



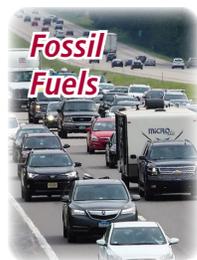
The State of Maine's Carbon Budget

Version 1.0

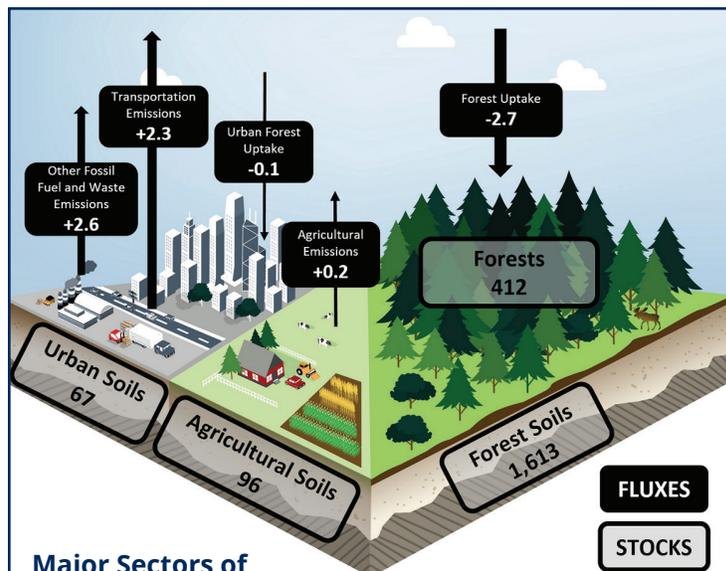
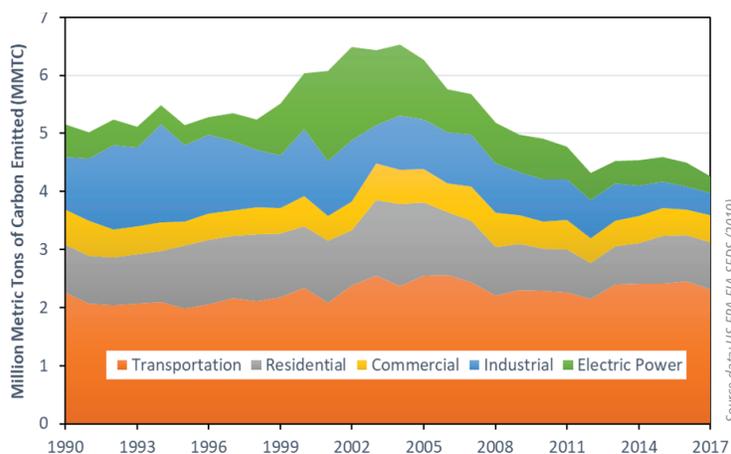
Greenhouse gases (GHGs) are emitted by human activities to the atmosphere (sources) and contribute to climate warming, but with some portion of the carbon (C) taken up and sequestered in natural and managed ecosystems (sinks). Accounting for this C budget is required for understanding human impacts on climate, guiding mitigation strategies, and informing future projections. This fact sheet illustrates an initial attempt to piece together the full C budget for the state of Maine.

Key Findings

- GHG emissions in Maine are dominated by burning fossil fuels, primarily from the transportation sector, but with a sharp decline in electric power emissions over the last decade.
- Carbon 'offsets' are estimated as 55% for forest growth and 75% for the total annual C cycle.
- Critical uncertainties in the budget arise from undersampled or unknown components. Improved assessments require advances in stock quantification and flux monitoring.



The plot below shows C emissions over time (since 1990) from the major sources of fossil fuel combustion in Maine. Carbon emissions from fossil fuel combustion in Maine peaked in 2002-04, and have been declining by ~3% per year since. Despite the decline, transportation emissions have maintained a steady pace and currently account for more than half of total emissions.



Major Sectors of Maine's Carbon Budget

The simplified C budget of Maine shows estimates of current stocks and annual fluxes in million metric tons of carbon (MMTC, from 2006 to 2016) for the major components. Maine's land-based currently stores more than 2 billion tons C, primarily (~75%) in forest soils. Of the 5.1 MMTC emitted annually by the sources shown, 2.8 MMTC (~55%) is offset by C uptake from forest growth.



Trees take up C from the atmosphere through photosynthesis and adds it as biomass. As the C cycles through the ecosystem it is either returned to the atmosphere through decomposition or incorporated into the soil. In managed forests, live biomass is also removed in harvest and that C can be made into short- (e.g., pulp) or long- (e.g., sawlogs) term products. About 89% of Maine consists of forests (the most of any state), which account for the vast majority of C uptake and storage in this budget.

Forest Component	2006 Stock (MMTC)	2016 Stock (MMTC)	Stock Change (MMTC/yr)
Live Biomass	385	412	2.675
Dead Organic Matter	45	47	0.132
Soil Carbon	1,612	1,613	0.133
Total Forest Carbon	2,042	2,071	2.940

Agriculture



Carbon in crop residues can be incorporated into the soil, depending on management practices across the diversity of Maine's 7,600 farms. Livestock are a major source of the emissions from this sector.



In built environments, the C stored in trees, gardens, lawns, and wooden structures from residential areas and parks are increasingly important in keeping C out of the atmosphere.

Wetlands

There are more than 277,000 acres of wetlands in Maine, including bogs and fens where C is stored in saturated organic (e.g., peat) and mineral soils.



Inland Waters

Carbon is transported from land through Maine's rivers to the ocean. Some of that C is buried in lake sediments, while much of it outgasses from the water column.



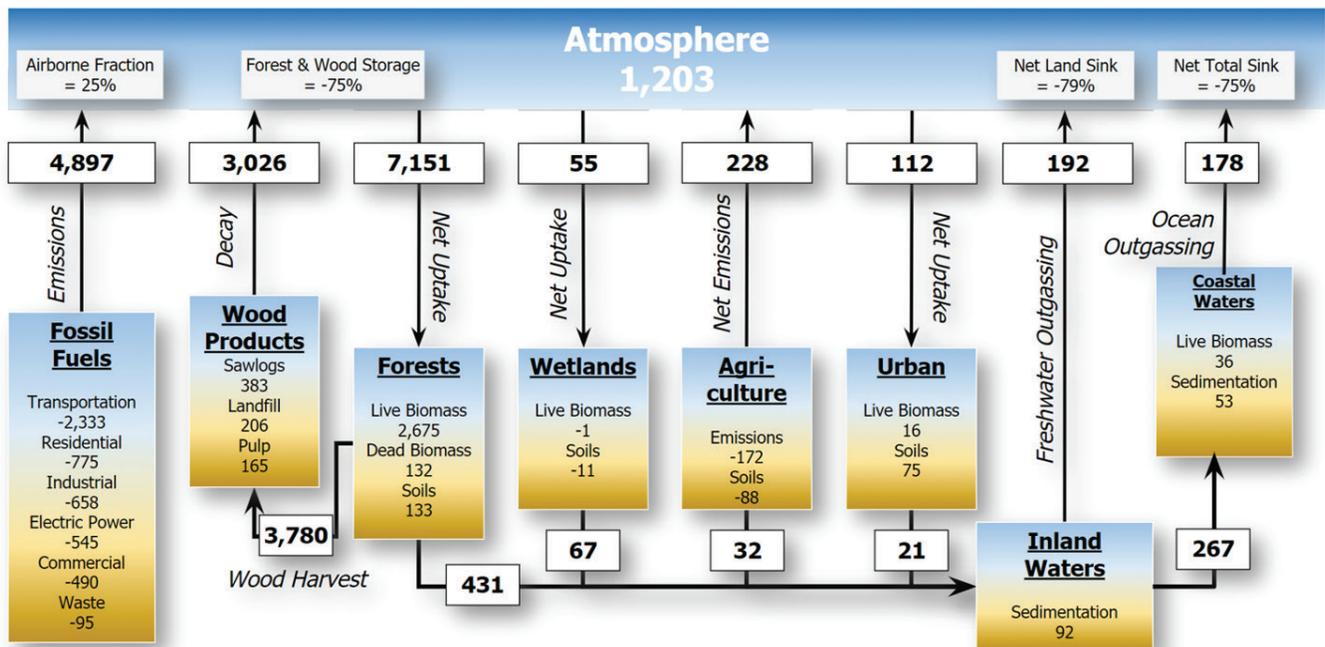
Coastal Ecosystems

"Blue Carbon" is found in salt marshes and eelgrass ecosystems, which have high rates of C storage in their sediments despite their relatively small area in Maine.



The Major Components of Maine's Carbon Cycle

The budget illustration below depicts the current state of the C cycle in Maine (all estimates are given as annual averages, in thousand metric tons of C per year, for 2006 to 2016). The synthesis of C flows through the various components represents the net effect of Maine's C cycle on the amount of GHGs in the atmosphere—or its contribution to the speeding-up or slowing down of climate warming. This budget analysis suggests that ~25% of the 4.9 MMTC/yr emitted on average from fossil fuels in Maine is effectively contributed to the atmosphere (i.e., the "airborne fraction") after accounting for sources and sinks in the state's lands and waters. Using this full budget approach, Maine's net emissions are estimated to be approximately 1.2 MMTC/yr.



Inventory and Monitoring



- The U.S. Energy Information Administration reports annual estimates of fossil fuel emissions by energy-consuming sector in each state. Agricultural emissions and other sources are compiled in the U.S. Environmental Protection Agency's National Greenhouse Gas Inventory and Reporting.
- Forest stocks and wood products are estimated by the U.S. Forest Service, which updates its Forest Inventory Analysis plot measurements across the country on a 5- to 10-year cycle. Fluxes in other land covers are estimated locally and extrapolated by satellite imagery, such as with the National Land Cover Dataset.
- The U.S. Geological Survey maintains a large network of river sampling stations throughout the country that are used to estimate the lateral flux of C from land to the coastal ocean.
- In Maine, atmospheric GHGs are measured at a NOAA "tall tower" in Argyle, and the Howland Research Forest is one of the longest-running ecosystem C flux monitoring sites in the world.



This analysis was compiled by the Center for Research on Sustainable Forests at the University of Maine, in collaboration with the Maine Forest Service and Bates College. More information, including data sources and references, can be found online by visiting the Forest Climate Change Initiative website at: crsf.umaine.edu/forest-climate-change-initiative/carbon-budget

