CURRENT FOREST AND WOODLAND CARBON STORAGE AND FLUX IN CALIFORNIA: AN ESTIMATE FOR THE 2010 STATEWIDE ASSESSMENT

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ABSTRACT

This study used USDA Forest Service Forest Inventory and Analysis (FIA) plot data, forest growth models, wildland fire emission estimates and timber harvest data to estimate the live tree carbon storage and flux of California's forests and woodlands. Approximately 30 Tg CO2e per year was estimated as the annual flux for all California forests. The forest inventory components not analyzed here may reduce this to about 28 Tg CO2e per year. Over 80 percent of the annual net sequestration was estimated to come from public forestlands; however the private lands forest growth was likely underestimated given the growth models that were used. Suggestions for continued improvements in forest carbon inventory estimates include more accurate projections, biomass function improvements, continued FIA data collection, and spatial data analysis of change from natural and anthropogenic disturbance.

INTRODUCTION

The forestry sector, in the global context of the forest industry and the forests themselves, was estimated by the IPCC to produce about 17 percent of global greenhouse gas (GHG) emissions (IPCC 2007). The majority of these emissions were from tropical deforestation. Temperate and boreal forests, while generally not under the socio-economic development pressures of some tropical forests, can also impact GHG accounting at the state and national levels. The EPA estimates that U.S. forests sequester approximately 600 megatonnes (Tg) of CO2e per year (EPA 2004). Conversely, the recent mountain pine beetle (Dendroctonus ponderosae) outbreak in British Columbia was estimated to cause 990 Tg of CO2e emission from 2000 to 2020, taking the forest from a sink to a large net carbon emitter (Kurz et al. 2008).

The EPA forest carbon estimates included live trees, understory vegetation, forest floor, down dead wood, soils, wood products in use, and landfilled wood products (EPA 2004). The California Energy Commission (CEC) commissioned a study of forest carbon in California that estimated 7.5 Tg of CO2e per year were sequestered (Brown et al. 2004). The carbon pools included in that study were the on-site pools, excluding wood products. The California Air Resources Board (CARB), in developing the Scoping Plan (CARB 2008) for implementation of The Global Warming Solutions Act of 2006 (AB 32), used a conservative target of annual forest sequestration that was derived from the CEC report. This sequestration estimate was 5.0 Tg of CO2e per year.

CARB is required to periodically report on GHG emissions in California (CARB 2009). CARB uses an atmospheric flow approach to estimate net flux between pools. Refinements of forest carbon cycling will assist in ensuring that AB 32 targets are met. This study, which is summarized in the California Forest and Range Assessment (FRAP 2010), provides estimates of some elements of an inventory with a focus on areas that were most likely to be substantially different from existing estimates. This includes live tree and wood products pools with mortality losses from competition, pests and fire.

METHODS

A ten-year period was used to characterize sequestration in tree growth; emissions from tree mortality caused by fire, harvest and other agents; and storage in in-use and landfill wood product pools. The most recent 10-year period was used for each component to most accurately estimate current fluxes. The current economic recession was generally not included in these estimates, which likely overestimate 2009-2010 harvest levels and associated emissions and storage.

The USDA Forest Service's Forest Inventory and Analysis (FIA) data was relied on for estimates of current storage (FIA 2008). Stock change estimates were derived by applying forest growth simulations. The FIA data is generally measured on 10-year cycles in California although shorter cycles exist on some National Forests (FIA 2009a). Modeling simulations were necessary because the FIA plots were essentially relocated, with minor overlap of a subplot,

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in 2001 so that insufficient re-measurements exist for reliable stock change estimates.

Each FIA plot cluster was grown using one of four variants of the USDA Forest Service's Forest Vegetation Simulator (FVS). A computer application called the California Forest and Range Analysis System (CFRAS) was developed by the author in Microsoft Visual Basic to serve as a menu-driven user interface to read and process FIA data, call FVS simulators, and process FVS output (Robards 2010). The FVS variants and the geographic areas they cover are listed in Table 1. The number of plots were evenly distributed in each year from 2001 to 2007 so that the 10-year projections of growth was averaged over a seven year period.

The CFRAS application processed the tree lists at time zero and ten years to calculate the above and below-ground live tree carbon. Above-ground biomass (bole, bark and crown limbs) used the USDA Forest Service FIA regional volume and biomass functions (FIA 2009b; FIA 2009c). The below-ground biomass was estimated using the following model from Cairns (1997).

$$BGB = e^{-0.7747+0.8836x\log(AGB)} \quad [1]$$

where,
AGB = above-ground biomass,
BGB = below-ground biomass.

Carbon was estimated by multiplying biomass by 0.5. Carbon dioxide was estimated by multiplying carbon by 3.67.

Simulations were made for four land bases in California:

- all forestland,
- public forestland only,
- private forestland only, and
- private timberland only.

Timberland is a subset of forestland and is defined as lands capable of producing in excess of 20 cubic feet/acre/year at its maximum production.

TREE GROWTH

The difference in tree size over the ten-year projection period was the tree growth, which was calculated in terms of carbon tonnes by plot. No harvesting or mortality was assumed (i.e. all trees survived). This was termed simply "growth."

NON-FIRE EMISSIONS FROM MORTALITY

Two projections of growth were made using the FIA data and FVS models; the first with no mortality simulated (see Tree Growth above) and the second with background and density-related mortality enabled. The difference in carbon estimates was the amount of carbon associated with mortality, which was assumed to be an immediate emission. Since trees decay over several years, sometimes many decades, this is a conservative assumption.

The background mortality was simulated by default; by using the MORTMULT keyword (Van Dyck 2007) with a zero parameter the background mortality was turned off. The density-related mortality, which uses the stand density index (SDI) concept (Reineke 1933), is also simulated by default. The SDIMAX keyword was used to switch off density related mortality by setting the maximum SDI parameter to 9999 and the percentage of maximum density where mortality was invoked set to 95 percent. This essentially required a SDI value of 9,499 for mortality to be invoked, which is an order of magnitude above observed SDI's.

WILDFIRE RELATED EMISSIONS

Wildfire emissions were estimated from official state estimates of emissions associated with wildfires. The FIA data was not appropriate for this estimate because of the lack of a re-measurement and because the sparse cluster design will not be accurate for change detection without auxiliary data. Wildfire carbon monoxide emissions were retrieved for each county from the CARB online database of annual estimated average emissions (CARB 2010). Queries were made for each county for wildfire emissions of carbon monoxide (CO). A $CO2/CO$ ratio of 13 was used (Klaus Scott, ARB, personal communication) to estimate carbon dioxide ($CO2$) from CO.

The acres of forested public and private lands in each county were estimated using FRAP vegetation data (2006). The proportion of public and private forestland was estimated by dividing by the number of total acres for a county. These proportions were then multiplied by the $CO2$ emissions estimate for each county. Totaling the county estimates resulted in an estimate of the average statewide annual $CO2$ emissions associated with wildfire.

WOOD PRODUCTS POOLS

Wood products pools, like the wildfire emissions, were estimated from a source independent of the FIA data. The lack of re-measurement data and therefore harvest estimates made the use of a separate data source necessary.

Harvest emissions from bole wood were estimated from 10-year average Board of Equalization data and DOE 1605(b) conversion factors. The average annual board foot production was 1.713 billion board feet. The conversion from board feet to metric tons of carbon was assumed to be 0.427 (DOE 2007, table 1.7). $CO2$ was estimated from C by multiplying by 3.67. Harvest amounts were prorated to private and public lands based on BOE averages and were 92.8 percent and 7.2 percent respectively.

Non-merchantable emissions were estimated using harvest efficiency along with top, stump and root relationships to the bole (Cairns et al. 1997; Christensen et al. 2008). The following proportions of tree biomass were assumed.

• Roots are 20.63 percent of live tree based on belowground to aboveground ratio of .26 (Cairns et al. 1997).
• Non-bole aboveground biomass is 28.54 percent based on ratio of tops, limbs, and stumps to merchantable bole (Christensen et al. 2008) equal to 0.562.
• Bole biomass is 50.82 percent, which is the remainder of the total live tree biomass.
• Total live tree biomass excluded foliage.

Storage due to wood products in-use and landfill were calculated based on the 10-year average storage from the DOE 1605(b) emission inventory technical guidelines for voluntary reporting of GHGs (DOE 2007, Part I). Softwood mill efficiency was estimated to be 0.675. The loss due to defect was estimated to be 6.15 percent (Morgan and Spoelma 2008). The average storage of wood products in in-use for the first 10 years was estimated to be 5.32 percent. The landfill storage estimate for the first decade was 6.7 percent.

Portions of harvests were of live trees and others were salvaged from dead or dying trees. The California Board of Equalization data distinguishes between green and dead wood. Dead wood was estimated to be 22.8 percent on average over ten years. This amount of harvest was removed from the emission portion, not storage, to avoid double counting with the wildfire and mortality emissions.

INVENTORY COMPONENTS NOT ANALYZED

Brown et al. (2004) identified eight components related to carbon flux in the baseline analysis for forest and range carbon. They were:

• fire (emission),
• harvest (emission),
• development (emission),
• unverified increases in stocks (sequestration),
• other increases in stocks (sequestration),
• pest-related (emission),
• seasonal, and
• regrowth (sequestration).

The CARB inventory analysis (CARB 2009, Table 2) used nine categories in the forestry sector accounting, which followed the 2006 IPCC guidelines (IPCC 2006). They were:

• forest biomass growth,
• fire,
• other disturbances (such as insect pest damage),
• development,
• timber harvest slash,
• fuel wood,
• wood waste dumps,
• discarded wood and paper in landfills, and
• composting of wood waste materials.

Considering the factors from the two sources above, the following inventory elements were not analyzed in this paper.

• Development,
• fuel wood,
• wood waste dumps, and
• composting of wood waste materials.

No benefits from urban forests were estimated including sequestration or energy conservation benefits. No other biogenic emissions such as GHGs from urban trees or emissions from non-wildfires were estimated. Wood stored in landfills prior to the current analysis, and associated emissions from landfills, was not analyzed. Imports and exports of wood products and logs were not included in this paper, including leakage effects from California's high wood products demand and policy-constrained supply.

RESULTS

The results of the carbon stocks and sequestration analysis are presented by land base type in tables 2 through 5. The estimated annual sequestration rate for all California forestlands was about 30 Tg of CO2e (Table 2). A third of the approximately 60 Tg of CO2e per year that could be sequestered was lost to non-wildfire related mortality. Ten percent was estimated to be lost to wildfire-related mortality. About eight percent was lost to harvest-related emissions while less than three percent was estimated to be in wood product pools. This left about one half of the potentially sequestered live tree carbon after estimated emissions deductions. These percentages varied slightly for private and public landowner classes due to most harvesting being associated with private lands.

The estimate for private forestlands was about 5 Tg of CO2e per year (Table 3). Public forestlands were estimated to sequester about 25 Tg of CO2e per year (Table 4). Considering only private timberlands, rather than forestlands, yielded an estimate of about half a Tg more per year of CO2e (Table 5).

A summary of the total CO2e tonnes by land class, along with other measures of forest stocking and change, is shown in Table 6. The annual change estimate does not include wildfire or harvest related emissions, only model mortality. Table 7 is expressed on a per acre basis and also includes SDI density. Estimates of per acre live tree carbon stocks were highest on private timberlands. Private forestlands were lowest, which is reasonable since this will include significant acreages of non-commercial hardwood and other forest lands. The SDI values for landowner classes were in the same ranking as carbon. On average across landowner types, there was about 160 tonnes per acre of CO2e. This compares with about 3.5 thousand cubic feet (MCF) per acre and 14 thousand board feet (MBF) per acre.

The annual per acre stock change, net of modeled mortality, was estimated to be about 1¼ tonnes of CO2e per year for all ownerships. Public forestland was estimated to be sequestering twice the amount of carbon as private forestland. When considering only private timberlands, however, the difference narrows to 20 percent. Interestingly, the annual per acre board foot production on private timberlands is 40 percent higher than public forestlands. For all ownership types, the projected number of trees per acre decreased while stand densities increased. Some of this increase in density will be countered by harvesting and wildfire emissions.

DISCUSSION

This analysis is an inventory compilation and modeling exercise with unknown error. The general realism of these estimates may be considered by comparing the estimates to the results from other studies. The per acre carbon stocks for all forestlands in California was estimated by Christensen et al., (2008) as 33.7 tons (30.6 tonnes) C per acre above-ground live tree carbon. The estimate of aboveground live tree carbon from this analysis was 31.1 tonnes C per acre, which compares favorably as a check on the analysis. The Christensen study was based on 2001-2005 FIA data, while this study included two additional years of FIA data. Hudiburg et al. (2009) estimated average stocks of 6.5 to 19 kg/m2 across Northern California and Oregon, which equates to 96.5 to 282.2 tonnes CO2e per acre. That estimate brackets the values in this report.

The FVS growth models used in this analysis were developed primarily from data on national forests and are used for long-term planning on national forests. Intensively managed forests, as found on many private timberlands, will likely have growth underestimated and mortality overestimated. Coast redwood, which is primarily privately owned, is missing from FVS; the other softwoods category was used as a surrogate in this study. Therefore, the private lands estimates should be considered a lower range of possible results, particularly for the coast redwood region and for plantations.

The CARB (2009) forest inventory estimate contains components that were not included in this paper. Additional emissions of 0.021 Tg CO2e per year from development, 1.514 Tg CO2e per year from fuel wood use, and 0.808 Tg CO2e per year of wood waste composting sums to 2.3 Tg CO2e per year. Combining these addition sources of emission would reduce the statewide forest carbon flux from 30.4 Tg CO2e per year to 28.1 Tg CO2e per year.

The differences in the public and private lands may be a function of stand age as well as productivity. Hudiburg et al., (2009, figure 6) showed that there are marked differences in stand age distributions, with private lands having substantially younger stands. A USDA Forest Service analysis (Goines and Nechodom 2009) showed that while national forests are currently sequestering substantial amounts of carbon, there are long-term risks associated with storage given disturbance and management assumptions. Consideration should be given to both the amounts of carbon sequestered and the probability of long-term storage. Potential long-term sustainable carbon storage on private lands needs further analysis. Hudiburg et al. (2009) estimate that total landscape stocks in Oregon and Northern California could theoretically be increased 46 percent. The relative amount of current stocks in relation to long-term sustainable stocks is of considerable policy interest and needs further study.

This paper should be considered an interim step in moving towards a more accurate and consistent estimate of forest carbon flux in California. Effects from development and other disturbance will require monitoring in a spatial context that plot inventories alone cannot provide. Wood products decay rates will likely continue to rely on estimates from the national inventory, which is informed by USDA Forest Service research. This study focused on the live tree components of forests. Refined models of other forest plant species and the incorporation of dead wood decay and soil carbon models will provide a more complete forest carbon inventory. As additional FIA data is collected and re-measurements begin, then stock change measurements may begin to calibrate and supplant model predictions of current forest carbon flux. Finally, the biomass functions used have been observed to have anomalies in bark biomass for some species. Given the importance of biomass functions in carbon estimation, the evaluation and improvement of biomass functions should be a priority.

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LITERATURE CITED

Brown, S.; Pearson, T.; Dushku, A. [and others]. 2004. Baseline greenhouse gas emissions and removals for forest, range, and agricultural lands in California. Winrock International, for the California Energy Commission, PIER Energy-Related Environmental Research. 500-04069F, p. 80.

Cairns, M.A.; Brown, S.; Helmer, E.H.; Baumgardner, G.A. 1997. Root biomass allocation in the world's upland forests. Oecologia. 111:1-11.

CARB. 2008. Climate change scoping plan: A framework for change. California Air Resources Board, Sacramento, p. 133.

CARB. 2009. California's 1990-2004 greenhouse gas emissions inventory and 1990 emissions level: forest and rangelands methods excerpted from the full Technical Support Document. California Air Resources Board, Sacramento, p. 18.

CARB. 2010. 2009 almanac emission projection data. California Air Resources Board, Sacramento, p. http://www.arb.ca.gov/app/emsinv/emssumcat.php.

Christensen, G.A.; Campbell, S.J.; Fried, J.S. 2008. California's forest resources, 2001-2005: five-year Forest Inventory and Analysis report. Gen. Tech. Rep. PNWGTR-763. U.S. Department of Agriculture Forest Service, PNW Research Station, Portland, OR, p. 183.

Dixon, G.E. 2009a. Inland California and Southern Cascades (CA) variant overview, Forest Vegetation Simulator. U.S. Department of Agriculture Forest Service, Forest Management Service Center, Fort Collins, CO. p. 62.

Dixon, G.E. 2009b. South Central Oregon and Northeastern California (SO) Variant Overview, Forest Vegetation Simulator. USDA Forest Service, Forest Management Service Center, Fort Collins, p. 78.

Dixon, G.E. 2009c. Western Sierra Nevada (WS) Variant Overview, Forest Vegetation Simulator. U.S. Department of Agriculture Forest Service, Forest Management Service Center, Fort Collins, CO, p. 47.

Dixon, G.E.; Johnson, R. 2009. Klamath mountains (NC) Variant Overview, Forest Vegetation Simulator. U.S. Department of Agriculture Forest Service, Forest Management Service Center, Fort Collins, CO. p. 48.

DOE. 2007. Technical guidelines, voluntary reporting of greenhouse gases (1605(b)) program. Office of Policy and International Affairs U.S. Department of Energy, Washington, D.C. p. 280.

EPA. 2004. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2002. U.S. Environmental Protection Agency, Washington, D.C. p. 304.

FIA. 2008. FIA Database Description and Users Guide, version 3.0, revision 1. U.S. Department of Agriculture Forest Service, p. 243.

FIA. 2009a. Forest Inventory and Analysis National Program, Data and Tools. U.S. Department of Agriculture Forest Service.

FIA. 2009b. Regional biomass equations used by FIA to estimate bole, bark and branches (dated 13 May 2009). U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station.

FIA. 2009c. Volume estimation for the PNW-FIA Integrated Database (dated 13 May 2009). U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station.

FRAP. 2010. California Forest and Range Assessment. California Department of Forestry and Fire Protection, Sacramento.

Goines, B.; Nechodom, M. 2009. National Forest Carbon Inventory Scenarios for the Pacific Southwest Region (California). U.S. Department of Agriculture Forest Service, p. 81.

Hudiburg, T.; Law, B.; Turner, D.P. [and others]. 2009. Carbon dynamics or Oregon and Northern California forests and potential land-based carbon storage. Ecological Applications. 19:163-180.

IPCC. 2006. 2006 IPCC guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston HAS. Volume 4: Agriculture, forestry and other land uses Eds.

Biennia, L.; Miwa, K.; Negara, T.; Tanabe, K. Kanagawa, Japan. IPCC 2007. Climate Change 2007: Synthesis Report. Intergovernmental Panel on Climate Change, Fourth Assessment Report, Valencia, Spain, p. 73.

Kurz, W.A.; Dymond, C.; Stinson, G [and others]. 2008. Mountain pine beetle and forest carbon feedback to climate change. Nature. 452: 987-990.

Morgan, T.A. Spoelma 2008. California logging utilization. Western Journal of Applied Forestry. 23:12-18.

Reineke, L.H. 1933. Perfecting a stand-density index for even-aged forests. Journal of Agricultural Research. 46:627-638.

Robards, T.A. 2010. California Forest and Range Analysis System (CFRAS). California Department of Forestry and Fire Protection, Sacramento, CA.

Van Dyck, M.G. 2007. Keyword reference guide for the forest vegetation simulator. U.S. Department of Agriculture Forest Service. Forest Management Service Center: 130.

Table 1—Forest Vegetation Simulator variant information and geographic area where applied

FVS Variant Name	Reference	Latitude (Degrees)		Longitude (Degrees)	
		East	West	South	North
South Central Oregon and Northeast California (SO)	(Dixon 2009b)	-120.0	-122.5	41.2	42.0
		-120.0	-121.3	40.4	41.2
Klamath Mountains (NC)	(Dixon and Johnson 2009)	-123.3	-124.5	40.3	42.0
		-123.0	-124.5	39.4	40.3
		-121.4	-124.0	37.2	39.4
		-121.4	-122.5	35.0	37.2
Westside Sierra Nevada (WS)	(Dixon 2009c)	-114.0	-121.4	32.5	42.0
Inland California and Southern Cascades (CA)	(Dixon 2009a)	-122.5	-123.3	41.2	42.0
		-121.3	-123.3	40.4	41.2
		-121.3	-123.3	39.4	40.4

Table 2—Results for all California forestlands (32,114,317 acres). Harvest emissions were reduced by 22.8% for to avoid double-counting with mortality and fire emissions

Source	Type	C (tonnes)	CO2e (tonnes)
Growth	Storage	-16,367,285	-60,067,936
Model Mortality	Emission	5,455,351	20,021,137
Wildfire	Emission	1,719,915	6,312,087
Harvest (merch)	Emission	565,315	2,074,706
Harvest (non-merch)	Emission	791,776	2,905,819
WP (in-use)	Pool	-389,436	-1,429,231
WP (landfill)	Pool	-48,796	-179,081
Net		**-8,273,161**	**-30,362,499**

Table 3—Results for California private forestlands (12,646,761 acres). Harvest emissions were reduced by 22.8% for to avoid double-counting with mortality and fire emissions

Source	Type	C (tonnes)	CO2e (tonnes)
Growth	Storage	-3,708,104	-13,608,743
Model Mortality	Emission	1,136,233	4,169,977
Wildfire	Emission	304,478	1,117,436
Harvest (merch)	Emission	524,612	1,925,327
Harvest (non-merch)	Emission	734,768	2,696,600
WP (in-use)	Pool	-361,397	-1,326,326
WP (landfill)	Pool	-45,283	-166,188
Net		**-1,414,691**	**-5,191,917**

Table 4—Results for California public forestlands (19,467,566 acres). Harvest emissions were reduced by 22.8% for to avoid double-counting with mortality and fire emissions

Source	Type	C (tonnes)	CO2e (tonnes)
Growth	Storage	-12,660,007	-46,462,226
Model Mortality	Emission	4,319,121	15,851,175
Wildfire	Emission	1,415,436	5,194,651
Harvest (merch)	Emission	40,703	149,379
Harvest (non-merch)	Emission	57,008	209,219
WP (in-use)	Pool	-28,039	-102,905
WP (landfill)	Pool	-3,513	-12,894
Net		**-6,859,292**	**-25,173,600**

Table 5—Results for California private timberlands (7,647,009 acres). Harvest emissions were reduced by 22.8% for to avoid double-counting with mortality and fire emissions.

Source	Type	C (tonnes)	CO2e (tonnes)
Growth	Storage	-3,603,556	-13,225,049
Model Mortality	Emission	1,010,508	3,708,564
Wildfire	Emission	184,106	675,670
Harvest (merch)	Emission	524,612	1,925,327
Harvest (non-merch)	Emission	734,768	2,696,600
WP (in-use)	Pool	-361,397	-1,326,326
WP (landfill)	Pool	-45,283	-166,188
Net		**-1,556,240**	**-5,711,402**

Table 6—Summary table of total estimated carbon, volume and tree density stocking and annual change (net of mortality only) by landowner class

		Stocks				*Change, Net of Mortality*			
Landbase	Acres	CO2e (tonnes)	Cubic Vol. (MCF)	Bd. Ft. Vol (MBF)	No. Trees	CO2e (tonnes)	Total MCF	Merch MBF	No. Trees
All Forestlands	32,114,317	5,099,162,048	113,695,755	447,709,621	10,058,521,955	40,046,799	1,419,806	5,764,470	-58,328,612
Public Forestland	19,467,566	3,343,515,541	76,368,749	340,794,682	5,685,834,310	30,611,051	751,107	3,438,690	-38,089,971
Private Forestland	12,646,761	1,755,647,124	37,327,502	106,914,068	4,372,687,646	9,438,766	668,726	2,325,853	-20,237,568
Private Timberland	7,647,009	1,418,463,058	31,054,447	103,118,272	4,364,675,374	9,516,486	591,411	2,242,743	-17,094,787

Table 7—Summary table of per acre estimated carbon, volume, and density stocking and annual change (net of mortality only) by landowner class

	Stocks					*Change, Net of Mortality*				
Landbase	CO2e (tonnes)	Cubic Vol. (MCF)	Bd. Ft. Vol (MBF)	No. Trees	SDI	CO2e (tonnes)	Cubic Vol. (MCF)	Bd. Ft. Vol (MBF)	No. Trees	SDI
All Forestlands	158.8	3.5	13.9	313.2	214.1	1.247	0.044	0.179	-1.816	2.422
Public Forestland	171.7	3.9	17.5	292.1	225.1	1.572	0.039	0.177	-1.957	2.015
Private Forestland	138.8	3.0	8.5	345.8	197.1	0.746	0.053	0.184	-1.600	3.050
Private Timberland	185.5	4.1	13.5	570.8	258.0	1.244	0.077	0.293	-2.235	4.189