REVIEW

of Sierra Pacific Industries Report

"Carbon Sequestration in Californian Forests: Two Case Studies in Managed Watersheds"

by C. James, B. Krumland, and P. J. Eckert

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Prepared by Dr. Olga N. Krankina
Department of Forest Science
Oregon State University
Corvallis, OR 97331

for
Defenders of Wildlife
Sierra Forest Legacy
Forests Forever
ForestEthics
Ebbetts Pass Forest Watch

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Summary

The Sierra Pacific Industries Report "Carbon Sequestration in Californian Forests: Two Case Studies in Managed Watersheds" evaluates 4 management scenarios (3 scenarios with initial condition reflecting current status of forest stands and one theoretical scenario representing "normal" or "regulated" forest). While the press release and the text of the report emphasize the advantages of intensive management scenario, the calculation results indicate that within the first 40-60 years of future projections the "custodial management" scenario leads to greater carbon storage than the intensive management scenario. Thus the conclusions of the report are not fully consistent with the results of calculations. This inconsistency is significant because the effects of carbon removal from the atmosphere are critical within the next decades and the time horizon of policy decisions tends to be even shorter.

The approach adopted in the report includes several assumptions that bias the results in favor of intensive management. The model projects carbon yields in Ponderosa Pine plantations sustained through age 80 at the level twice as high as naturally regenerating mixed conifer stands and this projection appears unrealistic. If in fact the growth rates of plantations decline with age this would reduce the carbon gains in intensive management scenario. While the assumption regarding the long-term growth rates of plantations seems questionable, the assumption that harvest residues and wood products begin to accumulate at the start of the projections is demonstrably untrue. The report does not include any specifics on past timber harvest but it mentions the fact that virtually all the stands in the examined watersheds are second-growth. This suggests wide-spread past harvest that had to result in substantial carbon stores both in harvest residues and in wood products. New harvest would offset some of the decomposition losses in these pools but it is unclear if any real net carbon gains would occur. In addition, stasis is assumed for all dead biomass pools including snags and forest floor (which has to include logs even though they are not mentioned). In reality, logs and snags are created by tree mortality and are **NOT** in stasis (equilibrium) when there is a change in forest management. These are significant carbon pools and losses from these pools were shown to be a major source of carbon to the atmosphere as old-growth forests were harvested in the PNW. As forest stands grow older, dead biomass pools increase unless timber harvest removes live trees. Aggressive management reduces tree mortality which is input into dead biomass carbon pools; the result is the extremely low level of dead biomass, especially coarse woody debris in intensively managed forests. Omission of the essential link between live and dead biomass pool is a major flaw of the report that likely biased the results in favor of intensive management scenario.

Some aspects of carbon calculations employ sound methods described in great detail but several critical pieces of information are missing making it impossible to fully understand the results. The most important among the missing information is the history of timber harvest and resulting distribution of forest stands by age classes; this is a major factor that controls future change in carbon pools. Furthermore, there is no indication of how (if at all) the response to thinning was accounted for both in terms of growth of the remaining tree stand and regeneration/ingrowth. If the model in fact assumes no growth response to thinning and no regeneration resulting from opening of the tree canopy this would bias the results against thinning and in favor of clearcutting. The report did not consider non-intervention scenario or "business as usual" baseline for Sierra Pacific Industries operations.

Introduction

This review was prepared at the request of ForestEthics, Defenders of Wildlife, Sierra Forest Legacy, Forests Forever, and Ebbetts Pass Forest Watch to assess the scientific merit of the materials presented in Sierra Pacific Industries Report "Carbon Sequestration in Californian Forests: Two Case Studies in Managed Watersheds" (further referred to as SPI Report). The review evaluates the overall approach, assumptions, methods, results and their interpretations. The critique of the report focuses on flaws that are significant for results and policy recommendations; minor errors, inconsistencies, and inaccuracies in terms are not discussed. The focus of the review is on policy-relevant information contained in the report and no policy recommendations are provided or implied.

Methods and Assumptions

Scenarios.

The report examines four management scenarios including Custodial Management (light to moderate selection harvests), Option C Selective Management (heavy thinning that reduces the stocking to minimum allowed level), Intensive Management (converting all remaining mixed conifer forests to Ponderosa Pine plantations with 80-year rotation age), Regulated Management (hypothetical – even distribution of plantations by eight 10-year classes). While the first three scenarios are generally comparable as they are initiated with the results of forest inventory, the fourth scenario cannot be directly compared to the first three as the initial condition is the fully established "normal" or "regulated" forest. This starting point is achieved by the Intensive Management Scenario after 80 years. Therefore direct comparison of projected gains in carbon pools that involve Regulated management Scenario (e.g., p. 3; bottom paragraphs) is inappropriate. Note that the Business as Usual scenario (showing the long-term effects of current company management extended into the future) was not included in the report and neither was a "no management" scenario (showing the long term effect of natural processes of carbon exchange between the existing forest stands and the atmosphere). The latter two scenarios would be critical for a meaningful assessment of the role of forest management practices.

Carbon Pools.

Estimation methods for live biomass components are carefully documented and appear solid. However, the transitions from live to dead biomass pools are not properly accounted for. For example, stasis is assumed for all dead biomass pools including snags and forest floor (which has to include logs even though they are not mentioned). As a result, the SPI projections do not include losses or gains in dead biomass pools. In reality, these pools are created by tree mortality and are NOT in stasis (equilibrium) when there is a change in forest management. These are very significant carbon pools and losses from these pools were shown to be a major source of carbon to the atmosphere as old-growth forests were harvested in the PNW (Harmon et al. 1990). As forest stands grow older, dead biomass pools increase unless timber harvest removes live trees. Aggressive management reduces tree mortality which is input into dead biomass carbon pools; the result is the extremely low level of dead biomass, especially coarse woody debris in intensively managed forests. There is a vast body of literature on the subject. Omission of the essential link between live and dead biomass pool is a major flaw of the report that likely biased the results in favor of intensive management scenario.

The only context where the transition from live to dead biomass is actually accounted for involves timber harvest and associated production of logging residue and wood materials. However, in this case it is assumed that harvest residues and wood products begin to accumulate at the start of the projections and this assumption is demonstrably untrue. The report does not include any specifics on past harvest but it mentions the fact that virtually all the stands in the examined watersheds are second-growth. This suggests wide-spread past harvest that had to result in substantial carbon stores both in harvest residues (including stumps, tops, roots, branches decomposing over time) and in wood products. New harvest would offset some of the losses in these pools but it is unclear if any real net carbon gains would occur.

The assumption that forest products taken out of service and transferred to landfills retain carbon in perpetuity (p. 29; bottom) is clearly untrue. While the decomposition is slow in landfills it does occur and carbon is gradually released into the atmosphere. The no-decomposition assumption is yet another one that biases the results in favor of intensive management scenario.

Finally, the assumption that wood products are taken out of service at an annual rate of 1% per year is also unrealistic. This would imply that 50% of long-term wood materials produced in 1930-ies are still in service today.

Response to thinning. The report text does not describe if and how the response of forest stands to thinning is simulated other than "reducing the basal area and 'reseeding' the model for future forecasts" (p. 47 last paragraph). From the presentation of results (p. 31) one can surmise that the model assumes declining growth rates as the stands get older and no regeneration/ingrowth occurs in response to repeated thinning. In reality mixed conifer forests can be expected to produce an abundant and productive new generation of trees after the main canopy is thinned (e.g., Zald et al. 2008-in press). While the available data on growth and regeneration response to thinning of mixed conifer stands may be limited, assuming that there is no response at all obviously biased the results in favor of the Intensive management scenario.

Projected growth of Ponderosa Pine plantations. The SPI Report admits that "Ponderosa pine plantation management is in its relative infancy in California" (p. 48) yet they project the growth of these plantations at twice the rate of native mixed conifer stands AND assume that this growth rate can be sustained through age 80, even though the only data available for older managed ponderosa pine plantations comes from "a few" stands 50-70 years old. Clearly, the assumption of high growth rates sustained throughout the 80-year rotation is poorly supported by data, yet it is a critical assumption that results in unrealistically high carbon store and yield projections for "regulated management scenario" and for the rapid increase in carbon stores projected for intensive management scenario as greater and greater proportion of forest lands is converted to plantations (Figures 12.2, 12.3 and 12.4).

Results and their interpretations.

Change in carbon pools over time as reported on Figure 12.2 indicates that among the 3 comparable scenarios (i.e., excluding the theoretical "regulated scenario") the least intrusive "custodial management" results in greater forest carbon pools during the first 40 years of projection period for Upper San Antonio Creek watershed and during 60+ years in Canyon Creek watershed. When the total carbon pool is considered (including harvest residues and wood

products; Figure 12.4) there is little difference among the three comparable scenarios during the first 40 years of projection period, but still custodial management results in slightly bigger carbon pools. Thus during the time period that is both policy-relevant and critical in terms of addressing climate change the custodial management gives better results than other management scenarios (!). This is a truly amazing result considering that the calculations were biased in favor of intensive management scenario as described above. Nevertheless the SPI Report concludes in summary on page 3 (bottom) that "Intensively managed and regulated forests show substantial increases in the forest carbon pool and total carbon pool yield when compared to the other more extensive Option C Selection and Custodial management approaches." This is also the main message of the press release based on SPI Report. These conclusions of the SPI Report are supported by calculation results only for the last 3-4 decades of the 100-year projection period, but they are untrue for a significant (and the most policy-relevant) portion of the time-interval examined.

The role of wood products and harvest residues is very important in supporting the conclusions of SPI Report: they account for more than a half of all carbon gains projected for Intensive management scenario. Yet, the estimated increase in carbon pools associated with wood products and harvest residues is the function of assuming that these pools are at zero level at the start of the planning period and this assumption is clearly untrue.

Missing considerations and information

History of forest harvest, other disturbance, and resulting distribution of forest stands by age classes in not presented. Past management is a major factor that shapes future patterns of carbon accumulation and loss in forest landscapes (e.g., Alig et al. 2006). The SPI Report gives some indications that the examined forest landscapes were heavily harvested in the past, including a nearly 30% increase in carbon stores for custodial management scenario during the first 60 years of projections in Canyon Creek watershed. Using forest landscapes heavily harvested in the past as the starting point for future projections minimized losses associated with harvest of existing stands as the land is converted to Ponderosa Pine plantations in intensive management scenario. For landscapes with higher stocking and less harvest impact in the past the losses associated with conversion to plantations would be greater.

No management intervention scenario is not considered. Reduction of timber harvest in PNW National Forests resulted in dramatic increase in forest carbon stores (Alig et al. 2006). Figures in Appendix I suggest that allowing the existing mixed conifer forests attain age 160 years would result in forest carbon pool that is more than twice as high as the average forest carbon store in a regulated scenario for plantations.

The risk of fire is not considered even though the examined watersheds are located in a forest region with considerable fire risk. While the risk of fire and associated carbon emissions apply to all management scenarios the impact of fire on carbon stores can be expected to be higher in Ponderosa Pine Plantations than in native mixed conifer stands. Including the potential impact of fire would reduce the projected carbon pools for all scenarios, but more so for intensive management and regulated scenarios.

In conclusion, there are several significant flaws in the approach adopted by the SPI Report and these flaws likely bias the calculation results if favor of intensive management scenario. Even with that apparent bias, the results indicate advantages of less intrusive management (custodial management) at the time scales that are relevant for policy decisions (years to decades).

References

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