Note: The content of this publication draws heavily on several similar publications produced by the Vermont Department of Forests, Parks and Recreation.

What is forest carbon?

The carbon cycle:

The carbon cycle is the key to life on Earth. Through natural processes, carbon is exchanged among living organisms, soil, rocks, water, and the atmosphere. Humans have disrupted the carbon cycle by burning fossil fuels and disturbing ecosystems, resulting in a significant increase in emissions of CO_2 and other GHG into the atmosphere where they alter the Earth's energy balance and cause climate change. Because CO_2 is removed from the atmosphere through photosynthesis, plants and forests are vital in maintaining the carbon cycle.

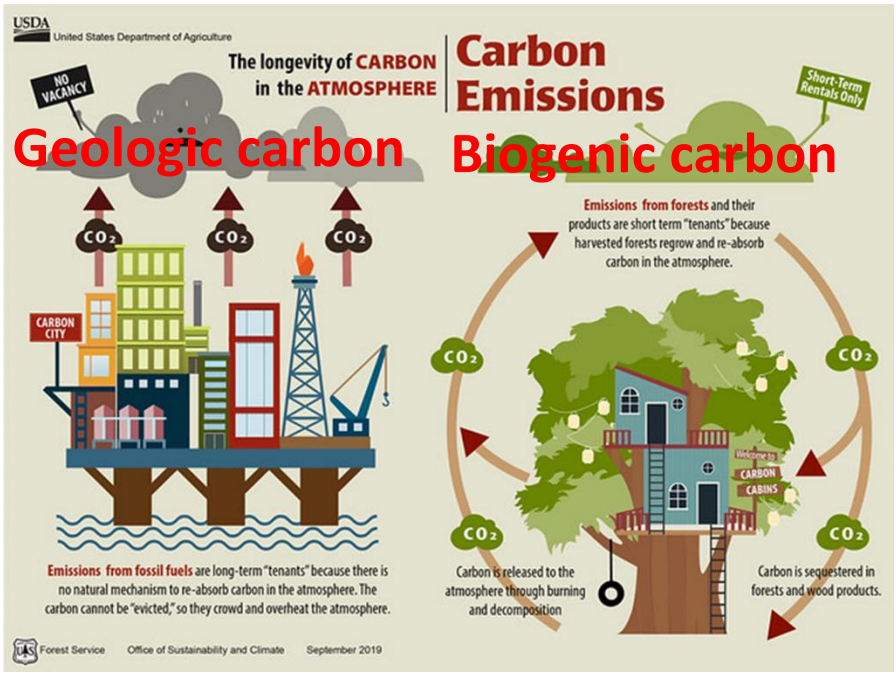

Figure 1

Geologic carbon is carbon that has been locked within the earth for millennia. Carbon released upon burning of fossil fuels is geologic carbon (Figure 1). This is also called the 'slow carbon cycle' because it takes millions of years for carbon to move through rocks to the atmosphere. Oceans are part of the geologic carbon cycle. **Biogenic carbon** is carbon in plants, soils, and organisms. This is also called the 'fast carbon cycle' because carbon is exchanged with the atmosphere much quicker than the geologic carbon cycle. The biogenic carbon cycle re-captures the carbon released through this system while the geologic carbon is not re-captured except that oceans are natural carbon sinks that sequester carbon dioxide in the atmosphere, regardless of the source.

Note: The content of this publication draws heavily on several similar publications produced by the Vermont Department of Forests, Parks and Recreation.

How do forests use carbon?

Through photosynthesis, trees and other plants take in CO_2 from the air to make carbon-based sugars (*carbo*hydrates) using water and sunlight, releasing oxygen to the atmosphere in the process. Trees and other plants use these sugars to maintain day-to-day processes (and respire CO_2 in doing so). But trees also use carbohydrates to grow their trunk, branches, roots, leaves, and other vegetative parts. The proportion that a tree uses for growth compared to respiration depends on the tree's species and age, along with the time of year and environmental conditions. When a tree produces seeds or makes defense chemicals to ward off insects, there is less energy (carbohydrates) to devote to growth.

Figure 2

Unlike non-woody plants, trees can store an incredible amount of carbon in wood. Wood gets its strength and flexibility from the carbon-based compounds cellulose, hemicellulose, and lignin. About 50% of a tree's dry weight is made up of carbon.

If a tree dies and is decomposed by microbes or burned in a fire – whether in the forest or a woodstove – CO_2 is released back to the atmosphere but at different rates. This carbon can then be taken in by another tree and the cycle repeats.

What is the difference between carbon storage and carbon sequestration?

Carbon storage is the total amount of carbon contained in a forest both aboveground (trees) and below ground (soil) at a given time.

Carbon sequestration is the process of removing carbon from the atmosphere through photosynthesis (Figure 3) and storing it in another form that cannot immediately be released - wood (Figure 2). It is the rate of carbon uptake from the atmosphere. In forests, young, quick-growing living plants sequester the most carbon, but soils can sequester smaller amounts through natural geologic processes. The carbon *stored* in the forest accrues over time because of the annual carbon *sequestration* of living plants and the comparatively slow decomposition of dead plant matter. Carbon sequestration is expressed as a negative value because it indicates the removal of CO_2 from the atmosphere, i.e. that there is less CO_2 to contribute to climate change.

Note: The content of this publication draws heavily on several similar publications produced by the Vermont Department of Forests, Parks and Recreation.

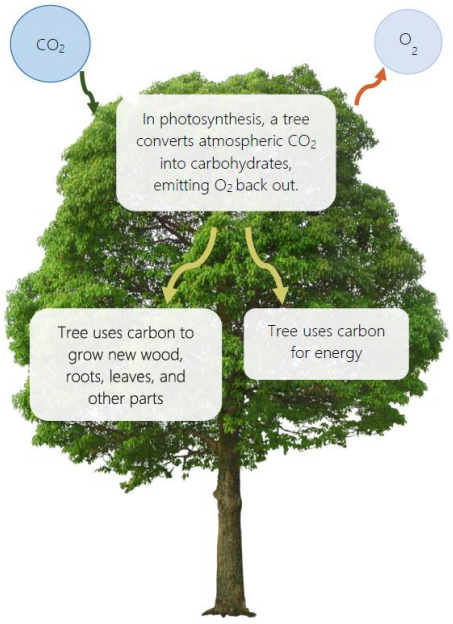

Figure 3

Carbon emissions are the opposite of carbon sequestration. It is the rate of CO_2 released to the atmosphere. Forest carbon can be re-emitted to the atmosphere through decomposition, respiration, or combustion. The rate of carbon emissions is expressed as a positive number per unit of time because when CO_2 is emitted to the atmosphere, the amount of CO_2 in the atmosphere increases.

In a forest, the combination of carbon sequestration and carbon emissions is the *net carbon flux* or the change in carbon storage over time. In other words, net flux accounts both for the uptake of CO_2 by live plants and soils, for emissions of CO_2 due to respiration, decomposition, and disturbances, and for the transfer of carbon to other parts of the forest.

When carbon flux is a negative number (less than zero), the forest sequestered more CO_2 than it emitted. This is called a *carbon sink* and the total carbon storage of the forest will increase by the amount sequestered. Currently, the forests of the northeast U.S. are carbon sinks. Young to middle-aged forests sequester the most carbon while older forests have the most carbon storage (Figure 4).

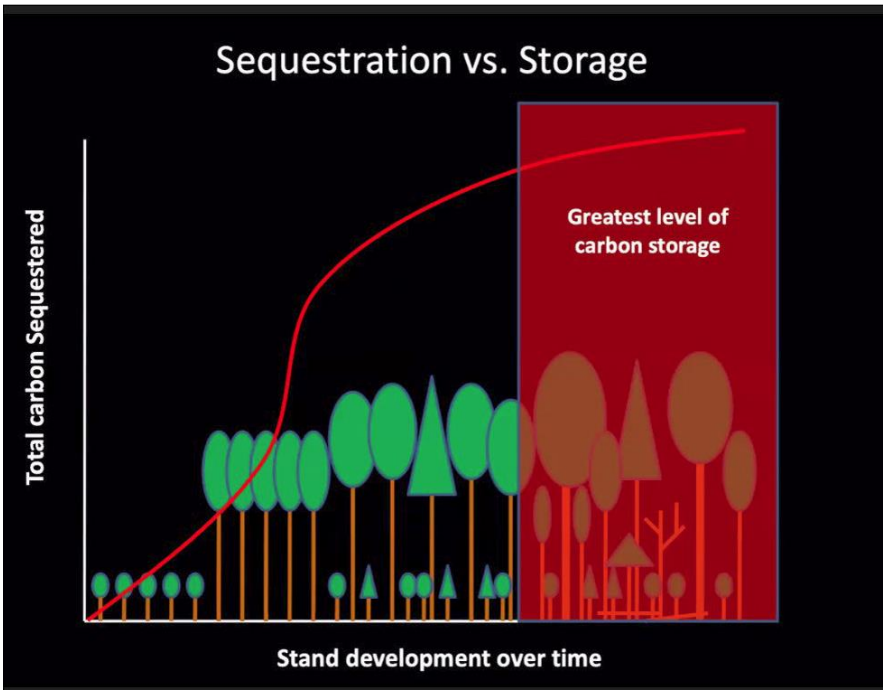

Figure 4 Source: William Keeton, University of Vermont

When carbon flux is a positive number (greater than zero), the forest emitted more CO_2 than it took in. This is called a *carbon source* and the total carbon storage of the forest will decrease by the amount emitted. This can occur if a large amount of carbon was released from the forest due to natural or human-caused disturbance, including large fires, land clearing, converting forest to non-forest use, or insects and disease. If the forest can regrow, it can quickly return to being a carbon sink.