A review of the California Forest Carbon Plan: Draft for Public Review, released on January 20, 2017

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Background

In late January of 2017, I was approached by Susan Robinson of Ebbetts Pass Forest Watch and asked if I could provide a critical review of the California Forest Carbon Plan - draft public review version (hereafter referred to as the CFCP) based on my professional expertise on forest carbon dynamics. After a brief conversation clarifying the scope and independence of my review, I agreed to prepare and deliver a document articulating the strengths and shortcomings of the CFCP as I saw them, in return for a modest consulting fee. The views and opinions expressed in this review are mine only do not necessarily reflect that of other individuals, or organizations.

Summary

The CFCP advocates for increased logging and prescribed burning on public forest land and a continuation of business-as-usual logging on commercial forests. A case is made that both these actions result in favorable ecological, economic and social outcomes and that under this management regime state-wide forest carbon stocks will, in future decades, aggrade to levels higher than they are today. While the arguments in favor of forest restoration are generally defendable, the actions proposed by the CFCP rely almost entirely on a single dogmatic narrative of improved forest health through harvest without acknowledging the roll natural disturbance can play in maintaining healthy forest function or the easy carbon savings that would result from increasing rotation lengths on lands managed for timber production. The degree to which the CFCP would accelerate the restoration of historic structure to certain fire-prone pine forests in California, it has my endorsement. However, I believe an improved forest carbon plan would: 1) less often conflate climate adaptation through managed resilience with climate mitigation through carbon sequestration, 2) explicitly embrace natural disturbance as part of the solution rather than part of the problem, and 3) rely less on existing rubrics of sustainability to keep commercial timberland carbon neutral and resilient to disturbance. In the sections below I elaborate on these three themes and provide advice on how these shortcomings may be addresses while keeping within the stated objectives and scope of the CFCP.

Conflating forest health with carbon storage

I agree with the CFCP that thinning certain over-stocked forests in fire-prone landscapes represents a wise balance between climate mitigation (afforded through maximizing carbon storage) and climate adaptation (afforded through increased

resilience to climate driven stressors), but any suggestion that this plan maximizes both adaptation and mitigation is a falsehood.

Too often, the CFCP mistakenly implies that increased tree harvest and wood utilization drives increased carbon storage. When at best such activities can be compatible with increased forest carbon storage above current amounts while providing a level of ecological services much greater than if forests were managed solely to maximize carbon storage. Throughout the CFCP it is asserted that reductions in forest carbon stocks associated with restoration thinning will be replaced by growth of the remaining trees within a few decades, but the reader is regularly led to believe that such growth and storage would not occur without the thinning (pages 9, 10, 48, and 61). While it is true and well-established that thinning can redistribute productivity to remaining trees, I am unaware of a single study, or plausible mechanism, by which tree removal increases stand-level productivity (and by extension carbon stocks). For instance, the CFCP fairly cites Battles et al. (2015) as empirical evidence that thinned forests can "within a decade or two" regain the carbon lost due to the removal of smaller trees, but fails to acknowledge that the un-thinned control forests in this same study continued to grow over this period and, at all times, contained more carbon that the thinned ones. Even when one considers the protection thinning affords forests from carbon losses in high-severity fire, thinned forests contain less carbon over space and time than do fire suppressed ones (provided conditions afford timely post-fire regeneration). Such is well-established in several reviews of the subject, all of which are notable missing from the CFCP citations (Campbell et al., 2012; Restaino and Peterson 2013; Young, 2015; Kalies and Kent 2016).

Does this mean thinning forests cannot be part of a plan to keep forest carbon stocks growing in California? Does this mean that restored thin forests can't contain more carbon tomorrow than their fire-suppressed counterparts do today? Absolutely not. However, for the CFCP to maintain its integrity and ability to withstand future scrutiny, it should be more transparent regarding the carbon costs of maintaining fire-resilient forests and describe restoration for what it is: a deliberate and desired departure from our current trajectory towards even denser forests. To better, and more accurately, articulate the CFCP's balance between historical resilience and maximum carbon storage over space and time, I suggest three revisions to the document.

First, the CFCP should emphasize and reiterate its statement: "Accumulating evidence suggests that in Mediterranean-climate forests such as those of California, the optimal, resilient level of carbon storage in living trees is much less than what the site can maximally support at a given point in time" (page 48). Framing all subsequent endorsement of thinning in this larger narrative would help the CFCP better advocate for restoration.

Second, CFCP should consider adopting the conceptual narrative of Loudermilk et al. (2014) who argues that certain forests maintained at low density, over time and space, can contain *more* carbon than dense forests do now, *less* carbon than dense forests would later (even when subject to fire), and *potentially more* carbon than dense forests would later in the event that climate change significantly compromised their capacity to regenerate after disturbance. Such a narrative captures the concept of "safeguarding" against forest collapse while also acknowledging the perpetual carbon costs of doing so.

Thirdly, the CFCP should state clearly that a contribution by the forest sector to California's commitment to reduce carbon emissions need not maximize forest carbon storage, only grow it from current levels. As such, the base line to which future carbon stocks should be measured should be current forests now (prior to proposed restoration) not future forest conditions if left untreated (which by the CFCP's own buried admission) would render restoration as a loss. As written, the CFCP already assumes this rubric, but rather than stating it clearly, the document too often leads the reader into thinking its plan to "safeguard" carbon in forests is one also that maximizes it.

Failure to embrace natural disturbance as part of the solution rather than part of the problem

Throughout the CFCP, wildfire, insect mortality, and drought mortality are all described as undesirable carbon losses to be mitigated through preemptive thinning when it is generally understood that California forests are in need of more fire not less (Stephens et al., 2007; Marlon et al., 2012; Baker, 2015) and that insect mortality, and drought mortality function primarily to thin forests (Harvey et al., 2013; Meigs et al., 2016), much like that proposed through selective harvest. Clearly, prescribed thinning, unlike natural mortality, can insure retention of the most desirable trees, and prescribed fire can be conducted to minimize smoke pollution relative to that of wildfire. However, the severity distributions of wildfire in most California forest types today are not substantially different than they are thought to have been historically, and are only slightly skewed toward high severity among the lower-elevation pine forests typically targeted for restoration (Riely et al., 2017).

Why should the CFCP embrace natural disturbance as part of the solution? Simply put, all evidence points towards an increase in natural forest mortality in future decades, and a plan based primarily on fighting this trend with selective harvest is doomed only to fail. Explicitly acknowledging natural disturbance as an acceptable means by which to restore natural, resilient function to fire-suppressed forests would go a long way to improve the credibility of the CFCP, but the document need also rectify a persistent mischaracterization of dead trees as solely a source of carbon emissions compromising the capacity of California forests to function as net sinks. So long as mortality outpaces decay, which appears to be the case for many California forests today, dead trees collectively represent an aggrading carbon pool, not a shrinking one; just like that regularly claimed to occur in products made from wood thinned from forests. Moreover, there is no evidence I am aware of that trees surviving pulses of natural mortality pulses do not experience compensatory growth in the same manner in which trees surviving selective harvest are regularly claimed to. As currently written, the CFCP is peppered with claims that dead trees are driving California forests into a net sink (pages 1, 49, 59, 62, 75), but nowhere is this miss-calculation so glaring than in Tables 12 and 13 where forest carbon balance is compared across ownership classes. In this otherwise informative section, net forest carbon stores are calculated as growth minus mortality minus harvest when net forest carbon stores are, by definition, growth minus decomposition of dead trees minus harvest. Simply put, the sequestration of carbon in forests is defined by stocks, not fluxes, and dead trees are carbon stocks

which function to keep carbon away from the atmosphere regardless of the fact that they are releasing it. The CFCP's dogmatic obsession with minimizing natural mortality, dismissing dead trees as a carbon loss, and building markets to afford their salvage runs counter to its stated objective of thinning forests, returning natural disturbance to the ecosystem, and building carbon stocks on the landscape.

Overreliance on existing accounting schemes to keep commercial timberland carbon neutral

Frank declarations regarding the "differing imperatives" between public forests and privately owned timberland (page 104) are indeed a useful starting point in discussing the role production forests may play in achieving state-wide carbon balance goals. Unfortunately, the CFCP goes on to rely almost entirely on the existing California Forest Practice Act and Rules to insure carbon neutrality in privately owned forests without any critical assessment as to whether these rules are appropriate for assessing carbon balance or whether management practices deemed sustainable in past years will be reliably so under future climate conditions. Moreover, the CFCP appears to embrace, without critical assessment, some rather far-fetched assertions that "managed forest stands show substantial carbon sequestration benefits over unmanaged stands" (page 71)

I realize that a comprehensive re-evaluation of California's Forest Practice Act and Rules is beyond the scope of the CFCP, but to best insure the goals of maintaining carbon storage across all forest lands of California, the CFCP should propose contingency plans for the modification of harvest practices (if even voluntary) in the event that current rubrics of sustainability fail to grow carbon on private lands under a changing climate. Such contingencies should be uncontentious since, unlike carbon storage on public land (which is admittedly complicated by nuanced and scale-dependent issues such as multi-use and resilience to stochastic events), carbon storage on production timberland is easily tuned by adjusting rotation interval (Harmon et al., 1990; Mitchell et al., 2012). In short, the California's Forest Practice Act should be a starting point, not an ending point for the CFCP objectives.

Regarding assertions by the CFCP that forests managed for timber production function to store more carbon than unmanaged ones, the citations provided are insufficiently documented to back such claims and appear to be based on several false or exaggerated assumptions. A creditable CFCP should better scrutinize these assertions keeping in mind these three facts:

First, when un-merchantable harvest residue, finds its way to a mill, utilizing it for energy through combustion is reasonable, but to credit this entire carbon stream as a carbon offset denies the fact that a an equal amount of energy could have been acquired through the combustion of much less fossil fuel and the fact that energy demand by the mill was itself created by the harvest. As it pertains to the objective of the CFCP, fuel offsets should apply only to any residual energy sent to independent users, with the additional realization that just because a fuel source is renewable does not make it carbon neutral (TerMikaelian et al., 2015)

Second, the use of wood products often involves less energy for manufacturing than some other materials used for building, but it is not always clear how much of this

energy is fossil-based, whether the amount of carbon involved in fossil energy is constant, or whether the amount of energy involved is constant over time. Some of these factors would likely lower the initial displacement of fossil carbon and reduce the long-term benefits.

Thirdly, despite noted improvements in wood utilization and disposal methods over the last couple of decades, the longevity of forest biomass once harvested is, by the CFCP's own calculations, not substantially different than a dead tree left in the forest to decay and or combust. Citing Smith et al. (2006), the CFCP claims that after 100 years, approximately 61% wood product carbon is release to the atmosphere, yet after the same period, dead bole wood left to decay and combust in the forests releases approximately 63% percent of its carbon into the atmosphere (Campbell et al., 2016). This parity in decomposition leaves long-term landfill storage as the only demonstrable difference between trees left to decay in the forest and those entering the product stream, which necessary comes at the cost of reducing time-averaged forest carbon stocks (Stewart and Sharma, 2015).

In addition to weak logic regarding the capacity of production forests to store carbon, there exists a double standard in the CFCP regarding the preceded threats posed by high tree density on public versus private lands. While there seems to be a rush to thin fire-suppressed forests on public land in order to reduce future drought and fire mortality, the CFCP makes no mention of the need to do so on production forests, which by design have higher water demands and canopy fuel densities. Obviously, a certain tree density is required to keep production forests profitable, but if the authors of the CFCP feel so strongly that healthy forests of the future must be thinner than they currently are, then such must also apply to the large fraction of California forests managed for timber production.

I acknowledge that timber production is an exceedingly important part of California's economy (especially for certain rural communities), California and the world over need wood, and that wood can be produced from California forest in a carbon-neutral manner. In general, the CFCP has done well by including commercial timber production in their overriding carbon plan. However, to embrace in totality claims that managed forests do a better job than unmanaged ones in sequestering carbon from the atmosphere leads inevitably to one awfully-strange conclusion: maximum carbon storage by California forests would be achieved by converting all forest lands into young production forests subject to comprehensive fire suppression, and that our best hope for sequestering carbon from the atmosphere lies in the expansion of the build environment. The CFCP can do better than to fall into this trap, while also acknowledging the needs to generate timber and profit from privately owned forests.

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