# Indicator 5.22:



## Total forest ecosystem carbon pools and fluxes

Grant M. Domke and Lara T. Murray

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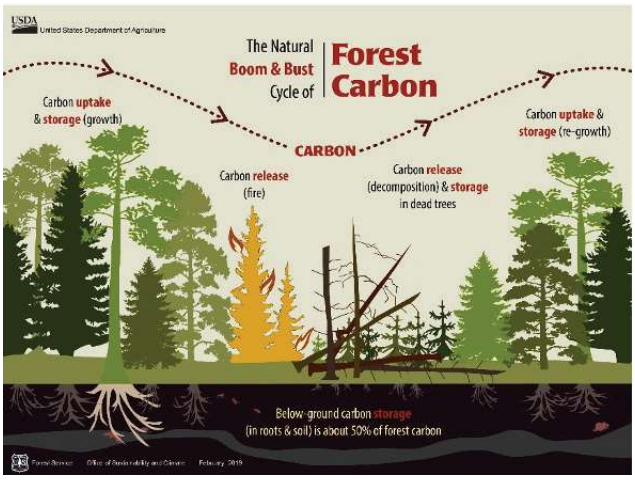
## What is the indicator and why is it important?

Forest ecosystems are the largest terrestrial carbon sink on Earth. In the United States, forests and harvested wood products that come from forests store the equivalent of nearly 3 decades of carbon emitted from economy-wide fossil fuels. Carbon is continuously cycled through forest ecosystem pools and the atmosphere. This is driven by biogeochemical processes including photosynthesis, respiration, decomposition; disturbances such as fires or pest outbreaks; and anthropogenic activities like harvesting, thinning, and replanting. As trees photosynthesize and grow, carbon dioxide is removed from the atmosphere and stored as carbon in living tree biomass. When trees die and otherwise deposit organic material on the forest floor, carbon is released as carbon dioxide into the atmosphere and some is transferred to the other carbon pools (litter, dead wood, and soil) by organisms that facilitate decay and decomposition. Here we summarize carbon stocks in forests in the United States as well as the annual fluxes in ecosystem pools (see box 1 for a description of the carbon pools included). We also describe carbon stock changes and transfers associated with land conversions to and from forest ecosystems.




**Box 1. Carbon Pools included in United States Greenhouse Gas Estimation**

For estimating carbon stocks or stock change (C flux), the following five storage pools are considered (Intergovernmental Panel on Climate Change 2006):

Aboveground biomass—all living biomass above the soil including stem, stump, branches, bark, seeds, and foliage. This pool includes live understory.

Belowground biomass—all living biomass of coarse living roots greater than 2 millimeters diameter.

Dead wood—all nonliving woody biomass either standing, lying on the ground (but not including litter), or in the soil.

Litter—the litter, fumic, and humic layers, and all nonliving biomass with a diameter less than 7.5 centimeters at transect intersection, lying on the ground.

Soil organic C—all organic material in soil to a depth of 1 meter but excluding the coarse roots of the belowground pools.

In addition, two harvested wood pools are commonly included when estimating C flux (not shown here—see indicator 5.24):

- Harvested wood products (HWP) in use.
- HWP in solid waste disposal sites.

# What does the indicator show?

In 2018, forests in the United States had an estimated uptake of 675.1 million metric tons of carbon dioxide equivalent (MMT $CO_2$ Eq.) and emitted to the atmosphere or transferred to another land use category an estimated 127.4 MMT $CO_2$ Eq. resulting in net uptake of 547.6 MMT $CO_2$ Eq. (fig. 22-1; Domke et al. 2020a). This net uptake is equivalent to approximately 10 percent of the total economy-wide $CO_2$ Eq. (fig. 22-2) emissions. Interannual variability is driven, in large part, by disturbance, and while most States in the conterminous United States are net carbon sinks each year, several Intermountain West States are net sources of carbon (figs. 22-3 and 22-4). This is due to the frequency and severity of natural disturbances which have increased in recent decades. In most States, live biomass is the primary source of carbon uptake, but in several Intermountain West States, dead wood is the largest source of uptake due to transfer of carbon from live biomass pools to dead wood following disturbance. While live biomass contributes most to the carbon sequestration

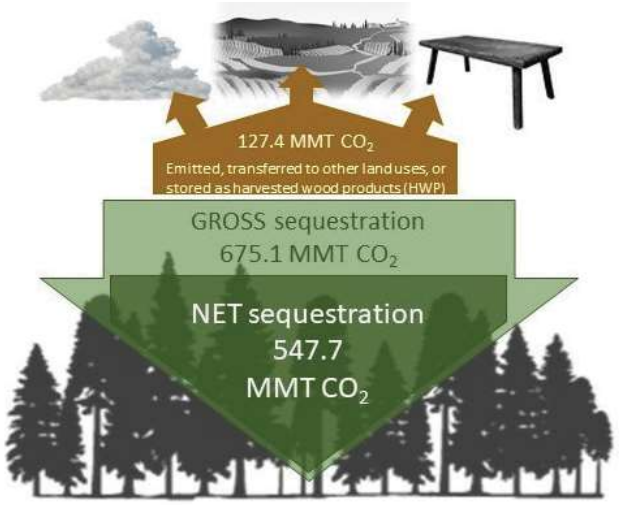



Figure 22-1—Estimated carbon dioxide flux from forests in 2018.

capacity of U.S. forests, the majority of carbon is stored in soil (fig. 22-5, Domke et al. 2020a). Soil carbon, both mineral and organic, accounts for more than 56 percent of the total carbon stocks in the United States, followed by combined live aboveground and belowground carbon pools that contribute 32 percent.

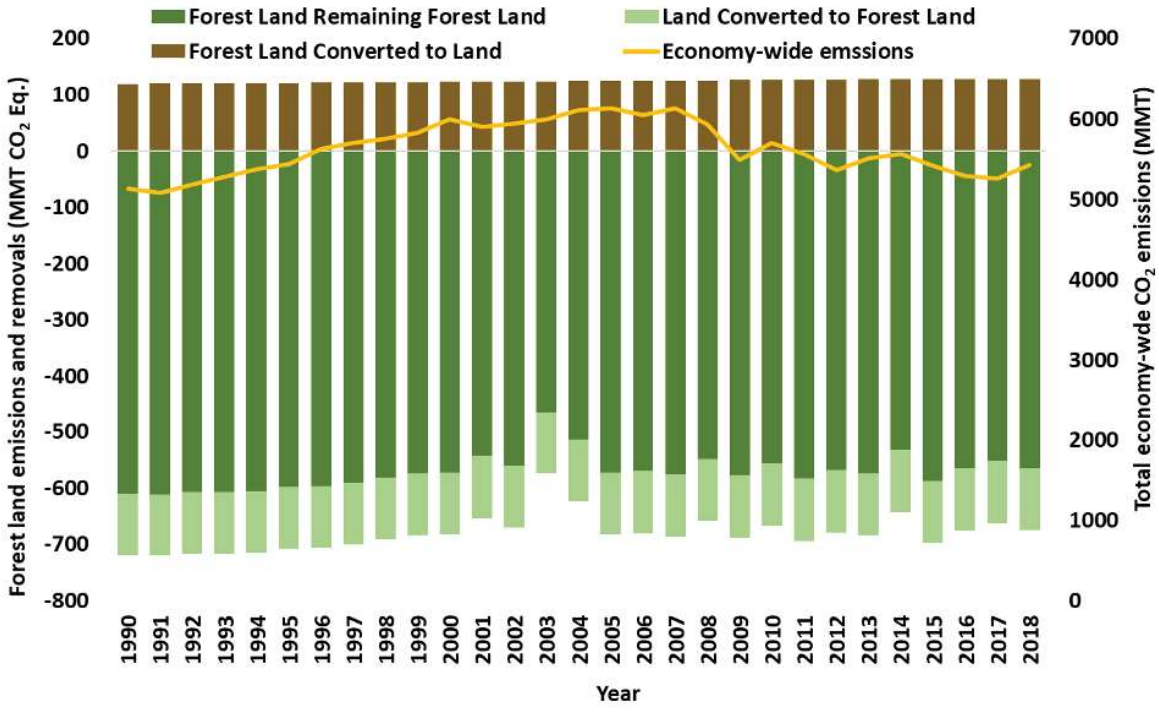



Figure 22-2—Estimated emissions and removals from forest land remaining forest land, land converted to forest land, and forest land converted to land and total economy-wide carbon dioxide emissions in the United States (MMT $CO_2$ Eq.). Negative estimates indicate net C uptake (i.e., a net removal of C from the atmosphere).

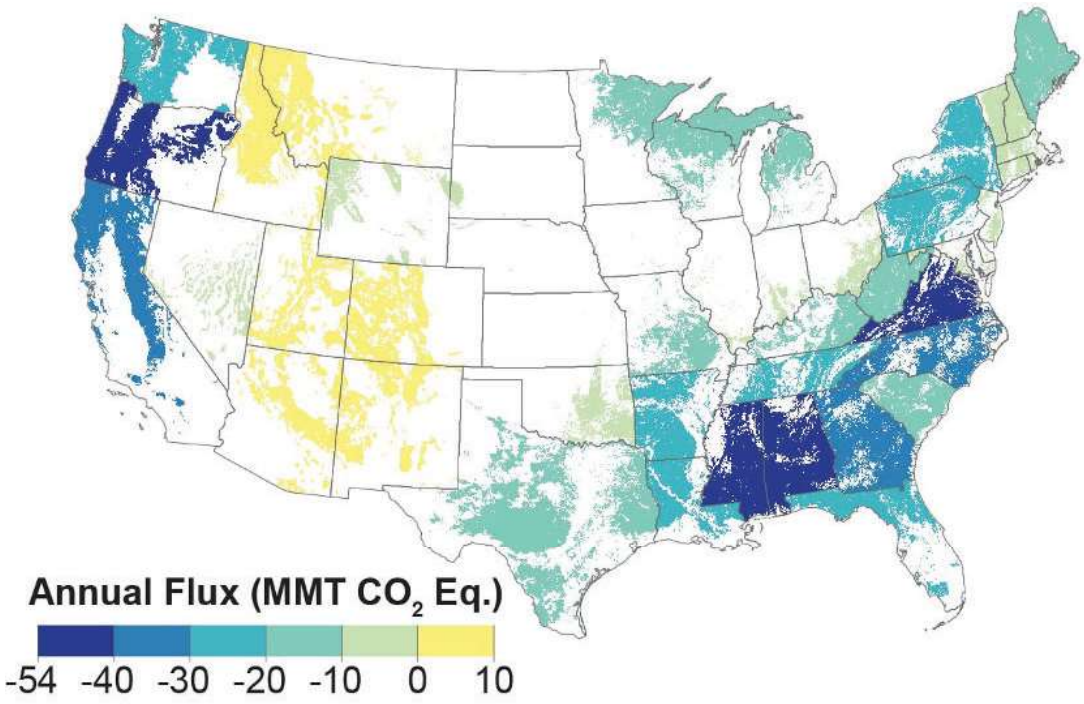



Figure 22-3—Estimated greenhouse gas emissions and removals on forest land by State in 2018. Negative estimates indicate net C uptake (i.e., a net removal of C from the atmosphere). Adapted from Domke et al. 2020b.

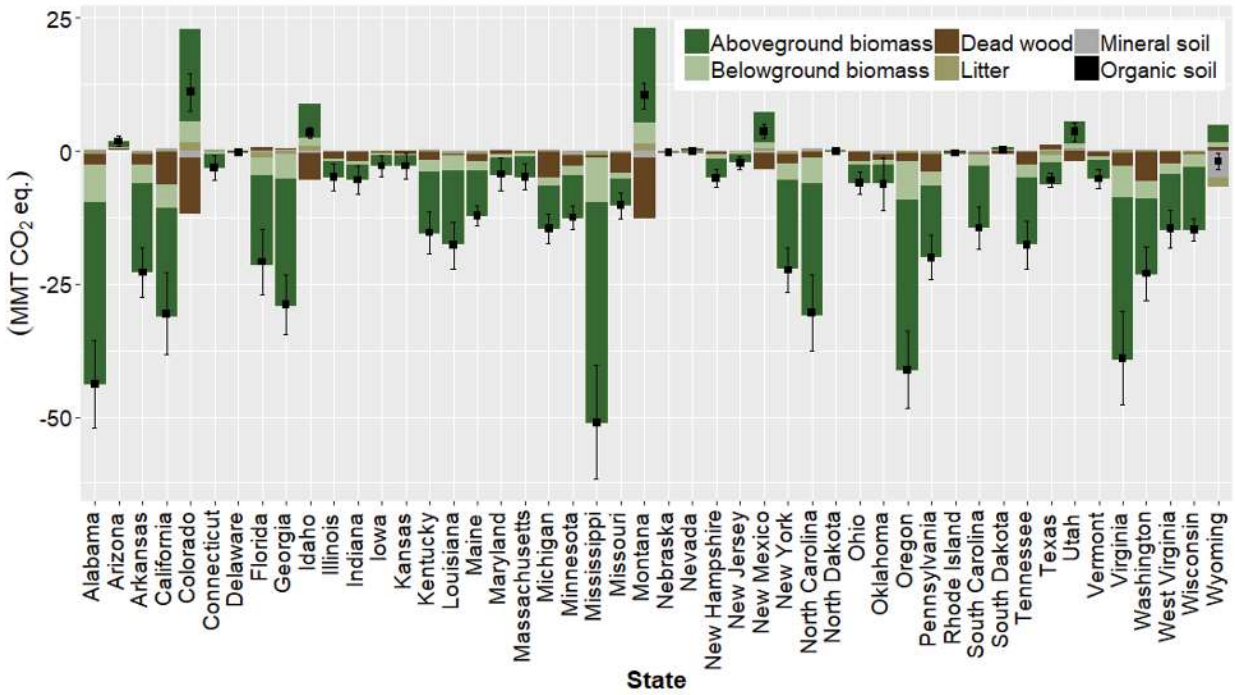



Figure 22-4—Estimated emissions and removals from forest land remaining forest land by carbon pool for each conterminous State in 2018 (MMT CO2 Eq.). Note that points and confidence intervals (95 percent) reflect net flux for all carbon pools in each State. Individual State estimates will not sum to national total estimates due to independent rounding. Negative estimates indicate net C uptake (i.e., a net removal of C from the atmosphere).

# What has changed since 2010?

The contribution of forest land to emissions offsets in the United States has remained relatively stable since 2005, despite steady declines in economy-wide $CO_2$ emissions over that period (fig. 22-2, U.S. EPA 2020). This suggests that the forest carbon sink in the United States, which is driven in large part by forest regrowth following harvest and natural disturbance, is slowly diminishing.

The interannual variability observed in carbon stock change estimates can be attributed to disturbance and harvesting, and to a lesser extent, land use conversions (fig. 22-2). Over the time series, soil carbon stocks have declined slightly and live biomass stocks have increased (fig. 22.5). It is not clear if these trends will continue, however forests remain the Country's largest terrestrial carbon sink and there is growing evidence that these forests have the capacity to sequester and store substantially more carbon (Fargione et al. 2018, Domke et al. 2020b).

# References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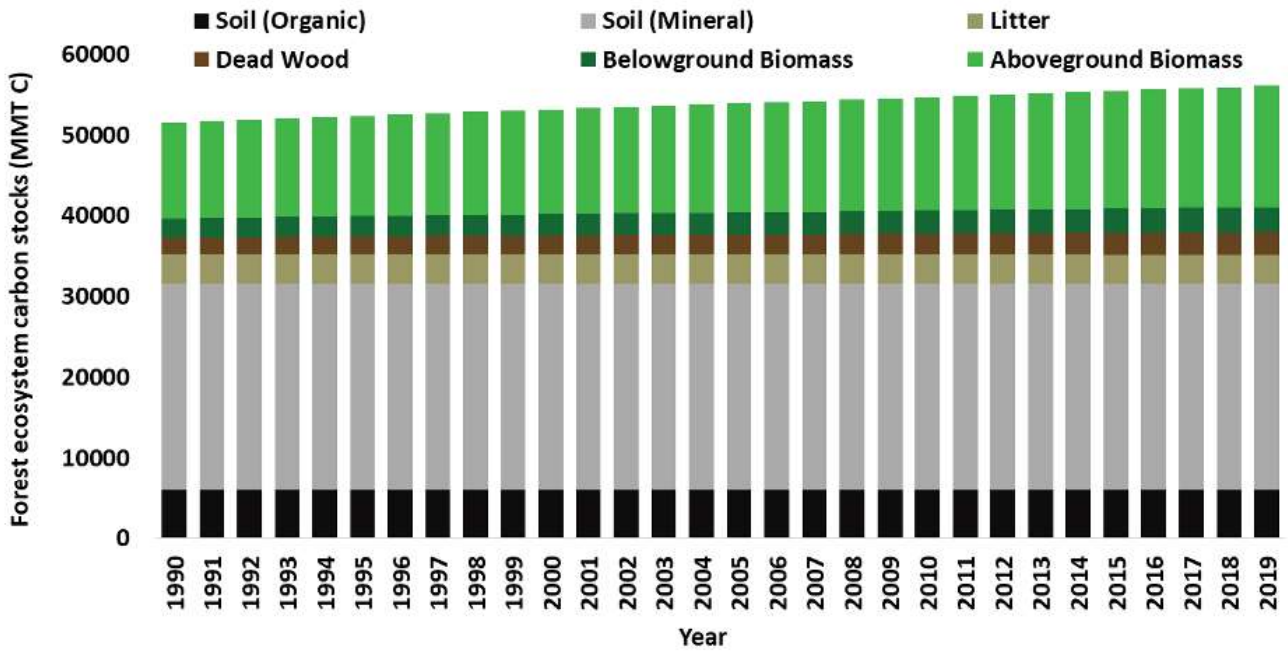


Figure 22-5—Total forest ecosystem carbon stock by pool over the 1990–2019 time period in the United States.