ASSESSING CARBON SEQUESTRATION ON PUBLIC TIMBERLAND IN THE CONTERMINOUS UNITED STATES

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ABSTRACT.—Carbon was estimated and projected for public timberland using the FORCARB model, linked to a modified version of the Aggregate Timberland Assessment System (ATLAS). Public forests contain about one third of the carbon in timberland in the conterminous U.S. The average annual carbon flux is greater for public forests than for private forests; however, carbon flux is greater for private forests if carbon in use and energy from harvested wood is considered. Reducing baseline public forest harvests by 25 percent or reducing baseline inventory estimates by 3 percent while holding private forest estimates constant has a relatively small influence on carbon inventory projections.

INTRODUCTION

Increasing concentrations of CO_2 and other greenhouse gases in the atmosphere have prompted the international community to investigate strategies to mitigate emissions. One set of strategies involves sequestering carbon in forests. There have been several studies on carbon sequestration in forests (for example, Heath and Birdsey 1993), including Birdsey and Heath (1995), that reported estimates for public timberlands. None of the studies analyzed and reported carbon for public timberlands in the United States in a way consistent with carbon estimates on private timberland. In this study, I develop a version of FORCARB (see Plantinga and Birdsey 1993) to project carbon for public timberland that is available for timber harvest. I project carbon inventory by decade for 50 years, and calculate carbon flux indirectly by subtraction. Both inventory and flux are of interest to policy makers. I also examine disposition and storage of carbon after harvest.

I concentrate on estimating carbon on timberland, which is forest land capable of producing 20 cubic feet per acre per year of industrial wood and is administratively available for timber harvest. About 475 million acres in the conterminous U.S. are considered timberland. Approximately 25 percent of this area is public forest land, of which the USDA Forest Service manages 65 percent. The Rocky Mountain Region has the largest area of public timberland, followed by the North. The Pacific coast features similar acreage to the North, while the South contains the smallest area (see Table 1).

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Table 1.—Area[a] (thousands of acres) of timberland by region and owner group

	Owner group		
Region	National Forest	Other Govt.	Private Owner
North	9,545	22,725	125,529
Pacific Coast	23,380	5,696	24,976
Rocky Mt.	35,459	5,986	21,183
South	11,554	9,065	178,690

[a] For National Forest and Private Owner, see Powell et al. (1993). Other Government includes Native American lands, from Waddell et al. (1989).

METHODS

Models

The carbon budget model FORCARB has been used to project carbon on private timberland. The model uses forest inventory projections from the Timber Assessment Market Model (see Haynes et al. 1995) and the Aggregate Timberland Assessment System (ATLAS) (Mills and Kincaid 1992) as a basis for tree carbon and areal extent of forest types. FORCARB estimates carbon in soil, forest floor, and understory vegetation for the forests as partitioned by the ATLAS model in terms of area, forest type, and age-class. The fate of harvested carbon is estimated using a model based on the work of Row and Phelps (1991). There are four disposition categories: products, landfills, energy, and emissions. Emissions include wood burned without generation of usable energy, or emissions from decomposing wood. For more information about FORCARB, see Plantinga and Birdsey (1993) or Heath and Birdsey (1993).

To develop a version for public forest land, I assumed carbon estimates for tree growth, soil carbon, and detrital carbon on public forest land for a specific region, forest type, and age-class to be equivalent to estimates as described in FORCARB for private forest land of average to low productivity. I supposed that most areas are managed passively until harvest, except for certain regions such as the South, where management activities are a common practice. I also assumed that the ratio of carbon in products processed or manufactured from harvested timber from public forests is equal to the ratio for harvests from private forests.

Data

Forest inventory data for public forests was extracted from two sources. In the Eastern U.S., data were compiled from the USDA Forest Service Forest Inventory and Analysis Eastwide data base (Hanson et al. 1992). In the Western U.S., data were compiled from the USDA Forest Service RPA data base (see Powell et al. 1993).[2] The majority of the data in the Eastwide data base was collected recently using similar sampling designs. Much of the data for the West from the RPA data base has not been updated since the 1987 compilation of data, with the exception of most of the Southern Rocky Mountain States.

[2] Volume and area by age class for Washington and Oregon were provided by Dr. Andrew Plantinga, currently with the University of Maine, Orono, ME

Data was compiled for two owner groups, National Forest and Other Government. Data for National Forests in the West were collected using a different sampling design, and it is not known how that design may affect sample estimates (compared with the inventories collected on private lands). Currently, new inventories are being undertaken on western National Forest lands using protocols comparable to private forest land inventories. Other Government data include all non-National Forest Government owners, including other Federal, State, county, and municipal owners. Native American lands are also included here because they have been traditionally considered public land, and including them in this analysis was necessary for consistent results. Most of the Other Government data were collected using sampling designs similar to those used on private lands.

Area and average volume were compiled by region, ownership (National Forest or Other Government), major forest type, and age-class. Forests of unknown age or considered uneven aged were assigned to an age-class based on their volume and stocking. Areas with age-class zero sometimes lacked data on forest type. Those areas were assigned forest type based on the estimated percentages of forest type in the county.

Scenarios

For the base scenario, I used removals for National Forest and Other Government from the base run[3] for the 1993 RPA Timber Assessment (Haynes et al. 1995). I compiled the estimates by decade for the period 1980-2040. The projection was started in the year 1980 for regions with older inventory data, and in the year 1990 for regions with more recent inventory data. The base scenario is not the most likely scenario; it is simply the scenario that would occur if the model is accurate, and current policy remains unchanged.

I ran two other scenarios to investigate the sensitivity of the results to changes in inputs. The second scenario was the same as the base, except that I reduced harvests by 25 percent. In the third scenario, I reduced the initial inventory by 3 percent, while keeping harvests the same as the base. Estimates from privately-owned forests were held constant. I chose 3 percent because the sampling error for total volumes for States is often on the order of 3 percent.

RESULTS AND DISCUSSION

Carbon inventories for three scenarios on public timberland are shown in Figure 1. Public timberland sequestered more carbon than it emitted. The amount of carbon was similar even if harvests were reduced by 25 percent or if beginning inventory featured 3 percent less volume in all forest types, indicating that small differences in harvests and inventory may have relatively small effect on results.

[3] Log Run 207. Dr. Richard Haynes, PNW Research Station, Portland, OR provided these estimates.

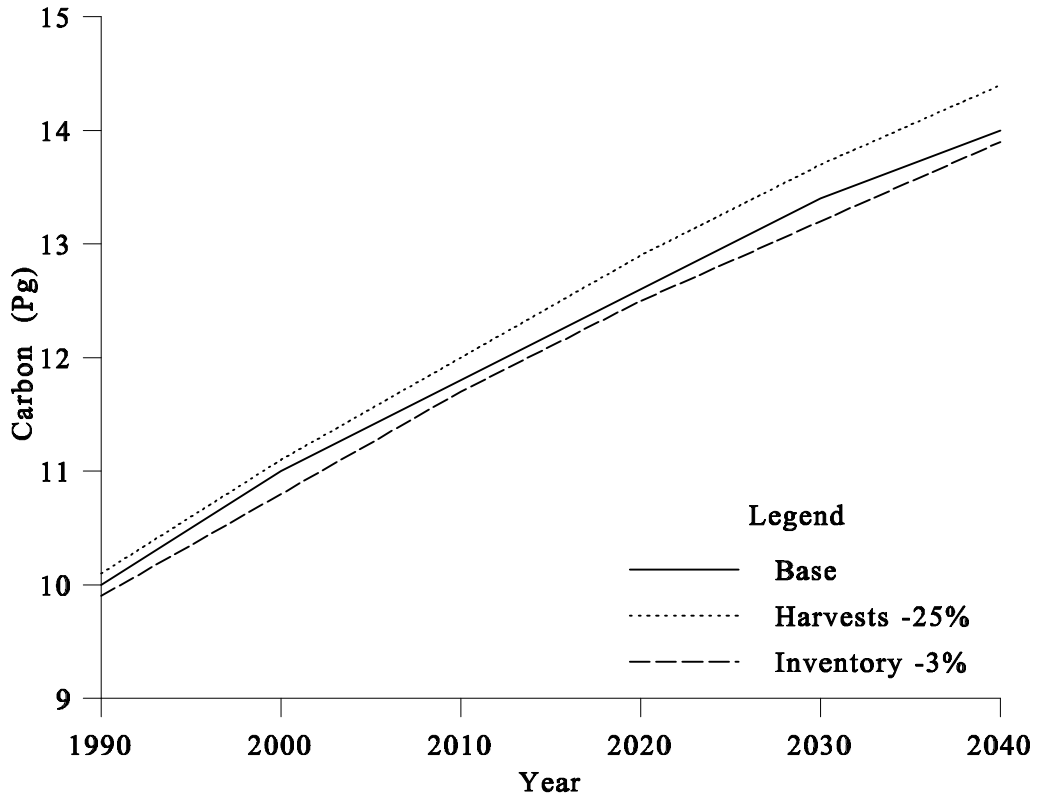

Figure 1.—Carbon inventory for three scenarios for public timberland and products.

Table 2 lists carbon flux over time for public timberland and carbon in use from removals from public timberland, along with carbon flux from privately owned U.S. timberland for comparison.

Table 2.—Carbon flux[a] (Tg/yr) for timberland and in use and energy[b] for base scenario[c]

Period	Owner group			
	Private		Public	
	Forest	In Use	Forest	In Use
1990-1999	76	--	82	--
2000-2009	58	129	76	15
2010-2019	32	134	72	15
2020-2029	13	139	65	15
2030-2039	2	150	58	15

[a] A positive flux indicates that the amount of carbon in forests in increasing. Tg/yr = teragrams per year
[b] Includes carbon in products, landfills, and emitted for usable energy.
[c] Scenario 207 (see Haynes et al. 1995). I obtain removals from public timberland from this scenario.

Previously, Birdsey and Heath (1995) indicated that carbon was accruing on U.S. timberlands on both National Forest and Other Government lands. Using simple inventory and growth relationships, they projected an average increase of 83 teragrams per year (Tg/yr) on National Forests, and 49 Tg/yr on Other Government between the years 2000 and 2040. Our analysis indicates there is an increase, but that it is about half that amount. Part of the difference may be because their estimates include Alaska timberlands, but the size of acreage in Alaskan timberland is at most 5 percent of either type of public ownership, and it is doubtful such a small land base could sequester enough carbon to make up the difference in estimates.

Carbon is accumulating in public timberland at a greater rate than in private timberland. However, when carbon in use and energy from timber removals is also counted, more carbon is being sequestered in private timberland. The actual accounting system is thus very important in determining whether an activity in forests is sequestering more carbon or less carbon than another activity.

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