

Carbon Balance of Forest Thinning and Bioenergy Production

by

Katharine C. Kelsey
Environmental Studies Program
University of Colorado, Boulder, CO



Introduction

Scott looked out the window of a light green Forest Service office building nestled among the trees in southwest Colorado. Striking red rocks were exposed in long red strips along the hillslope across the valley. The light green of the valley bottom slowly graded to a darker shade as Scott's eye wandered upslope to the ponderosa pine forest. In the background, rocky peaks reached up to heights over 12,000 feet. Scott thought about the 7000 km² expanse of the National Forest where he worked and how it resembled an intricate patchwork quilt. Not only did the vegetation vary across the steep topography of the forest, but the ways in which the forest was managed varied as well. Some regions of the forest were systematically harvested for timber production, others areas were maintained for recreation, and still others were routinely "thinned" by removing smaller diameter trees and understory vegetation in order to reduce the risk of high severity wildfire.

Down the valley, Scott's eye traveled across a region of forest where the trees looked less dense, and he could see the tree trunks and the ground through the canopy. Scott had been the head silviculturalist on the thinning project that had recently finished treating that stand. Each year it was up to Scott to determine how much of the ponderosa pine forest in this National Forest should be treated. In the past his primary goal for treating forests had always been reducing the risk of high-severity wildfire, especially in areas where there were many houses present within fire prone areas. But ever since the introduction of the Forest Service Climate Change Strategy in 2011, the staff of all national forests were also expected to complete the Climate Change Scorecard, which required answers to questions regarding carbon stocks and fluxes (Figure 2). According to the Climate Change Strategy, Scott and his colleagues now had to think about how forest treatments were going to affect the amount of carbon stored in forest biomass.



Figure 1. Ponderosa pine forest in southwest Colorado.

Part I – Effects of Forest Treatment and Fire Suppression on Ponderosa Pine Forests

It was time for Scott and his unit to submit information for the annual Climate Change Scorecard. In order to bring his colleagues up to speed, Scott had to prepare a presentation to explain how fire exclusion and forest treatments affect carbon storage in ponderosa pine forests.

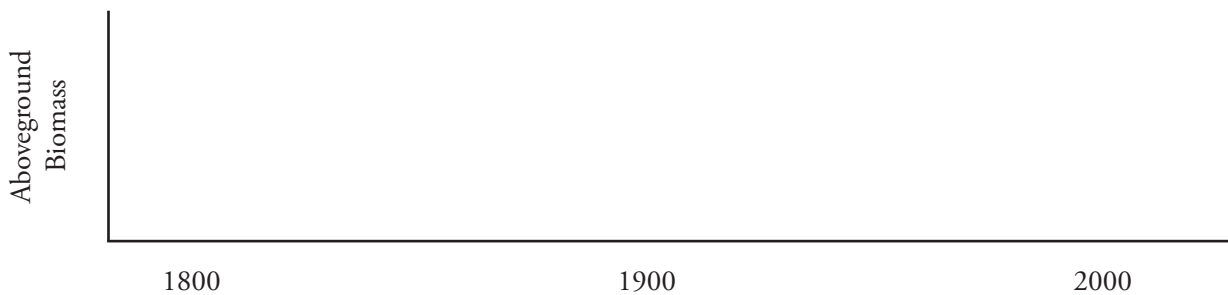
The Forest Service Climate Change Performance Scorecard, 2011 (version 1.3) To be completed annually by each National Forest or Grassland (Unit).		
Scorecard Element	Unit Name	Yes/No
Mitigation and Sustainable Consumption		
9. Carbon Assessment and Stewardship	Does the Unit have a baseline assessment of carbon stocks and an assessment of the influence of disturbance and management activities on these stocks? Is the Unit integrating carbon stewardship with the management of other benefits being provided by the Unit?	
10. Sustainable Operations	Is progress being made toward achieving sustainable operations requirements to reduce the environmental footprint of the Agency?	

Figure 2. Carbon objectives of Climate Change Performance Scorecard. Adapted from <http://www.fs.fed.us/climatechange/advisor/scorecard.html>.

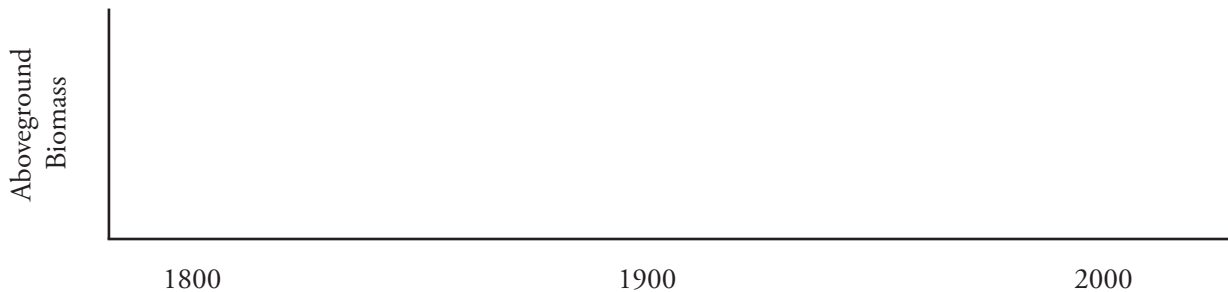
Task 1

In the spaces below, use information from your reading of Hurteau et al. (2011) to draw plots of aboveground live-tree forest carbon storage over time for the following scenarios that Scott would like to discuss in his presentation. Be prepared to draw your plots on the board and explain them to the class.

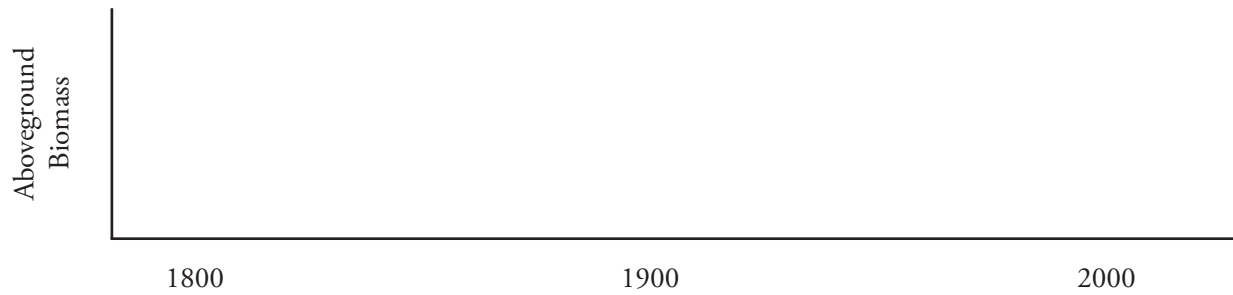
1. Aboveground forest biomass in live trees (the amount of biomass in the aboveground portion of live trees) through time in a ponderosa pine forest. Start 100 years preceding fire-exclusion (i.e., 1800) and continue for 100 years following fire exclusion, which began circa 1900.



2. Same plot as above but with a wildfire in 2010.



3. Same plot as above but with a forest treatment in 2008 and a wildfire in 2010.



Reference

Hurteau, M.D., M.T. Stoddard, and P.Z. Fulé. 2011. The carbon costs of mitigating high-severity wildfire in Southwestern ponderosa pine. *Glob. Chang. Biol.* 17(4), 1516–1521, doi:10.1111/j.1365-2486.2010.02295.x.

Part II – Woody Biomass in Electricity Generation

A private entrepreneur approaches the Forest Service with a proposition: he would like to build an electricity generation plant that is fueled from woody biomass. He will purchase the woody biomass that is removed from the forest during treatment and use it to fuel the electricity generation plant. Normally in this region, electricity comes from a coal-burning power plant.

The entrepreneur says that this situation is beneficial for everyone because he will make money by selling the electricity he produces from the plant and the Forest Service will have the funds to complete the necessary forest treatments. He also says that his solution will lower total carbon emissions to the atmosphere, even though bioenergy production requires burning the biomass and releasing carbon to the atmosphere.

Task 2

The district ranger calls Scott into his office to ask for his opinion on the bioenergy proposal. Answer the following questions in response to the district ranger's request for further information on the bioenergy proposition.

1. Do you think the use of woody biomass to produce electricity will lower total carbon emissions? Yes or No? (Assume that all energy production from biomass will replace energy production from coal.)
2. Prepare a 2–3 sentence statement explaining your answer, and identify what, if any, additional information you would like to have in order to answer this question.

Part III – Recommendation to the Forest Service

Your final task is to make a recommendation to the district ranger regarding whether or not the National Forest should sign a long-term contract with the bioenergy entrepreneur. Your recommendation will consist of two parts. First provide your recommendation to the Forest Service as if the forest managers were exclusively interested in reducing ultimate carbon emissions to the atmosphere; then provide your recommendation considering carbon as only one of many important factors. Your answers may be the same or different.

Conditions of the contract and additional information:

- The bioenergy plant will use woody biomass removed from the forest during routine forest treatments to mitigate fire danger.
- The contract will be effective for 10 years.
- The total area of the National Forest is 700,000 hectares.

Task 3

Use the table and figures below to answer the following questions that will help you formulate your recommendation.

1. According to Figure 3, which fuel source, coal or bioenergy, produces greater carbon emissions for the production of 5 MW electricity for one year? Approximately what percent of the carbon emissions from bioenergy electricity production will be offset by avoided coal emissions? How many Mg of carbon is this per year? Please answer in about two complete sentences. You can assume that electricity generation from biomass will replace electricity generation from coal.
2. Using Figure 4, determine the carbon balance for the forest treatment in the years 2030, 2070, and 2110. (If the carbon balance is positive (+), it means that overall, carbon has been taken up by the forest; if the balance is negative (–), it means that overall carbon has been released from the forest; and if it is neutral (0) it means that the same amount of carbon released has also been taken up through regrowth.)
3. Combine information from Figure 3 and Figure 4 to determine in what year the carbon balance of the forest treatment in 2012, and the subsequent electricity production, reaches zero. In other words, how long will it take for the forest to grow enough to uptake all the carbon released during energy production, when you include the coal offset?
4. Now that you have more information, return to the question from Part II. Will the bioenergy plant reduce overall carbon emissions to the atmosphere? Did your group make a different decision now that you have more information? Take one sentence to explain.
5. Prepare a 3–5 sentence statement of your recommendation to the Forest Service. Start with whether or not the Forest Service should sign a contract with the bioenergy entrepreneur, from a purely carbon perspective. What timescale did you consider in your recommendation? Did you have to make any assumptions? What did you assume? Was there any additional information you needed in order to make your recommendation? Finally, what considerations other than carbon balance do you think should be considered in your final decision? (For example, will the bioenergy production process help provide much needed funding to the Forest Service?) Do these considerations change your recommendation? How did you weight these variables?

Table 1.

<i>Forest Service Action</i>	<i>Current Conditions (without Biofuel Contract)</i>	<i>Projected Conditions (with Biofuel Contract)</i>
Cost to FS of forest treatment (dollars/hectare)	\$ 1750	\$ 950
Number of hectares treated per year	500	600–800

