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A CASE STUDY: HOW CALIFORNIA'S FORESTS STORE CARBON AND IMPROVE AIR QUALITY

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INTRODUCTION

California's forests are complex and diverse ecosystems that play a key role in the state's environmental health. Forests are one of the few proven, efficient factories that capture carbon dioxide (CO_2) from the atmosphere and store it for long periods of time as carbon, both in the forest and as wood products.

Trees and plants grow through the miracle of the photosynthetic process, harnessing the energy from our sun to store carbon (C), while releasing oxygen (O_2) in a key step of the Carbon Cycle (see pg. 7).

The state's sixteen million acres of productive forests are capable of making significant contributions to offset emissions from California's autos and factories. Currently, Sierra Pacific Industries (Sierra Pacific) is the owner of over 1.6 million acres of these productive forests. Given its extensive research program, its large data set of site specific forest measurements, and its modeling capability, Sierra Pacific was able to collaborate with a number of researchers and experts from around the country to examine carbon storage in a California forest setting.

We are grateful for the help received in model development, analysis of results, and peer review for this critical issue. This paper is a brief summary of the main study we conducted for Sierra Pacific. We encourage readers to review the complete study available on Sierra Pacific's website.[4] We hope our efforts will generate dialogue and further scientific inquiry on this critical issue of the role of California's forests in carbon sequestration.

THE STUDY SHOWS

- With intensive management and accounting for carbon in products, as much as 150% more tons of carbon per acre can be sequestered compared to other less intensive management scenarios.
- Failing to account for carbon taken from CO_2 in the air and stored in forest products and mill residue significantly understates the total amount of carbon sequestered by California's managed forestlands.
- On the Sierra Pacific acres that the State has approved for intensive management as compared to selection management, the net gain in the amount of carbon and CO_2 sequestered over the next 10 decades could offset the annual CO_2 emissions from over 877,000 vehicles or greater than 5 million tons of CO_2 equivalents.
- Protocols should be developed for California that accurately assess forests and wood products total carbon and CO_2 sequestration over time, and encourages participation by forest landowners.

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[4] Sierra Pacific Website: www.spi-ind.com. The study can found under the Our Forests Tab in the Research and Monitoring section.

STUDY DESIGN

Sierra Pacific selected two watersheds in which it is a major landowner to use its comprehensive plot database to describe and model the carbon sequestered over a 100-year planning period. These example watersheds were chosen to determine both what happens to carbon storage on forests of different site productivity and to compare and contrast the amount of carbon storage on the same lands subject to four different management scenarios.

These forest management scenarios were developed and modeled over a 100-year time frame with results produced for each decade. The researchers' intent was to model three management scenarios that are current forest practices, as well as examine a fourth scenario that approximates a theoretical managed forest. The scenarios are:

1. The Custodial management scenario is a proxy for the low level, non-product driven management currently employed on a large percentage of the federal forest lands in the state. This scenario was modeled with help from USDA - Forest Service personnel. It removes approximately 1% of the tree volume of the forest in each watershed per year or 10% per decade.
2. The Selection management scenario models the selection harvest system under the California State Forest Practice Rules (Option C) for private forests. It reduces the tree volume by 25%-45% over the 100-year time frame to levels allowed by California Forest Practice Rules. It relies on natural regeneration instead of planting to meet the reforestation standards required by the Rules following tree harvest.
3. The Intensive scenario is based on an even-aged forest management system and is applied to lands the same rules deem appropriate for this type of management. Approximately 12.5% of the lands suitable for this scenario are harvested and replanted every decade.
4. The theoretical, managed scenario is realized when periodic harvest is equal to periodic growth in a stable equilibrium over time. Most California forests ownerships have not reached this point yet, but it represents the theoretical maximum in terms of carbon storage over the long term.

Even though carbon is being sequestered in riparian buffer zones, areas of special concern under the rules, and wildlife core areas, these areas were excluded from all scenarios in order to facilitate the comparison of the effects of each management scenario. These areas would have had sequestered equal amounts of carbon in each scenario.

All four scenarios meet legal standards and are being employed today by various landowners in California's forests. They were applied to the land base in two watersheds using current on-site measurements routinely collected by Sierra Pacific. A dataset consisting of 2,586 ground plots in the two watersheds provided the raw data to estimate carbon sequestration for all four management scenarios.

CARBON POOLS

Several "pools" or sources of carbon must be accounted for and tracked as both gains and losses to construct accurate carbon storage budgets. Carbon exists in the tree stems, roots, limbs, and needles as well as in shrubs and forest litter. It also exists in the products derived from forests such as lumber and plywood. As trees are harvested, a certain amount of carbon remains as forest residue. This residue may be transported to an alternative energy plant and burned to produce energy—an offset of fossil fuel use. It may also be converted into other forest products such as landscape bark or left in the forest to contribute to the forest litter carbon pool. In some cases it is burned to reduce future fire risk.

All carbon storage sources must be accounted for and tracked throughout the 100-year plan period resulting in a very complex analysis. While modeling the differences in the amount of carbon stored in trees and harvested wood products, other carbon pools were treated as follows: Consistent with other studies, carbon stored in the soil, shrubs, and naturally occurring forest duff and litter was assumed to be in equilibrium over time and unaffected by management scenario. Carbon in roots was held constant, a likely conservative estimate since trees, especially planted trees, have an actively growing root system. A decay rate was applied to harvest residue remaining on the forest floor after logging. These decisions allow for clear comparison of the four main management scenarios.

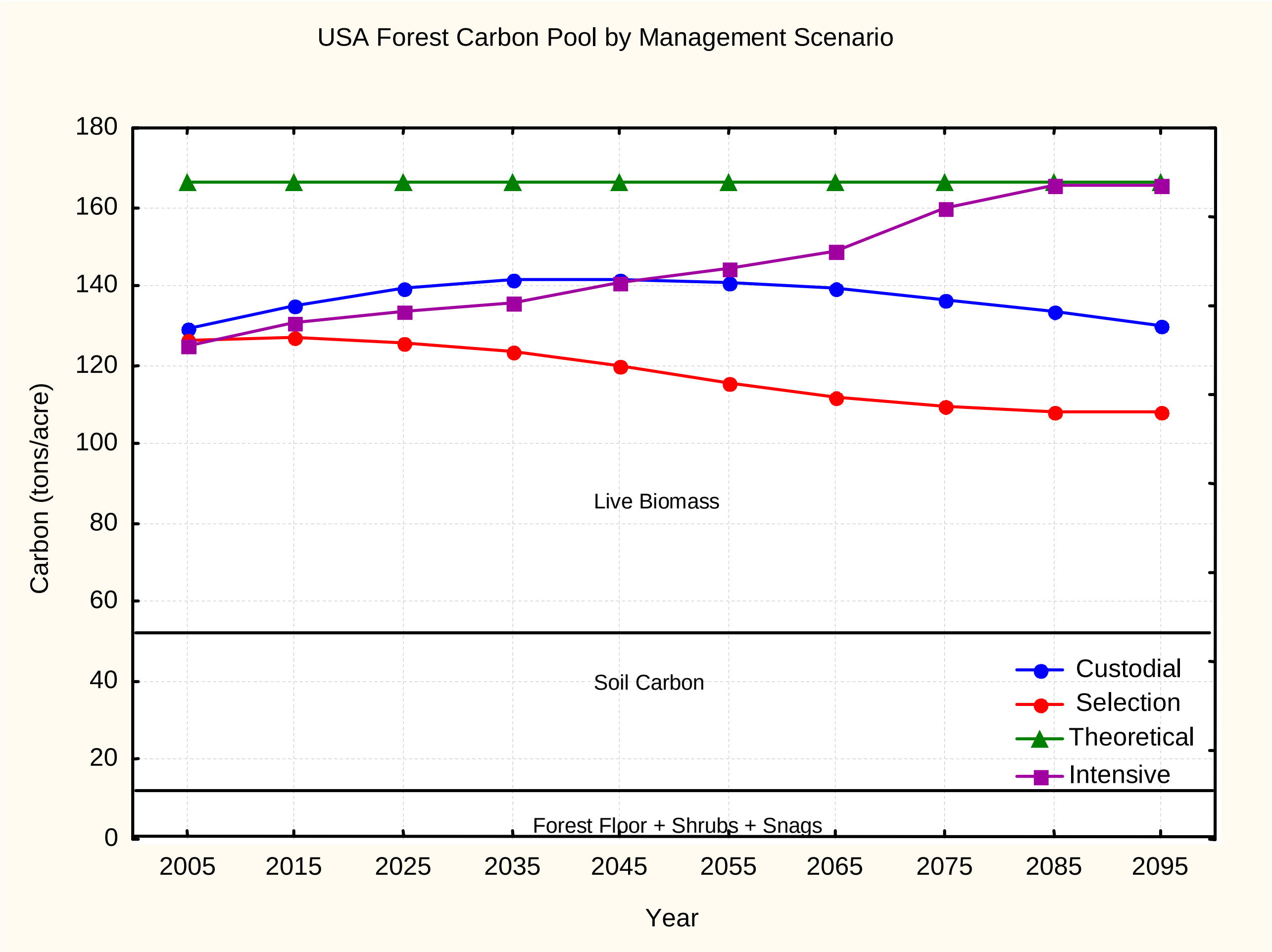
RESULTS

Current carbon assessments are most often presented in terms of CO_2 equivalents rather than carbon (C) alone. To convert the forest and product carbon pools from tons of C/acre to tons of CO_2/acre we used the Federal EPA's accepted conversion factor of 3.67 (i.e., one ton of C is equivalent to 3.67 tons of CO_2). The results below show the CO_2 equivalent in brackets after the number for carbon stored (C).

The trends in carbon storage are similar in both watersheds for the four forest management scenarios analyzed. The more productive Upper San Antonio Creek (USA) watershed showed higher carbon yields than the Canyon Creek (CC) watershed. For simplicity, the remainder of this discussion focuses on the differences between the four management scenarios for the USA watershed recognizing that the trends are the same for Canyon Creek. The USA watershed is typical of about 85% of Sierra Pacific's land base.

<u>FOREST CARBON POOL</u> (excluding Products and Forest Harvest Residue)

Figure 1 Forest Carbon Pools by Management Scenario Upper San Antonio Creek Watershed.

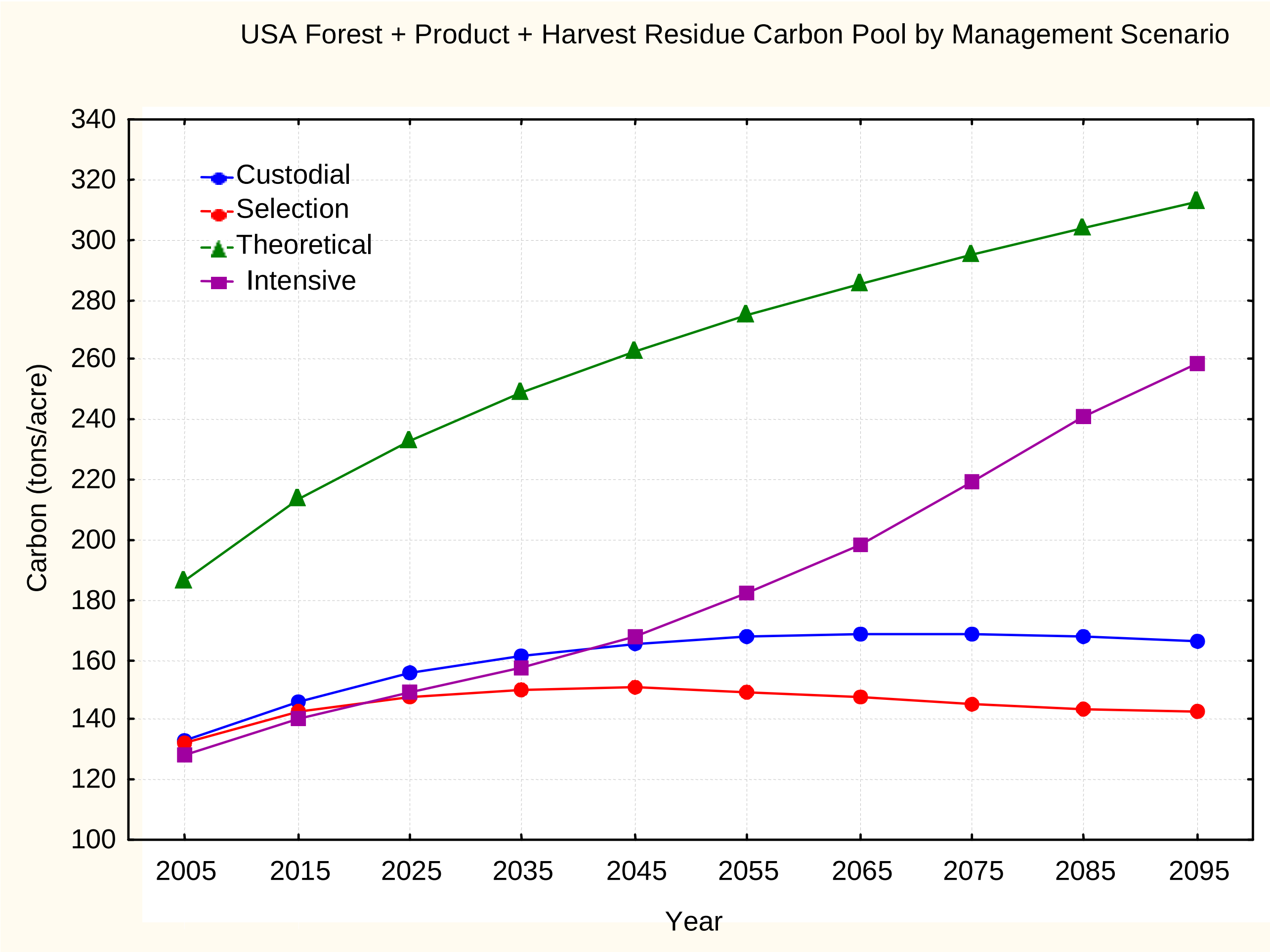


- The Custodial Management scenario showed a gradual increase followed by a period of stability and eventual decline in carbon storage during the 100-year time frame. Values ranged from 125 tons C/acre (459 tons CO_2/acre) to 140 tons C/acre (514 tons CO_2/acre). Carbon storage increased 15 C/acre (55 tons CO_2/acre) tons per acre for the first five decades as the forest grew, then declined about the same amount over the last five decades as growth rates slowed in the older stands.
- The Selection Management scenario showed a slow steady decline in carbon storage over time from 125 tons C/acre (459 tons CO_2/acre) to around 108 tons C/acre (396 tons CO_2/acre). This was the lowest volume of forest carbon pool for the four management scenarios analyzed.
- The Intensive Management showed a steady increase for the first eight decades and then a leveling off that is roughly equivalent to the rate of sequestration for the theoretical regulated forest—approximately 168 tons C/acre (617 tons CO_2/acre) .

The study found there is little difference in the forest carbon pools between the custodial and intensive management in the early decades. The trends diverge in the later decades as growth under the custodial scenario slows and the newer faster growing intensively managed forests begin to dominate the watershed.

TOTAL CARBON POOL (including Forest Pool, Wood Products, and Forest Residue)

Figure 2 Total Carbon Pool by Management Scenario (Forest carbon pool + Wood Products carbon pool + Harvest Residue carbon pool) Upper San Antonio Creek Watershed.



- Including carbon sequestered in forest products and harvest residues significantly changes the projections of carbon storage. The increase between the forest carbon pool and the total carbon pool is about 35 tons C/acre (128 tons CO_2/acre) at the end of the tenth decade for both the Selection and Custodial scenarios.
- In contrast, the increase between forest and total pools is over 90 tons C/acre (330 tons CO_2/acre) for the intensive management projections and over 150 tons C/acre (550 tons CO_2/acre) for the theoretical managed scenario.

When accounting for carbon stored in wood products and harvest residues, intensively managed forests show substantial increases in carbon sequestration over passive forms of forest management.

CONCLUSIONS

- With intensive management and accounting for carbon in products, as much as 150% more tons of carbon per acre can be sequestered compared to other less intensive management scenarios.

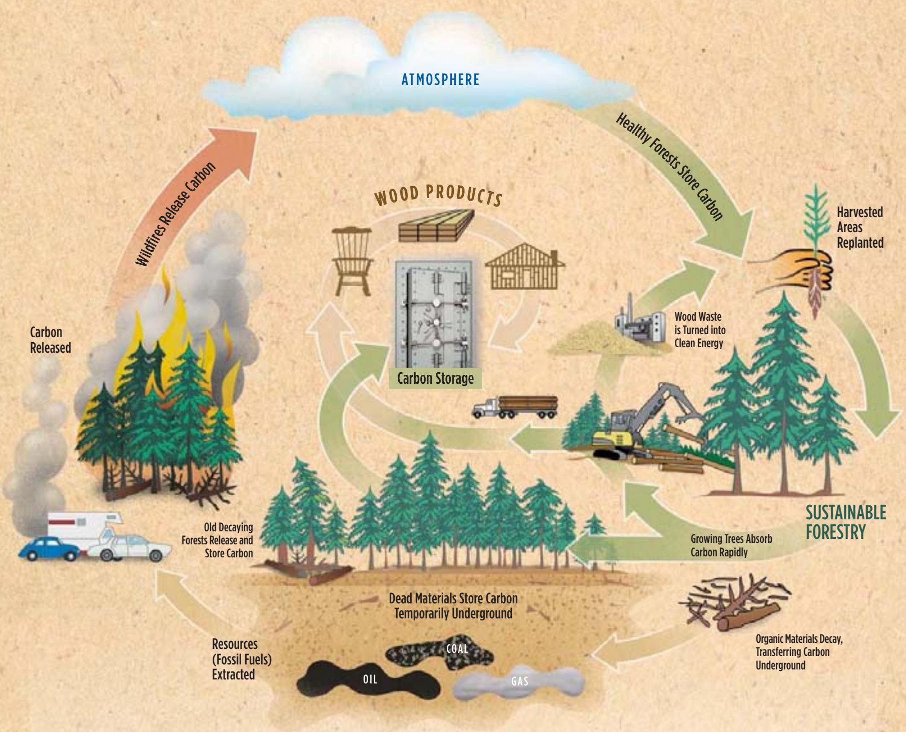
- Failing to account for carbon taken from CO_2 in the air and stored in forest products and mill residue significantly understates the total amount of carbon sequestered by California's managed forestlands.

- On the Sierra Pacific acres that the State has approved for intensive management as compared to selection management, the net gain in the amount of carbon and CO_2 sequestered over the next 10 decades could offset the annual CO_2 emissions from over 877,000 vehicles or greater than 5 million tons of CO_2 equivalents.

- Protocols should be developed for California that accurately assess forests and wood products total carbon and CO_2 sequestration over time, and encourages participation by forest landowners.

The Carbon Cycle

Forestry Never Looked So Cool



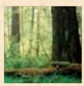
Carbon Released
Catastrophic fires release carbon that has been stored in trees into the atmosphere. Manufacturing and automobiles also contribute carbon to the atmosphere by burning fossil fuels. Natural processes like volcanoes and decomposition also release carbon to the atmosphere.

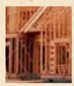


Carbon Absorbed
Young, healthy forests absorb carbon more rapidly than older, dense forests. Older forests release carbon at the same rate that they absorb it, neutralizing their effect on global warming. Sustainably managing forests is an effective way to store carbon. Trees also produce oxygen that we all need.



Carbon Stored
As a tree grows, it stores carbon in its trunk, branches and roots. Sustainably managed forests continuously store and absorb carbon. Trees store carbon for a long time. When trees are harvested, the carbon continues to be stored in wood products. Harvested forests are replanted and the cycle begins again.





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