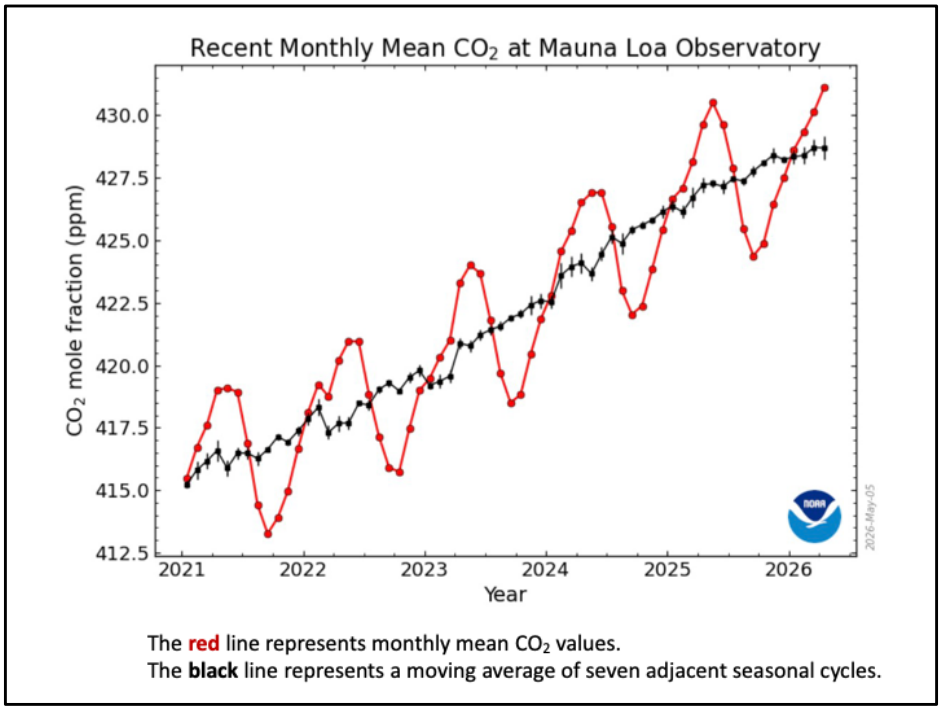
by Paul Lauenstein

Good morning. My name is Paul Lauenstein. I am currently serving as Chair of WSCAC. Following are my personal views on carbon sequestration by the watershed forests. They are my own views and not necessarily those of WSCAC.



Most of the earth's temperate forests are in the northern hemisphere. The carbon they sequester is critically important in slowing the rate of climate change.

From: https://nph.onlinelibrary.wiley.com/doi/10.1111/nph.14255



Buildup of CO_2 in the atmosphere traps heat, causing global warming. Forests significantly reduce the rate of increase in the amount of CO_2 in the atmosphere..

In summer, atmospheric CO_2 falls because northern temperate forests remove CO2 from the atmosphere and sequester it.

In winter, CO_2 rises because northern temperate forests go dormant and stop sequestering CO_2.

Were it not for carbon sequestration by forests, the concentration of CO_2 in the atmosphere would be rising much faster.

Massachusetts' Goal of Net-Zero by 2050

"The statewide emissions limit for 2050 was set at Net Zero, defined as "A level of statewide greenhouse gas emissions that is equal in quantity to the amount of carbon dioxide or its equivalent that is removed from the atmosphere and stored annually by, or attributable to, the Commonwealth."

From: https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2050

To do its part to mitigate climate change, Massachusetts has set a goal of net zero greenhouse gas emissions by 2050.

The Mass.gov web site states, "The statewide emissions limit for 2050 was set at Net Zero, defined as "A level of statewide greenhouse gas emissions that is equal in quantity to the amount of carbon dioxide or its equivalent that is removed from the atmosphere and stored annually by, or attributable to, the Commonwealth."

By sequestering carbon, the watershed forests mitigate climate change, and help Massachusetts achieve its stated goal of net-zero greenhouse gas emissions by 2050. This vital ecosystem service should be taken into account when managing these public forests.

Last fall I visited the Fisk Hill Young Forest Focus Area* off Rte. 202 in New Salem.

The 12.5-acre site was clear-cut last summer.

Deer and moose browse will inhibit forest regeneration at this site, as will soil compaction resulting from heavy logging machines. Invasive plants will also inhibit forest regeneration.

**DWSP Harvest Permit Number: 3173*
DWSP Proposal ID: NS-22-17
DCR Forest Cutting Plan File Numbers: 204-33999-23, 204-43061-25

Ruts in the access road show that heavy logging equipment was used.

Studies suggest that much of the stored carbon in many forest soils originates from roots and their associated mycorrhizal networks.

Heavy logging equipment compacts the soil and damages mycorrhizal networks.

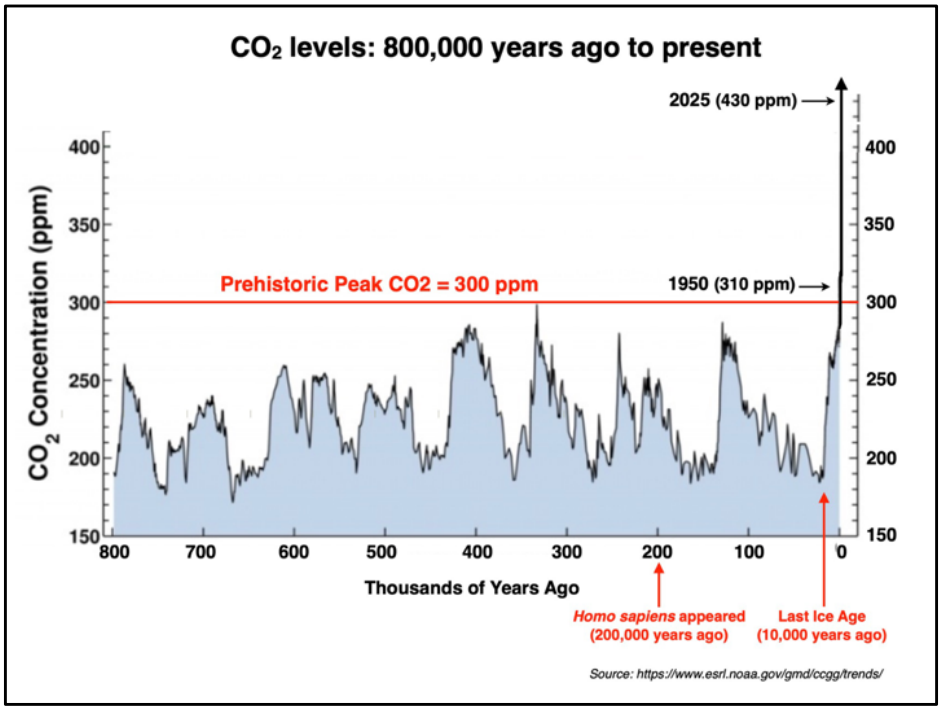
See: https://www.spun.earth/networks/mycorrhizal-fungi?gad_source=1&gad_campaignid=22524648645&gbraid=0AAAAA9rKQOOl_gBCEHOg8V-f1GMk07n6B&gclid=Cj0KCQjww8rQBhDjARIsAE43KPNjyXF11K_sjdIURgRQ7akcOHfzctqmPrbdRbV3sD8qtQcpBxdriW4aAuIVEALw_wcB

I also visited a site near Gate 31 that had been thinned last summer. Trees of varying age classes and diverse species were left behind. They are big enough to resist deer and moose browse, and will jump-start forest regeneration at this site.

Even the thinned forest near Gate 31 showed evidence of soil compaction. The dotted lines show where a rut was made by heavy logging equipment. A 2024 study entitled “Effects of Logging-Induced Soil Compaction on the Abundance and Characteristics of Fine Roots and Mycorrhizal Associations in Forest Soils and their Recovery” states:

“Soil compaction in forests, often a result of logging activities, poses a significant threat to soil functioning and ecosystem services. Root systems and their symbiotic relationships with mycorrhizae are particularly affected. Given the vital role that sustainably managed forest ecosystems play for climate change resilience and mitigation, understanding the effects of soil compaction on belowground functioning is critical. Our results suggest that different harvesting methods result in very different levels of soil compaction, leading to contrasting effects on fine root traits such as a reduction of absorptive surface area relative to biomass in compacted soil. The persistence of negative effects on the old skidding trails highlights the long-lasting impact on root systems and their mycorrhizal symbionts, and thus key ecosystem functions. This emphasizes the importance of conserving forest soils and the need to identify and implement management strategies to minimize soil compaction and promote recovery. These efforts are vital for ensuring the sustainable provision of ecosystem services by the 'hidden half' of forests.” (meaning the half that’s underground)

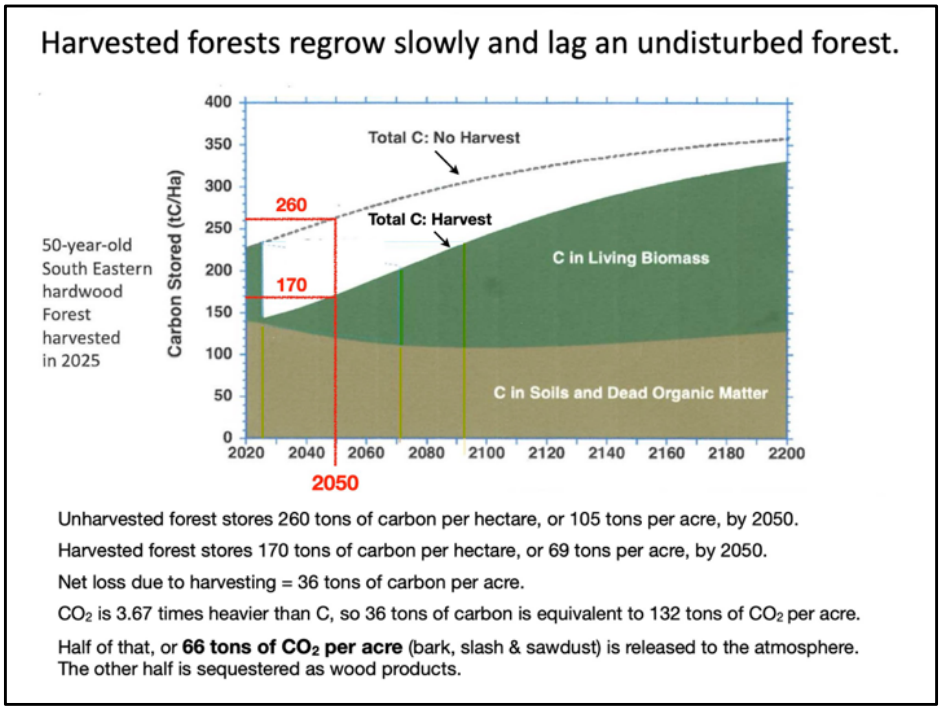
– From: https://ui.adsabs.harvard.edu/abs/2024EGUGA..2617507G/abstract



There is already far more CO_2 in the atmosphere than there has been for the past 800,000 years.

Over my lifetime, atmospheric CO_2 has risen from 310 ppm to 430 ppm, and the rate of increase is accelerating.

CO_2 in the atmosphere persists for centuries unless it is removed and sequestered.



Unharvested forest stores 260 tons of carbon per hectare, or 105 tons per acre, by 2050.

Harvested forest stores 170 tons of carbon per hectare, or 69 tons per acre, by 2050.

Net loss due to harvesting = 36 tons of carbon per acre.

CO_2 is 3.67 times heavier than C, so 36 tons of carbon is equivalent to 132 tons of CO_2 per acre.

Roughly half of that, or **66 tons of CO_2 per acre** is bark, slash & sawdust, which is released to the atmosphere as it decomposes.

From: Bulletin of the Atomic Scientists, Volume 78, Issue 3, pages 128 to 138
https://www.tandfonline.com/doi/full/10.1080/00963402.2022.2062933#abstract
https://thebulletin.org/premium/2022-05/does-wood-bioenergy-help-or-harm-the-climate/

Climeworks Direct Air Capture plant in Iceland

The Climeworks Direct Air Capture plant in Iceland removes carbon from the air and stores it underground. Last year (2025) Climeworks was charging its customers $1,000 per ton to remove CO_2 from the atmosphere*.

If it costs $1,000 to artificially sequester a ton of CO_2, then 66 tons of CO_2 per acre would be worth $66,000 per acre. Had it not been clear-cut, the value of the carbon that would have been sequestered by the trees at the 12.5 acre Fisk Hill site would have been approximately $825,000.

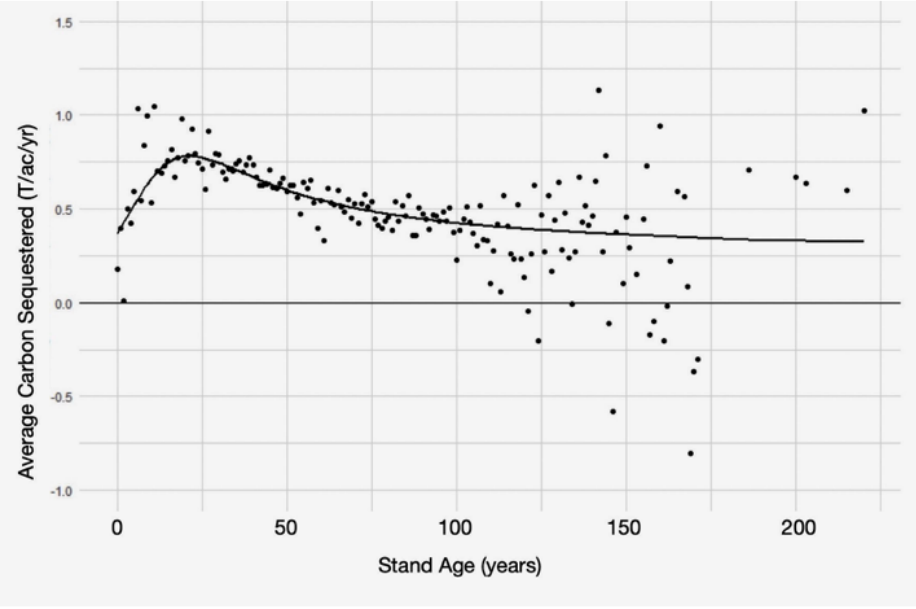
**See: https://climate.mit.edu/ask-mit/what-most-efficient-way-remove-co2-atmosphere*

- *A 34-year study has found that viable seed production in five major European forest tree species has fallen by more than 30%.*
- *Researchers said warmer summers were consistently linked to lower seed production, while moisture and spring temperatures appeared to have less influence.*
- *Oaks and Scots pine recorded the steepest declines, at about 65% and 64% respectively, according to the study.*
- *The authors said forests may continue to look intact even as their ability to reproduce and recover is already weakening.*
- *The findings raise concerns for forest regeneration, biodiversity, carbon storage and long-term climate resilience.*

According to a new study, climate change is reducing the ability of major European forest trees to reproduce, with viable seed production falling by more than 30% over three decades.

This raises concerns about the rate at which forests can regenerate after clear-cutting.

From: https://www.nature.com/articles/s41558-026-02638-5.epdf



From: "Estimating Carbon for Forest Stewardship Climate Plans" at Mass.gov

Because of the consequences of climate change for people, wildlife, and even trees, the public has an interest in maximizing the carbon-sequestering capacity of forests, especially considering the high cost of artificially removing carbon from the atmosphere, and concerns about the ability of the forest to regenerate after clear-cutting with heavy logging machines.

DCR should take that into account when developing management plans for the watershed forests.

For each project summary in its annual forestry plan, DCR should include an estimate of the amount of CO_2 that will be sequestered over the years remaining until 2050, and also an estimate of how much would be sequestered if the forest were left unharvested. "Estimating Carbon for Forest Stewardship Climate Plans" can be found on the Climate Forestry page at Mass.gov.

See: https://www.mass.gov/doc/estimating-carbon-for-forest-stewardship-climate-plans-1/download