Some thoughts on DellaSala Oregon forest carbon monitoring comments from 8/1/18

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Section I is primarily policy considerations which are not relevant to the monitoring report.

Section II is titled "Unsupported Statements in Christensen et al. (2017) Need to be Avoided" and responses are provided below.

1) The report sets an arbitrarily low bar of 5 MMT CO_2 e for annual sequestration levels (i.e. reference level) – this figure was ostensibly based on an unpublished report (not peer reviewed). As it stands its rather unambitious in terms of optimizing carbon in forests as current sequestration levels are nearly 8 times higher than the reference level under status quo management, thereby presenting an underwhelming picture for improvements. The ODF report should consider scientifically supported reference levels that are climatically meaningful such as increasing carbon retention timelines and sequestration levels that were most likely present before forests were intensively logged (see Mackey et al. 2013). Prior flux levels can be estimated by back-calculations from published references (e.g., Wimberly et al. 2002, also consult with Drs. Harmon and Law for back-casting methods).

   Response: the 5 MMT CO2e/yr target comes from California legislation. Oregon does not have any comparable target, so there's probably no reason to set one. If forests were in equilibrium over extended periods before intensive logging, net sequestration would of necessity be zero. The choice of any time period or "back-casting" method, published or otherwise, would be arbitrary.

2) Changes in land use are overly conservative – the report includes only forest carbon losses due to deforestation and is inexplicably silent on forest degradation even though degradation (i.e., selective logging, thinning, salvage, etc) is known to be a significant contributor to emissions (see discussion below).

   Response: Degradation is not necessarily a change in land use. In fact, the land-use change analysis, because it is focused strictly on forests, is overly liberal because it assumes that when a forest converts to a non-forest land use, all the aboveground forest carbon pools go to zero, and come from zero when the reverse is true. Selective logging, thinning, salvage, etc., are activities that are captured by the inventory and reflected in the results.

3) Tree mortality is over emphasized and taken out of context– tree mortality is highest on federal lands. However, this is likely due to forests aging overtime and storing carbon long-term in dead pools. That is - much of the carbon from tree mortality simply transfers from live to dead pools, slowly decomposing as sequestration from emerging vegetation increases. Because federal lands have more old growth than nonfederal lands, this result is not surprising nor is it necessarily an ecological concern or a need for more management. The report is also silent on carbon retention times even though long-term carbon stores (live and dead pools above and below ground) are critical to climate stabilization (see Smithwich et al. 2009, Keith et al. 2009 and see below).

   Response: Tree mortality was emphasized because California was (is?) experiencing a significant mortality event and there was a lot of interest in it. Our data show that recent mortality has resulted in increasing dead wood stores. Carbon retention times are not relevant to this report, which is

concerned with stocks and flux. The concept of carbon retention requires the assumption that there is a constant rate of change (e.g., decomposition), which is a convenient assumption but is not necessary for a measurement-based analysis of stocks and stock changes.

4) Most of C stocks are on public lands – this is critically important and as discussed above there is a need to include carbon retention times along with stocks and flows, which the report is otherwise silent on. Notably, the OGWC (2018) and published regional studies (Krankina et al. 2012, 2014) document the relative importance of federal lands in representing the vast majority of unlogged carbon-dense forests and long-term carbon stores (below). This important distinction needs to be recognized by ODF for its relative importance.

   Response: Patterns of stocks and flux in relation to ownership are embedded throughout the report. But if there's areas in the Oregon report that neglect to describe the results in the tables, that could certainly be added. As described in response to the previous point, carbon retention time is a concept that is not necessary to the assessment of current stocks and flux.

5) As noted above, the California report did not include **carbon density** estimates in relation to published accounts and C retention times per forest type, ecoregion, and landowner -- a discussion of why this is important from a climate and ecological standpoint would be value added.

   Response: Carbon density estimates were not requested by the California stakeholders, although the data to calculate overall estimates (area and total carbon stocks) are presented in the tables. It is certainly doable if it is of interest to Oregon stakeholders. As mentioned above, C retention times are not useful or necessary for this analysis. The California report does include comparison to other statewide carbon estimates, and we plan on doing that for Oregon. Many of the published studies focus on a much more restricted land-base (e.g., westside old growth) so it's not clear what the comparison with the representative FIA database would buy you. Regardless, some of those comparisons have been published already (Gray et al. 2014a, b).

6) If all sectors are required to reduce emissions to 1990s levels – forestry – even as a net sink – needs to reduce its emissions as well. The OGWC (2018), for example, recommended that net forestry emissions be reduced even though the state's forests are currently operating as a carbon sink. That is –status quo management is not an acceptable reference, additionality and long-term carbon storage are what matters most climatically and ecologically.

   Response: This is a policy issue that is outside the scope of the FIA-based report on stocks and flux.

7) "Promote afforestation/avoid deforestation associated with land-use change." While this is important, there's no mention of emissions from **forest degradation** as noted. The ODF report needs to split out carbon flux associated with deforestation vs. that associated with forest degradation in order to ensure reliable accounting (see below). Also, in situations where clearcut logging takes place, replanting forests does not compensate for emissions from logging as replanted forests can take decades to centuries to recoup the carbon emitted from logging operations depending on site conditions, timber harvest methods, and forest age classes.

   Response: If "forest degradation" could be defined in a way we could interpret from the data, we might be able to report on those forests as a separate category if that was desired. Regardless, the FIA estimates measure flux on all stands managed (or not) in any manner that might be desirable (or not).

The statement on afforestation/deforestation was taken out of basic IPCC and other basic science recommendations (e.g., McKinley et al. 2011).

8) The report recommends increasing C stores through "sustainable forest management practices." What does this really mean? It's undefined and nebulous. See Law et al. (2018) for some general recommendations to consider in the ODF report.

Response: The report mentions this as one option to increasing stores. There are many approaches to management that can include in-forest carbon stores. Listing them is outside the scope of the report.

9) The report recommends considering the age of the stand and other forest management objectives. Ecologically, and from a carbon standpoint, old forests are unequivocally important in carbon stores, ecosystem services, biodiversity, and resilience to climate change (see Keith et al. 2009, Olson et al. 2012, Brandt et al. 2014, Frey et al. 2016, Strassburg et al. 2017, Griscom et al. 2017). This should be emphasized by ODF to avoid similar short comings.

Response: The "ecological importance" of stands of a particular age is outside the scope of the report.

10) The report recommends "managing forest densities and fuels where appropriate." What does this mean and how will it affect carbon stores (i.e., C retention times will go down and C flux from management will go up, yet no mention of this in their report).

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

11) The report recommends "increasing C in HWP pools including wood used for energy." No life cycle analysis is provided to support this assertion (but see Scharlemann and Laurance 2008, Searchinger et al. 2009, Hudiburg et al. 2014, Law et al. 2018 for significant woody biomass emissions and concerns).

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

12) The report again states "consider wood energy and material substitution effects." No life cycle analysis or literature review is provided to support this assertion.

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

13) The report recommends "fuels management treatments on federal lands to reduce the risk of catastrophic wildfire." This finding is unsupported as stated above regarding the relatively low emissions from wildfires vs. thinning (i.e., Figure 6 above). Wildfires also are not ecological

catastrophes (see DellaSala and Hanson 2015) and the report statement reflects an inherent bias regarding the ecologically beneficial role of wildfires.

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

14) "Work with other agencies and legislative authorities to ensure development of policies, infrastructure and funding to support fuels reduction and biomass utilization." Same comment as above – unsubstantiated assertion that contradicts findings on wildfire emissions compared to harvest emissions.

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

15) "C removed from the atmosphere by forest growth or stored in harvested wood products for the U.S. in 2015 were estimated to offset 11.8% of U.S. emissions from industry and agriculture." This statement needs context, particularly in comparison to long-term carbon stores in forests vs. wood products (see OGWC 2018 for contrary statements about stores in forests being much longer than that in materials). The main point of a climatically meaningful framework should be to reduce emissions from ALL sectors – forestry an important emission source that can be actively reduced – so how will that be accomplished?

Response: The report summarizes research and findings from a variety of publications. The guidance in the report was to follow IPCC accounting, which treats forest industry emissions as part of the manufacturing sector, not the forest and other lands sector. While alternative accounting frameworks are indeed possible, this is not a policy document. The focus is on in-forest stocks and change, and harvested wood products stock and change. Interested parties are welcome to interpret the results using whatever accounting method they deem most appropriate.

16) "Another concern with increasing carbon stores in forests is the notion of permanence; areas that are fire-prone are at higher risk that live trees will be killed and C lost to fire and decay, especially in forest types where denser (higher C) forests are likely to burn at higher severity." While this statement may be true, it is out of context and needs to be based on literature showing carbon removed from the forest by logging typically exceeds that emitted in most forest fires, even severe ones (as noted above). Additionally, most of the C in a fire is not lost to the atmosphere – by comparison, only the living biomass (foliage, duff layer) is combusted in severe fires (a relatively small proportion of large fire complexes) with most of the remaining carbon unaffected or transferring from live to dead pools.

Response: The report attempts to cover the range of options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

17) "The use of harvested wood and wood products may reduce overall C emissions through their use as biomass energy in situations where the use of wood as biomass for fuel results in fewer C emissions from the use of fossil fuels. Another effect of using wood products could be through

substitution of wood instead of steel or concrete, which result in more C and other greenhouse gas emissions to produce." Again – this statement is falsified by the published literature and lacks carbon life cycle analysis (see Scharlemann and Laurance 2008, Searchinger et al. 2009, Hudiburg et al. 2014, Law et al. 2018).

Response: The report mentions many options and considerations for management that have been discussed in the literature (e.g., McKinley et al. 2011). Further details are outside the scope of the report.

18) "Only on reserved forest lands managed by the USDA Forest Service are carbon losses from mortality in the live tree pool estimated to exceed gains from live tree growth." Notably, this is likely due to forests maturing, which is ecologically desirable. As noted, most carbon from tree mortality is transferred from live to dead pools and not emitted all at once.

Response: Actually the pattern is driven by most of the forests already being near C density carrying capacity and some of those forests experiencing high-severity disturbance (fire). We made clear in multiple places that mortality involves a transfer from the live pool to the dead. What is "ecologically desirable" is outside the scope of this report.

19) "Additionally, as the forests age in unharvested stands, growth rates slow. Older forests tend to store more carbon, but they might not accumulate new carbon as quickly as younger, fast-growing stands. Consequently, the stocks and flux represented in this report may not be sustainable in the future without forest management." This statement is largely conjecture and unsupported (see Keith et al. 2009, Smithwick et al. 2009).

Response: True, the last sentence is conjecture; it is not clear that forest management can substantially change those patterns and that statement should be removed. The rest of the statement is basic biology that has been confirmed in dozens, if not hundreds, of studies (e.g., Gray et al. 2016).

Key Literature and Data Analysis Suggestions

I have attached several pdfs of published studies on forest ecosystems, wildfires, and carbon in the Pacific Northwest of direct relevance to the ODF report. In addition, I am requesting that you consider the following in the ODF report:

- Include a comprehensive literature review of forest carbon stocks, fluxes, emissions from logging, wildfire, and other natural disturbances along with statements regarding degrees of confidence (uncertainty) in key findings based on the FIA analysis (see attached Memo from Dr. Mark Harmon on datasets and methods).
- Compare annual emissions from logging with other sectors (CO_2 e). ODF should use the social cost of carbon to evaluate long-term potential impacts to human health and socio-economic systems from emissions[5].
- Provide breakdown of forest carbon stores by ecoregion, forest type, and landowner.

- Provide spatially explicit identification of high carbon stores (see Krankina et al. 2014 for published carbon density thresholds) overlaid on land use (GAP land use codes 1-4 –protected to intensively managed – see Krankina et al. 2014). It should be noted, and emphasized in the ODF report, that at least in the tropics about 1% of the oldest trees store more than 50% of the carbon in Amazonia (Fauset et al. 2013) and old forests globally are critical to climate stabilization (see Keith et al. 2009).
- Provide a graphic displaying carbon retention times by ownership (at a minimum), forest type, and ecoregion (see figure below) and discuss the value of long retention times.
- Overlay tree mortality with forest age classes to determine if mortality is associated with forest maturation.
- Include a comprehensive review of carbon stores and flux prior to industrial logging (e.g., see Wimberley et al. 2002) as a reference or discussion point for comparison to current emissions and any other reference levels chosen.
- Provide a literature review of wood product stores using five steps noted above.
- Include a comparison of carbon stores/flux using FIA datasets vs. the NECB dataset in Law et al. 2018.
- Correlate (or cite) high carbon density areas with other ecosystem services and biodiversity (see Brandt et al. 2014, Strassburg et al. 2017).
- Discuss emissions from deforestation and **degradation**, including the contribution of roads, pesticides, herbicides, burning of slash, etc. While difficult to estimate, forest degradation plays a significant role in emissions. Notably, the UN REDD+ programme recognizes degradation as an emissions source that needs to be reduced[6]. Methods for monitoring degradation have been employed in tropical rainforests (see Houghton 2012). Comparable methodologies are needed in the US in order to comply with global accords such as the Paris Climate Change Agreement and the Aichi biodiversity and sustainable development targets[7], in addition to ensuring that emission estimates are accounting for all significant atmospheric contributions.

Responses:

- I have not seen Harmon's memo on uncertainty but could certainly consider his approach.
- This report is designed to be a comprehensive summary of carbon stocks and flux in Oregon; other than a basic summary of the carbon cycle in forests, an in-depth literature review of other research on carbon is outside the scope of this report.
- Logging emission are not part of the forest land sector as defined by IPCC and outside the scope of this report. We do report net changes on lands that were harvested.
- We could do a stock breakdown by ecoregion, forest type and landowner, if it's not already in there.
- Spatial modeling is outside the scope of this report. We provide design-based estimates with a minimum of assumptions.
- Calculation of C retention times and their required assumptions are outside the scope of this report and unnecessary to understand the basic questions of interest.
- Stand age becomes an ambiguous variable in uneven-aged stands and was not of interest in the California report, but analyses of mortality with stand age be included in this report, if desired.
- Conjecture on stocks and flux prior to industrial logging in the state is way outside the scope of this report.

- To the extent we can compare apples to apples, we will do basic comparisons of results with other research, including Law et al. (2018).
- Analyses of biodiversity and ecosystem services is way outside the scope of this report.
- Degradation has not been something treated in the US NGHGI and other IPCC reports we have based this report on. Houghton (2012) does not appear to be a definitive framework for monitoring degradation, which would apparently include any management that reduces biomass density (e.g., thinning). We already report on flux on lands that have experienced any kind of harvest (thinning as well as clearcutting). Is more information desired?

Literature cited

Gray, A. N. and T. R. Whittier. 2014. Carbon stocks and changes on Pacific Northwest national forests and the role of disturbance, management, and growth. Forest Ecology and Management 328:167-178. http://www.treesearch.fs.fed.us/pubs/46566

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