frontiers | Frontiers in Forests and Global Change

TYPE General Commentary
PUBLISHED 25 September 2024
DOI 10.3389/ffgc.2024.1419180

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OPEN ACCESS

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RECEIVED 17 April 2024
ACCEPTED 05 September 2024
PUBLISHED 25 September 2024

CITATION
Mildrexler DJ, Berner LT, Law BE, Birdsey RA and Moomaw WR (2024) Response: Commentary: Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest. *Front. For. Glob. Change* 7:1419180. doi: 10.3389/ffgc.2024.1419180

Response: Commentary: Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest

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KEYWORDS

carbon, climate mitigation, eastern Oregon, large trees, national forests, 21-inch rule, biodiversity

A Commentary on
Commentary: Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest

by Johnston, J. D., Hagmann, R. K., Seager, S. T., Merschel, A. G., Franklin, J. F., and Johnson, K. N. (2021). *Front. For. Glob. Change* 4:653774. doi: 10.3389/ffgc.2021.653774

1 Introduction

Mildrexler et al. (2020) showed that large trees play a major role in the accumulated carbon stocks in six National Forests in eastern Oregon and Washington. Large trees (Diameter at Breast Height (DBH) $\geq$ 53 cm or 21 inches) comprised just 3% of the 636,520 trees on 3,335 plots but contained 42% of aboveground carbon (AGC) stocks.

Government policy has protected trees $\geq$21 inches DBH from being cut for the past 25 years in these forests. We stated, "Given the urgency of keeping additional carbon out of the atmosphere and continuing carbon accumulation from the atmosphere to protect the climate system, it would be prudent to continue protecting ecosystems with large trees for their carbon stores, and also for their co-benefits of habitat for biodiversity, resilience to drought and fire, and microclimate buffering under future climate extremes." Johnston et al. (2021) disagreed with aspects of our study. We respond here to the main points of their critique and continue to argue against downgrading of the "21 inch" protection (from a standard to a guideline).

2 Carbon fluxes and forest vulnerability

In response to criticism around carbon fluxes and accumulation, we note that our study included an estimate (Figure 1 in Mildrexler et al., 2020) of tree carbon accumulation by 2050 for the study area, and cited

Law et al. (2018) and Buotte et al. (2020) as providing additional support for our contention that study forests have high potential to increase carbon accumulation and relatively low vulnerability to future drought and fire.

3 Large trees and the carbon cycle

It is generally well understood that stem mass and carbon content increase nonlinearly with diameter (e.g., Luyssaert et al., 2008; Stephenson et al., 2014; Lutz et al., 2021). Our findings are consistent with those for large areas of the world's forests where about half the aboveground carbon is concentrated in the largest 1–5% of trees (e.g., Lutz et al., 2018; McNicol et al., 2018; Piponiot et al., 2022). Natural forests take time to develop, and it can take centuries for forests to reaccumulate carbon lost through harvesting (Birdsey et al., 2006; Hudiburg et al., 2009). This is an important lens through which policy—and especially changes to policy—must be viewed given their long-term implications.

It is our view that a strongly precautionary approach is required to prevent potential perverse outcomes from changes to policy. Johnston et al.'s opinion that landscape carbon stocks will be stabilized by harvesting large trees, reflects a different view as to effects of harvesting and fire on carbon storages and fluxes. Our view is informed by the large amounts of CO_2 that are rapidly released to the atmosphere following harvest (James et al., 2018; Stenzel et al., 2021). We also note that harvest-related emissions have been estimated as 5–10 times fire emissions in the region (Harris et al., 2016; Hudiburg et al., 2019). Johnston et al. state that "carbon stores in eastern Oregon's forests accumulated because fire was effectively excluded". However, fire exclusion followed many decades of logging which depleted large tree stocks (Henjum et al., 1994). It is important to recognize the historic carbon effects of harvesting and fire suppression.

We support restoration treatments that include thinning of smaller and some mid-sized trees and reintroduction of fire. These treatments are not inhibited by the 21-inch rule and exploit valuable synergies (Mildrexler et al., 2023). For example, in dry forests these treatments can help spur growth of large trees (Hurteau et al., 2019; Liang et al., 2018; Young and Ager, 2024).

4 Large tree co-occurrence

Johnston et al. argue that widespread logging of large trees will protect old-growth ponderosa pine (*Pinus ponderosa*) and western larch (*Larix occidentalis*) from large grand fir (*Abies grandis*). Using data from Forest Service inventory plots, we showed that large ponderosa pine is by far the most common tree species in our study forests and co-occurs with large grand fir on only 8% of some 3,335 plots (Mildrexler et al., 2023). It is 7 times more likely to find large ponderosa pine without any large grand fir than to find them co-occurring. In our view this spatially limited co-occurrence is an important part of the mixed conifer ecology of the study area and does not justify a policy change that weakens large tree protections.

5 Diversity of eastern Oregon's forests

Johnston et al. criticized our description of study area forests including their role in microclimatic buffering. For example, subsequent analysis showed that relatively wet fir/spruce/hemlock forest types were 12°F cooler than the dry ponderosa pine type (Mildrexler et al., 2023). Fire history studies reveal a diversity of fire regimes in moist mixed-conifer forests, including evidence of moderate- and high-severity fire. This contrasts with an historic pattern of low-severity fires regimes (Heyerdahl et al., 2001) in dry forests. We argue that Johnston et al.'s characterization of Eastern Oregon's forests as "dry" is an oversimplification, and that our description is substantially correct.

6 Changes to the 21-inch rule

Johnston et al. support a policy change that in our view weakens large tree protections for all species [United States Department of Agriculture (USDA) Forest Service, 2021]. We have previously written, "This represents a major shift in management of large trees across the region, highlighting escalating tradeoffs between goals for carbon sequestration to mitigate climate change, and efforts to increase the pace, scale, and intensity of cutting across national forest lands" (Mildrexler et al., 2023).

7 Conclusion

Protection of existing natural forests is the highest priority for reducing greenhouse gas emissions (Moomaw et al., 2019; Waring et al., 2020; IPCC, 2022; Pan et al., 2024) and we argue against policy changes that weaken those protections. We do not have time for regrowth to meet these critical climate goals (Friedlingstein et al., 2023).

Author contributions

DM: Writing – original draft, Writing – review & editing. LB: Writing – review & editing. BL: Writing – review & editing. RB: Writing – review & editing. WM: Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

LB was employed by EcoSpatial Services L.L.C.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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