Washington Forest Ecosystem Carbon Inventory: 2002-2016

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Acronyms

C – carbon

CF – cubic feet

CH_4 - methane

CI – confidence interval

CO - carbon monoxide

CO_2e – carbon dioxide equivalent

DBH – diameter at breast height

DNR – Washington State Department of Natural Resources

EPA – Environmental Protection Agency

FF – Forest Land Remaining Forest (IPCC terminology)

FIA – Forest Inventory and Analysis

FIADB – FIA database

FMRL – Forest Management Reference Level

GHG – greenhouse gas

GRM – Growth, Removals and Mortality

HA – hectares

HWP – harvested wood product

ICE – Image-based Change Estimation

IPCC – Intergovernmental Panel on Climate Change

LF – Forest Land Conversions (IPCC terminology)

mm – millimeter

MMT – million metric tons

MT – metric tons

NFS – National Forest System

NGHGI – National Greenhouse Gas Inventory

NMVOC – non-methane volatile organic compounds

N_2O – nitrous oxide

NO_x - nitrogen oxides

NRCS – Natural Resources Conservation Service

NRI – Natural Resources Inventory

PNW – Pacific Northwest Research Station

RPA – Resources Planning Act

SE – Standard error of the estimate

SOC – soil organic carbon

µm – micrometer i.e., one millionth of a meter

UNFCCC – United Nations Framework Convention on Climate Change

USDA – United States Department of Agriculture

USFS – United States Forest Service

USGS – United States Geological Survey

WA-DNR –Washington State Department of Natural Resources, shortened to “DNR” in summary tables

Table of Contents

Acronyms 2
Chapter 1. Executive summary and key findings 8
Chapter 2. Introduction 17
2.1 Washington's Forest Carbon Accounting Background 17
2.2 U.S. National Greenhouse Gas Inventory 20
2.3 Forest carbon cycle overview 21
2.4 Overview of Washington forests 25
Chapter 3. Forest ecosystem carbon inventory methods 28
3.1 Use of IPCC inventory approach/methods 28
3.1.1 Rationale for use of Tier 3 approach 29
3.1.2 Determining the Forest Management Reference Level 30
3.2 Forest inventory compilation methods 32
3.2.1 Inventory design 32
3.2.2 Forest land-use and land-use change 33
3.2.3 Carbon pool calculations 35
3.2.4 Flux calculations 38
3.2.5 Disturbance classification and assessment 39
3.2.6 Estimation of additional greenhouse gases 40
3.2.7 Measurement units 41
Chapter 4 Forest ecosystem results: Carbon stocks, flux and trends 42
4.1 Statewide - Forest Carbon Stocks, Flux and Trends 43
4.1.1 Forest Land Area: 2007-2016 43
4.1.2 Carbon Stocks - Statewide: 2007-2016 46
4.1.3 Carbon Flux Statewide: 2002-2006 & 2012-2016 47
4.1.4 Source of Carbon Flux – Statewide (disturbance effects) 50
4.1.5 Trends - Statewide 52
4.2 Ownership - Forest Carbon Stocks, Flux and Trends by Land Ownership 55
4.2.1 Carbon Stocks by Ownership 55
4.2.2 Carbon Flux by Ownership 64
4.2.3 Source of Flux by Ownership (Disturbance Effects) 68
4.2.4 Trends by Ownership 79
4.3 Geographic Region - Forest Carbon Stocks, Flux and Trends by Geographic Region 81
4.3.1 Carbon Stock by Geographic Region 81

4.3.2 Carbon Flux by Geographic Region 93
4.3.3 Source of Flux by Geographic Region 103
4.4 WA-DNR Region– Forest Carbon Stocks, Flux and Trends by WA-DNR Regions 111
4.4.1 Carbon Stocks by WA-DNR Region 111
4.4.2 Carbon Flux by Eastern and Western WA-DNR Regions 115
4.4.3 Source of Flux by WA-DNR Region 117
4.5 Converted Forest Lands 123
Chapter 5. Comparison with other reports 125
5.1 National Greenhouse Gas Inventory 125
5.2 Other comprehensive carbon research in Washington 126
Chapter 6. Strategies to improve the inventory 128
6.1 Options to improve data collection methods 129
6.1.1 Increase the number of plots and/or the frequency of measurement 129
6.1.2 Improve estimation of non-sampled plots 131
6.1.3 Increase use of remote sensing 131
6.1.4 Improve tracking of dead and down wood 132
6.2 Options to improve data compilation 132
6.2.1 Better tree biomass equations 132
6.2.2 Potential improvements – Carbon reporting 133
References 135
Glossary 143
Appendix: 2002-2016 Washington forest ecosystem carbon inventory tables 147
A. Forest Land Area 147
B. Forest Carbon Flux 150
C. Forest Carbon Stocks 192
D. Forest Land Conversions 232
E. Net Flux from Other Greenhouse Gas Emissions 234

Appendix organization:

A: Area Tables
A1 - A3: Forest land area by ownership group, forest type, all Washington, and ecological region.
B: Forest Carbon Flux Tables
B1 - B10: Annual net change in carbon stocks on forest land by pool, owner group, all Washington, ecological region, county region, WA-DNR region (annual and per year/acre).
B11 - B20: Annual net change in carbon stocks for pools, excluding soils and forest floor, on forest land by disturbance, forest land status, owner group, all Washington, county region, WA-DNR region, ecological region (annual and per year/acre).
B21: Annual net change in carbon stocks on timberland for all pools by owner group, all Washington.
B22 - B23: Average annual growth, mortality, harvest, and net change in aboveground live tree carbon by ownership, and land status on forest land, all Washington (annual and per year/acre).
B24 - B25: Average annual growth, mortality, harvest, and net change in aboveground live tree carbon by ownership, and land status on productive forests (timberland), all Washington (annual and per year/acre).
B26: Annual net change in carbon Stocks on forest land for all pools by county, all Washington.
B27 - B28: Average annual carbon (CO_2e) flux in live trees from growth, harvest, and mortality by National Forest (annual and per year/acre).
B29 - B42: Annual net change in carbon stocks on forest land for all pools by owner group, and ecological region (annual and per year/acre).
C: Forest Carbon Stocks Tables
C1 - C11: Forest land carbon stocks by pool, ownership, all Washington, county region, ecological region, WA-DNR region, land status (total and per acre).
C12 - C13: Forest land carbon stocks by pool and county, all Washington (total and per acre).
C14 - C15: Forest land carbon stocks by National Forest (total and per acre).
C16 - C31: Forest land carbon stocks by ownership, pool, all Washington, and ecological region (total and per acre).
C32 - C37: Forest land carbon stocks by forest type, pool, all Washington, and WA-DNR region (total and per acre).

C38: Forest carbon stocks by 10-year inventory period, by pool, all Washington.
C39: Live tree carbon stocks by 10-year inventory period, by ownership, all Washington.
C40: Forest carbon stocks by 10-year inventory period, by ownership, all Washington.
D: Forest Land Conversion Tables
D1: Annual change in forest land area to/from other IPCC land-use classes, all Washington.
D2: Annual change in carbon pools due to change in land-use between forest and non-forest, all Washington.
E: Net Flux from Other Greenhouse Emissions Tables
E1: Annual net emissions of non-CO_2 greenhouse gases from fire, all Washington.

Chapter 1. Executive summary and key findings

This forest ecosystem carbon inventory provides the state's first comprehensive assessment of forest ecosystem carbon stocks, flux and trends. It is designed to address the state's need for a reliable carbon accounting system to help track changes in forest carbon and to meet legislatively-mandated carbon sequestration and greenhouse gas reduction goals and reporting requirements. In addition to this inventory, the US Forest Service (USFS) is also producing a companion assessment of carbon stocks and flux in harvested wood products. Together, these assessments will provide a more robust understanding of carbon dynamics across Washington's landscape.

Results in this report are based on measurements conducted on 9,978 forested plots throughout Washington by the USFS Forest Inventory and Analysis Program (FIA). Plots are measured on a ten-year cycle, and ten percent of Washington's plots are measured every year. Washington's first full cycle of inventory occurred from 2002-2011, and this current assessment for the 2016 reporting period is based on five years (or 50 percent) of re-measurement data (2012-2016) to estimate change in carbon. Reporting of carbon stock, which is the amount of carbon in one or more pools (e.g., live trees, downed wood, harvested wood products) at a single point in time, is reported in metric tons of carbon (MT C). Flux, which is the net change in carbon in one or more pools over a specific period in time, is reported in metric tons of carbon dioxide equivalent (MT CO_2e). This inventory and reporting approach is consistent with and comparable to similar work conducted by USFS for forest ecosystem carbon in California and Oregon.

Carbon Pools and Calculations

For carbon stock, this report takes various approaches to measuring and modeling C storage in the following carbon pools:

- *Aboveground live tree*—Estimates of aboveground live-tree woody C were based on measured trees and regional FIA equations of the sum of bole, bark, and branch biomass;
- *Aboveground standing dead tree*—Estimates of aboveground standing dead tree carbon followed the same procedures as for aboveground live trees, but are modified to account for broken tops and decay;
- *Belowground live and standing dead tree* (i.e., roots) —Estimates of belowground biomass (i.e., coarse roots > 2 mm diameter) were based on the ratios for species-groups developed in Jenkins et al. (2003) as implemented in Woodall et al. (2011);
- *Aboveground down woody debris*—Estimates of carbon in down wood were based on field measurements of coarse wood (≥ 3 inches intersect diameter) and counts of

fine wood (≥ 0.25 to < 3 inches diameter). Piles were not included, as the field estimates of pile density in the initial years of the inventory were unreliable;

- *Aboveground and belowground understory vegetation*—Estimates of above- and belowground biomass and C of understory vegetation (which includes live trees < 1 inch in diameter) are based on the calculations from the U.S. Forest Carbon Budget Model;
- *Forest floor*—Estimates for carbon in the forest floor (i.e., duff and litter) use the same model used in the National Greenhouse Gas Inventory (NGHGI) which was based on FIA and soil survey data and predictor variables of location, elevation, forest type group, live tree C, and some climate variables.
- *Soil*—Estimates of soil organic C stocks were calculated to a 1-meter depth using the modeled estimates from Domke et al. (2017) as implemented in the latest NGHGI report.

For carbon flux, the Growth, Removals, and Mortality (GRM) approach was used to calculate change in forest C pools and the magnitude of flux. This approach compares measurements taken on the same set of plots and trees 10 years apart. The change in C was calculated for individual trees between measurements. For live trees that died or were cut between measurements, growth equations were used to estimate tree diameter and height at the midpoint of the measurement interval and calculate C at the time of death. In addition, for each plot measurement, FIA crews identified the types of treatments and disturbances that occurred on each stand delineated on the plot since the previous measurement using categories such as fire, cut, insect and disease, and weather. Change in C for standing dead trees was based on the difference in calculated C at each time-period and would include live tree C entering this pool through mortality, and dead tree C leaving this pool through decay, transition to other pools, or combustion. Changes in down wood C were estimated at the plot level, and included tree C entering this pool from live or standing dead pools and C leaving this pool through decay, transition to other pools, or combustion. Changes in understory vegetation, forest floor, and soil were based on modeled estimates.

Most of the tables report uncertainty in terms of the standard error of the estimate (SE). Many of the figures, and numbers in the text followed by " ± ", report the 95% confidence interval around the estimate, which is calculated as 1.96 times the SE.

Overview of Washington Forests

For the 2016 reporting period, FIA estimates ***there are approximately 22.1 million acres of forest land across all ownerships in Washington***. Approximately 57% (12.7 million acres) of these forests are managed by federal agencies and state/local governments (Figure 4.1, Table 4.1). Private ownerships are approximately evenly divided between corporate forest lands (approximately 4.8 million acres) and non-corporate forest lands (tribal nations, individuals, and organizations, approximately 4.7 million acres). Across the state, Douglas-fir has the greatest area of all forest types at approximately 40%, or 8.9 ± 0.3 million acres, followed by the fir/spruce/hemlock forest type group at approximately 17%, or 3.8 ± 0.2 million acres (Table 4.1).

Washington Forest Ecosystem Carbon Summary

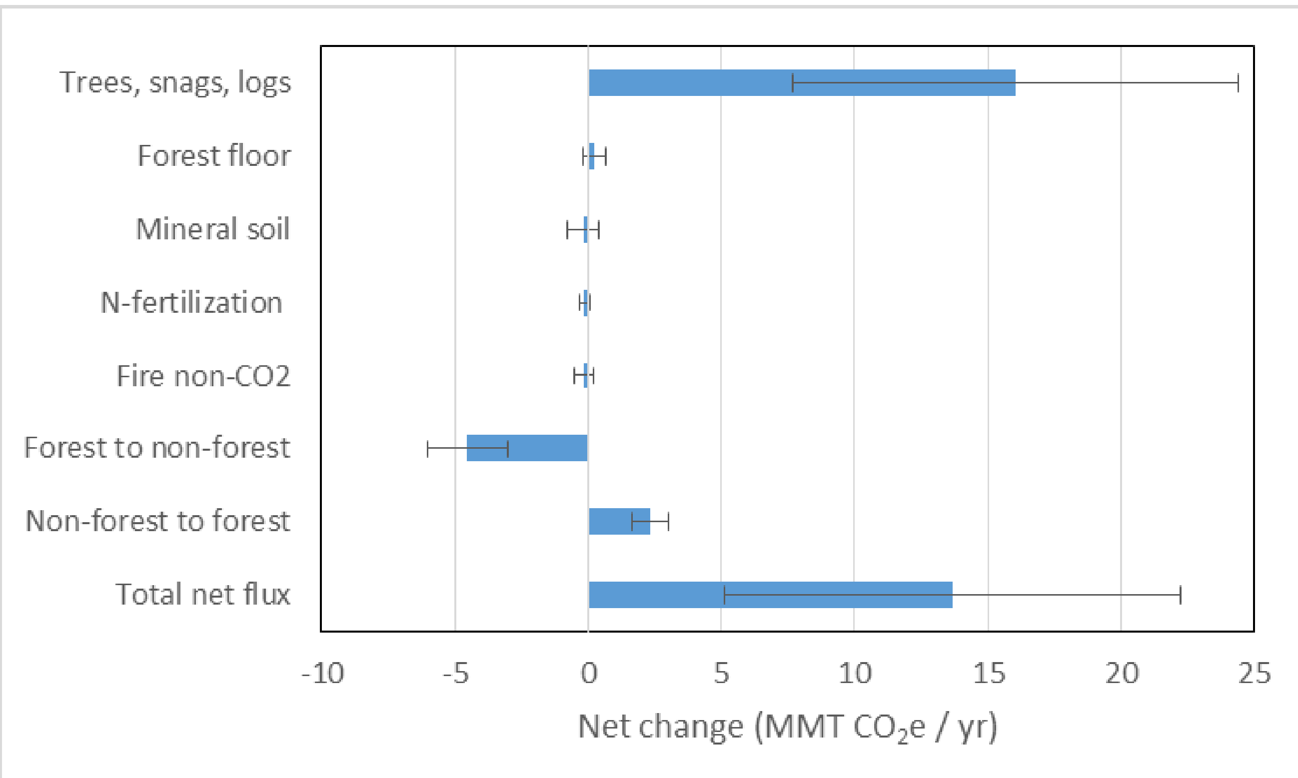
	FIA Inventory Estimate	**Sampling Error of the Estimate (SE)**
Total forest area (see 4.1.1)	22,120,335 acres	119,543 acres
Total forest carbon stocks (see 4.1.2)	2.72 billion metric tons carbon	18.47 million metric tons carbon
Average carbon stocks per acre (all ownerships and regions) (see 4.1.2)	122.88 metric tons carbon	0.67 metric tons carbon
Total annual net change in forest carbon (flux) including land use change and non-CO2 from wildfire (see 4.1.3)	+13.7 million metric tons CO_2e	4.37 million metric tons CO_2e
Total annual net change in forest carbon excluding land use and non-CO2 from wildfire (see 4.1.3)	+16.13 million metric tons CO_2e	4.40 million metric tons CO_2e
Average annual flux per acre excluding land use and non-CO2 (see 4.1.3)	+0.73 metric tons CO_2e	0.20 metric tons CO_2e
Forest land conversion (see 4.5):		
Average annual forest loss	20,848 acres	3,981 acres
Average annual forest gain	14,479 acres	2,811 acres
Average annual net change	-6,369 acres	4,878 acres

Statewide Results for Carbon Stocks

For the 2016 reporting period, ***there are 2.7 ± 0.04 billion metric tons of carbon stocks stored on forest land including forest floor and forest soils across all ownerships in Washington*** (Table 4.2). Almost half of all stored carbon is found belowground in forest soils (45%). The largest vegetation pool is live trees (40%) including carbon in live foliage and live roots. The remaining stored carbon is distributed among down wood (5%), forest floor (5%), standing dead trees (4%), and understory vegetation pools (1%). On a per acre basis, there are 122.9 ± 1.4 metric tons of carbon stocks per acre on average stored on forest land including forest floor and forest soils across all ownerships in Washington (Table 4.2). On average, there are 55.4 metric tons of carbon stored in forest soils per acre, 49 metric tons C stored in live trees per acre, and 6.8 metric tons C per acre being stored as downed wood.

Statewide Results for Carbon Flux

FIA data from the 2016 reporting period indicates that ***Washington's forests are a net sink of greenhouse gases from the atmosphere.*** Washington's statewide rate of carbon sequestration from all forest ecosystem pools across all ownerships is 16.1 ± 8.6 million metric tons CO_2e per year, excluding net CO_2e contributions from other sources such as harvested wood products, land converting to and from a forested condition, and non- CO_2 greenhouse gas emissions from wildfire (Table 4.3). Changes in land-use between forest and non-forest conditions are estimated to result in a net reduction of -2.2 ± 1.6 MMT CO_2e per year (Table 4.4, Figure 4.2). After accounting for land-use changes and non-CO_2 greenhouse gas emissions (methane and nitrous oxide) from wildfire of -0.2 ± 0.4 MMT CO_2e per year, ***the 2016 statewide rate of carbon sequestration on all forest land is 13.7 ± 8.6 MMT CO_2e per year***.



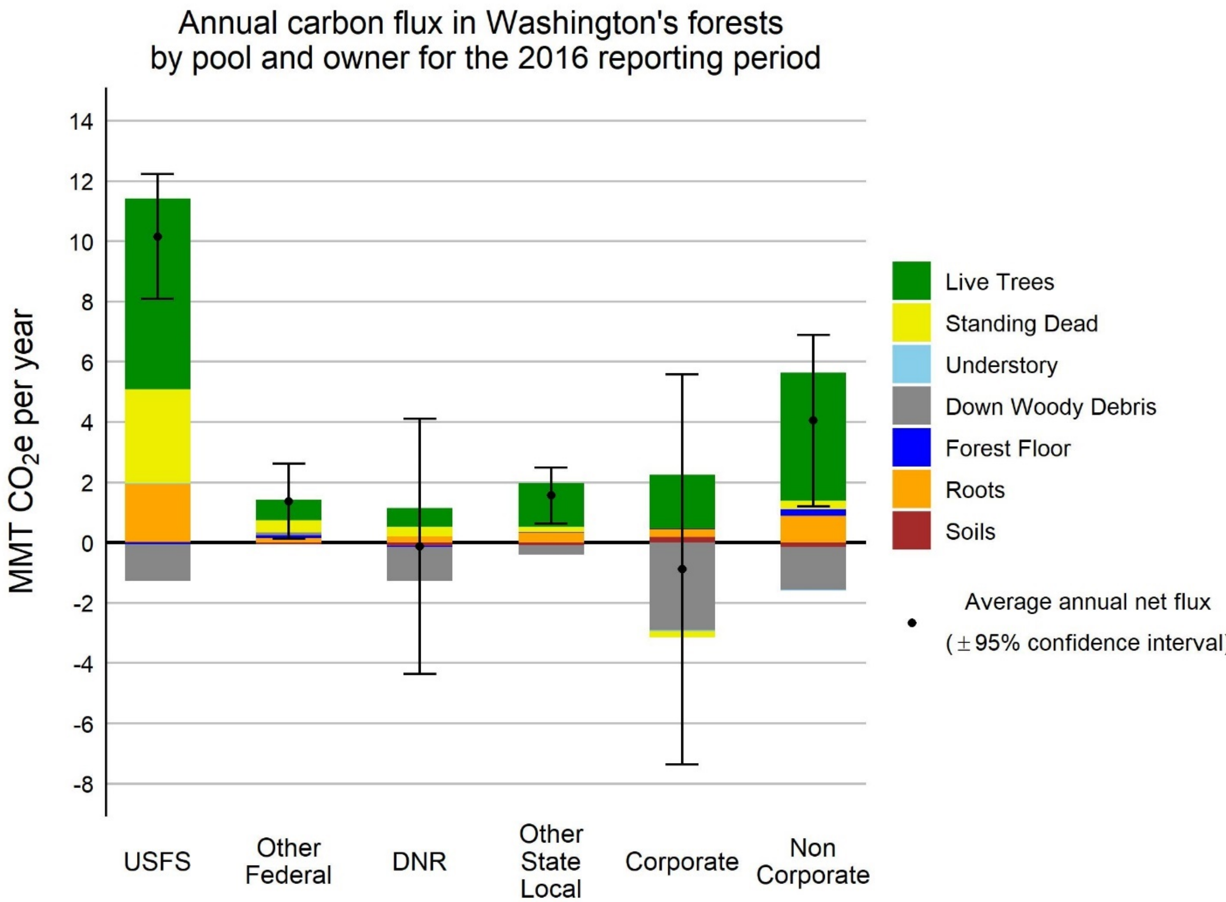
Copy of Figure 4.2. Statewide average annual net CO_2e flux from forest pools, land use, and land use change. Error bars are 95% confidence intervals. See Table 4.4 for more information.

Net live tree flux is composed of three components of change: 1) annual rate of tree mortality, 2) annual rate of live tree harvest, and 3) annual gross tree growth. ***Statewide on all ownerships, gross tree growth is exceeding mortality and harvest by 14.3 ± 6.4 MMT CO_2e.***

Gross growth is also a key driver of net flux across all pools including live trees, downed wood, standing dead, and soils; 94% of the annual net CO_2e flux is accounted for in tree growth (Table 4.5). It is interesting to note that the rate of CO_2e leaving the live tree pool due to mortality may slightly exceed harvest (Table 4.5). Other notable pools impacting net flux include standing dead trees, which are accumulating faster than they are leaving the pool, resulting in a net gain of 4.1 ± 1.8 MMT CO_2e annually (Table 4.3). Despite the increase in standing dead trees, any related increase in inputs to downed trees, fallen logs, and other woody material into the downed wood pool is not compensating for losses from decomposition, removal, or fire, resulting in a net loss reducing statewide CO_2e sequestration by 6.9 ± 2.3 MMT annually (Table 4.3). Similar to trends in other west coast states, this decrease in downed wood carbon is more heavily pronounced on private corporate forests and may be a result of historic high levels of downed wood that are decreasing over time. It is also important to note that while sections 4.2.3.2 and 4.2.3.3 of this report provide additional details on mortality events, the current compilation does not show how much of the CO_2e leaving the live tree pool due to mortality (-32.9 ± 2.4 MMT CO_2e per year) ends up in other pools such as standing dead trees or downed woody debris.

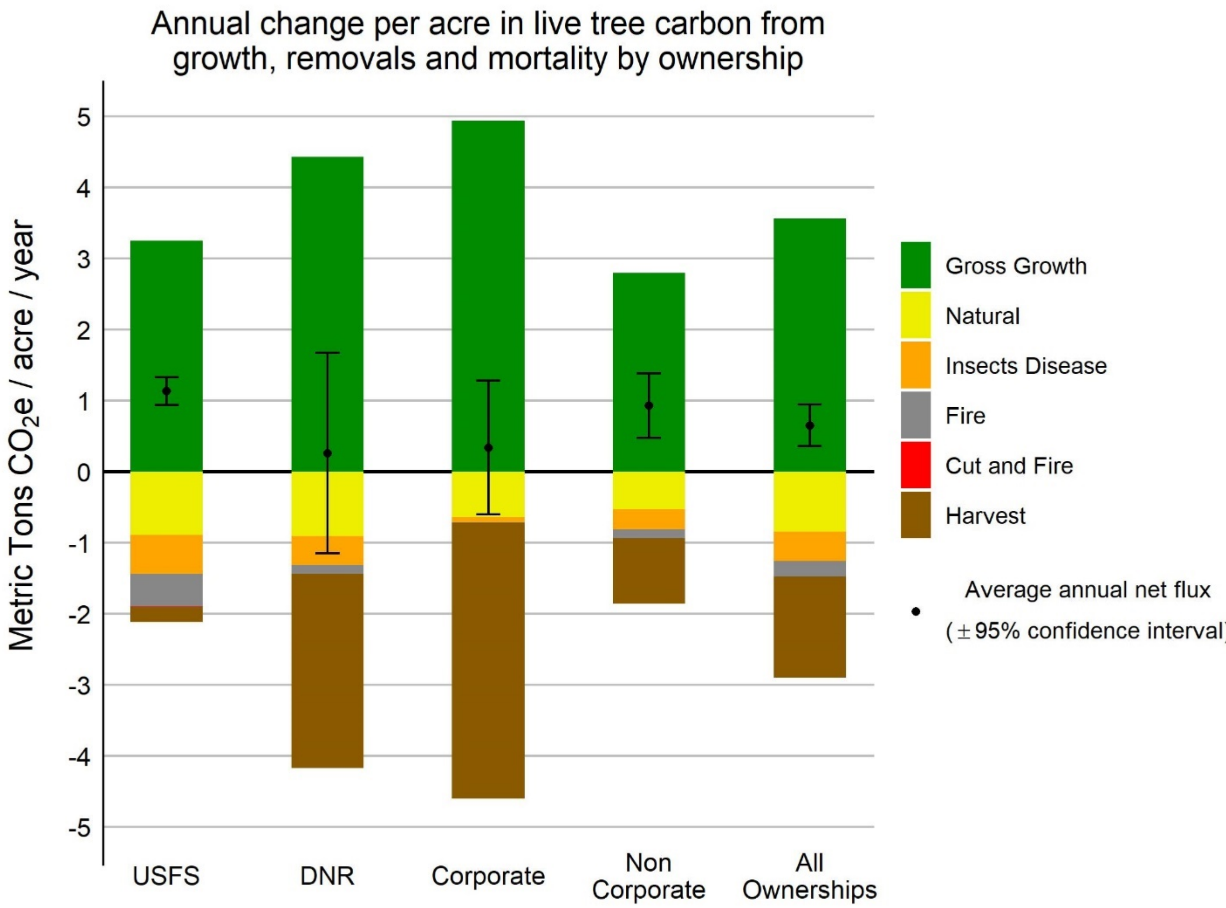
Results by Ownership

Across Washington's forests, ***63 percent of the 16.1 ± 8.6 million metric tons CO_2e being sequestered each year on forest land remaining forest is taken up by the National Forests*** (10.2 ± 2.1 MMT CO_2e per year, or 1.23 ± 0.3 MT CO_2e/ac/yr). Of the forest land managed by private owners, those managed by non-corporate owners are sequestering carbon at a rate of 4.0 ± 2.8 MMT CO_2e per year (0.9 ± 0.6 MT CO_2e/ac/yr). Although the estimate for net annual change on WA-DNR and private corporate forest lands is negative (-0.1 ± 4.2MMT CO_2e and -0.9 ± 6.5 MMT CO_2e per year respectively), the variation in the estimate of current annual growth when accounting for trees removed through management activities is too large to determine if the average net annual rate of carbon sequestration is statistically different from zero (Table 4.10, Figure 4.9).



Copy of Figure 4.9. Washington estimated average annual carbon flux by forest pool and ownership (MMT CO_2e/yr), 2002-2006 to 2012-2016. Estimates exclude emissions from land-use changes and non-CO_2 greenhouse gases. Roots includes belowground live and dead tree roots. Understory includes aboveground and belowground pools. Error bars represent 95% confidence intervals around point estimates for net flux. Figure derived from Appendix Table B1.

Carbon sequestration as gross tree growth on an annual per acre basis is highest on private corporate and WA-DNR forests (4.9 ± 0.3 MT CO_2e/ac/yr and 4.4 ± 0.4 MT CO_2e/ac/yr, respectively), with slightly less carbon sequestration due to gross tree growth on other state and local government ownerships (4.2 ± 0.7 MT CO_2e/ac/yr). Private non-corporate and USDA Forest Service ownerships have the lowest carbon sequestration from gross tree growth on an annual per acre basis at 2.8 ± 0.12 MT CO_2e/ac/yr and 2.9 ± 0.05 MT CO_2e/ac/yr respectively (Table 4.13, Figure 4.10). These trends highlight that while the National Forests are sequestering the highest total quantity of CO_2e per year in the state, the rate of CO_2e uptake through gross growth on a per acre basis is highest on private corporate and WA-DNR forests. In addition, ***private corporate and WA-DNR forests also have the highest rates of annual timber harvest, together accounting for more than 80% of the average annual flux of 31.2 ± 5.4 MMT CO_2e out of the standing live tree pool due to harvest*** (Table 4.12)***.*** These two ownerships are therefore expected to contribute more to the harvested wood products carbon pool than forests managed by private non-corporate owners, National Forests, or other federal forest lands.



Copy of Figure 4.10. Average annual net change per acre in aboveground live tree carbon by ownership in Washington's forests (MT CO_2e/ac/yr), 2002-2006 to 2012-2016. Error bars represent the 95% confidence interval of net change. Figure derived from Appendix Table B2.

The National Forests are storing 40% of the carbon stocks and manage 37% of the forest land base (Figure 4.6) while private ownerships together store 36% of the carbon stocks and manage 43% of forest land. This difference in the proportion of carbon stores per area of land base illustrates the generally older over-story stands, denser tree stocking, and additional dead and down wood carbon stores found on National Forests as compared to more intensively managed private ownerships. Live tree storage ranges from 82.93 ± 6.1 MT C/ac on other federal forests to 27.20 ± 1.6 MT C/ac on private non-corporate forests. Soil carbon stocks range from 59.01 ± 1.0 MT C/ac on other federal forests to 52.90 ± 0.6 MT C/ac for private non-corporate (Table 4.9).

Results by Geographic Region

Carbon stock and flux results vary significantly between eastern and western Washington with western Washington accounting for the majority of stocks and annual sequestration, and eastern Washington showing losses from the live tree pool and within certain ownerships. ***Counties west of the Cascade divide account for 93% of Washington's annual forest carbon sequestration from all pools*** (15.0 ± 8.2 MMT CO_2e per year and 1.3 ± 0.7 MT CO_2e/ac/yr) (Tables 4.27 and 4.28). The forests of Skamania, King, and Lewis counties had the highest rates of carbon sequestration, with each exceeding 2.6 MMT of CO_2e annually. Those three counties accounted for 50 percent of the net increase in non-soil CO_2e sequestered each year by Washington's forests. In contrast, ***carbon is being transferred out of the live tree pool in the eastern county forests at a rate of 1.1 ± 2.4 MMT CO_2e per year*** (0.1 ± 0.2 MT CO_2e/ac/yr).

Counties west of the Cascade divide currently contain 65% of all forest carbon stocks, and 73% of all live tree carbon stocks (Table 4.21). ***On a per acre basis, forests in westside counties currently store an average of 146.2 ± 2.2 MT C/ac (Table 4.22) while eastside counties currently store an average of 94.9 ± 1.2 MT C/ac (Table 4.24).*** Eastside forests currently store 35% of statewide forest carbon stocks, and 27% of all live tree carbon stocks (Table 4.23). Relative to the amount of carbon stocks in live trees, eastside forests store a disproportionally large share of carbon stocks in dead trees accounting for 46% of the statewide carbon in this pool.

Of the National Forests or other forested areas managed by the USDA Forest Service, most forests were estimated as gaining carbon, with the greatest increases on the Gifford Pinchot and Mt. Baker-Snoqualmie National Forests at 4.4 ± 0.8 and 3.5 ± 1.2 MMT CO_2e per year, respectively, which also had the highest growth rates. The Colville National Forest had a substantial increase of 2.0 ± 0.4 MMT CO_2e per year due to modest growth rates and substantial increases in dead wood. The Okanogan and Umatilla National Forests are estimated to be experiencing a net loss of carbon each year based on all pools (-1.5 ± 0.9 MMT CO_2e per year and -1.0 ± 0.7 MMT CO_2e per year, respectively) (Table 4.15). The majority of carbon going into the standing dead tree pool is coming from forests managed by the USDA Forest Service, accounting for 83% of the annual change in standing dead tree carbon in eastern Washington counties.

Results for DNR-Managed Lands

The mean carbon stock per acre from all pools for all WA-DNR regions is 131.8 ± 5.4 MT C/ac, ranging from 153.9 ± 7.4 MT C/ac in the western regions, to 90.3 ± 4.9 MT C/ac in the eastern regions. The net average annual carbon flux for all pools on all WA-DNR forest land is -0.1 ± 4.2 MMT CO_2e/yr (-0.05 ± 1.9 MT CO_2e/ac/yr) (Tables 4.36 and 4.37) indicating that ***on average, on all WA-DNR forest land the transfer of CO_2e into the live tree and other carbon pools is nearly***

equal with the transfers of CO_2e out of the forest carbon pools. Splitting these results by geography and carbon pool shows that eastern WA-DNR regions have an average annual live tree carbon loss of 0.3 ± 0.7 MMT CO_2e/yr after accounting for mortality and harvest while western WA-DNR regions have an average annual live tree carbon gain of 0.9 ± 3.1 MMT CO_2e/yr (Table 4.36). However, 95% confidence intervals around estimates of net change for the western and eastern regions are too wide to determine whether the current trend in annual carbon flux less is statistically different from zero. On a per acre basis for WA-DNR forests in eastern Washington, tree mortality, including mortality from insects, disease, wildfire, and natural succession, is the largest driver of carbon loss from live trees. In contrast, harvest is the largest driver of carbon loss from live trees for WA-DNR forests in western Washington (Table 4.37).

Converted Forest Lands

Forested land was both lost and gained in Washington between 2002-2006 and 2012-2016, with ***the estimated net annual change in forested lands totaling -6,369 ± 4,878 acres per year***. Total annual conversion of lands from forested to non-forested is estimated at 20,848 ± 3,981 acres per year. The largest category of forest loss was conversion to developed uses (-10,778 ± 2,131 acres per year), which includes conversion to roads (52%; primarily new logging roads) and housing (26%). Other conversion categories include cropland, grassland, water and other. Conversely, total conversion from non-forest to forest is estimated at 14,479 ± 2,811 acres per year (a major source was reforestation of abandoned logging roads). ***For carbon sequestration, the net conversion of land between forest and non-forest uses resulted in a net reduction of -2.2 ± 1.6 MMT CO_2e per year***.

Improvements to the Inventory

Washington State may desire more precision in its carbon estimates than the current inventory provides. While the data in this report are robust, there may be need for greater precision in some regions or some ownerships or some forest types, especially where the confidence interval is wide, carbon management is a priority, or where it is not currently possible to statistically determine if flux is positive or negative. In addition, there may be need for faster responsiveness to detect or track changing carbon dynamics and tree mortality more quickly due to changing climate conditions, other disturbances (wildfire, insects, disease) or land use alterations. Options to improve inventory precision are provided in Chapter 6 and include improving data collection methods (increase the number of plots; increase the frequency of measurement; improve estimation of non-sampled plots; increase use of remote sensing; and improve tracking of dead and down wood) and improvements to data compilation (update tree biomass equations; and increase consistency in carbon reporting across platforms).

Chapter 2. Introduction

On May 29, 2018, Washington State Department of Natural Resources (WA-DNR) contracted with the U.S. Forest Service Pacific Northwest Research Station Forest Inventory and Analysis (Forest Service Agreement No. 18-CO-11261979-066) to assess Washington's statewide forest ecosystem carbon stock, flux and trend information for the period 2002-2016.

This report documents results of this forest ecosystem carbon inventory. The report provides summaries of carbon stocks and flux by region, ownership, tree species, and carbon pool. The report also establishes a Forest Management Reference Level per IPCC guidelines as a basis for future assessment of forest carbon trends. Strategies to improve future inventory precision are provided in Chapter 6.

U.S. Forest Service (USFS) scientists have produced similar forest ecosystem carbon inventories for California and Oregon. This Washington forest ecosystem carbon inventory employs consistent methodology and is comparable with recent inventories from California and Oregon.

2.1 Washington's Forest Carbon Accounting Background

The carbon sequestration potential of forests and other lands and waters can play a significant role in reducing atmospheric greenhouse gas concentrations (IPCC in press, UNEP2017). To clarify and track that potential, the state requires a reliable forest carbon accounting system.

This inventory provides the state's first comprehensive assessment of forest ecosystem carbon stocks, flux and trends. In addition to this inventory, USFS is also producing a companion assessment of carbon stocks and flux in harvested wood products. Together, these assessments will provide a more robust understanding of carbon dynamics across Washington's landscape and can provide a reliable forest carbon accounting system that will contribute to achieving Washington's carbon sequestration and greenhouse gas reduction goals.

The state has established a number of greenhouse gas and carbon sequestration goals. This section provides a summary of targets and goals that are relevant to this forest ecosystem carbon inventory.

In 2020, the Washington State Legislature passed ESSHB 2311, which updated previous statewide emission reduction limits and reporting requirements established in RCW 70.235.020. The updated legislation declares, "The state shall limit anthropogenic emissions of greenhouse gases to achieve the following emission reductions for Washington state:

i. By 2020, reduce overall emissions of greenhouse gases in the state to 1990 levels, or ninety million five hundred thousand metric tons;
ii. By 2030, reduce overall emissions of greenhouse gases in the state to fifty million metric tons, or forty-five percent below 1990 levels;

iii. By 2040, reduce overall emissions of greenhouse gases in the state to twenty-seven million metric tons, or seventy percent below 1990 levels;
iv. By 2050, reduce overall emissions of greenhouse gases in the state to five million metric tons, or ninety-five percent below 1990 levels."

Washington's baseline 1990 greenhouse gas emission levels were 90.5 million metric tons of carbon dioxide equivalent (MMT CO_2e). The state's most recent greenhouse gas emissions inventory reports that Washington's 2015 total greenhouse gas emissions were 97.4 MMT CO_2e, or 6.9 MMT CO_2e higher than the 1990 baseline levels (WADOE 2018). The 2018 report also finds that Washington's greenhouse gas emissions increased by about 6.1 percent from 2012 to 2015. As of 2015, greenhouse gas emission trends in Washington were increasing away from the 1990 target rather than reducing towards it.

The carbon sequestration performance or potential of forests and other lands and waters has not previously been included in Washington's greenhouse gas tracking and reporting. However, the 2020 Legislature, in ESSHB 2311, states…

> … all pathways to one and one-half degrees Celsius rely on some amount of negative emissions through carbon sequestration. It is therefore the intent of the legislature to strengthen Washington's statutory greenhouse gas emission limits to reflect current science … and to encourage voluntary actions that increase carbon sequestration on natural and working lands and storage in the related products from those lands.
>
> … it is the policy of the state to promote the removal of excess carbon from the atmosphere through voluntary and incentive based sequestration activities in Washington including, but not limited to, on natural and working lands and by recognizing the potential for sequestration in products and product supply chains.
>
> It is the policy of the state to prioritize carbon sequestration in amounts necessary to achieve the carbon neutrality goal established in RCW 70.235.020, and at a level consistent with pathways to limit global warming to one and one-half degrees.
>
> All agencies of state government… shall seek all practicable opportunities … to cost effectively maximize carbon sequestration and carbon storage in their nonland management agency operations, contracting, and grant-making activities.

In future state greenhouse gas emission inventory reports, this and future forest ecosystem carbon inventories can support efforts to track and assess progress towards GHG and carbon sequestration goals.

Other state laws also underscore the need for a reliable carbon accounting system for forests, harvested wood products, and other natural resource sectors. Relevant legislation enacted in 2020 includes:

- ESSHB 2528: Establishes a new policy of the state to support the contributions of all working forests and the synergistic forest products sector to the state's climate response; and a new policy of the state to support the participation of working forests in current and future carbon markets;
- SSSB 5947: Establishes a sustainable farms and fields grant program to enable farmers and ranchers to adopt practices that increase appropriate quantities of carbon stored in and above their soil and to initiate or expand the use of precision agriculture on their farms;
- ESHB 2713: Directs state and local governments to consider using locally-produced compost to achieve carbon sequestration and other benefits;
- ESSB 6248 Sec. 7007 (2020 Capital Budget): Directs state agencies, whenever possible, to review and consider embodied carbon reported in environmental product declarations when evaluating proposed structural materials for construction projects; and
- ESSB 6168 (2020 Supplemental Operating Budget): Establishes a new Climate Resiliency Account and directs the state to dedicate expenditures from the account to activities that strengthen the resiliency of communities and the natural environment.

Relevant legislation from previous years includes:

- RCW 80.80.030: Directs the governor to develop policy recommendations to the legislature on how the state can achieve greenhouse gas emissions reduction goals, including forest and other carbon sequestration options;
- RCW 79.155.030: Specifies program management principles for community forest trust lands, including maintaining the land in a working status through revenue sources such as carbon storage;
- RCW 79.10.530: Directs WA-DNR to recommend potential non-timber revenue sources, including carbon sequestration, that could finance specific forest health treatments; and
- RCW 76.13.120: States that the natural carbon storage potential of growing trees is among the societal benefits of economically viable working forests and that working forests may be part of the state's overall carbon sequestration strategy. Further, this legislations directs that if the state creates a climate strategy, information regarding the carbon sequestration benefits of the forest riparian easement program must be shared with other state programs using methods and protocols established in the state climate strategy that attempt to quantify carbon storage or account for carbon emissions.

WA-DNR also requires a reliable forest carbon accounting system to track progress on agency carbon goals and policies. WA-DNR’s current Strategic Plan (WADNR 2018) establishes a goal of smart carbon reduction efforts that reduce emissions and strengthen local economies (Goal D2). WA-DNR’s strategies include seizing opportunities to generate benefits for trust beneficiaries and communities by incentivizing carbon sequestration on public and private lands (Strategy D2.2).

In 2018, WA-DNR's statewide elected leader, Commissioner of Public Lands Hilary Franz, published a set of carbon principles, stating that climate change poses the greatest threat to WA-DNR's long-term ability to fulfill its mission of supporting Washington's communities and landscapes. One of the Commissioner's four carbon principles is to accelerate carbon sequestration by tapping into the potential of Washington's forests, farms, ranchland, coastlines, wetlands, riparian corridors, and soils to sequester and store carbon, and by investing in statewide carbon sequestration programs that incentivize keeping working farms and forests working and maximizing carbon stored in trees and soils. In February 2020, Commissioner Franz released DNR's Plan for Climate Resilience, which identifies responses to climate change risks and reconfirms DNR's commitment to reversing GHG trends through carbon sequestration in forests, harvested wood products, soils, grasslands, agricultural systems, aquatic systems, and geologic formations.

The Washington State Legislature has specifically funded carbon inventory activities. In the 2020 sustainable farms and fields grant program (SSSB 5947), a portion of the funds are available to develop analytical tools, measurement estimation and verification methods. In 2019 the Legislature directed WA-DNR to build on this Forest Ecosystem Carbon Inventory by conducting complementary carbon inventories of harvested wood products, wildfire emissions, land management activities, and sawmill energy use and emissions. It also directed WA-DNR to compile and provide access to information on existing opportunities for carbon compensation services and other incentive-based carbon reducing programs to assist forestland owners interested in voluntarily engaging in carbon markets. Finally, this legislation directed WA-DNR to form a natural and working lands carbon sequestration advisory group to help guide these activities. WA-DNR must submit a report to the legislature by December 1, 2020 summarizing the results of the inventories and assessing actions that may improve the efficiency and effectiveness of carbon inventory activities.

2.2 U.S. National Greenhouse Gas Inventory

The U.S. Environmental Protection Agency coordinates and compiles summaries and analyses by multiple agencies to produce the National Greenhouse Gas Inventory (NGHGI). The most recent published report provides national estimates of stocks and flux of greenhouse gases for 1990-2018 (US EPA 2020). The last NGHGI that included state-level estimates was released in 2016. The core dataset for forest carbon used in the NGHGI is the USDA Forest Service's Forest Inventory and Analysis (FIA) inventory. The inventory is based on empirical field measurements of carbon pools and on models that complement the field measurements for pools and/or time periods with few data. The NGHGI follows IPCC guidance as closely as possible with available datasets.

This report differs from the NGHGI analysis in that some of the fluxes can be estimated from measurements available in Washington, rather than models designed for national estimation, and it does not attempt to model results back to 1990 for all lands. Instead, we summarize available empirical data for that time-period and identify alternatives for improving estimates.

We refer to the methods of the NGHGI extensively, however, for estimating flux in pools and processes for which empirical data are limited (e.g., soils). This report also includes the use of regional biomass equations instead of national models, and adjustments for decay and fragmentation of snags that differ from the NGHGI.

2.3 Forest carbon cycle overview

The global carbon cycle includes movement of carbon (C) among vegetation, soil, ocean, rock, and atmosphere (Ryan et al. 2010). Although the amount of C in vegetation and soils (i.e., **stocks**) is much smaller than that in the ocean, the movement of C to and from the atmosphere (i.e., **flux**) is comparable. Live vegetation absorbs C from the atmosphere through photosynthesis and fixation of C in living material, and vegetation and soils emit C to the atmosphere through respiration and microbial decay of dead plant matter (Figure 2.1). Forests are particularly important to the carbon cycle because they can store large amounts of C and can be dynamic over relatively short time periods (e.g., decades). Forests in the Northern Hemisphere in particular are absorbing more C from the atmosphere than they are emitting (Pacala et al. 2001, Yin et al. 2018). C removed from the atmosphere by forest growth or stored in harvested wood products for the U.S. in 2017 were estimated to offset 11.3% of U.S. emissions from industry and agriculture (US EPA 2020).

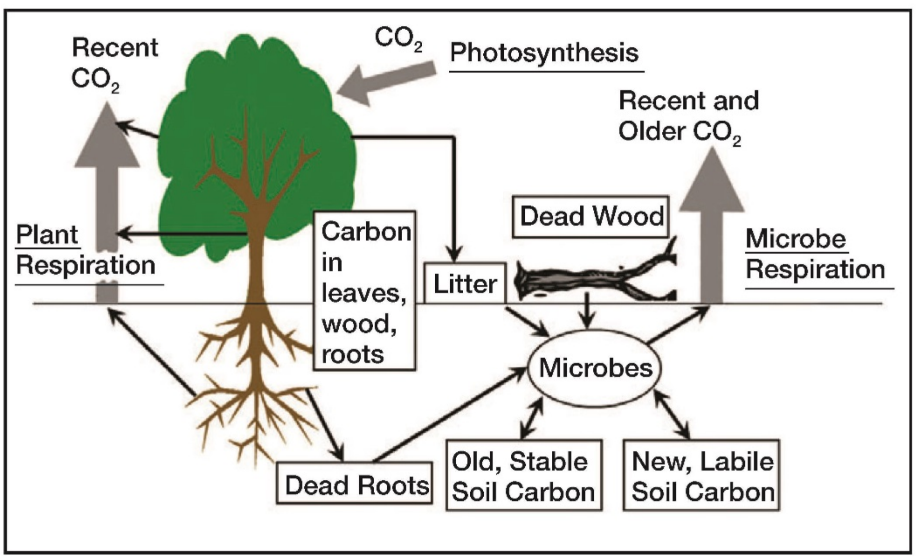


Figure 2.1: Flows of carbon in a forest from the atmosphere to the forest and back. Carbon is stored mostly in live and dead wood as forests grow (extracted from Ryan et al. 2010 Figure 2). This figure does not include C removed from harvest, C removed from fire, C consumed by animals, or soil C removed in groundwater or erosion.

Live forest vegetation builds plant tissues with carbon dioxide (CO_2) from the atmosphere through the process of photosynthesis. A large proportion of the photosynthetic carbon is respired by living plant cells, but a portion of it goes into the production of tissues like leaves, twigs, fine roots, flowers and fruits, and wood and bark in boles, branches, and coarse roots. Depending on their longevity (a matter of weeks for fine roots, or centuries for tree boles, depending on disturbance or harvest), these tissues die and transfer to other pools (e.g., leaves to litter, branches to down wood, live tree boles to standing dead or harvested logs) where they begin to decompose due to microbial action, whereby C is emitted to the atmosphere, primarily as CO_2. The increase in volume or biomass of live trees over a specific time period is called **gross growth**, and is similar to estimates of net primary production (NPP) of wood. The volume or biomass of live trees that die during a specific time period is called **mortality**. The difference between gross growth and mortality is the net change in live tree volume or biomass, referred to as **net growth**, which can be positive or negative. Some of the partially-decomposed tissue stays in the soil mineral and organic layers, where C may accumulate over time. When the net effect of the many C fluxes in a forest results in increased storage of C it is referred to as **sequestration**.

While tree mortality occurs naturally in all forests, natural disturbance events such as wildfire, pest outbreaks, wind throw, and drought can result in high mortality rates, potentially killing all aboveground live vegetation over large areas. In the case of wildfire, some C (as well as other greenhouse gases such as N_2O) can be emitted directly to the atmosphere through combustion, or lost from the area as soot. Some carbon compounds found in the fine particulate matter in soot (≤ 2.5 μm in diameter) is referred to as "black carbon" and although it only remains in the atmosphere for a few weeks, it contributes to the greenhouse effect by absorbing solar radiation and heating the atmosphere. In some cases, black carbon can take on the form of charcoal, which can be a stable, long-lived form of C in the forest. Dead tissue left after the disturbance then decays, emitting C to the atmosphere over weeks in the case of scorched needles or over decades to centuries in the case of large dead trees. In severely disturbed forests, C emissions to the atmosphere will initially exceed absorption, and total C will decrease (Figure 2.2). As vegetation becomes established and the amount of growing tissue increases, at some point C absorption will exceed emissions, and total C stocks will increase. This net flux from the atmosphere (accumulation) decreases as forests age and comes close to zero, or equilibrium, in forests that are 300 or more years old (Gray et al. 2016). At this point when annual emissions equal annual uptake, forests have reached the **carbon sink saturation point.**

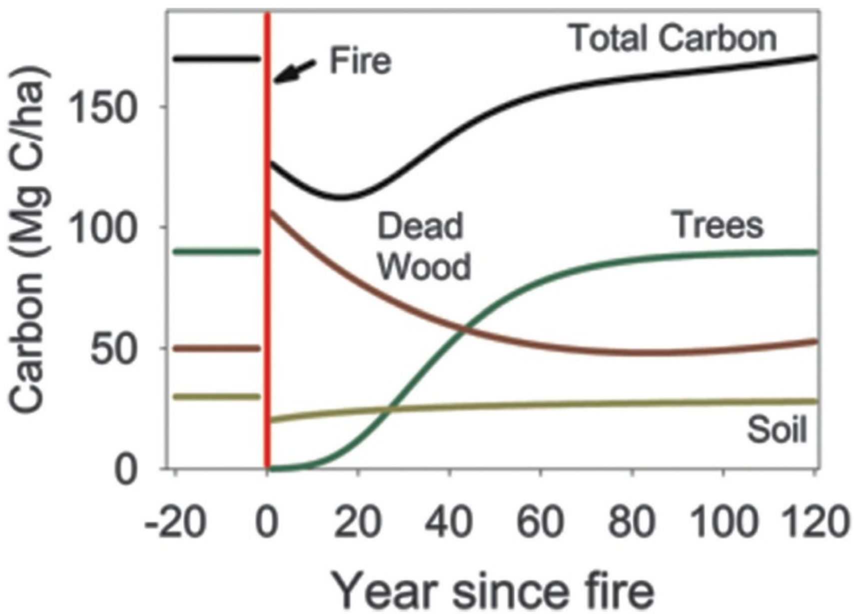


Figure 2.2: Idealized cartoon of carbon trajectories in live trees, dead wood, and soil in a forest where all trees are killed by severe wildfire and vegetation subsequently regenerates (extracted from Ryan et al. 2010 Figure 3). With sufficient time, the forest will recover the carbon lost in the fire and the decomposition of trees killed by the fire as long as there were no conversions to lower carbon vegetation types such as shrub lands or grasslands.

In addition to growth and mortality, the C stored in forests can change through increases in forest area (**afforestation**) or decreases in forest land (**deforestation**). While vegetation on afforested sites may accumulate at rates comparable to regenerating forest, levels of soil C tend to take longer (e.g., several decades) to accumulate to levels typically found in forests. Consequently, recently afforested areas may not reflect a significant gain in soil C for many years. Similarly, deforested lands lose soil C over decades until they reach levels typical of non-forest land-uses. While trees are often found in non-forest land-uses (e.g., urban areas, windbreaks or stream buffers in agricultural lands), their C stocks are typically included in the carbon assessments of those other land-uses, identified as different sectors of national assessments.

Tree harvest removes C from forests in the form of logs. However, the C in those logs is emitted to the atmosphere at different rates depending on how the wood and bark are used, so the tracking of the fate of forest C in various harvested wood products (HWP) becomes an important part of forest C accounting. Some portions of harvested trees remain in the forest, moving between forest ecosystem carbon pools and decay slowly along with other dead tissue (e.g., branches and foliage) or are disposed of through in-forest burning with immediate carbon and other greenhouse gas emissions. Other parts become stored in short-lived or long-lived products (e.g., paper and house frames, respectively), converted into other bioproducts, or burned to supply industrial or residential energy and/or heat. At the mill, sawlogs, pulpwood, fuelwood (termed **timber product classes**) are converted to primary timber products (i.e., lumber, plywood, veneer, residues, etc.). Each of these products are then allocated to various end-uses such as residential construction, manufacturing, packaging and shipping, or biomass energy, to name a few. Wood products within these various end-uses have different lifetimes. A product's **half-life** is the number of years it takes for half of the initial amount of wood to be discarded and can be used to determine how much of the original product remains in use versus disposed (Skog 2008). Once disposed, discarded wood products decay over time releasing carbon back to the atmosphere. The process by which this happens is dependent on the manner of disposal. In anaerobic environments such as in landfills, wood decay releases carbon (mostly in the form of methane (CH_4), a more potent greenhouse gas than CO_2) and ceases after several decades, leaving a carbon fraction that persists in solid form indefinitely. Newer landfill technologies are being implemented in parts of the country to allow for methane capture and combustion (oxidation), thus reducing overall methane emissions to the atmosphere with formation of CO_2, a less powerful greenhouse gas. In some cases, at the end of product use-life, products can remain in use through recycling, burned for energy, or burned as waste (Stockmann et al. 2012). When the product is kept out of the landfill methane emissions from landfill decay are substantially decreased. While this report focuses on pools and flux within the forest ecosystem, a separate report on HWP is in progress.

Fossil fuel and other emissions not derived directly from forest ecosystems that are generated in the forest management and manufacturing process are typically not included in forest sector C analyses but are included in the industrial sector (e.g., US EPA 2020).

Accumulating C in standing forests is one clear way to increase absorption from the atmosphere. Accumulating C in forests could be accomplished by reducing the amount of C removed during harvest. However, to the extent that the demand for wood products remains, one result could be **leakage** where storing more carbon in forests in one region (or country) is offset by reduced storage of carbon in other regions, with no net gain in global carbon storage (McKinley et al. 2011). Conversely, intensive commercial timber production may decrease demand for wood from other lands, thereby increasing the in-forest carbon stocks on those other lands (Heath et al. 2010).

Another concern with increasing carbon stocks in forests is the notion of **permanence**; areas that are fire-prone are at higher risk that live trees will be killed and C lost to fire and decay, especially in forest types where denser (higher C) forests are likely to burn at higher severity. The use of harvested wood and wood products may reduce overall C emissions through their use as **biomass energy** in situations where the use of wood as biomass for fuel results in fewer C emissions from the use of fossil fuels. Another effect of using wood products could be through **substitution** of wood instead of steel or concrete, which result in more C and other greenhouse gas emissions to produce.

While tracking the changes in C stocks (and therefore C flux) can be relatively straight-forward, quantifying leakage, permanence, and substitution can be more difficult. One example of an analysis that incorporated biomass energy as a reduction in fossil fuel emissions compared overall emissions from open pile burning of logging residues to processing and burning in a biomass energy plant, and found a net reduction in emissions of 0.54 tons CO_2e per dry ton of biomass (Figure 2.3; Springsteen et al. 2015).

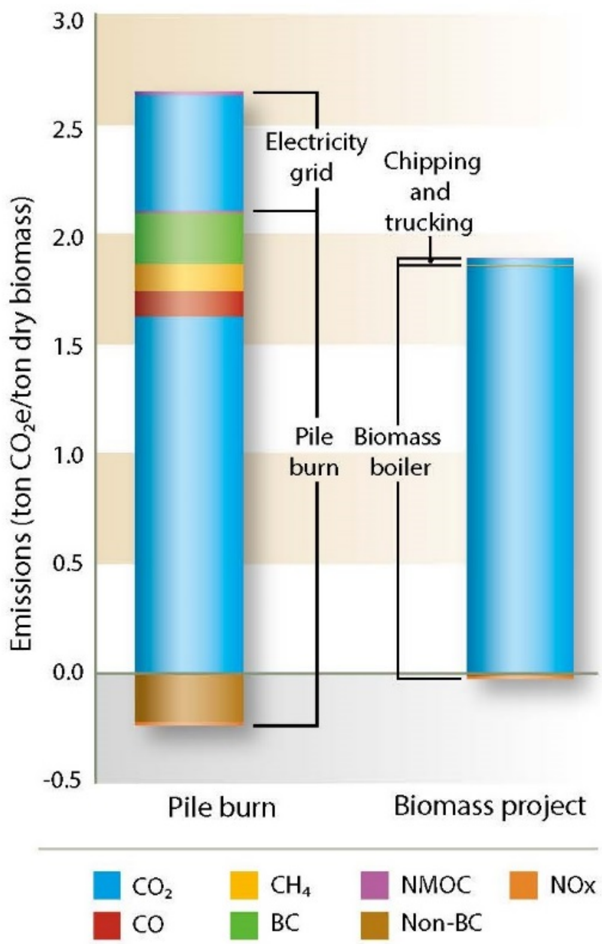


Figure 2.3: Comparison of greenhouse gas emissions between a pile burn of logging residue versus chipping, hauling, and burning it in a biomass energy plant. Analysis estimates CO_2-equivalent effects of different gases and particulates, as well as the additional emissions needed in the case of the pile burn to generate the same amount of electricity from natural gas. Terms in the legend not described elsewhere: "BC" is black carbon, "Non-BC" is the remaining carbon in soot, "NMOC" is non-methane organic compounds (Extracted from Springsteen et al. 2015, Figure 6).

2.4 Overview of Washington forests

Washington hosts a wide variety of tree species, including many species of conifers as well as oaks and other hardwoods. Forest stands are classified into **forest types** based on the predominant species in a stand to support inventory and reporting. These are further aggregated into forest type groups based on overlap in species composition. The Forest Inventory and Analysis (FIA) program defines a variety of coniferous forest types in Washington including Douglas-fir, fir/spruce/mountain hemlock, western hemlock/Sitka spruce, Ponderosa pine, lodgepole pine, western larch, and others. Hardwood forest types include alder/maple, aspen/birch, western oak, and elm/ash/cottonwood among others.

FIA **land status** distinguishes **forest land** from non-forest (i.e., crops, improved pasture, residential areas, city parks, etc.) and other area (i.e., water), and also distinguishes differences in **forest land status**. For example, forest land in Washington is categorized into timberland and other forest land based on its ability to grow commercial tree species (**productive capacity**) and its availability for timber extraction. Lands that can produce 20 cubic feet of wood volume per acre per year of commercial tree species are termed **Productive Forest land**. Productive forest land that is available for management for timber production (i.e., not in a **reserve status**) is called **Timberland**. Forest land that is not capable of producing 20 cubic feet of wood volume per acre per year of commercial tree species is called **Other forest land**. Forests in reserve status (i.e., wilderness designation, National Monuments, National Parks, etc.) can include both productive and other forest land. Although management for production of wood products in reserved forests is precluded, in some cases timber harvest can still occur for various objectives (i.e., restoration, salvage, etc.). Approximately 80 percent (17.8 million acres) of the 22.1 million acres of forest land in Washington are classified as timberland, with an estimated 3.2 million acres of productive forest land in reserves (Palmer et al. 2019). There are approximately 520 thousand acres of non-reserved other forest land (i.e., 2 percent of all forest land) and 640 thousand acres of reserved other forest land. In this report, most analyses and results are presented for all forest land, without distinguishing by productivity or reserve status.

Management and use of forest land is often a function of ownership and land status in Washington. Washington's total forest land is divided between private and public ownership. The federal government manages 44% of these lands, with the remaining areas under Department of Natural Resources (10%), other state and local government (2.8%) or private management (43%) (see Figure 4.1). Forest land managed by tribal nations are 8.5% of the total and are included in private ownership (Palmer et al. 2019).

For the 17.8 million acres of forest qualifying as timberland (see definition above) in the state, approximately 5.9 million acres are managed by the federal government, 9.2 million are in private ownership, with the remaining 2.7 million acres in other public ownership. Approximately 200 thousand of the 520 thousand acres of other forest land in non-reserved status is privately owned, with most of the remainder in federal management.

Of the 3.8 million acres of forest land in Washington in reserved status (National Wilderness designations, etc.), 95 percent are managed by the federal government, with the remainder in other public ownership. To better understand the carbon dynamics in Washington's forests, information in this report and appendices is provided for different forest types, ownerships, forest reserve classes, and on a regional basis (see Figure 4.13a,b).

The focus of this report is not to present or debate policy options and the desirability of different approaches to forest management. However, we expect that a comprehensive assessment of carbon stocks and fluxes, broken down by pool, ownership, and disturbance impacts, will help ground and guide those policy discussions going forward.

Chapter 3. Forest ecosystem carbon inventory methods

3.1 Use of IPCC inventory approach/methods

The Intergovernmental Panel on Climate Change (**IPCC**) was created in 1988 to prepare assessments on all aspects of climate change and its impacts based on available scientific information and is the key international body studying global warming. The IPCC issues guidance on reporting carbon stock inventories and emissions designed to implement the international United Nations Framework Convention on Climate Change (UNFCCC) 1992 Kyoto Protocol agreement. Although the U.S. is not a signatory to the Kyoto Protocol, the U.S. NGHGI follows IPCC guidance for international reporting for subsequent agreements and negotiations. Similarly, although Washington is not a reporting party to the Kyoto Protocol, this inventory will comply with IPCC-defined "good practices" with one exception (see discussion of "settlements" in section 3.2.2). The 2006 IPCC "Guidelines for National Greenhouse Gas Inventories" (IPCC 2006) provides a conceptual framework, sectoral scope definition, description of tiered inventory methods, calculation steps and uncertainty assessment steps. An important element specified in the 2006 Guidelines is a **key category analysis** in which key emissions categories are identified and prioritized. This Washington State forest ecosystem carbon report supports the goals of the 2006 IPCC framework by determining whether the forest sector in Washington is sequestering carbon from or emitting carbon to the atmosphere, and by how much.

The key categories described in IPCC (2006) for forest-related fluxes include:

- CO_2 emissions and removals resulting from C stock changes in biomass, dead organic matter and mineral soils; and
- CO_2 and non-CO_2 emissions from fire on all managed land, including methane (CH_4), nitrous oxide (N_2O), non-methane volatile organic compounds (NMVOC), nitrogen oxides (NO_x), and carbon monoxide (CO).

Minor elements that may be relevant to forested wetlands and fertilized forest plantations include:

- N_2O emissions from managed soils, and
- CO_2 emissions associated with liming and urea application to managed soils.

The U.S. NGHGI calculates N_2O emissions from southeastern pine forests and commercial Douglas-fir stands in western Oregon and Washington that are fertilized (US EPA 2020), and we include this calculation in this report. The U.S. NGHGI only calculates CO_2 emissions associated with liming and urea for agricultural soils, so these emissions are assumed to be negligible for Washington forests and are not included in this report.

The IPCC guidelines only require reporting for **managed lands** under the assumption that nations cannot affect, or be held responsible, for changes happening on lands that are not directly influenced by humans. According to IPCC 2006, "managed land is land where human interventions and practices have been applied to perform production, ecological or social functions" (Paustian et al. 2006). Because even most Wilderness areas and National Parks in the U.S. are impacted by human management in some form, e.g., from fire suppression, in practice all lands in the lower 48 states are considered "managed" (e.g., US EPA 2020, Ogle et al. 2018).

In 2014, the IPCC published the "Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol" (IPCC 2014) which provides additional guidance on estimating flux from land-use, land-use change and forestry (LULUCF) activities. For forest land, the primary change from IPCC 2006 are guidelines for reporting on forest management and on harvested wood products (HWP). Procedures for estimating HWP stocks and flux will be addressed in a separate report.

3.1.1 Rationale for use of Tier 3 approach

The IPCC guidance on greenhouse gas accounting describes three "tiers" or levels of complexity and precision for reporting that accommodate the range of data and institutional support in different countries. Two approaches to calculating change are recognized which can be applied at any tier. Gain-loss methods estimate the net balance of additions to and removals from each carbon stock. Stock-difference methods track the amounts in each carbon stock and their change over time.

Tier 1 methods are the simplest, and apply IPCC equations and default parameter values for emission and stock change factors (e.g., deforestation/afforestation, disturbance, harvest, grazing) to available information on land-use and activity (e.g., from land cover maps derived from satellite mapping). Tier 2 can use the same approach as Tier 1 but applies region- or country-specific emission and stock change factors. Tier 3 methods apply models and inventory measurements tailored to national conditions, are repeated over time, are driven by high-resolution activity data and disaggregated at sub-national levels. Models are expected to undergo quality checks, audits, and validations and be thoroughly documented.

Most nations with more detailed economic and natural resource information are expected to follow the Tier 3 approach. This is the approach used by the U.S. NGHGI for the forest sector, and by this report as well, which employs the stock-difference method based on the extensive FIA inventory and a wide range of economic, environmental, and natural resource data already being collected for a variety of objectives. A significant portion of estimates in Tier 3 stock-change methods rely on repeated measurements of individual C pools at different points in time, collected in a well-defined statistical framework. In contrast, Tier 3 gain-loss methods, such as those employed in the Canadian NGHGI, rely on inventories and other sampling for initial estimates of carbon pools and apply models and activity data on components such as disturbance and harvest to estimate change over time.

Six land-use classes are recognized in IPCC assessments. While the IPCC does not prescribe specific definitions for each class, it does require that countries explicitly and consistently define and track them. These land-uses are further defined for the U.S. in the NGHGI (US EPA 2020) and are described in section 3.2.2. The IPCC land-use classes are:

1. Forest land: includes all land with woody vegetation, using consistent and well-defined criteria for minimum area, minimum cover, and minimum height at maturity to define “forest land” (specifying minimum width too is “good practice”). Assessment of this land-use class is split between land remaining forest land, and land converted to forest land from other uses. In the U.S., the FIA definition for forest land is used for reporting this category (see section 3.2.2).

2. Cropland: cropped land and agro-forestry where vegetation area, cover, or height falls below the minima for forest land.

3. Grassland: includes rangelands and pasture not considered cropland. Also includes systems with woody vegetation or herbs that fall below thresholds for forest land. For example, chaparral falls in this category in the U.S. NGHGI.

4. Wetlands: areas of peat extraction and covered by water for all or part of the year that doesn’t fall in the vegetated or settlement categories.

5. Settlements: developed land, including transportation infrastructure and settlements of any size, unless placed in other categories by national definitions.

6. Other land: bare soil, rock, ice, and all other land areas, including unmanaged lands.

In addition to identifying these six land-use categories and subcategories, IPCC requires distinguishing natural from planted forest, identifying areas subject to different natural disturbances and their effects on flux, identifying areas subject to management, and identifying areas of mineral and organic soils, with the latter split into drained, wet, or rewetting.

3.1.2 Determining the Forest Management Reference Level

The concept of a Forest Management Reference Level (FMRL) was established in the 1992 Kyoto Protocols and guidelines for implementing it are described in IPCC (2014, section 2.7.5). The FMRL is a reference value of average annual net emissions and removals from “forest management” (i.e., all lands that remain forested or that change land-use to/from forest). All pools and gases and the area under forest management that are included in the calculation of the FMRL are to be identified. The FMRL facilitates consistent comparison of forest carbon stocks and losses through time by comparing one or more time periods to a reference that is calculated in the same way, including all the same pools and assumptions. The UNFCCC refers to emissions in 1990 as the reference that targets are tied to for future emissions levels.

For Washington, the availability of forest inventory data is more limited for the period including 1990 than for more recent years (2002 and on). Specifically, field measurements that span 1990 and that can be used to estimate change only consist of live trees on timberland outside of National Forests (Gray et al. 2005, 2006). Estimation of flux in 1990 for other lands and carbon pools requires substantial modeling and/or extrapolation from more recent datasets. An extrapolation approach was adopted for U.S. forests in the most recent U.S. NGHGI but the resolution of the estimates currently does not support analysis at less than the state level (US EPA 2020, Woodall et al. 2015). Some national and international assessments and negotiations have used other dates as reference (e.g., 2005) to align better with available data.
In this report, we establish an FMRL for in-forest carbon based on data from the complete 10-year inventory in Washington conducted during the time-period 2002-2011 (the first comprehensive, standardized FIA inventory of Washington's forest lands since 1967).

The FMRL for in-forest carbon is not intended to identify ideal or desired forest conditions. The values reflected in the FMRL are a result of past and current management, land use practices, disturbance rates, and climatic conditions. The utility of the FMRL is in identifying a point in time for comparison of subsequent estimates, which can aid further investigation of causes for differences and implications for future policies.

In this report, the FMRL provides a complete estimate of all pools of forest carbon in Washington and the trends over time as 10-year moving averages. Although there are large overlaps between periods, re-measurement data makes it possible to review trends from complete samples (i.e., all plots) in Washington for 2002-2011, 2003-2012, 2004-2013, 2005-2014, 2006-2015, and 2007-2016. However, estimates of change between 10-year stock averages (i.e., Stock-Change approach) are a less accurate and less precise way to infer flux than the Growth, Removals and Mortality (GRM) method described below. The FMRL identifies six key pools including Aboveground Live (trees and shrubs), Aboveground Dead (standing snags and down wood), Belowground Live (roots), Belowground Dead, Forest Floor Litter and Soil Organic Carbon (organic soil layers). The Harvested Wood Product (HWP) carbon pools will be determined for the FMRL in a separate report.

Although we present data for the FMRL and 10-year moving stock averages to compare to it, in this report we determine annual flux through the Growth, Removals and Mortality (GRM) approach (see section 3.2.4). Comprehensive forest inventories that are based on re-measured, permanent sample plots have the potential to provide the most accurate estimates of changes in forest volume and carbon. The direct measurement of growth, removals and mortality meets IPCC Tier 3 standards for reporting based on advanced country-specific data and methods. GRM is still a stock-difference approach, but by measuring changes in the same trees and ingrowth on the same plots over time the components of change in stocks can be detailed (i.e., growth, removals, mortality), which aids interpretation of results.

The Forest Inventory and Analysis Program (FIA) began a new inventory of forest land in Washington in 2002 by installing a complete sample of the state each year using 10% of the full set of plots (9,525 on land, excluding census water). This equates to a complete sample of all inventory plots in Washington every 10 years. FIA completed their first full annualized inventory of Washington forests in 2011 (previous inventories were conducted periodically on a nominal 10-year interval). In 2012, FIA began re-measuring the same plot locations as established in 2002 and as of 2016, they had re-measured 50% of the plots in the state. As FIA re-measures more forest inventory plots in Washington (through 2021 and beyond) the ability to derive more precise estimates of change for smaller domains of interest (e.g., regions and ownerships) will improve, and will be incorporated into future annual reports. The USDA Forest Service Pacific Northwest Research Station (PNW) manages the FIA program for the state of Washington.

3.2 Forest inventory compilation methods

This section is designed to document the basic estimation and compilation methods used for this report, and identify options for improving estimates in future reports. As mentioned above, this assessment relies primarily on empirical data from FIA inventories of the forests of Washington and to a large extent applies methods and models used in the NGHGI in accordance with IPCC guidance.

3.2.1 Inventory design

The population, or scope, of the inventory of Washington is the boundaries of the state, including offshore islands and approximately 3 nautical miles of ocean out from the coastline. Beginning in the 2002 nationally standardized annual inventory, the sampling frame for this area was determined by a national layer of hexagons approximately 6,000 acres in size. Plot sample locations were identified within each hexagon in a manner sometimes referred to as "randomized systematic". For hexagons that contained plot locations that were part of the previous FIA or National Forest System (NFS) inventories, the previous plot was selected for the annual inventory (or one was randomly selected if more than one was present). For hexagons without a previous plot, a new location was randomly generated within the hexagon. In addition, in 2002 NFS began installing the annualized FIA inventory using the same procedures on their earlier Current Vegetation Survey (CVS) inventory plot locations, based on a square grid of plots every 1,875 acres outside of Wilderness (Max et al. 1996). FIA has included this sample and the data collected in their databases, estimates, and reports since 2002. The total number of plots (forested, non-forested, and census water) in Washington is 9,978.

The systematically located plots can straddle different land types and stand boundaries. FIA field crews apply established rules for delineating different "condition classes" which are different land uses or forest types within the plot footprint. Forest land conditions can be delineated based on differences in owner group, forest type, or diameter size class into separate stands. All data collected on the plot are identified to the condition class on which they occur.

The hexagons in Washington are assigned to ten evenly dispersed panels. Each panel is measured in a specific year, providing a balanced annual sample of the state each year. All panels are measured after ten years, at which point the cycle starts over and plots are re-measured on a ten-year interval. The first cycle of annual inventory in Washington occurred in 2002-2011, and five years of re-measurement data are available for this report, covering 2012-2016.

All inventory estimates are based upon the grid of plots and the classifications and measurements taken on them. The precision of the estimates is improved, however, by incorporating information from independent, ancillary datasets in a process referred to as "post-stratification" (MacLean 1972, Bechtold and Patterson 2005). Satellite imagery, historic maps, and ownership layers are combined and pixels with similar attributes related to forest/non-forest delineation and forest characteristics, and land areas sampled with the same plot density, are grouped into strata. The number of pixels in each strata and the number of plots that intersect them are used to define weights for each plot in the inventory. Potentially forested plots that were unable to be sampled (e.g., access was denied or plots were too hazardous to measure safely) are assumed to be missing at random. The methods represent nonsampled plots by increasing the weights of sampled plots found in the same strata as the nonsampled plots.

The plot sample and stratification are used in the calculation of sampling errors, which are provided with the results of this report as standard errors (sampling error is the type of error, standard error, SE, is one way of expressing it). These error ranges describe the uncertainty associated with sampling the forest (i.e., with plots) instead of measuring the entire population (i.e., all the trees in the state). The standard error for designed inventory estimates, when added to and subtracted from the estimated value, describes the 66-percent confidence interval around that value. Similarly, multiplying the SE by 1.96 provides the 95-percent confidence interval. Additional details on inventory design and estimation methods are provided in Bechtold and Patterson (2005) and Palmer et al. (2019).

3.2.2 Forest land-use and land-use change

As provided for in IPCC guidelines, the NGHGI uses the FIA definition of forest land to define the specific lands covered, including the change in land-use between forest land and other land-uses. The current FIA definition of forest land (Woudenberg et al. 2010) is land with at least 10 percent cover by live forest trees of any size, or that formerly had such cover and that will be artificially or naturally regenerated (i.e., is not being managed for non-forest uses). The area must be at least 1 acre in size and at least 120 feet wide. Tree-covered areas where management precludes natural vegetation development (e.g., through mowing, disking, regular herbicide application, or intensive grazing) are not considered forest land. FIA maintains a national list of species that are considered forest trees; these generally are species that form dominant central stems and attain heights greater than 16 feet over the majority of their range. However, some international definitions refer to trees being able to attain 16 feet in height "in situ", and recent NGHGI and Resources Planning Act (RPA) reports (Oswalt et al. 2014) have reclassified some forest land as "woodland". The in-situ criterion implemented for NGHGI/RPA classifies plots based on a combination of current tree height, forest type, site class, and ecoregion. None of the forest land measured in Washington meet the criteria that would result in changes of FIA data from forest land to woodland.

The NGHGI also states that "land is not classified as Forest Land if completely surrounded by urban or developed lands, even if the criteria are consistent with the tree area and cover requirements for Forest Land. These areas are classified as Settlements" (US EPA 2020). Forested FIA plots in urban areas were not specifically excluded from the NGHGI calculations; instead, forest estimates were adjusted by the land-use categories derived from the USDA Natural Resources Conservation Service (NRCS) Natural Resources Inventory (NRI) to implement these criteria (e.g., USDA NRCS 2015). In this analysis, we did not separate out FIA-classified forested lands that fell in the NGHGI-class of urban from total forest land.

Inventory crews delineate the area covered by different land-uses that fall in the FIA plot footprint. These proportions, in combination with the plot weights from the stratification, enable FIA to estimate the area of all land-use classes in the state (i.e., forest, non-forest, water). In sparsely covered stands, crews take additional measurements and estimates (e.g., of dead or harvested trees) to determine whether the 10 percent tree canopy cover threshold is met. Non-forest land-uses are identified either on the ground (for field-visited plots) or using recent imagery (for non-field-visited plots), which makes it possible to classify non-forest lands into most of the other IPCC classes (i.e., cropland, grassland, settlements, other). When plots were re-measured, changes in land-use within the plot footprint were delineated, enabling the estimation of change in forest land area and the land-uses that forest lands are coming from or changing into. Wetlands are delineated in the USDA NRCS NRI used in the NGHGI, but their locations are not yet clear; we assumed there was no land-use change between wetlands and forest.

The NGHGI definitions for non-forest land-uses are:

- Cropland: Areas used to produce adapted crops for harvest, including both cultivated and non-cultivated (e.g., hay, orchards), and agroforestry and windbreaks.
- Grassland: Areas where plant cover is composed principally of grasses, grass-like plants (i.e., sedges and rushes), forbs, or shrubs, including pastures and native rangelands. Savannas, deserts, and tundra, and drained wetlands with the appropriate plant cover are included. Systems with woody vegetation or herbs that fall below the thresholds for forest land are also included in grasslands (i.e., chaparral).
- Wetlands: Areas covered or saturated by water for all or part of the year, in addition to the areas of lakes, reservoirs, and rivers. Does not include areas of drained wetland that meet other categories, or un-drained forested wetlands.

- Settlements: Areas of at least 0.25 acres that includes residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; parks within urban and built-up areas; and highways, railroads, and other transportation facilities. Also included are tracts of less than 10 acres that may meet the definitions for Forest Land, Cropland, Grassland, or Other Land but are completely surrounded by urban or built-up land.
- Other Land: Areas of bare soil, rock, ice, and all land areas that do not fall into any of the other five land-use categories. Following IPCC (2006), C stock changes and non-CO_2 emissions are not estimated for Other Lands. However, C stock changes and non-CO_2 emissions are estimated for Land Converted to Other Land during the first 20 years following conversion to account for legacy effects.

Prior to the implementation of the national FIA field guide 6.0 in 2012, the definition of forest land used on the west coast was slightly different and was based on a 10 percent stocking threshold rather than cover. This was changed to cover to improve national and international consistency and the ability to relate ground classifications to imagery. The change in definition has little impact on the majority of forest land in Washington which easily exceeds both thresholds, but can lead to some differences in sparse forest conditions that may be found in oak and subalpine woodlands (Azuma and Gray 2014). Nevertheless, the change raises the possibility that areas may change designation due to procedural change and not real change on the ground. PNW-FIA field crews distinguish procedural from real changes and take additional measurements of cover and stocking in sparse stands to better quantify the relationship between cover and stocking in different forest conditions. This makes it possible to compare estimates between older and newer inventories.

This report incorporates improved assessments of land-use change, after accounting for definition changes, procedural changes, and previous errors. This analysis of land-use change is NOT reflected in the publicly available online FIA databases, which have not updated previous classifications of inventory plots to match current procedure. The PNW-FIA program is currently evaluating how to incorporate new tables and queries in online databases that reflect the correct analyses of change using current definitions while maintaining previous data used to generate earlier assessments.

3.2.3 Carbon pool calculations

The following categories constitute the carbon pools included in this analysis. We are always seeking ways to improve the accuracy and precision of inventory calculations and estimates. These might include developing or adopting better models, collecting additional data, or employing new estimation algorithms. We identify some of those opportunities as ***potential improvements*** in the text in this section and discuss them in more detail in Chapter 6.

Aboveground live tree—Estimates of aboveground live-tree woody C were based on regional FIA equations of the sum of bole, bark, and branch biomass in metric tons for each tree measurement multiplied by 0.5, the C fraction of biomass. Bole biomass (ground to tip) was calculated from regional species-specific volume equations documented in Zhou and Hemstrom (2010) and species-specific wood density values documented in Woudenberg et al. (2010). Bark and branch biomass were calculated from regional species-specific equations selected from Means et al. (1994) and documented in Zhou and Hemstrom (2010), except red alder branch equation (equation 16) used Snell and Little (1983) and Douglas-fir and red alder bark equations (equations 8 and 20) used Means et al. (1994) equations 5 and 275, respectively. Most equations use both diameter at breast height (dbh) and height data, whereas a few bark and branch equations use diameter only. Foliage biomass was calculated using the Jenkins et al. (2003) ratios to total tree biomass as implemented in Woodall et al. (2011) and added to aboveground wood biomass before calculating aboveground live tree C. In contrast, the NGHGI estimates of live tree biomass are based on the “component ratio method” equations in Woodall et al. (2011). An expansion factor derived from the fixed-area plot size was used to convert individual tree C to an area basis (e.g., metric tons per acre).

Aboveground standing dead tree—Estimates of aboveground standing dead tree carbon followed the same procedures as for aboveground live trees, but with the following modifications. Gross volume from ground to tip was adjusted for broken tops by calculating the gross volume (to an intact “total” height estimated in the field or modeled using Barrett (2006)) and the net volume to the broken “actual” height with a Flewelling (1994) taper equation for Douglas-fir. The proportion of net to gross volume from the Flewelling equation was applied to reduce the gross volume calculated for each tree. In addition, the biomass of all components (bole, bark, and branch) were reduced for decay using the hardwood/softwood parameters in Harmon et al. (2011), Table 6. Standing dead biomass was further reduced to account for the tendency of bark and branches to be dropped from snags sooner than bole biomass; component reductions described in Harmon et al. (2011) were applied to further reduce bark and branch biomass. Biomass calculations in metric tons were multiplied by 0.5 to calculate C. In contrast, the NGHGI estimates of standing dead tree biomass are based on the equations in Woodall et al. (2011) and the species-specific decay-reduction factors in the table REF_SPECIES in Woudenberg et al. (2010). The species-specific decay factors tend to be based on small datasets and highly variable among similar species; the hardwood/softwood parameters are more reliable. Stumps are not included, and it is unlikely that they will be included in future inventories without substantial additional effort.

Belowground live and standing dead tree (i.e., roots) —Estimates of belowground biomass (i.e., coarse roots > 2 mm diameter) were based on the ratios for species-groups developed in Jenkins et al. (2003) as implemented in Woodall et al. (2011); i.e., adjusting the estimate by the ratio of the FIA volume-based estimate of bole biomass to the Jenkins equation-based estimate.

Decay class of standing dead trees was used to reduce belowground calculations using the species- and decay class-specific parameters in the REF_SPECIES table (Woudenberg et al. 2010); biomass calculations in metric tons were multiplied by 0.5 to calculate C.

Aboveground down woody debris*—**Estimates of carbon in down wood were based on the transect-intercept measurements of coarse wood (≥ 3 inches intersect diameter) and counts of fine wood (≥ 0.25 to < 3 inches diameter). Piles were not included, as the field estimates of pile density in the initial years of the inventory were unreliable. Biomass of coarse wood was calculated using the equations in Woodall and Monleon (2008) with wood density and decay-class reduction factors from the REF_SPECIES table (Woudenberg et al. 2010). A ***potential improvement for a future report would involve using the hardwood/softwood decay-reduction parameters from Harmon et al. (2011) instead (as described above for snags), as they are less variable among similar species than the species-specific variables in REF_SPECIES, which were also derived from Harmon et al. (2011). Log inclinations were measured in PNW inventories starting in 2013 with the implementation of core FIA manual 6.0. Where available, inclinations were factored into the calculation of coarse wood biomass and carbon (inclined logs have a lower probability of being intercepted by a transect, so the calculated C per acre is greater than if the same log were lying flat). For the smaller size classes of down wood ("fine wood") we followed the procedures in Woodall and Monleon (2008) where the fine wood piece counts in each size class are multiplied by a quadratic mean diameter (QMD) to calculate volume, and a wood density factor to calculate biomass, which is multiplied by 0.5 to calculate C. Parameters are specific to forest type group and available in REF_FOREST_TYPE_GROUP in the FIA database (FIADB) (Woudenberg et al. 2010). Although measurements of piles were taken, estimates of wood density in piles tended to be unrealistically high, particularly in the initial inventory years. As a result, we currently do not include pile data in the down wood calculations, but may be able to develop replacements for current values with reasonable assumptions with greater scrutiny.

Aboveground and belowground understory vegetation—Estimates of above- and belowground biomass and C of understory vegetation (which includes live trees < 1 inch in diameter) are based on the calculations from the U.S. Forest Carbon Budget Model (FORCARB2) (Smith et al. 2006), as populated in the FIADB. Calculations are based on FORCARB estimates of live-tree biomass, (calculated from forest type and stand age), and are highest at low levels of live tree biomass and decline slightly at higher levels. Dead understory vegetation is not included and there are no plans to include it at this time. It was previously identified that a potential improvement for a future report would use the cover and layer height data collected on FIA plots to calculate understory biomass directly, provided suitable equations can be found. However, after further research it was determined that potential equations were very general and from different vegetation types/areas that are likely not relevant for Washington.

Forest floor—Estimates for carbon in the forest floor (i.e., duff and litter) use the same model used in the NGHGI which was based on FIA Phase 3 data and predictor variables of location, elevation, forest type group, live tree C, and some climate variables (Domke et al. 2016).

Although PNW-FIA crews have measured forest floor depth on the down wood transects since the beginning of annual inventory, there were methodological problems in the initial years and the estimates are quite sensitive to small measurement errors of depth (e.g., a tenth of an inch). ***A potential improvement*** for a future report is to continue evaluating flux estimates using more recently remeasured forest floor depths and adopt them if/when they prove to be reliable.

Soil—Only a limited number of FIA plots have had soil cores collected from the top 20 cm of the soil profile, so unlike the aboveground live tree and standing dead tree carbon pools, the soil carbon pool is based primarily on modeled estimates. We estimate soil organic C stocks to a 1-meter depth using the modeled estimates from Domke et al. (2017) as implemented in the latest NGHGI report. This model incorporated data from soil cores on FIA plots with other national datasets and values compare favorably with those calculated from FIA cores in Washington. The new values are 3.4 times greater than those estimated from the earlier NGHGI model by Smith et al. (2006) and correspond well with other expert estimates of forest soil C (citations in Domke et al. 2017).

3.2.4 Flux calculations

The Growth, Removals, and Mortality (i.e., GRM) approach was used to calculate change in forest C pools and the magnitude of flux by comparing measurements taken on the same set of plots and trees 10 years apart.

All flux calculations were summarized based on the condition classification at the initial measurement (e.g., owner, forest type, etc.). It was fairly common for the condition classification on a plot to change over time: usually it was a result of disturbance or management changing the forest type and/or stand size class, but sometimes there was a change in land-use on the plot. The change in C was calculated for individual trees between measurements. For live trees that died or were cut between measurements, growth equations were used to estimate tree diameter and height at the midpoint of the measurement interval and calculate C at the time of death (Bechtold and Patterson 2005); using the dimensions at the first measurement would result in a biased under-estimate for mortality and harvest. New trees that grew into the sapling size class (≥ 1-inch diameter) between estimates were considered ingrowth (a component of growth). Live tree C was allocated into the components of change based on initial and re-measurement tree status, namely: growth, removals, and mortality. Change in C for standing dead trees was based on the difference in calculated C at each time-period and would include live tree C entering this pool through mortality, and dead tree C leaving this pool through decay, transition to other pools, or combustion; trees that fell over or were cut were assigned zero for the second measurement. Changes in down wood C were estimated at the plot level, based on calculations that did not incorporate log inclination from the most recent measurements. Changes in this pool include tree C entering this pool from live or standing dead pools and C leaving this pool through decay, transition to other pools, or combustion. Changes in understory vegetation were based on modeled estimates (from live tree biomass) from each measurement. Flux was also calculated for forest floor and mineral soil C based on the difference in modeled estimates for each plot at each measurement, using the models described in sections 3.2.3. While there is some confidence in the estimates of forest floor and mineral soil C stocks using these models, their accuracy at estimating changes in forest floor and mineral soil C in Washington is currently unknown.

For land-use change (i.e., forest to non-forest or non-forest to forest), all non-soil pools were assumed to be zero for non-forest conditions. Although in some cases this is unrealistic (e.g., not all trees are cut when houses are built on forest land), there are currently no data to estimate those pools on non-forest lands. For soil organic carbon (SOC), the IPCC Tier 2 approach is to use country-specific data to assign carbon concentrations by land-use, climate zone, and soil type, and assume a 20-year lag for SOC to reach a new equilibrium. However, most of the recent IPCC values and research on SOC focus on agricultural soils and effects of different types of management (Ogle et al. 2003, IPCC 2006). The approach in Ogle et al. (2003), which is used in the NGHGI, assumes that forest, rangeland, and urban land-uses have the same SOC as uncultivated land (primarily due to lack of information for urban). Because the agricultural land-uses involved in land-use changes in Washington were either pasture or orchard (i.e., did not involve any plowing or intensive row cropping), we assumed that SOC changes due to land-use were zero.

3.2.5 Disturbance classification and assessment

In addition to evaluating levels of mortality and harvest for live trees, understanding how natural disturbances and harvest treatments affect all carbon pools in a stand is useful. For each plot measurement, FIA crews identify the types of treatments and disturbances that have occurred on each stand delineated on the plot since the previous measurement. Up to three management treatments, and up to three natural disturbances can be coded per stand. Disturbances must meet a minimum threshold that cause mortality or damage to at least 25 percent of all trees in a stand or 50 percent of an individual species' count. We classified disturbance codes hierarchically for analysis, with both fire and harvest taking precedence over other disturbances. Harvest treatments of Trees removed (generic), Clearcut, Partial heavy, Partial light, Precommercial, and Improvement were classified as “Cut”. Any record of fire (Fire [generic], Ground fire, and Crown fire) were classified as “Fire”. If either of these types were recorded, they were identified with the condition; if both were recorded, the condition was classified as “Cut and Fire”. (Note: Cut and Fire includes stands that were thinned and prescribe burned, as well as stands that were burned by wildfire and salvage-logged.) If neither of those were coded, then any insect or disease disturbances were used to classify the condition disturbance as “Insect and Disease”. If nothing had been classified yet, then any weather disturbances (including landslide and avalanche) were coded as “Weather”. Finally, if none of the previous had been recorded but treatment codes for Firewood cutting, Incidental cutting, Stand conversion, Clean and release, or Chaining were present, then the disturbance was classified as “Other cut”. Although estimated trends in area burned are similar between FIA and other methods, other approaches don't distinguish forest from non-forest burned area (Christensen et al. 2016).

Because change analyses are based on the conditions as designated at the first measurement, and disturbance is coded at the second measurement, when condition mapping may change, a mechanism to associate the disturbance code with the condition as classified at the first measurement is needed. For changes in tree carbon, the individual trees were assigned to both the current and previous condition IDs. For the other pools (e.g., down wood and understory veg) biomass estimates for each subplot were proportioned by the condition-change proportions on the subplot to link up the first and second measurements and calculate change. ***Potential addition***: there is substantial interest in using remote sensing of disturbances to provide modeled up-to-date estimates of change; however, this would also require modeling growth, mortality, and decay on the undisturbed plots which could require substantial effort.

3.2.6 Estimation of additional greenhouse gases

The primary non-CO_2 greenhouse gas emissions for forest land are for methane (CH_4) and nitrous oxide (N_2O) from combustion in prescribed fire and wildfire. The default IPCC (2006) method is to estimate pre-fire fuel mass (live vegetation, litter, and dead wood), and apply combustion factors for the amount of woody material consumed (defaults in IPCC 2006 Table 2.6). Because we have measurements of change in C pools on plots that burned, we used the change in C on each burned plot instead. We then multiplied the amount combusted by emissions factors listed in IPCC 2006 Table 2.5 (CH_4=4.7, N_2O=0.26 g/kg of dry matter burnt for non-tropical forests). The CO_2 equivalents for the greenhouse gas effect of these gases (i.e., 100-year global warming potentials) are listed in IPCC (2007b) as CH_4=25 and N_2O=298. Greenhouse gas equivalents were not found for CO and NO_x, so analyses of emissions of these gases were not included, which is consistent with the NGHGI. WA-DNR is conducting a separate assessment of greenhouse gas emissions from wildfire that is expected to provide more comprehensive and up-to-date estimates.

For N_2O emissions due to fertilization of commercial Douglas-fir stands in western Washington, we followed the NGHGI approach (EPA 2020, page 6-41) where the area estimates (2.19 million acres in this case) are multiplied by the typical rate used in this region (200 pounds N per acre applied to 20 of every 1,000 acres of private industrial Douglas-fir timberland per year) to estimate total N applied (Briggs 2007). The total N applied to forests was multiplied by the IPCC (2006) default emission factor of one percent to estimate direct N_2O emissions. For indirect emissions, the volatilization and leaching/runoff N fractions for forest land were calculated using the IPCC default factors of 10 percent and 30 percent, respectively. The amount of N volatilized was multiplied by the IPCC default factor of one percent for the portion of volatilized N that was converted to N_2O off-site. The amount of N leached/runoff was multiplied by the IPCC default factor of 0.075 percent for the portion of leached/runoff N that was converted to N_2O off-site. The resulting estimates are summed to obtain total indirect emissions. We calculate the size of this emission at 0.13 ± 0.1 MMT CO_2e per year. While we report the state total, we did not incorporate this flux as a standard component of all the reported estimates.

3.2.7 Measurement units

Following convention, we report carbon stocks in metric tons of carbon (MT C). Similarly, changes in carbon stocks that involve transfers between different forest pools or to/from the atmosphere are reported in units of metric tons of carbon dioxide equivalent (MT CO_2e). This is done to put the various greenhouse gases (e.g., CO_2, CH_4, and N_2O) on the same footing in terms of their absorption of infrared radiation. One metric ton of carbon in live and dead biomass or soil is equal to 3.667 metric tons CO_2e, based simply on the ratios of molecular weights of C and CO_2.

Chapter 4 Forest ecosystem results: Carbon stocks, flux and trends

In this analysis, results of carbon physically present in the forest are given in metric tons (MT) of carbon (C) (see section 3.2.7). Results of carbon flux, the amount and rate of gaseous carbon being emitted or sequestered by the forest, are given in metric tons (MT), or million metric tons (MMT), of carbon dioxide equivalent (CO_2e) per year. Net changes in individual carbon pools are also shown in units of CO_2e and referred to as flux to provide insight into the components of change, even if they aren't a direct flux with the atmosphere (e.g., tree mortality, which is a conversion from live to dead wood that initially stays in the ecosystem). Carbon can be converted to CO_2e by multiplying by 3.667. Negative values indicate a loss such as an emission or a transfer between pools. Combinations of attributes that occur at such low frequency that they are not sampled by the FIA plot grid (or don't occur at all) are designated with a dash ("—") in table cells (e.g., western juniper forest type on DNR managed lands in Table 4.1). Ranges in the text (i.e., ±) represent a 95% confidence interval (CI), while estimates in the tables report the standard error (SE; CI = 1.96*SE). See section 3.2.1 for more information on errors and confidence intervals. We are less confident in estimates of carbon storage and net flux based on modeled pools (e.g. belowground roots, soils) than we are of those based on directly measured pools (e.g. trees and down wood). There is also less confidence in estimates where the sample error is large relative to the estimate, which can occur for values summarized for a small area or a filtered set of specific criteria (e.g. C in storage for a forest type, single ownership, and a small forested region). An estimate of error (SE, and 95% CI) is provided as an aid in interpretation and as a measure of confidence in each summarized result. The sampling error for modeled attributes does not account for potentially much larger amount of error associated with the model itself. Additionally, modeled attributes are developed by estimating total carbon storage and not carbon change. Any small bias for carbon model totals can lead to very large biases for carbon change.

4.1 Statewide - Forest Carbon Stocks, Flux and Trends

Washington Forest Ecosystem Carbon Summary

	FIA Inventory Estimate	**Sampling Error of the Estimate (SE)**
Total forest area (see 4.1.1)	22,120,335 acres	119,543 acres
Total forest carbon stocks (see 4.1.2)	2.72 billion metric tons carbon	18.47 million metric tons carbon
Average carbon stocks per acre (all ownerships and regions) (see 4.1.2)	122.88 metric tons carbon	0.67 metric tons carbon
Total annual net change in forest carbon (flux) including land use change and non-CO2 from wildfire (see 4.1.3)	+13.7 million metric tons CO_2e	4.37 million metric tons CO_2e
Total annual net change in forest carbon excluding land use and non-CO2 from wildfire (see 4.1.3)	+16.13 million metric tons CO_2e	4.40 million metric tons CO_2e
Average annual flux per acre excluding land use and non-CO2 (see 4.1.3)	+0.73 metric tons CO_2e	0.20 metric tons CO_2e
Forest land conversion (see 4.5):		
Average annual forest loss	20,848 acres	3,981 acres
Average annual forest gain	14,479 acres	2,811 acres
Average annual net change	-6,369 acres	4,878 acres

4.1.1 Forest Land Area: 2007-2016

Statewide estimated area of forest land is provided as a reference when interpreting total carbon stock results. For the 2016 reporting period, FIA estimates there are approximately 22.1 million acres of forest land across all ownerships in Washington. Approximately 57% (12.7 million acres) of these forests are managed by federal agencies and state/local governments Figure 4.1, Table 4.1). Private ownerships are approximately evenly divided between corporate forest lands (approximately 4.8 million acres) and non-corporate forest lands (tribal nations, individuals, and organizations, approximately 4.7 million acres). By geographic region, most (70%) of the forested acres are found within the four westside regions (from Cleland et al. 2007) comprised of the Northern Cascades, Puget Trough, Coast Range, and Western Cascades (see map in Figure 4.13). The region with the greatest share of forested area is the Northern Cascades having 25% of all forested acres in the state. But this distinction is also attributed to how the boundaries were selected for the region. The Puget Trough region has the distinction of being the only forested area with a disproportionately larger share of privately owned forests (70%) compared to those managed by public agencies (30%). Douglas-fir has the greatest area of all forest types at approximately 40%, or 8.9 ± 0.3 million acres, followed by the fir/spruce/hemlock forest type group at approximately 17%, or 3.8 ± 0.2 million acres (Table 4.1).

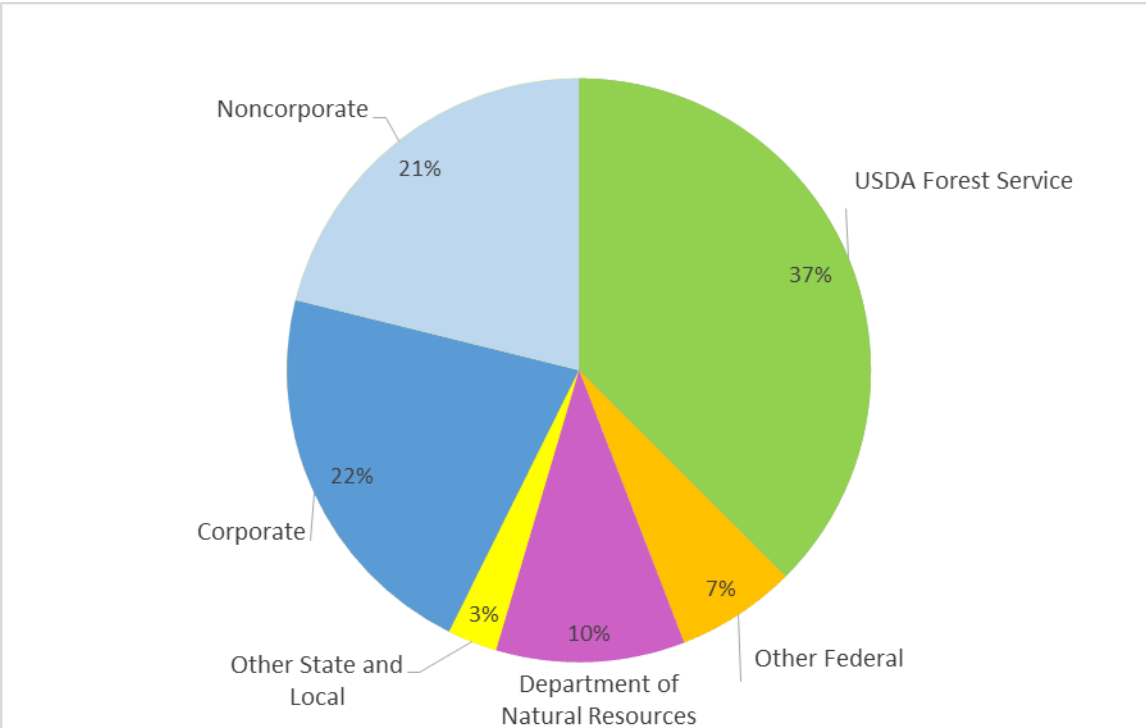


Figure 4.1: Percent of Washington's forest land base by owner (2007-2016).

Table 4.1. Area of forest land by forest type and ownership group, 2007-2016: All Washington. Appendix Table A2.

	Public								Private							
Forest Type	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand acres															
Softwoods:																
Douglas-fir	2,824	67	455	46	1,101	60	259	37	2,638	104	1,624	85	4,262	121	8,901	156
Fir / spruce / mountain hemlock	2,708	80	455	43	124	26	68	20	280	39	220	35	500	52	3,856	109
Western Hemlock / Sitka spruce	951	43	429	41	376	42	86	21	787	63	358	44	1,144	74	2,986	105
Lodgepole pine	461	39	11	7	27	12	13	9	23	11	146	28	169	30	680	52
Ponderosa pine	367	27	52	15	193	31	73	20	238	37	1,112	73	1,351	79	2,036	91
Western juniper	2	2	--	--	--	--	--	--	--	--	--	--	--	--	2	2
Western larch	220	21	9	7	35	15	5	6	24	11	78	20	101	23	371	36
Western white pine	14	5	--	--	--	--	--	--	--	--	--	--	--	--	14	5
Other western softwoods	134	27	--	--	7	7	--	--	--	--	9	7	9	7	150	28
Total	7,683	62	1,410	44	1,862	59	505	52	3,990	117	3,547	116	7,537	125	18,997	147
Hardwoods:																
Alder / maple	107	17	34	13	185	31	157	29	475	48	602	54	1,077	70	1,560	83
Aspen / birch	31	7	--	--	14	8	4	4	23	12	64	18	87	22	136	25
Elm / ash / cottonwood	17	7	7	5	10	8	38	14	45	15	74	20	119	25	191	31
Western oak	1	1	3	4	6	6	--	--	38	15	107	24	145	28	155	29
Woodland hardwoods	12	6	--	--	--	--	--	--	4	3	8	7	12	8	25	10
Other hardwoods	28	7	4	4	4	4	3	3	43	15	78	21	120	25	160	27
Total	197	21	48	15	219	33	202	32	628	55	932	67	1,560	83	2,226	97
Nonstocked	413	36	12	9	109	23	24	12	142	26	197	33	339	42	897	62
All forest types	8,293	51	1,470	44	2,190	54	731	62	4,760	123	4,676	125	9,436	112	22,120	120

4.1.2 Carbon Stocks - Statewide: 2007-2016

FIA plot measurements indicate that for the most recent 10-year reporting cycle (2007-2016) there are 2.7 ± 0.04 billion metric tons of carbon stocks stored on forest land including forest floor and forest soils across all ownerships in Washington (Table 4.2). Almost half of all stored carbon is found belowground in forest soils (45%). The largest vegetation pool is stored in live trees (40%) including carbon in live foliage and live roots. The remaining stored carbon is distributed among the dead trees (4%), down wood (5%), forest floor (5%) and understory vegetation pools (1%). It is important to note that carbon removed from the forest such as trees harvested for timber are not accounted for in these carbon pools. This is however an important forest carbon pool to consider when accounting for the flow of carbon through the forest ecosystem. A separate analysis forthcoming to accompany this report accounts for carbon in harvested wood products.

On a per acre basis, there are 122.9 ± 1.4 metric tons of carbon stocks per acre on average stored on forest land including forest floor and forest soils across all ownerships in Washington (Table 4.2). On average, for each forested acre in the largest carbon pools there is over 55 ± 0.2 metric tons of carbon stored in forest soils, about 49 ± 0.9 metric tons stored in live trees, and nearly 7 ± 0.2 metric tons per acre being stored as downed wood.

Table 4.2. Statewide total carbon stocks and per acre from all ownerships by forest pool on forest land based on plots measured 2007-2016. Appendix Tables C1 and C2.

	Statewide Forest Carbon Stocks			
	Total	**SE**	**Total**	**SE**
CARBON POOL	*million metric tons C*		*metric tons C per acre*	
Live trees				
Aboveground live[1]	901.6	10.5	40.8	0.5
Belowground live	182.0	2.2	8.2	0.1
Dead trees				
Aboveground dead	80.5	2.0	3.6	0.1
Belowground dead	22.1	0.5	1.0	<0.1
Understory vegetation				
Aboveground	25.4	0.2	1.1	<0.1
Belowground	2.8	<0.1	0.1	<0.1
Downed wood	149.8	2.3	6.8	0.1
Forest Floor	129.0	0.8	5.8	<0.1
Soil Organic C	1,224.8	6.9	55.4	0.1
TOTAL FOREST STOCKS	***2,718.2***	***18.5***	***122.9***	***0.7***

[1]includes live tree foliage

4.1.3 Carbon Flux Statewide: 2002-2006 & 2012-2016

Estimated average annual net carbon sequestration, also known as carbon flux, is based on a 10-year average from plots and trees initially measured from 2002 through 2006 then re-measured 10 years later beginning in 2012 through 2016. Results from this remeasurement period are referred to as 2016 results, or results from the 2016 reporting period throughout the report. Remeasuring permanently located inventory plots gives the FIA forest inventory program the unique ability to fully evaluate and monitor changes on each plot in all carbon pools, especially changes in tree growth, removals, and mortality across all ownerships and forested areas of the state. Most of the results focus on net change in forest ecosystem carbon for forestland remaining forested at both measurement intervals, and incorporates effects on CO_2 flux from growth, harvest, and mortality from any disturbances such as wildfire. In addition, we account for the carbon impacts of land changing to or from forestland, and for gasses in addition to CO_2 that are emitted from combustion in wildfire.

As of the 2016 reporting period, according to the FIA plot measurements, Washington's statewide rate of carbon sequestration from all forest ecosystem pools across all ownerships is 16.1 ± 8.6 million metric tons CO_2e per year, excluding net CO_2e contributions from other sources such as harvested wood products, land moving to and from a forested condition, and non-CO_2 greenhouse gas emissions from wildfire (Table 4.3). On average across all ownerships, this is equivalent to annually sequestering 0.73 ± 0.4 metric tons CO_2e per acre from all forest land. Changes in land-use between forest and non-forest land condition is estimated to have a net loss of 2.17 ± 1.6 MMT CO_2e per year (Table 4.4, Figure 4.2). After accounting for land-use changes and non-CO_2 greenhouse gas emissions (methane and nitrous oxide) from wildfire, the 2016 statewide rate of carbon sequestration on all forest land is 13.7 ± 8.6 MMT CO_2e per year.

Table 4.3. Statewide average annual net CO_2e flux and net flux per acre from all ownerships by forest pool in forest land remaining forest land based on plots initially measured between 2002-2006 and re-measured between 2012-2016. Appendix Tables B1 and B2.

	Statewide Forest CO_2e Net Flux			
	Total	**SE**	**Total**	**SE**
	million metric tons CO_2e per year		*metric tons CO_2e per year per acre*	
CARBON POOL				
Live trees				
Aboveground live[1]	15.14	3.29	0.65	0.15
Belowground live	3.11	0.75	0.14	0.03
Dead trees				
Aboveground dead	4.08	0.91	0.18	0.04
Belowground dead	0.64	0.23	0.03	0.01
Understory vegetation				
Aboveground	-0.06	0.04	<-0.01	<0.01
Belowground	-0.01	<0.01	<-0.01	<0.01
Downed wood	-6.85	1.19	-0.31	0.05
NET VEGETATION FLUX	***16.06***	***4.27***	***0.73***	***0.20***
Forest Floor	0.25	0.21	0.01	<0.01
N-fertilization[2]	-0.13	0.10	<0.01	<0.01
Soil Organic C	-0.17	0.30	-0.01	0.01
TOTAL FOREST NET FLUX	***16.00***	***4.40***	***0.73***	***0.20***

[1]includes live tree foliage

[2]estimated CO_2e emission associated with nitrogen fertilization on commercial timberland in western Washington

Table 4.4. Statewide average annual net CO_2e flux from forest pools and non-CO_2 emissions from forest fires in forest land remaining forest land. Plots initially measured between 2002-2006 and re-measured between 2012-2016. See Section 4.5 for additional detail on forest land conversions. Appendix Tables B1, D2, and E1.

	Statewide Forest CO_2e Net Flux	
	Total	**SE**
Land-use category	*million metric tons CO_2e*	
Forest land remaining forest land		
Changes in forest carbon	16.06	4.27
Changes in forest floor	0.25	0.21
N-fertilization	-0.13	0.10
Changes in soil organic carbon	-0.17	0.30
Non-CO_2 emissions from forest fires	-0.17	0.18
net flux	***15.84***	***4.29***
Forest land conversions		
Changes in forest carbon, forest to non-forest	-4.52	0.77
Changes in forest land, non-forest to forest	2.35	0.35
net flux	***-2.17***	***0.81***
Total net flux	***13.67***	***4.37***

Note: negative numbers are a net loss to the forest.

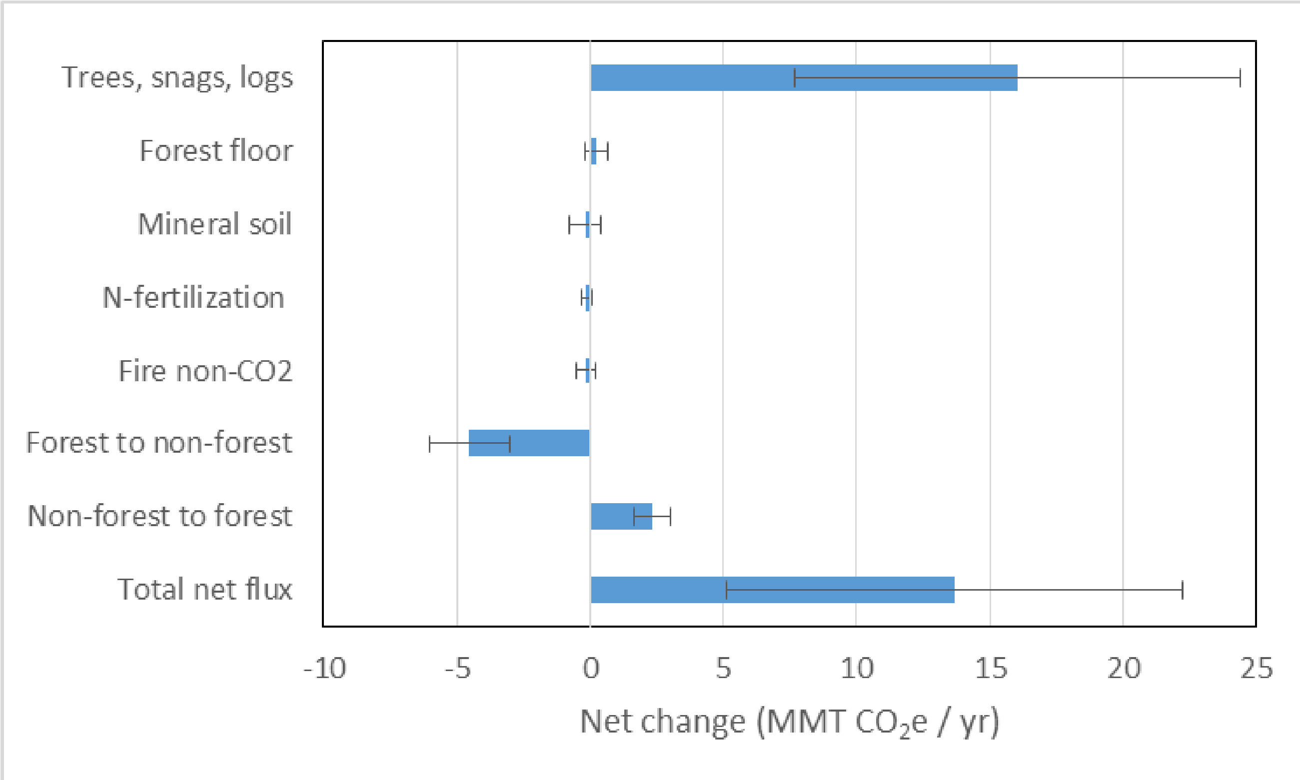


Figure 4.2. Statewide average annual net CO_2e flux from forest pools, land use, and land use change. Error bars are 95% confidence intervals. See Table 4.4 for more information.

4.1.4 Source of Carbon Flux – Statewide (disturbance effects)

Net live tree flux is composed of three components of change: 1) annual rate of tree mortality, 2) annual rate of live tree harvest, and 3) annual gross tree growth. Statewide on all ownerships, gross tree growth is exceeding mortality and harvest by 14.3 ± 6.4 MMT CO_2e. Gross growth is also a key driver of net flux; 94% of the annual net CO_2e flux is accounted for in tree growth (Table 4.5). It is interesting to note that the rate of CO_2e leaving the live tree pool due to mortality may slightly exceed harvest (Table 4.5). Other notable pools impacting net flux include standing dead trees, which are accumulating faster than they are leaving the pool, resulting in a net gain of 4.1 ± 1.8 MMT CO_2e annually (Table 4.3). Despite the increase in standing dead trees, any related increase in inputs to downed trees, fallen logs, and other woody material into the downed wood pool is not compensating for losses from decomposition, removal, or fire, resulting in a net loss reducing statewide CO_2e sequestration by 6.9 ± 2.3 MMT annually (Table 4.3). Similar to trends in other west coast states, this decrease in downed wood carbon is more heavily pronounced on private corporate forests and may be a result of historic high levels of downed wood that are decreasing over time.

Table 4.5. Statewide average annual net CO_2e flux and net flux per acre from all ownerships in standing live trees by component of change, from 2002-2006 to 2012-2016. Appendix Tables B1 and B2.

	Statewide Forest CO_2e Flux			
	Total	**SE**	**Total**	**SE**
CARBON POOL	*million metric tons CO_2e per year*		*metric tons CO_2e per acre per year*	
Standing live trees[1]				
Mortality	-32.9	1.2	-1.49	0.06
Removals	-31.2	2.7	-1.42	0.12
Gross growth	78.4	1.2	3.56	0.05
Net Live Tree Flux	***14.3***	***3.3***	***0.65***	***0.15***

[1]excluding live tree foliage

Other than planned management activities such as timber harvest, the reduction in Washington's live tree net CO_2e flux due to tree mortality is driven by many factors. The cause of death is recorded for each mortality tree encountered when plots are remeasured and is summarized below (Table 4.6). Natural causes such as competition-related mortality or other physical attribution are the leading cause of CO_2e flux due to tree mortality in Washington's forests, accounting for more than half (56%) of all causes. Insects and diseases account for 28% of CO_2e flux due to tree death. Trees killed directly by forest fires account for 14.9% of all tree mortality annually throughout the state. For all causes, tree mortality accounts for 42% of the annual reduction in CO_2e in gross live tree growth that is redirected into other carbon pools such as standing dead trees, downed woody debris, or as an emission if consumed in wildfire. Refer to sections 4.2.3.2 and 4.2.3.3 for a detailed discussion of effects from recent tree mortality events and wildfire impacts on carbon stocks and CO_2e flux. It is also important to note that while sections 4.2.3.2 and 4.2.3.3 provide additional details on mortality events, this current compilation of FIA data do not show how much of the CO_2e leaving the live tree pool due to mortality (-32.9 ± 2.4 MMT CO_2e per year) ends up in other pools such as standing dead trees or downed woody debris.

Table 4.6. Statewide live tree mortality annual CO_2e flux and flux per acre from all ownerships by attribution other than harvest, from 2002-2006 to 2012-2016. Appendix Tables B11 and B12.

	Statewide Live Tree Mortality CO_2e Flux			
	Total	**SE**	**Total**	**SE**
LIVE TREE MORTALITY ATTRIBUTION[1]	*million metric tons CO_2e per year*		*metric tons CO_2e per acre per year*	
Fire killed	-4.9	0.7	-0.22	0.03
Cut and fire[2]	-0.1	<0.1	-0.00	0.00
Insects and disease	-9.3	0.9	-0.42	0.04
Natural and other causes	-18.5	0.8	0.84	0.04
Net Mortality Change	***-32.9***	***1.2***	***-1.49***	***0.06***

[1]estimated live tree harvest is include as "removals" in previous table
[2]plots where mortality has occurred due to both harvest and fire (i.e., wildfire and salvage or thinning and prescribed fire)

4.1.5 Trends - Statewide

As described in the 1992 Kyoto Protocols and Guidelines (and explained in Sec. 3.1.2), the concept of a forest management reference level (FMRL) is used to establish reference forest carbon stock values so that average annual net change from managed forests can be calculated (IPCC 2014, section 2.7.5) and for comparing long term trends and projections to reference conditions in a consistent fashion. For this report, we have established FIA's initial 10-year forest inventory in Washington as the FMRL reference, which was installed from 2002 through 2011. Calculating a current stock in a consistent way with the FMRL is an IPCC-recommended approach to carbon accounting and allows evaluation of relative changes in Washington forest carbon stocks by pool and ownership between measurement periods.

However, estimates of change between 10-year stock averages (i.e., Stock-Change approach) are less accurate and precise than those made using the Growth, Removals and Mortality (GRM) approach used by FIA and shown in the other sections of this chapter. Each successive 10-year period includes 9 years of the previous period's measurements. For example, the periods 2005-2014 and 2006-2015 share data for years 2006-2014. Although these 10-year moving stock averages can be used for estimating the relative direction of change between periods, especially between two full 10-year inventories, it is a less-precise approach for evaluating flux.

Under Washington's current status of remeasured plot data (50%), a more accurate and meaningful way to calculate change is by using the GRM approach. The GRM method compares measurements taken on the same set of plots and trees at different times. This method measures trees 10 years apart to allow enough growth between each measurement to reliably distinguish measurement of actual change from possible measurement error. In addition, it makes it possible to identify causes of changes to individual plots instead of simply comparing total stocks. The GRM approach to calculate change is the approach used nationally by the FIA Program and is also used for this report (see section 4.1.3).

Our estimate of C flux and current statewide trends is determined by comparing measurements taken in 2002-2006 to those taken on the same plots and trees in 2012-2016. This provides 5 years of re-measured tree data to calculate actual growth, removals, and mortality on the same set of trees. However, because the current estimates of change use only 5 years of re-measured plot data, only 50% of all the plots initially installed from 2002 to 2011 are included. As more plots are remeasured, estimates of flux are likely to change slightly and sampling error will decline as plots approach 100% re-measurement in 2021 and beyond.

Table 4.7 provides FMRL estimates from 2002-2011 by forest carbon pools including the total estimated carbon for this initial 10-year period. The 2002-2011 FMRL for total carbon from all pools including estimates for soil organic carbon and carbon found on the forest floor is 2,744.55 ± 40.38 MMT C. The live tree pool accounts for approximately 33% of the entire forest carbon pool, while organic carbon in forest soils account for 45% of the total carbon. Standing dead trees, down wood, understory vegetation, forest floor and roots account for the remaining carbon. The current stock values for each of these pools are estimated as stock totals for each 10-year period (i.e., complete plot set) through the current period of 2007-2016. During this time, there is no meaningful change in most carbon pools from the established FMRL except slightly in growth from live trees (Figure 4.3), demonstrating the limitation in using this approach as it does not take full advantage of re-measurement information. The 2016 statewide rate of carbon sequestration with the GRM approach on all forest land including flux from forest land conversions but excluding other greenhouse gas emissions from fire, is estimated at 13.67 ± 8.6 MMT CO_2e per year. Using the stock-change approach to compare the 2007-2016 to 2002-2011 time-periods, which is equivalent to a difference of 5 years, puts the net change in carbon stocks on all forest land at approximately -26.36 ± 54.3 MMT C. When this value is converted to CO_2e and annualized it is equivalent to approximately -16.1 MMT CO_2e per year. This value is less than the net sequestration rate determined by the direct-measurement GRM approach yet the large confidence interval suggests is not different from zero which again highlights some of the challenges with using the stock-change approach until full re-measurement is complete. Future forest carbon pools are projected out to the year 2020 by applying current flux estimates based on re-measured trees to each 2007-2016 C pool estimate (Figure 4.3) assuming a constant flux rate.

Table 4.7: Forest carbon pools by 10-year inventory period, 2002-2010 through 2007-2016. Appendix Table C38.

	Live Trees		Dead Trees		Down wood		Understory		Belowground roots		Forest Floor		Soil		Total carbon	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	902.00	11.95	75.66	1.98	160.03	2.61	28.69	0.19	203.25	2.69	130.76	0.97	1244.14	7.08	2744.54	20.60
2003-2012	884.56	10.21	76.25	1.89	155.10	2.33	28.60	0.18	199.77	2.32	129.71	0.87	1235.48	6.81	2709.46	17.94
2004-2013	890.69	10.27	77.19	1.95	152.31	2.33	28.44	0.18	201.36	2.34	129.46	0.86	1230.93	6.84	2710.36	18.05
2005-2014	896.08	10.31	78.04	1.98	150.10	2.25	28.38	0.18	202.64	2.34	129.43	0.85	1229.12	6.84	2713.80	18.09
2006-2015	899.20	10.47	79.01	1.98	148.69	2.26	28.34	0.18	203.42	2.37	129.28	0.85	1228.03	6.84	2715.98	18.32
2007-2016	901.59	10.50	80.50	2.02	149.85	2.33	28.27	0.18	204.15	2.37	129.01	0.85	1224.81	6.87	2718.18	18.47

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Note: Please review section 4.1.5 for an understanding of how stock changes calculated from this table differ from flux determined by directly measuring growth, removals and mortality on the same plots over time.

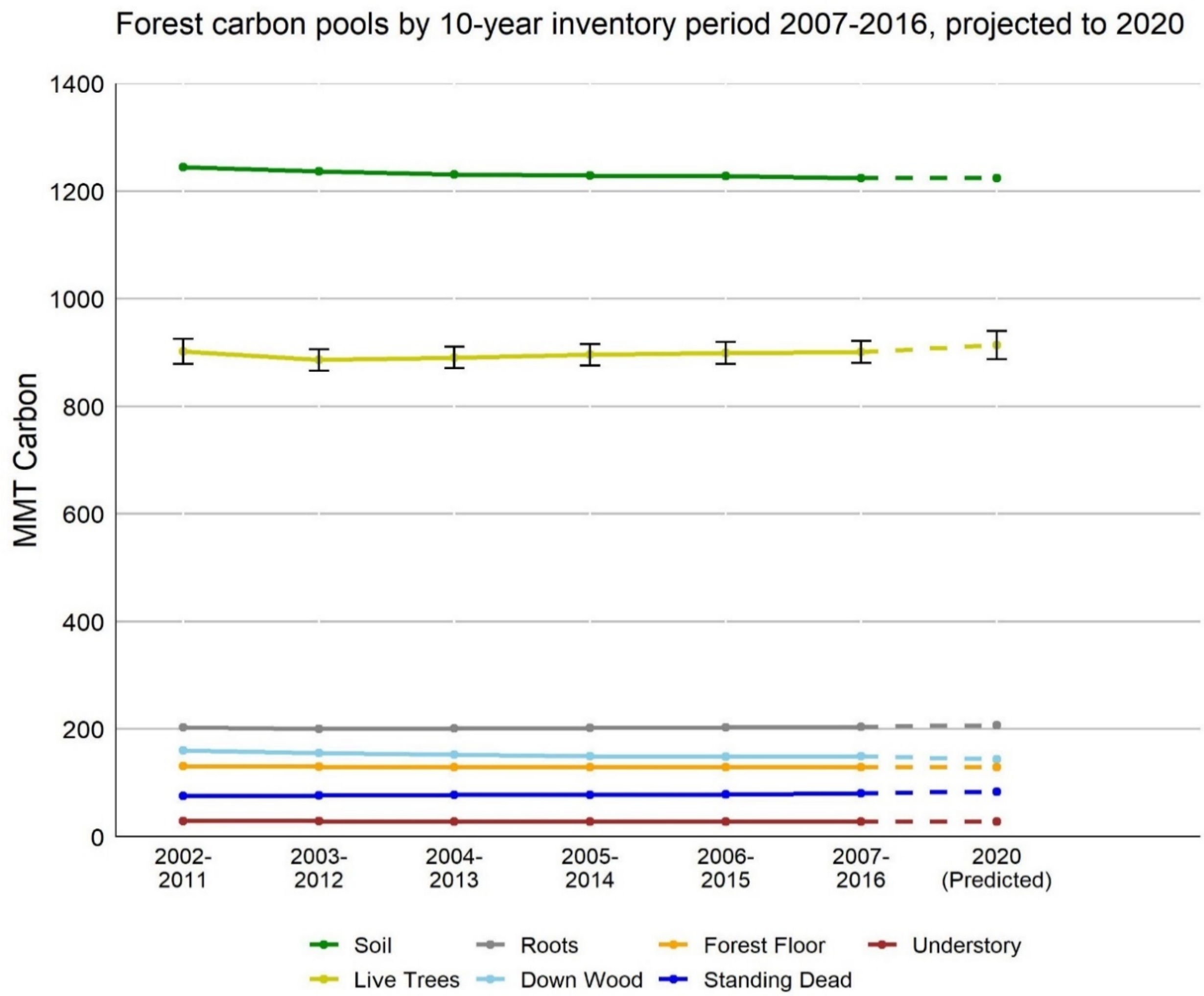


Figure 4.3. Washington carbon stocks by source pool, 2002-2011 through 2007-2016 with projection to 2020. Error bars represent 95% confidence interval of live tree carbon stocks to 2020. Please review section 4.1.5 for an understanding of how stock changes differ from flux determined by directly measuring growth, removals and mortality on the same plots over time.

4.2 Ownership - Forest Carbon Stocks, Flux and Trends by Land Ownership

4.2.1 Carbon Stocks by Ownership

Similar to most western states, a large proportion of Washington's forest lands are managed by public agencies, with the National Forests comprising the largest share of these public lands. National Forests are found throughout the state but are primarily distributed across the Cascade Mountain Range (Figure 4.4). Approximately 64% of all carbon stocks in Washington's forests are found on public lands, with the National Forests managing the largest share of all carbon stocks (40%) (Figure 4.5, Table 4.8). Washington State Department of Natural Resources (WA-DNR) manages about 11% of the state's forest carbon, similar to the other federal agencies, including the National Parks, which manage about 10% of the carbon stocks. Other state and local government agencies manage the remaining 3% of public carbon stocks. For this report we divide privately owned forests between those owned and managed by a corporation from those owned and managed by non-corporate entities (tribes, individuals, and organizations). In Washington, carbon stocks on privately owned forest land is nearly evenly divided with corporate owners managing about 19% of the forest carbon, and private non-corporate entities owning 17%.

There is a close relationship between the proportion of forest land area by ownership and total stored carbon. Differences in this relationship between ownerships are a reflection of current management priorities, previous management practices, forest policy, recent disturbances, and the inherent productive ability of the land base. For example, the National Forests are storing 40% of the carbon stocks and manage 37% of the forest land base (Figure 4.6). While private ownerships together store 36% of the carbon stocks and manage 43% of forest land. This difference in the proportion of carbon stores per area of land base illustrates the generally older over-story stands, denser tree stocking, and additional dead and down wood carbon stores found on National Forests as compared to more intensively managed private ownerships. On private ownerships more live tree carbon is removed through management such as timber harvest with a proportion going into storage as wood products. Other state and local governments, including forests managed by WA-DNR, store 14% of the carbon stocks and manage 13% of forest land.

Closer examination of carbon stocks by owner and carbon pool, in total and on a per acre basis, further highlights differences in land management policy and productive capacity. For example, the proportion of total carbon in most pools is fairly uniform across ownerships. The exception being the amount of carbon currently being stored in dead material as either standing dead trees or downed wood (Figure 4.7). In this case the federal agencies together have about 11% of their total carbon stocks in dead material. The private ownerships currently have the least carbon in dead material, about 7% (Table 4.8). Carbon stored in dead woody material on WA-DNR forest land is in the middle and close to the statewide average of 9%.

Carbon density, the amount of carbon stored in all pools per acre, also reveals differences between ownerships. In this case it's the other federal agencies, specifically the National Park Service, which has the highest carbon density (187.6 ± 8.8 metric tons of carbon stocks per acre; note the larger 95% confidence interval relative to other ownerships due to having less forest land area resulting in fewer sampled inventory plots and increasing uncertainty in the estimate) (Figure 4.8, Table 4.9). The Forest Service and WA-DNR forest lands have a similar carbon density of about 132 metric tons per acre. The private ownerships have the lowest densities on average (102.4 ± 1.6 metric tons of carbon stocks per acre). See Section 4.3 for additional summary tables of forest carbon stocks and flux by ownership groups into western and eastern county regions.

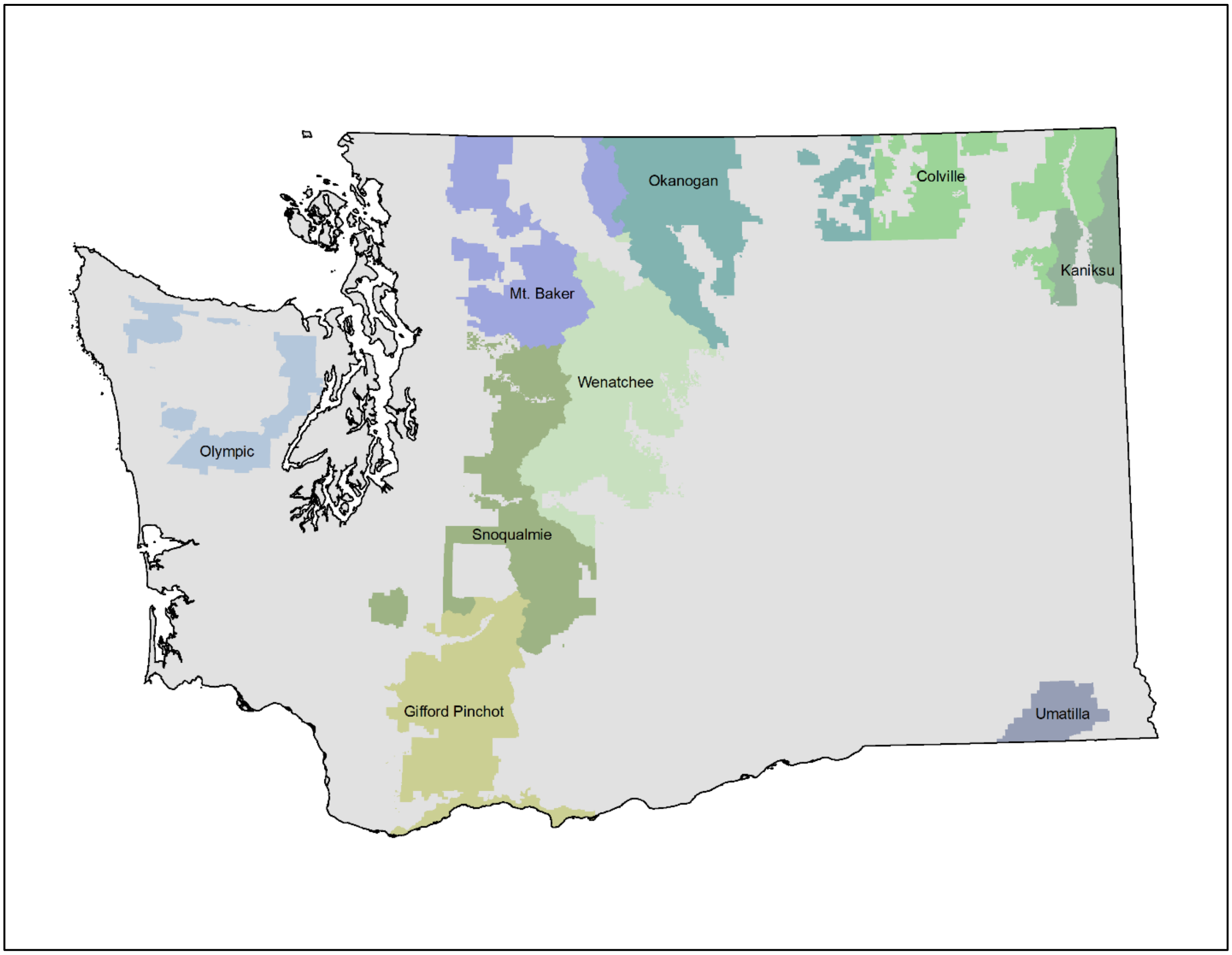


Figure 4.4. Washington National Forest System boundaries.

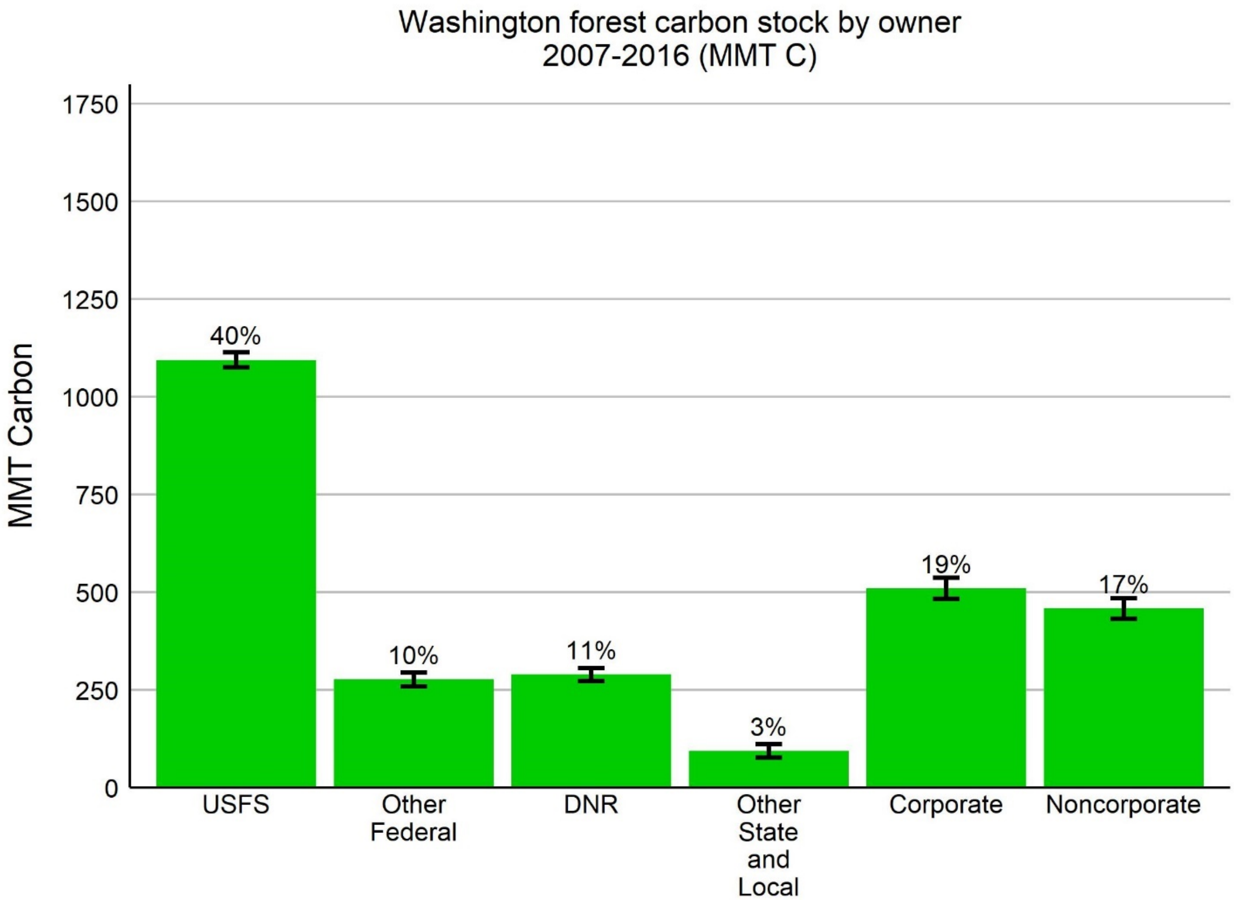


Figure 4.5. Washington forest land total carbon stocks by ownership (million metric tons carbon, MMT C), 2007-2016. Error bars represent the 95% confidence interval of the estimated total carbon stocks. Figure derived from Appendix Table C1.

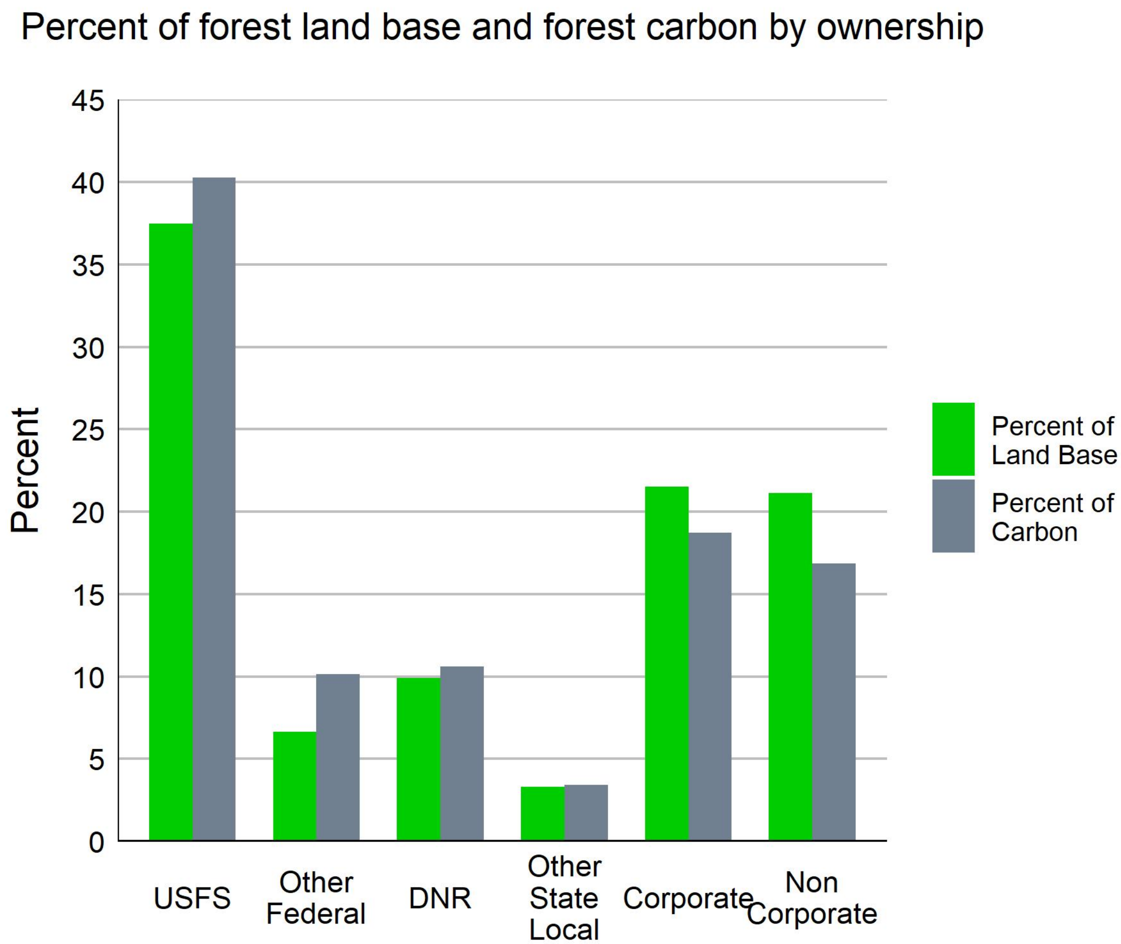


Figure 4.6. Washington statewide percent of forest land base and percent of statewide carbon stocks by owner, 2007-2016. Figure derived from Appendix Tables A1, and C1.

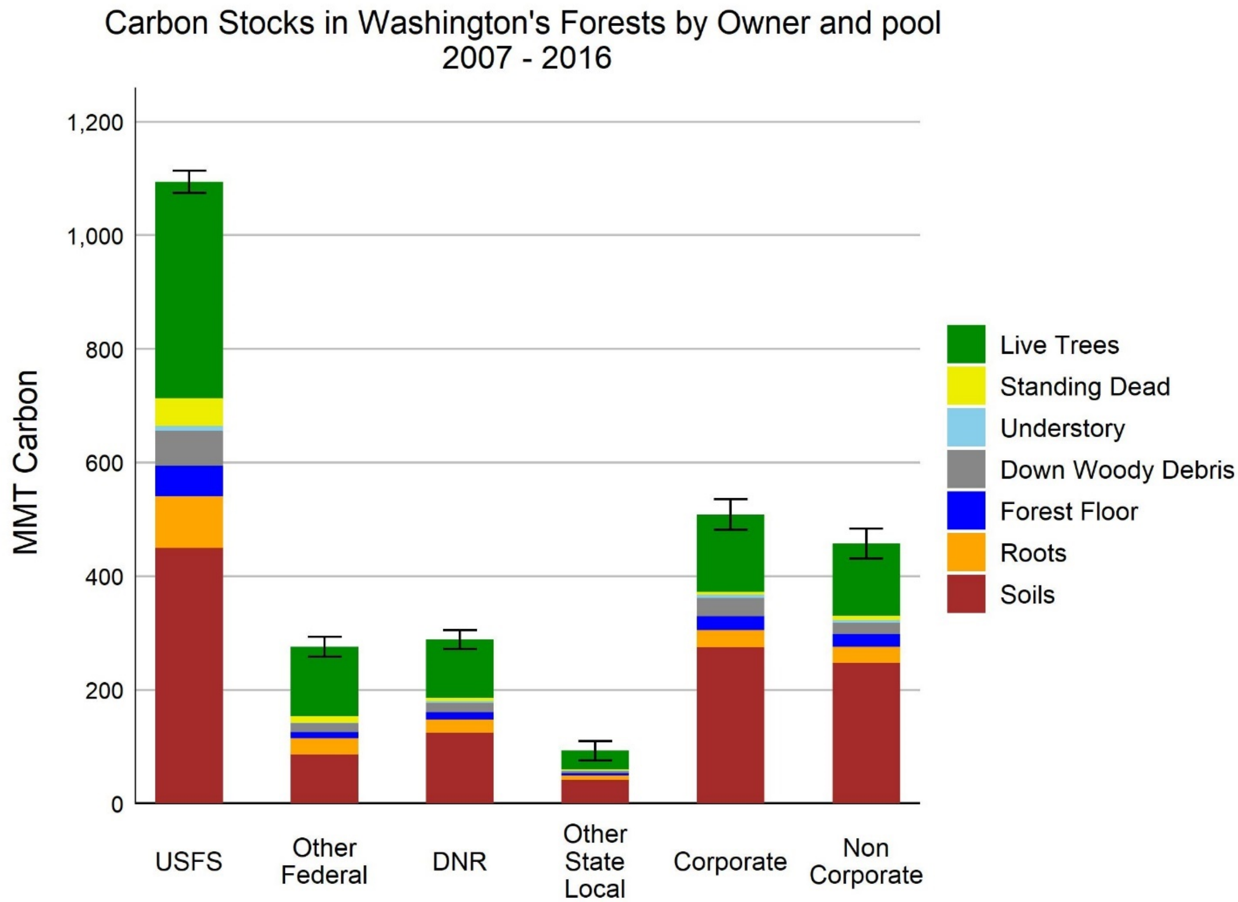


Figure 4.7. Washington statewide average forest carbon stock by pool and ownership (MMT C), 2007-2016. Error bars represent 95% confidence interval of estimated total stock for each ownership. Figure derived from Appendix Table C1.

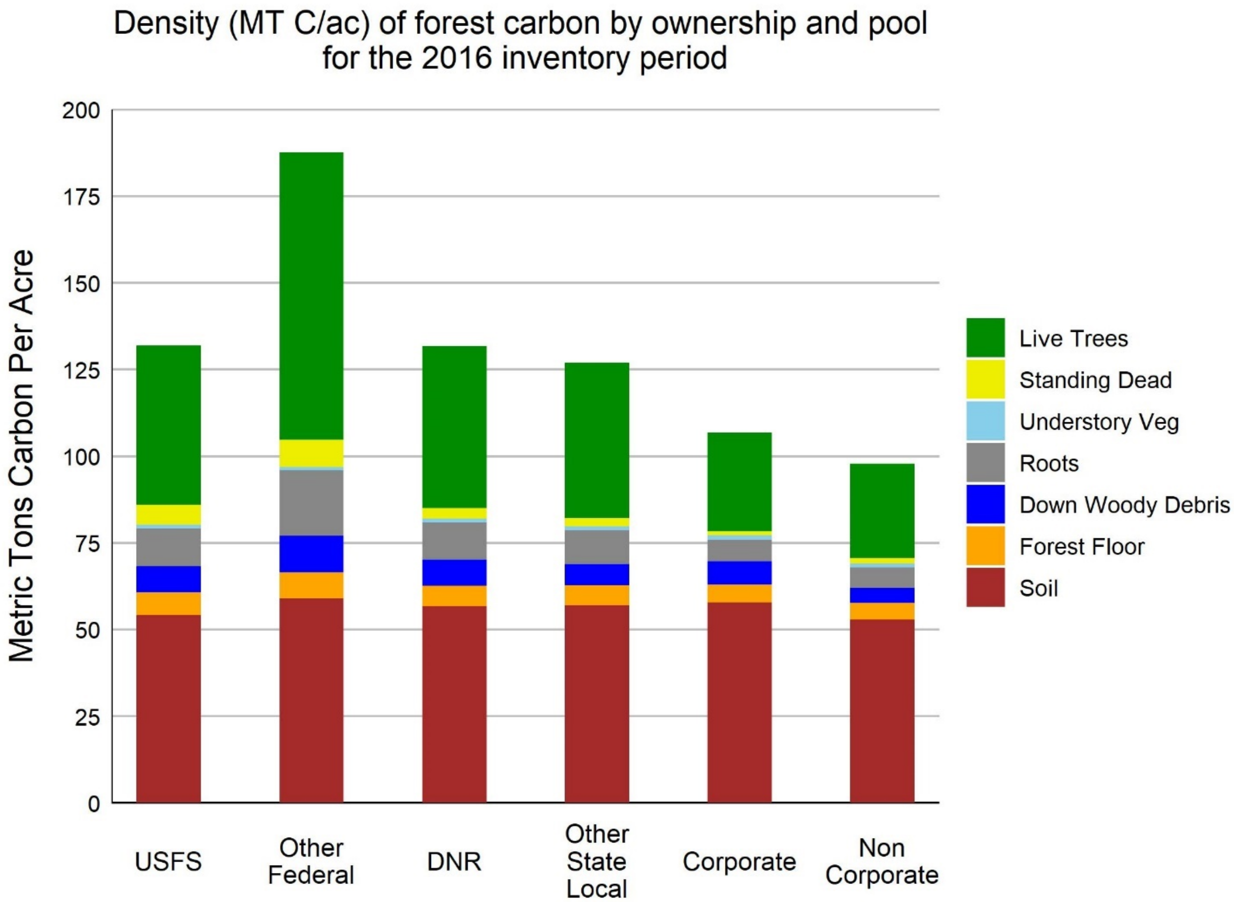


Figure 4.8. Washington statewide carbon density (MT C/acre) by ownership and pool, 2007-2016. Figure derived from Appendix Table C2.

Table 4.8. Forest land carbon stock for each pool by ownership and land status, 2007-2016: all Washington. Appendix Table C1.

	Public								Private							
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million metric tons C[1]															
Live trees																
Aboveground	382	6	122	5	103	5	33	4	136	5	127	5	263	6	902	10
Belowground	77	1	24	1	21	1	7	1	28	1	25	1	53	1	182	2
Dead trees																
Aboveground	48	2	11	1	7	1	2	0	5	0	7	1	13	1	80	2
Belowground	13	0	3	0	2	0	0	0	1	0	2	0	3	0	22	1
Understory vegetation																
Aboveground	9	0	1	0	3	0	1	0	6	0	5	0	11	0	25	0
Belowground	1	0	0	0	0	0	0	0	1	0	1	0	1	0	3	0
Down wood	62	1	16	1	17	1	4	1	32	1	20	1	52	1	150	2
Forest Floor	54	0	11	0	13	0	4	0	25	1	23	1	47	1	129	1
Soil	450	3	87	3	124	3	42	4	275	7	247	7	522	6	1,225	7
Total Carbon	1,095	10	276	9	289	8	93	9	509	14	458	13	966	13	2,718	18

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Table 4.9. Forest land carbon stock per acre for each pool by ownership and land status, 2007-2016: all Washington. Appendix Table C2.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C[1] per acre															
Live trees																
Aboveground	46.01	0.69	82.93	3.13	46.80	1.90	44.78	3.26	28.50	0.85	27.20	0.82	27.85	0.57	40.76	0.47
Belowground	9.23	0.14	16.58	0.65	9.71	0.41	8.97	0.68	5.86	0.18	5.42	0.17	5.64	0.12	8.23	0.10
Dead trees																
Aboveground	5.81	0.20	7.73	0.48	2.98	0.25	2.43	0.37	1.11	0.07	1.58	0.12	1.34	0.07	3.64	0.09
Belowground	1.59	0.05	2.13	0.13	0.85	0.07	0.66	0.09	0.31	0.02	0.42	0.03	0.37	0.02	1.00	0.02
Understory vegetation																
Aboveground	1.10	0.00	1.01	0.01	1.16	0.01	1.13	0.02	1.27	0.01	1.17	0.01	1.22	0.01	1.15	0.00
Belowground	0.12	0.00	0.11	0.00	0.13	0.00	0.13	0.00	0.14	0.00	0.13	0.00	0.14	0.00	0.13	0.00
Down wood	7.42	0.14	10.67	0.73	7.61	0.37	5.95	0.68	6.71	0.22	4.21	0.18	5.47	0.14	6.77	0.10
Forest Floor	6.51	0.03	7.40	0.15	5.83	0.11	5.84	0.19	5.15	0.07	4.83	0.06	4.99	0.04	5.83	0.03
Soil	54.23	0.11	59.01	0.49	56.74	0.41	57.02	0.68	57.78	0.32	52.90	0.28	55.36	0.21	55.37	0.11
Total Carbon	132.02	0.98	187.57	4.51	131.82	2.78	126.91	4.79	106.83	1.24	97.87	1.22	102.39	0.82	122.88	0.67

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

4.2.2 Carbon Flux by Ownership

As a single ownership, federally managed forests constitute the largest share of overall net annual CO_2e sequestration (i.e., flux resulting in increased stocks) in Washington. Changes in live tree stocks were responsible for most of the flux. National forests alone account for 42% of the annual net change in live trees due to growth (Table 4.10). Adding forest land managed by other federal agencies brings the total contribution to 46% of the net change coming from federal forests. Tree growth on private ownerships, corporate and non-corporate owners, has a net contribution of 40% to the overall rate of sequestration in live trees after accounting for removals due to harvest and mortality. Other state and local government managed forests contribute about 10%, and trees growing in WA-DNR-managed forests contribute 4% to the state's net annual CO_2e sequestration.

Evaluating the contribution of each ownership by carbon pool reveals the significant amount that National Forests and non-corporate private ownerships provide to overall annual carbon sequestration. It is the combined effect of annual growth on live trees from all ownerships that overcome annual carbon losses due to any single source of emission (Figure 4.9). Of the 16.1 ± 8.6 MMT CO_2e per year being sequestered in Washington's forests, 63 percent (10.2 ± 2.1 MMT CO_2e per year) is taken up by forest land on the National Forests (or 1.2 ± 0.2 MT CO_2e/ac/yr). Of the forest land managed by private owners, those managed by non-corporate owners are sequestering carbon at a rate of 4.0 ± 2.8 MMT CO_2e per year (0.9 ± 0.6 MT CO_2e/ac/yr). Although the estimate for net annual change on WA-DNR and private corporate forest lands is negative (-0.1 ± 4.2MMT CO_2e and -0.9 ± 6.5 MMT CO_2e per year respectively), the variation in the estimate of current annual growth when accounting for trees removed through management activities is too large to determine if the average net annual rate of carbon sequestration is statistically different from zero. On a per acre basis sequestration from WA-DNR forests is -0.05 ± 1.88 MT CO_2e/ac/yr and the rate for private corporate forests is -0.18± 1.29 MT CO_2e/ac/yr reflecting the wide variation in estimated sequestration from these ownerships.

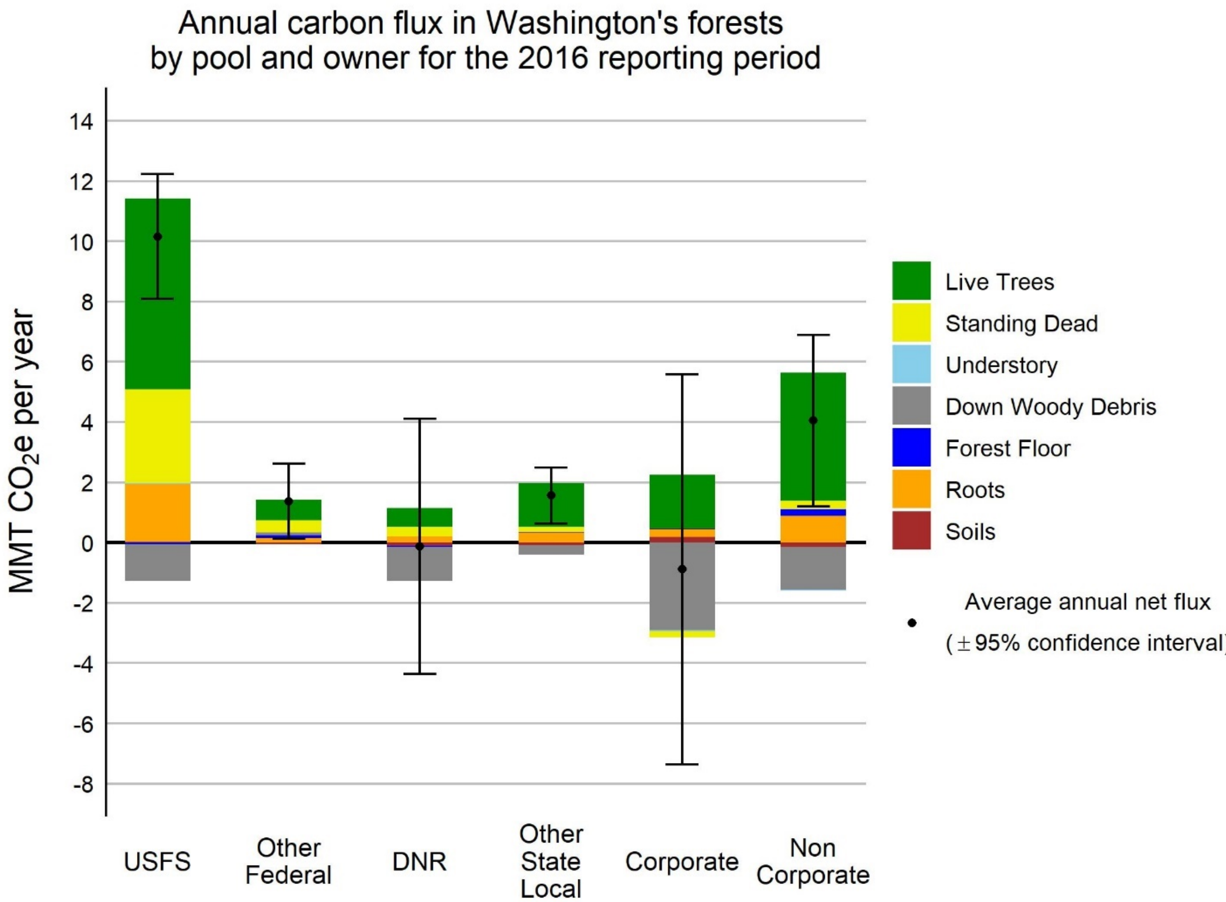


Figure 4.9. Washington estimated average annual carbon flux by forest pool and ownership (MMT CO_2e/yr), 2002-2006 to 2012-2016. Estimates exclude emissions from land-use changes and non-CO_2 greenhouse gases. Roots includes belowground live and dead tree roots. Understory includes aboveground and belowground pools. Error bars represent 95% confidence intervals around point estimates for net flux. Figure derived from Appendix Table B1.

Table 4.10. Statewide estimate of average annual net carbon flux (CO_2e) by pools and owner, 2002-2006 to 2012-2016. Changes in CO_2e due to land-use and non-CO_2 greenhouse gas emissions are not included. Appendix Table B1.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-16,702	927	-4,180	500	-3,209	387	-1,070	235	-3,617	396	-4,094	395	-7,711	533	-32,872	1,250
Cut	-1,226	221	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Gross Growth	23,913	423	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Net	5,985	1,032	651	489	567	1,607	1,379	377	1,678	2,385	4,042	1,027	5,721	2,600	14,303	3,283
Foliage	337	65	35	29	63	91	74	21	115	144	209	59	324	156	833	195
Tree Roots																
Live	1,190	242	145	112	185	362	320	82	408	544	864	228	1,272	590	3,112	746
Dead	731	194	8	52	14	63	13	24	-155	42	29	69	-126	81	641	227
Standing Dead	3,128	785	396	225	312	239	158	108	-203	133	291	272	87	304	4,082	910
Dead Woody Debris	-1,208	593	103	394	-1,120	437	-308	145	-2,897	655	-1,417	513	-4,314	828	-6,846	1,184
Understory Vegetation																
Above Ground	20	18	0	5	2	12	-10	6	-37	26	-33	17	-70	31	-58	38
Below Ground	2	2	0	1	0	1	-1	1	-4	3	-4	2	-8	3	-6	4
Total	10,186	1,004	1,339	617	23	2,063	1,626	460	-1,094	3,230	3,980	1,389	2,886	3,526	16,060	4,274
Forest Floor	-51	126	84	41	-41	66	26	23	20	116	213	82	233	141	250	206
Soils	22	122	-48	47	-103	95	-89	53	189	174	-146	177	43	248	-175	301
Total (including soils and forest floor)	10,156	1,060	1,375	632	-121	2,126	1,563	476	-885	3,303	4,047	1,448	3,162	3,616	16,135	4,396

Table 4.11. Statewide estimate of average annual net carbon flux (CO_2e) per acre by pools and owner, 2002-2006 to 2012-2016. Changes in CO_2e due to land-use and non-CO_2 greenhouse gas emissions are not included. Appendix Table B2.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.02	0.11	-2.76	0.32	-1.44	0.17	-1.55	0.27	-0.72	0.08	-0.94	0.08	-0.83	0.06	-1.49	0.06
Cut	-0.15	0.03	-0.08	0.07	-2.73	0.66	-0.65	0.32	-3.88	0.42	-0.92	0.20	-2.50	0.25	-1.42	0.12
Gross Growth	2.89	0.05	3.28	0.20	4.43	0.21	4.19	0.37	4.94	0.16	2.80	0.12	3.94	0.10	3.56	0.05
Net	0.72	0.12	0.43	0.32	0.26	0.72	1.99	0.49	0.34	0.48	0.93	0.23	0.61	0.28	0.65	0.15
Foliage	0.04	0.01	0.02	0.02	0.03	0.04	0.11	0.03	0.02	0.03	0.05	0.01	0.03	0.02	0.04	0.01
Tree Roots																
Live	0.14	0.03	0.10	0.07	0.08	0.16	0.46	0.11	0.08	0.11	0.20	0.05	0.14	0.06	0.14	0.03
Dead	0.09	0.02	0.01	0.03	0.01	0.03	0.02	0.04	-0.03	0.01	0.01	0.02	-0.01	0.01	0.03	0.01
Standing Dead	0.38	0.09	0.26	0.15	0.14	0.11	0.23	0.15	-0.04	0.03	0.07	0.06	0.01	0.03	0.19	0.04
Dead Woody Debris	-0.15	0.07	0.07	0.26	-0.50	0.20	-0.44	0.20	-0.58	0.13	-0.33	0.12	-0.46	0.09	-0.31	0.05
Understory Vegetation																
Above Ground	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.00	-0.01	0.00	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.23	0.12	0.88	0.40	0.01	0.93	2.35	0.61	-0.22	0.65	0.92	0.32	0.31	0.38	0.73	0.19
Forest Floor	-0.01	0.02	0.06	0.03	-0.02	0.03	0.04	0.03	0.00	0.02	0.05	0.02	0.02	0.02	0.01	0.01
Soils	0.00	0.01	-0.03	0.03	-0.05	0.04	-0.13	0.08	0.04	0.03	-0.03	0.04	0.00	0.03	-0.01	0.01
Total (including soils and forest floor)	1.23	0.13	0.91	0.41	-0.05	0.96	2.26	0.64	-0.18	0.66	0.93	0.33	0.34	0.39	0.73	0.20

4.2.3 Source of Flux by Ownership (Disturbance Effects)

Annually on a per acre basis, carbon sequestration as gross tree growth is highest on forest lands managed by private corporations (4.9 ± 0.3 MT CO_2e/ac/yr) and WA-DNR (4.4 ± 0.4 MT CO_2e/ac/yr), with slightly less gross tree growth on other state and local government ownerships (4.2 ± 0.7 MT CO_2e/ac/yr) (Table 4.13). Private corporate and WA-DNR forests also have the highest rate of annual timber harvest and are expected to contribute more to the harvested wood products carbon pool as compared to contributions from the other ownerships including forests managed by private non-corporate owners, National Forests, or other federal forest lands (Table 4.12).

Transfers of sequestered carbon from the live tree pool into dead wood pools from mortality are represented as a negative flux as shown by the portion of the bars below the horizontal zero line in figure 4.10. These carbon transfers are driven primarily by timber harvest, but also by wildfire and other mortality events. In Washington's forests, mortality attributed to other causes (e.g., competition, wind, landslide, unknown) and referred to as "natural" is consistently occurring at a rate greater than any other cause of mortality (except harvest) across all ownerships.

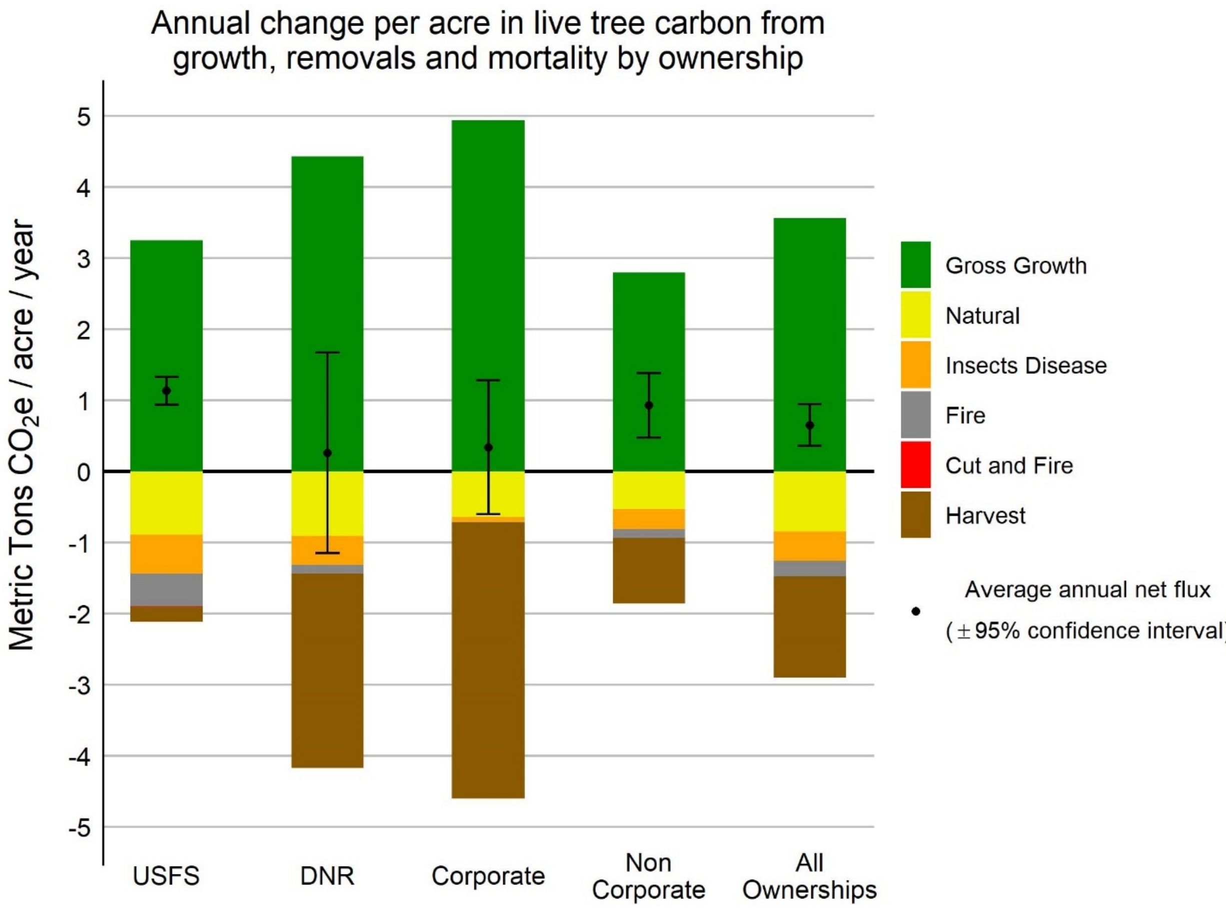


Figure 4.10. Average annual net change per acre in aboveground live tree carbon by ownership in Washington's forests (MT CO_2e/ac/yr), 2002-2006 to 2012-2016. Error bars represent the 95% confidence interval of net change. Figure derived from Appendix Table B2.

Table 4.12. Forest land average annual growth, mortality, harvest, and net change in aboveground live tree carbon (CO_2e) pool by ownership of Washington's forests, 2002-2006 to 2012-2016. Appendix Table B23.

	Public										Private						All Owners	
	USDA Forest Service		USDA Forest Service (reserved)		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2e per year																	
Gross tree growth	23,913	423	4,659	284	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Removals - harvest	-1,226	221	--	--	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Mortality - fire killed	-3,895	611	-1,159	499	-39	39	-297	156	-110	108	-29	29	-551	191	-580	193	-4,920	669
Mortality - cut and fire[1]	-42	22	--	--	--	--	--	--	--	--	--	--	-22	19	-22	19	-64	29
Mortality - insects and disease	-5,827	734	-2,554	698	-779	268	-888	230	-243	105	-373	87	-1,235	251	-1,608	264	-9,345	861
Mortality - natural/other	-6,939	410	-1,667	266	-3,362	450	-2,024	312	-717	182	-3,215	391	-2,286	261	-5,501	452	-18,543	829
Net change	**5,985**	**1,032**	**-722**	**828**	**651**	**489**	**567**	**1,607**	**1,379**	**377**	**1,678**	**2,385**	**4,042**	**1,027**	**5,721**	**2,600**	**14,303**	**3,283**

[1]plots where tree mortality has occurred due to both harvest and fire

Table 4.13. Forest land average annual growth, mortality, harvest, and net change per acre in aboveground live tree carbon (CO_2e) pool by ownership of Washington's forests, 2002-2006 to 2012-2016. Appendix Table B22.

	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Metric tons CO2e/acre/year															
Gross tree growth	2.89	0.05	3.28	0.20	4.43	0.21	4.19	0.37	4.94	0.16	2.80	0.12	3.94	0.10	3.56	0.05
Removals - harvest	-0.15	0.03	-0.08	0.07	-2.73	0.66	-0.65	0.32	-3.88	0.42	-0.92	0.20	-2.50	0.25	-1.42	0.12
Mortality - fire killed	-0.47	0.07	-0.03	0.03	-0.13	0.07	-0.16	0.16	-0.01	0.01	-0.13	0.04	-0.06	0.02	-0.22	0.03
Mortality - cut and fire[1]	-0.01	0.00	--	--	--	--	--	--	--	--	-0.00	0.00	-0.00	0.00	-0.00	0.00
Mortality - insects and disease	-0.70	0.09	-0.52	0.17	-0.40	0.10	-0.35	0.14	-0.07	0.02	-0.28	0.06	-0.17	0.03	-0.42	0.04
Mortality - natural/other	-0.84	0.05	-2.22	0.30	-0.91	0.14	-1.04	0.23	-0.64	0.08	-0.53	0.06	-0.59	0.05	-0.84	0.04
Net change	**0.72**	**0.12**	**0.43**	**0.32**	**0.26**	**0.72**	**1.99**	**0.49**	**0.34**	**0.48**	**0.93**	**0.23**	**0.61**	**0.28**	**0.65**	**0.15**

[1]plots where tree mortality has occurred due to both harvest and fire

4.2.3.1 Disturbance effects on carbon flux

In addition to their effects on live trees, management and disturbance affect other forest ecosystem pools. To assess these impacts, we classified stands by the type of harvest and/or disturbance that had occurred between inventory measurements (see section 3.2.5). In stands that experienced harvesting, the loss of aboveground live tree C on National Forest lands was somewhat greater than growth when also accounting for natural mortality (-0.42 ± 0.3 MMT CO_2e per year), since on average growth was roughly proportional to harvest in those stands over the 10-year measurement interval (Table 4.14). In contrast, on private corporate lands, the net change in aboveground live tree C on harvested stands was -13.9 ± 3.8 MMT CO_2e per year, reflecting the greater area of forest being cut as well as greater proportional removals of live trees in stands that were cut, compared to other owners. For example, change in aboveground live tree C was -10.1 ± 2.3 MT CO_2e per acre per year in cut stands on private corporate land, compared to -2.0 ± 1.4 on National Forest land (Appendix Table B12). The net change in aboveground live tree C per acre was greater on WA-DNR lands at -13.8 ± 6.4 MT CO_2e per acre per year (-5.0 ± 2.7 MMT CO_2e per year total), probably reflecting harvest on longer rotations than on private lands.

Accounting for additional losses of dead wood and roots resulted in a net change of -29.8 ± 6.7 MMT CO_2e per year (or -11.0 ± 1.2 MT CO_2e per acre per year) in stands where harvesting occurred across all ownerships in Washington (Table 4.14). Of the estimated 31.2 ± 5.4 MMT CO_2e per year of aboveground live tree C cut within the forest, live tree growth across all lands (including growth on harvested and unharvested portions) annually exceeded harvest and mortality, with a net increase of 14.3 ± 6.4 MMT CO_2e per year (or 0.65 ± 0.29 MT CO_2e per acre per year) (also shown in Table 4.5).

The total net change in C in stands that experienced fire in Washington was -2.8 ± 0.9 MMT CO_2e per year. Most of that loss occurred on National Forest lands. The aboveground C in mortality trees in fire-affected stands of -3.9 ± 1.2 MMT CO_2e per year was 68 percent higher than the net change of -2.8 ± 0.9 MMT CO_2e per year on National Forests because the net change figure includes C captured through live tree growth and retained through the increase of C in standing dead trees (Table 4.14). In contrast to stands experiencing fire or cutting, stands affected by weather disturbances or insect and disease accumulated C in the live and dead wood pools.

Overall, the state's substantial annual tree growth rates across all forest ownerships, in particular on stands experiencing other disturbances and on undisturbed stands, resulted in a net overall sequestration of nearly 16.1 ± 8.4 MMT CO_2e per year in spite of annual statewide losses due to fire and cutting.

Okanogan county was estimated to have a net loss of carbon based on all pools (-1.7 ± 1.0 MMT CO_2e per year) due to mortality from fire and insect and disease being greater than growth plus the associated increase in dead wood (Appendix Table B26). A few other counties, including

Pacific, Snohomish, Klickitat, and Stevens also had net losses of C, with harvest and mortality being similar to or somewhat higher than growth, with additional losses in dead wood. The forests of Skamania, King, and Lewis counties had the highest rates of carbon sequestration, with each exceeding 2.6 MMT of CO_2e annually. Those three counties accounted for 50 percent of the net increase in non-soil CO_2e sequestered each year by Washington's forests. See figure 4.13b for a map of Washington counties.

Of the National Forests or other forested areas managed by the USDA Forest Service in Washington, the Okanogan National Forest was currently estimated to have a net loss of -1.5 ± 0.9 MMT CO_2e per year based on all pools (Table 4.15). The Umatilla National Forest also had a net loss at -1.0 ± 0.7 MMT CO_2e per year. All other forests were estimated as gaining carbon, with the greatest increases on the Gifford Pinchot and Mt. Baker-Snoqualmie National Forests at 4.4 ± 0.8 and 3.5 ± 1.2 MMT CO_2e per year, respectively, which also had the highest growth rates. The Colville National Forest had a substantial increase of 2.0 ± 0.4 MMT CO_2e per year due to modest growth rates and substantial increases in dead wood. See figure 4.4 for a map of National Forests within Washington.

Table 4.14. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type affecting stands and ownership, 2002-2006 to 2012-2016.

	Public								Private							
Change in Carbon Pool by disturbance	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-83	24	-4	4	-306	145	-15	10	-376	151	-455	137	-831	204	-1,239	252
Cut	-952	209	-116	112	-5,803	1,465	-441	230	-18,845	2,128	-3,661	896	-22,507	2,286	-29,817	2,722
Gross Growth	616	103	27	26	1,137	233	242	144	5,315	544	1,783	281	7,099	603	9,121	666
Net Live	-418	153	-93	90	-4,972	1,386	-214	173	-13,906	1,937	-2,333	798	-16,239	2,081	-21,936	2,505
Standing Dead Change	-16	13	-7	6	-215	129	0	6	-459	77	-270	72	-728	104	-966	167
Dead Woody Debris Change	-45	61	-20	20	49	165	33	23	-707	384	81	177	-626	423	-609	459
Total Net	-595	196	-145	141	-6,560	1,812	-225	208	-19,048	2,676	-3,253	1,083	-22,301	2,869	-29,826	3,400
Cut and Fire																
Mortality	-42	22	--	--	--	--	--	--	--	--	-22	19	-22	19	-64	29
Cut	-131	65	--	--	--	--	--	--	--	--	-56	48	-56	48	-187	80
Gross Growth	21	11	--	--	--	--	--	--	--	--	16	12	16	12	37	16
Net Live	-153	74	--	--	--	--	--	--	--	--	-61	42	-61	42	-213	85
Standing Dead Change	-49	40	--	--	--	--	--	--	--	--	-13	21	-13	21	-62	45
Dead Woody Debris Change	-5	8	--	--	--	--	--	--	--	--	-8	7	-8	7	-13	10
Total Net	-257	138	--	--	--	--	--	--	--	--	-97	58	-97	58	-354	150
Fire																
Mortality	-3,895	611	-39	39	-297	156	-110	108	-29	29	-551	191	-580	193	-4,920	669
Cut	-43	20	--	--	--	--	--	--	--	--	--	--	--	--	-43	20
Gross Growth	561	67	10	10	91	50	36	25	8	8	236	86	244	86	943	123
Net Live	-3,376	568	-29	29	-205	118	-73	94	-21	21	-315	162	-336	164	-4,021	610
Standing Dead Change	1,814	401	15	15	153	106	74	73	6	7	188	97	194	97	2,249	433
Dead Woody Debris Change	-335	116	0	0	-30	18	-10	7	-15	13	-160	88	-175	89	-549	148
Total Net	-2,311	422	-17	17	-97	99	-8	36	-32	29	-316	147	-348	150	-2,781	460

Table 4.14. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and ownership, 2002-2006 to 2012-2016. Appendix Table B11 (Continued).

Change in Carbon Pool by disturbance	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
Insect and Disease																
Mortality	-5,827	734	-779	268	-888	230	-243	105	-373	87	-1,235	251	-1,608	264	-9,345	861
Cut	-67	28	--	--	-47	50	--	--	-7	7	-41	23	-48	25	-162	63
Gross Growth	5,929	317	683	181	1,722	355	443	185	2,116	442	1,697	254	3,813	505	12,591	735
Net Live	36	668	-96	162	787	314	200	147	1,735	376	422	213	2,157	430	3,084	881
Standing Dead Change	1,988	587	114	94	351	142	59	48	29	32	413	172	442	175	2,953	637
Dead Woody Debris Change	-32	280	164	194	-249	215	-19	78	-318	90	-164	101	-483	135	-618	432
Total Net	2,435	439	193	181	1,199	398	301	147	1,937	453	893	241	2,830	511	6,959	814
Other cut and weather																
Mortality	-1,196	265	-583	220	-220	94	-216	104	-866	305	-204	98	-1,070	320	-3,285	490
Cut	-14	11	--	--	-43	46	--	--	-83	63	-64	32	-147	70	-203	85
Gross Growth	897	144	474	145	465	169	381	169	1,477	347	485	142	1,962	373	4,179	486
Net Live	-313	207	-109	143	202	110	165	124	528	382	217	103	745	396	690	497
Standing Dead Change	-50	65	-26	72	-18	28	-2	31	21	28	-28	63	-6	69	-102	126
Dead Woody Debris Change	46	141	274	84	29	62	-41	58	-39	145	24	37	-15	149	294	237
Total Net	-393	254	102	201	272	150	166	202	671	478	274	119	945	492	1,091	640
Less than 25% disturbed																
Mortality	-5,660	336	-2,775	424	-1,498	272	-487	148	-1,973	219	-1,627	204	-3,600	284	-14,020	678
Cut	-20	7	-10	10	-163	143	-11	10	-403	137	-195	84	-598	160	-802	215
Gross Growth	15,889	456	3,763	377	6,417	592	1,798	345	15,718	1,043	7,935	661	23,653	1,120	51,519	1,372
Net Live	10,209	487	978	422	4,755	562	1,301	266	13,342	948	6,113	579	19,455	1,028	36,697	1,322
Standing Dead Change	-559	321	299	193	43	84	27	56	199	96	-0	158	199	185	10	429
Dead Woody Debris Change	-839	481	-314	335	-919	342	-271	108	-1,818	507	-1,189	461	-3,007	682	-5,351	966
Total Net	11,307	721	1,206	536	5,209	724	1,392	328	15,378	1,268	6,479	812	21,858	1,423	40,972	1,823
Total																
Mortality	-16,702	927	-4,180	500	-3,209	387	-1,070	235	-3,617	396	-4,094	395	-7,711	533	-32,872	1,250
Cut	-1,226	221	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Gross Growth	23,913	423	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Net Live	5,985	1,032	651	489	567	1,607	1,379	377	1,678	2,385	4,042	1,027	5,721	2,600	14,303	3,283
Standing Dead Change	3,128	785	396	225	312	239	158	108	-203	133	291	272	87	304	4,082	910
Dead Woody Debris Change	-1,208	593	103	394	-1,120	437	-308	145	-2,897	655	-1,417	513	-4,314	828	-6,846	1,184
Total Net	10,186	1,004	1,339	617	23	2,063	1,626	460	-1,094	3,230	3,980	1,389	2,886	3,526	16,060	4,274

Note: total Net value includes change from roots and understory vegetation which are not enumerated in this table.

Table 4.15. Average annual carbon (CO_2e) flux in aboveground live trees from growth, harvest, and mortality, and total (excluding Forest Floor and Soils), by National Forest, 2002-2006 to 2012-2016. Appendix Table B27.

	Region 6																	
	Colville		**Gifford Pinchot**		**Idaho Panhandle**		**Mt. Baker-Snoqualmie**		**Okanogan**		**Olympic**		**Umatilla**		**Wenatchee**		**Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Thousand Metric Tons CO2 equivalent per year																	
Standing Live																		
Gross Growth	2,844	106	5,485	221	387	28	6,013	325	2,167	170	2,884	133	538	111	3,594	239	23,913	423
Harvest	-169	64	-156	79	-10	6	-22	15	-173	59	-482	176	-123	54	-91	34	-1,226	221
Fire killed	-293	142	-221	127	--	--	--	--	-2,370	530	--	--	-540	207	-470	149	-3,895	611
Cut and fire	--	--	--	--	--	--	--	--	-3	3	--	--	-39	22	--	--	-42	22
Insects and disease	-1,034	163	-510	166	-126	25	-236	99	-1,849	659	-144	57	-173	64	-1,754	282	-5,827	734
Natural/other	-376	49	-1,175	113	-23	7	-2,545	259	-364	118	-1,385	206	-264	101	-808	181	-6,939	410
Total Mortality	-1,702	205	-1,906	227	-149	21	-2,781	269	-4,585	823	-1,529	208	-1,016	222	-3,032	347	-16,702	927
Net Flux	972	220	3,423	293	228	44	3,210	372	-2,590	763	873	268	-601	215	471	338	5,985	1,032
All Pools																		
Net Flux	**2,044**	**194**	**4,396**	**396**	**279**	**69**	**3,521**	**617**	**-1,498**	**438**	**1,263**	**368**	**-954**	**366**	**1,106**	**316**	**10,156**	**1,060**

4.2.3.2 Implications of recent tree mortality events on carbon flux

Recent large fires, insect outbreaks, and drought conditions in Washington's forests have caused tree mortality to fluctuate. Concerns are sometimes raised that high levels of mortality, particularly on National Forest lands that are not managed as intensively as other ownerships, have caused the forests in Washington to become net emitters of carbon due to dead tree decay. Here we summarize recent trends in mortality in relation to other carbon fluxes.

On average, between 2002-2016, there were approximately 8.6 billion live trees in Washington, of which about 147 million died each year, for an annual mortality rate of 1.71% ± 0.12% (95% CI). For National Forests, there were 3.7 billion live trees, of which 65 million died each year, for an annual mortality rate of 1.77% ± 0.15%. As shown in report Table 4.10 (Appendix Table B1), storage of carbon in live trees increased on most ownerships over this time-period, while storage in dead wood (standing dead and woody debris) remained stable or declined. Mortality rates in terms of carbon were highest on National Forest system lands (1.2 ± 0.07%), with 35% of the mortality occurring on plots affected by insects and disease, and 34% occurring on undisturbed plots (Appendix Table B11). Despite the mortality on National Forest, the increase in the aboveground live tree wood pool was significant (6.0 ± 2.0 MMT CO_2e per year) with a modest increase in the snag plus down wood pool (1.9 ± 0.9 MMT CO_2e per year).

The amount of carbon in mortality trees ranged between 20-65 MMT CO_2e over the assessment period (Figure 4.11). These tree-based mortality percentages don't match the stand-based disturbance codes from Table 4.6 because in many cases mortality was not severe enough in a stand to warrant being coded as a disturbance. Mortality rates in terms of live tree C was 1.0% per year for the state and ranged from 2.4% in the Blues & Columbia Basin to 0.6% in the Western Cascades ecoregions.

The immediate effect of a pulse of tree mortality is the transfer of live tree carbon to dead tree carbon. The decreasing dead woody debris pool in recent years (Table 4.10) indicates that dead wood was being added to the pool at a slower rate than it was decaying, possibly in response to prior pulses of mortality (e.g., in high fire years). Live tree growth is the engine that drives forest carbon sequestration. For the balance to result in a net emission, mortality would have to exceed growth for an extended period such that the live tree pool declines and decay of the larger dead wood pool results in greater emissions.

Given a total aboveground dead pool of 77 ± 1.1 MMT C on National Forests (not including litter or duff), annual decay could range from a low of 2.8 MMT CO_2e per year (1%) to 14.2 MMT CO_2e per year (5%)(decay rates are highly variable—Kahl et al. 2017 found the former rate for conifers and the latter for hardwoods). In order for forests on National Forests to be net emitters, the sum of additions to dead wood (mortality) and live wood (net live), or gross growth minus harvest (currently 25.0 ± 2.0 MMT CO_2e per year) would need to fall below the actual flux from decomposition.

The available data on mean carbon storage in recent years in Washington, and on National Forests in particular, indicates that the forests are still a net sink of carbon from the atmosphere. It is possible that during specific years of severe drought, growth rates can become so low and mortality so high that decay exceeds new storage. A physiological model based on annual climate would likely be required to assess that question (e.g., Turner et al. 2016).

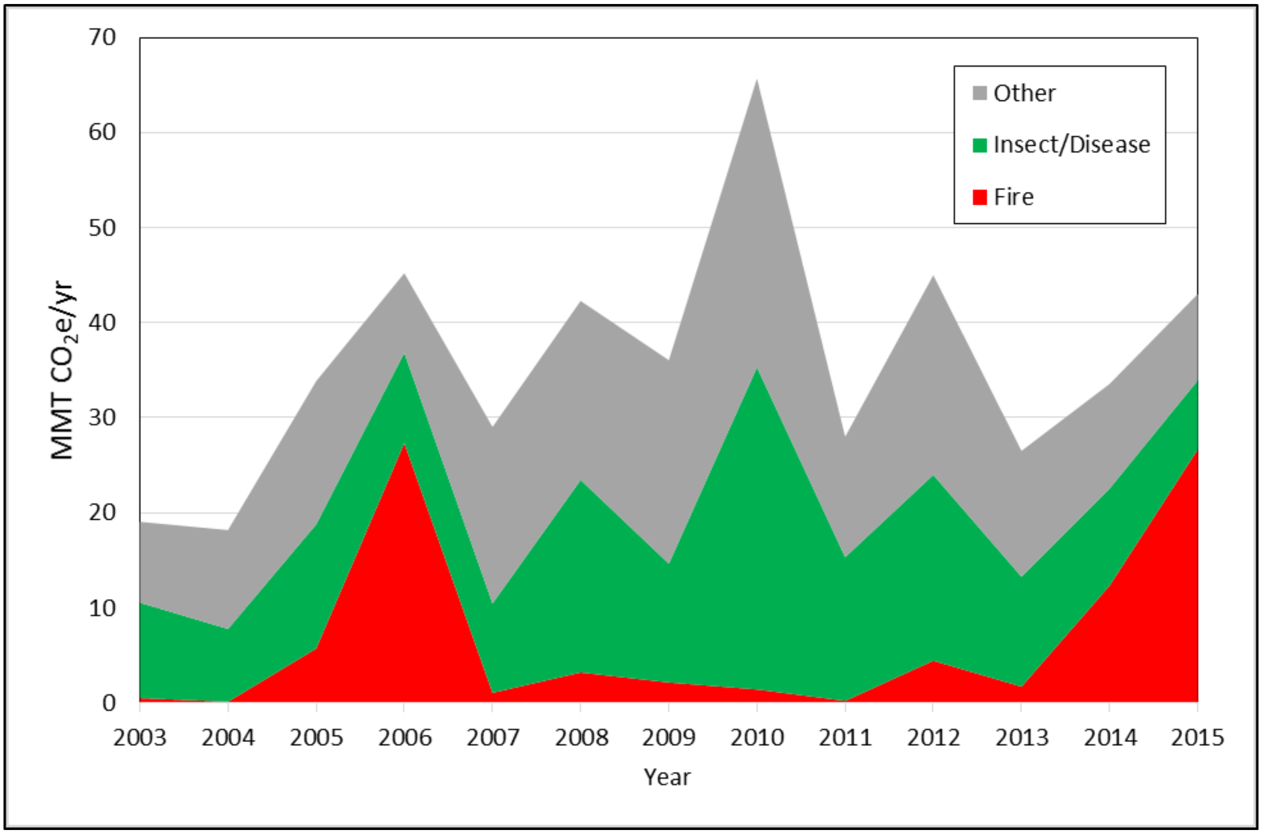


Figure 4.11. Estimated amount of carbon in mortality trees in Washington by year and cause of death (MMT CO_2e/yr) 2003-2015.

4.2.3.3 Net flux of non-CO_2 GHG emissions from wildfire

Based on FIA plot measurements, fire is estimated to affect 86 ± 18 thousand acres per year (95% CI), with an additional 5 ± 4 thousand acres per year affected by both fire and cutting. Emissions of methane and nitrous oxides due to fires on forest land are estimated to add 166 ± 36 thousand metric tons of CO_2e per year (95% CI) to Washington's statewide emissions (Table 4.16). (Note that CO_2 emissions are already included in the previous net flux tables and are included here only for context.) The greatest source of these emissions was from fire on

National Forest lands (Figure 4.12). A substantial amount was also estimated for the “cut and fire” category on private lands. There are a few uncertainties with this estimate that may result in compensating effects. Our approach underestimates non-CO_2 gas emissions because we currently do not have an estimate of combustion of forest floor; and because, in the use of net change in C, some of the C that was combusted would be masked by subsequent forest growth. Alternatively, our approach may overestimate non-CO_2 gas emissions because some of the cut and fire category were cut before they were burned, so the amount combusted was less than the net change; and because some of the change in C of dead wood came from decay after the fire, and not entirely from combustion. We will examine options to refine this estimate. Nevertheless, we believe the calculation based on field measurements will be more accurate than a default emission factor applied to an estimate of area burned as in the default approach for IPCC 2006.

Table 4.16. Annual Net Emissions of CO_2 and Non- CO_2 Greenhouse Gases from Fire, 2002-2006 to 2012-2016: All Washington. CO_2 values are from table 4.10 and were used to calculate the other gases. Appendix Table E1.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Cut and Fire																
CO2	-257	138	--	--	--	--	--	--	--	--	-97	58	-97	58	-354	150
CH4	-8	4	--	--	--	--	--	--	--	--	-3	2	-3	2	-11	5
N2O	-5	3	--	--	--	--	--	--	--	--	-2	1	-2	1	-7	3
Fire																
CO2	-2,311	422	-17	17	-97	99	-8	36	-32	29	-316	147	-348	150	-2,781	460
CH4	-74	14	-1	1	-3	3	-0	1	-1	1	-10	5	-11	5	-89	15
N2O	-49	9	-0	0	-2	2	-0	1	-1	1	-7	3	-7	3	-59	10
Total Fire																
CO2	-2,568	442	-17	17	-97	99	-8	36	-32	29	-413	157	-445	160	-3,135	482
CH4	-82	14	-1	1	-3	3	-0	1	-1	1	-13	5	-14	5	-100	15
N2O	-54	9	-0	0	-2	2	-0	1	-1	1	-9	3	-9	3	-66	10

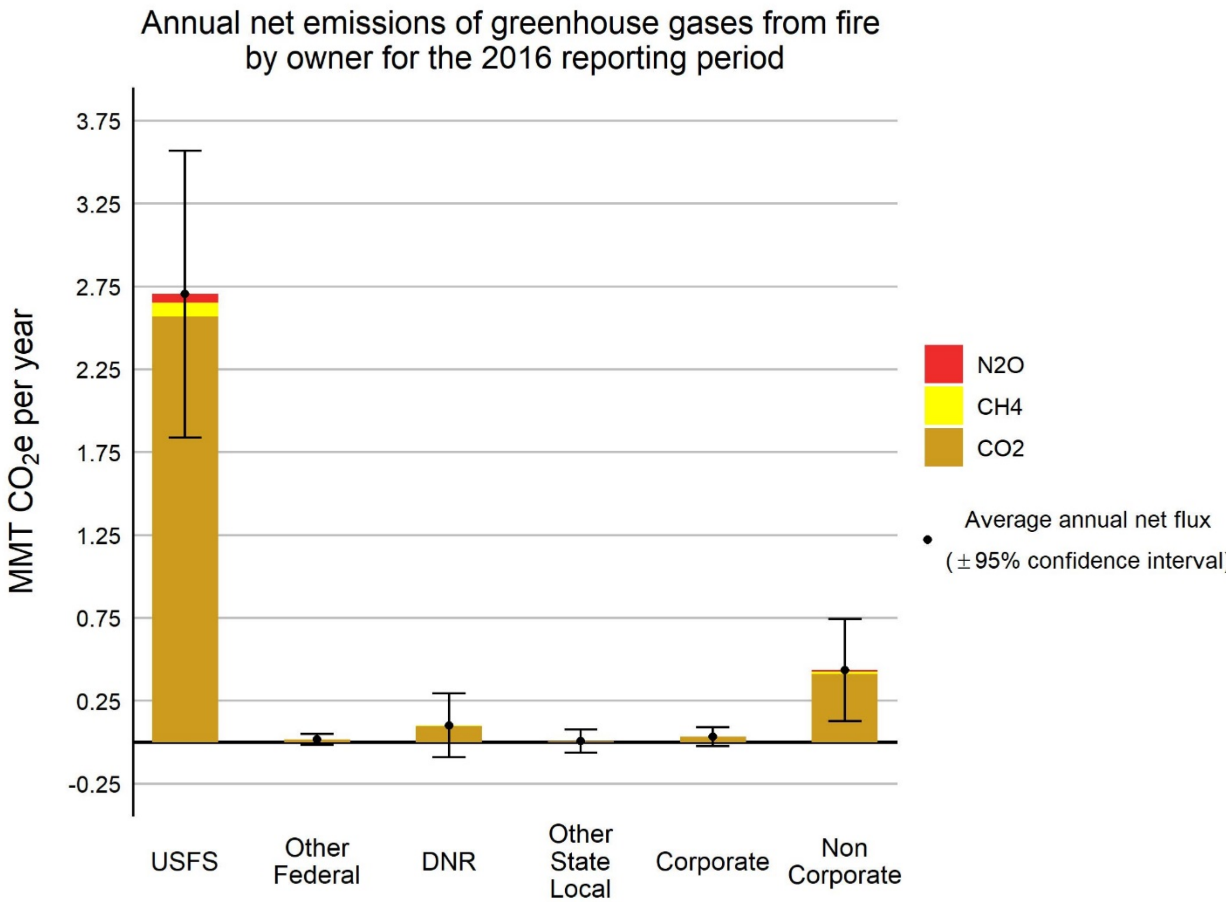


Figure 4.12. Washington annual net emissions of greenhouse gases from fire by ownership (MMT CO_2e/yr), 2002-2006 to 2012-2016. Appendix Table E1.

4.2.4 Trends by Ownership

We evaluated current C stocks by ownership from the 2002-2011 FMRL in 10-year periods to 2007-2016. See section 4.1.5 for a discussion of forest management reference levels (FMRL) and the stock-change approach to evaluate change. The aboveground live tree C pool by ownership is highlighted in Table 4.17. The live tree pool is evaluated on its own since remeasurement has so far suggested an elevated rate of annual flux relative to all other C pools. Most ownerships indicate increasing or nearly flat C stocks throughout this time-period based on the 2002-2011 FMRL and the standard error of each estimate. This same trend persists when evaluating the sum of all C pools by the same ownerships (Table 4.18).

Table 4.17: Live tree carbon stocks in 10-year inventory periods by ownership, 2002-2011 through 2007-2016. Appendix Table C39.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	386.41	7.84	124.36	5.01	108.16	5.17	28.51	3.31	127.56	5.28	126.99	5.26	254.56	6.43	902.00	11.95
2003-2012	376.11	5.69	122.60	5.10	102.40	4.53	29.98	3.41	130.44	5.02	123.02	4.93	253.47	5.66	884.56	10.21
2004-2013	378.89	5.77	120.57	5.06	102.37	4.53	31.17	3.49	133.69	5.06	124.00	4.94	257.68	5.68	890.69	10.27
2005-2014	380.59	5.85	119.39	5.02	103.82	4.52	31.83	3.53	134.98	5.13	125.47	5.00	260.46	5.73	896.08	10.31
2006-2015	380.80	5.96	121.50	5.07	103.22	4.58	32.04	3.58	135.06	5.07	126.58	5.05	261.64	5.77	899.20	10.47
2007-2016	381.59	5.95	121.91	5.09	102.51	4.51	32.74	3.67	135.66	5.08	127.17	5.09	262.83	5.82	901.59	10.50

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Note: Please review section 4.1.5 for an understanding of how stock changes calculated from this table differ from flux determined by directly measuring growth, removals and mortality (GRM) on the same plots over time

Table 4.18. Forest carbon stocks in 10-year inventory periods by ownership, 2002-2011 through 2007-2016. Appendix Table C40. Includes forest carbon stocks from all pools; live and dead trees, down wood, understory, belowground roots, forest floor, and soils.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	1,108.72	12.97	280.56	9.19	301.95	10.52	84.63	8.23	496.90	13.79	471.78	13.76	968.68	13.64	2,744.54	20.60
2003-2012	1,090.64	9.58	277.70	8.90	287.64	8.37	86.54	8.38	503.87	13.86	463.08	13.46	966.95	12.70	2,709.46	17.94
2004-2013	1,093.31	9.62	272.61	8.94	285.66	8.37	89.25	8.46	509.47	13.80	460.06	13.43	969.54	12.71	2,710.36	18.05
2005-2014	1,095.34	9.72	270.69	8.89	288.30	8.43	91.51	8.55	508.93	13.86	459.04	13.45	967.97	12.73	2,713.80	18.09
2006-2015	1,094.28	9.94	274.68	8.94	288.13	8.53	92.09	8.61	507.72	13.73	459.08	13.44	966.79	12.74	2,715.98	18.32
2007-2016	1,094.80	9.95	275.76	9.00	288.73	8.49	92.79	8.68	508.51	13.73	457.60	13.49	966.11	12.84	2,718.18	18.47

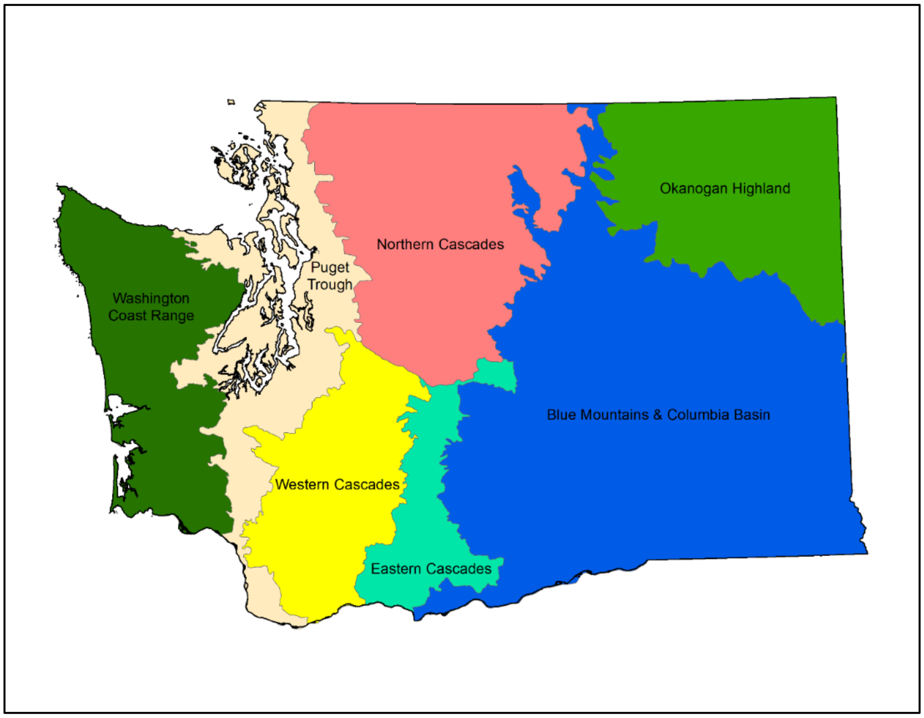
[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Note: Please review section 4.1.5 for an understanding of how stock changes calculated from this table differ from flux determined by directly measuring growth, removals and mortality (GRM) on the same plots over time.

4.3 Geographic Region - Forest Carbon Stocks, Flux and Trends by Geographic Region

4.3.1 Carbon Stock by Geographic Region

Forest carbon stocks summarized by specific pool as found in each ecological or county region provides insight into the geographic distribution of carbon stocks among Washington's diverse forests and ecological conditions (Figure 4.13a). Differences in productivity between the wet forests west of the Cascade Range are apparent from the dryer forests east of the divide when total carbon stocks are compared (Figure 4.14, Table 4.19). The four westside ecological regions currently contain 77% of all forest carbon stocks (Northern Cascades, Puget Trough, Washington Coast Range, and Western Cascades), with the Northern Cascades and Washington Coast Range together accounting for nearly half of all carbon stocks (49%) in the state. On the eastside, these regions currently store 23% of total forest carbon stocks (Blue Mountains and Columbia Basin, Eastern Cascades, Okanogan Highland). In this report we consider the Northern Cascades ecological region as being west of the Cascade Range despite the eastern most boundary being geographically east of the divide. Additionally, how carbon stocks are allocated within each ecological region and pool is further impacted by ownership. As discussed in section 4.2.1, differences in forest management by ownership and policy implications also play an important role in the allocation of current carbon stocks. These differences are also evident within and between ecological regions as the proportion of forest land managed by different owners change (Figure 4.13a).



a) Ecoregions

b) Counties

Figure 4.13. Washington a) Ecoregions, based on ecological sections as described by Cleland et al. (2007); and b) Counties used in this analysis, dark line closely following the crest of the Cascade Mountain Range differentiates Westside and Eastside counties.

On a per acre basis, the differences in productivity by geographic area become more apparent, with the westside forests currently having the densest forests and all westside regions exceeding the state-wide average of 122.9 ± 1.3 MT C/ac (Table 4.20). The east-side ecological regions have carbon stocks per acre of less than 100 MT/ac with the combined Blue Mountains and Columbia Basin region having the lowest carbon density at 83.8 ± 4.0 MT C/ac. Looking closer at the pools within each of these regions shows how carbon stocks are distributed and transferred between each pool. In general, the west-side regions have a percentage of live tree carbon stocks per acre exceeding 40%. However, dead tree and downed wood carbon pools can indicate impacts of other ecological processes. For example, the Northern Cascades ecological region currently has 38% of live tree stocks per acre in live trees, but also has the highest percentage of carbon stocks in dead trees and down wood carbon pools at 11%. This suggests higher degree of disturbance per acre in the region relative to other forests.

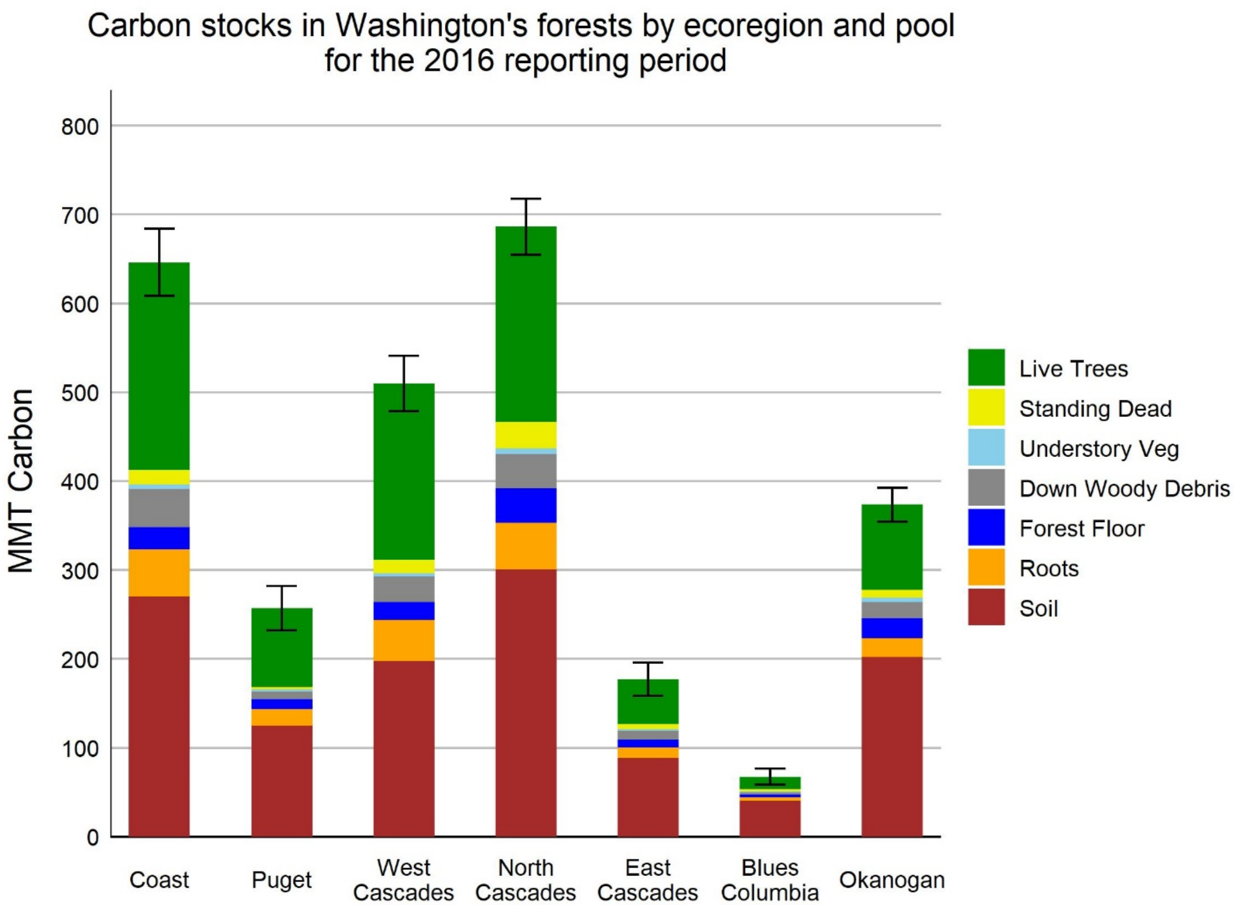
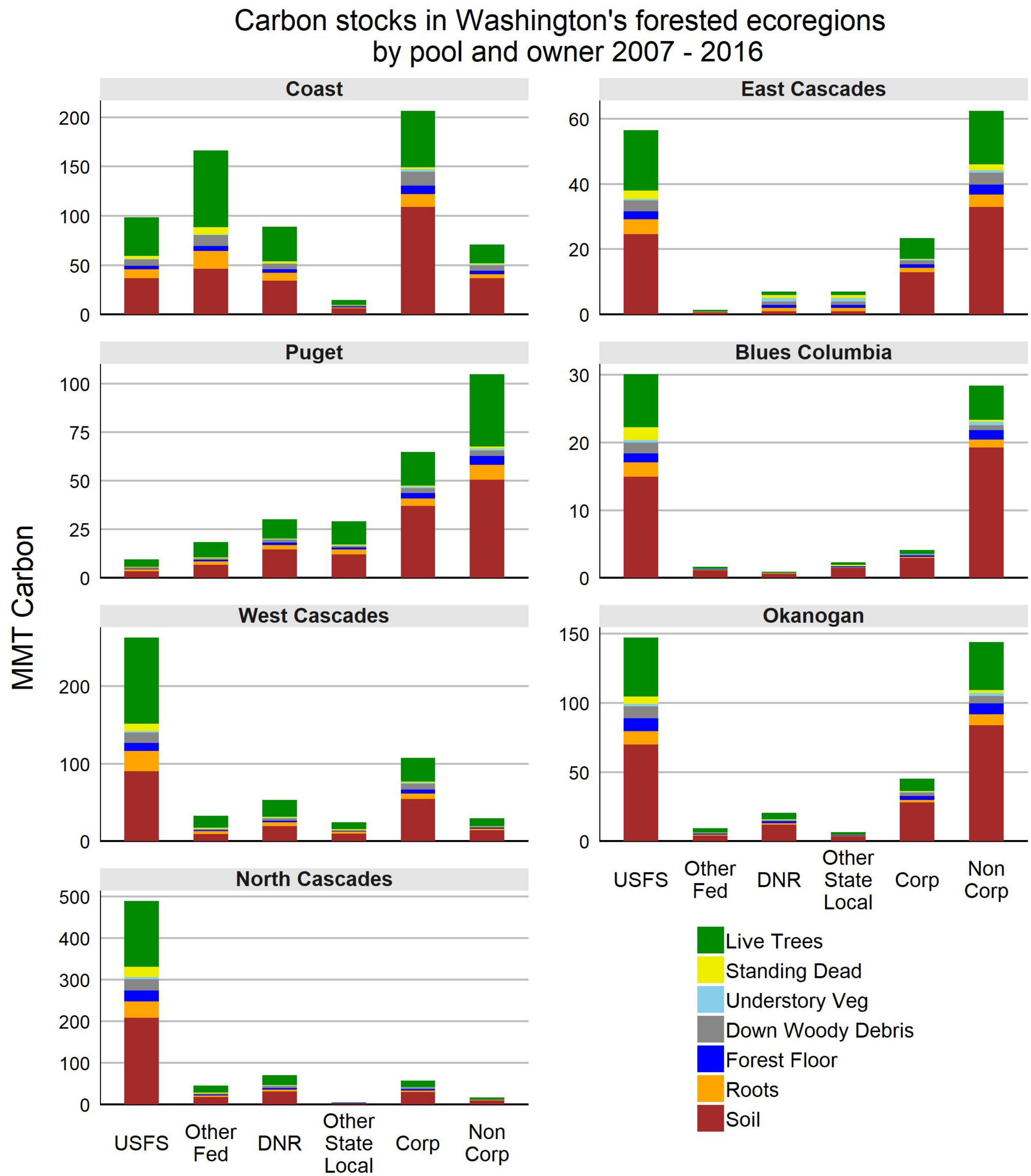


Figure 4.14. Average carbon stock by pool and ecological region (MMT C), 2007-2016. Error bars represent 95% confidence interval of estimated total stock for each region. Appendix Table C7.



a) 1Ecoregions

Figure 4.15. Washington statewide average forest carbon stock by pool, ownership, and ecoregion (MMT C), 2007-2016. Error bars represent 95% interval of estimated total stock for each ownership. Figure derived from Appendix Tables C18, C20, C22, C24, C26, C28, and C30. Note the different y-axis scales on individual graphs.

Table 4.19. Forest land carbon stocks by ecological region and pool, 2007-2016. Appendix Table C7.

Carbon Pool	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C[1]															
Live trees																
Aboveground	14.37	1.36	50.88	3.45	219.61	7.02	96.23	3.06	88.44	5.30	233.74	8.61	198.32	7.09	901.59	10.50
Belowground	2.89	0.28	10.24	0.71	43.44	1.42	18.65	0.61	17.96	1.11	47.57	1.77	41.27	1.49	182.03	2.19
Dead trees																
Aboveground	2.41	0.38	5.49	0.57	30.05	1.67	8.66	0.50	2.91	0.28	16.13	0.90	14.84	0.84	80.50	2.02
Belowground	0.62	0.10	1.40	0.14	7.97	0.42	2.16	0.12	0.87	0.08	4.86	0.27	4.24	0.23	22.13	0.53
Understory vegetation																
Aboveground	0.97	0.07	1.99	0.11	6.16	0.14	4.85	0.13	2.47	0.12	4.85	0.15	4.15	0.13	25.44	0.16
Belowground	0.11	0.01	0.22	0.01	0.68	0.02	0.54	0.01	0.27	0.01	0.54	0.02	0.46	0.01	2.83	0.02
Down wood	2.61	0.23	9.77	0.70	38.37	1.32	18.20	0.65	8.96	0.61	43.32	1.91	28.62	1.19	149.85	2.33
Forest Floor	3.21	0.23	8.47	0.44	39.17	0.90	22.26	0.57	10.77	0.53	25.29	0.78	19.83	0.63	129.01	0.85
Soil	40.45	2.86	88.74	4.55	300.91	6.50	201.99	5.33	124.48	5.90	270.16	7.81	198.08	6.12	1,224.81	6.87
Total Carbon	67.64	4.72	177.21	9.63	686.38	16.05	373.54	9.81	257.13	12.68	646.46	19.34	509.82	15.95	2,718.18	18.47

Ecological Region spans the seven regional column groups (Blues+Columbia Basin through Western Cascades).

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Table 4.20. Forest land carbon stocks per acre by ecological region and pool, 2007-2016. Appendix Table C8.

Carbon Pool	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C[1] per acre															
Live trees																
Aboveground	17.81	1.33	28.25	1.30	39.99	1.02	23.28	0.51	42.93	1.71	55.79	1.57	54.52	1.36	40.76	0.47
Belowground	3.58	0.28	5.69	0.27	7.91	0.21	4.51	0.10	8.72	0.37	11.35	0.32	11.35	0.29	8.23	0.10
Dead trees																
Aboveground	2.99	0.47	3.05	0.28	5.47	0.29	2.10	0.11	1.41	0.12	3.85	0.20	4.08	0.20	3.64	0.09
Belowground	0.77	0.12	0.78	0.07	1.45	0.07	0.52	0.03	0.42	0.03	1.16	0.06	1.17	0.05	1.00	0.02
Understory vegetation																
Aboveground	1.21	0.02	1.11	0.01	1.12	0.01	1.17	0.01	1.20	0.01	1.16	0.01	1.14	0.01	1.15	0.00
Belowground	0.13	0.00	0.12	0.00	0.12	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13	0.00
Down wood	3.24	0.24	5.43	0.27	6.99	0.20	4.40	0.12	4.35	0.21	10.34	0.37	7.87	0.23	6.77	0.10
Forest Floor	3.98	0.08	4.70	0.06	7.13	0.07	5.39	0.05	5.23	0.09	6.04	0.08	5.45	0.06	5.83	0.03
Soil	50.13	0.23	49.28	0.23	54.79	0.17	48.87	0.13	60.42	0.37	64.48	0.27	54.46	0.24	55.37	0.11
Total Carbon	83.84	2.05	98.40	1.95	124.98	1.47	90.38	0.76	124.81	2.22	154.30	2.23	140.16	1.92	122.88	0.67

Ecological Region columns: Blues+Columbia Basin through Western Cascades.

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Analysis of regional county groups provide additional insights on the distribution of carbon stocks throughout Washington's forests when summarized by western and eastern regions. As found with the ecological regions, moisture regime and productivity differences in carbon stocks are highlighted when counties are grouped relative to being located west or east of the Cascade Range divide (Figure 4.13b). Counties found west of the Cascade divide currently contain 65% of all forest carbon stocks, and 73% of all live tree carbon stocks (Figure 4.16, Table 4.21). Westside county forests account for 54% of carbon in dead trees, but account for 68% of carbon found in down wood as logs and other woody debris. On a per acre basis, forests found in westside counties currently store an average of 146.2 ± 2.2 MT C/ac (Table 4.22). Forests in eastside counties currently store an average of 94.9 ± 1.2 MT C/ac (Table 4.24). This represents 35% of statewide forest carbon stocks, and 27% of all live tree carbon stocks (Table 4.23). Relative to the amount of carbon stocks in live trees, eastside forests store a disproportionally large share of carbon stocks in dead trees accounting for 46% of the statewide carbon in this pool.

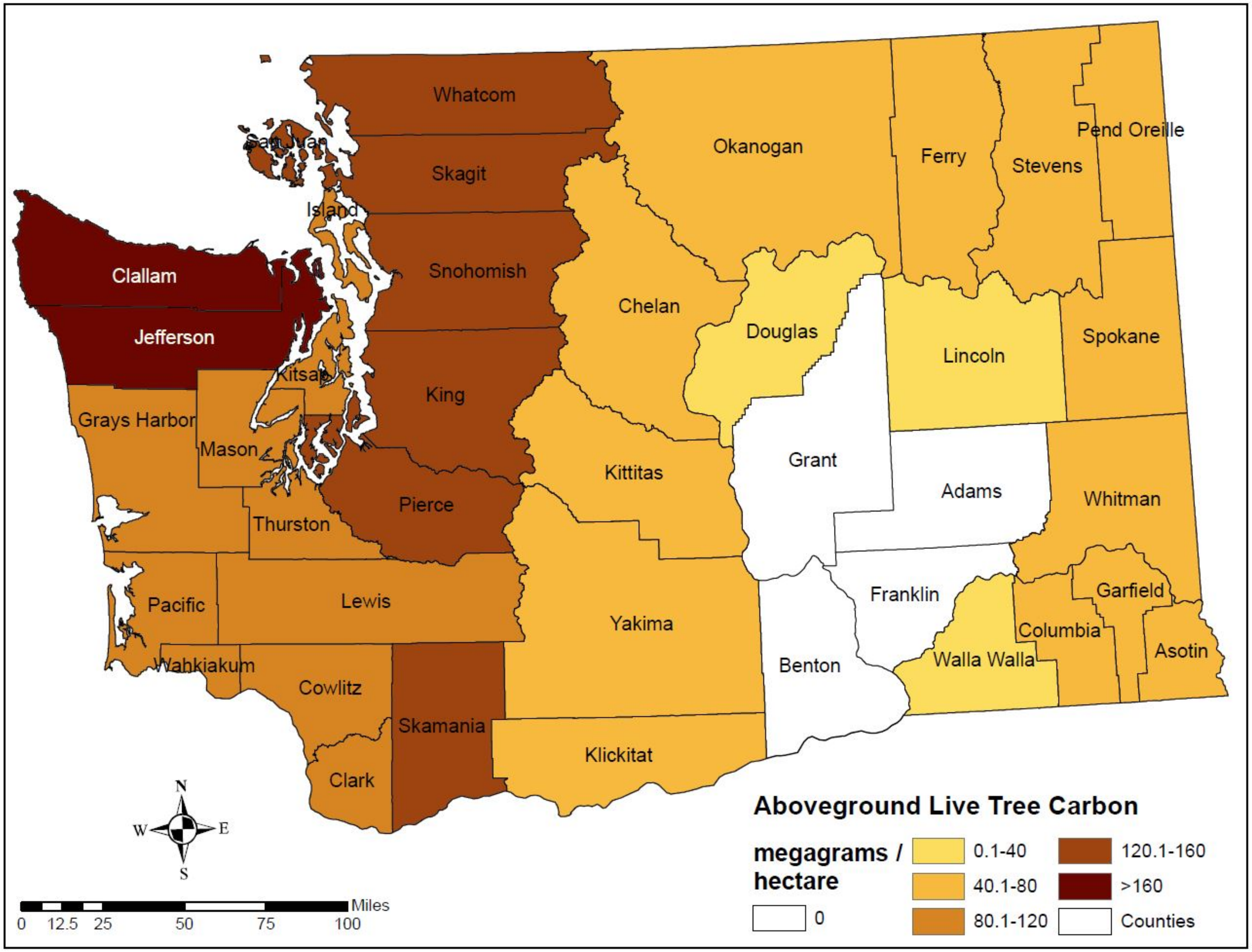


Figure 4.16. Washington average aboveground live tree carbon (megagrams per hectare) by county, 2007-2016. Map depicts only the live tree carbon pool (extracted from Palmer et al. 2019, Figure 17)

Table 4.21. Western Washington: Forest land carbon stock by ownership and land status, 2007-2016. Appendix Table C5.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	244.32	5.31	115.78	5.22	85.07	4.69	27.60	3.53	118.20	4.93	67.29	4.42	185.49	5.73	658.25	10.44
Belowground	49.84	1.09	23.15	1.07	17.87	1.00	5.55	0.72	24.56	1.05	13.49	0.92	38.06	1.21	134.46	2.17
Dead trees																
Aboveground	19.66	0.77	10.42	0.66	4.96	0.51	1.26	0.26	4.32	0.32	2.37	0.27	6.68	0.40	42.98	1.22
Belowground	6.19	0.23	2.90	0.19	1.46	0.15	0.36	0.07	1.24	0.10	0.70	0.08	1.94	0.12	12.86	0.36
Understory vegetation																
Aboveground	3.63	0.05	1.27	0.05	1.63	0.06	0.55	0.06	4.75	0.14	1.95	0.10	6.70	0.15	13.79	0.17
Belowground	0.40	0.01	0.14	0.01	0.18	0.01	0.06	0.01	0.53	0.02	0.22	0.01	0.74	0.02	1.53	0.02
Down wood	32.92	0.98	14.71	1.11	13.22	0.87	3.50	0.60	27.91	1.28	9.45	0.83	37.35	1.42	101.70	2.24
Forest Floor	25.29	0.39	9.74	0.39	8.77	0.38	3.07	0.35	19.66	0.65	9.33	0.52	28.98	0.69	75.85	0.93
Soil	201.22	2.78	76.34	2.70	86.81	3.31	29.88	3.18	225.35	6.75	102.28	5.31	327.63	6.94	721.89	8.13
Total Carbon	583.48	9.40	254.46	9.45	219.96	9.36	71.84	8.11	426.52	13.22	207.08	11.11	633.59	13.83	1,763.33	20.56

Table 4.22. Western Washington: Forest land carbon stock per acre by ownership and land status, 2007-2016. Appendix Table C6.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	70.479	1.376	91.274	3.512	59.520	2.648	56.031	4.137	31.671	1.017	40.290	1.826	34.336	0.897	54.585	0.790
Belowground	14.376	0.285	18.252	0.726	12.504	0.570	11.270	0.860	6.581	0.222	8.079	0.393	7.044	0.194	11.150	0.166
Dead trees																
Aboveground	5.670	0.215	8.218	0.510	3.469	0.338	2.565	0.456	1.157	0.080	1.416	0.147	1.237	0.072	3.564	0.100
Belowground	1.786	0.065	2.288	0.144	1.022	0.099	0.739	0.121	0.333	0.024	0.420	0.041	0.360	0.021	1.066	0.029
Understory vegetation																
Aboveground	1.048	0.006	1.002	0.011	1.142	0.013	1.108	0.021	1.273	0.009	1.170	0.013	1.241	0.008	1.143	0.004
Belowground	0.116	0.001	0.111	0.001	0.127	0.001	0.123	0.002	0.141	0.001	0.130	0.001	0.138	0.001	0.127	0.000
Down wood	9.497	0.272	11.599	0.829	9.249	0.517	7.105	0.930	7.477	0.269	5.655	0.391	6.914	0.222	8.434	0.169
Forest Floor	7.296	0.063	7.676	0.171	6.134	0.145	6.240	0.248	5.267	0.083	5.584	0.131	5.365	0.070	6.290	0.047
Soil	58.047	0.181	60.182	0.542	60.739	0.472	60.681	0.692	60.382	0.331	61.237	0.458	60.646	0.270	59.863	0.157
Total Carbon	168.315	1.962	200.601	5.064	153.906	3.781	145.864	5.878	114.282	1.413	123.980	2.414	117.280	1.222	146.223	1.113

Table 4.23. Eastern Washington: Forest land carbon stock by ownership and land status, 2007-2016. Appendix Table C3.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	137.27	3.38	6.13	1.17	17.45	1.94	5.14	1.06	17.46	1.82	59.88	3.11	77.34	3.42	243.33	5.35
Belowground	26.74	0.69	1.23	0.24	3.41	0.38	1.01	0.21	3.34	0.36	11.84	0.63	15.18	0.69	47.56	1.08
Dead trees																
Aboveground	28.49	1.52	0.94	0.32	1.58	0.30	0.51	0.17	0.96	0.14	5.04	0.53	5.99	0.54	37.51	1.68
Belowground	6.99	0.37	0.23	0.08	0.39	0.07	0.12	0.04	0.25	0.04	1.28	0.13	1.53	0.14	9.27	0.41
Understory vegetation																
Aboveground	5.46	0.06	0.22	0.03	0.91	0.07	0.28	0.04	1.27	0.09	3.52	0.13	4.79	0.14	11.66	0.17
Belowground	0.61	0.01	0.02	0.00	0.10	0.01	0.03	0.00	0.14	0.01	0.39	0.01	0.53	0.02	1.30	0.02
Down wood	28.60	0.67	0.97	0.19	3.45	0.36	0.85	0.20	4.03	0.41	10.24	0.62	14.27	0.71	48.15	1.07
Forest Floor	28.69	0.32	1.14	0.18	4.01	0.32	1.19	0.19	4.87	0.37	13.25	0.50	18.12	0.55	53.15	0.73
Soil	248.48	2.68	10.42	1.51	37.47	2.75	11.81	1.77	49.67	3.57	145.09	5.26	194.75	5.53	502.92	6.86
Total Carbon	511.32	6.83	21.30	3.33	68.76	5.51	20.95	3.31	81.99	6.20	250.52	9.72	332.51	10.31	954.85	13.92

Table 4.24. Eastern Washington: Forest land carbon stock per acre by ownership and land status, 2007-2016. Appendix Table C4.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	28.442	0.650	30.422	3.608	22.920	1.821	21.553	3.015	16.985	1.260	19.923	0.721	19.174	0.621	24.185	0.435
Belowground	5.540	0.135	6.088	0.747	4.476	0.357	4.220	0.627	3.253	0.259	3.939	0.148	3.764	0.128	4.727	0.089
Dead trees																
Aboveground	5.904	0.307	4.642	1.387	2.075	0.358	2.145	0.618	0.933	0.122	1.675	0.163	1.486	0.125	3.729	0.163
Belowground	1.448	0.074	1.157	0.333	0.515	0.086	0.511	0.138	0.245	0.032	0.425	0.041	0.379	0.031	0.921	0.040
Understory vegetation																
Aboveground	1.131	0.007	1.092	0.047	1.195	0.021	1.171	0.043	1.237	0.019	1.171	0.011	1.188	0.010	1.159	0.006
Belowground	0.126	0.001	0.121	0.005	0.133	0.002	0.130	0.005	0.137	0.002	0.130	0.001	0.132	0.001	0.129	0.001
Down wood	5.926	0.130	4.793	0.628	4.536	0.326	3.579	0.658	3.919	0.283	3.409	0.165	3.539	0.142	4.786	0.091
Forest Floor	5.944	0.034	5.669	0.330	5.268	0.141	5.005	0.201	4.734	0.110	4.409	0.051	4.492	0.047	5.283	0.030
Soil	51.485	0.123	51.651	0.924	49.224	0.351	49.470	0.560	48.312	0.325	48.275	0.165	48.284	0.148	49.986	0.094
Total Carbon	105.946	0.925	105.635	5.389	90.342	2.505	87.785	4.166	79.756	1.846	83.356	1.085	82.438	0.926	94.905	0.637

4.3.2 Carbon Flux by Geographic Region

In Washington, half of the annual CO_2e sequestration in live tree gross growth is occurring in two ecological regions, the forests of the Western Cascades and the Washington Coast Range (Figures 4.17, Table 4.25). Due to the high rate of annual tree growth, these regions also account for 62% of the net CO_2e sequestered annually from tree growth in Washington's forests, but note the wide 95% confidence intervals (associated with increased statistical uncertainty from estimating the amount of CO_2e removed in harvested trees) around the estimated annual net flux for all regions. The Western Cascades region accounts for 42% of the state's total annual net CO_2e flux in live trees at 6.0 ± 2.8 MMT per year (1.6 ± 0.8 MT CO_2e/ac/yr), considerably more than the live tree net flux of 3.8 ± 4.0 MMT CO_2e sequestered annually (0.9 ± 0.9 MT CO_2e/ac/yr) from the Washington Coast Range (Tables 4.25 and 4.26). However, this does not account for carbon removed through timber harvest where a portion is sequestered as harvested wood products. The combination of a high rate of annual tree growth and relatively less impact by tree mortality on net live tree carbon sequestration means that the Western Cascades and Washington Coast Range are annually sequestering the most carbon in the state.

The Northern Cascades ecological region has a unique delineation being composed of mostly westside forests, and a component of dry eastside forests challenging interpretation of inventory results. This region is experiencing the highest annual rate of mortality where on average there is 11.0 ± 1.9 MMT of CO_2e per year in tree mortality, or 33% of the statewide total annual mortality. This region is also experiencing the highest rate of CO_2e conversion into the standing dead tree carbon pool at 2.9 ± 1.5 MMT CO_2e per year, or 71% of the statewide total. By ownership within the Northern Cascades ecological region, tree mortality on Forest Service managed land is out of proportion to other federally managed lands, reducing overall net live tree flux. This high mortality rate is reflected in CO_2e flux converted to standing dead trees on Forest Service lands within the region where 81% of the CO_2e flux in standing dead trees is on this ownership (Figure 4.18).

After accounting for tree mortality from all causes and carbon removed through timber harvest, the combined Blue Mountains and Columbia Basin ecological region is converting carbon into other pools faster than what is being gained through live tree growth. The current net change in live tree growth for this region is -0.5 ± 0.5 MMT CO_2e (-0.6 ± 0.6 MT CO_2e/ac/yr); note that the 95% confidence interval includes a net loss of zero.

Annual CO_2e flux by pool and ownership from each ecological region shows increased statistical uncertainty as wider confidence intervals for many of the estimates (Figure 4.18). The increased uncertainty illustrates the current useful limit of the FIA collected measurement data and compiled estimates. As the sample size of measured plots decreases through additional estimation classifications covering smaller geographic scales the statistical uncertainty with each estimate quickly increases. Despite the increased uncertainty there is useful information that can be obtained from this detailed look at annual CO_2e flux.

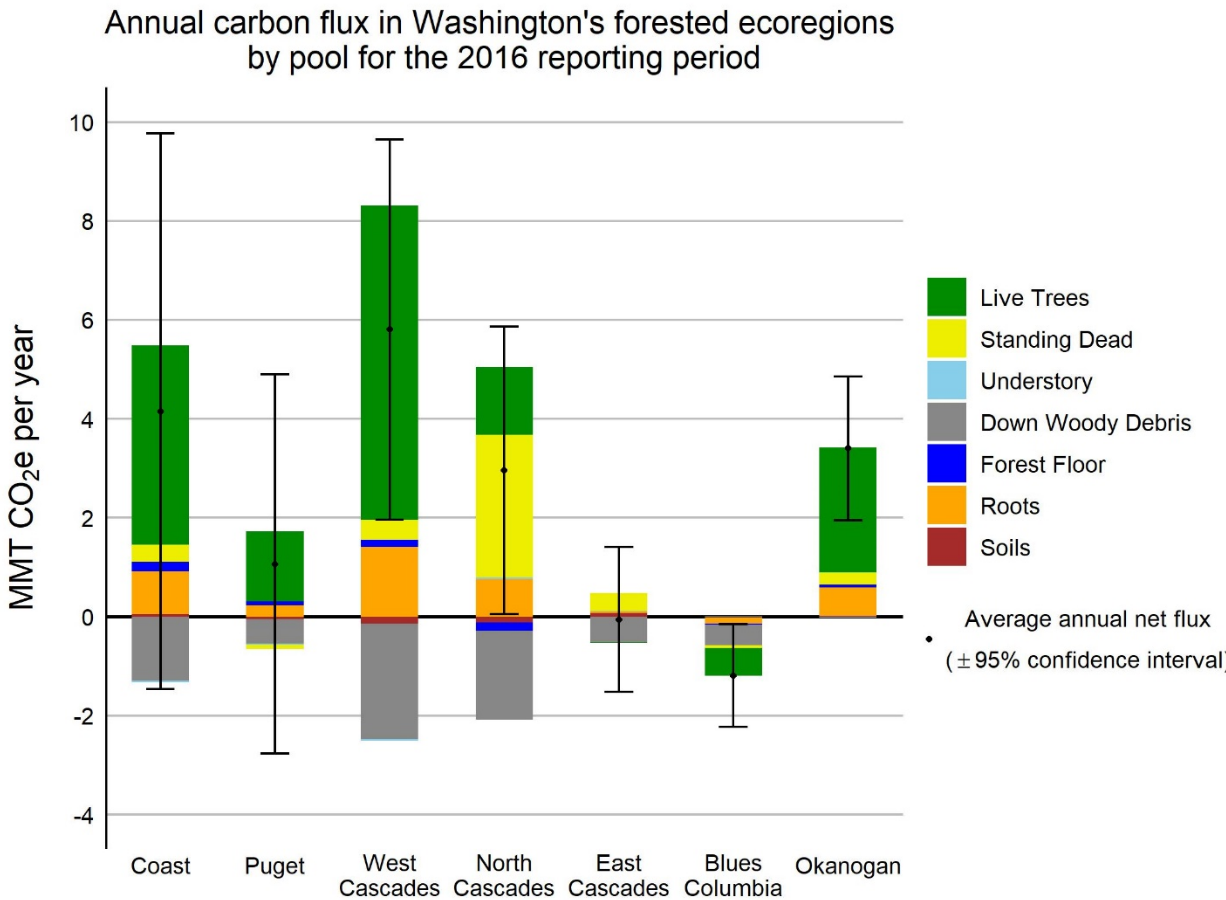


Figure 4.17. Average annual carbon flux in Washington's forested ecological regions by pool (MMT CO_2e/yr), 2002-2006 to 2012-2016. Error bars represent 95% confidence interval of net change. Appendix Table B3.

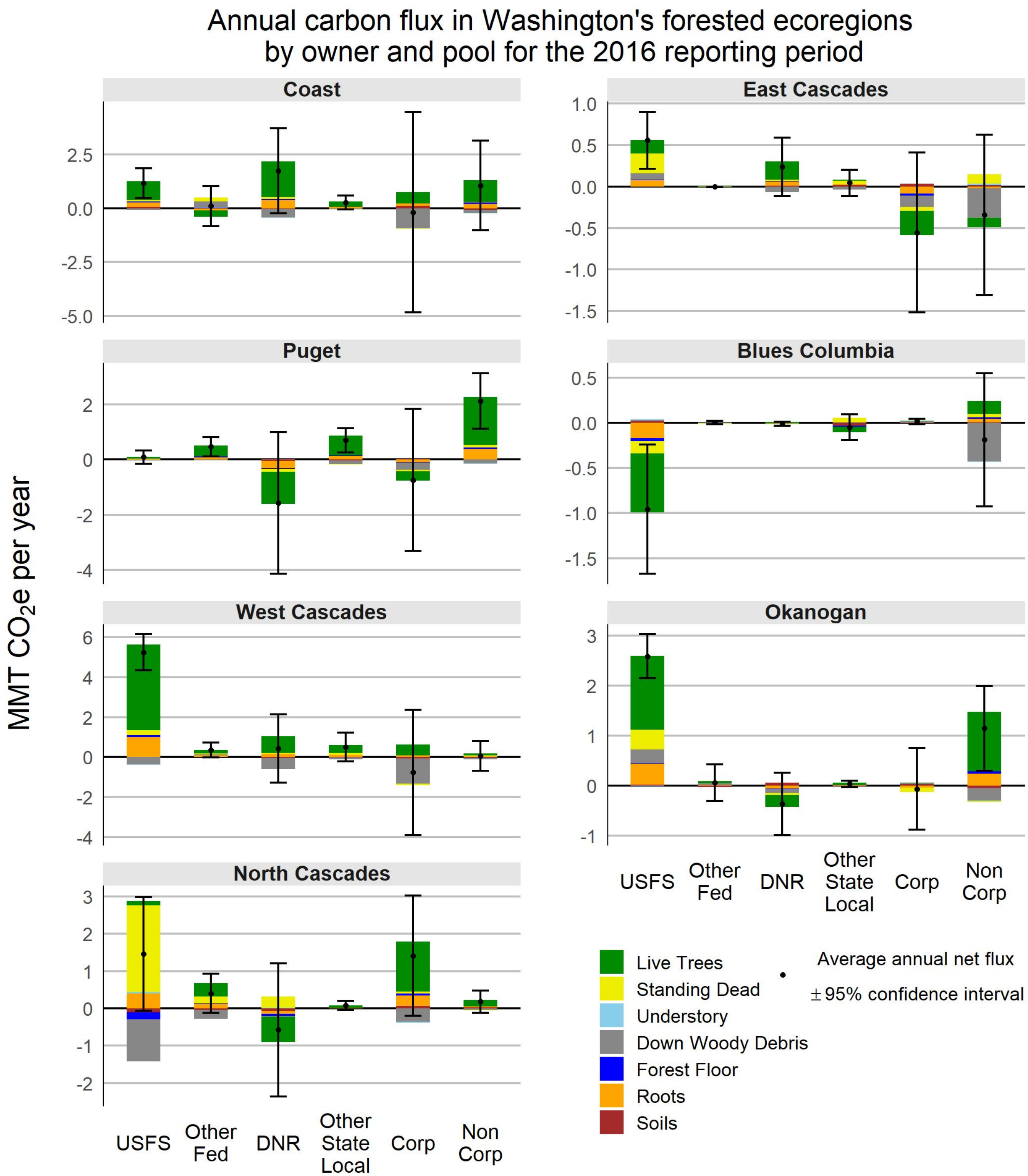


Figure 4.18. Washington average annual net CO_2e flux by ecoregion, pool and ownership (MMT CO_2e/yr), 2002-2006 to 2012-2016. Roots includes belowground live and dead tree roots. Understory includes aboveground understory vegetation. Error bars represent 95% confidence interval of net change. Figure derived from Appendix Tables B29, B31, B33, B35, B37, B39, and B41. Note the different y-axis scales on individual graphs.

Table 4.25. Average annual net CO_2e flux by ecological region and pool, 2002-2006 to 2012-2016. Appendix Table B3.

Change in Carbon Pool	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-1,506	268	-2,336	339	-10,960	929	-3,631	323	-2,300	360	-7,684	674	-4,455	419	-32,872	1,250
Cut	-259	83	-1,871	494	-2,662	858	-2,886	485	-5,855	1,469	-11,281	1,858	-6,400	1,283	-31,214	2,735
Gross Growth	1,240	167	4,207	377	14,952	754	8,905	422	9,498	746	22,750	1,142	16,837	942	78,389	1,247
Net	-525	258	-0	563	1,330	1,274	2,388	585	1,343	1,482	3,786	2,065	5,982	1,439	14,303	3,283
Foliage	-32	15	-7	34	33	78	144	34	73	78	247	126	376	88	833	195
Tree Roots																
Live	-112	55	-39	127	99	297	530	121	286	325	942	472	1,407	331	3,112	746
Dead	-15	41	68	61	652	185	49	48	-49	33	-71	63	7	64	641	227
Standing Dead	-59	179	358	249	2,888	748	246	202	-96	112	341	245	404	230	4,082	910
Dead Woody Debris	-413	386	-520	286	-1,799	620	3	237	-493	237	-1,295	671	-2,330	493	-6,846	1,184
Understory Vegetation																
Above Ground	8	9	15	10	36	18	-19	13	-25	14	-36	20	-37	17	-58	38
Below Ground	1	1	2	1	4	2	-2	1	-3	2	-4	2	-4	2	-6	4
Total	-1,149	524	-124	737	3,244	1,427	3,338	713	1,037	1,904	3,908	2,804	5,806	1,885	16,060	4,274
Forest Floor	-28	22	-6	32	-168	131	51	56	73	68	187	103	141	73	250	206
Soils	-12	51	76	70	-118	150	13	116	-45	93	54	164	-143	107	-175	301
Total (including soils and forest floor)	-1,189	531	-55	747	2,958	1,484	3,402	739	1,065	1,955	4,150	2,866	5,804	1,959	16,135	4,396

Note: the regional column headings (Blues+Columbia Basin through Western Cascades) appear on the page under a spanning heading "Ecological Region".

Table 4.26. Average annual net CO_2e flux per acre by ecological region and pool, 2002-2006 to 2012-2016. Appendix Table B4.

Change in Carbon Pool	Blues+Columbia Basin Total	Blues+Columbia Basin SE	Eastern Cascades Total	Eastern Cascades SE	Northern Cascades Total	Northern Cascades SE	Okanogan Highland Total	Okanogan Highland SE
	metric tons CO2 equivalent per year and acre							
Standing Live tree								
Mortality	-1.77	0.28	-1.28	0.16	-2.00	0.16	-0.91	0.08
Cut	-0.30	0.10	-1.03	0.26	-0.49	0.16	-0.72	0.12
Gross Growth	1.45	0.12	2.31	0.13	2.74	0.10	2.23	0.07
Net	-0.62	0.31	0.00	0.31	0.24	0.23	0.60	0.15
Foliage	-0.04	0.02	0.00	0.02	0.01	0.01	0.04	0.01
Tree Roots								
Live	-0.13	0.07	-0.02	0.07	0.02	0.05	0.13	0.03
Dead	-0.02	0.05	0.04	0.03	0.12	0.03	0.01	0.01
Standing Dead	-0.07	0.21	0.20	0.14	0.53	0.13	0.06	0.05
Dead Woody Debris	-0.48	0.45	-0.29	0.16	-0.33	0.11	0.00	0.06
Understory Vegetation								
Above Ground	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	-1.35	0.60	-0.07	0.40	0.59	0.26	0.83	0.18
Forest Floor	-0.03	0.03	0.00	0.02	-0.03	0.02	0.01	0.01
Soils	-0.01	0.06	0.04	0.04	-0.02	0.03	0.00	0.03
Total (including soils and forest floor)	-1.39	0.61	-0.03	0.41	0.54	0.27	0.85	0.19

Change in Carbon Pool	Puget Trough Total	Puget Trough SE	Washington Coast Range Total	Washington Coast Range SE	Western Cascades Total	Western Cascades SE	Total Total	Total SE
	metric tons CO2 equivalent per year and acre							
Standing Live tree								
Mortality	-1.19	0.17	-1.81	0.15	-1.20	0.10	-1.49	0.06
Cut	-3.02	0.72	-2.66	0.42	-1.73	0.33	-1.42	0.12
Gross Growth	4.90	0.20	5.36	0.17	4.54	0.15	3.56	0.05
Net	0.69	0.76	0.89	0.48	1.61	0.39	0.65	0.15
Foliage	0.04	0.04	0.06	0.03	0.10	0.02	0.04	0.01
Tree Roots								
Live	0.15	0.17	0.22	0.11	0.38	0.09	0.14	0.03
Dead	-0.03	0.02	-0.02	0.01	0.00	0.02	0.03	0.01
Standing Dead	-0.05	0.06	0.08	0.06	0.11	0.06	0.19	0.04
Dead Woody Debris	-0.25	0.12	-0.30	0.16	-0.63	0.13	-0.31	0.05
Understory Vegetation								
Above Ground	-0.01	0.01	-0.01	0.00	-0.01	0.00	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.54	0.98	0.92	0.66	1.57	0.51	0.73	0.19
Forest Floor	0.04	0.04	0.04	0.02	0.04	0.02	0.01	0.01
Soils	-0.02	0.05	0.01	0.04	-0.04	0.03	-0.01	0.01
Total (including soils and forest floor)	0.55	1.01	0.98	0.67	1.57	0.53	0.73	0.20

By regional county groups, differences found in current estimates of CO_2e flux by western and eastern Washington counties parallel patterns found between western and eastern ecological regions. The majority of CO_2e sequestration is occurring in the western counties due to the high rate of annual tree growth in these forests. Together, counties west of the Cascade divide account for 93% of Washington's annual forest carbon flux from all pools (15.0 ± 8.2 MMT per year (1.3 ± 0.7 MT CO_2e/ac/yr) (Tables 4.27 and 4.28). Net CO_2e flux in the western counties live tree pool is sequestering 15.4 ± 6.0 MMT per year (1.3 ± 0.5 MT CO_2e/ac/yr).

Annual carbon flux for forests found in the eastern counties indicate CO_2e is being sequestered but at a slower rate, and in different pools than found in the western counties. Counties east of the Cascade divide have an annual forest carbon flux from all pools of 1.1 ± 2.6 MMT per year (0.1 ± 0.3 MT CO_2e/ac/yr) (Tables 4.29 and 4.30). While live tree gross growth shows CO_2e being sequestered at an annual rate of 19.7 ± 1.1 MT CO_2e/ac/yr MM in the eastern counties, the combined rate of tree mortality with harvest results in an annual net loss of carbon from the live tree pool. Carbon is being transferred out of the live tree pool in the eastern county forests at a rate of 1.1 ± 2.4 MMT per year (0.1 ± 0.2 MT CO_2e/ac/yr). It is likely the increased tree mortality can account for the corresponding increase in carbon being transferred into the standing dead tree pool. In eastern Washington forests, the standing dead tree carbon pool is accumulating carbon at an annual rate that exceeds all other pools at 3.3 ± 1.6 MMT per year (0.3 ± 0.2 MT CO_2e/ac/yr). By ownership, the majority of carbon going into the standing dead tree pool is coming from forests managed by the USDA Forest Service, accounting for 83% of the annual change in standing dead tree carbon in eastern Washington counties (Figure 4.19). This contrasts with privately owned forests in eastern counties that contribute 2% of carbon in the standing dead tree pool.

Table 4.27. Western Washington: Annual net change in carbon stocks on forest land for all pools by owner group, 2002-2006 to 2012-2016. Appendix Table B7.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-6,047	376	-3,693	490	-2,308	326	-809	196	-3,293	392	-1,466	212	-4,759	429	-17,616	831
Cut	-652	193	-10	10	-5,288	1,451	-395	224	-17,338	2,106	-1,977	803	-19,315	2,237	-25,660	2,671
Gross Growth	14,383	368	4,418	376	8,451	568	2,567	440	22,381	1,114	6,471	652	28,851	1,139	58,669	1,322
Net	7,684	525	714	466	855	1,565	1,364	357	1,749	2,336	3,028	879	4,777	2,499	15,394	3,051
Foliage	443	34	39	28	81	88	73	19	126	141	156	50	283	150	920	180
Tree Roots																
Live	1,598	131	159	109	244	353	314	79	455	534	670	195	1,125	569	3,439	695
Dead	74	66	-9	49	-55	45	-5	17	-125	40	-9	28	-134	49	-129	107
Standing Dead	347	251	321	216	-7	155	67	65	-90	126	98	90	8	155	736	403
Dead Woody Debris	-1,070	470	-1	388	-946	420	-288	133	-2,815	641	-358	224	-3,173	677	-5,478	1,009
Understory Vegetation																
Above Ground	-39	5	1	4	-2	11	-9	5	-37	25	-41	10	-78	26	-128	30
Below Ground	-4	1	0	0	-0	1	-1	1	-4	3	-5	1	-9	3	-14	3
Total	9,033	773	1,223	587	170	2,022	1,515	447	-741	3,167	3,540	1,145	2,799	3,376	14,740	4,076
Forest Floor	141	104	85	39	3	57	30	18	33	109	151	69	184	129	442	180
Soils	104	58	16	23	-145	71	-59	39	48	151	-117	132	-69	201	-153	226
Total (including soils and forest floor)	9,278	813	1,324	597	27	2,085	1,486	460	-660	3,239	3,573	1,192	2,913	3,459	15,029	4,186

Table 4.28. Western Washington: Annual net change in carbon stocks per acre on forest land for all pools by owner group, 2002-2006 to 2012-2016. Appendix Table B8.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.785	0.107	-2.949	0.373	-1.624	0.217	-1.599	0.302	-0.815	0.094	-1.148	0.139	-0.895	0.079	-1.482	0.068
Cut	-0.192	0.057	-0.008	0.008	-3.721	1.013	-0.781	0.424	-4.293	0.509	-1.549	0.619	-3.634	0.417	-2.159	0.224
Gross Growth	4.245	0.108	3.528	0.216	5.946	0.258	5.077	0.439	5.541	0.183	5.070	0.288	5.428	0.154	4.937	0.087
Net	2.268	0.158	0.570	0.366	0.601	1.099	2.697	0.594	0.433	0.577	2.372	0.654	0.899	0.467	1.296	0.255
Foliage	0.131	0.010	0.031	0.022	0.057	0.062	0.145	0.032	0.031	0.035	0.122	0.038	0.053	0.028	0.077	0.015
Tree Roots																
Live	0.472	0.039	0.127	0.086	0.172	0.248	0.620	0.129	0.113	0.132	0.525	0.145	0.212	0.106	0.289	0.058
Dead	0.022	0.019	-0.007	0.039	-0.039	0.032	-0.009	0.033	-0.031	0.010	-0.007	0.022	-0.025	0.009	-0.011	0.009
Standing Dead	0.102	0.074	0.256	0.172	-0.005	0.109	0.133	0.126	-0.022	0.031	0.077	0.070	0.002	0.029	0.062	0.034
Dead Woody Debris	-0.316	0.139	-0.001	0.310	-0.665	0.294	-0.570	0.249	-0.697	0.156	-0.281	0.174	-0.597	0.126	-0.461	0.085
Understory Vegetation																
Above Ground	-0.011	0.001	0.000	0.003	-0.001	0.008	-0.018	0.009	-0.009	0.006	-0.032	0.007	-0.015	0.005	-0.011	0.002
Below Ground	-0.001	0.000	0.000	0.000	-0.000	0.001	-0.002	0.001	-0.001	0.001	-0.004	0.001	-0.002	0.001	-0.001	0.000
Total	2.666	0.228	0.977	0.457	0.119	1.422	2.996	0.780	-0.183	0.785	2.773	0.860	0.527	0.634	1.240	0.342
Forest Floor	0.042	0.031	0.068	0.031	0.002	0.040	0.060	0.035	0.008	0.027	0.118	0.053	0.035	0.024	0.037	0.015
Soils	0.031	0.017	0.012	0.018	-0.102	0.049	-0.116	0.075	0.012	0.037	-0.092	0.103	-0.013	0.038	-0.013	0.019
Total (including soils and forest floor)	2.739	0.239	1.057	0.464	0.019	1.467	2.940	0.813	-0.163	0.802	2.799	0.897	0.548	0.650	1.265	0.351

Table 4.29. Eastern Washington: Annual net change in carbon stocks on forest land for all pools by owner group, 2002-2006 to 2012-2016. Appendix Table B5.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**			
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-10,656	857	-487	151	-901	247	-261	131	-324	72	-2,628	344	-2,952	348	-15,257	976
Cut	-574	108	-116	112	-768	296	-57	57	-2,000	503	-2,039	414	-4,040	641	-5,555	725
Gross Growth	9,531	240	540	130	1,381	213	333	92	2,253	296	5,682	400	7,935	460	19,720	577
Net	-1,699	885	-63	146	-288	368	15	121	-71	488	1,015	535	944	722	-1,091	1,213
Foliage	-106	55	-4	8	-19	22	1	7	-11	29	53	32	42	43	-86	74
Tree Roots																
Live	-408	202	-14	28	-58	78	7	23	-47	105	194	118	147	158	-327	270
Dead	657	183	17	17	69	43	18	18	-29	12	38	63	8	64	770	200
Standing Dead	2,781	745	76	66	319	182	91	87	-113	44	192	257	79	261	3,346	818
Dead Woody Debris	-138	361	104	63	-175	131	-20	57	-82	134	-1,059	461	-1,140	479	-1,368	620
Understory Vegetation																
Above Ground	59	17	-0	3	4	5	-1	3	1	9	8	14	8	17	70	25
Below Ground	7	2	-0	0	0	1	-0	0	0	1	1	2	1	2	8	3
Total	1,153	637	115	191	-147	402	111	108	-353	650	441	789	88	1,023	1,321	1,287
Forest Floor	-192	72	-1	14	-43	34	-5	13	-13	38	62	44	49	58	-192	100
Soils	-82	108	-63	41	42	63	-31	35	141	86	-29	117	112	146	-22	199
Total (including soils and forest floor)	878	677	51	204	-148	406	76	124	-225	662	474	825	249	1,059	1,106	1,341

Table 4.30. Eastern Washington: Annual net change in carbon stocks per acre on forest land for all pools by owner group, 2002-2006 to 2012-2016. Appendix Table B6.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**			
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.181	0.172	-1.867	0.439	-1.125	0.278	-1.406	0.591	-0.341	0.066	-0.856	0.102	-0.734	0.080	-1.503	0.094
Cut	-0.118	0.022	-0.443	0.443	-0.960	0.352	-0.305	0.297	-2.105	0.478	-0.665	0.131	-1.005	0.154	-0.547	0.070
Gross Growth	1.951	0.047	2.067	0.358	1.726	0.191	1.794	0.227	2.371	0.176	1.852	0.091	1.974	0.082	1.943	0.043
Net	-0.348	0.181	-0.243	0.553	-0.359	0.456	0.082	0.655	-0.075	0.513	0.331	0.174	0.235	0.179	-0.108	0.119
Foliage	-0.022	0.011	-0.016	0.029	-0.023	0.027	0.006	0.035	-0.012	0.030	0.017	0.010	0.010	0.011	-0.009	0.007
Tree Roots																
Live	-0.084	0.041	-0.055	0.105	-0.073	0.097	0.037	0.125	-0.049	0.111	0.063	0.038	0.037	0.039	-0.032	0.027
Dead	0.135	0.037	0.066	0.061	0.086	0.053	0.097	0.091	-0.031	0.012	0.012	0.020	0.002	0.016	0.076	0.020
Standing Dead	0.569	0.152	0.290	0.239	0.399	0.221	0.489	0.444	-0.119	0.045	0.063	0.084	0.020	0.065	0.330	0.080
Dead Woody Debris	-0.028	0.074	0.399	0.231	-0.218	0.162	-0.106	0.305	-0.086	0.141	-0.345	0.149	-0.284	0.118	-0.135	0.061
Understory Vegetation																
Above Ground	0.012	0.003	-0.000	0.012	0.005	0.006	-0.005	0.015	0.001	0.010	0.003	0.005	0.002	0.004	0.007	0.002
Below Ground	0.001	0.000	-0.000	0.001	0.001	0.001	-0.001	0.002	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.000
Total	0.236	0.131	0.442	0.731	-0.183	0.502	0.600	0.575	-0.372	0.683	0.144	0.257	0.022	0.255	0.130	0.127
Forest Floor	-0.039	0.015	-0.004	0.055	-0.054	0.041	-0.024	0.070	-0.014	0.040	0.020	0.014	0.012	0.014	-0.019	0.010
Soils	-0.017	0.022	-0.242	0.155	0.052	0.079	-0.166	0.189	0.149	0.090	-0.009	0.038	0.028	0.036	-0.002	0.020
Total (including soils and forest floor)	0.180	0.139	0.195	0.782	-0.185	0.506	0.410	0.663	-0.237	0.697	0.155	0.269	0.062	0.263	0.109	0.132

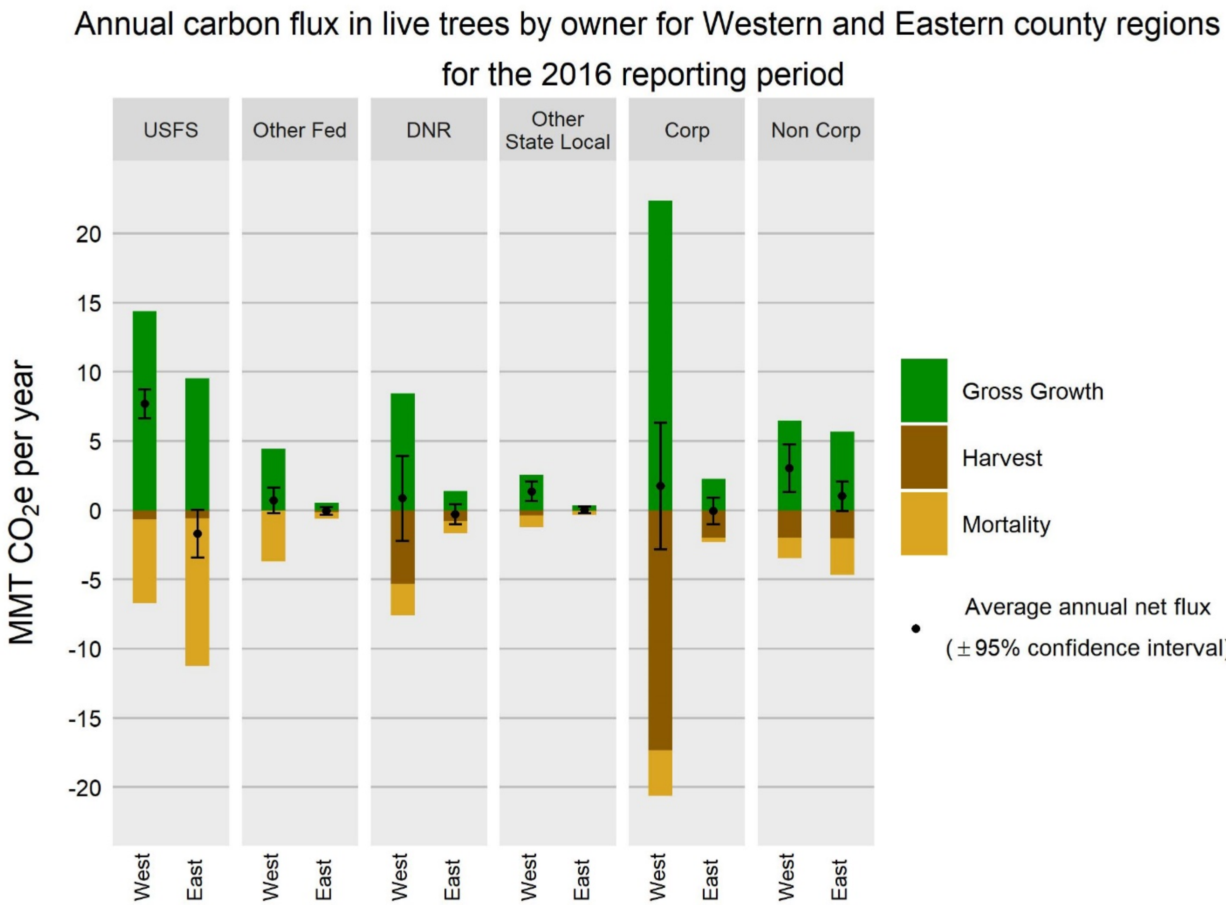


Figure 4.19. Average annual net CO_2e flux in live trees from growth, harvest and mortality by ownership for Western and Eastern Washington county regions (MMT CO_2e/yr), 2002-2006 to 2012-2016. Error bars represent 95% confidence interval of estimated net flux. Appendix Tables B5 and B7.

4.3.3 Source of Flux by Geographic Region

In Washington, gross growth in live trees is the primary driver of live tree CO_2e flux in most regions. Notable exceptions include the east-side ecological regions of the combined Blue Mountains and Columbia Basin, and the East Cascades where less annual gross growth and increased tree mortality is driving each of these regions to a point where they are possibly losing more CO_2e through transfers to other carbon pools than what is being gained in live tree growth (Figure 4.20, Table 4.31). The Washington Coast Range ecological region has the greatest rate of gross annual growth at 22.8 ± 2.2 MMT CO_2e/yr (5.4 ± 0.3 MT CO_2e/yr/ac) however due to this region's highly productive tree growth it also has the highest rate of harvest in the state at 11.3 ± 3.6 MMT CO_2e/yr (2.7 ± 0.8 MT CO_2e/yr/ac) (Tables 4.32 and 4.33).

Specific drivers of CO_2e flux by ecological region, other than gross growth on live trees, includes mortality caused by harvesting, wildfire, insects and diseases, or other natural sources such as weather-related disturbances. The Northern Cascades ecological region has the distinction of experiencing both the greatest rate of mortality due to wildfire and the greatest rate of growth loss due to insect and disease mortality. In this region, wildfire related mortality accounts for a transfer of 2.9 ± 1.1 MMT CO_2e/yr (6.6 ± 1.5 MT CO_2e/yr/ac), which is about 27% of all tree mortality in the region. Insect and disease related mortality accounts for a transfer of 3.5 ± 1.4 MMT CO_2e/yr (2.7 ± 0.9 MT CO_2e/yr/ac), which is 32% of all tree mortality in region. The other large driver of tree mortality in this region is naturally occurring on undisturbed areas (plots with less than 25% of the area disturbed) and accounts for another 35% of total mortality that results in a transfer of CO_2e into other pools such as standing dead trees or downed woody material (Tables 4.32 and 4.33).

Similarly, in the counties of western Washington gross growth is the primary driver of live tree CO_2e flux. Of the 17.6 ± 1.6 MMT CO_2e/yr of live tree mortality in the region, 66% is accounted for in undisturbed stands (primarily of natural causes or successional mortality), 13% attributed to insect and disease causes, with weather and other causes making up the remainder. But for counties east of the Cascade divide the primary driver of CO_2e flux is effects of reduced annual gross growth combined with increased tree mortality. Live tree mortality in eastern counties is nearly as much as the western counties at 15.3 ± 1.9 MMT CO_2e/yr, but this region accounts for only 25% of the statewide gross annual growth. Primary drivers of live tree mortality in eastern counties are insect and disease related (46%) and fire related causes (32%) (See appendix tables B13, B14, B15, and B16).

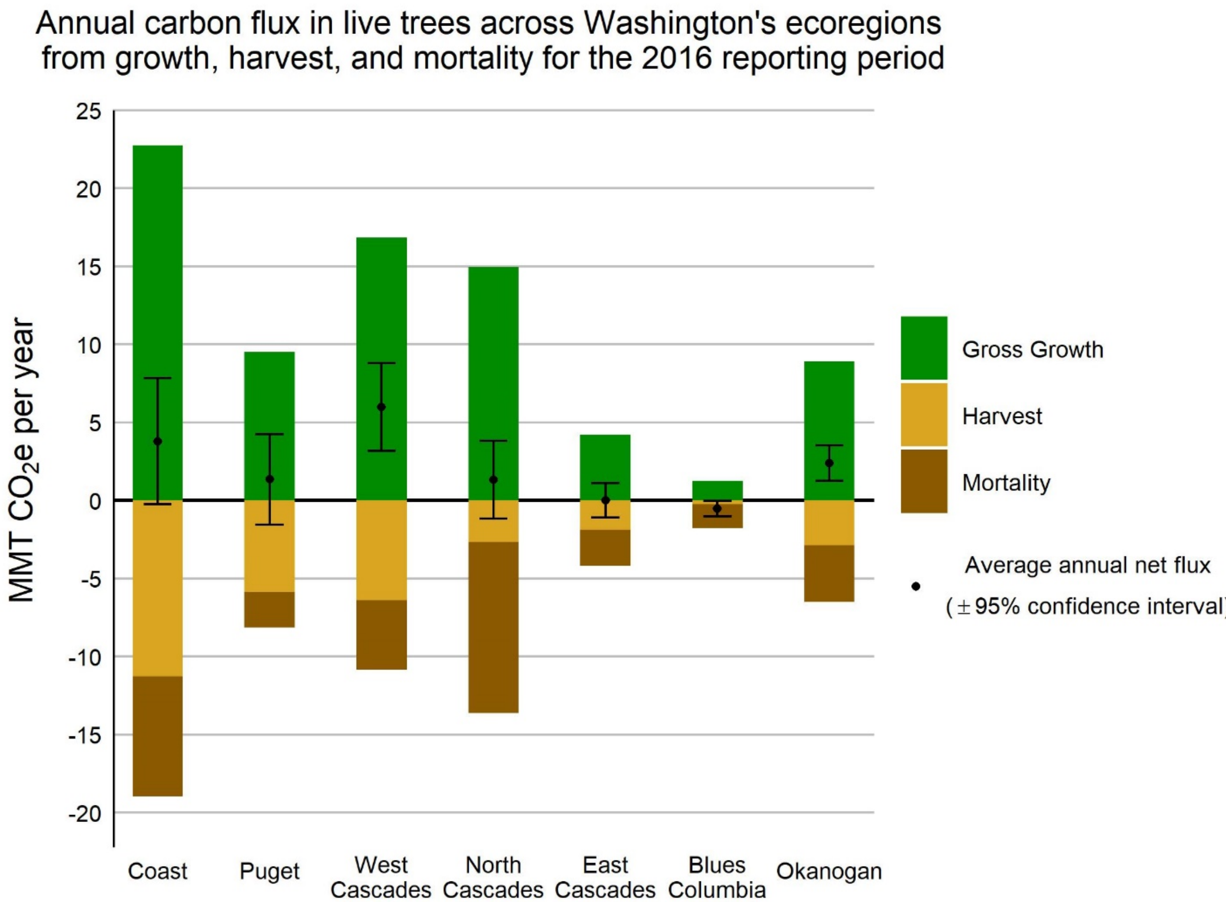


Figure 4.20. Average annual net CO_2e flux in live trees from growth, harvest and mortality by ecological region (MMT CO_2e/yr), 2002-2006 to 2012-2016. Error bars represent 95% confidence interval of estimated net flux. Appendix Table B3.

Table 4.31. Average annual net CO_2e flux in live trees from growth, harvest, mortality by ecological region, 2002-2006 to 2012-2016. Table derived from Appendix Table B3.

	Ecological Region														Total	
	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand Metric Tons CO2 equivalent per year															
Gross Growth	1,240	167	4,207	377	14,952	754	8,905	422	9,498	746	22,750	1,142	16,837	942	78,389	1,247
Harvest	-259	83	-1,871	494	-2,662	858	-2,886	485	-5,855	1,469	-11,281	1,858	-6,400	1,283	-31,214	2,735
Mortality	-1,506	268	-2,336	339	-10,960	929	-3,631	323	-2,300	360	-7,684	674	-4,455	419	-32,872	1,250
Net Flux	**-525**	**258**	**-0**	**563**	**1,330**	**1,274**	**2,388**	**585**	**1,343**	**1,482**	**3,786**	**2,065**	**5,982**	**1,439**	**14,303**	**3,283**

Table 4.32. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and ecoregion, 2002-2006 to 2012-2016.

	Ecological Region															
Change in Carbon Pool by disturbance	**Blues+Columbia Basin**		**Eastern Cascades**		**Northern Cascades**		**Okanogan Highland**		**Puget Trough**		**Washington Coast Range**		**Western Cascades**		**Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-36	19	-237	135	-100	55	-209	54	-146	66	-427	185	-85	37	-1,239	252
Cut	-137	63	-1,840	493	-2,427	847	-2,577	476	-5,759	1,468	-10,785	1,836	-6,293	1,278	-29,817	2,722
Gross Growth	130	56	640	132	701	184	1,063	181	1,682	311	3,403	479	1,502	285	9,121	666
Net Live	-44	33	-1,437	442	-1,826	755	-1,722	409	-4,223	1,335	-7,809	1,672	-4,875	1,179	-21,936	2,505
Standing Dead Change	5	4	-60	83	-117	80	-197	60	-187	70	-239	62	-171	52	-966	167
Dead Woody Debris Change	-3	17	-46	132	-34	68	241	142	11	151	-556	338	-221	180	-609	459
Total Net	-51	49	-1,958	626	-2,534	1,048	-2,188	553	-5,594	1,731	-10,835	2,324	-6,667	1,582	-29,826	3,400
Cut and Fire																
Mortality	-58	29	--	--	-3	3	-4	3	--	--	--	--	--	--	-64	29
Cut	-83	53	--	--	-30	32	-73	52	--	--	--	--	--	--	-187	80
Gross Growth	13	6	--	--	8	9	16	12	--	--	--	--	--	--	37	16
Net Live	-128	69	--	--	-24	25	-60	43	--	--	--	--	--	--	-213	85
Standing Dead Change	-45	40	--	--	2	2	-19	21	--	--	--	--	--	--	-62	45
Dead Woody Debris Change	-1	7	--	--	-1	1	-10	7	--	--	--	--	--	--	-13	10
Total Net	-219	133	--	--	-29	30	-106	63	--	--	--	--	--	--	-354	150
Fire																
Mortality	-798	247	-350	129	-2,911	560	-717	228	--	--	--	--	-144	113	-4,920	669
Cut	-13	10	-9	7	--	--	-20	16	--	--	--	--	--	--	-43	20
Gross Growth	140	36	153	75	448	75	191	52	--	--	--	--	11	8	943	123
Net Live	-671	221	-207	123	-2,463	515	-546	198	--	--	--	--	-133	105	-4,021	610
Standing Dead Change	136	110	175	81	1,573	381	296	138	--	--	--	--	70	60	2,249	433
Dead Woody Debris Change	-5	53	-122	94	-383	92	-51	42	--	--	--	--	11	9	-549	148
Total Net	-682	296	-169	94	-1,500	312	-358	150	--	--	--	--	-72	56	-2,781	460

Table 4.32. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and ecoregion, 2002-2006 to 2012-2016. Appendix Table B19 (continued).

	Ecological Region															
Change in Carbon Pool by disturbance	**Blues+Columbia Basin**		**Eastern Cascades**		**Northern Cascades**		**Okanogan Highland**		**Puget Trough**		**Washington Coast Range**		**Western Cascades**		**Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Insect and Disease																
Mortality	-235	73	-1,350	273	-3,477	706	-1,811	201	-264	122	-763	259	-1,444	312	-9,345	861
Cut	-19	12	-15	11	-47	30	-38	15	--	--	-44	50	--	--	-162	63
Gross Growth	322	104	1,559	253	2,572	258	3,315	264	763	257	1,642	386	2,418	409	12,591	735
Net Live	68	52	193	246	-952	622	1,466	226	499	213	836	326	974	366	3,084	881
Standing Dead Change	-37	45	439	179	1,732	577	260	102	18	32	97	94	446	159	2,953	637
Dead Woody Debris Change	-79	68	-5	148	-311	232	129	123	-14	54	-84	257	-255	150	-618	432
Total Net	-52	90	773	258	553	337	2,337	256	640	271	1,127	384	1,581	448	6,959	814
Other cut and weather																
Mortality	--	--	-18	11	-672	192	-40	19	-563	269	-1,731	345	-261	117	-3,285	490
Cut	--	--	-1	1	-23	15	-60	31	-39	46	-80	62	--	--	-203	85
Gross Growth	10	12	94	70	751	162	184	83	645	200	1,815	332	681	233	4,179	486
Net Live	10	12	75	60	56	166	84	55	42	252	4	342	421	180	690	497
Standing Dead Change	--	--	3	2	-11	60	-71	45	10	47	-53	84	20	31	-102	126
Dead Woody Debris Change	1	1	-12	13	128	98	1	13	-37	95	304	181	-91	69	294	237
Total Net	12	15	88	66	201	193	27	50	30	323	255	444	478	253	1,091	640
Less than 25% disturbed																
Mortality	-379	115	-380	79	-3,798	338	-850	134	-1,327	206	-4,763	530	-2,522	231	-14,020	678
Cut	-7	7	-7	7	-134	141	-119	74	-57	24	-372	134	-107	52	-802	215
Gross Growth	627	119	1,762	233	10,472	699	4,136	320	6,408	627	15,890	1,035	12,225	795	51,519	1,372
Net Live	241	108	1,375	206	6,540	634	3,167	280	5,025	530	10,755	955	9,595	721	36,697	1,322
Standing Dead Change	-118	131	-198	131	-290	287	-23	76	64	65	535	203	40	136	10	429
Dead Woody Debris Change	-326	375	-335	178	-1,198	554	-306	133	-453	145	-959	489	-1,775	432	-5,351	966
Total Net	-157	400	1,143	257	6,552	885	3,626	329	5,961	647	13,361	1,248	10,486	925	40,972	1,823
Total																
Mortality	-1,506	268	-2,336	339	-10,960	929	-3,631	323	-2,300	360	-7,684	674	-4,455	419	-32,872	1,250
Cut	-259	83	-1,871	494	-2,662	858	-2,886	485	-5,855	1,469	-11,281	1,858	-6,400	1,283	-31,214	2,735
Gross Growth	1,240	167	4,207	377	14,952	754	8,905	422	9,498	746	22,750	1,142	16,837	942	78,389	1,247
Net Live	-525	258	-0	563	1,330	1,274	2,388	585	1,343	1,482	3,786	2,065	5,982	1,439	14,303	3,283
Standing Dead Change	-59	179	358	249	2,888	748	246	202	-96	112	341	245	404	230	4,082	910
Dead Woody Debris Change	-413	386	-520	286	-1,799	620	3	237	-493	237	-1,295	671	-2,330	493	-6,846	1,184
Total Net	-1,149	524	-124	737	3,244	1,427	3,338	713	1,037	1,904	3,908	2,804	5,806	1,885	16,060	4,274

Table 4.33. Average annual net carbon (CO_2e) change per acre by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and ecoregion, 2002-2006 to 2012-2016.

Change in Carbon Pool by disturbance	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Cut																
Mortality	-0.44	0.16	-0.68	0.36	-0.43	0.22	-0.37	0.08	-0.38	0.16	-0.60	0.25	-0.22	0.09	-0.46	0.09
Cut	-1.69	0.46	-5.28	1.01	-10.59	2.97	-4.55	0.57	-15.08	2.84	-15.18	1.91	-16.43	2.14	-11.04	0.82
Gross Growth	1.59	0.27	1.84	0.17	3.06	0.45	1.88	0.20	4.40	0.37	4.79	0.35	3.92	0.44	3.38	0.16
Net Live	-0.54	0.38	-4.12	1.00	-7.97	2.85	-3.04	0.59	-11.06	2.91	-10.99	2.00	-12.73	2.34	-8.12	0.82
Standing Dead Change	0.07	0.04	-0.17	0.24	-0.51	0.33	-0.35	0.09	-0.49	0.16	-0.34	0.08	-0.45	0.12	-0.36	0.06
Dead Woody Debris Change	-0.04	0.21	-0.13	0.38	-0.15	0.30	0.43	0.24	0.03	0.39	-0.78	0.47	-0.58	0.46	-0.23	0.17
Total Net	-0.62	0.59	-5.62	1.46	-11.05	3.98	-3.86	0.82	-14.65	3.73	-15.25	2.77	-17.41	3.08	-11.04	1.11
Cut and Fire																
Mortality	-4.04	0.52	--	--	-0.75	0.75	-0.12	0.05	--	--	--	--	--	--	-1.28	0.63
Cut	-5.86	2.40	--	--	-9.06	9.06	-2.27	1.02	--	--	--	--	--	--	-3.75	1.27
Gross Growth	0.89	0.02	--	--	2.52	2.52	0.50	0.23	--	--	--	--	--	--	0.75	0.22
Net Live	-9.01	2.12	--	--	-7.29	7.29	-1.88	0.85	--	--	--	--	--	--	-4.29	1.50
Standing Dead Change	-3.19	2.40	--	--	0.59	0.59	-0.58	0.51	--	--	--	--	--	--	-1.25	0.86
Dead Woody Debris Change	-0.10	0.48	--	--	-0.28	0.28	-0.32	0.15	--	--	--	--	--	--	-0.26	0.17
Total Net	-15.39	5.82	--	--	-8.70	8.70	-3.29	0.56	--	--	--	--	--	--	-7.12	2.62
Fire																
Mortality	-5.80	1.14	-4.07	1.37	-6.59	0.78	-3.92	0.96	--	--	--	--	-20.80	3.58	-5.75	0.54
Cut	-0.10	0.07	-0.11	0.09	--	--	-0.11	0.09	--	--	--	--	--	--	-0.05	0.02
Gross Growth	1.02	0.15	1.78	0.61	1.01	0.09	1.04	0.18	--	--	--	--	1.54	0.03	1.10	0.09
Net Live	-4.88	1.09	-2.40	1.52	-5.57	0.80	-2.98	0.91	--	--	--	--	-19.25	3.61	-4.70	0.55
Standing Dead Change	0.99	0.80	2.03	0.93	3.56	0.61	1.62	0.70	--	--	--	--	10.11	3.99	2.63	0.42
Dead Woody Debris Change	-0.04	0.38	-1.41	0.91	-0.87	0.17	-0.28	0.22	--	--	--	--	1.65	0.41	-0.64	0.15
Total Net	-4.96	1.53	-1.97	1.00	-3.39	0.57	-1.96	0.69	--	--	--	--	-10.48	0.90	-3.25	0.44

Note: the printed table has a spanning header "Ecological Region" above the seven ecoregion columns.

Table 4.33. Average annual net carbon (CO_2e) change per acre by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and ecoregion, 2002-2006 to 2012-2016. Appendix Table B20 (continued).

Change in Carbon Pool by disturbance	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Insect and Disease																
Mortality	-1.47	0.31	-2.18	0.32	-2.72	0.47	-1.25	0.12	-1.83	0.67	-3.10	0.81	-2.70	0.37	-2.11	0.17
Cut	-0.12	0.08	-0.02	0.02	-0.04	0.02	-0.03	0.01	--	--	-0.18	0.20	--	--	-0.04	0.01
Gross Growth	2.01	0.33	2.52	0.25	2.01	0.12	2.29	0.11	5.27	0.90	6.68	0.75	4.53	0.43	2.84	0.11
Net Live	0.42	0.26	0.31	0.40	-0.75	0.47	1.01	0.14	3.45	1.07	3.40	1.14	1.82	0.67	0.70	0.20
Standing Dead Change	-0.23	0.26	0.71	0.26	1.36	0.42	0.18	0.07	0.12	0.22	0.40	0.38	0.83	0.27	0.67	0.14
Dead Woody Debris Change	-0.49	0.37	-0.01	0.24	-0.24	0.18	0.09	0.09	-0.10	0.37	-0.34	1.04	-0.48	0.28	-0.14	0.10
Total Net	-0.33	0.55	1.25	0.38	0.43	0.26	1.62	0.15	4.42	1.34	4.58	1.32	2.96	0.75	1.57	0.17
Other cut and weather																
Mortality	--	--	-1.17	0.12	-2.15	0.44	-0.59	0.12	-3.45	1.38	-3.99	0.70	-1.86	0.62	-2.89	0.36
Cut	--	--	-0.05	0.05	-0.08	0.05	-0.88	0.34	-0.24	0.24	-0.19	0.14	--	--	-0.18	0.07
Gross Growth	2.77	2.77	6.01	1.72	2.40	0.32	2.70	0.55	3.96	0.70	4.19	0.44	4.85	0.82	3.68	0.26
Net Live	2.77	2.77	4.78	1.81	0.18	0.53	1.23	0.62	0.26	1.55	0.01	0.79	2.99	0.93	0.61	0.43
Standing Dead Change	--	--	0.19	0.14	-0.04	0.19	-1.05	0.49	0.06	0.29	-0.12	0.19	0.14	0.21	-0.09	0.11
Dead Woody Debris Change	0.18	0.18	-0.79	0.57	0.41	0.31	0.01	0.20	-0.23	0.58	0.70	0.41	-0.64	0.46	0.26	0.21
Total Net	3.49	3.49	5.61	1.85	0.64	0.63	0.40	0.71	0.19	1.98	0.59	1.00	3.40	1.48	0.96	0.55
Less than 25% disturbed																
Mortality	-0.83	0.22	-0.50	0.09	-1.19	0.09	-0.50	0.07	-1.06	0.14	-1.67	0.17	-0.95	0.08	-1.09	0.05
Cut	-0.01	0.01	-0.01	0.01	-0.04	0.04	-0.07	0.04	-0.05	0.02	-0.13	0.05	-0.04	0.02	-0.06	0.02
Gross Growth	1.37	0.16	2.34	0.19	3.27	0.16	2.43	0.12	5.13	0.25	5.56	0.21	4.63	0.18	4.00	0.08
Net Live	0.53	0.22	1.82	0.20	2.04	0.17	1.86	0.12	4.02	0.24	3.76	0.26	3.63	0.19	2.85	0.09
Standing Dead Change	-0.26	0.28	-0.26	0.17	-0.09	0.09	-0.01	0.04	0.05	0.05	0.19	0.07	0.01	0.05	0.00	0.03
Dead Woody Debris Change	-0.71	0.82	-0.44	0.23	-0.37	0.17	-0.18	0.08	-0.36	0.11	-0.34	0.17	-0.67	0.15	-0.42	0.07
Total Net	-0.34	0.87	1.52	0.32	2.05	0.26	2.13	0.15	4.77	0.32	4.68	0.35	3.97	0.30	3.18	0.13
Total																
Mortality	-1.77	0.28	-1.28	0.16	-2.00	0.16	-0.91	0.08	-1.19	0.17	-1.81	0.15	-1.20	0.10	-1.49	0.06
Cut	-0.30	0.10	-1.03	0.26	-0.49	0.16	-0.72	0.12	-3.02	0.72	-2.66	0.42	-1.73	0.33	-1.42	0.12
Gross Growth	1.45	0.12	2.31	0.13	2.74	0.10	2.23	0.07	4.90	0.20	5.36	0.17	4.54	0.15	3.56	0.05
Net Live	-0.62	0.31	0.00	0.31	0.24	0.23	0.60	0.15	0.69	0.76	0.89	0.48	1.61	0.39	0.65	0.15
Standing Dead Change	-0.07	0.21	0.20	0.14	0.53	0.13	0.06	0.05	-0.05	0.06	0.08	0.06	0.11	0.06	0.19	0.04
Dead Woody Debris Change	-0.48	0.45	-0.29	0.16	-0.33	0.11	0.00	0.06	-0.25	0.12	-0.30	0.16	-0.63	0.13	-0.31	0.05
Total Net	-1.35	0.60	-0.07	0.40	0.59	0.26	0.83	0.18	0.54	0.98	0.92	0.66	1.57	0.51	0.73	0.19

4.4 WA-DNR Region– Forest Carbon Stocks, Flux and Trends by WA-DNR Regions

This section reports on estimates of forest carbon stocks and flux as measured on FIA inventory plots from 2002 through 2016 within the six regions defined and managed by Washington DNR. The regions divide the state geographically into the Northeast, Northwest, Olympic, Pacific Cascade, South Puget Sound, and Southeast areas (See map, Figure 4.21). For this report, results by WA-DNR region are specific to only forested state trust lands within each region. All other ownerships are excluded in the reported estimates. In addition, due to large standard error associated with individual WA-DNR regions as a result of the small number of plots on forested state trust lands, results in this section are grouped by WA-DNR regions west of the Cascade crest (Northwest, Olympic, Pacific Cascade, and South Puget Sound) and regions east of the Cascade crest (Northeast and Southeast).

4.4.1 Carbon Stocks by WA-DNR Region

FIA currently estimates there are 2.2 ± 0.1 million acres of forest land managed by Washington DNR. Total forest carbon stocks from all pools are estimated to be 288.7 ± 16.6 MMT C, which is about 11% of all forest carbon stocks in the state (Table 4.34). By WA-DNR region, those west of the Cascade divide currently store the most forest carbon in all pools at 220.0 ± 18.3 MMT C, accounting for 76.2% of all WA-DNR carbon stocks (Tables 4.34 and 4.35). The western regions also have the greatest percentage of carbon stocks in the live tree pool relative to the eastern WA-DNR regions, at 39%. The eastern regions' live tree pools account for 25% of the of carbon stocks in the region. However the percentage of carbon stocks in standing dead trees and down wood is similar between the western and eastern regions relative to total stocks at 8% in the west and 7% in the east. The mean forest carbon density from all pools for all WA-DNR regions is 131.8 ± 5.4 MT C/ac, ranging from a mean carbon density of 153.9 ± 7.4 MT C/ac in the western regions, to 90.3 ± 4.9 MT C/ac in the eastern regions.

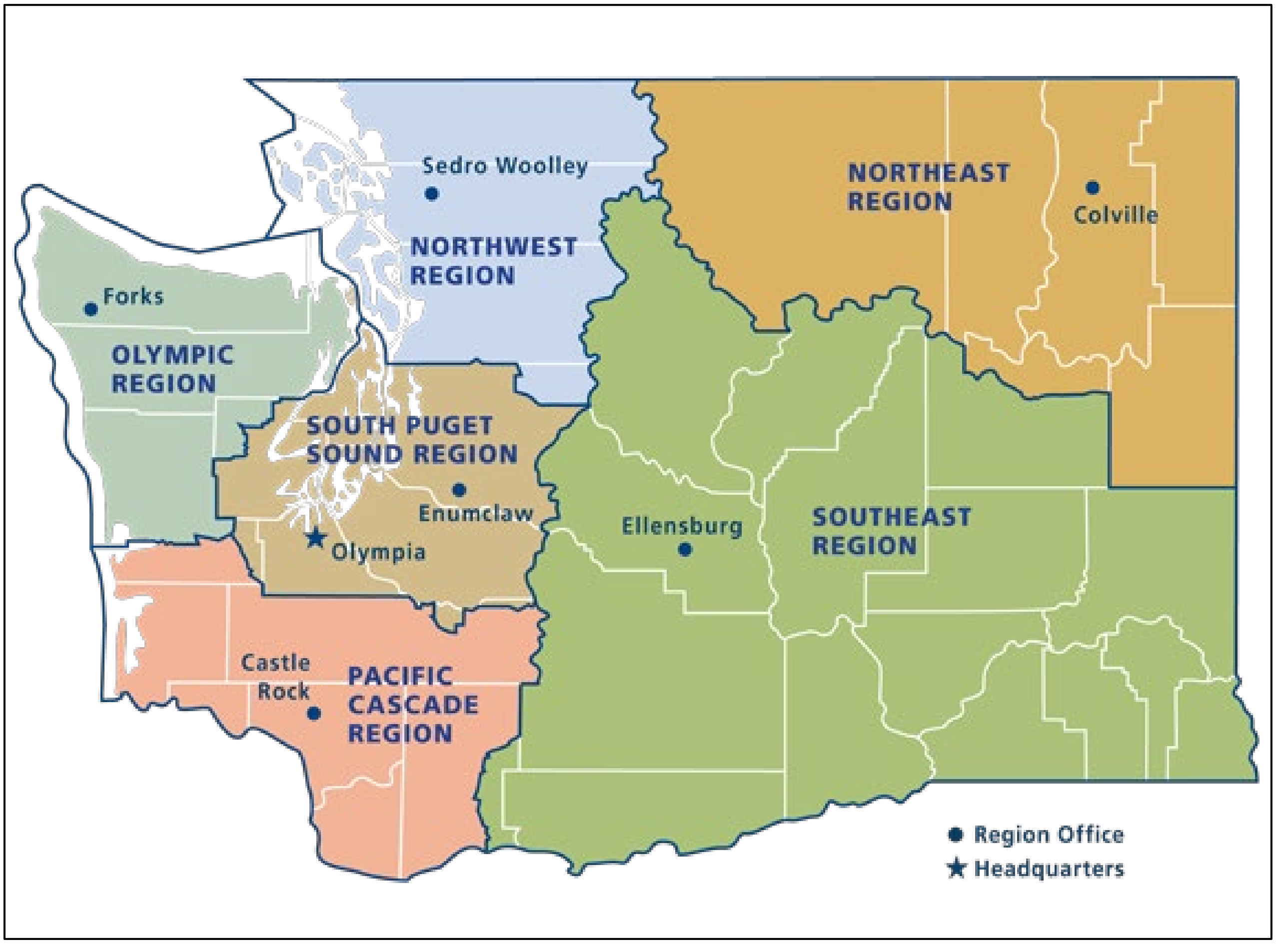


Figure 4.21. Washington Department of Natural Resources upland management regions and district boundaries. Map source: [https://www.dnr.wa.gov/about/dnr-regions-and-districts.](https://www.dnr.wa.gov/about/dnr-regions-and-districts)

Table 4.34. Forest land carbon stocks by eastern and western WA-DNR regions and pool, 2007-2016. Appendix Table C9

Carbon Pool		East Total		West Total		DNR Total	
		Total	SE	Total	SE	Total	SE
		Million metric tons C[1]					
Live trees							
	Aboveground	17.45	1.94	85.07	4.69	102.51	4.51
	Belowground	3.41	0.38	17.87	1.00	21.28	0.96
Dead trees							
	Aboveground	1.58	0.30	4.96	0.51	6.54	0.56
	Belowground	0.39	0.07	1.46	0.15	1.85	0.16
Understory vegetation							
	Aboveground	0.91	0.07	1.63	0.06	2.54	0.07
	Belowground	0.10	0.01	0.18	0.01	0.28	0.01
Down wood		3.45	0.36	13.22	0.87	16.67	0.87
Forest Floor		4.01	0.32	8.77	0.38	12.78	0.37
Soil		37.47	2.75	86.81	3.31	124.28	3.05
Total Carbon		68.76	5.51	219.96	9.36	288.73	8.49

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

Table 4.35. Forest land carbon stocks per acre by eastern and western WA-DNR regions and pool, 2007-2016. Appendix Table C10

Carbon Pool	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	metric tons C[1] per acre					
Live trees						
Aboveground	22.920	1.821	59.520	2.648	46.802	1.904
Belowground	4.476	0.357	12.504	0.570	9.714	0.407
Dead trees						
Aboveground	2.075	0.358	3.469	0.338	2.985	0.251
Belowground	0.515	0.086	1.022	0.099	0.846	0.071
Understory vegetation						
Aboveground	1.195	0.021	1.142	0.013	1.160	0.011
Belowground	0.133	0.002	0.127	0.001	0.129	0.001
Down wood	4.536	0.326	9.249	0.517	7.611	0.365
Forest Floor	5.268	0.141	6.134	0.145	5.833	0.106
Soil	49.224	0.351	60.739	0.472	56.738	0.409
Total Carbon	90.342	2.505	153.906	3.781	131.817	2.780

[1]Multiply carbon (C) by 3.667 to calculate equivalent carbon dioxide (CO_2e)

4.4.2 Carbon Flux by Eastern and Western WA-DNR Regions

The net average annual carbon flux for all pools, on all WA-DNR forest land is -0.1 ± 4.2 MMT CO_2e/yr (-0.05 ± 1.9 MT CO_2e/ac/yr) (Tables 4.36 and 4.37) indicating that on average, on all WA-DNR forest land the transfer of CO_2e into the live tree and other carbon pools is nearly equal with the transfers of CO_2e out of the forest carbon pools. However, this does not account for the carbon stored in harvested wood products. The net average annual carbon flux for live trees on all WA-DNR forest land is higher at 0.6 ± 3.1 MMT CO_2e/yr (0.3 ± 1.4 MT CO_2e/ac/yr), indicating gross growth of live trees could be slightly exceeding harvest and mortality over all WA-DNR forest land. However, the wide 95% confidence interval around the estimate indicates a high level of uncertainty.

By WA-DNR region, 86% of average annual growth on live trees occurs in regions west of the Cascade divide, estimated as a total of 8.4 ± 1.1 MMT CO_2e/yr across 1.43 million acres of west side WA-DNR forests, which is equivalent to 5.9 ± 0.5 MT CO_2e/ac/yr. This rate of gross tree growth on a per acre basis is the highest of any ownership for the west side of the state. After accounting for harvest and mortality in the regions, the live tree pool is adding carbon at an average annual rate of 0.8 ± 3.1 MMT CO_2e/yr (0.6 ± 2.2 MT CO_2e/ac/yr). However, after accounting for changes in all other carbon pools net average annual carbon flux for the western regions is 0.03 ± 4.1 MMT CO_2e/yr (0.02 ± 2.9 MT CO_2e/ac/yr) indicating on average, net annual carbon transfers out of forest carbon pools in the western region are nearly equal to transfers of carbon into these pools. Average annual growth on live trees in eastern WA-DNR regions accounts for 14% of all gross growth at 1.4 ± 0.4 MMT CO_2e/yr (1.7 ± 0.4 MT CO_2e/ac/yr) and has an average annual live tree net flux of -0.3 ± 0.7 MMT CO_2e/yr (-0.4 ± 0.9 MT CO_2e/ac/yr) after accounting for mortality and harvest. This indicates, on average, a net loss of carbon from the live tree pool in the eastern region. However, wide 95% confidence intervals around estimates of net change for the western and eastern regions include zero making the current trend in net average annual carbon flux less reliable. The 95% confidence intervals are expected to narrow as remeasurement of FIA plots approach 100%.

Table 4.36. Average annual net CO_2e flux by pool and WA-DNR region, 2002-2006 to 2012-2016. Appendix Table B9.

Change in Carbon Pool	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year					
Standing Live tree						
Mortality	-901	247	-2,308	326	-3,209	387
Cut	-768	296	-5,288	1,451	-6,056	1,467
Gross Growth	1,381	213	8,451	568	9,832	531
Net	-288	368	855	1,565	567	1,607
Foliage	-19	22	81	88	63	91
Tree Roots						
Live	-58	78	244	353	185	362
Dead	69	43	-55	45	14	63
Standing Dead	319	182	-7	155	312	239
Dead Woody Debris	-175	131	-946	420	-1,120	437
Understory Vegetation						
Above Ground	4	5	-2	11	2	12
Below Ground	0	1	-0	1	0	1
Total	-147	402	170	2,022	23	2,063
Forest Floor	-43	34	3	57	-41	66
Soils	42	63	-145	71	-103	95
Total (including soils and forest floor)	-148	406	27	2,085	-121	2,126

Table 4.37. Average annual net CO_2e flux per acre by pool and WA-DNR region, 2002-2006 to 2012-2016. Appendix Table B10.

Change in Carbon Pool	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre					
Standing Live tree						
Mortality	-1.13	0.28	-1.62	0.22	-1.44	0.17
Cut	-0.96	0.35	-3.72	1.01	-2.73	0.66
Gross Growth	1.73	0.19	5.95	0.26	4.43	0.21
Net	-0.36	0.46	0.60	1.10	0.26	0.72
Foliage	-0.02	0.03	0.06	0.06	0.03	0.04
Tree Roots						
Live	-0.07	0.10	0.17	0.25	0.08	0.16
Dead	0.09	0.05	-0.04	0.03	0.01	0.03
Standing Dead	0.40	0.22	0.00	0.11	0.14	0.11
Dead Woody Debris	-0.22	0.16	-0.67	0.29	-0.50	0.20
Understory Vegetation						
Above Ground	0.00	0.01	0.00	0.01	0.00	0.01
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00
Total	-0.18	0.50	0.12	1.42	0.01	0.93
Forest Floor	-0.05	0.04	0.00	0.04	-0.02	0.03
Soils	0.05	0.08	-0.10	0.05	-0.05	0.04
Total (including soils and forest floor)	-0.18	0.51	0.02	1.47	-0.05	0.96

4.4.3 Source of Flux by WA-DNR Region

Gross growth of live trees generally drives carbon flux and sequestration overall. For all WA-DNR forest land gross tree growth is 9.8 ± 1.0 MMT CO_2e/yr (4.4 ± 0.4 MT CO_2e/ac/yr) (Tables 4.38 and 4.39). By WA-DNR region, harvest in the western management regions account for 87% of the state's total harvest-driven CO_2e change in the live tree pool at -5.3 ± 2.8 MMT CO_2e/yr (-3.7 ± 2.0 MT CO_2e/ac/yr), with harvest in the eastern regions accounting for the remaining 13% at -0.8 ± 0.6 MMT CO_2e/yr (-1.0 ± 0.7 MT CO_2e/ac/yr). A proportion of carbon removed from the live tree pool through harvest is transferred and sequestered into a range of harvested wood products and accounted for in a separate analysis.

Tree mortality acts as an important ecological driver of carbon flux and disturbance in forests. The FIA inventory accounts for mortality by reconciling the cause and estimated timing of tree death on remeasured plots. Tree mortality plays a large role as an agent of change in forests managed by the state but the sources of mortality change between western and eastern WA-DNR management regions. The leading driver of mortality in the western regions occurs in undisturbed stands (61%) and is likely due to natural causes such as successional tree mortality with stand development. Other leading causes of tree mortality in the western regions is due to insects and diseases (21%) and other non-specific or weather-related causes (9%). In the eastern regions, natural tree mortality in undisturbed stands accounts for only 10% of causes. Mortality due to insect and diseases or wildfire are the leading sources of tree mortality in this region. Mortality due to insects or disease accounts for 44% of the total, and fire related causes are the second leading driver of tree mortality in eastern regions, accounting for 33% of the total average annual mortality.

Table 4.38. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and WA-DNR region, 2002-2006 to 2012-2016.

	East		West			
Change in Carbon Pool by disturbance	**Total**		**Total**		**DNR Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year					
Cut						
Mortality	-110	83	-196	121	-306	145
Cut	-758	296	-5,045	1,449	-5,803	1,465
Gross Growth	214	78	923	224	1,137	233
Net Live	-653	258	-4,319	1,374	-4,972	1,386
Standing Dead Change	33	72	-249	106	-215	129
Dead Woody Debris Change	31	53	18	157	49	165
Total Net	-753	306	-5,808	1,798	-6,560	1,812
Cut and Fire						
Mortality	--	--	--	--	--	--
Cut	--	--	--	--	--	--
Gross Growth	--	--	--	--	--	--
Net Live	--	--	--	--	--	--
Standing Dead Change	--	--	--	--	--	--
Dead Woody Debris Change	--	--	--	--	--	--
Total Net	--	--	--	--	--	--
Fire						
Mortality	-297	156	--	--	-297	156
Cut	--	--	--	--	--	--
Gross Growth	91	50	--	--	91	50
Net Live	-205	118	--	--	-205	118
Standing Dead Change	153	106	--	--	153	106
Dead Woody Debris Change	-30	18	--	--	-30	18
Total Net	-97	99	--	--	-97	99

Table 4.38. Average annual net carbon (CO_2e) change by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and WA-DNR region, 2002-2006 to 2012-2016. Appendix Table B17 (continued).

Change in Carbon Pool by disturbance	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year					
Insect and Disease						
Mortality	-397	162	-491	164	-888	230
Cut	-4	4	-43	50	-47	50
Gross Growth	501	149	1,222	325	1,722	355
Net Live	99	182	688	257	787	314
Standing Dead Change	204	123	146	72	351	142
Dead Woody Debris Change	-6	92	-243	195	-249	215
Total Net	374	179	825	357	1,199	398
Other cut and weather						
Mortality	-3	3	-217	94	-220	94
Cut	-3	4	-39	46	-43	46
Gross Growth	20	23	445	168	465	169
Net Live	14	16	188	109	202	110
Standing Dead Change	--	--	-18	28	-18	28
Dead Woody Debris Change	1	1	28	62	29	62
Total Net	19	23	253	148	272	150
Less than 25% disturbed						
Mortality	-94	41	-1,404	271	-1,498	272
Cut	-3	3	-160	143	-163	143
Gross Growth	555	149	5,861	593	6,417	592
Net Live	458	129	4,297	560	4,755	562
Standing Dead Change	-71	40	114	74	43	84
Dead Woody Debris Change	-171	76	-748	335	-919	342
Total Net	309	146	4,899	717	5,209	724
Total						
Mortality	-901	247	-2,308	326	-3,209	387
Cut	-768	296	-5,288	1,451	-6,056	1,467
Gross Growth	1,381	213	8,451	568	9,832	531
Net Live	-288	368	855	1,565	567	1,607
Standing Dead Change	319	182	-7	155	312	239
Dead Woody Debris Change	-175	131	-946	420	-1,120	437
Total Net	-147	402	170	2,022	23	2,063

Table 4.39. Average annual net carbon (CO_2e) change per acre by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and WA-DNR region, 2002-2006 to 2012-2016.

Change in Carbon Pool by disturbance	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre					
Cut						
Mortality	-0.845	0.578	-0.857	0.493	-0.853	0.377
Cut	-5.832	1.354	-22.020	4.579	-16.163	3.280
Gross Growth	1.649	0.308	4.027	0.498	3.166	0.405
Net Live	-5.028	1.194	-18.850	4.709	-13.849	3.258
Standing Dead Change	0.257	0.551	-1.086	0.407	-0.600	0.350
Dead Woody Debris Change	0.240	0.398	0.078	0.683	0.136	0.457
Total Net	-5.794	1.475	-25.347	6.096	-18.272	4.266
Cut and Fire						
Mortality	--	--	--	--	--	--
Cut	--	--	--	--	--	--
Gross Growth	--	--	--	--	--	--
Net Live	--	--	--	--	--	--
Standing Dead Change	--	--	--	--	--	--
Dead Woody Debris Change	--	--	--	--	--	--
Total Net	--	--	--	--	--	--
Fire						
Mortality	-5.320	1.549	--	--	-5.320	1.549
Cut	--	--	--	--	--	--
Gross Growth	1.638	0.382	--	--	1.638	0.382
Net Live	-3.682	1.478	--	--	-3.682	1.478
Standing Dead Change	2.737	1.368	--	--	2.737	1.368
Dead Woody Debris Change	-0.541	0.216	--	--	-0.541	0.216
Total Net	-1.738	1.718	--	--	-1.738	1.718

Table 4.39. Average annual net carbon (CO_2e) change per acre by aboveground pool, and total (excluding Forest Floor and Soils), on forest land by disturbance type and WA-DNR region, 2002-2006 to 2012-2016. Appendix Table B18 (continued).

Change in Carbon Pool by disturbance	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre					
Insect and Disease						
Mortality	-1.449	0.519	-2.871	0.691	-1.995	0.427
Cut	-0.013	0.013	-0.252	0.252	-0.105	0.112
Gross Growth	1.824	0.397	7.147	0.686	3.868	0.538
Net Live	0.363	0.659	4.024	1.081	1.768	0.647
Standing Dead Change	0.745	0.421	0.856	0.366	0.788	0.295
Dead Woody Debris Change	-0.022	0.335	-1.420	1.087	-0.558	0.476
Total Net	1.364	0.585	4.826	1.676	2.693	0.786
Other cut and weather						
Mortality	-0.307	0.307	-2.589	0.818	-2.376	0.767
Cut	-0.397	0.397	-0.470	0.470	-0.463	0.475
Gross Growth	2.279	2.279	5.305	0.676	5.022	0.689
Net Live	1.575	1.575	2.245	0.892	2.183	0.815
Standing Dead Change	--	--	-0.221	0.337	-0.200	0.305
Dead Woody Debris Change	0.144	0.144	0.329	0.748	0.312	0.678
Total Net	2.250	2.250	3.015	1.274	2.944	1.160
Less than 25% disturbed						
Mortality	-0.284	0.114	-1.498	0.260	-1.181	0.199
Cut	-0.010	0.010	-0.171	0.152	-0.129	0.113
Gross Growth	1.675	0.311	6.254	0.335	5.057	0.310
Net Live	1.381	0.279	4.585	0.446	3.748	0.357
Standing Dead Change	-0.215	0.114	0.122	0.078	0.034	0.066
Dead Woody Debris Change	-0.515	0.208	-0.799	0.350	-0.725	0.264
Total Net	0.933	0.395	5.228	0.618	4.105	0.495
Total						
Mortality	-1.125	0.278	-1.624	0.217	-1.445	0.169
Cut	-0.960	0.352	-3.721	1.013	-2.726	0.661
Gross Growth	1.726	0.191	5.946	0.258	4.426	0.211
Net Live	-0.359	0.456	0.601	1.099	0.255	0.723
Standing Dead Change	0.399	0.221	-0.005	0.109	0.141	0.107
Dead Woody Debris Change	-0.218	0.162	-0.665	0.294	-0.504	0.197
Total Net	-0.183	0.502	0.119	1.422	0.010	0.929

4.5 Converted Forest Lands

On average, approximately 21 ± 8 thousand acres (95% CI) of forest land were converted to non-forest (i.e., deforested) every year in Washington between 2002-2006 and 2012-2016 (Table 4.40) (Refer to Sections 3.2.4 and 4.1.3 for an explanation of date ranges for flux calculations). Most of the deforestation (52%) was conversion to development, 26% of which was to housing and 52% of which was to roads (primarily new logging roads). Another 17% of the deforestation was conversion to water, primarily caused by rivers eroding banks or creating new channels. Conversely, approximately 14 ± 6 thousand acres of non-forest land were converted to forest every year (i.e., afforestation). Most of the afforestation (62%) occurred on developed uses (primarily rights of way—e.g., abandoned logging roads), with another 26% from other lands (natural tree encroachment, e.g., in old landslides). Overall, the estimate for the net loss of forest land is not statistically significant at the rate of 6.4 ± 9.6 thousand acres per year. The confidence interval is large compared to the estimate because it is a relatively rare event at the scale of the inventory. Net forest land losses tended to occur (not significant) on timberland as well as non-productive "other forest", with some apparent gains on reserved lands.

Table 4.40. Annual change in forest land area to/from other IPCC land-use classes in Washington, 2002-2006 to 2012-2016. Appendix Table D1.

Table LU1: Annual change in forest land area to/from other IPCC landuse classes in Washington, 2002-6 to 2012-16.

Nonforest land use	Forest to nonforest		Nonforest to forest		Net change to forest	
	Total	SE	Total	SE	Total	SE
	Acres per year					
Cropland	2,677	1,781	576	370	-2,101	1,819
Developed	10,778	2,131	8,996	1,390	-1,781	2,534
Grassland	2,273	2,051	1,057	592	-1,215	2,135
Other	1,671	1,030	3,768	2,343	2,097	2,560
Water	3,450	1,417	81	60	-3,369	1,418
Total	20,848	3,981	14,479	2,811	-6,369	4,878

Note: Totals may be off because of rounding

Deforestation resulted in a reduction of 4.5 ± 1.5 MMT CO_2e from forest carbon pools per year (Table 4.41). This was compensated for by the addition of 2.3 ± 0.7 MMT CO_2e per year due to afforestation, resulting in a significant net reduction of 2.2 ± 1.6 MMT CO_2e per year. Most of the gains and losses were due to the live tree pool. Confidence in land classification is high, because FIA plots are visited on the ground in the case where there is any potential for forest land to be present on the plot (based on past history, the vegetation of the local area, and examination of aerial photography). Non-forest plots which are not field visited are classified from aerial photography of at least one-meter resolution. Where definitions have changed over time, field crew measurements and detailed written descriptions are used to correctly assess change between forested lands and other land-uses.

Table 4.41. Annual change in carbon pools due to change in land-use between forest and non-forest in Washington, 2002-2006 to 2012-2016. Appendix Table D2.

	Forest to nonforest		Nonforest to forest		Net change	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**
Carbon pool	*Thousand metric tons CO2 equivalent per year*					
Live tree	-3,108	630	1,555	266	-1,552	649
Standing dead	-177	69	57	10	-120	70
Down wood	-342	77	197	30	-145	81
Understory veg	-201	35	122	24	-79	42
Litter	-690	114	417	72	-273	134
Soil*	0		0		0	
All pools	-4,518	771	2,348	349	-2,170	810

* No changes in landuse involved cultivated land so soil organic carbon change w as assumed to be zero (Ogle et al. 2003)

Chapter 5. Comparison with other reports

5.1 National Greenhouse Gas Inventory

The U.S. National Greenhouse Gas Inventory (NGHGI) is aggregated at the national level, so state-level estimates are not available to compare to those produced here. However, a report that uses the same data and methods is produced periodically that provides disaggregated results at regional and state levels. The most recent version of this report provides forest carbon stock and flux estimates from 1990 to 2018 (Domke et al. 2020). The NGHGI-basedreport estimates live tree net stock change at 17.2 MMT CO_2e per year for Washington for the 2001-2016 period, while in this report we estimate the change at 18.2 MMT CO_2e per year (Table 5.1). The primary cause for this difference is in the use of regional equations used to calculate biomass from the tree measurements. While both methods are based on the same merchantable tree volume calculations as described in section 3, we use a set of regionally derived biomass equations while the NGHGI uses national component ratio equations. Both approaches use equations with built-in assumptions and are based on small datasets resulting in estimates of unknown accuracy (Weiskittel et al. 2015). This issue is further discussed in chapter 6 of this report. In addition, the NGHGI flux estimates use a stock-change approach as opposed to a GRM approach but given the similarity of the estimates from both approaches in this report the effect is likely minor.

Table 5.1. Differences between net carbon sequestration rates for Washington in the U.S. NGHGI and this report (MMT CO_2e/yr).

Inventory	Live Tree[1]	Non-live tree, non-soil	Method/year
	Net Sequestration, MMT CO_2e/yr		
U.S. NGHGI (Domke et al. 2020)	17.2	5.3	Stock-change, FIA direct-measurement 2013
WA Forest Ecosystem (i.e., this report)	18.2	-2.2	GRM, FIA direct-measurement 2016

[1] Live tree includes aboveground wood, foliage, and roots

The Domke et al. (2020) report estimates total non-soil stock change at 22.3 MMT CO_2e; after subtracting the live tree change this results in a non-live tree, non-soil stock change of 5.3 MMT CO_2e per year. In comparison, we estimate losses in those pools of 2.2 MMT CO_2e per year, with most of the change attributed to down wood. While the difference in tree-level biomass equations may have played a role, the use of models based on forest type and stand age to estimate down wood may have been a factor as well.

5.2 Other comprehensive carbon research in Washington

Few peer-reviewed studies were found that produced estimates of current forest carbon stocks and flux for Washington State. If there are some that we have missed, we will incorporate them in future comparisons of estimates.

A comprehensive study of live and dead carbon pools was done for National Forests in Washington and Oregon using their CVS inventory and assessing change from 1993-7 to 1997-2007 (Gray and Whittier 2014). The field measurements and data compilation methods were quite similar to those of FIA, with the primary difference to this report being that Gray and Whittier (2014) used a modified Component Ratio Method (CRM, Woodall et al. 2011) rather than regional biomass equations. From Table 4 in Gray and Whittier (2014) and area of NFS forestland in each region, the sum of non-soil C pools in Washington was 523 MMT C, compared to 591 MMT C in this report. Although the live tree C accounted for most of the difference in estimates, the effect of using different biomass equations is not clear, given that the CRM method under- or over-estimates some species in our region, but is quite accurate for Douglas-fir, the most abundant species in Washington (Poudel et al. 2018). The ~10-year time difference and the estimated increase of 2.8 MMT C/yr for live trees on NFS lands from this report could account for some of the difference in stock estimates. Flux estimates could not be readily compared because they were not reported at the state or sub-state level in Gray and Whittier (2014).

Campbell et al. 2007 estimated the combustion of carbon pools in the 2002 Biscuit fire in southwest Oregon, and their results have been subsequently used in many analyses of fire emissions, including in Washington (e.g., Raymond 2012). Campbell et al. 2007 estimated the fire emitted 3.83 MMT C over an area of 203,000 ha, or 18.9 MT C/ha. Our change analysis for all fires in Washington 2002-2016 suggested flux of 18.3 MT C/ha. In addition to the different spatial and temporal scales, our analysis did not try to estimate change in litter, duff, and soil, which accounted for approximately 10 MT C/ha in Campbell et al.'s analysis. The higher loss in the live and dead tree pools in our analysis may be due to: the inclusion of unburned areas within the Biscuit fire perimeter in their analysis; post-fire decay of burnt and killed trees, snags, and down wood captured by our measurements; higher carbon densities in Washington's forests that burned during this period; and/or higher fire severities in the Washington fires during this period.

More recently, Ganguly et al. 2020 used the Washington Forest Biomass Calculator to estimate biomass accumulation, harvest levels, and wood products carbon storage from private lands in Washington State. For biomass accumulation, the study found that "net yearly accumulation of biomass in the State's private forests leads to additional global warming mitigation benefits equivalent to 7.4 MMT CO_2e." In our report, we estimate net change in the live tree pool for the 2007-2016 reporting period from all private forests to be a gain of 5.7 ± 5.1 MMT CO_2e per year. The largest portion of this live tree annual sequestration is from non-corporate private forests at 4.0 ± 2.0 MMT CO_2e per year, with the remainder from corporate private forests. We consider the estimate from Ganguly et al. 2020 of 7.4 MMT CO_2e to be consistent with our estimate for net change in the live tree pool given that it is within our estimated error range.

Chapter 6. Strategies to improve the inventory

This assessment is intended to address the state's need for a reliable carbon accounting system to help track changes in forest carbon over time and to meet legislatively-mandated carbon sequestration and greenhouse gas reduction goals and reporting requirements (See Chapter 2.1). While the data in this report is robust, increased precision may be desired to achieve the state's needs. As noted in Chapter 4, confidence in the estimates is lower where the sample error is large relative to the estimate, which can occur for values summarized for a small area or a filtered set of specific criteria (e.g. C in storage for a forest type, single ownership, and a small forested region). Precision is also hindered due to denial of access to some plots (i.e., non-sampled plots), limited tracking of dead and downed wood, and generalized biomass equations. Furthermore, as climate change and human modifications quicken the pace of forest change, there may be a lag time before changes in carbon dynamics are detected.

In future FIA inventories, precision will be improved (i.e., the confidence interval will narrow) as more plots are re-measured. As noted in Chapter 3.2, this current inventory is based on 50 percent of the re-measured plots. Following compilation of the 2021 inventory data, 100 percent of Washington's FIA plots will be re-measured, which should reduce the statistical errors to 71 percent of those found for estimates in this report, therefore increasing statistical certainty.

However, there may be reasons to seek additional precision in the state's forest carbon accounting system. For example, there may be need for greater precision in some regions or some ownerships or some forest types, especially where the confidence interval is wide, carbon management is a priority, or where it is not currently possible to statistically determine if flux is positive or negative. In addition, there may be need for faster responsiveness to detect or track changing carbon dynamics and tree mortality more quickly due to changing climate conditions, other disturbances (wildfire, insects, disease) or land use alterations. Many states have augmented the FIA methodology to address specific needs. For example:

- California has initiated efforts to reduce the measurement cycle from 10 years to 5 years, in order to describe changes in carbon flux more quickly. The plans call for starting additional measurements in 2021.
- Michigan maintained a tripled plot intensity sample (one plot every 2,000 acres instead of one plot every 6,000 acres) through 2008 on all ownerships to obtain more precise estimates for smaller geographic areas and vegetation types. Funding limitations during and after 2008 led to switching to the base intensity. However, National Forests resumed sampling at triple-intensity in 2010 (Pugh et al. 2017). Most FIA inventories on National Forests in the East are currently double- or triple-intensified.
- Minnesota has maintained a doubled plot intensity sample (one plot every 3,000 acres) since 2000 on all ownerships to obtain more precise estimates for smaller geographic areas and vegetation types.

- Eastern state FIA program are funded by Congress at a level that supports FIA plot measurement on a 7-year cycle (while western states are funded for a 10-year cycle). Most southeastern states (except Louisiana) as well as Maine, Minnesota, and New Jersey, have contributed to the program to bring the measurement cycle down to 5 years (Castillo and Alvarez 2020).

Options to improve inventory precision include improving data collection methods (increase the number of plots; increase the frequency of measurement; improve estimation of non-sampled plots; increase use of remote sensing; and improve tracking of dead and down wood) and improvements to data compilation (update tree biomass equations; and increase consistency in carbon reporting across platforms). These are described below.

6.1 Options to improve data collection methods

6.1.1 Increase the number of plots and/or the frequency of measurement

In most parts of Washington state, FIA plots are spaced at approximately one per 6,000 acres and a plot is scheduled for measurement once every ten years. Increasing the intensity of the FIA inventory—by increasing the number of plots (spatial intensification) or increasing the frequency of plot measurement (temporal intensification) or both—are potential strategies for gaining more precise information on conditions and changes in Washington's forest lands. These improvements would provide more precise estimates of changes on specific ownerships or vegetation types as well as more precise estimates of the timing and causes of changes to forests. However, each approach (spatial and temporal) provides increased precision in unique ways.

In the case of spatial intensification, more plots would enable more precise estimates for particular categories of interest, for example specific forest types, landowners, and regions. It would also increase precision for all the inventory estimates. Spatial intensification is already being employed in Washington on National Forest lands outside of designated Wilderness, where the Pacific Northwest Region (Region 6) is funding an increased plot density of one per 1,850 acres. In Washington, there are 6,139 base grid land plots on lands that are not already spatially-intensified that could be added to.

In the case of temporal intensification, a shorter cycle would provide better resolution on the timing of changes. Currently, only 10% of plots are measured each year, limiting the inventory's ability to detect changing trends early. If the pace of forest carbon change quickens due to climate change, wildfire, human activities or other causes, temporal intensification will help detect it faster. Doubling the number of annually measured plots to 20% would cut the re-measurement cycle from ten years down to five years and would increase the ability to detect changing trends. However, the precision of estimates for any specific year (e.g., area burned in 2009) would be the same as the current inventory, as all the plots are used to calculate stocks and flux. There are currently 7,234 plots on the base grid (all ownerships) that could be subject to temporal intensification.

Increasing the number of plots that go into an estimate will reduce the standard error of the estimate by the reciprocal of the square root of the increase in intensity. For example, doubling the number of plots (spatially or temporally) will decrease the standard error by 0.71 (=1/√2). For instance, the estimate of live tree carbon flux on private lands in the Coast Range is 1.440 ± 1.859 (SE) MMT CO_2e (Appendix Table B39), based on available re-measurement of 5/10 of the plots in Washington. In this case, the standard error is larger than the actual measurement. If the number of plots had been doubled, the SE would be reduced to 1.320. Once the 10-year re-measurement cycle is complete, the SE using all the re-measured plots with a double-intensity would be reduced to 0.937, or almost half the current error estimate (1.859). The effect of spatial intensification is also illustrated by SEs that tend to be proportionally lower for National Forests compared to other owners, where the proportion = SE/Total. Note that intensifying the sample for a particular land type only improves error estimates for that area; errors for the population as a whole (the state) are only slightly affected, because the land base or attribute with the highest variance has the greatest effect on precision.

Two important considerations for plot intensification are duration and definition. An intensification effort undertaken for a few years and then abandoned will not helpfully contribute to reducing errors and could complicate estimation. For example, in the case of estimating carbon flux, it wouldn't be until most of the second cycle of intensification measurements were complete that the investment would pay off. Precise definitions of the criteria for intensification are crucial. Intensification must be consistent with FIA protocols in order to contribute to inventory estimates. To the extent they are mapped, intensifying in specific vegetation types is a possibility, but vegetation can change over time with disturbance, management, and colonization, and it is not feasible to constantly adapt the design and include those estimates in standard inventory estimation. Plots of course can be installed to support other efforts (e.g., remote sensing modeling, habitat description). The other consideration on design is complexity. While it is straightforward to accommodate different spatial intensities in different areas through stratification, and increased temporal intensification, it would be exceedingly difficult to temporally intensify some portions of the population or plot sets (e.g. only the base grid) and still include all the measurements in a unified estimation.

There are important logistical considerations involved in increasing the FIA sample each year, whether by spatial or temporal intensification, to ensure the resulting data are useful and accurate. The current federal cost (field, data management, analysis, and overhead combined) is approximately $1500 per plot measurement. In many states, field work for intensified measurement is done by state crews or contractors. Regardless of who employs the field crews, significant training and field testing is vital to ensure high-quality data. Fluctuation in budgets that result in changing the number and timing of plot measurement would complicate the analysis of the inventory and could render some intensified data unusable.

This report can serve as a starting point to identify specific concerns surrounding uncertainty values, such as for a particular ownership or region, or timing of estimates with further discussion regarding the best strategies to address these concerns.

6.1.2 Improve estimation of non-sampled plots

Currently, there are 9,978 FIA plots in Washington state. However, field crews can only access 6,112 of these plots. Approximately 3,866 forested FIA plots (39%) in Washington are not being measured. The primary reason for these non-sampled plots is denial of access on private non-industrial ownerships.

The issue of non-sampled plots is a concern in Washington and nationally. The best solution statistically is to reduce the number of non-sampled plots. The PNW-FIA program is experimenting with ways to increase access on private lands in collaboration with agencies and Universities in California, for example through partnerships with state forestry agencies or other trusted entities to communicate the benefits of the inventory. There may be opportunities for improved outreach and coordination between FIA, the state, and local agencies and organizations in Washington as well. To account for non-sampled plots, the current national FIA approach assumes that the missing plots have the same characteristics as the mean of the rest of the plots in the same stratum. However, the strata are fairly coarse and this assumption could be resulting in biased estimates (i.e., inaccuracies). These biases could affect state-level or ecoregion-level estimates as well as the particular areas that are under-sampled. Several strategies are currently underway to address non-sampled plots during estimation, including use of remote sensing, statistical procedures, and/or modeling. Opportunities exist to collaborate with agencies and Universities in Washington to expand this work and/or implement solutions more quickly.

6.1.3 Increase use of remote sensing

Remotely-sensed data are already an integral part of inventory estimation as it is a key attribute used to post-stratify the data and build estimates and sampling errors. Two efforts are underway in PNW-FIA to evaluate incorporating newer remote sensing-related datasets to improve the precision of estimates. One of those datasets is three-dimensional vegetation layers developed from digital aerial photography (Strunk et al. 2019, 2020), which might provide better estimates of forest biomass density than the currently used two-dimensional cover imagery. The other is annual change in Landsat imagery that captures most disturbance and harvest and might improve estimates of change and carbon flux.

In addition to the inventory estimation design framework, change detection from satellite images is often used to model potential changes in disturbed and non-sampled areas. However, incorporating remotely sensed data on all lands is currently limited because the model estimates have difficulty assessing growth and land-use change (Battles et al. 2018); modeling growth, mortality, and decay on the undisturbed plots would require substantial effort and potentially introduce bias in the sample. These calculations would essentially be independent estimates outside the inventory estimation framework. Use of high-resolution imagery (e.g., aerial photography) could greatly improve estimation of characteristics of non-sampled plots.

Improved estimation of changes in land-use and land cover on non-forest plots, and more rapid assessment of change on forest plots, should be possible by additional analysis of inventory plots with high-resolution imagery. FIA is currently developing the Image-based Change Estimation (ICE) project that interprets changes in cover and land-use at every forest and non-forest plot location on a 2-3 year schedule in order to provide more consistent and timely estimates of change. These data could be useful in estimating change in carbon stocks on non-forest land-uses that FIA currently is not funded to measure in the field (e.g., chaparral, agriculture, urban).

6.1.4 Improve tracking of dead and down wood

This assessment identified a substantial decline in the dead and down wood pool in WA relative to the increases seen in the other forest pools. The reasons for this decline cannot be determined under our current data collection protocols because we don't track individual pieces through time (as we do with live trees and snags). While we are able to accurately assess the changes in this pool, and determine inputs from mortality and snag-fall at an aggregate level, we are unable to tease apart the relative impacts of mortality, snag-fall, combustion, and decay on these changes. Tracking the status, density, and causes of change of individual pieces of dead and down wood over time could provide insights on these changes. For example, fast decomposition of particular sizes and species of down wood, or removal and combustion of dead wood, could be driving a lot of the pattern. It would take some time to develop reliable field and laboratory protocols (e.g., through pilot studies), and would require additional funding (or dropping of other measurements) to implement the inventory, potentially on a subset of plots, or as separate research from inventory altogether.

6.2 Options to improve data compilation

6.2.1 Better tree biomass equations

One of the weakest links in all forest carbon estimates may be the equations used to calculate tree biomass. The tree carbon estimates in this report are based on a combination of tree volume, bark, and branch equations that were created from independent datasets. Most of the biomass equations were developed to provide initial approximations, and are almost all based on small numbers of trees with a narrow range of sizes from one or two locations. These equations are then applied to all the trees in a region, resulting in estimates of unknown accuracy (Temesgen et al. 2015, Weiskittel et al. 2015). For example, the bark and branch calculations for all Ponderosa pine on the west coast are based on a sample of 23 trees at Pringle Falls Experimental Forest in central Oregon. While alternative national-scale biomass equations developed by Jenkins et al. (2003) are often used, they are essentially a reformulation and averaging of the same limited sets of regional equations. The national FIA component ratio estimates described in Woodall et al. (2011) are a potential improvement because they are scaled to the volume equations used by FIA, which generally are based on much larger samples than the biomass equations, but the overall accuracy of the estimates is still unknown.

The FIA program has attempted to reduce this uncertainty by funding detailed biomass studies to collect new felled-tree data in geographically-distributed samples of trees growing in a range of conditions, that combine taper-based volume measurements with biomass measurements so that estimates will be additive and accurate. The initial effort is focused on the most abundant species in the nation (and includes the species that make up 75% of cubic volume in the west). For species found in Washington, these included Douglas-fir, western hemlock, ponderosa pine, lodgepole pine, red alder, and grand fir. In addition, the project is incorporating existing and publicly-available tree volume and biomass measurements into an open library to aid in model development (Weiskittel et al. 2015). This is enabling the development of a consistent set of biomass equations for additional species found in Washington, including Pacific silver fir, subalpine fir, Engelmann spruce, Sitka spruce, western redcedar, and mountain hemlock (Poudel et al. 2019). Collection of new felled-tree data and compilation of existing datasets was completed in the end of 2019. Current efforts (summer 2020) are evaluating alternative approaches for building compatible volume and biomass equations and methods for estimation of species with few data points. The plan is to select new volume and biomass equations by early 2021, publish the methods and comparison with existing approaches in 2021, and reconfigure FIA compilation to implement the new volume and biomass estimates in 2022, including recompiling all previously-measured trees and their growth, mortality, and removal calculations.

6.2.2 Potential improvements – Carbon reporting

FIA carbon inventory data is now being incorporated into numerous carbon and greenhouse gas reporting frameworks at the local, state, national, and international levels. Although the methodology for this analysis is generally consistent with IPCC methodology, there are two changes that FIA could make to improve the compatibility of this data with other standards and improve the overall accuracy of the inventory, if desired by the State:

1) Remove forests less than 10 acres in size entirely surrounded by urban area, as in the IPCC criteria, where they are classified as settlements. There might be a relatively simple (though imprecise) way to do this by identifying all forest plots within urban areas, or by classifying satellite-based vegetation maps and identifying plots where tree cover patches are too small. While this change would align with IPCC landuse definitions, the

change to estimates of carbon stock and flux estimates for Washington would likely be indiscernible.

2) Include data for standing dead trees <5.0 inches dbh when it becomes available, rather than only those greater than 5.0 inches dbh. While this change would provide a more complete assessment of standing dead trees, the increase in mass for this carbon pool is expected to be minimal.

The efforts of hundreds of people engaged in inventory design, data collection, data management and compilation, quality assurance and analysis, and research made this report possible. As additional inventory data are collected, opportunities for more precise analyses of Washington's carbon stocks and trends will be possible in the future.

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Glossary

Afforestation: An increase in the area of forest land caused by a change in land-use; includes intentionally planted and tended lands as well as lands naturally occupied by establishing trees.

Biomass energy: The use of harvested wood, particularly unmerchantable residues, to meet commercial and residential energy and/or heating needs, potentially reducing the use of fossil fuels to meet those needs instead. Considered by many to be a net reduction in carbon emissions since those residues would otherwise decay and result in emissions anyway (albeit at a slower rate).

Carbon sink saturation point: The point at which annual forest emission equals uptake as forests age.

Corporate forest land: An ownership class of private forest lands owned by a company, corporation, legal partnership, investment firm, bank, timberland investment management organization (TIMO), or real estate investment trust (REIT).

Culmination of mean annual increment: The point in stand development when the rate of accumulation of wood over the life of the stand reaches a maximum, calculated as the amount of wood accumulated divided by the number of years elapsed.

Decomposition: Consumption of organic matter, primarily by microbes, resulting in carbon dioxide emissions to the atmosphere.

Deforestation: A decrease in the area of forest land caused by a change in land-use; does not include areas of temporary tree mortality from logging or fire where planting or natural regeneration is expected to occur.

Forest land: Under the FIA definition, Land that has at least 10 percent crown cover by live tally trees of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide. Forest land includes transition zones, such as areas between forest and non-forest lands that meet the minimal tree stocking/cover and forest areas adjacent to urban and built-up lands. Roadside, streamside, and shelterbelt strips of trees must have a width of at least 120 feet and continuous length of at least 363 feet to qualify as forest land. Unimproved roads, trails, and meadows less than 120 feet wide or less than an acre in size, and streams less than 30 feet wide in forest areas are classified as forest. Tree-covered areas in agricultural production settings, such as fruit orchards, or tree-covered areas in urban settings subjected to regular mowing, such as city parks, are not considered forest land. Per this definition, chaparral is not included in the definition for forest land unless it also meets the minimum stocking or crown cover requirements to qualify as forest land.

Forest land status: Refers to the different FIA categories of forest land (i.e., productive forest land, timberland, other forest land) including the reserve categories (i.e., reserved or unreserved), defined below.

Forest type: A classification of forest land based upon and named for the tree species that forms the plurality of live-tree stocking. Additional information on how FIA determines forest type and the algorithm used for classification is found in Bechtold and Patterson, 2005.

Flux: In this report, flux describes the net change in carbon in one or more pools over a specific period of time, expressed as either a total or a rate (to distinguish change from C stocks). Often expressed as an exchange with the atmosphere. However not all carbon exchanges occur with the atmosphere (e.g., live trees convert to dead wood when they die).

Gross Growth: The increase in wood volume or biomass between the previous and current measurement of trees that were alive at the previous measurement.

IPCC: The Intergovernmental Panel on Climate Change is a United Nations-sponsored panel of scientists that develops guidance on the conduct of carbon emissions assessments, among other things.

Key category analysis: An assessment where key carbon emission categories are identified and prioritized, called for in the 2006 IPCC Guidelines.

Land status: Refers to the FIA distinction between forest land and non-forest (i.e., crops, improved pasture, residential areas, city parks, etc.) or other area (i.e., water). Also includes forest land status categories.

Leakage: Where increases in carbon stores in one region from reduced harvest are offset by decreases in carbon stores in another region from increased harvest to meet demand, resulting in no net reduction, or less of a net reduction, in carbon emissions to the atmosphere.

Logging residues: Slash, such as tops and limbs, and sub-merchantable material left on-site after harvest.

Loss: A net decrease in carbon stores in one or more pools (categories) over a specific period of time.

Managed land: An IPCC designation of lands included in carbon emission assessments, consisting of those where human interventions and practices have affected production, ecological or social functions. In practice, the United States considers all lands except for portions of interior Alaska as “managed”.

Mortality: The wood volume or biomass of live trees that died between the previous and current measurement.

Mortality tree: A measured tree within a plot that died between the previous and current measurement. This does not include trees that were harvested. For the current measurement, a mortality tree counts as a decrease in the live tree pool, and may count as an increase in the standing dead or down wood debris pool, or an emission due to fire.

Net Growth: The net change in live tree wood volume or biomass between the previous and current measurement, equivalent to gross growth minus mortality.

Noncorporate forest land: Private forest land owned by nongovernmental conservation or natural resource organizations; unincorporated partnerships, associations, or clubs; individuals or families; or Native Americans.

Other forest land: Forested lands not capable of producing at least 20 cubic feet of wood per acre at culmination of mean annual increment.

Permanence: Refers to the desire for increases in carbon stores to last over the long term, particularly in the calculation of carbon credits, and not result in increased risk of losses from natural disturbance.

Pool: A category containing carbon mass, e.g., live trees, down wood, harvested wood products.

Productive Capacity: Ability for land to grow commercial tree species.

Productive forest land: Forested lands capable of producing at least 20 cubic feet of wood per acre at culmination of mean annual increment.

Reserve status: Lands where management for the production of wood products is precluded permanently by law, including Wildernesses, National Parks, National Recreation Areas, and State Parks. In some cases, timber harvest can occur for various resource objectives (i.e., restoration, salvage, etc.).

Respiration: The process of living tissues using carbohydrates and producing carbon dioxide emissions to the atmosphere, for example leaves and roots of living trees.

Sequestration: A net increase in carbon stores in one or more pools (categories) over a specific period of time.

Substitution: Refers to the possibility that the use of wood products in construction or other products results in a net reduction of carbon emissions if the alternatives require more carbon-based energy to produce.

Stocks: The amount of carbon in one or more pools (categories) at one point in time (synonym: stores).

Stores: The amount of carbon in one or more pools (categories) at one point in time (synonym: stocks).

Timberland: Forested lands capable of producing at least 20 cubic feet of wood per acre at culmination of mean annual increment, and not reserved (i.e., where management for production of wood products is not precluded).

Working forests: Forests in which trees are harvested regularly.

Appendix: 2002-2016 Washington forest ecosystem carbon inventory tables

A. Forest Land Area

Table A1: Area of Forest Land by Half State and Ownership Group, 2007-2016: All Washington.

	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand acres															
Eastern Washington	4,826	49	202	28	761	56	239	36	1,028	74	3,005	108	4,033	114	10,061	138
Western Washington	3,467	47	1,268	45	1,429	54	492	52	3,732	110	1,670	85	5,402	112	12,059	132
Total	8,293	51	1,470	44	2,190	54	731	62	4,760	123	4,676	125	9,436	112	22,120	120

Table A2: Area of Forest Land by Forest Type and Ownership Group, 2007-2016: All Washington.

Forest Type	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand acres															
Softwoods:																
Douglas-fir	2,824	67	455	46	1,101	60	259	37	2,638	104	1,624	85	4,262	121	8,901	156
Fir / spruce / mountain hemlock	2,708	80	455	43	124	26	68	20	280	39	220	35	500	52	3,856	109
Western Hemlock / Sitka spruce	951	43	429	41	376	42	86	21	787	63	358	44	1,144	74	2,986	105
Lodgepole pine	461	39	11	7	27	12	13	9	23	11	146	28	169	30	680	52
Ponderosa pine	367	27	52	15	193	31	73	20	238	37	1,112	73	1,351	79	2,036	91
Western juniper	2	2	--	--	--	--	--	--	--	--	--	--	--	--	2	2
Western larch	220	21	9	7	35	15	5	6	24	11	78	20	101	23	371	36
Western white pine	14	5	--	--	--	--	--	--	--	--	--	--	--	--	14	5
Other western softwoods	134	27	--	--	7	7	--	--	--	--	9	7	9	7	150	28
Total	7,683	62	1,410	44	1,862	59	505	52	3,990	117	3,547	116	7,537	125	18,997	147
Hardwoods:																
Alder / maple	107	17	34	13	185	31	157	29	475	48	602	54	1,077	70	1,560	83
Aspen / birch	31	7	--	--	14	8	4	4	23	12	64	18	87	22	136	25
Elm / ash / cottonwood	17	7	7	5	10	8	38	14	45	15	74	20	119	25	191	31
Western oak	1	1	3	4	6	6	--	--	38	15	107	24	145	28	155	29
Woodland hardwoods	12	6	--	--	--	--	--	--	4	3	8	7	12	8	25	10
Other hardwoods	28	7	4	4	4	4	3	3	43	15	78	21	120	25	160	27
Total	197	21	48	15	219	33	202	32	628	55	932	67	1,560	83	2,226	97
Nonstocked	413	36	12	9	109	23	24	12	142	26	197	33	339	42	897	62
All forest types	8,293	51	1,470	44	2,190	54	731	62	4,760	123	4,676	125	9,436	112	22,120	120

Table A3: Area of Forest Land Remaining Forest Land by Ownership Group and Ecological Region in Washington, 2007-2016.

	Public		Private		All Ownerships	
	Total	SE	Total	SE	Total	SE
			Thousand acres			
Blues+Columbia Basin:						
Unreserved forest land	231	18	448	50	679	53
Reserved forest land	126	22	--	--	126	22
Total forest land	358	28	448	50	806	57
Eastern Cascades:						
Unreserved forest land	747	52	962	72	1,709	88
Reserved forest land	92	27	--	--	92	27
Total forest land	839	58	962	72	1,801	93
Northern Cascades:						
Unreserved forest land	2,876	69	697	62	3,574	93
Reserved forest land	1,918	76	--	--	1,918	76
Total forest land	4,794	97	697	62	5,491	115
Okanogan Highland:						
Unreserved forest land	1,691	46	2,329	97	4,020	107
Reserved forest land	114	27	--	--	114	27
Total forest land	1,805	52	2,329	97	4,133	110
Puget Trough:						
Unreserved forest land	489	50	1,452	82	1,941	94
Reserved forest land	119	27	--	--	119	27
Total forest land	608	56	1,452	82	2,060	97
Washington Coast Range:						
Unreserved forest land	1,121	55	2,285	98	3,406	111
Reserved forest land	781	49	--	--	781	49
Total forest land	1,903	74	2,285	98	4,187	121
Western Cascades:						
Unreserved forest land	1,723	59	1,263	81	2,987	99
Reserved forest land	649	54	--	--	649	54
Total forest land	2,373	79	1,263	81	3,636	112
All Washington:						
Unreserved forest land	8,880	84	9,436	112	18,316	114
Reserved forest land	3,799	71	--	--	3,799	71
Total forest land	12,679	95	9,436	112	22,115	120

B. Forest Carbon Flux

Table B1: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-16,702	927	-4,180	500	-3,209	387	-1,070	235	-3,617	396	-4,094	395	-7,711	533	-32,872	1,250
Cut	-1,226	221	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Gross Growth	23,913	423	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Net	5,985	1,032	651	489	567	1,607	1,379	377	1,678	2,385	4,042	1,027	5,721	2,600	14,303	3,283
Foliage	337	65	35	29	63	91	74	21	115	144	209	59	324	156	833	195
Tree Roots																
Live	1,190	242	145	112	185	362	320	82	408	544	864	228	1,272	590	3,112	746
Dead	731	194	8	52	14	63	13	24	-155	42	29	69	-126	81	641	227
Standing Dead	3,128	785	396	225	312	239	158	108	-203	133	291	272	87	304	4,082	910
Dead Woody Debris	-1,208	593	103	394	-1,120	437	-308	145	-2,897	655	-1,417	513	-4,314	828	-6,846	1,184
Understory Vegetation																
Above Ground	20	18	0	5	2	12	-10	6	-37	26	-33	17	-70	31	-58	38
Below Ground	2	2	0	1	0	1	-1	1	-4	3	-4	2	-8	3	-6	4
Total	10,186	1,004	1,339	617	23	2,063	1,626	460	-1,094	3,230	3,980	1,389	2,886	3,526	16,060	4,274
Forest Floor	-51	126	84	41	-41	66	26	23	20	116	213	82	233	141	250	206
Soils	22	122	-48	47	-103	95	-89	53	189	174	-146	177	43	248	-175	301
Total (including soils and forest floor)	10,156	1,060	1,375	632	-121	2,126	1,563	476	-885	3,303	4,047	1,448	3,162	3,616	16,135	4,396

Table B2: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.02	0.11	-2.76	0.32	-1.44	0.17	-1.55	0.27	-0.72	0.08	-0.94	0.08	-0.83	0.06	-1.49	0.06
Cut	-0.15	0.03	-0.08	0.07	-2.73	0.66	-0.65	0.32	-3.88	0.42	-0.92	0.20	-2.50	0.25	-1.42	0.12
Gross Growth	2.89	0.05	3.28	0.20	4.43	0.21	4.19	0.37	4.94	0.16	2.80	0.12	3.94	0.10	3.56	0.05
Net	0.72	0.12	0.43	0.32	0.26	0.72	1.99	0.49	0.34	0.48	0.93	0.23	0.61	0.28	0.65	0.15
Foliage	0.04	0.01	0.02	0.02	0.03	0.04	0.11	0.03	0.02	0.03	0.05	0.01	0.03	0.02	0.04	0.01
Tree Roots																
Live	0.14	0.03	0.10	0.07	0.08	0.16	0.46	0.11	0.08	0.11	0.20	0.05	0.14	0.06	0.14	0.03
Dead	0.09	0.02	0.01	0.03	0.01	0.03	0.02	0.04	-0.03	0.01	0.01	0.02	-0.01	0.01	0.03	0.01
Standing Dead	0.38	0.09	0.26	0.15	0.14	0.11	0.23	0.15	-0.04	0.03	0.07	0.06	0.01	0.03	0.19	0.04
Dead Woody Debris	-0.15	0.07	0.07	0.26	-0.50	0.20	-0.44	0.20	-0.58	0.13	-0.33	0.12	-0.46	0.09	-0.31	0.05
Understory Vegetation																
Above Ground	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.00	-0.01	0.00	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.23	0.12	0.88	0.40	0.01	0.93	2.35	0.61	-0.22	0.65	0.92	0.32	0.31	0.38	0.73	0.19
Forest Floor	-0.01	0.02	0.06	0.03	-0.02	0.03	0.04	0.03	0.00	0.02	0.05	0.02	0.02	0.02	0.01	0.01
Soils	0.00	0.01	-0.03	0.03	-0.05	0.04	-0.13	0.08	0.04	0.03	-0.03	0.04	0.00	0.03	-0.01	0.01
Total (including soils and forest floor)	1.23	0.13	0.91	0.41	-0.05	0.96	2.26	0.64	-0.18	0.66	0.93	0.33	0.34	0.39	0.73	0.20

Table B3: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Ecological Region, 2002-2006 to 2012-2016: All Washington.

	Ecological Region															
Change in Carbon Pool	**Blues+Columbia Basin**		**Eastern Cascades**		**Northern Cascades**		**Okanogan Highland**		**Puget Trough**		**Washington Coast Range**		**Western Cascades**		**Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-1,506	268	-2,336	339	-10,960	929	-3,631	323	-2,300	360	-7,684	674	-4,455	419	-32,872	1,250
Cut	-259	83	-1,871	494	-2,662	858	-2,886	485	-5,855	1,469	-11,281	1,858	-6,400	1,283	-31,214	2,735
Gross Growth	1,240	167	4,207	377	14,952	754	8,905	422	9,498	746	22,750	1,142	16,837	942	78,389	1,247
Net	-525	258	-0	563	1,330	1,274	2,388	585	1,343	1,482	3,786	2,065	5,982	1,439	14,303	3,283
Foliage	-32	15	-7	34	33	78	144	34	73	78	247	126	376	88	833	195
Tree Roots																
Live	-112	55	-39	127	99	297	530	121	286	325	942	472	1,407	331	3,112	746
Dead	-15	41	68	61	652	185	49	48	-49	33	-71	63	7	64	641	227
Standing Dead	-59	179	358	249	2,888	748	246	202	-96	112	341	245	404	230	4,082	910
Dead Woody Debris	-413	386	-520	286	-1,799	620	3	237	-493	237	-1,295	671	-2,330	493	-6,846	1,184
Understory Vegetation																
Above Ground	8	9	15	10	36	18	-19	13	-25	14	-36	20	-37	17	-58	38
Below Ground	1	1	2	1	4	2	-2	1	-3	2	-4	2	-4	2	-6	4
Total	-1,149	524	-124	737	3,244	1,427	3,338	713	1,037	1,904	3,908	2,804	5,806	1,885	16,060	4,274
Forest Floor	-28	22	-6	32	-168	131	51	56	73	68	187	103	141	73	250	206
Soils	-12	51	76	70	-118	150	13	116	-45	93	54	164	-143	107	-175	301
Total (including soils and forest floor)	-1,189	531	-55	747	2,958	1,484	3,402	739	1,065	1,955	4,150	2,866	5,804	1,959	16,135	4,396

Table B4: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Ecological Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	Ecological Region														Total	
	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.77	0.28	-1.28	0.16	-2.00	0.16	-0.91	0.08	-1.19	0.17	-1.81	0.15	-1.20	0.10	-1.49	0.06
Cut	-0.30	0.10	-1.03	0.26	-0.49	0.16	-0.72	0.12	-3.02	0.72	-2.66	0.42	-1.73	0.33	-1.42	0.12
Gross Growth	1.45	0.12	2.31	0.13	2.74	0.10	2.23	0.07	4.90	0.20	5.36	0.17	4.54	0.15	3.56	0.05
Net	-0.62	0.31	0.00	0.31	0.24	0.23	0.60	0.15	0.69	0.76	0.89	0.48	1.61	0.39	0.65	0.15
Foliage	-0.04	0.02	0.00	0.02	0.01	0.01	0.04	0.01	0.04	0.04	0.06	0.03	0.10	0.02	0.04	0.01
Tree Roots																
Live	-0.13	0.07	-0.02	0.07	0.02	0.05	0.13	0.03	0.15	0.17	0.22	0.11	0.38	0.09	0.14	0.03
Dead	-0.02	0.05	0.04	0.03	0.12	0.03	0.01	0.01	-0.03	0.02	-0.02	0.01	0.00	0.02	0.03	0.01
Standing Dead	-0.07	0.21	0.20	0.14	0.53	0.13	0.06	0.05	-0.05	0.06	0.08	0.06	0.11	0.06	0.19	0.04
Dead Woody Debris	-0.48	0.45	-0.29	0.16	-0.33	0.11	0.00	0.06	-0.25	0.12	-0.30	0.16	-0.63	0.13	-0.31	0.05
Understory Vegetation																
Above Ground	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	0.01	-0.01	0.00	-0.01	0.00	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	-1.35	0.60	-0.07	0.40	0.59	0.26	0.83	0.18	0.54	0.98	0.92	0.66	1.57	0.51	0.73	0.19
Forest Floor	-0.03	0.03	0.00	0.02	-0.03	0.02	0.01	0.01	0.04	0.04	0.04	0.02	0.04	0.02	0.01	0.01
Soils	-0.01	0.06	0.04	0.04	-0.02	0.03	0.00	0.03	-0.02	0.05	0.01	0.04	-0.04	0.03	-0.01	0.01
Total (including soils and forest floor)	-1.39	0.61	-0.03	0.41	0.54	0.27	0.85	0.19	0.55	1.01	0.98	0.67	1.57	0.53	0.73	0.20

Table B5: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Eastern Washington.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-10,656	857	-487	151	-901	247	-261	131	-324	72	-2,628	344	-2,952	348	-15,257	976
Cut	-574	108	-116	112	-768	296	-57	57	-2,000	503	-2,039	414	-4,040	641	-5,555	725
Gross Growth	9,531	240	540	130	1,381	213	333	92	2,253	296	5,682	400	7,935	460	19,720	577
Net	-1,699	885	-63	146	-288	368	15	121	-71	488	1,015	535	944	722	-1,091	1,213
Foliage	-106	55	-4	8	-19	22	1	7	-11	29	53	32	42	43	-86	74
Tree Roots																
Live	-408	202	-14	28	-58	78	7	23	-47	105	194	118	147	158	-327	270
Dead	657	183	17	17	69	43	18	18	-29	12	38	63	8	64	770	200
Standing Dead	2,781	745	76	66	319	182	91	87	-113	44	192	257	79	261	3,346	818
Dead Woody Debris	-138	361	104	63	-175	131	-20	57	-82	134	-1,059	461	-1,140	479	-1,368	620
Understory Vegetation																
Above Ground	59	17	-0	3	4	5	-1	3	1	9	8	14	8	17	70	25
Below Ground	7	2	-0	0	0	1	-0	0	0	1	1	2	1	2	8	3
Total	1,153	637	115	191	-147	402	111	108	-353	650	441	789	88	1,023	1,321	1,287
Forest Floor	-192	72	-1	14	-43	34	-5	13	-13	38	62	44	49	58	-192	100
Soils	-82	108	-63	41	42	63	-31	35	141	86	-29	117	112	146	-22	199
Total (including soils and forest floor)	878	677	51	204	-148	406	76	124	-225	662	474	825	249	1,059	1,106	1,341

Table B6: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Eastern Washington.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**			
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.181	0.172	-1.867	0.439	-1.125	0.278	-1.406	0.591	-0.341	0.066	-0.856	0.102	-0.734	0.080	-1.503	0.094
Cut	-0.118	0.022	-0.443	0.443	-0.960	0.352	-0.305	0.297	-2.105	0.478	-0.665	0.131	-1.005	0.154	-0.547	0.070
Gross Growth	1.951	0.047	2.067	0.358	1.726	0.191	1.794	0.227	2.371	0.176	1.852	0.091	1.974	0.082	1.943	0.043
Net	-0.348	0.181	-0.243	0.553	-0.359	0.456	0.082	0.655	-0.075	0.513	0.331	0.174	0.235	0.179	-0.108	0.119
Foliage	-0.022	0.011	-0.016	0.029	-0.023	0.027	0.006	0.035	-0.012	0.030	0.017	0.010	0.010	0.011	-0.009	0.007
Tree Roots																
Live	-0.084	0.041	-0.055	0.105	-0.073	0.097	0.037	0.125	-0.049	0.111	0.063	0.038	0.037	0.039	-0.032	0.027
Dead	0.135	0.037	0.066	0.061	0.086	0.053	0.097	0.091	-0.031	0.012	0.012	0.020	0.002	0.016	0.076	0.020
Standing Dead	0.569	0.152	0.290	0.239	0.399	0.221	0.489	0.444	-0.119	0.045	0.063	0.084	0.020	0.065	0.330	0.080
Dead Woody Debris	-0.028	0.074	0.399	0.231	-0.218	0.162	-0.106	0.305	-0.086	0.141	-0.345	0.149	-0.284	0.118	-0.135	0.061
Understory Vegetation																
Above Ground	0.012	0.003	-0.000	0.012	0.005	0.006	-0.005	0.015	0.001	0.010	0.003	0.005	0.002	0.004	0.007	0.002
Below Ground	0.001	0.000	-0.000	0.001	0.001	0.001	-0.001	0.002	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.000
Total	0.236	0.131	0.442	0.731	-0.183	0.502	0.600	0.575	-0.372	0.683	0.144	0.257	0.022	0.255	0.130	0.127
Forest Floor	-0.039	0.015	-0.004	0.055	-0.054	0.041	-0.024	0.070	-0.014	0.040	0.020	0.014	0.012	0.014	-0.019	0.010
Soils	-0.017	0.022	-0.242	0.155	0.052	0.079	-0.166	0.189	0.149	0.090	-0.009	0.038	0.028	0.036	-0.002	0.020
Total (including soils and forest floor)	0.180	0.139	0.195	0.782	-0.185	0.506	0.410	0.663	-0.237	0.697	0.155	0.269	0.062	0.263	0.109	0.132

Table B7: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Western Washington.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-6,047	376	-3,693	490	-2,308	326	-809	196	-3,293	392	-1,466	212	-4,759	429	-17,616	831
Cut	-652	193	-10	10	-5,288	1,451	-395	224	-17,338	2,106	-1,977	803	-19,315	2,237	-25,660	2,671
Gross Growth	14,383	368	4,418	376	8,451	568	2,567	440	22,381	1,114	6,471	652	28,851	1,139	58,669	1,322
Net	7,684	525	714	466	855	1,565	1,364	357	1,749	2,336	3,028	879	4,777	2,499	15,394	3,051
Foliage	443	34	39	28	81	88	73	19	126	141	156	50	283	150	920	180
Tree Roots																
Live	1,598	131	159	109	244	353	314	79	455	534	670	195	1,125	569	3,439	695
Dead	74	66	-9	49	-55	45	-5	17	-125	40	-9	28	-134	49	-129	107
Standing Dead	347	251	321	216	-7	155	67	65	-90	126	98	90	8	155	736	403
Dead Woody Debris	-1,070	470	-1	388	-946	420	-288	133	-2,815	641	-358	224	-3,173	677	-5,478	1,009
Understory Vegetation																
Above Ground	-39	5	1	4	-2	11	-9	5	-37	25	-41	10	-78	26	-128	30
Below Ground	-4	1	0	0	-0	1	-1	1	-4	3	-5	1	-9	3	-14	3
Total	9,033	773	1,223	587	170	2,022	1,515	447	-741	3,167	3,540	1,145	2,799	3,376	14,740	4,076
Forest Floor	141	104	85	39	3	57	30	18	33	109	151	69	184	129	442	180
Soils	104	58	16	23	-145	71	-59	39	48	151	-117	132	-69	201	-153	226
Total (including soils and forest floor)	9,278	813	1,324	597	27	2,085	1,486	460	-660	3,239	3,573	1,192	2,913	3,459	15,029	4,186

Table B8: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Western Washington.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.785	0.107	-2.949	0.373	-1.624	0.217	-1.599	0.302	-0.815	0.094	-1.148	0.139	-0.895	0.079	-1.482	0.068
Cut	-0.192	0.057	-0.008	0.008	-3.721	1.013	-0.781	0.424	-4.293	0.509	-1.549	0.619	-3.634	0.417	-2.159	0.224
Gross Growth	4.245	0.108	3.528	0.216	5.946	0.258	5.077	0.439	5.541	0.183	5.070	0.288	5.428	0.154	4.937	0.087
Net	2.268	0.158	0.570	0.366	0.601	1.099	2.697	0.594	0.433	0.577	2.372	0.654	0.899	0.467	1.296	0.255
Foliage	0.131	0.010	0.031	0.022	0.057	0.062	0.145	0.032	0.031	0.035	0.122	0.038	0.053	0.028	0.077	0.015
Tree Roots																
Live	0.472	0.039	0.127	0.086	0.172	0.248	0.620	0.129	0.113	0.132	0.525	0.145	0.212	0.106	0.289	0.058
Dead	0.022	0.019	-0.007	0.039	-0.039	0.032	-0.009	0.033	-0.031	0.010	-0.007	0.022	-0.025	0.009	-0.011	0.009
Standing Dead	0.102	0.074	0.256	0.172	-0.005	0.109	0.133	0.126	-0.022	0.031	0.077	0.070	0.002	0.029	0.062	0.034
Dead Woody Debris	-0.316	0.139	-0.001	0.310	-0.665	0.294	-0.570	0.249	-0.697	0.156	-0.281	0.174	-0.597	0.126	-0.461	0.085
Understory Vegetation																
Above Ground	-0.011	0.001	0.000	0.003	-0.001	0.008	-0.018	0.009	-0.009	0.006	-0.032	0.007	-0.015	0.005	-0.011	0.002
Below Ground	-0.001	0.000	0.000	0.000	-0.000	0.001	-0.002	0.001	-0.001	0.001	-0.004	0.001	-0.002	0.001	-0.001	0.000
Total	2.666	0.228	0.977	0.457	0.119	1.422	2.996	0.780	-0.183	0.785	2.773	0.860	0.527	0.634	1.240	0.342
Forest Floor	0.042	0.031	0.068	0.031	0.002	0.040	0.060	0.035	0.008	0.027	0.118	0.053	0.035	0.024	0.037	0.015
Soils	0.031	0.017	0.012	0.018	-0.102	0.049	-0.116	0.075	0.012	0.037	-0.092	0.103	-0.013	0.038	-0.013	0.019
Total (including soils and forest floor)	2.739	0.239	1.057	0.464	0.019	1.467	2.940	0.813	-0.163	0.802	2.799	0.897	0.548	0.650	1.265	0.351

Table B9: Annual Net Change in Carbon Stocks on Forest Land for All Pools by WA-DNR Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year					
Standing Live tree						
Mortality	-901	247	-2,308	326	-3,209	387
Cut	-768	296	-5,288	1,451	-6,056	1,467
Gross Growth	1,381	213	8,451	568	9,832	531
Net	-288	368	855	1,565	567	1,607
Foliage	-19	22	81	88	63	91
Tree Roots						
Live	-58	78	244	353	185	362
Dead	69	43	-55	45	14	63
Standing Dead	319	182	-7	155	312	239
Dead Woody Debris	-175	131	-946	420	-1,120	437
Understory Vegetation						
Above Ground	4	5	-2	11	2	12
Below Ground	0	1	-0	1	0	1
Total	-147	402	170	2,022	23	2,063
Forest Floor	-43	34	3	57	-41	66
Soils	42	63	-145	71	-103	95
Total (including soils and forest floor)	-148	406	27	2,085	-121	2,126

Table B10: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by WA-DNR Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	East Total		West Total		DNR Total	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre					
Standing Live tree						
Mortality	-1.13	0.28	-1.62	0.22	-1.44	0.17
Cut	-0.96	0.35	-3.72	1.01	-2.73	0.66
Gross Growth	1.73	0.19	5.95	0.26	4.43	0.21
Net	-0.36	0.46	0.60	1.10	0.26	0.72
Foliage	-0.02	0.03	0.06	0.06	0.03	0.04
Tree Roots						
Live	-0.07	0.10	0.17	0.25	0.08	0.16
Dead	0.09	0.05	-0.04	0.03	0.01	0.03
Standing Dead	0.40	0.22	0.00	0.11	0.14	0.11
Dead Woody Debris	-0.22	0.16	-0.67	0.29	-0.50	0.20
Understory Vegetation						
Above Ground	0.00	0.01	0.00	0.01	0.00	0.01
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00
Total	-0.18	0.50	0.12	1.42	0.01	0.93
Forest Floor	-0.05	0.04	0.00	0.04	-0.02	0.03
Soils	0.05	0.08	-0.10	0.05	-0.05	0.04
Total (including soils and forest floor)	-0.18	0.51	0.02	1.47	-0.05	0.96

Table B11: Annual Net Change in Carbon Stocks for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: All Washington.

	Public								Private							
Change in Carbon Pool by disturbance	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-83	24	-4	4	-306	145	-15	10	-376	151	-455	137	-831	204	-1,239	252
Cut	-952	209	-116	112	-5,803	1,465	-441	230	-18,845	2,128	-3,661	896	-22,507	2,286	-29,817	2,722
Gross Growth	616	103	27	26	1,137	233	242	144	5,315	544	1,783	281	7,099	603	9,121	666
Net Live	-418	153	-93	90	-4,972	1,386	-214	173	-13,906	1,937	-2,333	798	-16,239	2,081	-21,936	2,505
Standing Dead Change	-16	13	-7	6	-215	129	0	6	-459	77	-270	72	-728	104	-966	167
Dead Woody Debris Change	-45	61	-20	20	49	165	33	23	-707	384	81	177	-626	423	-609	459
Total Net	-595	196	-145	141	-6,560	1,812	-225	208	-19,048	2,676	-3,253	1,083	-22,301	2,869	-29,826	3,400
Cut and Fire																
Mortality	-42	22	--	--	--	--	--	--	--	--	-22	19	-22	19	-64	29
Cut	-131	65	--	--	--	--	--	--	--	--	-56	48	-56	48	-187	80
Gross Growth	21	11	--	--	--	--	--	--	--	--	16	12	16	12	37	16
Net Live	-153	74	--	--	--	--	--	--	--	--	-61	42	-61	42	-213	85
Standing Dead Change	-49	40	--	--	--	--	--	--	--	--	-13	21	-13	21	-62	45
Dead Woody Debris Change	-5	8	--	--	--	--	--	--	--	--	-8	7	-8	7	-13	10
Total Net	-257	138	--	--	--	--	--	--	--	--	-97	58	-97	58	-354	150
Fire																
Mortality	-3,895	611	-39	39	-297	156	-110	108	-29	29	-551	191	-580	193	-4,920	669
Cut	-43	20	--	--	--	--	--	--	--	--	--	--	--	--	-43	20
Gross Growth	561	67	10	10	91	50	36	25	8	8	236	86	244	86	943	123
Net Live	-3,376	568	-29	29	-205	118	-73	94	-21	21	-315	162	-336	164	-4,021	610
Standing Dead Change	1,814	401	15	15	153	106	74	73	6	7	188	97	194	97	2,249	433
Dead Woody Debris Change	-335	116	0	0	-30	18	-10	7	-15	13	-160	88	-175	89	-549	148
Total Net	-2,311	422	-17	17	-97	99	-8	36	-32	29	-316	147	-348	150	-2,781	460
Insect and Disease																
Mortality	-5,827	734	-779	268	-888	230	-243	105	-373	87	-1,235	251	-1,608	264	-9,345	861
Cut	-67	28	--	--	-47	50	--	--	-7	7	-41	23	-48	25	-162	63
Gross Growth	5,929	317	683	181	1,722	355	443	185	2,116	442	1,697	254	3,813	505	12,591	735
Net Live	36	668	-96	162	787	314	200	147	1,735	376	422	213	2,157	430	3,084	881
Standing Dead Change	1,988	587	114	94	351	142	59	48	29	32	413	172	442	175	2,953	637
Dead Woody Debris Change	-32	280	164	194	-249	215	-19	78	-318	90	-164	101	-483	135	-618	432
Total Net	2,435	439	193	181	1,199	398	301	147	1,937	453	893	241	2,830	511	6,959	814
Other cut and weather																
Mortality	-1,196	265	-583	220	-220	94	-216	104	-866	305	-204	98	-1,070	320	-3,285	490
Cut	-14	11	--	--	-43	46	--	--	-83	63	-64	32	-147	70	-203	85
Gross Growth	897	144	474	145	465	169	381	169	1,477	347	485	142	1,962	373	4,179	486
Net Live	-313	207	-109	143	202	110	165	124	528	382	217	103	745	396	690	497
Standing Dead Change	-50	65	-26	72	-18	28	-2	31	21	28	-28	63	-6	69	-102	126
Dead Woody Debris Change	46	141	274	84	29	62	-41	58	-39	145	24	37	-15	149	294	237
Total Net	-393	254	102	201	272	150	166	202	671	478	274	119	945	492	1,091	640
Less than 25% disturbed																
Mortality	-5,660	336	-2,775	424	-1,498	272	-487	148	-1,973	219	-1,627	204	-3,600	284	-14,020	678
Cut	-20	7	-10	10	-163	143	-11	10	-403	137	-195	84	-598	160	-802	215
Gross Growth	15,889	456	3,763	377	6,417	592	1,798	345	15,718	1,043	7,935	661	23,653	1,120	51,519	1,372
Net Live	10,209	487	978	422	4,755	562	1,301	266	13,342	948	6,113	579	19,455	1,028	36,697	1,322
Standing Dead Change	-559	321	299	193	43	84	27	56	199	96	-0	158	199	185	10	429
Dead Woody Debris Change	-839	481	-314	335	-919	342	-271	108	-1,818	507	-1,189	461	-3,007	682	-5,351	966
Total Net	11,307	721	1,206	536	5,209	724	1,392	328	15,378	1,268	6,479	812	21,858	1,423	40,972	1,823
Total																
Mortality	-16,702	927	-4,180	500	-3,209	387	-1,070	235	-3,617	396	-4,094	395	-7,711	533	-32,872	1,250
Cut	-1,226	221	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Gross Growth	23,913	423	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Net Live	5,985	1,032	651	489	567	1,607	1,379	377	1,678	2,385	4,042	1,027	5,721	2,600	14,303	3,283
Standing Dead Change	3,128	785	396	225	312	239	158	108	-203	133	291	272	87	304	4,082	910
Dead Woody Debris Change	-1,208	593	103	394	-1,120	437	-308	145	-2,897	655	-1,417	513	-4,314	828	-6,846	1,184
Total Net	10,186	1,004	1,339	617	23	2,063	1,626	460	-1,094	3,230	3,980	1,389	2,886	3,526	16,060	4,274

Table B12: Annual Net Change in Carbon Stocks per Acre for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: All Washington.

	Public								Private							
Change in Carbon Pool by disturbance	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Cut																
Mortality	-0.40	0.10	-0.28	0.28	-0.85	0.38	-0.28	0.14	-0.27	0.11	-0.66	0.18	-0.40	0.09	-0.46	0.09
Cut	-4.62	0.82	-7.76	7.76	-16.16	3.28	-8.45	1.85	-13.71	1.14	-5.27	1.14	-10.88	0.88	-11.04	0.82
Gross Growth	2.99	0.31	1.82	1.82	3.17	0.40	4.63	1.60	3.87	0.24	2.57	0.26	3.43	0.19	3.38	0.16
Net Live	-2.03	0.70	-6.22	6.22	-13.85	3.26	-4.10	2.72	-10.11	1.19	-3.36	1.09	-7.85	0.89	-8.12	0.82
Standing Dead Change	-0.08	0.06	-0.44	0.44	-0.60	0.35	0.01	0.11	-0.33	0.05	-0.39	0.09	-0.35	0.04	-0.36	0.06
Dead Woody Debris Change	-0.22	0.29	-1.35	1.35	0.14	0.46	0.63	0.32	-0.51	0.28	0.12	0.25	-0.30	0.20	-0.23	0.17
Total Net	-2.89	0.88	-9.73	9.73	-18.27	4.27	-4.32	3.44	-13.85	1.65	-4.69	1.47	-10.78	1.23	-11.04	1.11
Cut and Fire																
Mortality	-2.40	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.67	0.63	-0.67	0.63	-1.28	0.63
Cut	-7.46	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.73	1.73	-1.73	1.73	-3.75	1.27
Gross Growth	1.18	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.23	0.51	0.23	0.75	0.22
Net Live	-8.68	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.89	0.84	-1.89	0.84	-4.29	1.50
Standing Dead Change	-2.81	1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.39	0.57	-0.39	0.57	-1.25	0.86
Dead Woody Debris Change	-0.26	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25	0.13	-0.25	0.13	-0.26	0.17
Total Net	-14.62	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.01	0.21	-3.01	0.21	-7.12	2.62
Fire																
Mortality	-7.54	0.70	-2.98	2.98	-5.32	1.55	-3.79	3.79	-1.23	0.82	-2.53	0.62	-2.41	0.57	-5.75	0.54
Cut	-0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.02
Gross Growth	1.09	0.07	0.75	0.75	1.64	0.38	1.25	0.03	0.34	0.23	1.08	0.30	1.01	0.27	1.10	0.09
Net Live	-6.53	0.70	-2.23	2.23	-3.68	1.48	-2.54	2.79	-0.89	0.58	-1.45	0.65	-1.40	0.59	-4.70	0.55
Standing Dead Change	3.51	0.60	1.13	1.13	2.74	1.37	2.54	2.54	0.26	0.26	0.86	0.39	0.81	0.36	2.63	0.42
Dead Woody Debris Change	-0.65	0.20	0.03	0.03	-0.54	0.22	-0.33	0.06	-0.65	0.24	-0.73	0.37	-0.73	0.33	-0.64	0.15
Total Net	-4.47	0.59	-1.33	1.33	-1.74	1.72	-0.27	1.22	-1.37	0.64	-1.45	0.58	-1.44	0.52	-3.25	0.44
Insect and Disease																
Mortality	-2.38	0.26	-3.45	0.87	-1.99	0.43	-1.85	0.59	-0.94	0.15	-1.58	0.26	-1.37	0.18	-2.11	0.17
Cut	-0.03	0.01	0.00	0.00	-0.10	0.11	0.00	0.00	-0.02	0.02	-0.05	0.03	-0.04	0.02	-0.04	0.01
Gross Growth	2.42	0.08	3.03	0.45	3.87	0.54	3.38	0.98	5.31	0.60	2.18	0.20	3.24	0.29	2.84	0.11
Net Live	0.01	0.27	-0.43	0.71	1.77	0.65	1.53	1.01	4.35	0.55	0.54	0.27	1.83	0.32	0.70	0.20
Standing Dead Change	0.81	0.23	0.51	0.40	0.79	0.30	0.45	0.35	0.07	0.08	0.53	0.21	0.37	0.14	0.67	0.14
Dead Woody Debris Change	-0.01	0.11	0.72	0.85	-0.56	0.48	-0.15	0.58	-0.80	0.18	-0.21	0.13	-0.41	0.11	-0.14	0.10
Total Net	1.00	0.18	0.85	0.80	2.69	0.79	2.30	0.93	4.86	0.74	1.15	0.28	2.40	0.36	1.57	0.17
Other cut and weather																
Mortality	-3.60	0.66	-2.90	0.91	-2.38	0.77	-2.26	0.70	-3.18	0.97	-1.43	0.58	-2.58	0.67	-2.89	0.36
Cut	-0.04	0.03	0.00	0.00	-0.46	0.48	0.00	0.00	-0.30	0.22	-0.45	0.20	-0.35	0.16	-0.18	0.07
Gross Growth	2.70	0.25	2.36	0.47	5.02	0.69	3.99	0.99	5.42	0.64	3.40	0.47	4.73	0.48	3.68	0.26
Net Live	-0.94	0.61	-0.54	0.71	2.18	0.82	1.73	1.14	1.94	1.32	1.52	0.60	1.79	0.89	0.61	0.43
Standing Dead Change	-0.15	0.19	-0.13	0.36	-0.20	0.31	-0.03	0.32	0.08	0.10	-0.19	0.44	-0.02	0.17	-0.09	0.11
Dead Woody Debris Change	0.14	0.42	1.36	0.26	0.31	0.68	-0.42	0.58	-0.14	0.53	0.17	0.26	-0.04	0.36	0.26	0.21
Total Net	-1.18	0.75	0.51	0.99	2.94	1.16	1.74	2.01	2.46	1.67	1.92	0.66	2.28	1.12	0.96	0.55
Less than 25% disturbed																
Mortality	-1.19	0.07	-2.62	0.37	-1.18	0.20	-1.27	0.31	-0.68	0.07	-0.66	0.07	-0.67	0.05	-1.09	0.05
Cut	0.00	0.00	-0.01	0.01	-0.13	0.11	-0.03	0.03	-0.14	0.05	-0.08	0.03	-0.11	0.03	-0.06	0.02
Gross Growth	3.34	0.09	3.55	0.24	5.06	0.31	4.69	0.44	5.38	0.22	3.20	0.19	4.38	0.15	4.00	0.08
Net Live	2.15	0.10	0.92	0.39	3.75	0.36	3.39	0.42	4.57	0.21	2.47	0.18	3.60	0.15	2.85	0.09
Standing Dead Change	-0.12	0.07	0.28	0.18	0.03	0.07	0.07	0.14	0.07	0.03	0.00	0.06	0.04	0.03	0.00	0.03
Dead Woody Debris Change	-0.18	0.10	-0.30	0.32	-0.72	0.26	-0.71	0.26	-0.62	0.17	-0.48	0.18	-0.56	0.12	-0.42	0.07
Total Net	2.38	0.15	1.14	0.49	4.10	0.49	3.63	0.61	5.27	0.34	2.61	0.29	4.05	0.23	3.18	0.13
Total																
Mortality	-2.02	0.11	-2.76	0.32	-1.44	0.17	-1.55	0.27	-0.72	0.08	-0.94	0.08	-0.83	0.06	-1.49	0.06
Cut	-0.15	0.03	-0.08	0.07	-2.73	0.66	-0.65	0.32	-3.88	0.42	-0.92	0.20	-2.50	0.25	-1.42	0.12
Gross Growth	2.89	0.05	3.28	0.20	4.43	0.21	4.19	0.37	4.94	0.16	2.80	0.12	3.94	0.10	3.56	0.05
Net Live	0.72	0.12	0.43	0.32	0.26	0.72	1.99	0.49	0.34	0.48	0.93	0.23	0.61	0.28	0.65	0.15
Standing Dead Change	0.38	0.09	0.26	0.15	0.14	0.11	0.23	0.15	-0.04	0.03	0.07	0.06	0.01	0.03	0.19	0.04
Dead Woody Debris Change	-0.15	0.07	0.07	0.26	-0.50	0.20	-0.44	0.20	-0.58	0.13	-0.33	0.12	-0.46	0.09	-0.31	0.05
Total Net	1.23	0.12	0.88	0.40	0.01	0.93	2.35	0.61	-0.22	0.65	0.92	0.32	0.31	0.38	0.73	0.19

Table B13: Annual Net Change in Carbon Stocks for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: Eastern Washington.

Change in Carbon Pool by disturbance	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-45	16	-4	4	-110	83	-5	5	-33	15	-301	119	-334	120	-498	146
Cut	-313	80	-116	112	-758	296	-57	57	-1,959	501	-1,788	404	-3,747	636	-4,990	716
Gross Growth	195	38	27	26	214	78	23	21	563	131	955	171	1,518	211	1,977	230
Net Live	-162	64	-93	90	-653	258	-39	42	-1,430	433	-1,134	372	-2,564	566	-3,511	632
Standing Dead Change	-12	10	-7	6	33	72	3	4	-97	34	-209	68	-306	76	-288	105
Dead Woody Debris Change	-44	52	-20	20	31	53	-5	6	99	96	93	154	192	181	155	197
Total Net	-259	87	-145	141	-753	306	-50	55	-1,841	590	-1,623	553	-3,465	802	-4,671	875
Cut and Fire																
Mortality	-42	22	--	--	--	--	--	--	--	--	-22	19	-22	19	-64	29
Cut	-131	65	--	--	--	--	--	--	--	--	-56	48	-56	48	-187	80
Gross Growth	21	11	--	--	--	--	--	--	--	--	16	12	16	12	37	16
Net Live	-153	74	--	--	--	--	--	--	--	--	-61	42	-61	42	-213	85
Standing Dead Change	-49	40	--	--	--	--	--	--	--	--	-13	21	-13	21	-62	45
Dead Woody Debris Change	-5	8	--	--	--	--	--	--	--	--	-8	7	-8	7	-13	10
Total Net	-257	138	--	--	--	--	--	--	--	--	-97	58	-97	58	-354	150
Fire																
Mortality	-3,847	609	-39	39	-297	156	-110	108	-29	29	-551	191	-580	193	-4,873	667
Cut	-43	20	--	--	--	--	--	--	--	--	--	--	--	--	-43	20
Gross Growth	552	66	10	10	91	50	36	25	8	8	236	86	244	86	934	123
Net Live	-3,338	566	-29	29	-205	118	-73	94	-21	21	-315	162	-336	164	-3,982	609
Standing Dead Change	1,802	401	15	15	153	106	74	73	6	7	188	97	194	97	2,237	432
Dead Woody Debris Change	-328	116	0	0	-30	18	-10	7	-15	13	-160	88	-175	89	-543	148
Total Net	-2,271	420	-17	17	-97	99	-8	36	-32	29	-316	147	-348	150	-2,741	458
Insect and Disease																
Mortality	-4,965	707	-183	88	-397	162	-142	74	-115	43	-1,194	249	-1,310	252	-6,998	776
Cut	-67	28	--	--	-4	4	--	--	-7	7	-41	23	-48	25	-118	38
Gross Growth	4,575	246	119	52	501	149	219	83	604	177	1,596	248	2,200	301	7,614	425
Net Live	-457	645	-65	57	99	182	77	59	482	148	361	208	843	254	498	721
Standing Dead Change	1,891	580	60	36	204	123	37	42	-22	18	432	172	410	173	2,602	620
Dead Woody Debris Change	147	239	10	26	-6	92	-0	53	-109	45	-149	100	-258	109	-107	285
Total Net	1,857	311	10	55	374	179	139	81	467	163	855	235	1,322	284	3,703	467
Other cut and weather																
Mortality	-341	158	-40	38	-3	3	--	--	--	--	-53	25	-53	25	-437	164
Cut	-14	11	--	--	-3	4	--	--	-15	13	-51	30	-66	33	-83	35
Gross Growth	283	87	13	9	20	23	--	--	34	29	181	82	215	87	531	125
Net Live	-72	124	-27	35	14	16	--	--	19	16	77	54	96	56	12	141
Standing Dead Change	9	22	2	2	--	--	--	--	--	--	-69	45	-69	45	-58	50
Dead Woody Debris Change	15	63	61	42	1	1	--	--	5	5	-1	13	5	14	82	77
Total Net	-47	117	31	31	19	23	--	--	30	26	18	47	48	53	51	134
Less than 25% disturbed																
Mortality	-1,415	165	-221	118	-94	41	-4	3	-147	48	-506	99	-653	109	-2,387	234
Cut	-7	4	--	--	-3	3	--	--	-18	10	-105	74	-123	74	-134	74
Gross Growth	3,904	228	370	125	555	149	55	26	1,044	204	2,698	283	3,742	338	8,626	449
Net Live	2,482	204	150	83	458	129	50	25	879	178	2,087	256	2,965	303	6,105	395
Standing Dead Change	-859	226	5	52	-71	40	-22	22	-0	22	-137	141	-137	142	-1,085	276
Dead Woody Debris Change	77	224	54	37	-171	76	-5	21	-63	75	-834	412	-897	419	-942	483
Total Net	2,130	334	236	97	309	146	30	31	1,024	227	1,603	466	2,627	513	5,332	636
Total																
Mortality	-10,656	857	-487	151	-901	247	-261	131	-324	72	-2,628	344	-2,952	348	-15,257	976
Cut	-574	108	-116	112	-768	296	-57	57	-2,000	503	-2,039	414	-4,040	641	-5,555	725
Gross Growth	9,531	240	540	130	1,381	213	333	92	2,253	296	5,682	400	7,935	460	19,720	577
Net Live	-1,699	885	-63	146	-288	368	15	121	-71	488	1,015	535	944	722	-1,091	1,213
Standing Dead Change	2,781	745	76	66	319	182	91	87	-113	44	192	257	79	261	3,346	818
Dead Woody Debris Change	-138	361	104	63	-175	131	-20	57	-82	134	-1,059	461	-1,140	479	-1,368	620
Total Net	1,153	637	115	191	-147	402	111	108	-353	650	441	789	88	1,023	1,321	1,287

Table B14: Annual Net Change in Carbon Stocks per Acre for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: Eastern Washington.

	Public								Private							
Change in Carbon Pool by disturbance	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Cut																
Mortality	-0.37	0.10	-0.28	0.28	-0.84	0.58	-0.38	0.11	-0.11	0.05	-0.57	0.21	-0.40	0.14	-0.45	0.12
Cut	-2.53	0.49	-7.76	7.76	-5.83	1.35	-4.08	1.08	-6.70	1.13	-3.36	0.58	-4.54	0.58	-4.51	0.47
Gross Growth	1.58	0.13	1.82	1.82	1.65	0.31	1.67	0.07	1.92	0.25	1.79	0.19	1.84	0.15	1.79	0.12
Net Live	-1.32	0.47	-6.22	6.22	-5.03	1.19	-2.78	1.12	-4.89	1.15	-2.13	0.63	-3.11	0.59	-3.17	0.47
Standing Dead Change	-0.09	0.08	-0.44	0.44	0.26	0.55	0.20	0.16	-0.33	0.10	-0.39	0.12	-0.37	0.08	-0.26	0.09
Dead Woody Debris Change	-0.36	0.42	-1.35	1.35	0.24	0.40	-0.33	0.19	0.34	0.32	0.17	0.29	0.23	0.22	0.14	0.18
Total Net	-2.10	0.63	-9.73	9.73	-5.79	1.48	-3.58	1.45	-6.29	1.62	-3.05	0.94	-4.20	0.85	-4.22	0.67
Cut and Fire																
Mortality	-2.40	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.67	0.63	-0.67	0.63	-1.28	0.63
Cut	-7.46	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.73	1.73	-1.73	1.73	-3.75	1.27
Gross Growth	1.18	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.23	0.51	0.23	0.75	0.22
Net Live	-8.68	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.89	0.84	-1.89	0.84	-4.29	1.50
Standing Dead Change	-2.81	1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.39	0.57	-0.39	0.57	-1.25	0.86
Dead Woody Debris Change	-0.26	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25	0.13	-0.25	0.13	-0.26	0.17
Total Net	-14.62	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.01	0.21	-3.01	0.21	-7.12	2.62
Fire																
Mortality	-7.49	0.70	-2.98	2.98	-5.32	1.55	-3.79	3.79	-1.23	0.82	-2.53	0.62	-2.41	0.57	-5.72	0.54
Cut	-0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.02
Gross Growth	1.08	0.07	0.75	0.75	1.64	0.38	1.25	0.03	0.34	0.23	1.08	0.30	1.01	0.27	1.10	0.09
Net Live	-6.50	0.70	-2.23	2.23	-3.68	1.48	-2.54	2.79	-0.89	0.58	-1.45	0.65	-1.40	0.59	-4.67	0.55
Standing Dead Change	3.51	0.61	1.13	1.13	2.74	1.37	2.54	2.54	0.26	0.26	0.86	0.39	0.81	0.36	2.63	0.42
Dead Woody Debris Change	-0.64	0.20	0.03	0.03	-0.54	0.22	-0.33	0.06	-0.65	0.24	-0.73	0.37	-0.73	0.33	-0.64	0.15
Total Net	-4.42	0.59	-1.33	1.33	-1.74	1.72	-0.27	1.22	-1.37	0.64	-1.45	0.58	-1.44	0.52	-3.22	0.44
Insect and Disease																
Mortality	-2.33	0.29	-2.34	0.69	-1.45	0.52	-1.44	0.55	-0.59	0.16	-1.60	0.27	-1.39	0.22	-1.98	0.19
Cut	-0.03	0.01	0.00	0.00	-0.01	0.01	0.00	0.00	-0.04	0.04	-0.05	0.03	-0.05	0.03	-0.03	0.01
Gross Growth	2.15	0.07	1.52	0.42	1.82	0.40	2.21	0.35	3.10	0.46	2.13	0.20	2.33	0.19	2.16	0.07
Net Live	-0.21	0.30	-0.83	0.63	0.36	0.66	0.77	0.54	2.47	0.42	0.48	0.27	0.89	0.25	0.14	0.20
Standing Dead Change	0.89	0.26	0.77	0.35	0.74	0.42	0.37	0.40	-0.11	0.09	0.58	0.22	0.43	0.18	0.74	0.17
Dead Woody Debris Change	0.07	0.11	0.12	0.34	-0.02	0.34	0.00	0.53	-0.56	0.19	-0.20	0.13	-0.27	0.11	-0.03	0.08
Total Net	0.87	0.15	0.13	0.71	1.36	0.59	1.40	0.73	2.39	0.56	1.14	0.28	1.40	0.26	1.05	0.13
Other cut and weather																
Mortality	-2.32	0.72	-1.33	0.88	-0.31	0.31	0.00	0.00	0.00	0.00	-0.76	0.14	-0.61	0.17	-1.60	0.46
Cut	-0.09	0.08	0.00	0.00	-0.40	0.40	0.00	0.00	-0.85	0.85	-0.73	0.35	-0.75	0.28	-0.30	0.12
Gross Growth	1.93	0.32	0.45	0.10	2.28	2.28	0.00	0.00	1.94	1.94	2.58	0.57	2.45	0.47	1.94	0.26
Net Live	-0.49	0.80	-0.88	0.98	1.58	1.58	0.00	0.00	1.08	1.08	1.10	0.63	1.09	0.50	0.04	0.52
Standing Dead Change	0.06	0.14	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	-0.98	0.50	-0.79	0.43	-0.21	0.18
Dead Woody Debris Change	0.10	0.43	2.02	0.31	0.14	0.14	0.00	0.00	0.31	0.31	-0.01	0.18	0.06	0.16	0.30	0.28
Total Net	-0.32	0.77	1.03	0.79	2.25	2.25	0.00	0.00	1.70	1.70	0.26	0.66	0.55	0.57	0.19	0.50
Less than 25% disturbed																
Mortality	-0.72	0.08	-1.77	0.77	-0.28	0.11	-0.09	0.06	-0.35	0.10	-0.34	0.06	-0.35	0.05	-0.55	0.05
Cut	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	-0.04	0.02	-0.07	0.05	-0.07	0.04	-0.03	0.02
Gross Growth	2.00	0.09	2.97	0.55	1.67	0.31	1.25	0.34	2.48	0.25	1.84	0.13	1.98	0.12	1.99	0.07
Net Live	1.27	0.10	1.20	0.60	1.38	0.28	1.16	0.34	2.08	0.24	1.42	0.13	1.57	0.12	1.41	0.07
Standing Dead Change	-0.44	0.11	0.04	0.42	-0.21	0.11	-0.51	0.45	0.00	0.05	-0.09	0.10	-0.07	0.08	-0.25	0.06
Dead Woody Debris Change	0.04	0.11	0.43	0.27	-0.52	0.21	-0.12	0.48	-0.15	0.18	-0.57	0.28	-0.47	0.22	-0.22	0.11
Total Net	1.09	0.18	1.89	0.57	0.93	0.40	0.68	0.62	2.43	0.35	1.09	0.31	1.39	0.26	1.23	0.14
Total																
Mortality	-2.18	0.17	-1.87	0.44	-1.13	0.28	-1.41	0.59	-0.34	0.07	-0.86	0.10	-0.73	0.08	-1.50	0.09
Cut	-0.12	0.02	-0.44	0.44	-0.96	0.35	-0.31	0.30	-2.11	0.48	-0.66	0.13	-1.01	0.15	-0.55	0.07
Gross Growth	1.95	0.05	2.07	0.36	1.73	0.19	1.79	0.23	2.37	0.18	1.85	0.09	1.97	0.08	1.94	0.04
Net Live	-0.35	0.18	-0.24	0.55	-0.36	0.46	0.08	0.65	-0.07	0.51	0.33	0.17	0.23	0.18	-0.11	0.12
Standing Dead Change	0.57	0.15	0.29	0.24	0.40	0.22	0.49	0.44	-0.12	0.05	0.06	0.08	0.02	0.06	0.33	0.08
Dead Woody Debris Change	-0.03	0.07	0.40	0.23	-0.22	0.16	-0.11	0.30	-0.09	0.14	-0.34	0.15	-0.28	0.12	-0.13	0.06
Total Net	0.24	0.13	0.44	0.73	-0.18	0.50	0.60	0.57	-0.37	0.68	0.14	0.26	0.02	0.25	0.13	0.13

Table B15: Annual Net Change in Carbon Stocks for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: Western Washington.

	Public								Private							
Change in Carbon Pool by disturbance	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-38	18	--	--	-196	121	-9	9	-343	151	-154	69	-497	166	-741	206
Cut	-639	193	--	--	-5,045	1,449	-384	223	-16,886	2,088	-1,874	803	-18,759	2,222	-24,828	2,657
Gross Growth	421	96	--	--	923	224	219	142	4,752	532	829	227	5,581	574	7,143	635
Net Live	-256	139	--	--	-4,319	1,374	-175	168	-12,476	1,902	-1,199	708	-13,675	2,019	-18,425	2,446
Standing Dead Change	-4	9	--	--	-249	106	-2	4	-361	70	-61	22	-422	73	-677	129
Dead Woody Debris Change	-1	31	--	--	18	157	38	22	-806	372	-12	87	-818	382	-764	415
Total Net	-335	176	--	--	-5,808	1,798	-176	201	-17,207	2,629	-1,630	933	-18,837	2,777	-25,155	3,312
Cut and Fire																
Mortality	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cut	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross Growth	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Net Live	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Standing Dead Change	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dead Woody Debris Change	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Net	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fire																
Mortality	-48	52	--	--	--	--	--	--	--	--	--	--	--	--	-48	52
Cut	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross Growth	9	10	--	--	--	--	--	--	--	--	--	--	--	--	9	10
Net Live	-39	42	--	--	--	--	--	--	--	--	--	--	--	--	-39	42
Standing Dead Change	12	13	--	--	--	--	--	--	--	--	--	--	--	--	12	13
Dead Woody Debris Change	-6	7	--	--	--	--	--	--	--	--	--	--	--	--	-6	7
Total Net	-40	43	--	--	--	--	--	--	--	--	--	--	--	--	-40	43
Insect and Disease																
Mortality	-861	196	-596	254	-491	164	-100	74	-258	76	-41	29	-298	84	-2,347	377
Cut	-0	1	--	--	-43	50	--	--	--	--	--	--	--	--	-44	50
Gross Growth	1,354	202	565	175	1,222	325	223	165	1,511	407	101	61	1,613	412	4,977	608
Net Live	492	174	-31	152	688	257	123	134	1,254	347	61	43	1,314	350	2,586	508
Standing Dead Change	97	87	54	87	146	72	22	24	50	26	-19	14	31	29	351	147
Dead Woody Debris Change	-179	145	154	192	-243	195	-19	57	-210	78	-16	14	-225	80	-511	325
Total Net	577	311	183	173	825	357	162	123	1,470	424	38	54	1,508	428	3,255	671
Other cut and weather																
Mortality	-855	213	-543	217	-217	94	-216	104	-866	305	-151	95	-1,017	319	-2,848	462
Cut	--	--	--	--	-39	46	--	--	-68	61	-13	11	-81	62	-120	77
Gross Growth	613	115	461	145	445	168	381	169	1,443	346	304	117	1,747	364	3,647	471
Net Live	-241	166	-82	139	188	109	165	124	509	382	140	88	648	392	679	477
Standing Dead Change	-58	61	-28	72	-18	28	-2	31	21	28	41	44	63	52	-45	115
Dead Woody Debris Change	32	126	213	72	28	62	-41	58	-44	144	25	34	-20	148	212	224
Total Net	-346	225	71	199	253	148	166	202	641	477	255	109	896	489	1,040	626
Less than 25% disturbed																
Mortality	-4,245	295	-2,554	415	-1,404	271	-483	148	-1,826	214	-1,121	181	-2,947	267	-11,632	646
Cut	-12	6	-10	10	-160	143	-11	10	-385	137	-90	40	-475	142	-668	202
Gross Growth	11,985	403	3,392	373	5,861	593	1,744	344	14,674	1,034	5,237	612	19,911	1,109	42,893	1,354
Net Live	7,727	442	828	417	4,297	560	1,251	265	12,463	940	4,026	529	16,489	1,012	30,592	1,296
Standing Dead Change	300	226	294	187	114	74	50	52	200	93	137	72	337	118	1,094	329
Dead Woody Debris Change	-916	425	-368	332	-748	335	-266	106	-1,755	502	-355	205	-2,110	540	-4,409	838
Total Net	9,177	641	970	531	4,899	717	1,363	326	14,355	1,256	4,876	674	19,230	1,353	35,640	1,737
Total																
Mortality	-6,047	376	-3,693	490	-2,308	326	-809	196	-3,293	392	-1,466	212	-4,759	429	-17,616	831
Cut	-652	193	-10	10	-5,288	1,451	-395	224	-17,338	2,106	-1,977	803	-19,315	2,237	-25,660	2,671
Gross Growth	14,383	368	4,418	376	8,451	568	2,567	440	22,381	1,114	6,471	652	28,851	1,139	58,669	1,322
Net Live	7,684	525	714	466	855	1,565	1,364	357	1,749	2,336	3,028	879	4,777	2,499	15,394	3,051
Standing Dead Change	347	251	321	216	-7	155	67	65	-90	126	98	90	8	155	736	403
Dead Woody Debris Change	-1,070	470	-1	388	-946	420	-288	133	-2,815	641	-358	224	-3,173	677	-5,478	1,009
Total Net	9,033	773	1,223	587	170	2,022	1,515	447	-741	3,167	3,540	1,145	2,799	3,376	14,740	4,076

Table B16: Annual Net Change in Carbon Stocks per Acre for Pools excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Owner Group, 2002-2006 to 2012-2016: Western Washington.

	Public								Private							
Change in Carbon Pool by disturbance	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Cut																
Mortality	-0.46	0.19	0.00	0.00	-0.86	0.49	-0.25	0.25	-0.32	0.14	-0.95	0.32	-0.40	0.13	-0.46	0.12
Cut	-7.73	1.68	0.00	0.00	-22.02	4.58	-10.04	2.06	-15.60	1.37	-11.58	4.32	-15.08	1.33	-15.57	1.25
Gross Growth	5.10	0.46	0.00	0.00	4.03	0.50	5.71	1.87	4.39	0.27	5.12	0.66	4.49	0.25	4.48	0.21
Net Live	-3.09	1.55	0.00	0.00	-18.85	4.71	-4.58	3.68	-11.53	1.46	-7.41	4.12	-10.99	1.39	-11.56	1.31
Standing Dead Change	-0.05	0.11	0.00	0.00	-1.09	0.41	-0.06	0.11	-0.33	0.06	-0.38	0.09	-0.34	0.05	-0.42	0.07
Dead Woody Debris Change	-0.01	0.37	0.00	0.00	0.08	0.68	0.98	0.19	-0.74	0.34	-0.08	0.54	-0.66	0.30	-0.48	0.26
Total Net	-4.06	1.95	0.00	0.00	-25.35	6.10	-4.59	4.67	-15.90	2.02	-10.07	5.41	-15.14	1.90	-15.78	1.76
Cut and Fire																
Mortality	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Live	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standing Dead Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dead Woody Debris Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fire																
Mortality	-13.89	13.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-13.89	13.89
Cut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Growth	2.69	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.69	2.69
Net Live	-11.21	11.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-11.21	11.21
Standing Dead Change	3.57	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57	3.57
Dead Woody Debris Change	-1.86	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.86	1.86
Total Net	-11.55	11.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-11.55	11.55
Insect and Disease																
Mortality	-2.74	0.40	-4.04	1.25	-2.87	0.69	-3.16	1.58	-1.26	0.21	-1.32	0.55	-1.27	0.20	-2.61	0.31
Cut	0.00	0.00	0.00	0.00	-0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.06
Gross Growth	4.31	0.34	3.82	0.51	7.15	0.69	7.03	2.83	7.41	0.80	3.28	0.24	6.87	0.77	5.54	0.34
Net Live	1.57	0.57	-0.21	1.03	4.02	1.08	3.87	3.30	6.15	0.76	1.97	0.72	5.60	0.75	2.88	0.48
Standing Dead Change	0.31	0.27	0.37	0.58	0.86	0.37	0.70	0.68	0.25	0.11	-0.61	0.28	0.13	0.12	0.39	0.16
Dead Woody Debris Change	-0.57	0.48	1.04	1.28	-1.42	1.09	-0.60	1.72	-1.03	0.29	-0.50	0.37	-0.96	0.26	-0.57	0.36
Total Net	1.84	0.98	1.24	1.14	4.83	1.68	5.09	2.25	7.21	1.05	1.24	1.57	6.43	1.05	3.62	0.64
Other cut and weather																
Mortality	-4.60	1.09	-3.18	1.05	-2.59	0.82	-2.26	0.70	-3.40	1.02	-2.08	1.08	-3.11	0.83	-3.30	0.45
Cut	0.00	0.00	0.00	0.00	-0.47	0.47	0.00	0.00	-0.27	0.24	-0.18	0.15	-0.25	0.19	-0.14	0.09
Gross Growth	3.30	0.36	2.70	0.50	5.30	0.68	3.99	0.99	5.66	0.65	4.19	0.66	5.34	0.54	4.22	0.30
Net Live	-1.30	0.93	-0.48	0.81	2.25	0.89	1.73	1.14	2.00	1.41	1.93	1.00	1.98	1.12	0.79	0.54
Standing Dead Change	-0.31	0.31	-0.16	0.42	-0.22	0.34	-0.03	0.32	0.08	0.11	0.57	0.54	0.19	0.15	-0.05	0.13
Dead Woody Debris Change	0.17	0.68	1.25	0.29	0.33	0.75	-0.42	0.58	-0.17	0.56	0.34	0.46	-0.06	0.45	0.25	0.26
Total Net	-1.86	1.24	0.42	1.15	3.02	1.27	1.74	2.01	2.52	1.78	3.52	0.68	2.74	1.39	1.20	0.70
Less than 25% disturbed																
Mortality	-1.51	0.10	-2.74	0.41	-1.50	0.26	-1.42	0.35	-0.73	0.08	-1.11	0.15	-0.84	0.07	-1.36	0.07
Cut	0.00	0.00	-0.01	0.01	-0.17	0.15	-0.03	0.03	-0.15	0.05	-0.09	0.04	-0.14	0.04	-0.08	0.02
Gross Growth	4.28	0.13	3.63	0.26	6.25	0.34	5.13	0.46	5.87	0.25	5.18	0.34	5.67	0.20	5.03	0.11
Net Live	2.76	0.16	0.89	0.43	4.59	0.45	3.68	0.45	4.99	0.24	3.98	0.35	4.70	0.20	3.59	0.12
Standing Dead Change	0.11	0.08	0.32	0.20	0.12	0.08	0.15	0.15	0.08	0.04	0.14	0.07	0.10	0.03	0.13	0.04
Dead Woody Debris Change	-0.33	0.15	-0.39	0.35	-0.80	0.35	-0.78	0.28	-0.70	0.20	-0.35	0.20	-0.60	0.15	-0.52	0.10
Total Net	3.28	0.23	1.04	0.55	5.23	0.62	4.01	0.67	5.75	0.38	4.82	0.47	5.48	0.30	4.18	0.18
Total																
Mortality	-1.78	0.11	-2.95	0.37	-1.62	0.22	-1.60	0.30	-0.82	0.09	-1.15	0.14	-0.90	0.08	-1.48	0.07
Cut	-0.19	0.06	-0.01	0.01	-3.72	1.01	-0.78	0.42	-4.29	0.51	-1.55	0.62	-3.63	0.42	-2.16	0.22
Gross Growth	4.25	0.11	3.53	0.22	5.95	0.26	5.08	0.44	5.54	0.18	5.07	0.29	5.43	0.15	4.94	0.09
Net Live	2.27	0.16	0.57	0.37	0.60	1.10	2.70	0.59	0.43	0.58	2.37	0.65	0.90	0.47	1.30	0.26
Standing Dead Change	0.10	0.07	0.26	0.17	0.00	0.11	0.13	0.13	-0.02	0.03	0.08	0.07	0.00	0.03	0.06	0.03
Dead Woody Debris Change	-0.32	0.14	0.00	0.31	-0.67	0.29	-0.57	0.25	-0.70	0.16	-0.28	0.17	-0.60	0.13	-0.46	0.08
Total Net	2.67	0.23	0.98	0.46	0.12	1.42	3.00	0.78	-0.18	0.78	2.77	0.86	0.53	0.63	1.24	0.34

Table B17: Annual Net Change in Carbon Stocks for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and WA-DNR Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool by disturbance	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year					
Cut						
Mortality	-110	83	-196	121	-306	145
Cut	-758	296	-5,045	1,449	-5,803	1,465
Gross Growth	214	78	923	224	1,137	233
Net Live	-653	258	-4,319	1,374	-4,972	1,386
Standing Dead Change	33	72	-249	106	-215	129
Dead Woody Debris Change	31	53	18	157	49	165
Total Net	-753	306	-5,808	1,798	-6,560	1,812
Cut and Fire						
Mortality	--	--	--	--	--	--
Cut	--	--	--	--	--	--
Gross Growth	--	--	--	--	--	--
Net Live	--	--	--	--	--	--
Standing Dead Change	--	--	--	--	--	--
Dead Woody Debris Change	--	--	--	--	--	--
Total Net	--	--	--	--	--	--
Fire						
Mortality	-297	156	--	--	-297	156
Cut	--	--	--	--	--	--
Gross Growth	91	50	--	--	91	50
Net Live	-205	118	--	--	-205	118
Standing Dead Change	153	106	--	--	153	106
Dead Woody Debris Change	-30	18	--	--	-30	18
Total Net	-97	99	--	--	-97	99
Insect and Disease						
Mortality	-397	162	-491	164	-888	230
Cut	-4	4	-43	50	-47	50
Gross Growth	501	149	1,222	325	1,722	355
Net Live	99	182	688	257	787	314
Standing Dead Change	204	123	146	72	351	142
Dead Woody Debris Change	-6	92	-243	195	-249	215
Total Net	374	179	825	357	1,199	398
Other cut and weather						
Mortality	-3	3	-217	94	-220	94
Cut	-3	4	-39	46	-43	46
Gross Growth	20	23	445	168	465	169
Net Live	14	16	188	109	202	110
Standing Dead Change	--	--	-18	28	-18	28
Dead Woody Debris Change	1	1	28	62	29	62
Total Net	19	23	253	148	272	150
Less than 25% disturbed						
Mortality	-94	41	-1,404	271	-1,498	272
Cut	-3	3	-160	143	-163	143
Gross Growth	555	149	5,861	593	6,417	592
Net Live	458	129	4,297	560	4,755	562
Standing Dead Change	-71	40	114	74	43	84
Dead Woody Debris Change	-171	76	-748	335	-919	342
Total Net	309	146	4,899	717	5,209	724
Total						
Mortality	-901	247	-2,308	326	-3,209	387
Cut	-768	296	-5,288	1,451	-6,056	1,467
Gross Growth	1,381	213	8,451	568	9,832	531
Net Live	-288	368	855	1,565	567	1,607
Standing Dead Change	319	182	-7	155	312	239
Dead Woody Debris Change	-175	131	-946	420	-1,120	437
Total Net	-147	402	170	2,022	23	2,063

Table B18: Annual Net Change in Carbon Stocks per Acre for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and WA-DNR Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool by disturbance	East Total		West Total		DNR Total	
	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre					
Cut						
Mortality	-0.845	0.578	-0.857	0.493	-0.853	0.377
Cut	-5.832	1.354	-22.020	4.579	-16.163	3.280
Gross Growth	1.649	0.308	4.027	0.498	3.166	0.405
Net Live	-5.028	1.194	-18.850	4.709	-13.849	3.258
Standing Dead Change	0.257	0.551	-1.086	0.407	-0.600	0.350
Dead Woody Debris Change	0.240	0.398	0.078	0.683	0.136	0.457
Total Net	-5.794	1.475	-25.347	6.096	-18.272	4.266
Cut and Fire						
Mortality	--	--	--	--	--	--
Cut	--	--	--	--	--	--
Gross Growth	--	--	--	--	--	--
Net Live	--	--	--	--	--	--
Standing Dead Change	--	--	--	--	--	--
Dead Woody Debris Change	--	--	--	--	--	--
Total Net	--	--	--	--	--	--
Fire						
Mortality	-5.320	1.549	--	--	-5.320	1.549
Cut	--	--	--	--	--	--
Gross Growth	1.638	0.382	--	--	1.638	0.382
Net Live	-3.682	1.478	--	--	-3.682	1.478
Standing Dead Change	2.737	1.368	--	--	2.737	1.368
Dead Woody Debris Change	-0.541	0.216	--	--	-0.541	0.216
Total Net	-1.738	1.718	--	--	-1.738	1.718
Insect and Disease						
Mortality	-1.449	0.519	-2.871	0.691	-1.995	0.427
Cut	-0.013	0.013	-0.252	0.252	-0.105	0.112
Gross Growth	1.824	0.397	7.147	0.686	3.868	0.538
Net Live	0.363	0.659	4.024	1.081	1.768	0.647
Standing Dead Change	0.745	0.421	0.856	0.366	0.788	0.295
Dead Woody Debris Change	-0.022	0.335	-1.420	1.087	-0.558	0.476
Total Net	1.364	0.585	4.826	1.676	2.693	0.786
Other cut and weather						
Mortality	-0.307	0.307	-2.589	0.818	-2.376	0.767
Cut	-0.397	0.397	-0.470	0.470	-0.463	0.475
Gross Growth	2.279	2.279	5.305	0.676	5.022	0.689
Net Live	1.575	1.575	2.245	0.892	2.183	0.815
Standing Dead Change	--	--	-0.221	0.337	-0.200	0.305
Dead Woody Debris Change	0.144	0.144	0.329	0.748	0.312	0.678
Total Net	2.250	2.250	3.015	1.274	2.944	1.160
Less than 25% disturbed						
Mortality	-0.284	0.114	-1.498	0.260	-1.181	0.199
Cut	-0.010	0.010	-0.171	0.152	-0.129	0.113
Gross Growth	1.675	0.311	6.254	0.335	5.057	0.310
Net Live	1.381	0.279	4.585	0.446	3.748	0.357
Standing Dead Change	-0.215	0.114	0.122	0.078	0.034	0.066
Dead Woody Debris Change	-0.515	0.208	-0.799	0.350	-0.725	0.264
Total Net	0.933	0.395	5.228	0.618	4.105	0.495
Total						
Mortality	-1.125	0.278	-1.624	0.217	-1.445	0.169
Cut	-0.960	0.352	-3.721	1.013	-2.726	0.661
Gross Growth	1.726	0.191	5.946	0.258	4.426	0.211
Net Live	-0.359	0.456	0.601	1.099	0.255	0.723
Standing Dead Change	0.399	0.221	-0.005	0.109	0.141	0.107
Dead Woody Debris Change	-0.218	0.162	-0.665	0.294	-0.504	0.197
Total Net	-0.183	0.502	0.119	1.422	0.010	0.929

Table B19: Annual Net Change in Carbon Stocks for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Ecological Region, 2002-2006 to 2012-2016: All Washington.

	Ecological Region															
Change in Carbon Pool by disturbance	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Cut																
Mortality	-36	19	-237	135	-100	55	-209	54	-146	66	-427	185	-85	37	-1,239	252
Cut	-137	63	-1,840	493	-2,427	847	-2,577	476	-5,759	1,468	-10,785	1,836	-6,293	1,278	-29,817	2,722
Gross Growth	130	56	640	132	701	184	1,063	181	1,682	311	3,403	479	1,502	285	9,121	666
Net Live	-44	33	-1,437	442	-1,826	755	-1,722	409	-4,223	1,335	-7,809	1,672	-4,875	1,179	-21,936	2,505
Standing Dead Change	5	4	-60	83	-117	80	-197	60	-187	70	-239	62	-171	52	-966	167
Dead Woody Debris Change	-3	17	-46	132	-34	68	241	142	11	151	-556	338	-221	180	-609	459
Total Net	-51	49	-1,958	626	-2,534	1,048	-2,188	553	-5,594	1,731	-10,835	2,324	-6,667	1,582	-29,826	3,400
Cut and Fire																
Mortality	-58	29	--	--	-3	3	-4	3	--	--	--	--	--	--	-64	29
Cut	-83	53	--	--	-30	32	-73	52	--	--	--	--	--	--	-187	80
Gross Growth	13	6	--	--	8	9	16	12	--	--	--	--	--	--	37	16
Net Live	-128	69	--	--	-24	25	-60	43	--	--	--	--	--	--	-213	85
Standing Dead Change	-45	40	--	--	2	2	-19	21	--	--	--	--	--	--	-62	45
Dead Woody Debris Change	-1	7	--	--	-1	1	-10	7	--	--	--	--	--	--	-13	10
Total Net	-219	133	--	--	-29	30	-106	63	--	--	--	--	--	--	-354	150
Fire																
Mortality	-798	247	-350	129	-2,911	560	-717	228	--	--	--	--	-144	113	-4,920	669
Cut	-13	10	-9	7	--	--	-20	16	--	--	--	--	--	--	-43	20
Gross Growth	140	36	153	75	448	75	191	52	--	--	--	--	11	8	943	123
Net Live	-671	221	-207	123	-2,463	515	-546	198	--	--	--	--	-133	105	-4,021	610
Standing Dead Change	136	110	175	81	1,573	381	296	138	--	--	--	--	70	60	2,249	433
Dead Woody Debris Change	-5	53	-122	94	-383	92	-51	42	--	--	--	--	11	9	-549	148
Total Net	-682	296	-169	94	-1,500	312	-358	150	--	--	--	--	-72	56	-2,781	460
Insect and Disease																
Mortality	-235	73	-1,350	273	-3,477	706	-1,811	201	-264	122	-763	259	-1,444	312	-9,345	861
Cut	-19	12	-15	11	-47	30	-38	15	--	--	-44	50	--	--	-162	63
Gross Growth	322	104	1,559	253	2,572	258	3,315	264	763	257	1,642	386	2,418	409	12,591	735
Net Live	68	52	193	246	-952	622	1,466	226	499	213	836	326	974	366	3,084	881
Standing Dead Change	-37	45	439	179	1,732	577	260	102	18	32	97	94	446	159	2,953	637
Dead Woody Debris Change	-79	68	-5	148	-311	232	129	123	-14	54	-84	257	-255	150	-618	432
Total Net	-52	90	773	258	553	337	2,337	256	640	271	1,127	384	1,581	448	6,959	814
Other cut and weather																
Mortality	--	--	-18	11	-672	192	-40	19	-563	269	-1,731	345	-261	117	-3,285	490
Cut	--	--	-1	1	-23	15	-60	31	-39	46	-80	62	--	--	-203	85
Gross Growth	10	12	94	70	751	162	184	83	645	200	1,815	332	681	233	4,179	486
Net Live	10	12	75	60	56	166	84	55	42	252	4	342	421	180	690	497
Standing Dead Change	--	--	3	2	-11	60	-71	45	10	47	-53	84	20	31	-102	126
Dead Woody Debris Change	1	1	-12	13	128	98	1	13	-37	95	304	181	-91	69	294	237
Total Net	12	15	88	66	201	193	27	50	30	323	255	444	478	253	1,091	640
Less than 25% disturbed																
Mortality	-379	115	-380	79	-3,798	338	-850	134	-1,327	206	-4,763	530	-2,522	231	-14,020	678
Cut	-7	7	-7	7	-134	141	-119	74	-57	24	-372	134	-107	52	-802	215
Gross Growth	627	119	1,762	233	10,472	699	4,136	320	6,408	627	15,890	1,035	12,225	795	51,519	1,372
Net Live	241	108	1,375	206	6,540	634	3,167	280	5,025	530	10,755	955	9,595	721	36,697	1,322
Standing Dead Change	-118	131	-198	131	-290	287	-23	76	64	65	535	203	40	136	10	429
Dead Woody Debris Change	-326	375	-335	178	-1,198	554	-306	133	-453	145	-959	489	-1,775	432	-5,351	966
Total Net	-157	400	1,143	257	6,552	885	3,626	329	5,961	647	13,361	1,248	10,486	925	40,972	1,823
Total																
Mortality	-1,506	268	-2,336	339	-10,960	929	-3,631	323	-2,300	360	-7,684	674	-4,455	419	-32,872	1,250
Cut	-259	83	-1,871	494	-2,662	858	-2,886	485	-5,855	1,469	-11,281	1,858	-6,400	1,283	-31,214	2,735
Gross Growth	1,240	167	4,207	377	14,952	754	8,905	422	9,498	746	22,750	1,142	16,837	942	78,389	1,247
Net Live	-525	258	-0	563	1,330	1,274	2,388	585	1,343	1,482	3,786	2,065	5,982	1,439	14,303	3,283
Standing Dead Change	-59	179	358	249	2,888	748	246	202	-96	112	341	245	404	230	4,082	910
Dead Woody Debris Change	-413	386	-520	286	-1,799	620	3	237	-493	237	-1,295	671	-2,330	493	-6,846	1,184
Total Net	-1,149	524	-124	737	3,244	1,427	3,338	713	1,037	1,904	3,908	2,804	5,806	1,885	16,060	4,274

Table B20: Annual Net Change in Carbon Stocks per Acre for Pools Excluding Soils and Forest Floor on Forest Land by Disturbance, Forest Land Status and Ecological Region, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool by disturbance	Ecological Region														Total	
	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Cut																
Mortality	-0.444	0.161	-0.680	0.365	-0.435	0.216	-0.368	0.083	-0.382	0.157	-0.601	0.249	-0.222	0.089	-0.459	0.089
Cut	-1.687	0.461	-5.279	1.013	-10.590	2.965	-4.546	0.567	-15.081	2.845	-15.176	1.907	-16.433	2.138	-11.038	0.815
Gross Growth	1.594	0.275	1.836	0.167	3.057	0.448	1.876	0.199	4.404	0.369	4.789	0.351	3.923	0.440	3.376	0.158
Net Live	-0.537	0.377	-4.122	1.004	-7.969	2.853	-3.038	0.588	-11.059	2.913	-10.988	1.997	-12.732	2.339	-8.120	0.821
Standing Dead Change	0.066	0.043	-0.173	0.238	-0.510	0.332	-0.348	0.094	-0.489	0.159	-0.336	0.077	-0.446	0.119	-0.357	0.058
Dead Woody Debris Change	-0.038	0.208	-0.133	0.379	-0.150	0.298	0.426	0.245	0.029	0.395	-0.782	0.468	-0.578	0.459	-0.225	0.170
Total Net	-0.622	0.586	-5.619	1.458	-11.055	3.980	-3.860	0.817	-14.650	3.735	-15.246	2.774	-17.410	3.079	-11.042	1.114
Cut and Fire																
Mortality	-4.042	0.522	--	--	-0.753	0.753	-0.116	0.054	--	--	--	--	--	--	-1.283	0.630
Cut	-5.859	2.405	--	--	-9.060	9.060	-2.268	1.021	--	--	--	--	--	--	-3.754	1.267
Gross Growth	0.888	0.025	--	--	2.521	2.521	0.503	0.231	--	--	--	--	--	--	0.750	0.223
Net Live	-9.013	2.124	--	--	-7.292	7.292	-1.881	0.853	--	--	--	--	--	--	-4.288	1.501
Standing Dead Change	-3.192	2.404	--	--	0.595	0.595	-0.579	0.513	--	--	--	--	--	--	-1.248	0.856
Dead Woody Debris Change	-0.100	0.478	--	--	-0.282	0.282	-0.321	0.155	--	--	--	--	--	--	-0.256	0.173
Total Net	-15.385	5.823	--	--	-8.700	8.700	-3.286	0.561	--	--	--	--	--	--	-7.115	2.621
Fire																
Mortality	-5.799	1.139	-4.071	1.367	-6.588	0.785	-3.918	0.956	--	--	--	--	-20.795	3.583	-5.751	0.544
Cut	-0.098	0.073	-0.108	0.089	--	--	-0.111	0.090	--	--	--	--	--	--	-0.050	0.024
Gross Growth	1.018	0.155	1.777	0.614	1.014	0.089	1.044	0.179	--	--	--	--	1.541	0.029	1.102	0.094
Net Live	-4.879	1.089	-2.401	1.524	-5.574	0.797	-2.984	0.913	--	--	--	--	-19.255	3.612	-4.700	0.550
Standing Dead Change	0.989	0.805	2.031	0.925	3.558	0.611	1.617	0.698	--	--	--	--	10.109	3.989	2.629	0.423
Dead Woody Debris Change	-0.036	0.384	-1.414	0.908	-0.866	0.173	-0.279	0.216	--	--	--	--	1.652	0.409	-0.642	0.153
Total Net	-4.956	1.535	-1.965	1.001	-3.393	0.572	-1.956	0.688	--	--	--	--	-10.485	0.899	-3.251	0.442
Insect and Disease																
Mortality	-1.473	0.308	-2.179	0.325	-2.724	0.472	-1.253	0.115	-1.826	0.675	-3.102	0.814	-2.704	0.375	-2.111	0.168
Cut	-0.117	0.078	-0.024	0.017	-0.037	0.024	-0.026	0.010	--	--	-0.177	0.200	--	--	-0.037	0.014
Gross Growth	2.014	0.325	2.516	0.249	2.015	0.119	2.294	0.109	5.275	0.904	6.677	0.754	4.528	0.435	2.845	0.111
Net Live	0.424	0.265	0.312	0.396	-0.745	0.474	1.014	0.141	3.448	1.066	3.399	1.143	1.824	0.667	0.697	0.198
Standing Dead Change	-0.234	0.259	0.709	0.264	1.356	0.420	0.180	0.070	0.121	0.220	0.396	0.376	0.834	0.267	0.667	0.139
Dead Woody Debris Change	-0.494	0.370	-0.008	0.239	-0.243	0.181	0.089	0.086	-0.099	0.374	-0.341	1.037	-0.477	0.284	-0.140	0.097
Total Net	-0.326	0.545	1.247	0.380	0.433	0.263	1.617	0.151	4.424	1.339	4.584	1.321	2.961	0.747	1.572	0.172
Other cut and weather																
Mortality	--	--	-1.173	0.118	-2.148	0.441	-0.592	0.125	-3.455	1.376	-3.993	0.700	-1.856	0.618	-2.890	0.360
Cut	--	--	-0.049	0.049	-0.075	0.048	-0.876	0.343	-0.242	0.242	-0.185	0.142	--	--	-0.179	0.073
Gross Growth	2.766	2.766	6.007	1.718	2.401	0.323	2.700	0.554	3.957	0.703	4.186	0.436	4.849	0.819	3.676	0.257
Net Live	2.766	2.766	4.785	1.808	0.178	0.534	1.232	0.615	0.260	1.547	0.008	0.789	2.993	0.933	0.607	0.429
Standing Dead Change	--	--	0.189	0.140	-0.035	0.191	-1.045	0.491	0.058	0.286	-0.122	0.193	0.143	0.213	-0.090	0.110
Dead Woody Debris Change	0.183	0.183	-0.791	0.567	0.409	0.308	0.010	0.196	-0.227	0.578	0.702	0.407	-0.644	0.462	0.258	0.208
Total Net	3.493	3.493	5.609	1.851	0.644	0.627	0.396	0.708	0.186	1.983	0.589	1.001	3.401	1.478	0.960	0.551
Less than 25% disturbed																
Mortality	-0.831	0.217	-0.504	0.091	-1.186	0.095	-0.499	0.074	-1.062	0.140	-1.667	0.167	-0.955	0.077	-1.090	0.050
Cut	-0.015	0.015	-0.009	0.009	-0.042	0.044	-0.070	0.043	-0.045	0.019	-0.130	0.047	-0.041	0.020	-0.062	0.017
Gross Growth	1.374	0.163	2.336	0.192	3.269	0.161	2.427	0.116	5.130	0.249	5.561	0.212	4.628	0.184	4.005	0.082
Net Live	0.528	0.225	1.823	0.196	2.042	0.172	1.859	0.118	4.022	0.245	3.764	0.261	3.632	0.193	2.852	0.089
Standing Dead Change	-0.258	0.280	-0.263	0.170	-0.091	0.090	-0.013	0.045	0.051	0.052	0.187	0.070	0.015	0.052	0.001	0.033
Dead Woody Debris Change	-0.714	0.817	-0.444	0.227	-0.374	0.172	-0.179	0.077	-0.362	0.111	-0.336	0.170	-0.672	0.155	-0.416	0.074
Total Net	-0.345	0.873	1.516	0.320	2.046	0.258	2.128	0.149	4.772	0.323	4.676	0.351	3.969	0.296	3.185	0.131
Total																
Mortality	-1.767	0.278	-1.281	0.161	-2.005	0.157	-0.908	0.075	-1.186	0.169	-1.809	0.147	-1.202	0.098	-1.492	0.056
Cut	-0.304	0.096	-1.026	0.256	-0.487	0.155	-0.722	0.116	-3.020	0.723	-2.656	0.425	-1.727	0.332	-1.417	0.124
Gross Growth	1.455	0.121	2.307	0.128	2.735	0.102	2.227	0.072	4.899	0.200	5.356	0.167	4.543	0.155	3.558	0.054
Net Live	-0.616	0.305	-0.000	0.308	0.243	0.233	0.597	0.146	0.693	0.764	0.891	0.484	1.614	0.387	0.649	0.149
Standing Dead Change	-0.069	0.209	0.196	0.136	0.528	0.135	0.061	0.051	-0.049	0.058	0.080	0.058	0.109	0.062	0.185	0.041
Dead Woody Debris Change	-0.485	0.448	-0.285	0.155	-0.329	0.113	0.001	0.059	-0.254	0.121	-0.305	0.158	-0.629	0.128	-0.311	0.054
Total Net	-1.347	0.599	-0.068	0.404	0.593	0.260	0.835	0.179	0.535	0.983	0.920	0.658	1.567	0.510	0.729	0.194

Table B21: Annual Net Change in Carbon Stocks on Timberland for All Pools by Owner Group, 2002-2006 to 2012-2016: All Washington.

Change in Carbon Pool	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-11,113	476	-216	94	-2,914	369	-926	226	-3,596	395	-4,022	394	-7,618	533	-22,787	823
Cut	-1,226	221	-116	112	-6,032	1,467	-451	231	-19,338	2,145	-3,972	899	-23,310	2,300	-31,136	2,735
Gross Growth	19,052	341	707	221	9,482	547	2,308	391	24,498	1,118	11,973	722	36,471	1,093	68,020	1,205
Net	6,712	618	376	201	536	1,599	931	323	1,564	2,383	3,979	1,025	5,543	2,598	14,097	3,135
Foliage	397	37	20	11	63	90	52	18	110	144	205	59	315	156	847	185
Tree Roots																
Live	1,452	138	82	43	181	360	228	71	384	543	849	228	1,233	590	3,176	709
Dead	456	80	3	7	-28	57	31	23	-154	42	32	68	-121	80	342	129
Standing Dead	1,897	322	15	26	143	212	211	104	-202	133	298	271	97	303	2,363	502
Dead Woody Debris	-430	375	-101	76	-1,086	433	-194	129	-2,904	654	-1,419	513	-4,323	827	-6,134	1,018
Understory Vegetation																
Above Ground	-8	10	-5	2	1	12	-10	6	-35	26	-34	17	-68	31	-90	35
Below Ground	-1	1	-1	0	0	1	-1	1	-4	3	-4	2	-8	3	-10	4
Total	10,476	723	388	235	-190	2,058	1,249	411	-1,239	3,228	3,907	1,386	2,668	3,523	14,590	4,170
Forest Floor	43	51	20	14	-22	64	25	22	20	116	201	81	221	141	287	166
Soils	21	85	-22	21	-78	94	-59	43	175	173	-165	176	9	247	-129	281
Total (including soils and forest floor)	10,539	752	387	248	-290	2,121	1,215	432	-1,045	3,299	3,943	1,444	2,898	3,612	14,748	4,284

Table B22: Average Annual Growth, Mortality, Harvest, and Net Change per Acre in Aboveground Live Tree Carbon Pool by Ownership and Land Status of Washington's Forests, 2002-2006 to 2012-2016. The all ownerships category includes all other state and federal agencies managing fewer overall acres of forest land in Washington.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Metric tons CO2e/acre/year															
Gross tree growth	2.89	0.05	3.28	0.20	4.43	0.21	4.19	0.37	4.94	0.16	2.80	0.12	3.94	0.10	3.56	0.05
Removals - harvest	-0.15	0.03	-0.08	0.07	-2.73	0.66	-0.65	0.32	-3.88	0.42	-0.92	0.20	-2.50	0.25	-1.42	0.12
Mortality - fire killed	-0.47	0.07	-0.03	0.03	-0.13	0.07	-0.16	0.16	-0.01	0.01	-0.13	0.04	-0.06	0.02	-0.22	0.03
Mortality - cut and fire	-0.01	0.00	--	--	--	--	--	--	--	--	-0.00	0.00	-0.00	0.00	-0.00	0.00
Mortality - insects and disease	-0.70	0.09	-0.52	0.17	-0.40	0.10	-0.35	0.14	-0.07	0.02	-0.28	0.06	-0.17	0.03	-0.42	0.04
Mortality - natural/other	-0.84	0.05	-2.22	0.30	-0.91	0.14	-1.04	0.23	-0.64	0.08	-0.53	0.06	-0.59	0.05	-0.84	0.04
Net change	**0.72**	**0.12**	**0.43**	**0.32**	**0.26**	**0.72**	**1.99**	**0.49**	**0.34**	**0.48**	**0.93**	**0.23**	**0.61**	**0.28**	**0.65**	**0.15**

Table B23: Average Annual Growth, Mortality, Harvest, and Net Change in Aboveground Live Tree Carbon Pool by Ownership and Land Status of Washington's Forests, 2002-2006 to 2012-2016. The all ownerships category includes all other state and federal agencies managing fewer overall acres of forest land in Washington.

	Public										Private						All Owners	
	USDA Forest Service		USDA Forest Service (reserved)		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2e per year																	
Gross tree growth	23,913	423	4,659	284	4,957	368	9,832	531	2,900	448	24,634	1,118	12,153	724	36,787	1,090	78,389	1,247
Removals - harvest	-1,226	221	--	--	-126	112	-6,056	1,467	-451	231	-19,338	2,145	-4,017	900	-23,355	2,300	-31,214	2,735
Mortality - fire killed	-3,895	611	-1,159	499	-39	39	-297	156	-110	108	-29	29	-551	191	-580	193	-4,920	669
Mortality - cut and fire	-42	22	--	--	--	--	--	--	--	--	--	--	-22	19	-22	19	-64	29
Mortality - insects and disease	-5,827	734	-2,554	698	-779	268	-888	230	-243	105	-373	87	-1,235	251	-1,608	264	-9,345	861
Mortality - natural/other	-6,939	410	-1,667	266	-3,362	450	-2,024	312	-717	182	-3,215	391	-2,286	261	-5,501	452	-18,543	829
Net change	**5,985**	**1,032**	**-722**	**828**	**651**	**489**	**567**	**1,607**	**1,379**	**377**	**1,678**	**2,385**	**4,042**	**1,027**	**5,721**	**2,600**	**14,303**	**3,283**

Table B24: Average Annual Growth, Mortality, Harvest, and Net Change per Acre in Aboveground Live Tree Carbon Pool by Ownership and Land Status of Washington's Productive Forests, 2002-2006 to 2012-2016. The all ownerships category includes all other state and federal agencies managing fewer overall acres of forest land in Washington.

	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Metric tons CO2e/acre/year															
Gross tree growth	3.06	0.05	3.53	0.21	4.47	0.21	4.19	0.37	4.95	0.16	2.83	0.13	3.98	0.10	3.68	0.06
Removals - harvest	-0.16	0.03	-0.09	0.08	-2.77	0.67	-0.65	0.32	-3.91	0.42	-0.94	0.21	-2.54	0.25	-1.49	0.13
Mortality - fire killed	-0.50	0.08	--	--	-0.14	0.07	-0.16	0.16	-0.01	0.01	-0.13	0.04	-0.06	0.02	-0.23	0.03
Mortality - cut and fire	-0.01	0.00	--	--	--	--	--	--	--	--	-0.01	0.00	-0.00	0.00	-0.00	0.00
Mortality - insects and disease	-0.73	0.10	-0.57	0.19	-0.41	0.10	-0.35	0.14	-0.08	0.02	-0.29	0.06	-0.18	0.03	-0.43	0.04
Mortality - natural/other	-0.88	0.05	-2.41	0.32	-0.92	0.14	-1.04	0.23	-0.65	0.08	-0.53	0.06	-0.59	0.05	-0.86	0.04
Net change	**0.78**	**0.14**	**0.45**	**0.36**	**0.24**	**0.73**	**1.99**	**0.49**	**0.32**	**0.48**	**0.94**	**0.24**	**0.60**	**0.28**	**0.67**	**0.16**

Table B25: Average Annual Growth, Mortality, Harvest, and Net Change per Acre in Aboveground Live Tree Carbon Pool by Ownership and Land Status of Washington's Productive Forests, 2002-2006 to 2012-2016. The all ownerships category includes all other state and federal agencies managing fewer overall acres of forest land in Washington.

	Public										Private						All Owners	
	USDA Forest Service		USDA Forest Service (reserved)		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Metric tons CO2e/acre/year																	
Gross tree growth	3.06	0.05	2.23	0.14	3.53	0.21	4.47	0.21	4.19	0.37	4.95	0.16	2.83	0.13	3.98	0.10	3.68	0.06
Removals - harvest	-0.16	0.03	--	--	-0.09	0.08	-2.77	0.67	-0.65	0.32	-3.91	0.42	-0.94	0.21	-2.54	0.25	-1.49	0.13
Mortality - fire killed	-0.50	0.08	-0.62	0.27	--	--	-0.14	0.07	-0.16	0.16	-0.01	0.01	-0.13	0.04	-0.06	0.02	-0.23	0.03
Mortality - cut and fire	-0.01	0.00	--	--	--	--	--	--	--	--	--	--	-0.01	0.00	-0.00	0.00	-0.00	0.00
Mortality - insects and disease	-0.73	0.10	-1.25	0.38	-0.57	0.19	-0.41	0.10	-0.35	0.14	-0.08	0.02	-0.29	0.06	-0.18	0.03	-0.43	0.04
Mortality - natural/other	-0.88	0.05	-0.80	0.13	-2.41	0.32	-0.92	0.14	-1.04	0.23	-0.65	0.08	-0.53	0.06	-0.59	0.05	-0.86	0.04
Net change	**0.78**	**0.14**	**-0.44**	**0.44**	**0.45**	**0.36**	**0.24**	**0.73**	**1.99**	**0.49**	**0.32**	**0.48**	**0.94**	**0.24**	**0.60**	**0.28**	**0.67**	**0.16**

Table B26: Annual Net Change in Carbon Stocks on Forest Land for All Pools by County, 2007-2016.

	Standing Live tree										Tree Roots								Understory Vegetation											
	Mortality		Cut		Gross Growth		Net		Foliage		Live		Dead		Standing Dead		Dead Woody Debris		Above Ground		Below Ground		Total		Forest Floor		Soils		Total (including soils and forest floor)	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year																													
County																														
Asotin	-37.9	17.1	--	--	79.7	31.6	41.8	19.9	2.5	1.1	9.3	3.9	-0.5	2.4	-5.8	10.8	-52.9	27.6	-2.2	3.2	-0.2	0.4	-8.1	21.9	0.1	5.2	-4.3	11.4	-12.3	22.5
Chelan	-1,674.7	248.8	-96.5	51.3	2,110.4	228.2	339.3	249.1	9.1	14.0	30.0	50.6	11.0	35.4	68.3	151.5	117.3	149.9	7.1	5.5	0.8	0.6	582.9	257.9	-36.9	27.6	-9.6	53.3	536.4	275.0
Columbia	-727.4	226.4	-147.5	72.1	354.0	106.6	-520.9	214.9	-32.5	12.9	-120.5	48.5	-45.3	35.5	-188.1	148.0	-10.6	104.0	13.5	5.6	1.5	0.6	-903.1	355.7	-41.4	13.8	7.9	22.4	-936.6	355.3
Clallam	-2,116.4	363.2	-1,855.6	572.4	5,665.2	654.0	1,693.3	686.4	93.1	42.1	360.5	158.2	-38.4	24.1	-95.8	82.0	-490.5	292.2	-12.7	7.7	-1.4	0.9	1,508.1	866.9	98.0	52.8	-68.9	41.5	1,537.1	896.1
Clark	-134.3	55.4	-463.7	328.5	1,050.4	270.1	452.5	335.5	23.1	21.3	102.2	82.6	-17.8	14.4	-37.5	42.5	-107.5	92.0	-8.1	4.3	-0.9	0.5	406.0	460.8	8.5	7.2	-26.4	25.7	388.1	468.8
Cowlitz	-396.2	101.7	-2,360.5	802.6	3,768.4	596.9	1,011.7	883.5	60.2	54.4	229.6	205.1	2.0	13.8	59.8	51.4	-1,533.2	349.0	-7.5	8.5	-0.8	0.9	-178.2	1,217.6	17.5	26.4	-4.0	79.8	-164.7	1,226.8
Douglas	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ferry	-1,053.9	139.5	-261.0	82.8	2,202.0	202.7	887.1	185.3	54.6	10.8	211.5	39.4	46.4	23.4	206.1	96.4	-161.2	113.5	-3.4	6.1	-0.4	0.7	1,240.8	199.4	-6.8	24.6	7.2	69.6	1,241.3	210.7
Garfield	-316.8	69.7	-32.5	20.0	215.1	59.8	-134.3	61.9	-8.4	3.6	-29.3	12.7	10.7	10.7	30.9	42.4	53.7	38.7	-4.1	4.9	-0.5	0.5	-81.1	98.9	4.8	7.4	1.9	18.1	-74.3	102.2
Grays Harbor	-1,536.0	273.9	-3,931.2	1,163.0	6,918.2	739.7	1,450.9	1,253.6	113.6	74.5	380.8	282.6	-61.8	30.0	-50.6	97.4	-224.2	308.8	-19.7	12.8	-2.2	1.4	1,586.7	1,704.0	93.3	62.3	-5.1	119.6	1,675.0	1,754.1
Island	-96.3	73.5	-16.5	16.3	154.9	97.7	42.2	53.0	2.8	2.1	10.4	12.3	2.8	4.8	4.4	10.5	-2.1	3.8	-0.9	0.6	-0.1	0.1	59.4	59.4	6.4	4.3	-0.3	0.2	65.6	63.4
Jefferson	-2,570.7	484.8	-1,072.4	588.6	4,406.9	533.5	763.8	721.1	47.2	43.7	198.5	162.9	31.1	45.0	309.1	190.3	239.6	366.2	-6.9	7.9	-0.8	0.9	1,581.6	926.8	60.8	54.6	38.5	59.9	1,680.8	931.4
King	-1,125.6	194.0	-720.5	491.2	3,941.4	507.6	2,095.3	596.0	122.0	35.4	466.6	137.4	15.6	30.0	124.7	120.6	-144.9	199.6	-13.9	6.1	-1.5	0.7	2,663.8	813.7	66.2	34.9	-25.0	37.7	2,705.1	832.6
Kitsap	-248.1	98.2	-547.7	341.0	963.1	255.8	167.3	334.2	7.9	20.7	32.3	77.5	3.7	11.9	23.8	38.1	-110.1	73.0	0.9	4.6	0.1	0.5	125.9	454.7	-5.9	15.0	6.7	34.7	126.7	442.2
Kittitas	-898.7	171.2	-365.6	228.9	1,524.3	178.4	259.9	277.5	13.3	16.5	44.4	60.9	45.2	26.0	236.4	111.4	-281.1	105.7	-0.3	5.5	-0.0	0.6	317.9	351.5	28.2	18.7	31.0	89.3	377.1	397.7
Klickitat	-386.5	123.9	-1,170.8	418.6	1,496.2	254.3	-61.0	417.4	-4.5	24.6	-25.1	92.8	-0.8	21.8	20.9	94.5	-292.1	102.8	12.8	8.2	1.4	0.9	-348.5	539.4	-15.5	22.3	80.6	37.4	-283.3	537.6
Lewis	-1,463.9	215.0	-2,606.0	928.1	6,557.6	654.6	2,487.7	1,012.4	152.8	62.5	604.0	233.4	13.4	28.5	127.6	105.2	-523.2	251.5	-18.0	9.4	-2.0	1.0	2,842.2	1,307.4	5.2	46.1	-87.6	47.2	2,759.8	1,348.1
Lincoln	-96.1	61.0	-24.2	25.2	144.8	64.3	24.6	67.5	0.5	3.2	6.7	13.6	6.3	7.2	32.3	35.1	-7.2	23.4	1.1	1.9	0.1	0.2	64.3	55.2	4.5	5.7	27.2	28.6	96.0	78.6
Mason	-416.5	118.4	-678.1	357.4	2,072.0	355.8	977.4	405.8	63.8	25.6	224.6	96.1	-19.1	12.0	8.7	60.5	-161.8	112.0	-15.6	4.7	-1.7	0.5	1,076.2	510.4	58.4	23.1	27.9	31.9	1,162.5	515.3
Okanogan	-5,637.7	874.7	-453.6	152.9	2,923.5	217.2	-3,167.9	809.4	-193.2	50.5	-697.0	186.3	595.3	173.3	2,487.5	703.5	-343.7	264.9	53.0	15.6	5.9	1.7	-1,260.0	449.4	-225.0	70.5	-232.5	109.1	-1,717.4	502.5
Pacific	-1,058.3	258.3	-2,994.2	988.9	3,604.4	561.4	-448.1	1,005.0	-36.9	61.1	-95.3	227.9	-4.7	15.5	60.6	38.8	-60.3	266.1	4.3	10.1	0.5	1.1	-579.8	1,317.4	-52.6	43.0	-16.5	79.6	-648.9	1,367.6
Pend Oreille	-1,041.6	188.9	-282.2	102.8	2,593.4	234.4	1,269.6	247.1	81.8	14.7	293.9	51.6	16.3	29.8	62.6	126.9	117.7	93.7	-10.3	4.9	-1.1	0.5	1,830.5	260.9	45.4	25.6	34.0	29.0	1,909.9	269.7
Pierce	-569.1	134.5	-1,921.6	718.9	2,681.5	404.1	190.8	736.3	23.8	43.6	78.5	169.6	-60.6	28.5	-86.0	74.4	-293.1	254.9	1.9	9.6	0.2	1.1	-144.6	1,075.8	-25.6	48.2	28.6	53.3	-141.6	1,112.6
San Juan	-43.9	32.5	-1.2	1.2	319.6	148.2	274.5	121.7	14.6	6.7	59.8	27.0	-3.6	6.3	-16.4	24.8	4.9	35.2	-1.3	0.8	-0.1	0.1	332.3	169.5	3.4	5.6	0.9	0.6	336.6	171.1
Skagit	-1,078.3	172.0	-1,593.7	912.3	3,547.9	495.9	875.9	944.0	60.2	37.8	178.3	194.9	16.7	28.5	62.2	98.9	-166.0	322.3	-9.3	7.7	-1.0	0.9	1,017.0	1,129.4	38.2	31.2	-126.2	65.7	929.0	1,165.2
Skamania	-1,179.4	177.3	-634.4	334.8	4,062.4	308.9	2,248.6	364.0	128.9	22.1	486.4	82.7	1.8	28.6	27.2	103.1	-340.9	150.0	-17.0	5.6	-1.9	0.6	2,533.2	494.0	41.1	20.3	52.4	22.6	2,626.7	515.0
Snohomish	-1,888.8	346.9	-1,526.5	800.6	3,822.8	452.7	407.6	822.9	-0.1	49.1	-28.9	186.3	-30.8	37.3	32.2	162.2	-843.9	390.7	3.4	6.3	0.4	0.7	-460.2	1,151.0	-65.9	103.1	56.0	43.9	-470.1	1,196.6
Spokane	-170.3	62.2	-301.4	175.5	883.2	203.1	411.6	216.5	23.2	12.7	80.4	46.0	-5.7	6.6	-20.8	26.5	-44.2	52.3	-0.7	3.5	-0.1	0.4	443.7	255.7	15.2	21.5	-31.1	35.6	427.8	266.7
Stevens	-968.8	192.7	-1,789.7	417.9	2,585.4	284.2	-173.1	415.3	-13.2	24.0	-44.9	84.3	-15.9	20.7	-52.7	84.8	-3.2	149.2	-1.2	7.3	-0.1	0.8	-304.4	559.2	0.4	31.9	59.7	59.5	-244.2	574.9
Thurston	-395.2	140.0	-637.2	468.4	1,439.4	335.4	406.9	511.8	15.6	30.5	75.3	118.9	13.4	13.6	59.1	49.6	-100.8	93.5	-6.7	4.7	-0.7	0.5	462.1	690.6	40.6	17.3	39.1	26.6	541.8	706.0
Wahkiakum	-178.8	100.9	-549.0	476.5	640.1	229.4	-87.7	458.6	-1.8	29.5	-16.1	108.5	-8.0	8.4	-6.1	25.7	-51.3	96.1	3.0	3.8	0.3	0.4	-167.6	648.9	-1.4	15.9	-2.8	27.3	-171.8	665.5
Walla Walla	--	--	--	--	19.4	14.2	19.4	14.2	1.1	0.8	4.3	3.1	--	--	--	--	-3.3	4.1	-0.7	0.8	-0.1	0.1	20.7	15.3	-0.6	0.6	-14.2	15.1	5.9	15.0
Whatcom	-1,119.8	199.8	-1,549.8	773.4	3,053.2	400.1	383.7	755.8	28.9	46.2	92.0	176.3	15.0	33.7	129.0	124.4	-568.7	200.2	-3.6	6.1	-0.4	0.7	75.8	1,027.8	55.8	36.5	-40.7	31.6	90.9	1,056.2
Whitman	--	--	--	--	9.2	9.4	9.2	9.4	0.6	0.6	2.3	2.3	-0.6	0.6	-2.6	2.7	4.8	3.6	-0.6	0.6	-0.1	0.1	13.0	10.5	3.4	3.5	0.0	0.0	16.5	14.0
Yakima	-2,246.5	379.4	-629.5	256.2	2,579.3	294.5	-296.7	404.4	-21.5	25.6	-93.2	93.0	107.7	63.7	470.8	258.4	-462.4	459.5	6.4	7.9	0.7	0.9	-288.2	607.6	31.8	21.9	20.1	55.3	-236.3	617.2
All counties	-32,872.5	1,250.2	-31,214.3	2,735.4	78,389.5	1,246.6	14,302.7	3,283.2	833.1	194.9	3,111.9	745.9	640.7	226.7	4,082.2	909.6	-6,846.2	1,183.8	-57.5	38.5	-6.4	4.3	16,060.5	4,274.3	249.9	206.2	-175.3	301.0	16,135.1	4,396.3

Table B27: Average Annual Carbon (CO_2e) Flux in Live Trees from Growth, Harvest, and Mortality, 2002-2006 to 2012-2016: NATIONAL FOREST.

	Region 6																	
	Colville		Gifford Pinchot		Idaho Panhandle		Mt. Baker-Snoqualmie		Okanogan		Olympic		Umatilla		Wenatchee		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand Metric Tons CO2 equivalent per year																	
Standing Live																		
Gross Growth	2,844	106	5,485	221	387	28	6,013	325	2,167	170	2,884	133	538	111	3,594	239	23,913	423
Harvest	-169	64	-156	79	-10	6	-22	15	-173	59	-482	176	-123	54	-91	34	-1,226	221
Fire killed	-293	142	-221	127	--	--	--	--	-2,370	530	--	--	-540	207	-470	149	-3,895	611
Cut and fire	--	--	--	--	--	--	--	--	-3	3	--	--	-39	22	--	--	-42	22
Insects and disease	-1,034	163	-510	166	-126	25	-236	99	-1,849	659	-144	57	-173	64	-1,754	282	-5,827	734
Natural/other	-376	49	-1,175	113	-23	7	-2,545	259	-364	118	-1,385	206	-264	101	-808	181	-6,939	410
Total Mortality	-1,702	205	-1,906	227	-149	21	-2,781	269	-4,585	823	-1,529	208	-1,016	222	-3,032	347	-16,702	927
Net Flux	972	220	3,423	293	228	44	3,210	372	-2,590	763	873	268	-601	215	471	338	5,985	1,032
All Pools																		
Net Flux	**2,044**	**194**	**4,396**	**396**	**279**	**69**	**3,521**	**617**	**-1,498**	**438**	**1,263**	**368**	**-954**	**366**	**1,106**	**316**	**10,156**	**1,060**

Table B28: Average Annual Carbon (CO_2e) Flux per Acre in Live Trees from Growth, harvest, and Mortality, 2002-2006 to 2012-2016: NATIONAL FOREST.

	Region 6																	
	Colville		Gifford Pinchot		Idaho Panhandle		Mt. Baker-Snoqualmie		Okanogan		Olympic		Umatilla		Wenatchee		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Metric Tons CO2 equivalent per acre/year																	
Standing Live																		
Gross Growth	2.668	0.082	4.245	0.148	3.642	0.275	4.089	0.187	1.344	0.069	5.061	0.270	1.770	0.237	1.941	0.090	2.890	0.051
Harvest	-0.159	0.060	-0.120	0.062	-0.095	0.095	-0.015	0.010	-0.107	0.037	-0.846	0.310	-0.406	0.192	-0.049	0.019	-0.148	0.027
Fire killed	-0.275	0.134	-0.171	0.099	--	--	--	--	-1.470	0.315	--	--	-1.776	0.671	-0.254	0.081	-0.471	0.074
Cut and fire	--	--	--	--	--	--	--	--	-0.002	0.002	--	--	-0.129	0.076	--	--	-0.005	0.003
Insects and disease	-0.970	0.138	-0.395	0.122	-1.190	0.231	-0.160	0.067	-1.147	0.396	-0.253	0.100	-0.568	0.193	-0.947	0.138	-0.704	0.088
Natural/other	-0.352	0.046	-0.909	0.088	-0.213	0.068	-1.731	0.164	-0.226	0.070	-2.430	0.363	-0.867	0.303	-0.436	0.094	-0.839	0.049
Total Mortality	-1.597	0.174	-1.475	0.159	-1.403	0.194	-1.891	0.169	-2.844	0.462	-2.683	0.369	-3.340	0.630	-1.638	0.160	-2.019	0.111
Net Flux	0.912	0.214	2.649	0.237	2.144	0.423	2.183	0.249	-1.607	0.453	1.531	0.472	-1.976	0.727	0.254	0.183	0.723	0.125
All Pools																		
Net Flux	**1.917**	**0.191**	**3.402**	**0.319**	**2.626**	**0.662**	**2.394**	**0.415**	**-0.929**	**0.262**	**2.216**	**0.637**	**-3.137**	**1.098**	**0.597**	**0.170**	**1.228**	**0.128**

Table B29: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Blues+Columbia Basin.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-1,042	223	-20	19	-30	29	-111	108	-1	1	-303	98	-304	98	-1,506	268
Cut	-123	54	--	--	-4	4	--	--	-7	7	-125	62	-132	62	-259	83
Gross Growth	550	111	21	14	39	31	55	37	12	12	564	113	576	114	1,240	167
Net	-615	215	1	11	6	4	-56	98	5	5	135	102	140	102	-525	258
Foliage	-38	13	0	1	1	1	-3	5	0	0	7	5	8	5	-32	15
Tree Roots																
Live	-140	48	0	3	2	1	-7	16	1	1	31	21	32	21	-112	55
Dead	-30	37	-2	2	-2	2	9	15	--	--	9	13	9	13	-15	41
Standing Dead	-137	152	-7	6	-8	9	50	76	--	--	42	55	42	55	-59	179
Dead Woody Debris	3	110	8	11	-10	10	1	12	14	15	-429	370	-415	370	-413	386
Understory Vegetation																
Above Ground	10	7	0	0	-0	0	-1	2	1	1	-2	4	-1	4	8	9
Below Ground	1	1	0	0	-0	0	-0	0	0	0	-0	0	-0	0	1	1
Total	-946	365	1	10	-11	10	-7	48	22	22	-208	372	-186	373	-1,149	524
Forest Floor	-35	15	3	2	1	3	-10	10	-1	1	13	13	12	13	-28	22
Soils	24	27	-0	0	0	0	-35	26	-6	6	5	34	-1	35	-12	51
Total (including soils and forest floor)	-957	366	4	10	-10	11	-51	73	14	15	-189	377	-175	378	-1,189	531

Table B30: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Blues+Columbia Basin.

Change in Carbon Pool	Public: USDA Forest Service		Public: Other Federal		Public: DNR Managed Lands		Public: Other State and Local Government		Private: Corporate		Private: Non-corporate		Private: Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-3.33	0.61	-0.70	0.70	-1.20	1.02	-2.96	2.17	-0.09	0.09	-0.69	0.19	-0.68	0.19	-1.77	0.28
Cut	-0.39	0.19	--	--	-0.15	0.15	--	--	-0.65	0.65	-0.29	0.13	-0.29	0.13	-0.30	0.10
Gross Growth	1.76	0.23	0.73	0.05	1.58	0.95	1.45	0.52	1.19	1.19	1.28	0.15	1.28	0.15	1.45	0.12
Net	-1.96	0.71	0.04	0.41	0.23	0.02	-1.50	2.39	0.45	0.45	0.31	0.23	0.31	0.22	-0.62	0.31
Foliage	-0.12	0.04	0.00	0.03	0.03	0.01	-0.07	0.12	0.04	0.04	0.02	0.01	0.02	0.01	-0.04	0.02
Tree Roots																
Live	-0.45	0.15	0.02	0.09	0.09	0.03	-0.19	0.41	0.11	0.11	0.07	0.05	0.07	0.05	-0.13	0.07
Dead	-0.10	0.11	-0.06	0.06	-0.07	0.08	0.25	0.35	--	--	0.02	0.03	0.02	0.03	-0.02	0.05
Standing Dead	-0.44	0.45	-0.23	0.23	-0.32	0.35	1.34	1.77	--	--	0.10	0.12	0.09	0.12	-0.07	0.21
Dead Woody Debris	0.01	0.35	0.28	0.35	-0.41	0.29	0.02	0.32	1.40	1.40	-0.98	0.83	-0.92	0.81	-0.48	0.45
Understory Vegetation																
Above Ground	0.03	0.02	--	--	-0.02	0.01	-0.02	0.06	0.10	0.10	-0.01	0.01	0.00	0.01	0.01	0.01
Below Ground	0.00	0.00	--	--	--	--	0.00	0.01	0.01	0.01	--	--	--	--	--	--
Total	-3.02	1.05	0.05	0.36	-0.46	0.33	-0.18	1.26	2.10	2.10	-0.47	0.84	-0.41	0.83	-1.35	0.60
Forest Floor	-0.11	0.05	0.09	0.01	0.06	0.12	-0.26	0.21	-0.10	0.10	0.03	0.03	0.03	0.03	-0.03	0.03
Soils	0.08	0.08	--	--	--	--	-0.93	0.45	-0.59	0.59	0.01	0.08	0.00	0.08	-0.01	0.06
Total (including soils and forest floor)	-3.05	1.07	0.14	0.36	-0.40	0.43	-1.36	1.78	1.41	1.41	-0.43	0.86	-0.39	0.84	-1.39	0.61

Table B31: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Eastern Cascades.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-1,015	195	--	--	-131	85	-138	74	-76	29	-975	253	-1,051	254	-2,336	339
Cut	-40	18	--	--	-81	65	-48	56	-949	404	-753	271	-1,702	486	-1,871	494
Gross Growth	1,206	140	5	5	422	152	201	76	749	177	1,625	257	2,374	308	4,207	377
Net	150	177	5	5	210	165	14	65	-276	368	-103	345	-380	504	-0	563
Foliage	8	11	0	0	13	10	0	4	-18	22	-10	21	-28	30	-7	34
Tree Roots																
Live	26	38	1	1	48	37	1	15	-71	82	-45	80	-115	114	-39	127
Dead	51	24	-2	2	-0	18	8	10	-13	6	25	51	12	52	68	61
Standing Dead	242	105	-5	5	19	76	39	42	-50	21	114	207	64	208	358	249
Dead Woody Debris	74	142	-0	0	-65	58	-39	42	-133	62	-357	230	-490	238	-520	286
Understory Vegetation																
Above Ground	0	3	-0	0	-2	2	1	1	-1	5	16	8	16	9	15	10
Below Ground	0	0	-0	0	-0	0	0	0	-0	1	2	1	2	1	2	1
Total	552	169	-2	2	223	178	24	77	-562	496	-359	480	-920	691	-124	737
Forest Floor	7	12	1	1	6	6	3	8	-26	16	1	23	-24	28	-6	32
Soils	-1	18	-0	0	10	10	18	19	33	22	16	61	49	64	76	70
Total (including soils and forest floor)	558	176	-2	2	239	180	45	80	-554	493	-341	495	-895	699	-55	747

Table B32: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Eastern Cascades.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.09	0.30	--	--	-0.67	0.40	-1.27	0.52	-0.28	0.09	-1.30	0.29	-1.03	0.22	-1.28	0.16
Cut	-0.08	0.04	--	--	-0.41	0.31	-0.44	0.44	-3.47	1.28	-1.00	0.34	-1.66	0.44	-1.03	0.26
Gross Growth	2.48	0.19	0.47	0.47	2.16	0.54	1.84	0.30	2.74	0.28	2.17	0.22	2.32	0.18	2.31	0.13
Net	0.31	0.37	0.47	0.47	1.07	0.80	0.13	0.59	-1.01	1.33	-0.14	0.46	-0.37	0.49	0.00	0.31
Foliage	0.02	0.02	0.01	0.01	0.07	0.05	0.00	0.04	-0.07	0.08	-0.01	0.03	-0.03	0.03	0.00	0.02
Tree Roots																
Live	0.05	0.08	0.10	0.10	0.25	0.18	0.01	0.14	-0.26	0.29	-0.06	0.11	-0.11	0.11	-0.02	0.07
Dead	0.11	0.05	-0.25	0.25	0.00	0.09	0.07	0.09	-0.05	0.02	0.03	0.07	0.01	0.05	0.04	0.03
Standing Dead	0.50	0.20	-0.54	0.54	0.10	0.39	0.35	0.36	-0.18	0.07	0.15	0.28	0.06	0.20	0.20	0.14
Dead Woody Debris	0.15	0.29	-0.02	0.02	-0.33	0.28	-0.36	0.36	-0.49	0.20	-0.48	0.30	-0.48	0.23	-0.29	0.16
Understory Vegetation																
Above Ground	0.00	0.01	-0.01	0.01	-0.01	0.01	0.00	0.01	0.00	0.02	0.02	0.01	0.02	0.01	0.01	0.01
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.14	0.34	-0.24	0.24	1.14	0.86	0.22	0.70	-2.06	1.76	-0.48	0.64	-0.90	0.67	-0.07	0.40
Forest Floor	0.02	0.03	0.10	0.10	0.03	0.03	0.03	0.07	-0.09	0.06	0.00	0.03	-0.02	0.03	0.00	0.02
Soils	0.00	0.04	-0.02	0.02	0.05	0.05	0.16	0.17	0.12	0.07	0.02	0.08	0.05	0.06	0.04	0.04
Total (including soils and forest floor)	1.15	0.35	-0.17	0.17	1.22	0.86	0.41	0.72	-2.03	1.75	-0.45	0.66	-0.88	0.68	-0.03	0.41

Table B33: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Northern Cascades.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-8,693	870	-601	145	-1,075	258	-30	23	-476	123	-85	38	-561	130	-10,960	929
Cut	-162	55	--	--	-1,454	691	--	--	-938	510	-108	57	-1,046	513	-2,662	858
Gross Growth	8,993	393	935	228	1,894	334	85	68	2,684	488	361	120	3,045	501	14,952	754
Net	138	871	334	183	-635	651	55	45	1,270	631	168	97	1,438	638	1,330	1,274
Foliage	-25	55	20	11	-42	41	3	2	70	35	8	4	78	36	33	78
Tree Roots																
Live	-147	207	73	42	-142	153	13	11	264	139	37	19	301	140	99	297
Dead	537	177	45	20	59	47	1	1	13	13	-3	6	10	14	652	185
Standing Dead	2,335	718	189	85	306	185	2	4	60	45	-5	26	55	53	2,888	748
Dead Woody Debris	-1,137	487	-235	209	-22	217	-3	41	-360	226	-43	32	-402	228	-1,799	620
Understory Vegetation																
Above Ground	40	14	3	3	13	6	-0	1	-20	8	0	3	-20	9	36	18
Below Ground	4	2	0	0	1	1	-0	0	-2	1	0	0	-2	1	4	2
Total	1,745	714	430	258	-460	893	72	60	1,295	803	162	148	1,458	817	3,244	1,427
Forest Floor	-180	119	14	18	-55	41	2	2	51	34	0	9	52	35	-168	131
Soils	-105	98	-42	37	-60	52	0	1	68	93	21	17	89	95	-118	150
Total (including soils and forest floor)	1,460	777	402	267	-575	913	74	61	1,415	821	183	154	1,598	836	2,958	1,484

Table B34: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Northern Cascades.

	Public								Private						All Owners	
Change in Carbon Pool	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.29	0.21	-1.92	0.29	-1.84	0.36	-1.29	0.24	-0.83	0.19	-0.49	0.18	-0.75	0.15	-2.00	0.16
Cut	-0.04	0.01	--	--	-2.49	1.14	--	--	-1.63	0.86	-0.63	0.29	-1.40	0.67	-0.49	0.16
Gross Growth	2.37	0.09	2.98	0.47	3.25	0.39	3.66	0.78	4.67	0.52	2.10	0.47	4.08	0.44	2.74	0.10
Net	0.04	0.23	1.07	0.55	-1.09	1.11	2.37	0.56	2.21	1.04	0.98	0.51	1.93	0.82	0.24	0.23
Foliage	-0.01	0.01	0.06	0.03	-0.07	0.07	0.11	0.03	0.12	0.06	0.04	0.02	0.10	0.05	0.01	0.01
Tree Roots																
Live	-0.04	0.05	0.23	0.13	-0.24	0.26	0.57	0.16	0.46	0.23	0.21	0.10	0.40	0.18	0.02	0.05
Dead	0.14	0.05	0.14	0.06	0.10	0.08	0.03	0.03	0.02	0.02	-0.02	0.04	0.01	0.02	0.12	0.03
Standing Dead	0.61	0.19	0.60	0.23	0.53	0.31	0.11	0.17	0.10	0.08	-0.03	0.15	0.07	0.07	0.53	0.13
Dead Woody Debris	-0.30	0.13	-0.75	0.65	-0.04	0.37	-0.11	1.75	-0.63	0.39	-0.25	0.18	-0.54	0.30	-0.33	0.11
Understory Vegetation																
Above Ground	0.01	0.00	0.01	0.01	0.02	0.01	0.00	0.02	-0.03	0.01	0.00	0.02	-0.03	0.01	0.01	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.46	0.19	1.37	0.78	-0.79	1.53	3.08	1.67	2.25	1.35	0.94	0.83	1.95	1.06	0.59	0.26
Forest Floor	-0.05	0.03	0.04	0.06	-0.09	0.07	0.09	0.07	0.09	0.06	0.00	0.05	0.07	0.05	-0.03	0.02
Soils	-0.03	0.03	-0.13	0.12	-0.10	0.09	0.01	0.03	0.12	0.16	0.12	0.09	0.12	0.13	-0.02	0.03
Total (including soils and forest floor)	0.38	0.21	1.28	0.81	-0.99	1.56	3.17	1.70	2.46	1.37	1.06	0.85	2.14	1.08	0.54	0.27

Table B35: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Okanogan Highland.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-2,017	210	-170	102	-103	52	-3	3	-177	53	-1,161	211	-1,337	216	-3,631	323
Cut	-256	74	-116	112	-638	287	-8	9	-1,030	300	-839	224	-1,869	368	-2,886	485
Gross Growth	3,662	124	329	106	517	132	58	32	1,219	222	3,120	312	4,339	364	8,905	422
Net	1,389	231	43	126	-224	266	47	31	13	312	1,120	329	1,133	450	2,388	585
Foliage	90	13	3	6	-14	16	3	2	-4	18	66	19	62	26	144	34
Tree Roots																
Live	330	47	12	23	-49	56	11	7	-17	64	242	69	225	94	530	121
Dead	87	34	0	11	-10	5	-0	0	-22	9	-6	30	-28	32	49	48
Standing Dead	393	145	-1	43	-42	20	-1	2	-84	35	-20	127	-104	132	246	202
Dead Woody Debris	278	114	34	44	-75	75	-8	16	21	116	-246	147	-225	187	3	237
Understory Vegetation																
Above Ground	-8	4	-2	1	-1	3	-1	1	4	7	-9	10	-6	12	-19	13
Below Ground	-1	0	-0	0	-0	0	-0	0	0	1	-1	1	-1	1	-2	1
Total	2,558	211	89	178	-415	322	50	34	-88	404	1,145	410	1,057	575	3,338	713
Forest Floor	9	23	-1	6	-10	19	0	2	-1	33	55	34	53	47	51	56
Soils	22	48	-27	20	58	40	-15	15	26	38	-52	87	-27	95	13	116
Total (including soils and forest floor)	2,589	224	60	185	-367	319	36	33	-64	418	1,148	432	1,084	600	3,402	739

Table B36: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Okanogan Highland.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.42	0.14	-1.63	0.85	-0.40	0.18	-0.11	0.08	-0.33	0.09	-0.71	0.12	-0.61	0.09	-0.91	0.08
Cut	-0.18	0.05	-1.11	1.11	-2.45	0.96	-0.27	0.27	-1.90	0.49	-0.51	0.13	-0.86	0.16	-0.72	0.12
Gross Growth	2.57	0.07	3.15	0.48	1.98	0.31	1.90	0.42	2.24	0.26	1.91	0.12	1.99	0.11	2.23	0.07
Net	0.98	0.17	0.41	1.21	-0.86	1.00	1.52	0.55	0.02	0.57	0.68	0.19	0.52	0.20	0.60	0.15
Foliage	0.06	0.01	0.03	0.06	-0.06	0.06	0.09	0.03	-0.01	0.03	0.04	0.01	0.03	0.01	0.04	0.01
Tree Roots																
Live	0.23	0.03	0.11	0.22	-0.19	0.21	0.36	0.12	-0.03	0.12	0.15	0.04	0.10	0.04	0.13	0.03
Dead	0.06	0.02	0.00	0.10	-0.04	0.02	0.00	0.01	-0.04	0.02	0.00	0.02	-0.01	0.01	0.01	0.01
Standing Dead	0.28	0.10	-0.01	0.41	-0.16	0.07	-0.05	0.05	-0.15	0.06	-0.01	0.08	-0.05	0.06	0.06	0.05
Dead Woody Debris	0.20	0.08	0.32	0.41	-0.29	0.28	-0.27	0.55	0.04	0.21	-0.15	0.09	-0.10	0.09	0.00	0.06
Understory Vegetation																
Above Ground	-0.01	0.00	-0.02	0.01	-0.01	0.01	-0.03	0.03	0.01	0.01	-0.01	0.01	0.00	0.01	0.00	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.80	0.15	0.85	1.69	-1.59	1.18	1.62	0.48	-0.16	0.74	0.70	0.25	0.49	0.26	0.83	0.18
Forest Floor	0.01	0.02	-0.01	0.05	-0.04	0.07	0.02	0.05	0.00	0.06	0.03	0.02	0.02	0.02	0.01	0.01
Soils	0.02	0.03	-0.26	0.19	0.22	0.15	-0.47	0.45	0.05	0.07	-0.03	0.05	-0.01	0.04	0.00	0.03
Total (including soils and forest floor)	1.82	0.16	0.58	1.77	-1.41	1.18	1.17	0.71	-0.12	0.77	0.70	0.26	0.50	0.27	0.85	0.19

Table B37: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Puget Trough.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-110	68	-164	89	-195	99	-325	130	-720	260	-785	161	-1,505	305	-2,300	360
Cut	-161	115	--	--	-1,773	1,042	-9	10	-3,352	994	-560	289	-3,912	1,029	-5,855	1,469
Gross Growth	323	84	545	181	842	216	1,016	257	3,761	532	3,011	412	6,773	655	9,498	746
Net	51	109	381	148	-1,126	990	681	185	-311	994	1,667	393	1,356	1,069	1,343	1,482
Foliage	4	7	17	7	-43	46	35	9	-24	59	84	17	60	62	73	78
Tree Roots																
Live	15	25	69	30	-228	211	147	40	-77	226	360	82	283	240	286	325
Dead	3	5	-5	7	-31	20	-12	9	-25	13	21	18	-4	23	-49	33
Standing Dead	-6	9	-9	22	-101	64	-9	36	-54	49	84	63	30	80	-96	112
Dead Woody Debris	23	46	-26	34	20	139	-120	51	-260	138	-129	108	-389	176	-493	237
Understory Vegetation																
Above Ground	-0	1	-2	1	6	6	-4	2	-7	11	-18	4	-24	12	-25	14
Below Ground	-0	0	-0	0	1	1	-0	0	-1	1	-2	0	-3	1	-3	2
Total	88	116	425	169	-1,503	1,251	718	225	-758	1,305	2,067	507	1,310	1,400	1,037	1,904
Forest Floor	1	5	27	19	-24	32	18	11	-9	40	60	39	51	56	73	68
Soils	1	5	15	12	-53	52	-33	30	23	46	1	52	24	70	-45	93
Total (including soils and forest floor)	90	122	466	177	-1,580	1,311	703	225	-743	1,316	2,129	516	1,386	1,414	1,065	1,955

Table B38: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Puget Trough.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.86	1.05	-1.42	0.65	-1.02	0.45	-1.50	0.48	-0.97	0.33	-1.28	0.21	-1.11	0.21	-1.19	0.17
Cut	-2.72	1.82	--	--	-9.23	4.95	-0.04	0.04	-4.51	1.21	-0.91	0.46	-2.89	0.71	-3.02	0.72
Gross Growth	5.44	0.39	4.73	0.58	4.38	0.40	4.69	0.67	5.06	0.37	4.92	0.33	5.00	0.25	4.90	0.20
Net	0.87	1.82	3.31	0.75	-5.87	4.95	3.15	0.59	-0.42	1.34	2.72	0.55	1.00	0.79	0.69	0.76
Foliage	0.06	0.11	0.14	0.04	-0.22	0.23	0.16	0.03	-0.03	0.08	0.14	0.02	0.04	0.05	0.04	0.04
Tree Roots																
Live	0.25	0.41	0.60	0.18	-1.19	1.06	0.68	0.13	-0.10	0.30	0.59	0.11	0.21	0.18	0.15	0.17
Dead	0.05	0.08	-0.05	0.06	-0.16	0.10	-0.05	0.04	-0.03	0.02	0.03	0.03	0.00	0.02	-0.03	0.02
Standing Dead	-0.11	0.16	-0.08	0.19	-0.53	0.31	-0.04	0.17	-0.07	0.07	0.14	0.10	0.02	0.06	-0.05	0.06
Dead Woody Debris	0.38	0.77	-0.22	0.28	0.10	0.72	-0.56	0.21	-0.35	0.18	-0.21	0.17	-0.29	0.13	-0.25	0.12
Understory Vegetation																
Above Ground	-0.01	0.01	-0.02	0.01	0.03	0.03	-0.02	0.01	-0.01	0.01	-0.03	0.01	-0.02	0.01	-0.01	0.01
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.49	1.92	3.68	0.94	-7.83	6.23	3.31	0.82	-1.02	1.75	3.37	0.72	0.97	1.03	0.54	0.98
Forest Floor	0.01	0.09	0.23	0.14	-0.12	0.16	0.08	0.05	-0.01	0.05	0.10	0.06	0.04	0.04	0.04	0.04
Soils	0.02	0.08	0.13	0.09	-0.27	0.26	-0.15	0.14	0.03	0.06	0.00	0.08	0.02	0.05	-0.02	0.05
Total (including soils and forest floor)	1.52	2.02	4.04	0.89	-8.23	6.52	3.25	0.83	-1.00	1.76	3.47	0.73	1.02	1.04	0.55	1.01

Table B39: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Washington Coast Range.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-1,419	202	-2,907	496	-1,114	277	-62	40	-1,685	276	-496	129	-2,181	299	-7,684	674
Cut	-321	135	-10	10	-1,053	568	-82	76	-8,539	1,599	-1,276	757	-9,815	1,764	-11,281	1,858
Gross Growth	2,561	147	2,649	318	3,712	544	392	221	10,705	860	2,731	498	13,436	936	22,750	1,142
Net	821	246	-268	396	1,544	750	248	167	481	1,686	960	778	1,440	1,859	3,786	2,065
Foliage	52	14	-21	24	101	47	15	9	47	103	53	46	100	113	247	126
Tree Roots																
Live	184	54	-72	93	381	175	56	37	176	386	217	174	393	423	942	472
Dead	31	25	-20	41	11	22	-5	4	-66	27	-23	20	-89	34	-71	63
Standing Dead	57	75	181	193	100	73	-3	4	-17	92	23	61	6	110	341	245
Dead Woody Debris	-73	164	283	305	-398	248	-48	56	-920	482	-139	187	-1,059	517	-1,295	671
Understory Vegetation																
Above Ground	-4	3	3	3	-8	6	-0	0	-7	17	-20	9	-27	19	-36	20
Below Ground	-0	0	0	0	-1	1	-0	0	-1	2	-2	1	-3	2	-4	2
Total	1,067	335	87	466	1,731	995	263	160	-307	2,341	1,068	1,011	761	2,554	3,908	2,804
Forest Floor	41	11	22	30	34	27	4	4	12	77	76	54	88	95	187	103
Soils	64	40	-11	12	-29	35	-2	4	113	98	-82	119	31	155	54	164
Total (including soils and forest floor)	1,172	349	97	474	1,736	1,011	264	162	-182	2,384	1,062	1,060	880	2,613	4,150	2,866

Table B40: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Washington Coast Range.

	Public								Private						All Owners	
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**			
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-2.78	0.40	-3.94	0.58	-1.90	0.41	-1.19	0.50	-0.91	0.14	-0.97	0.21	-0.92	0.12	-1.81	0.15
Cut	-0.63	0.27	-0.01	0.01	-1.80	0.96	-1.57	1.57	-4.62	0.82	-2.50	1.44	-4.16	0.72	-2.66	0.42
Gross Growth	5.02	0.30	3.59	0.30	6.33	0.49	7.49	2.00	5.79	0.26	5.36	0.58	5.69	0.24	5.36	0.17
Net	1.61	0.48	-0.36	0.53	2.63	1.22	4.74	2.16	0.26	0.91	1.88	1.50	0.61	0.79	0.89	0.48
Foliage	0.10	0.03	-0.03	0.03	0.17	0.08	0.28	0.11	0.03	0.06	0.10	0.09	0.04	0.05	0.06	0.03
Tree Roots																
Live	0.36	0.11	-0.10	0.13	0.65	0.28	1.08	0.45	0.10	0.21	0.43	0.33	0.17	0.18	0.22	0.11
Dead	0.06	0.05	-0.03	0.06	0.02	0.04	-0.09	0.07	-0.04	0.01	-0.04	0.04	-0.04	0.01	-0.02	0.01
Standing Dead	0.11	0.15	0.25	0.26	0.17	0.12	-0.07	0.07	-0.01	0.05	0.04	0.12	0.00	0.05	0.08	0.06
Dead Woody Debris	-0.14	0.32	0.38	0.41	-0.68	0.42	-0.91	0.96	-0.50	0.26	-0.27	0.37	-0.45	0.22	-0.30	0.16
Understory Vegetation																
Above Ground	-0.01	0.01	0.00	0.00	-0.01	0.01	-0.01	0.00	0.00	0.01	-0.04	0.02	-0.01	0.01	-0.01	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.09	0.65	0.12	0.63	2.95	1.64	5.02	1.78	-0.17	1.27	2.10	1.96	0.32	1.08	0.92	0.66
Forest Floor	0.08	0.02	0.03	0.04	0.06	0.05	0.07	0.06	0.01	0.04	0.15	0.10	0.04	0.04	0.04	0.02
Soils	0.13	0.07	-0.02	0.02	-0.05	0.06	-0.04	0.07	0.06	0.05	-0.16	0.23	0.01	0.07	0.01	0.04
Total (including soils and forest floor)	2.30	0.67	0.13	0.64	2.96	1.67	5.05	1.83	-0.10	1.29	2.08	2.05	0.37	1.11	0.98	0.67

Table B41: Annual Net Change in Carbon Stocks on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Western Cascades.

	Public								Private							
Change in Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	thousand metric tons CO2 equivalent per year															
Standing Live tree																
Mortality	-2,406	312	-319	111	-561	166	-399	141	-481	97	-289	100	-771	139	-4,455	419
Cut	-162	80	--	--	-1,054	601	-304	211	-4,524	1,090	-356	239	-4,880	1,114	-6,400	1,283
Gross Growth	6,618	318	474	130	2,407	428	1,093	280	5,503	702	741	190	6,244	723	16,837	942
Net	4,050	371	155	104	793	700	390	253	497	1,143	96	263	593	1,172	5,982	1,439
Foliage	248	23	16	6	47	43	22	14	43	70	1	16	44	71	376	88
Tree Roots																
Live	921	85	61	25	174	161	99	57	131	262	21	63	152	270	1,407	331
Dead	54	47	-8	20	-14	23	12	13	-41	24	5	13	-36	27	7	64
Standing Dead	244	178	47	70	37	84	81	53	-59	56	53	55	-5	78	404	230
Dead Woody Debris	-375	203	41	111	-571	243	-91	108	-1,260	340	-73	62	-1,334	345	-2,330	493
Understory Vegetation																
Above Ground	-18	6	-1	2	-6	5	-5	4	-7	13	-1	3	-7	14	-37	17
Below Ground	-2	1	-0	0	-1	1	-1	0	-1	1	-0	0	-1	2	-4	2
Total	5,122	450	310	195	460	848	507	352	-697	1,535	103	352	-594	1,575	5,806	1,885
Forest Floor	105	30	19	10	7	22	8	14	-6	58	8	18	1	60	141	73
Soils	17	22	18	15	-31	24	-23	25	-68	88	-55	42	-123	98	-143	107
Total (including soils and forest floor)	5,244	456	348	191	436	872	492	367	-771	1,603	55	378	-716	1,646	5,804	1,959

Table B42: Annual Net Change in Carbon Stocks per Acre on Forest Land for All Pools by Owner Group, 2002-2006 to 2012-2016: Western Cascades.

Change in Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons CO2 equivalent per year and acre															
Standing Live tree																
Mortality	-1.43	0.16	-1.57	0.42	-1.48	0.36	-1.80	0.48	-0.48	0.08	-1.28	0.33	-0.63	0.10	-1.20	0.10
Cut	-0.10	0.05	--	--	-2.77	1.51	-1.37	0.89	-4.55	1.00	-1.57	1.00	-4.00	0.84	-1.73	0.33
Gross Growth	3.94	0.14	2.33	0.32	6.33	0.43	4.93	0.51	5.53	0.40	3.28	0.49	5.11	0.35	4.54	0.15
Net	2.41	0.23	0.76	0.47	2.09	1.81	1.76	1.06	0.50	1.15	0.42	1.16	0.49	0.96	1.61	0.39
Foliage	0.15	0.01	0.08	0.03	0.12	0.11	0.10	0.06	0.04	0.07	0.01	0.07	0.04	0.06	0.10	0.02
Tree Roots																
Live	0.55	0.05	0.30	0.12	0.46	0.42	0.45	0.23	0.13	0.26	0.10	0.28	0.12	0.22	0.38	0.09
Dead	0.03	0.03	-0.04	0.10	-0.04	0.06	0.05	0.06	-0.04	0.02	0.02	0.06	-0.03	0.02	0.00	0.02
Standing Dead	0.15	0.11	0.23	0.33	0.10	0.22	0.37	0.22	-0.06	0.06	0.24	0.23	0.00	0.06	0.11	0.06
Dead Woody Debris	-0.22	0.12	0.20	0.55	-1.50	0.59	-0.41	0.48	-1.27	0.31	-0.32	0.26	-1.09	0.26	-0.63	0.13
Understory Vegetation																
Above Ground	-0.01	0.00	0.00	0.01	-0.02	0.01	-0.02	0.02	-0.01	0.01	0.00	0.01	-0.01	0.01	-0.01	0.00
Below Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.05	0.28	1.53	0.87	1.21	2.22	2.29	1.50	-0.70	1.54	0.46	1.56	-0.49	1.29	1.57	0.51
Forest Floor	0.06	0.02	0.10	0.05	0.02	0.06	0.04	0.06	-0.01	0.06	0.03	0.08	0.00	0.05	0.04	0.02
Soils	0.01	0.01	0.09	0.07	-0.08	0.06	-0.11	0.11	-0.07	0.09	-0.24	0.18	-0.10	0.08	-0.04	0.03
Total (including soils and forest floor)	3.12	0.28	1.71	0.84	1.15	2.29	2.22	1.58	-0.78	1.61	0.25	1.67	-0.59	1.35	1.57	0.53

C. Forest Carbon Stocks

Table C1: Forest Land Carbon Stock for Each Pool by Ownership and Land Status, 2007-2016: All Washington.

	Public								Private							
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million metric tons C[1]															
Live trees																
Aboveground	382	6	122	5	103	5	33	4	136	5	127	5	263	6	902	10
Belowground	77	1	24	1	21	1	7	1	28	1	25	1	53	1	182	2
Dead trees																
Aboveground	48	2	11	1	7	1	2	0	5	0	7	1	13	1	80	2
Belowground	13	0	3	0	2	0	0	0	1	0	2	0	3	0	22	1
Understory vegetation																
Aboveground	9	0	1	0	3	0	1	0	6	0	5	0	11	0	25	0
Belowground	1	0	0	0	0	0	0	0	1	0	1	0	1	0	3	0
Down wood	62	1	16	1	17	1	4	1	32	1	20	1	52	1	150	2
Forest Floor	54	0	11	0	13	0	4	0	25	1	23	1	47	1	129	1
Soil	450	3	87	3	124	3	42	4	275	7	247	7	522	6	1,225	7
Total Carbon	1,095	10	276	9	289	8	93	9	509	14	458	13	966	13	2,718	18

Table C2: Forest Land Carbon Stock per Acre for Each Pool by Ownership and Land Status, 2007-2016: All Washington.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C[1] per acre															
Live trees																
Aboveground	46.01	0.69	82.93	3.13	46.80	1.90	44.78	3.26	28.50	0.85	27.20	0.82	27.85	0.57	40.76	0.47
Belowground	9.23	0.14	16.58	0.65	9.71	0.41	8.97	0.68	5.86	0.18	5.42	0.17	5.64	0.12	8.23	0.10
Dead trees																
Aboveground	5.81	0.20	7.73	0.48	2.98	0.25	2.43	0.37	1.11	0.07	1.58	0.12	1.34	0.07	3.64	0.09
Belowground	1.59	0.05	2.13	0.13	0.85	0.07	0.66	0.09	0.31	0.02	0.42	0.03	0.37	0.02	1.00	0.02
Understory vegetation																
Aboveground	1.10	0.00	1.01	0.01	1.16	0.01	1.13	0.02	1.27	0.01	1.17	0.01	1.22	0.01	1.15	0.00
Belowground	0.12	0.00	0.11	0.00	0.13	0.00	0.13	0.00	0.14	0.00	0.13	0.00	0.14	0.00	0.13	0.00
Down wood	7.42	0.14	10.67	0.73	7.61	0.37	5.95	0.68	6.71	0.22	4.21	0.18	5.47	0.14	6.77	0.10
Forest Floor	6.51	0.03	7.40	0.15	5.83	0.11	5.84	0.19	5.15	0.07	4.83	0.06	4.99	0.04	5.83	0.03
Soil	54.23	0.11	59.01	0.49	56.74	0.41	57.02	0.68	57.78	0.32	52.90	0.28	55.36	0.21	55.37	0.11
Total Carbon	132.02	0.98	187.57	4.51	131.82	2.78	126.91	4.79	106.83	1.24	97.87	1.22	102.39	0.82	122.88	0.67

Table C3: Eastern Washington: Forest Land Carbon Stock by Ownership and Land Status, 2007-2016: All Washington.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	137.27	3.38	6.13	1.17	17.45	1.94	5.14	1.06	17.46	1.82	59.88	3.11	77.34	3.42	243.33	5.35
Belowground	26.74	0.69	1.23	0.24	3.41	0.38	1.01	0.21	3.34	0.36	11.84	0.63	15.18	0.69	47.56	1.08
Dead trees																
Aboveground	28.49	1.52	0.94	0.32	1.58	0.30	0.51	0.17	0.96	0.14	5.04	0.53	5.99	0.54	37.51	1.68
Belowground	6.99	0.37	0.23	0.08	0.39	0.07	0.12	0.04	0.25	0.04	1.28	0.13	1.53	0.14	9.27	0.41
Understory vegetation																
Aboveground	5.46	0.06	0.22	0.03	0.91	0.07	0.28	0.04	1.27	0.09	3.52	0.13	4.79	0.14	11.66	0.17
Belowground	0.61	0.01	0.02	0.00	0.10	0.01	0.03	0.00	0.14	0.01	0.39	0.01	0.53	0.02	1.30	0.02
Down wood	28.60	0.67	0.97	0.19	3.45	0.36	0.85	0.20	4.03	0.41	10.24	0.62	14.27	0.71	48.15	1.07
Forest Floor	28.69	0.32	1.14	0.18	4.01	0.32	1.19	0.19	4.87	0.37	13.25	0.50	18.12	0.55	53.15	0.73
Soil	248.48	2.68	10.42	1.51	37.47	2.75	11.81	1.77	49.67	3.57	145.09	5.26	194.75	5.53	502.92	6.86
Total Carbon	511.32	6.83	21.30	3.33	68.76	5.51	20.95	3.31	81.99	6.20	250.52	9.72	332.51	10.31	954.85	13.92

Table C4: Eastern Washington: Forest Land Carbon Stock per Acre by Ownership and Land Status, 2007-2016: All Washington.

	Public								Private						All Owners	
Carbon Pool	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	28.442	0.650	30.422	3.608	22.920	1.821	21.553	3.015	16.985	1.260	19.923	0.721	19.174	0.621	24.185	0.435
Belowground	5.540	0.135	6.088	0.747	4.476	0.357	4.220	0.627	3.253	0.259	3.939	0.148	3.764	0.128	4.727	0.089
Dead trees																
Aboveground	5.904	0.307	4.642	1.387	2.075	0.358	2.145	0.618	0.933	0.122	1.675	0.163	1.486	0.125	3.729	0.163
Belowground	1.448	0.074	1.157	0.333	0.515	0.086	0.511	0.138	0.245	0.032	0.425	0.041	0.379	0.031	0.921	0.040
Understory vegetation																
Aboveground	1.131	0.007	1.092	0.047	1.195	0.021	1.171	0.043	1.237	0.019	1.171	0.011	1.188	0.010	1.159	0.006
Belowground	0.126	0.001	0.121	0.005	0.133	0.002	0.130	0.005	0.137	0.002	0.130	0.001	0.132	0.001	0.129	0.001
Down wood	5.926	0.130	4.793	0.628	4.536	0.326	3.579	0.658	3.919	0.283	3.409	0.165	3.539	0.142	4.786	0.091
Forest Floor	5.944	0.034	5.669	0.330	5.268	0.141	5.005	0.201	4.734	0.110	4.409	0.051	4.492	0.047	5.283	0.030
Soil	51.485	0.123	51.651	0.924	49.224	0.351	49.470	0.560	48.312	0.325	48.275	0.165	48.284	0.148	49.986	0.094
Total Carbon	105.946	0.925	105.635	5.389	90.342	2.505	87.785	4.166	79.756	1.846	83.356	1.085	82.438	0.926	94.905	0.637

Table C5: Western Washington: Forest Land Carbon Stock by Ownership and Land Status, 2007-2016: All Washington.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	244.32	5.31	115.78	5.22	85.07	4.69	27.60	3.53	118.20	4.93	67.29	4.42	185.49	5.73	658.25	10.44
Belowground	49.84	1.09	23.15	1.07	17.87	1.00	5.55	0.72	24.56	1.05	13.49	0.92	38.06	1.21	134.46	2.17
Dead trees																
Aboveground	19.66	0.77	10.42	0.66	4.96	0.51	1.26	0.26	4.32	0.32	2.37	0.27	6.68	0.40	42.98	1.22
Belowground	6.19	0.23	2.90	0.19	1.46	0.15	0.36	0.07	1.24	0.10	0.70	0.08	1.94	0.12	12.86	0.36
Understory vegetation																
Aboveground	3.63	0.05	1.27	0.05	1.63	0.06	0.55	0.06	4.75	0.14	1.95	0.10	6.70	0.15	13.79	0.17
Belowground	0.40	0.01	0.14	0.01	0.18	0.01	0.06	0.01	0.53	0.02	0.22	0.01	0.74	0.02	1.53	0.02
Down wood	32.92	0.98	14.71	1.11	13.22	0.87	3.50	0.60	27.91	1.28	9.45	0.83	37.35	1.42	101.70	2.24
Forest Floor	25.29	0.39	9.74	0.39	8.77	0.38	3.07	0.35	19.66	0.65	9.33	0.52	28.98	0.69	75.85	0.93
Soil	201.22	2.78	76.34	2.70	86.81	3.31	29.88	3.18	225.35	6.75	102.28	5.31	327.63	6.94	721.89	8.13
Total Carbon	583.48	9.40	254.46	9.45	219.96	9.36	71.84	8.11	426.52	13.22	207.08	11.11	633.59	13.83	1,763.33	20.56

Table C6: Western Washington: Forest Land Carbon Stock per Acre by Ownership and Land Status, 2007-2016: All Washington.

	Public								Private						All Owners	
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons C per acre															
Live trees																
Aboveground	70.479	1.376	91.274	3.512	59.520	2.648	56.031	4.137	31.671	1.017	40.290	1.826	34.336	0.897	54.585	0.790
Belowground	14.376	0.285	18.252	0.726	12.504	0.570	11.270	0.860	6.581	0.222	8.079	0.393	7.044	0.194	11.150	0.166
Dead trees																
Aboveground	5.670	0.215	8.218	0.510	3.469	0.338	2.565	0.456	1.157	0.080	1.416	0.147	1.237	0.072	3.564	0.100
Belowground	1.786	0.065	2.288	0.144	1.022	0.099	0.739	0.121	0.333	0.024	0.420	0.041	0.360	0.021	1.066	0.029
Understory vegetation																
Aboveground	1.048	0.006	1.002	0.011	1.142	0.013	1.108	0.021	1.273	0.009	1.170	0.013	1.241	0.008	1.143	0.004
Belowground	0.116	0.001	0.111	0.001	0.127	0.001	0.123	0.002	0.141	0.001	0.130	0.001	0.138	0.001	0.127	0.000
Down wood	9.497	0.272	11.599	0.829	9.249	0.517	7.105	0.930	7.477	0.269	5.655	0.391	6.914	0.222	8.434	0.169
Forest Floor	7.296	0.063	7.676	0.171	6.134	0.145	6.240	0.248	5.267	0.083	5.584	0.131	5.365	0.070	6.290	0.047
Soil	58.047	0.181	60.182	0.542	60.739	0.472	60.681	0.692	60.382	0.331	61.237	0.458	60.646	0.270	59.863	0.157
Total Carbon	168.315	1.962	200.601	5.064	153.906	3.781	145.864	5.878	114.282	1.413	123.980	2.414	117.280	1.222	146.223	1.113

Table C7: Forest Land Carbon Stock by Ecological Region and Land Status, 2007-2016: All Washington.

Carbon Pool	Ecological Region														Total	
	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	14.37	1.36	50.88	3.45	219.61	7.02	96.23	3.06	88.44	5.30	233.74	8.61	198.32	7.09	901.59	10.50
Belowground	2.89	0.28	10.24	0.71	43.44	1.42	18.65	0.61	17.96	1.11	47.57	1.77	41.27	1.49	182.03	2.19
Dead trees																
Aboveground	2.41	0.38	5.49	0.57	30.05	1.67	8.66	0.50	2.91	0.28	16.13	0.90	14.84	0.84	80.50	2.02
Belowground	0.62	0.10	1.40	0.14	7.97	0.42	2.16	0.12	0.87	0.08	4.86	0.27	4.24	0.23	22.13	0.53
Understory vegetation																
Aboveground	0.97	0.07	1.99	0.11	6.16	0.14	4.85	0.13	2.47	0.12	4.85	0.15	4.15	0.13	25.44	0.16
Belowground	0.11	0.01	0.22	0.01	0.68	0.02	0.54	0.01	0.27	0.01	0.54	0.02	0.46	0.01	2.83	0.02
Down wood	2.61	0.23	9.77	0.70	38.37	1.32	18.20	0.65	8.96	0.61	43.32	1.91	28.62	1.19	149.85	2.33
Forest Floor	3.21	0.23	8.47	0.44	39.17	0.90	22.26	0.57	10.77	0.53	25.29	0.78	19.83	0.63	129.01	0.85
Soil	40.45	2.86	88.74	4.55	300.91	6.50	201.99	5.33	124.48	5.90	270.16	7.81	198.08	6.12	1,224.81	6.87
Total Carbon	67.64	4.72	177.21	9.63	686.38	16.05	373.54	9.81	257.13	12.68	646.46	19.34	509.82	15.95	2,718.18	18.47

Table C8: Forest Land Carbon Stock per Acre by Ecological Region and Land Status, 2007-2016: All Washington.

Carbon Pool	Blues+Columbia Basin		Eastern Cascades		Northern Cascades		Okanogan Highland		Puget Trough		Washington Coast Range		Western Cascades		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	17.81	1.33	28.25	1.30	39.99	1.02	23.28	0.51	42.93	1.71	55.79	1.57	54.52	1.36	40.76	0.47
Belowground	3.58	0.28	5.69	0.27	7.91	0.21	4.51	0.10	8.72	0.37	11.35	0.32	11.35	0.29	8.23	0.10
Dead trees																
Aboveground	2.99	0.47	3.05	0.28	5.47	0.29	2.10	0.11	1.41	0.12	3.85	0.20	4.08	0.20	3.64	0.09
Belowground	0.77	0.12	0.78	0.07	1.45	0.07	0.52	0.03	0.42	0.03	1.16	0.06	1.17	0.05	1.00	0.02
Understory vegetation																
Aboveground	1.21	0.02	1.11	0.01	1.12	0.01	1.17	0.01	1.20	0.01	1.16	0.01	1.14	0.01	1.15	0.00
Belowground	0.13	0.00	0.12	0.00	0.12	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13	0.00
Down wood	3.24	0.24	5.43	0.27	6.99	0.20	4.40	0.12	4.35	0.21	10.34	0.37	7.87	0.23	6.77	0.10
Forest Floor	3.98	0.08	4.70	0.06	7.13	0.07	5.39	0.05	5.23	0.09	6.04	0.08	5.45	0.06	5.83	0.03
Soil	50.13	0.23	49.28	0.23	54.79	0.17	48.87	0.13	60.42	0.37	64.48	0.27	54.46	0.24	55.37	0.11
Total Carbon	83.84	2.05	98.40	1.95	124.98	1.47	90.38	0.76	124.81	2.22	154.30	2.23	140.16	1.92	122.88	0.67

Table C9: Forest Land Carbon Stock by WA-DNR region and Land Status, 2007-2016: All Washington.

		East		West			
Carbon Pool		**Total**		**Total**		**DNR Total**	
		Total	**SE**	**Total**	**SE**	**Total**	**SE**
		Million metric tons C					
Live trees							
	Aboveground	17.45	1.94	85.07	4.69	102.51	4.51
	Belowground	3.41	0.38	17.87	1.00	21.28	0.96
Dead trees							
	Aboveground	1.58	0.30	4.96	0.51	6.54	0.56
	Belowground	0.39	0.07	1.46	0.15	1.85	0.16
Understory vegetation							
	Aboveground	0.91	0.07	1.63	0.06	2.54	0.07
	Belowground	0.10	0.01	0.18	0.01	0.28	0.01
Down wood		3.45	0.36	13.22	0.87	16.67	0.87
Forest Floor		4.01	0.32	8.77	0.38	12.78	0.37
Soil		37.47	2.75	86.81	3.31	124.28	3.05
Total Carbon		68.76	5.51	219.96	9.36	288.73	8.49

Table C10: Forest Land Carbon Stock per Acre by WA-DNR Region and Land Status, 2007-2016: All Washington.

	East		West			
Carbon Pool	**Total**		**Total**		**DNR Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons C per acre					
Live trees						
Aboveground	22.920	1.821	59.520	2.648	46.802	1.904
Belowground	4.476	0.357	12.504	0.570	9.714	0.407
Dead trees						
Aboveground	2.075	0.358	3.469	0.338	2.985	0.251
Belowground	0.515	0.086	1.022	0.099	0.846	0.071
Understory vegetation						
Aboveground	1.195	0.021	1.142	0.013	1.160	0.011
Belowground	0.133	0.002	0.127	0.001	0.129	0.001
Down wood	4.536	0.326	9.249	0.517	7.611	0.365
Forest Floor	5.268	0.141	6.134	0.145	5.833	0.106
Soil	49.224	0.351	60.739	0.472	56.738	0.409
Total Carbon	90.342	2.505	153.906	3.781	131.817	2.780

Table C11: Forest Land Carbon Stock by Ownership and Land Status, 2007-2016: All Washington.

	USDA Forest Service										Other Federal										DNR Managed Lands										Other State and Local Government										Private							
Carbon Pool	Timberland		Other forest		Reserved - productive		Reserved - other		Total		Timberland		Other forest		Reserved - productive		Reserved - other		Total		Timberland		Other forest		Reserved - productive		Reserved - other		Total		Timberland		Other forest		Reserved - productive		Reserved - other		Total		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
																							Million metric tons C																											
Live trees																																																
Aboveground	270	3	5	1	96	5	11	2	382	6	8	2	0	0	109	5	5	2	122	5	98	5	1	0	4	1	0	0	103	5	25	3	0	0	7	2	--	--	33	4	136	5	127	5	263	6	902	10
Belowground	54	1	1	0	19	1	2	0	77	1	2	0	0	0	22	1	1	0	24	1	20	1	0	0	1	0	0	0	21	1	5	1	0	0	1	0	--	--	7	1	28	1	25	1	53	1	182	2
Dead trees																																																
Aboveground	29	1	1	0	16	1	2	1	48	2	0	0	0	0	10	1	1	0	11	1	6	1	0	0	0	0	0	0	7	1	2	0	0	0	0	0	--	--	2	0	5	0	7	1	13	1	80	2
Belowground	8	0	0	0	4	0	1	0	13	0	0	0	0	0	3	0	0	0	3	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	--	--	0	0	1	0	2	0	3	0	22	1
Understory vegetation																																																
Aboveground	6	0	0	0	2	0	1	0	9	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	--	--	1	0	6	0	5	0	11	0	25	0
Belowground	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--	0	0	1	0	1	0	1	0	3	0
Down wood	46	1	1	0	13	1	2	0	62	1	1	0	0	0	14	1	1	0	16	1	16	1	0	0	0	0	0	0	17	1	4	1	0	0	0	0	--	--	4	1	32	1	20	1	52	1	150	2
Forest Floor	37	0	2	0	13	0	3	0	54	0	1	0	0	0	9	0	1	0	11	0	12	0	0	0	1	0	0	0	13	0	4	0	0	0	1	0	--	--	4	0	25	1	23	1	47	1	129	1
Soil	308	2	15	1	100	3	27	3	450	3	8	2	0	0	70	2	8	2	87	3	119	3	1	1	4	1	1	0	124	3	35	3	1	0	6	1	--	--	42	4	275	7	247	7	522	6	1,225	7
Total Carbon	759	6	26	2	263	10	47	6	1,095	10	20	4	1	0	239	9	16	4	276	9	276	9	2	1	10	3	1	1	289	8	75	8	2	1	16	4	--	--	93	9	509	14	458	13	966	13	2,718	18

Table C12: Forest Land Carbon Stock by County, 2007-2016.

	Live trees				Dead trees				Understory vegetation											
	Aboveground		Belowground		Aboveground		Belowground		Aboveground		Belowground		Down wood		Forest Floor		Soil		Total Carbon	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																			
County																				
Asotin	1.3	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.3	0.1	3.3	0.8	5.5	1.2
Chelan	32.7	2.8	6.4	0.6	6.5	1.1	1.6	0.3	1.5	0.1	0.2	0.0	6.5	0.5	6.8	0.4	62.3	3.3	124.5	7.3
Columbia	4.2	0.9	0.9	0.2	1.0	0.2	0.3	0.1	0.2	0.0	0.0	0.0	1.0	0.2	0.9	0.1	10.5	1.4	19.0	2.7
Clallam	73.8	5.9	15.1	1.2	4.1	0.4	1.3	0.1	1.2	0.1	0.1	0.0	10.0	0.8	7.9	0.6	67.7	4.5	181.2	12.6
Clark	9.2	1.9	1.9	0.4	0.3	0.1	0.1	0.0	0.2	0.0	0.0	0.0	1.1	0.3	0.8	0.1	12.1	2.0	25.8	4.5
Cowlitz	22.1	2.6	4.6	0.6	0.9	0.2	0.3	0.0	0.8	0.1	0.1	0.0	3.6	0.4	2.4	0.2	33.4	3.1	68.2	6.7
Douglas	0.0	0.0	0.0	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.3
Ferry	29.5	2.0	5.8	0.4	2.7	0.3	0.7	0.1	1.5	0.1	0.2	0.0	5.2	0.4	6.4	0.3	59.3	3.3	111.3	6.2
Garfield	2.7	0.8	0.6	0.2	0.9	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.6	0.1	0.5	0.1	5.7	1.1	11.4	2.5
Grays Harbor	46.5	3.8	9.5	0.8	2.8	0.3	0.9	0.1	1.4	0.1	0.2	0.0	11.8	1.1	6.7	0.5	75.6	5.0	155.3	10.5
Island	2.1	0.7	0.4	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.3	0.1	2.6	0.8	5.9	1.9
Jefferson	73.3	6.2	14.5	1.2	7.3	0.8	2.1	0.2	1.0	0.1	0.1	0.0	13.3	1.3	6.4	0.5	61.3	4.4	179.4	13.5
King	46.9	4.2	9.5	0.9	3.1	0.5	0.9	0.1	1.0	0.1	0.1	0.0	7.0	0.7	6.1	0.5	52.0	4.0	126.6	10.1
Kitsap	7.4	1.9	1.5	0.4	0.3	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.6	0.1	0.8	0.2	9.6	1.8	20.4	4.2
Kittitas	23.3	1.9	4.6	0.4	2.3	0.3	0.6	0.1	0.9	0.1	0.1	0.0	4.3	0.4	4.5	0.3	40.0	2.8	80.5	5.6
Klickitat	13.5	1.9	2.6	0.4	0.8	0.2	0.2	0.0	0.7	0.1	0.1	0.0	1.9	0.2	2.4	0.2	27.8	2.8	49.9	5.3
Lewis	65.8	4.3	13.8	0.9	3.6	0.4	1.1	0.1	1.6	0.1	0.2	0.0	9.2	0.7	6.1	0.3	68.8	4.1	170.1	9.8
Lincoln	0.8	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.2	0.1	3.1	1.0	4.6	1.4
Mason	19.3	2.7	4.0	0.5	1.2	0.3	0.4	0.1	0.6	0.1	0.1	0.0	2.8	0.3	2.4	0.2	33.6	3.3	64.3	6.7
Okanogan	39.3	2.2	7.4	0.4	12.6	1.2	3.0	0.3	2.7	0.1	0.3	0.0	10.9	0.6	12.5	0.5	112.5	4.7	201.3	8.7
Pacific	21.8	2.7	4.6	0.6	0.8	0.1	0.2	0.0	0.7	0.1	0.1	0.0	5.1	0.7	2.8	0.3	36.9	3.7	73.0	7.6
Pend Oreille	24.5	1.6	4.8	0.3	2.7	0.3	0.7	0.1	0.8	0.1	0.1	0.0	4.5	0.3	5.0	0.3	40.2	2.4	83.3	4.9
Pierce	41.1	4.4	8.5	0.9	2.9	0.4	0.8	0.1	0.9	0.1	0.1	0.0	5.8	0.7	4.4	0.4	40.4	3.4	104.9	9.5
San Juan	5.6	1.6	1.2	0.3	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.4	0.1	0.6	0.2	5.2	1.3	13.2	3.5
Skagit	43.6	4.0	8.7	0.8	2.9	0.3	0.9	0.1	0.8	0.1	0.1	0.0	7.2	0.7	7.1	0.6	46.2	3.6	117.4	9.3
Skamania	63.8	3.6	13.4	0.8	4.8	0.4	1.4	0.1	1.1	0.1	0.1	0.0	7.8	0.5	5.2	0.2	55.2	2.5	152.9	7.6
Snohomish	54.8	4.9	10.9	1.0	3.7	0.4	1.2	0.1	0.9	0.1	0.1	0.0	7.4	0.8	6.8	0.5	51.4	3.7	137.3	10.3
Spokane	7.6	1.2	1.5	0.2	0.2	0.1	0.1	0.0	0.4	0.1	0.0	0.0	0.9	0.2	1.7	0.2	18.7	2.2	31.2	3.9
Stevens	25.0	1.8	4.8	0.4	1.8	0.2	0.4	0.1	1.4	0.1	0.2	0.0	4.7	0.4	6.1	0.4	58.8	3.7	103.2	6.4
Thurston	9.9	2.0	2.1	0.4	0.4	0.1	0.1	0.0	0.3	0.0	0.0	0.0	1.1	0.2	1.0	0.2	12.4	1.9	27.3	4.6
Wahkiakum	6.4	1.8	1.4	0.4	0.3	0.1	0.1	0.0	0.2	0.0	0.0	0.0	1.1	0.3	0.6	0.1	8.9	1.9	18.9	4.3
Walla Walla	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.7	0.4	1.0	0.6
Whatcom	44.7	4.0	8.9	0.8	3.3	0.4	0.9	0.1	0.9	0.1	0.1	0.0	6.2	0.6	7.3	0.6	48.7	3.8	121.0	9.6
Whitman	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	1.5	0.6	2.3	1.0
Yakima	38.2	3.4	7.7	0.7	5.7	0.7	1.5	0.2	1.2	0.1	0.1	0.0	7.2	0.6	5.7	0.4	58.3	3.9	125.6	9.1
All counties	901.6	10.5	182.0	2.2	80.5	2.0	22.1	0.5	25.4	0.2	2.8	0.0	149.9	2.3	129.0	0.9	1,224.8	6.9	2,718.2	18.5

Table C13: Forest Land Carbon Stock per Acre by County, 2007-2016.

	Live trees				Dead trees				Understory vegetation											
	Aboveground		Belowground		Aboveground		Belowground		Aboveground		Belowground		Down wood		Forest Floor		Soil		Total Carbon	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																			
County																				
Asotin	18.927	2.861	3.644	0.606	1.880	0.496	0.501	0.139	1.144	0.065	0.127	0.007	3.399	0.816	3.946	0.184	49.587	0.325	83.155	4.318
Chelan	26.384	1.758	5.169	0.357	5.270	0.801	1.287	0.188	1.188	0.016	0.132	0.002	5.273	0.265	5.473	0.093	50.286	0.299	100.462	2.580
Columbia	21.068	3.751	4.382	0.783	4.960	0.842	1.316	0.222	1.227	0.051	0.136	0.006	4.877	0.708	4.463	0.171	52.018	0.382	94.446	5.223
Clallam	70.284	3.641	14.394	0.768	3.904	0.355	1.226	0.113	1.097	0.015	0.122	0.002	9.535	0.499	7.545	0.154	64.423	0.355	172.529	4.837
Clark	45.284	5.778	9.471	1.291	1.534	0.328	0.473	0.095	1.212	0.034	0.135	0.004	5.332	0.892	3.685	0.170	59.226	1.130	126.351	7.555
Cowlitz	35.352	2.423	7.401	0.539	1.437	0.233	0.407	0.064	1.252	0.019	0.139	0.002	5.799	0.457	3.806	0.106	53.338	0.661	108.931	3.412
Douglas	8.739	3.742	1.840	0.844	--	--	--	--	1.300	0.106	0.144	0.012	1.831	1.831	2.934	0.567	52.019	0.548	68.809	4.151
Ferry	23.771	0.942	4.667	0.196	2.165	0.187	0.537	0.046	1.191	0.015	0.132	0.002	4.201	0.215	5.173	0.078	47.699	0.181	89.537	1.349
Garfield	23.940	4.800	4.903	1.027	8.142	2.465	2.072	0.610	1.152	0.041	0.128	0.005	5.474	0.815	4.232	0.214	50.228	0.370	100.272	8.925
Grays Harbor	40.346	2.268	8.259	0.472	2.409	0.225	0.767	0.075	1.223	0.018	0.136	0.002	10.265	0.722	5.855	0.159	65.624	0.573	134.884	3.160
Island	40.922	6.924	7.992	1.311	1.015	0.384	0.341	0.131	1.046	0.046	0.116	0.005	3.796	0.521	6.508	0.218	50.623	0.302	112.358	8.838
Jefferson	78.658	4.201	15.590	0.841	7.875	0.687	2.306	0.200	1.046	0.017	0.116	0.002	14.275	1.076	6.873	0.123	65.759	0.375	192.497	6.194
King	53.539	2.815	10.806	0.589	3.565	0.491	1.043	0.135	1.092	0.016	0.121	0.002	8.013	0.596	6.961	0.137	59.377	0.497	144.516	3.905
Kitsap	47.846	8.279	9.892	1.827	1.658	0.417	0.460	0.124	1.213	0.044	0.135	0.005	3.650	0.512	5.420	0.180	62.619	0.689	132.893	10.095
Kittitas	30.040	1.615	5.937	0.333	2.931	0.285	0.739	0.068	1.146	0.016	0.127	0.002	5.505	0.334	5.764	0.082	51.424	0.386	103.612	2.373
Klickitat	22.952	2.212	4.462	0.435	1.279	0.298	0.335	0.074	1.219	0.026	0.135	0.003	3.183	0.277	4.018	0.114	47.278	0.467	84.862	3.118
Lewis	50.054	2.285	10.497	0.501	2.716	0.267	0.807	0.075	1.195	0.013	0.133	0.001	7.014	0.405	4.639	0.082	52.308	0.423	129.364	3.148
Lincoln	12.326	2.052	2.446	0.412	0.914	0.754	0.218	0.177	1.123	0.076	0.125	0.008	2.511	0.478	3.499	0.134	50.121	0.761	73.283	2.566
Mason	39.856	4.035	8.183	0.818	2.543	0.502	0.730	0.135	1.246	0.022	0.138	0.002	5.673	0.521	5.017	0.155	69.335	0.438	132.721	5.726
Okanogan	17.816	0.699	3.335	0.136	5.723	0.504	1.367	0.123	1.206	0.013	0.134	0.001	4.943	0.217	5.675	0.076	50.971	0.227	91.168	1.276
Pacific	37.918	3.008	7.940	0.659	1.433	0.171	0.418	0.052	1.231	0.024	0.137	0.003	8.854	0.755	4.817	0.153	64.154	0.648	126.901	4.108
Pend Oreille	31.451	1.153	6.106	0.238	3.530	0.372	0.894	0.090	1.071	0.018	0.119	0.002	5.815	0.284	6.450	0.114	51.625	0.319	107.061	1.924
Pierce	54.652	3.845	11.295	0.825	3.893	0.466	1.061	0.124	1.162	0.021	0.129	0.002	7.724	0.606	5.894	0.130	53.656	0.463	139.466	5.233
San Juan	67.861	9.326	14.118	1.950	2.126	0.569	0.615	0.151	1.147	0.028	0.127	0.003	4.827	0.823	7.413	0.138	63.508	1.199	161.742	11.681
Skagit	56.343	3.209	11.250	0.670	3.716	0.383	1.141	0.112	1.072	0.016	0.119	0.002	9.265	0.591	9.117	0.235	59.615	0.374	151.638	4.312
Skamania	65.754	2.319	13.843	0.501	4.925	0.346	1.476	0.100	1.112	0.011	0.124	0.001	8.083	0.408	5.360	0.062	56.808	0.369	157.484	3.305
Snohomish	64.224	3.953	12.726	0.797	4.358	0.457	1.460	0.146	1.066	0.019	0.118	0.002	8.726	0.694	7.974	0.208	60.233	0.393	160.885	5.625
Spokane	19.418	2.087	3.788	0.440	0.622	0.189	0.164	0.050	1.091	0.029	0.121	0.003	2.230	0.317	4.352	0.192	47.675	0.366	79.461	3.143
Stevens	20.869	0.941	4.041	0.192	1.490	0.169	0.372	0.041	1.202	0.015	0.134	0.002	3.903	0.234	5.088	0.084	49.173	0.276	86.271	1.413
Thurston	41.222	5.577	8.683	1.257	1.511	0.409	0.436	0.118	1.234	0.033	0.137	0.004	4.513	0.637	4.328	0.187	52.009	1.071	114.073	7.837
Wahkiakum	45.967	8.388	9.676	1.839	2.190	0.771	0.668	0.225	1.221	0.047	0.136	0.005	7.668	1.244	4.568	0.340	63.453	1.287	135.548	11.685
Walla Walla	11.389	5.087	2.231	1.052	0.082	0.082	0.016	0.016	1.349	0.039	0.150	0.004	1.453	0.170	4.181	0.153	50.388	0.162	71.239	6.257
Whatcom	54.109	2.855	10.774	0.586	4.053	0.388	1.117	0.106	1.073	0.017	0.119	0.002	7.469	0.527	8.818	0.207	58.938	0.353	146.471	4.043
Whitman	17.343	6.691	3.577	1.265	0.129	0.058	0.035	0.016	1.117	0.153	0.124	0.017	1.842	0.422	3.728	0.384	48.407	0.268	76.303	8.550
Yakima	33.283	1.860	6.721	0.388	5.010	0.468	1.276	0.118	1.006	0.017	0.112	0.002	6.273	0.370	4.986	0.075	50.852	0.320	109.519	2.928
All counties	40.758	0.466	8.229	0.098	3.639	0.091	1.000	0.024	1.150	0.004	0.128	0.000	6.774	0.102	5.832	0.028	55.370	0.112	122.881	0.671

Table C14: Forest Land Carbon Stock by National Forest, 2007-2016.

Carbon Pool	Idaho Panhandle (Region 1)		Region 6: Colville		Gifford Pinchot		Mt. Baker-Snoqualmie		Okanogan		Olympic		Umatilla		Wenatchee		Columbia River Gorge National Scenic Area		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																			
Live trees																				
Aboveground	4	0	34	1	88	2	107	4	33	2	43	2	7	1	64	3	1	0	382	6
Belowground	1	0	7	0	19	0	21	1	6	0	9	0	1	0	13	1	0	0	77	1
Dead trees																				
Aboveground	1	0	4	0	7	0	9	1	11	1	3	0	2	0	11	1	0	0	48	2
Belowground	0	0	1	0	2	0	3	0	3	0	1	0	0	0	3	0	0	0	13	0
Understory vegetation																				
Aboveground	0	0	1	0	1	0	1	0	2	0	1	0	0	0	2	0	0	0	9	0
Belowground	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Down wood	1	0	7	0	10	0	15	1	8	1	7	0	2	0	12	1	0	0	62	1
Forest Floor	1	0	7	0	7	0	13	0	9	0	4	0	1	0	11	0	0	0	54	0
Soil	6	0	53	1	70	1	84	2	80	3	40	1	14	1	101	3	1	0	450	3
Total Carbon	12	0	114	3	205	4	254	7	154	7	108	4	28	3	215	8	3	1	1,095	10

Table C15: Forest Land Carbon Stock per Acre by National Forest, 2007-2016.

			Region 6																	
Carbon Pool	**Idaho Panhandle (Region 1)**		**Colville**		**Gifford Pinchot**		**Mt. Baker-Snoqualmie**		**Okanogan**		**Olympic**		**Umatilla**		**Wenatchee**		**Columbia River Gorge National Scenic Area**		**Total**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	metric tons C per acre																			
Live trees																				
Aboveground	32.963	2.122	32.254	0.692	68.950	1.749	72.562	2.574	21.803	1.065	71.838	2.713	27.121	3.089	32.634	1.315	61.014	4.128	46.014	0.691
Belowground	6.451	0.438	6.197	0.147	14.464	0.379	14.472	0.524	4.125	0.220	14.628	0.557	5.570	0.651	6.469	0.271	12.931	0.876	9.234	0.143
Dead trees																				
Aboveground	5.366	0.685	3.952	0.280	5.470	0.302	6.241	0.407	7.507	0.670	5.273	0.358	7.055	1.186	5.386	0.522	5.795	0.889	5.806	0.200
Belowground	1.438	0.183	0.965	0.068	1.635	0.086	1.953	0.120	1.794	0.165	1.901	0.142	1.847	0.296	1.335	0.123	2.085	0.447	1.589	0.051
Understory vegetation																				
Aboveground	1.005	0.026	1.119	0.011	1.091	0.008	1.002	0.010	1.159	0.015	1.063	0.012	1.152	0.035	1.117	0.012	1.072	0.044	1.096	0.005
Belowground	0.112	0.003	0.124	0.001	0.121	0.001	0.111	0.001	0.129	0.002	0.118	0.001	0.128	0.004	0.124	0.001	0.119	0.005	0.122	0.001
Down wood	6.358	0.493	6.400	0.214	8.187	0.305	9.899	0.517	5.477	0.256	12.120	0.655	5.937	0.589	5.924	0.220	9.313	1.427	7.419	0.136
Forest Floor	7.026	0.173	6.591	0.053	5.601	0.044	8.975	0.139	6.185	0.068	6.761	0.067	4.543	0.126	5.641	0.053	4.721	0.372	6.509	0.033
Soil	51.636	0.538	50.607	0.235	54.737	0.361	57.241	0.227	52.600	0.259	67.626	0.424	51.474	0.285	51.337	0.206	50.425	0.484	54.228	0.106
Total Carbon	112.354	3.074	108.210	1.071	160.258	2.469	172.457	3.695	100.778	1.637	181.327	3.914	104.825	4.685	109.968	1.931	147.475	4.906	132.017	0.980

Table C16: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: All Washington.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	381.6	5.9	121.9	5.1	102.5	4.5	32.7	3.7	135.7	5.1	127.2	5.1	262.8	5.8	901.6	10.5
Belowground	76.6	1.2	24.4	1.1	21.3	1.0	6.6	0.7	27.9	1.1	25.3	1.1	53.2	1.2	182.0	2.2
Dead trees																
Aboveground	48.1	1.7	11.4	0.7	6.5	0.6	1.8	0.3	5.3	0.3	7.4	0.6	12.7	0.6	80.5	2.0
Belowground	13.2	0.4	3.1	0.2	1.9	0.2	0.5	0.1	1.5	0.1	2.0	0.1	3.5	0.2	22.1	0.5
Understory vegetation																
Aboveground	9.1	0.1	1.5	0.0	2.5	0.1	0.8	0.1	6.0	0.2	5.5	0.2	11.5	0.1	25.4	0.2
Belowground	1.0	0.0	0.2	0.0	0.3	0.0	0.1	0.0	0.7	0.0	0.6	0.0	1.3	0.0	2.8	0.0
Down wood	61.5	1.2	15.7	1.1	16.7	0.9	4.4	0.6	31.9	1.3	19.7	1.0	51.6	1.5	149.9	2.3
Forest Floor	54.0	0.4	10.9	0.4	12.8	0.4	4.3	0.4	24.5	0.7	22.6	0.7	47.1	0.7	129.0	0.9
Soil	449.7	2.9	86.8	2.6	124.3	3.1	41.7	3.6	275.0	7.1	247.4	6.8	522.4	6.4	1,224.8	6.9
Total Carbon	1,094.8	9.9	275.8	9.0	288.7	8.5	92.8	8.7	508.5	13.7	457.6	13.5	966.1	12.8	2,718.2	18.5

Table C17: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: All Washington.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	46.014	0.691	82.927	3.134	46.802	1.904	44.778	3.261	28.499	0.849	27.198	0.825	27.855	0.566	40.758	0.466
Belowground	9.234	0.143	16.583	0.647	9.714	0.407	8.969	0.677	5.862	0.185	5.418	0.174	5.642	0.121	8.229	0.098
Dead trees																
Aboveground	5.806	0.200	7.727	0.476	2.985	0.251	2.428	0.368	1.108	0.068	1.583	0.117	1.343	0.067	3.639	0.091
Belowground	1.589	0.051	2.133	0.131	0.846	0.071	0.665	0.094	0.314	0.020	0.423	0.030	0.368	0.018	1.000	0.024
Understory vegetation																
Aboveground	1.096	0.005	1.015	0.011	1.160	0.011	1.129	0.020	1.265	0.008	1.170	0.009	1.218	0.006	1.150	0.004
Belowground	0.122	0.001	0.113	0.001	0.129	0.001	0.125	0.002	0.141	0.001	0.130	0.001	0.135	0.001	0.128	0.000
Down wood	7.419	0.136	10.665	0.726	7.611	0.365	5.954	0.678	6.709	0.224	4.211	0.180	5.471	0.144	6.774	0.102
Forest Floor	6.509	0.033	7.401	0.155	5.833	0.106	5.837	0.186	5.152	0.069	4.829	0.059	4.992	0.045	5.832	0.028
Soil	54.228	0.106	59.011	0.487	56.738	0.409	57.022	0.678	57.775	0.316	52.905	0.282	55.362	0.210	55.370	0.112
Total Carbon	132.017	0.980	187.574	4.513	131.817	2.780	126.907	4.789	106.825	1.236	97.868	1.218	102.387	0.816	122.881	0.671

Table C18: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Blues+Columbia Basin.

	Public								Private							
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million metric tons C															
Live trees																
Aboveground	7.9	1.0	0.3	0.2	0.1	0.1	0.4	0.2	0.6	0.2	5.1	0.8	5.7	0.8	14.4	1.4
Belowground	1.6	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	1.0	0.2	1.1	0.2	2.9	0.3
Dead trees																
Aboveground	1.9	0.4	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.3	0.1	0.3	0.1	2.4	0.4
Belowground	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.6	0.1
Understory vegetation																
Aboveground	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.1	0.5	0.1	1.0	0.1
Belowground	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0
Down wood	1.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.7	0.1	0.9	0.1	2.6	0.2
Forest Floor	1.3	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.1	1.4	0.2	1.6	0.2	3.2	0.2
Soil	15.0	1.1	1.1	0.6	0.6	0.4	1.5	0.5	3.0	0.9	19.3	2.3	22.2	2.5	40.4	2.9
Total Carbon	30.2	2.6	1.6	0.8	0.9	0.6	2.3	0.8	4.1	1.3	28.4	3.5	32.6	3.7	67.6	4.7

Table C19: Forest land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Blues+Columbia Basin.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	26.83	2.85	12.98	3.31	11.30	5.40	12.53	5.27	10.27	2.21	13.07	1.32	12.70	1.18	17.81	1.33
Belowground	5.48	0.60	2.53	0.71	2.23	1.10	2.37	1.05	2.11	0.49	2.58	0.26	2.51	0.23	3.58	0.28
Dead trees																
Aboveground	6.61	1.09	0.29	0.22	0.14	0.10	4.94	2.76	0.47	0.19	0.74	0.27	0.71	0.24	2.99	0.47
Belowground	1.73	0.27	0.06	0.05	0.06	0.05	1.08	0.54	0.13	0.05	0.19	0.06	0.18	0.06	0.77	0.12
Understory vegetation																
Aboveground	1.16	0.03	1.19	0.16	1.20	0.08	1.37	0.07	1.28	0.09	1.22	0.03	1.22	0.03	1.21	0.02
Belowground	0.13	0.00	0.13	0.02	0.13	0.01	0.15	0.01	0.14	0.01	0.14	0.00	0.14	0.00	0.13	0.00
Down wood	5.55	0.54	1.69	0.73	2.54	1.34	1.54	0.57	2.04	0.68	1.92	0.21	1.94	0.20	3.24	0.24
Forest Floor	4.55	0.12	4.11	0.28	3.44	0.27	3.49	0.29	3.62	0.25	3.66	0.12	3.66	0.11	3.98	0.08
Soil	51.21	0.30	48.70	0.63	50.25	1.67	48.36	1.36	50.32	0.78	49.52	0.36	49.62	0.33	50.13	0.23
Total Carbon	103.26	4.33	71.67	4.29	71.29	9.72	75.84	4.75	70.37	2.95	73.03	1.78	72.68	1.60	83.84	2.05

Table C20: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Eastern Cascades.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	18.5	1.8	0.4	0.3	7.0	1.5	2.2	0.7	6.3	1.4	16.4	2.0	22.7	2.4	50.9	3.5
Belowground	3.8	0.4	0.1	0.1	1.4	0.3	0.4	0.1	1.2	0.3	3.3	0.4	4.6	0.5	10.2	0.7
Dead trees																
Aboveground	2.5	0.4	0.1	0.1	0.5	0.2	0.3	0.1	0.2	0.1	1.9	0.4	2.1	0.4	5.5	0.6
Belowground	0.6	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.5	0.1	0.5	0.1	1.4	0.1
Understory vegetation																
Aboveground	0.5	0.0	0.0	0.0	0.3	0.0	0.1	0.0	0.3	0.1	0.7	0.1	1.1	0.1	2.0	0.1
Belowground	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0
Down wood	3.3	0.4	0.1	0.0	1.2	0.2	0.5	0.2	1.1	0.2	3.6	0.5	4.7	0.5	9.8	0.7
Forest Floor	2.6	0.2	0.1	0.0	1.2	0.2	0.6	0.1	1.1	0.2	3.0	0.3	4.1	0.3	8.5	0.4
Soil	24.6	2.0	0.7	0.5	12.1	1.8	5.4	1.3	12.9	1.9	32.9	3.0	45.9	3.5	88.7	4.5
Total Carbon	56.5	4.9	1.4	1.0	23.9	3.9	9.6	2.4	23.3	3.7	62.4	6.0	85.8	6.9	177.2	9.6

Table C21: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Eastern Cascades.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	39.41	2.20	33.86	12.43	28.17	4.37	20.82	4.08	22.31	3.59	24.07	1.93	23.56	1.72	28.25	1.30
Belowground	8.04	0.48	6.93	2.68	5.60	0.85	3.95	0.83	4.39	0.79	4.87	0.40	4.73	0.37	5.69	0.27
Dead trees																
Aboveground	5.33	0.58	7.80	3.83	2.02	0.57	2.54	0.97	0.79	0.20	2.78	0.49	2.20	0.36	3.05	0.28
Belowground	1.35	0.14	1.93	0.94	0.53	0.14	0.62	0.23	0.21	0.06	0.71	0.12	0.57	0.09	0.78	0.07
Understory vegetation																
Aboveground	1.04	0.02	1.12	0.22	1.15	0.04	1.05	0.06	1.23	0.04	1.09	0.03	1.13	0.02	1.11	0.01
Belowground	0.12	0.00	0.12	0.02	0.13	0.00	0.12	0.01	0.14	0.00	0.12	0.00	0.13	0.00	0.12	0.00
Down wood	7.06	0.50	4.22	1.22	4.62	0.47	4.89	1.24	3.93	0.47	5.32	0.51	4.91	0.39	5.43	0.27
Forest Floor	5.43	0.06	3.99	0.90	4.70	0.16	5.46	0.31	4.09	0.15	4.34	0.10	4.27	0.09	4.70	0.06
Soil	52.37	0.31	52.63	1.43	48.64	0.51	50.79	0.77	46.18	0.58	48.35	0.37	47.71	0.32	49.28	0.23
Total Carbon	120.14	3.43	112.60	22.02	95.56	5.88	90.23	5.64	83.27	4.93	91.66	2.93	89.21	2.53	98.40	1.95

Table C22: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Northern Cascades.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	158.1	5.3	16.8	2.7	23.8	3.0	1.7	0.7	14.6	2.0	4.6	1.0	19.2	2.2	219.6	7.0
Belowground	31.1	1.1	3.3	0.5	4.9	0.6	0.3	0.1	2.9	0.4	0.9	0.2	3.8	0.5	43.4	1.4
Dead trees																
Aboveground	25.7	1.6	1.6	0.4	1.9	0.3	0.1	0.0	0.7	0.1	0.1	0.0	0.9	0.2	30.1	1.7
Belowground	6.8	0.4	0.4	0.1	0.5	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	8.0	0.4
Understory vegetation																
Aboveground	4.3	0.1	0.3	0.0	0.6	0.1	0.1	0.0	0.6	0.1	0.2	0.0	0.8	0.1	6.2	0.1
Belowground	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.7	0.0
Down wood	27.1	1.0	2.1	0.4	4.2	0.5	0.3	0.1	4.1	0.5	0.7	0.2	4.7	0.6	38.4	1.3
Forest Floor	27.2	0.5	2.8	0.4	4.0	0.4	0.4	0.1	3.7	0.4	1.1	0.2	4.8	0.5	39.2	0.9
Soil	209.2	3.9	18.1	2.2	30.8	2.9	2.9	1.0	30.2	3.2	9.7	1.7	39.9	3.6	300.9	6.5
Total Carbon	489.9	10.7	45.6	6.1	70.9	7.3	5.6	2.0	57.1	6.3	17.4	3.2	74.5	7.0	686.4	16.0

Table C23: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Northern Cascades.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	40.78	1.20	52.23	5.08	43.57	3.66	33.95	7.22	27.88	2.60	26.45	3.11	27.52	2.09	39.99	1.02
Belowground	8.02	0.24	10.33	1.01	8.90	0.79	6.51	1.43	5.64	0.57	5.12	0.59	5.51	0.45	7.91	0.21
Dead trees																
Aboveground	6.62	0.39	5.01	0.96	3.42	0.49	1.03	0.46	1.34	0.24	0.86	0.24	1.22	0.19	5.47	0.29
Belowground	1.75	0.10	1.29	0.23	0.91	0.12	0.30	0.12	0.38	0.07	0.28	0.09	0.36	0.06	1.45	0.07
Understory vegetation																
Aboveground	1.10	0.01	1.07	0.03	1.18	0.03	1.18	0.06	1.20	0.02	1.15	0.03	1.19	0.02	1.12	0.01
Belowground	0.12	0.00	0.12	0.00	0.13	0.00	0.13	0.01	0.13	0.00	0.13	0.00	0.13	0.00	0.12	0.00
Down wood	6.99	0.23	6.45	0.78	7.66	0.69	5.75	1.67	7.81	0.65	3.80	0.86	6.80	0.56	6.99	0.20
Forest Floor	7.01	0.06	8.78	0.46	7.34	0.27	7.19	0.67	7.13	0.26	6.07	0.44	6.86	0.23	7.13	0.07
Soil	53.98	0.15	56.08	0.63	56.38	0.70	59.02	2.21	57.81	0.84	55.31	1.51	57.18	0.74	54.79	0.17
Total Carbon	126.38	1.71	141.36	7.02	129.50	5.45	115.06	11.91	109.33	4.07	99.16	5.32	106.77	3.35	124.98	1.47

Table C24: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Okanogan Highland.

	Public								Private							
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million metric tons C															
Live trees																
Aboveground	42.9	1.2	3.2	0.8	4.8	0.8	1.7	0.6	8.9	1.2	34.7	2.3	43.6	2.5	96.2	3.1
Belowground	8.2	0.2	0.7	0.2	0.9	0.2	0.4	0.1	1.7	0.2	6.8	0.5	8.5	0.5	18.7	0.6
Dead trees																
Aboveground	5.3	0.3	0.3	0.1	0.2	0.1	0.1	0.0	0.5	0.1	2.3	0.3	2.8	0.3	8.7	0.5
Belowground	1.3	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.6	0.1	0.7	0.1	2.2	0.1
Understory vegetation																
Aboveground	1.6	0.0	0.1	0.0	0.3	0.0	0.1	0.0	0.7	0.1	2.1	0.1	2.8	0.1	4.8	0.1
Belowground	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.3	0.0	0.5	0.0
Down wood	8.9	0.3	0.5	0.2	1.0	0.2	0.2	0.1	2.4	0.3	5.4	0.4	7.7	0.5	18.2	0.6
Forest Floor	9.1	0.2	0.5	0.1	1.3	0.2	0.4	0.1	2.9	0.3	8.0	0.4	11.0	0.5	22.3	0.6
Soil	70.0	1.4	4.2	1.0	12.0	1.7	3.7	1.0	27.9	2.7	84.0	4.3	111.9	4.7	202.0	5.3
Total Carbon	147.4	3.2	9.5	2.3	20.7	3.0	6.6	1.8	45.2	4.6	144.1	7.7	189.3	8.3	373.5	9.8

Table C25: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Okanogan Highland.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	30.80	0.59	37.44	4.33	19.52	1.96	21.90	5.63	15.81	1.50	19.63	0.81	18.71	0.72	23.28	0.51
Belowground	5.91	0.13	7.50	0.93	3.82	0.39	4.51	1.20	3.00	0.31	3.85	0.17	3.64	0.15	4.51	0.10
Dead trees																
Aboveground	3.79	0.23	3.02	1.18	0.92	0.26	0.94	0.42	0.90	0.16	1.32	0.17	1.21	0.13	2.10	0.11
Belowground	0.93	0.05	0.79	0.30	0.23	0.06	0.24	0.11	0.24	0.04	0.33	0.04	0.31	0.03	0.52	0.03
Understory vegetation																
Aboveground	1.13	0.01	1.01	0.06	1.17	0.04	1.22	0.08	1.24	0.03	1.20	0.01	1.21	0.01	1.17	0.01
Belowground	0.13	0.00	0.11	0.01	0.13	0.00	0.14	0.01	0.14	0.00	0.13	0.00	0.13	0.00	0.13	0.00
Down wood	6.37	0.19	5.47	1.12	3.86	0.56	2.42	0.42	4.20	0.42	3.03	0.17	3.31	0.17	4.40	0.12
Forest Floor	6.56	0.05	5.63	0.35	5.33	0.19	4.82	0.30	5.16	0.16	4.56	0.07	4.70	0.07	5.39	0.05
Soil	50.32	0.19	48.86	1.17	48.71	0.64	47.23	0.76	49.53	0.34	47.61	0.19	48.07	0.17	48.87	0.13
Total Carbon	105.93	0.93	109.84	7.62	83.67	2.68	83.41	7.98	80.21	2.23	81.65	1.16	81.30	1.03	90.38	0.76

Table C26: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Puget Trough.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	3.9	0.9	7.9	2.0	9.9	2.0	12.1	2.3	17.4	2.2	37.2	3.4	54.6	4.0	88.4	5.3
Belowground	0.8	0.2	1.7	0.4	2.1	0.4	2.4	0.5	3.6	0.5	7.4	0.7	11.0	0.8	18.0	1.1
Dead trees																
Aboveground	0.2	0.1	0.4	0.1	0.4	0.1	0.3	0.1	0.4	0.1	1.1	0.2	1.5	0.2	2.9	0.3
Belowground	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.3	0.0	0.5	0.1	0.9	0.1
Understory vegetation																
Aboveground	0.1	0.0	0.1	0.0	0.3	0.0	0.2	0.0	0.8	0.1	0.9	0.1	1.8	0.1	2.5	0.1
Belowground	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.3	0.0
Down wood	0.6	0.2	0.7	0.2	1.4	0.3	0.8	0.2	2.6	0.3	2.8	0.3	5.4	0.4	9.0	0.6
Forest Floor	0.4	0.1	0.7	0.2	1.3	0.2	1.2	0.2	2.7	0.3	4.5	0.3	7.2	0.4	10.8	0.5
Soil	3.5	0.8	6.7	1.5	14.7	2.3	12.0	1.9	37.1	3.6	50.5	3.8	87.6	5.0	124.5	5.9
Total Carbon	9.5	2.2	18.4	4.3	30.2	5.0	29.2	5.0	64.9	6.4	104.9	8.1	169.8	9.9	257.1	12.7

Table C27: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Puget Trough.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	65.28	6.09	67.70	7.59	42.78	5.32	60.35	5.96	28.15	2.54	44.68	2.54	37.63	1.87	42.93	1.71
Belowground	14.01	1.37	14.24	1.73	9.07	1.19	11.80	1.20	5.82	0.56	8.88	0.55	7.57	0.40	8.72	0.37
Dead trees																
Aboveground	3.62	0.56	3.38	0.78	1.80	0.43	1.68	0.30	0.71	0.11	1.33	0.19	1.06	0.12	1.41	0.12
Belowground	1.19	0.24	0.94	0.20	0.56	0.13	0.49	0.09	0.22	0.04	0.39	0.05	0.32	0.03	0.42	0.03
Understory vegetation																
Aboveground	1.16	0.01	1.07	0.04	1.24	0.03	1.11	0.03	1.33	0.02	1.13	0.01	1.21	0.01	1.20	0.01
Belowground	0.13	0.00	0.12	0.00	0.14	0.00	0.12	0.00	0.15	0.00	0.13	0.00	0.13	0.00	0.13	0.00
Down wood	10.67	1.65	5.61	1.26	6.23	0.87	4.17	0.38	4.16	0.39	3.39	0.22	3.72	0.21	4.35	0.21
Forest Floor	6.32	0.16	6.28	0.43	5.52	0.22	5.73	0.26	4.40	0.15	5.41	0.13	4.98	0.10	5.23	0.09
Soil	59.07	0.79	57.46	0.68	63.55	0.91	59.72	0.83	59.91	0.88	60.62	0.51	60.32	0.48	60.42	0.37
Total Carbon	161.45	8.42	156.81	10.45	130.89	6.67	145.17	7.68	104.83	3.25	125.95	3.28	116.95	2.41	124.81	2.22

Table C28: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Washington Coast Range.

	Public								Private						All Owners	
Carbon Pool	**USDA Forest Service**		**Other Federal**		**DNR Managed Lands**		**Other State and Local Government**		**Corporate**		**Non-corporate**		**Total**		**All Owners**	
	Total	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million metric tons C															
Live trees																
Aboveground	39.0	2.1	77.6	5.7	35.1	4.0	5.4	1.8	57.4	3.9	19.2	2.5	76.6	4.4	233.7	8.6
Belowground	7.9	0.4	15.4	1.1	7.3	0.8	1.1	0.4	12.0	0.8	3.9	0.5	15.9	0.9	47.6	1.8
Dead trees																
Aboveground	2.9	0.2	7.6	0.7	2.2	0.4	0.2	0.1	2.2	0.2	1.0	0.2	3.2	0.3	16.1	0.9
Belowground	1.1	0.1	2.2	0.2	0.7	0.1	0.1	0.0	0.6	0.1	0.3	0.1	0.9	0.1	4.9	0.3
Understory vegetation																
Aboveground	0.6	0.0	0.7	0.0	0.6	0.1	0.1	0.0	2.2	0.1	0.7	0.1	2.9	0.1	4.9	0.1
Belowground	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.5	0.0
Down wood	6.6	0.4	10.6	1.1	5.4	0.7	1.2	0.5	14.0	1.0	5.5	0.8	19.5	1.3	43.3	1.9
Forest Floor	3.7	0.2	5.5	0.4	3.2	0.3	0.6	0.2	8.9	0.5	3.5	0.4	12.4	0.6	25.3	0.8
Soil	36.8	1.5	46.6	2.9	34.5	3.1	6.2	1.6	109.2	5.7	36.8	3.7	146.0	6.3	270.2	7.8
Total Carbon	98.6	4.1	166.2	10.9	89.1	8.7	15.0	4.1	206.6	11.2	70.9	7.4	277.5	12.4	646.5	19.3

Table C29: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Washington Coast Range.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	72.56	3.00	107.70	5.08	63.87	4.60	55.83	12.28	33.66	1.60	33.10	2.96	33.52	1.40	55.79	1.57
Belowground	14.70	0.61	21.40	1.06	13.24	0.96	11.40	2.52	7.01	0.35	6.74	0.63	6.94	0.30	11.35	0.32
Dead trees																
Aboveground	5.45	0.39	10.57	0.77	4.05	0.66	2.04	0.73	1.27	0.12	1.73	0.31	1.38	0.12	3.85	0.20
Belowground	1.98	0.16	2.99	0.22	1.21	0.20	0.63	0.21	0.37	0.04	0.49	0.09	0.40	0.04	1.16	0.06
Understory vegetation																
Aboveground	1.05	0.01	0.96	0.01	1.12	0.02	1.13	0.06	1.26	0.01	1.23	0.03	1.26	0.01	1.16	0.01
Belowground	0.12	0.00	0.11	0.00	0.12	0.00	0.13	0.01	0.14	0.00	0.14	0.00	0.14	0.00	0.13	0.00
Down wood	12.28	0.71	14.71	1.30	9.79	0.92	12.80	3.90	8.21	0.45	9.48	0.93	8.53	0.41	10.34	0.37
Forest Floor	6.81	0.07	7.57	0.19	5.79	0.20	6.30	0.80	5.23	0.12	5.99	0.28	5.42	0.12	6.04	0.08
Soil	68.57	0.42	64.64	0.57	62.78	0.79	64.51	2.05	64.03	0.44	63.46	0.95	63.88	0.41	64.48	0.27
Total Carbon	183.51	4.33	230.64	7.10	161.97	6.76	154.76	18.48	121.18	2.19	122.35	4.19	121.47	1.94	154.30	2.23

Table C30: Forest Land Carbon Stocks by Ownership and Pool, 2007-2016: Western Cascades.

Carbon Pool	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
Live trees																
Aboveground	111.4	3.9	15.5	2.9	21.7	3.3	9.2	2.1	30.5	2.8	10.0	2.1	40.5	3.5	198.3	7.1
Belowground	23.2	0.8	3.2	0.6	4.7	0.7	1.9	0.4	6.4	0.6	2.0	0.4	8.4	0.7	41.3	1.5
Dead trees																
Aboveground	9.6	0.6	1.4	0.3	1.3	0.3	0.7	0.2	1.2	0.2	0.6	0.2	1.9	0.3	14.8	0.8
Belowground	2.8	0.2	0.4	0.1	0.4	0.1	0.2	0.1	0.3	0.1	0.2	0.0	0.5	0.1	4.2	0.2
Understory vegetation																
Aboveground	1.8	0.0	0.2	0.0	0.4	0.0	0.2	0.0	1.3	0.1	0.3	0.0	1.6	0.1	4.2	0.1
Belowground	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.5	0.0
Down wood	13.4	0.5	1.8	0.4	3.5	0.6	1.2	0.3	7.7	0.7	1.0	0.2	8.7	0.8	28.6	1.2
Forest Floor	9.8	0.3	1.2	0.2	1.8	0.2	1.1	0.2	4.9	0.4	1.1	0.2	6.0	0.4	19.8	0.6
Soil	90.5	2.6	9.3	1.6	19.4	2.4	9.9	1.9	54.8	4.0	14.1	2.1	68.9	4.4	198.1	6.1
Total Carbon	262.7	8.1	33.0	5.8	53.1	7.0	24.5	4.9	107.2	8.2	29.4	4.8	136.6	9.3	509.8	15.9

Table C31: Forest Land Carbon Stocks per Acre by Ownership and Pool, 2007-2016: Western Cascades.

Carbon Pool	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre															
Live trees																
Aboveground	66.89	1.64	82.88	9.04	61.43	5.63	54.71	6.39	30.17	1.72	39.63	5.86	32.06	1.82	54.52	1.36
Belowground	13.91	0.35	16.86	1.86	13.21	1.26	11.37	1.41	6.29	0.38	8.02	1.28	6.63	0.40	11.35	0.29
Dead trees																
Aboveground	5.78	0.31	7.28	0.97	3.65	0.71	4.12	1.17	1.21	0.17	2.54	0.64	1.48	0.19	4.08	0.20
Belowground	1.69	0.09	1.90	0.26	1.04	0.20	1.15	0.31	0.32	0.04	0.69	0.16	0.40	0.05	1.17	0.05
Understory vegetation																
Aboveground	1.07	0.01	1.05	0.03	1.14	0.02	1.10	0.03	1.29	0.02	1.13	0.04	1.26	0.02	1.14	0.01
Belowground	0.12	0.00	0.12	0.00	0.13	0.00	0.12	0.00	0.14	0.00	0.13	0.00	0.14	0.00	0.13	0.00
Down wood	8.05	0.27	9.48	1.51	9.98	1.04	7.34	1.05	7.61	0.47	3.91	0.51	6.87	0.40	7.87	0.23
Forest Floor	5.86	0.05	6.52	0.25	5.01	0.20	6.45	0.40	4.84	0.11	4.40	0.19	4.76	0.10	5.45	0.06
Soil	54.34	0.30	49.76	1.10	55.03	0.92	59.02	1.07	54.15	0.49	56.10	0.90	54.54	0.44	54.46	0.24
Total Carbon	157.70	2.33	175.84	12.55	150.61	8.13	145.39	9.43	106.03	2.43	116.55	8.02	108.13	2.53	140.16	1.92

Table C32: Forest Land Carbon Stocks by Forest Type and Pool, 2007-2016: WA-DNR West Region.

Carbon Pool	Softwoods: Douglas-fir		Fir / spruce / mountain hemlock		Western Hemlock / Sitka spruce		Lodgepole pine		Ponderosa pine		Western juniper		Western larch		Western white pine		Other western softwoods		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																			
Live trees																				
Aboveground	43.89	3.86	3.54	1.54	29.02	3.90	--	--	--	--	--	--	--	--	--	--	--	--	76.45	4.72
Belowground	9.66	0.87	0.71	0.30	5.85	0.79	--	--	--	--	--	--	--	--	--	--	--	--	16.21	1.00
Dead trees																				
Aboveground	2.19	0.31	0.28	0.17	2.12	0.41	--	--	--	--	--	--	--	--	--	--	--	--	4.60	0.51
Belowground	0.63	0.09	0.08	0.05	0.62	0.12	--	--	--	--	--	--	--	--	--	--	--	--	1.34	0.15
Understory vegetation																				
Aboveground	0.95	0.06	0.05	0.02	0.36	0.04	--	--	--	--	--	--	--	--	--	--	--	--	1.37	0.06
Belowground	0.11	0.01	0.01	0.00	0.04	0.00	--	--	--	--	--	--	--	--	--	--	--	--	0.15	0.01
Down wood	5.71	0.58	0.70	0.32	5.05	0.69	--	--	--	--	--	--	--	--	--	--	--	--	11.47	0.85
Forest Floor	4.20	0.29	0.34	0.12	3.11	0.37	--	--	--	--	--	--	--	--	--	--	--	--	7.65	0.38
Soil	46.45	3.14	3.00	0.97	23.55	2.67	--	--	--	--	--	--	--	--	--	--	--	--	73.00	3.26
Total Carbon	113.79	8.21	8.71	3.26	69.73	8.44	--	--	--	--	--	--	--	--	--	--	--	--	192.23	9.53

Carbon Pool	Hardwoods: Alder / maple		Aspen / birch		Elm / ash / cottonwood		Western oak		Woodland hardwood		Other hardwoods		Total		Nonstocked		All forest types	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																	
Live trees																		
Aboveground	7.69	1.50	--	--	0.69	0.62	--	--	--	--	--	--	8.38	1.60	0.24	0.18	85.07	4.69
Belowground	1.47	0.29	--	--	0.14	0.13	--	--	--	--	--	--	1.62	0.31	0.04	0.03	17.87	1.00
Dead trees																		
Aboveground	0.31	0.08	--	--	0.03	0.02	--	--	--	--	--	--	0.33	0.08	0.03	0.02	4.96	0.51
Belowground	0.11	0.03	--	--	0.01	0.01	--	--	--	--	--	--	0.12	0.03	0.01	0.00	1.46	0.15
Understory vegetation																		
Aboveground	0.19	0.03	0.00	0.00	0.01	0.01	--	--	--	--	--	--	0.20	0.03	0.06	0.02	1.63	0.06
Belowground	0.02	0.00	0.00	0.00	0.00	0.00	--	--	--	--	--	--	0.02	0.00	0.01	0.00	0.18	0.01
Down wood	1.16	0.24	--	--	0.13	0.12	--	--	--	--	--	--	1.29	0.26	0.46	0.23	13.22	0.87
Forest Floor	0.89	0.16	0.00	0.00	0.05	0.04	--	--	--	--	--	--	0.94	0.16	0.18	0.06	8.77	0.38
Soil	11.10	1.89	0.01	0.01	0.62	0.47	--	--	--	--	--	--	11.72	1.95	2.08	0.71	86.81	3.31
Total Carbon	22.95	3.98	0.01	0.01	1.67	1.37	--	--	--	--	--	--	24.63	4.17	3.11	1.17	219.96	9.36

Table C33: Forest Land Carbon Stocks per Acre by Forest Type and Pool, 2007-2016: WA-DNR West Region.

	Softwoods:																				Hardwoods:																	
Carbon Pool	Douglas-fir		Fir / spruce / mountain hemlock		Western Hemlock / Sitka spruce		Lodgepole pine		Ponderosa pine		Western juniper		Western larch		Western white pine		Other western softwoods		Total		Alder / maple		Aspen / birch		Elm / ash / cottonwood		Western oak		Woodland hardwoods		Other hardwoods		Total		Nonstocked		All forest types	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre																																					
Live trees																																						
Aboveground	56.449	3.410	65.097	18.510	79.392	5.653	--	--	--	--	--	--	--	--	--	--	--	--	63.845	3.007	41.950	4.166	--	--	67.654	27.109	--	--	--	--	--	--	43.280	4.354	6.179	3.953	59.520	2.648
Belowground	12.421	0.783	13.022	3.589	15.992	1.157	--	--	--	--	--	--	--	--	--	--	--	--	13.538	0.647	8.036	0.810	--	--	13.907	5.726	--	--	--	--	--	--	8.340	0.865	1.160	0.709	12.504	0.570
Dead trees																																						
Aboveground	2.818	0.363	5.222	2.746	5.806	0.902	--	--	--	--	--	--	--	--	--	--	--	--	3.839	0.396	1.674	0.327	--	--	2.537	0.230	--	--	--	--	--	--	1.719	0.311	0.735	0.542	3.469	0.338
Belowground	0.811	0.104	1.494	0.839	1.708	0.263	--	--	--	--	--	--	--	--	--	--	--	--	1.116	0.115	0.598	0.120	--	--	0.894	0.234	--	--	--	--	--	--	0.613	0.115	0.139	0.094	1.022	0.099
Understory vegetation																																						
Aboveground	1.226	0.011	0.967	0.032	0.987	0.025	--	--	--	--	--	--	--	--	--	--	--	--	1.141	0.013	1.056	0.038	1.728	1.728	1.046	0.106	--	--	--	--	--	--	1.056	0.037	1.603	0.000	1.142	0.013
Belowground	0.136	0.001	0.107	0.004	0.110	0.003	--	--	--	--	--	--	--	--	--	--	--	--	0.127	0.001	0.117	0.004	0.192	0.192	0.116	0.012	--	--	--	--	--	--	0.117	0.004	0.178	0.000	0.127	0.001
Down wood	7.343	0.587	12.912	4.353	13.828	1.094	--	--	--	--	--	--	--	--	--	--	--	--	9.575	0.585	6.329	0.777	--	--	12.620	5.120	--	--	--	--	--	--	6.657	0.834	12.175	3.489	9.249	0.517
Forest Floor	5.399	0.139	6.306	0.656	8.508	0.289	--	--	--	--	--	--	--	--	--	--	--	--	6.389	0.163	4.854	0.261	5.995	5.995	4.718	0.388	--	--	--	--	--	--	4.847	0.249	4.664	0.284	6.134	0.145
Soil	59.743	0.648	55.208	1.550	64.436	0.587	--	--	--	--	--	--	--	--	--	--	--	--	60.970	0.495	60.506	1.486	56.806	56.806	60.357	0.525	--	--	--	--	--	--	60.496	1.407	54.733	2.320	60.739	0.472
Total Carbon	146.345	4.562	160.336	29.970	190.766	8.087	--	--	--	--	--	--	--	--	--	--	--	--	160.540	4.301	125.120	5.295	64.721	64.721	163.849	39.215	--	--	--	--	--	--	127.126	5.698	81.565	8.830	153.906	3.781

Table C34: Forest Land Carbon Stocks by Forest Type and Pool, 2007-2016: WA-DNR East Region.

Million metric tons C

Carbon Pool	Softwoods: Douglas-fir Total	SE	Fir / spruce / mountain hemlock Total	SE	Western Hemlock / Sitka spruce Total	SE	Lodgepole pine Total	SE	Ponderosa pine Total	SE	Western juniper Total	SE	Western larch Total	SE	Western white pine Total	SE	Other western softwoods Total	SE	Total	SE
Live trees																				
Aboveground	10.43	1.75	1.86	0.66	0.32	0.27	0.75	0.37	2.88	0.57	--	--	0.67	0.37	--	--	0.09	0.09	17.01	1.94
Belowground	2.03	0.34	0.37	0.13	0.06	0.05	0.13	0.06	0.59	0.12	--	--	0.14	0.08	--	--	0.01	0.01	3.32	0.38
Dead trees																				
Aboveground	0.63	0.18	0.37	0.16	0.01	0.01	0.16	0.09	0.11	0.04	--	--	0.05	0.03	--	--	--	--	1.33	0.26
Belowground	0.15	0.04	0.09	0.04	0.00	0.00	0.04	0.02	0.03	0.01	--	--	0.01	0.01	--	--	--	--	0.33	0.06
Understory vegetation																				
Aboveground	0.42	0.05	0.07	0.02	0.01	0.01	0.02	0.01	0.19	0.03	--	--	0.05	0.02	--	--	0.01	0.01	0.76	0.06
Belowground	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	--	--	0.01	0.00	--	--	0.00	0.00	0.08	0.01
Down wood	1.41	0.23	0.55	0.18	0.10	0.07	0.16	0.08	0.46	0.10	--	--	0.36	0.16	--	--	0.00	0.00	3.04	0.35
Forest Floor	1.83	0.24	0.47	0.14	0.08	0.06	0.21	0.10	0.85	0.14	--	--	0.22	0.09	--	--	0.04	0.04	3.71	0.31
Soil	16.19	2.06	3.61	1.05	0.52	0.39	1.33	0.62	9.01	1.45	--	--	1.66	0.71	--	--	0.36	0.34	32.67	2.61
Total Carbon	33.14	4.47	7.40	2.22	1.10	0.82	2.80	1.29	14.14	2.33	--	--	3.16	1.38	--	--	0.51	0.50	62.26	5.37

Carbon Pool	Hardwoods: Alder / maple Total	SE	Aspen / birch Total	SE	Elm / ash / cottonwood Total	SE	Western oak Total	SE	Woodland hardwoods Total	SE	Other hardwoods Total	SE	Total	SE	Nonstocked Total	SE	All forest types Total	SE
Live trees																		
Aboveground	0.02	0.02	0.20	0.14	--	--	0.12	0.11	--	--	--	--	0.33	0.18	0.11	0.04	17.45	1.94
Belowground	0.00	0.00	0.04	0.03	--	--	0.02	0.02	--	--	--	--	0.07	0.04	0.02	0.01	3.41	0.38
Dead trees																		
Aboveground	--	--	0.08	0.06	--	--	--	--	--	--	--	--	0.08	0.06	0.17	0.11	1.58	0.30
Belowground	--	--	0.02	0.01	--	--	--	--	--	--	--	--	0.02	0.01	0.04	0.03	0.39	0.07
Understory vegetation																		
Aboveground	0.00	0.00	0.02	0.01	--	--	0.01	0.01	--	--	0.01	0.01	0.04	0.02	0.11	0.03	0.91	0.07
Belowground	0.00	0.00	0.00	0.00	--	--	0.00	0.00	--	--	0.00	0.00	0.00	0.00	0.01	0.00	0.10	0.01
Down wood	0.02	0.02	0.07	0.05	--	--	0.01	0.01	--	--	0.01	0.01	0.11	0.06	0.30	0.11	3.45	0.36
Forest Floor	0.00	0.00	0.08	0.05	--	--	0.01	0.01	--	--	0.02	0.02	0.11	0.05	0.19	0.05	4.01	0.32
Soil	0.06	0.06	0.76	0.46	--	--	0.29	0.29	--	--	0.23	0.22	1.35	0.59	3.45	0.95	37.47	2.75
Total Carbon	0.10	0.10	1.26	0.80	--	--	0.47	0.46	--	--	0.26	0.25	2.10	0.95	4.41	1.19	68.76	5.51

Table C35: Forest Land Carbon Stocks per Acre by Forest Type and Pool, 2007-2016: WA-DNR East Region.

	Softwoods:																			
Carbon Pool	Douglas-fir		Fir / spruce / mountain hemlock		Western Hemlock / Sitka spruce		Lodgepole pine		Ponderosa pine		Western juniper		Western larch		Western white pine		Other western softwoods		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre																			
Live trees																				
Aboveground	32.234	3.437	26.731	5.537	31.548	15.785	28.080	5.215	14.909	1.556	--	--	19.526	6.730	--	--	13.551	13.551	25.589	1.972
Belowground	6.262	0.670	5.238	1.191	6.309	3.103	4.806	0.731	3.049	0.333	--	--	3.936	1.390	--	--	1.637	1.637	4.994	0.388
Dead trees																				
Aboveground	1.947	0.516	5.345	1.681	1.158	0.703	6.065	1.667	0.556	0.165	--	--	1.376	0.450	--	--	--	--	2.004	0.350
Belowground	0.477	0.120	1.328	0.422	0.426	0.269	1.411	0.403	0.148	0.046	--	--	0.374	0.120	--	--	--	--	0.498	0.084
Understory vegetation																				
Aboveground	1.297	0.012	1.009	0.064	0.943	0.083	0.777	0.036	0.965	0.024	--	--	1.355	0.034	--	--	0.913	0.913	1.143	0.020
Belowground	0.144	0.001	0.112	0.007	0.105	0.009	0.086	0.004	0.107	0.003	--	--	0.151	0.004	--	--	0.101	0.101	0.127	0.002
Down wood	4.367	0.452	7.816	1.274	9.830	0.325	5.985	1.238	2.377	0.346	--	--	10.549	1.230	--	--	0.610	0.610	4.581	0.358
Forest Floor	5.671	0.145	6.802	0.627	7.970	0.519	7.783	0.448	4.408	0.114	--	--	6.274	0.395	--	--	6.417	6.417	5.581	0.136
Soil	50.037	0.507	51.727	1.350	51.685	3.558	49.512	1.869	46.632	0.423	--	--	47.917	1.028	--	--	52.626	52.626	49.144	0.373
Total Carbon	102.436	4.419	106.109	9.189	109.974	17.053	104.505	4.254	73.151	1.998	--	--	91.458	8.824	--	--	75.855	75.855	93.661	2.701

	Hardwoods:																	
Carbon Pool	Alder / maple		Aspen / birch		Elm / ash / cottonwood		Western oak		Woodland hardwoods		Other hardwoods		Total		Nonstocked		All forest types	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre																	
Live trees																		
Aboveground	13.775	13.775	14.259	4.818	--	--	19.711	19.711	--	--	--	--	13.108	3.783	1.486	0.410	22.920	1.821
Belowground	2.353	2.353	2.833	0.955	--	--	3.934	3.934	--	--	--	--	2.591	0.753	0.305	0.086	4.476	0.357
Dead trees																		
Aboveground	--	--	5.635	2.260	--	--	--	--	--	--	--	--	3.089	1.844	2.383	1.610	2.075	0.358
Belowground	--	--	1.338	0.485	--	--	--	--	--	--	--	--	0.734	0.416	0.600	0.393	0.515	0.086
Understory vegetation																		
Aboveground	1.502	1.502	1.499	0.079	--	--	1.356	1.356	--	--	1.728	1.728	1.504	0.066	1.572	0.000	1.195	0.021
Belowground	0.167	0.167	0.167	0.009	--	--	0.151	0.151	--	--	0.192	0.192	0.167	0.007	0.175	--	0.133	0.002
Down wood	13.326	13.326	5.101	1.583	--	--	2.421	2.421	--	--	1.829	1.829	4.284	1.192	4.206	1.027	4.536	0.326
Forest Floor	3.964	3.964	5.584	0.677	--	--	2.025	2.025	--	--	3.666	3.666	4.342	0.809	2.673	0.156	5.268	0.141
Soil	53.288	53.288	54.895	0.733	--	--	49.329	49.329	--	--	54.016	54.016	53.355	1.105	48.504	1.015	49.224	0.351
Total Carbon	88.374	88.374	91.311	6.658	--	--	78.927	78.927	--	--	61.430	61.430	83.174	6.173	61.903	3.363	90.342	2.505

Table C36: Forest Land Carbon Stocks by Forest Type and Pool, 2007-2016: All Washington.

	Softwoods:																			
Carbon Pool	Douglas-fir		Fir / spruce / mountain hemlock		Western Hemlock / Sitka spruce		Lodgepole pine		Ponderosa pine		Western juniper		Western larch		Western white pine		Other western softwoods		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																			
Live trees																				
Aboveground	383	10	174	7	216	9	14	1	34	2	0	0	12	1	0	0	2	0	834	11
Belowground	80	2	34	1	43	2	2	0	7	0	0	0	2	0	0	0	0	0	169	2
Dead trees																				
Aboveground	25	1	23	1	17	1	4	1	2	0	--	--	2	0	0	0	0	0	72	2
Belowground	7	0	6	0	5	0	1	0	0	0	--	--	0	0	0	0	0	0	20	1
Understory vegetation																				
Aboveground	11	0	4	0	3	0	1	0	2	0	0	0	0	0	0	0	0	0	21	0
Belowground	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Down wood	54	2	27	1	40	2	5	0	5	0	0	0	3	0	0	0	0	0	134	2
Forest Floor	48	1	26	1	26	1	4	0	9	0	0	0	2	0	0	0	1	0	116	1
Soil	495	9	211	6	188	7	34	3	95	4	0	0	17	2	1	0	8	1	1,048	8
Total Carbon	1,104	22	505	16	538	20	64	5	154	7	0	0	40	4	1	1	11	2	2,418	21

	Hardwoods:																	
Carbon Pool	Alder / maple		Aspen / birch		Elm / ash / cottonwood		Western oak		Woodland hardwoods		Other hardwoods		Total		Nonstocked		All forest types	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C																	
Live trees																		
Aboveground	52	3	3	1	8	2	2	1	0	0	2	1	66	4	1	0	902	10
Belowground	10	1	0	0	1	0	0	0	0	0	0	0	12	1	0	0	182	2
Dead trees																		
Aboveground	2	0	0	0	0	0	0	0	0	0	0	0	3	0	6	1	80	2
Belowground	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	22	1
Understory vegetation																		
Aboveground	2	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	25	0
Belowground	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Down wood	8	1	1	0	1	0	0	0	0	0	1	0	11	1	5	0	150	2
Forest Floor	7	0	1	0	1	0	0	0	0	0	1	0	10	0	3	0	129	1
Soil	94	5	7	1	11	2	7	1	1	0	9	2	130	6	46	3	1,225	7
Total Carbon	176	10	12	2	22	4	11	2	2	1	13	2	236	11	64	5	2,718	18

Table C37: Forest Land Carbon Stocks per Acre by Forest Type and Pool, 2007-2016: All Washington.

Carbon Pool	Softwoods: Douglas-fir		Fir / spruce / mountain hemlock		Western Hemlock / Sitka spruce		Lodgepole pine		Ponderosa pine		Western juniper		Western larch		Western white pine		Other western softwoods		Total	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	metric tons C per acre																			
Live trees																				
Aboveground	43.040	0.829	45.054	1.355	72.388	1.900	19.866	1.277	16.581	0.611	0.794	0.794	32.767	2.036	18.124	2.500	11.685	1.281	43.924	0.528
Belowground	9.024	0.182	8.914	0.282	14.255	0.374	3.570	0.253	3.417	0.130	0.127	0.127	6.531	0.440	3.767	0.485	1.862	0.247	8.918	0.111
Dead trees																				
Aboveground	2.761	0.141	5.918	0.286	5.728	0.276	5.956	0.679	0.781	0.083	--	--	4.097	0.610	12.342	1.990	1.065	0.247	3.790	0.100
Belowground	0.761	0.036	1.578	0.075	1.735	0.082	1.400	0.161	0.200	0.021	--	--	0.988	0.144	3.326	0.573	0.285	0.066	1.045	0.026
Understory vegetation																				
Aboveground	1.269	0.003	0.962	0.007	1.004	0.010	0.973	0.032	0.982	0.010	1.622	0.081	1.322	0.010	0.945	0.029	1.040	0.035	1.123	0.004
Belowground	0.141	0.000	0.107	0.001	0.112	0.001	0.108	0.004	0.109	0.001	0.180	0.009	0.147	0.001	0.105	0.003	0.116	0.004	0.125	0.000
Down wood	6.073	0.148	7.074	0.238	13.371	0.412	6.669	0.498	2.538	0.132	0.034	0.034	7.884	0.524	8.497	1.818	1.596	0.271	7.067	0.114
Forest Floor	5.360	0.032	6.615	0.049	8.874	0.113	5.778	0.125	4.323	0.050	2.612	0.274	6.594	0.102	6.198	0.154	5.209	0.234	6.094	0.031
Soil	55.630	0.184	54.764	0.176	62.797	0.283	49.910	0.698	46.519	0.137	48.535	0.267	46.838	0.237	48.323	0.430	51.496	0.286	55.189	0.119
Total Carbon	124.060	1.171	130.987	1.936	180.265	2.636	94.231	2.074	75.450	0.854	53.904	0.578	107.168	3.256	101.627	2.577	74.353	1.888	127.275	0.765

Carbon Pool	Hardwoods: Alder / maple		Aspen / birch		Elm / ash / cottonwood		Western oak		Woodland hardwoods		Other hardwoods		Total		Nonstocked		All forest types	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
Live trees																		
Aboveground	33.155	1.362	19.804	2.776	39.624	4.775	14.584	2.158	3.879	1.036	9.497	3.081	29.581	1.149	1.464	0.310	40.758	0.466
Belowground	6.262	0.262	3.657	0.506	7.164	0.904	2.731	0.424	0.749	0.205	1.798	0.598	5.553	0.220	0.291	0.062	8.229	0.098
Dead trees																		
Aboveground	1.232	0.107	2.835	0.829	1.066	0.354	0.349	0.112	3.384	1.887	0.981	0.322	1.260	0.102	6.345	0.861	3.639	0.091
Belowground	0.423	0.036	0.716	0.190	0.309	0.095	0.108	0.027	0.938	0.512	0.270	0.087	0.404	0.031	1.531	0.210	1.000	0.024
Understory vegetation																		
Aboveground	1.121	0.014	1.429	0.039	1.217	0.035	1.459	0.029	1.689	0.048	1.622	0.043	1.214	0.013	1.580	0.001	1.150	0.004
Belowground	0.125	0.002	0.159	0.004	0.135	0.004	0.162	0.003	0.188	0.005	0.180	0.005	0.135	0.001	0.176	0.000	0.128	0.000
Down wood	5.401	0.267	4.369	0.486	3.758	0.675	1.570	0.254	3.949	0.957	5.838	1.337	4.945	0.227	5.115	0.399	6.774	0.102
Forest Floor	4.713	0.087	5.401	0.248	3.951	0.193	2.640	0.064	3.609	0.182	4.483	0.219	4.517	0.073	3.546	0.082	5.832	0.028
Soil	60.297	0.463	53.398	1.177	57.235	0.768	47.607	0.982	50.204	0.614	58.312	1.233	58.474	0.396	51.512	0.389	55.370	0.112
Total Carbon	112.728	1.835	91.768	3.781	114.460	6.487	71.209	2.870	68.588	3.618	82.980	4.731	106.083	1.592	71.559	1.461	122.881	0.671

Table C38: Forest Carbon Pools by 10-Year Inventory Period, 2002-2016 All Washington.

	Live Trees		Dead Trees		Down wood		Understory		Belowground roots		Forest Floor		Soil		Total carbon	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	902.00	11.95	75.66	1.98	160.03	2.61	28.69	0.19	203.25	2.69	130.76	0.97	1244.14	7.08	2744.54	20.60
2003-2012	884.56	10.21	76.25	1.89	155.10	2.33	28.60	0.18	199.77	2.32	129.71	0.87	1235.48	6.81	2709.46	17.94
2004-2013	890.69	10.27	77.19	1.95	152.31	2.33	28.44	0.18	201.36	2.34	129.46	0.86	1230.93	6.84	2710.36	18.05
2005-2014	896.08	10.31	78.04	1.98	150.10	2.25	28.38	0.18	202.64	2.34	129.43	0.85	1229.12	6.84	2713.80	18.09
2006-2015	899.20	10.47	79.01	1.98	148.69	2.26	28.34	0.18	203.42	2.37	129.28	0.85	1228.03	6.84	2715.98	18.32
2007-2016	901.59	10.50	80.50	2.02	149.85	2.33	28.27	0.18	204.15	2.37	129.01	0.85	1224.81	6.87	2718.18	18.47

Table C39: Live Tree Carbon Stocks by Ownership and Land Status, 2002-2016 All Washington.

	Public								Private						All Owners	
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	386.41	7.84	124.36	5.01	108.16	5.17	28.51	3.31	127.56	5.28	126.99	5.26	254.56	6.43	902.00	11.95
2003-2012	376.11	5.69	122.60	5.10	102.40	4.53	29.98	3.41	130.44	5.02	123.02	4.93	253.47	5.66	884.56	10.21
2004-2013	378.89	5.77	120.57	5.06	102.37	4.53	31.17	3.49	133.69	5.06	124.00	4.94	257.68	5.68	890.69	10.27
2005-2014	380.59	5.85	119.39	5.02	103.82	4.52	31.83	3.53	134.98	5.13	125.47	5.00	260.46	5.73	896.08	10.31
2006-2015	380.80	5.96	121.50	5.07	103.22	4.58	32.04	3.58	135.06	5.07	126.58	5.05	261.64	5.77	899.20	10.47
2007-2016	381.59	5.95	121.91	5.09	102.51	4.51	32.74	3.67	135.66	5.08	127.17	5.09	262.83	5.82	901.59	10.50

Table C40: Forest Carbon Stocks by Ownership and Land Status, 2002-2016 All Washington.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million metric tons C															
2002-2011	1,108.72	12.97	280.56	9.19	301.95	10.52	84.63	8.23	496.90	13.79	471.78	13.76	968.68	13.64	2,744.54	20.60
2003-2012	1,090.64	9.58	277.70	8.90	287.64	8.37	86.54	8.38	503.87	13.86	463.08	13.46	966.95	12.70	2,709.46	17.94
2004-2013	1,093.31	9.62	272.61	8.94	285.66	8.37	89.25	8.46	509.47	13.80	460.06	13.43	969.54	12.71	2,710.36	18.05
2005-2014	1,095.34	9.72	270.69	8.89	288.30	8.43	91.51	8.55	508.93	13.86	459.04	13.45	967.97	12.73	2,713.80	18.09
2006-2015	1,094.28	9.94	274.68	8.94	288.13	8.53	92.09	8.61	507.72	13.73	459.08	13.44	966.79	12.74	2,715.98	18.32
2007-2016	1,094.80	9.95	275.76	9.00	288.73	8.49	92.79	8.68	508.51	13.73	457.60	13.49	966.11	12.84	2,718.18	18.47

D. Forest Land Conversions

Table D1: Annual Change in Forest Land Area to/from Other IPCC Land-Use Classes in Washington, 2002-2006 to 2012-2016.

	Timberland[1]		Other forest[2]		Reserved		All forest land	
	Total	SE	Total	SE	Total	SE	Total	SE
	Acres per year							
Forest to nonforest:								
Cropland	2,677	1,781					2,677	1,781
Developed	10,240	2,110	361	298	177	129	10,778	2,131
Grassland	505	445			1,767	2,002	2,273	2,051
Other	881	797	519	614	270	222	1,671	1,030
Water	2,088	1,061	804	842	558	419	3,450	1,417
Total	16,392	3,237	1,684	1,084	2,772	2,061	20,848	3,981
Nonforest to forest:								
Cropland	528	366	49	48			576	370
Developed	8,768	1,386	135	89	93	90	8,996	1,390
Grassland	974	590	83	57			1,057	592
Other	336	171			3,432	2,337	3,768	2,343
Water	1	1			80	60	81	60
Total	10,608	1,556	267	116	3,604	2,340	14,479	2,811
Net change to forest land:								
Cropland	-2,149	1,818	49	48			-2,101	1,819
Developed	-1,471	2,514	-226	311	-84	59	-1,781	2,534
Grassland	469	738	83	57	-1,767	2,002	-1,215	2,135
Other	-545	815	-519	614	3,161	2,348	2,097	2,560
Water	-2,087	1,061	-804	842	-478	419	-3,369	1,418
Total	-5,784	3,595	-1,417	1,090	832	3,115	-6,369	4,878

Note: Totals may be off because of rounding

[1] Forest land that is capable of producing in excess of 20 cubic feet per acre per year of w ood at culmination of mean annual increment.

[2] Forest land that is not capable of producing in excess of 20 cubic feet per acre per year of w ood at culmination of mean annual increment.

Table D2: Annual Change in Carbon Pools Due to Change in Land-Use Between Forest and Non-Forest in Washington, 2002-2006 to 2012-2016.

	Forest to nonforest		Nonforest to forest		Net change	
	Total	SE	Total	SE	Total	SE
Carbon pool	*Thousand metric tons CO2 equivalent per year*					
Live tree	-3,108	630	1,555	266	-1,552	649
Standing dead	-177	69	57	10	-120	70
Down wood	-342	77	197	30	-145	81
Understory veg	-201	35	122	24	-79	42
Litter	-690	114	417	72	-273	134
Soil[1]	0		0		0	
All pools	-4,518	771	2,348	349	-2,170	810

[1] No changes in landuse involved cultivated land so soil organic carbon change w as assumed to be zero (Ogle et al. 2003)

E. Net Flux from Other Greenhouse Gas Emissions

Table E1: Annual Net Emissions of Non-CO_2 Greenhouse Gases from Fire, 2002-2006 to 2012-2016: All Washington.

	Public								Private							
	USDA Forest Service		Other Federal		DNR Managed Lands		Other State and Local Government		Corporate		Non-corporate		Total		All Owners	
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	thousand metric tons CO2 equivalent per year															
Cut and Fire																
CO_2	-257	138	--	--	--	--	--	--	--	--	-97	58	-97	58	-354	150
CH_4	-8	4	--	--	--	--	--	--	--	--	-3	2	-3	2	-11	5
N_2O	-5	3	--	--	--	--	--	--	--	--	-2	1	-2	1	-7	3
Fire																
CO_2	-2,311	422	-17	17	-97	99	-8	36	-32	29	-316	147	-348	150	-2,781	460
CH_4	-74	14	-1	1	-3	3	-0	1	-1	1	-10	5	-11	5	-89	15
N_2O	-49	9	-0	0	-2	2	-0	1	-1	1	-7	3	-7	3	-59	10
Total Fire																
CO_2	-2,568	442	-17	17	-97	99	-8	36	-32	29	-413	157	-445	160	-3,135	482
CH_4	-82	14	-1	1	-3	3	-0	1	-1	1	-13	5	-14	5	-100	15
N_2O	-54	9	-0	0	-2	2	-0	1	-1	1	-9	3	-9	3	-66	10