A Review of SPI's study: "Carbon Sequestration in Californian Forests; Two Case Studies in Managed Watersheds"

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Sierra Pacific Industries (SPI) recently released a study[1] which purports to compare the total amount of carbon sequestered under three different forest management scenarios[2] for two different forested watersheds in the Sierra Nevada. The report concludes that a transition to forest plantations in which existing forests are replaced with genetically-selected, even-aged, monocultures – termed the "Intensive scenario" – would result in an increase in sequestered carbon of 75 to 95 tons C/acre[3] over 100 years compared to minimum compliance with Option C of the California Forest Practice Rules.[4]

As detailed below, the SPI study raises numerous methodological and policy issues that call into question both the quantitative conclusions and the value of those conclusions for the development of climate policy. A critical review of this study demonstrates that, contrary to the report's conclusions, replacing existing diverse forests with uniform tree plantations is unlikely to produce significant carbon benefits and will instead increase the risk of catastrophic fire and threaten the extensive range of benefits provided by existing forest ecosystems. This memo provides an overview of methodological problems with the analysis, offers revised estimates of the carbon savings from each of the three scenarios, and concludes with a discussion of the key policy issues raised by the SPI study

Methodological problems with the SPI study include the following:

- The SPI analysis is based on a non-peer-reviewed, unvalidated statistical model. While the authors acknowledge that their model violates normal statistical conditions, they reject alternative, unbiased approaches because they would be "tedious." (p. 43-45)

- GHG emissions from logging, transport, and landfills are ignored or assumed to be zero even though the Intensive management approach is likely to have significantly

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[1] "Carbon Sequestration in Californian Forests; Two Case Studies in Managed Watersheds." C. James, B. Krumland, and P. Eckert. Dec. 12, 2007

[2] The SPI study also includes a fourth scenario -- the "Regulated scenario" – which is intended to simulate carbon levels under long-term continued management using the Intensive management approach. Because the starting point is significantly different under the Regulated scenario than under the other three scenarios, it does not provide a relevant point of comparison and is not addressed in this memo.

[3] All carbon estimates in the SPI report are provided in "English" units of pounds and tons (i.e. 1 ton = 2,000 lbs.). This memo maintains this approach for simplicity of comparison with the SPI report.

[4] Option C of the CA Forest Practice Rules serves as the baseline for forest projects under CARB's forest protocols.

increased emissions in all of these categories compared to less intensive management approaches. (p. 26-30)

- The SPI analysis assumes that soil carbon levels remain constant across management scenarios, despite the significant soil disturbance proposed under the Intensive scenario. In the Intensive scenario, forest soils would be mechanically ripped to three feet deep after existing stands were cleared, likely resulting in a significant loss of soil carbon.[5] (p. 48)

- The analysis assumes a high average lifetime (i.e. half-life) of approximately 70 years for all wood products. (p. 30) This long lifetime is particularly unrealistic for paper and paper products which account for almost 30% of total wood products in the SPI model. The analysis also assumes wood carbon in landfills is permanently sequestered, disregarding both the U.S. Department of Energy and the Environmental Protection Agency's methodology that includes decay rates for land filled wood.[6] (p. 29) The use of a more realistic lifetime and decay rates would result in significantly reduced estimates of carbon storage in wood products and a smaller, if any, net climate benefit from increased wood product production in the Intensive scenario.

- The SPI analysis fails to include a scenario with reduced harvest levels that allow a forest to sequester significantly increased amounts of carbon in forest biomass. Both watersheds evaluated in the SPI analysis are middle-aged forests that are near their maximum rates of growth and with reduced harvest levels could double or triple the volume of carbon sequestered as well as provide valuable wildlife habitat. (p. 50) However, even the Custodial scenario is only designed to "maintain current stocking levels." (p. 20) A comparison of any of the SPI scenarios with a scenario designed to maximize forest carbon would demonstrate the climate benefits of a high-habitat value approach. Consideration of demand-side forest product programs like recycling and wood use efficiency could allow for reduced harvests.

- In order to estimate tree biomass from forest stand characteristics, the authors evaluate three different statistical live biomass (LBM) models and conclude that it isn't possible to "verify which of the … models … provide the most accurate biomass assessments." (p. 25) Given the difficulty in choosing among them, the report provides a comparison of forest carbon over time using each of the three models. (p. 33) This comparison shows significant differences among the LBM models, particularly for the Intensive scenario. However, despite these differences, the comparison across management scenarios that is reported in the Results and

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[5] Most studies quantifying soil carbon loss associated with mechanical turnover have involved agricultural practices. See, for example, S.A. Prior, R.L. Raper, and G.B. Runion, 2004. Effect of implement on soil CO_2 efflux: fall vs. spring tillage. Transactions of the ASAE. 47(2): 367-373.

[6] Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005,* Annex 3 p. 235, April 2007. Department of Energy, "Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program: Chapter 1, Emission Inventories, Part I: Appendix." p. 220, June 2006.

Executive Summary is arbitrarily limited to model 2[7], which produces the largest increase in sequestration from the Intensive scenario compared to the Option C scenario. The net carbon benefit estimated using either of the other two models appears to be approximately 40% lower than the reported results. (p. 33) Model 2 also produces an estimate of decreased sequestration from the Option C scenario that is approximately 50% larger than either of the other two models.

- In the text of the report the authors identify two different possible options for tracking harvest residue (e.g. tree tops, branches, and foliage). The first option is to assume that this material contributes to maintaining forest floor biomass, which the study elsewhere assumes to remain constant at 11.5 tons C/acre. (p. 23) The second option is to assume that this material comprises an additional pool of sequestered carbon. Of course, this latter approach assumes that the forest floor carbon pool somehow remains constant without continued additions to compensate for decomposition. Nevertheless, having identified these two options, the study only reports results using the latter option. As a result, the study concludes that in the Intensive scenario, harvest residue comprises a large incremental pool of sequestered carbon, totaling approximately 20-40 tons C/acre of additional sequestration by the end of the timeframe. (p. 39) In contrast, the report concludes that harvest residue adds no more than 5 tons C/acre under either the custodial or option C scenarios.

- The SPI analysis only provides a comparison of the sequestered carbon at the end of the 100-year study timeframe. However, the relevant comparison for climate policy is the average amount of sequestered carbon over the life of the project. Because the transition to the Intensive management approach initially results in a decrease in total carbon sequestered[8], it shows a net decrease in carbon sequestration relative to custodial management for the first 40 years of the analysis. (p. 40) Even under the favorable assumptions of this analysis, Intensive management does not result in an increase in average sequestration relative to custodial management for over 50 years. Overall, the average differences between the scenarios are much smaller than the reported differences at the end of the timeframe.

Given the significant methodological issues in the SPI analysis, the conclusion is far too flawed to provide useful policy guidance. Inclusion of soil carbon losses and process emissions, adoption of a more realistic wood product lifetime, proper accounting of harvest residues, and use of either one of the other LBM models would result in a dramatic reduction in the estimated climate benefits of Intensive management. A revised analysis that incorporates these improvements could show substantially different results.

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[7] "We arbitrarily used Model 2 as a comparative basis since model differences are largely proportional and can be inferred from the data in Figure 12.1." (p. 34)

[8] The reason for the initial decrease in sequestration rates is that the Intensive management scenario would replace middle-aged trees that sequester a great deal of carbon each year with very young trees that sequester very little carbon in their early years.

For example, it is possible to estimate how the results of the SPI analysis would change in response to three revisions: 1.) exclude paper/paper products from the wood products pool because they do not provide reliable long-term sequestration; 2.) assume that harvest residue contributes to maintaining stable levels of forest floor carbon rather than providing additional carbon storage; and 3.) use either LBM Model 1 or 3, rather than Model 2 which produces results that are significantly more favorable to the Intensive Scenario and less favorable to the Option C scenario.

As reported in Table 1, based on these three changes alone, the Intensive scenario results in lower average carbon sequestration compared to the Custodial scenario in both watersheds and lower sequestration than the Option C scenario in the Canyon Creek watershed. Moreover, as can be seen in Figures 1 and 2 below, the Intensive scenario results in a decrease in carbon sequestration relative to either of the other two scenarios for at least 45 years and continues to lag behind the Custodial scenario in the Canyon Creek watershed even after 90 years. As described above, there are a number of additional problems with the SPI analysis that bias their results in favor of the Intensive scenario. Inclusion of soil carbon losses, process emissions, and landfill decay rates would further reduce the purported benefits of the Intensive scenario relative to either the Custodial or Option C scenarios.

Quantitative results aside, the SPI study raises – but fails to address – three critical policy issues: forest fires, environmental impacts, and forest product demand.

1. Forest fires: The SPI analysis completely ignores the issue of fire. The authors reject any data from forest stands that have burned and make no mention of potential differences in vulnerability to fire across management scenarios. However, the Intensive management scenarios proposed by SPI would create dense stands of uniform, young, even-aged trees which are particularly vulnerable to catastrophic fire.[9] The increase in vulnerability to fire puts at risk the purported carbon benefits and could threaten nearby communities.

SPI is well aware of the threat of catastrophic forest fires. The California Forestry Association (CFA) has submitted a proposal to the AB32 Scoping Plan that highlights the risk of catastrophic fire and concludes that significant climate benefits result from aggressive thinning of dense young forests. Only by ignoring fire in this analysis is SPI able to avoid the inherent contradictions between the purported benefits of Intensive management found in this study and the supposed benefits of aggressive thinning claimed in the CFA proposal.

2. Environmental impacts: The Intensive management scenario proposed by SPI would have serious effects on environmental values other than climate. Replacement of diverse, uneven-aged, mixed species stands with even-aged monocultures would greatly reduce

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[9] See, for example, C.P. Weatherspoon and C. N. Skinner. 1995. As assessment of factors associated with damage to tree crowns from the 1987 wildfires in northern California. Forest Science 41(3): 430-451.

wildlife habitat and other environmental services provided by existing forests. Clear cuts and deep ripping of forest soils would greatly increase sedimentation rates and reduce stormwater buffering, resulting in destruction of streams and riparian ecosystems and increased flooding. Genetic selection of seedlings would reduce diversity, constrain the adaptive capacity of California's forests, and increase vulnerability to insects and disease.

In order to ensure that forest projects designed to sequester carbon do not compromise other environmental values, the forest protocols adopted by CARB last October require that all projects meet a set of eligibility criteria including maintenance of forests "that are comprised of multiple ages and mixed native species in the forest overstory and understory."[10]

The Intensive management approach proposed by SPI does not meet these criteria and would not be eligible to report carbon savings using the CARB forest protocols. The significant damage to other environmental values from conversion of complex forests to monoculture plantations reaffirms the importance of the eligibility criteria in the forest protocols and the value of including strong environmental standards in the development of state climate policy.

3. Forest product demand: The SPI analysis is limited to management scenarios that address the supply of forest products. It treats the demand for wood products as given and does not evaluate the potential climate benefits of policies that reduce demand and encourage more efficient use of timber, while allowing for lower harvest levels.

The SPI analysis also fails to address the substantial cost associated with reliance on increasing volumes of wood products in landfills as a source of long-term sequestration. A substantial fraction of the estimated benefit of the Intensive scenario is due to sequestration in landfills. Landfill storage is expensive and continued increases in transfers to landfills runs counter to the State's efforts to reduce waste streams.

Alternatively, policies to reduce the demand for wood products such as recycling and wood use efficiency can provide benefits by reducing harvest volumes and increasing sequestration in forests, rather than in landfills. Though beyond the scope of the SPI analysis, demand-side forest product policies should be considered in the development of the State's forest climate policy.

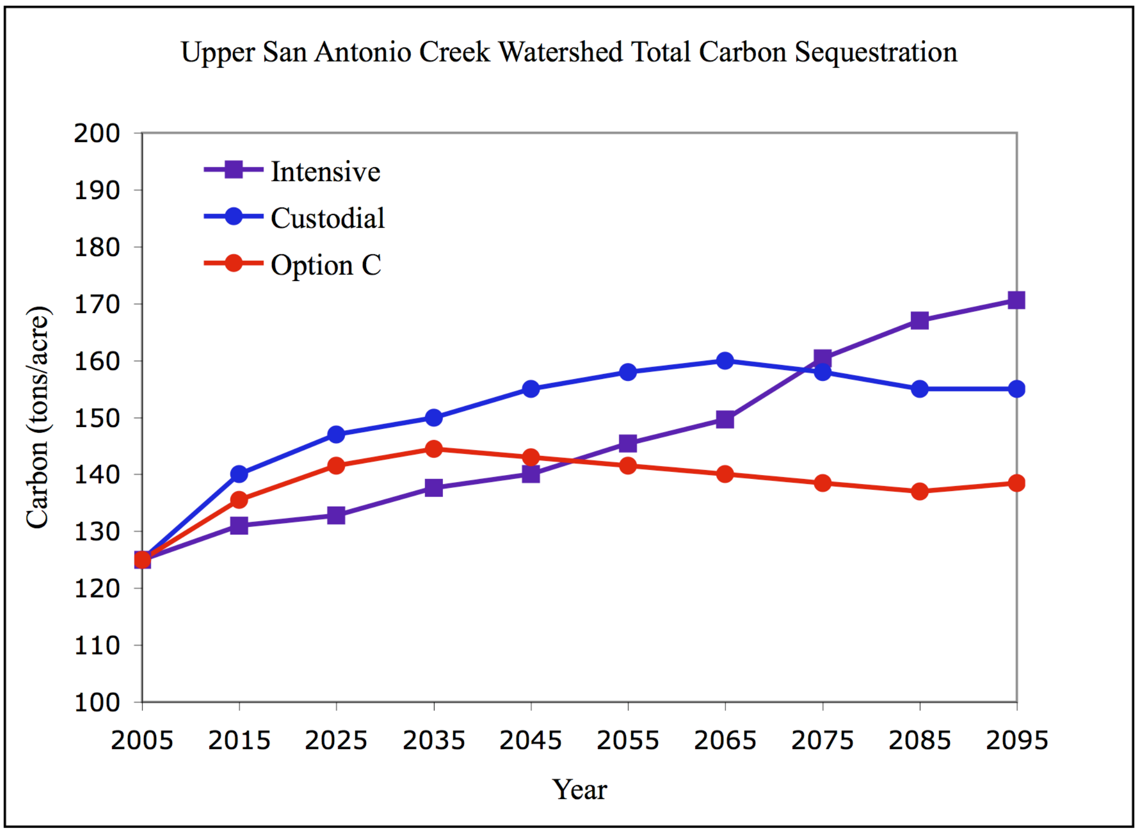
[10] Forest Project Protocol, p. 17

Table 1: Revised estimates of average total carbon sequestration by scenario*

	Upper San Antonio Creek Watershed	Canyon Creek Watershed
Intensive	146 tons C/acre	112 tons C/acre
Custodial	150 tons C/acre	123 tons C/acre
Option C	139 tons C/acre	115 tons C/acre

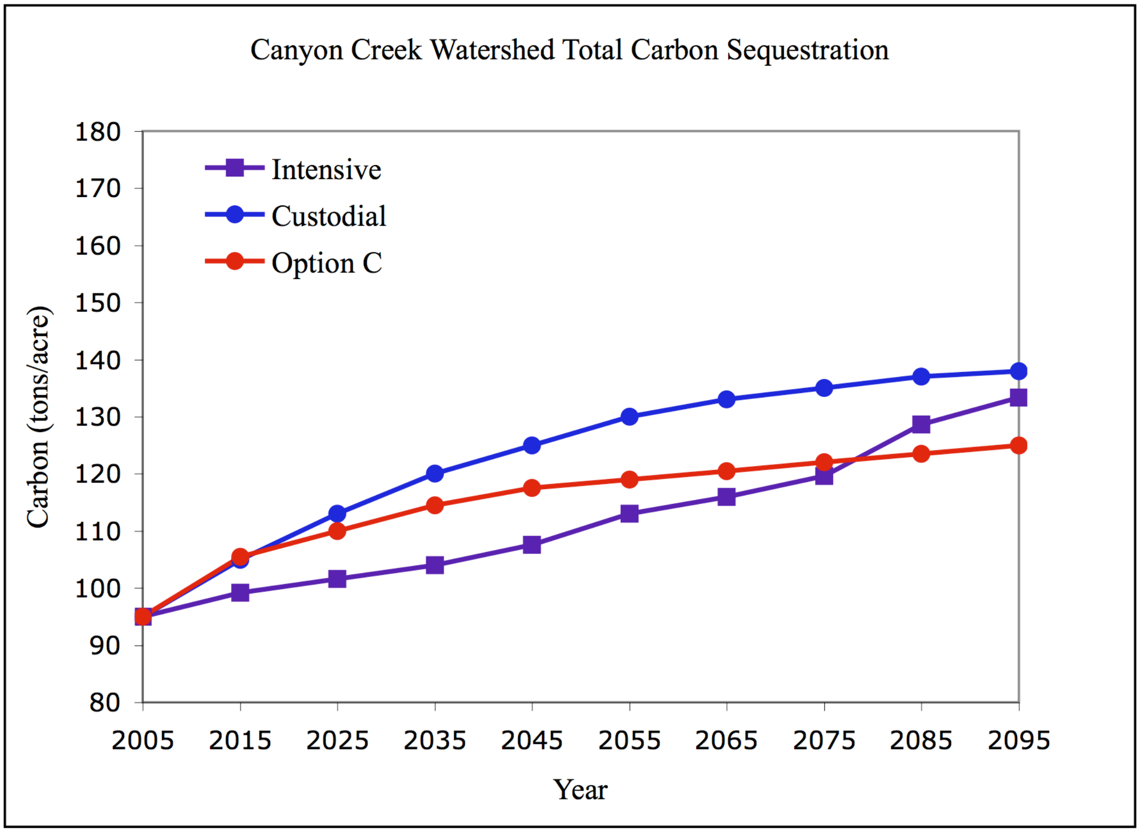
* Estimated results of SPI model with the following changes: 1.) paper/paper products excluded from long-term wood products pool; 2.) harvest residue contributes to maintaining stable levels of forest floor carbon rather than providing additional carbon storage; 3.) use of LBM Model 1 or 3; and 4.) total sequestration reported as average over timeframe rather than at end.

Figure 1: Revised estimates of total carbon sequestration for Upper San Antonio Creek Watershed*



* Estimated results of SPI model with the following changes: 1.) paper/paper products excluded from long-term wood products pool; 2.) harvest residue contributes to maintaining stable levels of forest floor carbon rather than providing additional carbon storage; and 3.) use of LBM Model 1 or 3.

Figure 2: Revised estimates of total carbon sequestration by scenario for Canyon Creek Watershed*



* Estimated results of SPI model with the following changes: 1.) paper/paper products excluded from long-term wood products pool; 2.) harvest residue contributes to maintaining stable levels of forest floor carbon rather than providing additional carbon storage; and 3.) use of LBM Model 1 or 3.