5.2 Forest Ecosystem Products and Services Reading

Land areas dominated by trees are called forests and cover about one-third of the world's dry land area. The world has many different kinds of forests including tropical, temperate, and taiga (northern boreal forests). Some forests may only contain a few tree species per acre while others have hundreds. Although they are characterized by trees, forest ecosystems provide homes for an incredible diversity of life at all trophic levels. This reading focuses on one forest ecosystem: the forest of the Catskill/Delaware watershed north of New York City. New York is famous for its clean, good-tasting water, and this forest is an important part of the story of why New York has such good water.

A Walk through the Forest

Here are some pictures that show what you would see in a walk through the Catskill/Delaware forest.

Figure 1: Walking beneath groves of mature trees, you might catch a glimpse of a bear or hear the call of a Black-throated Blue Warbler.

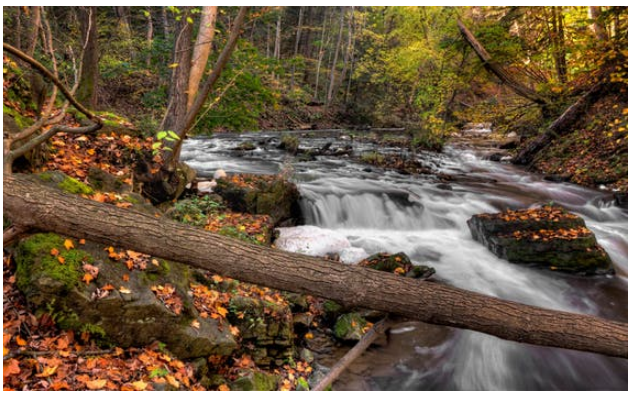
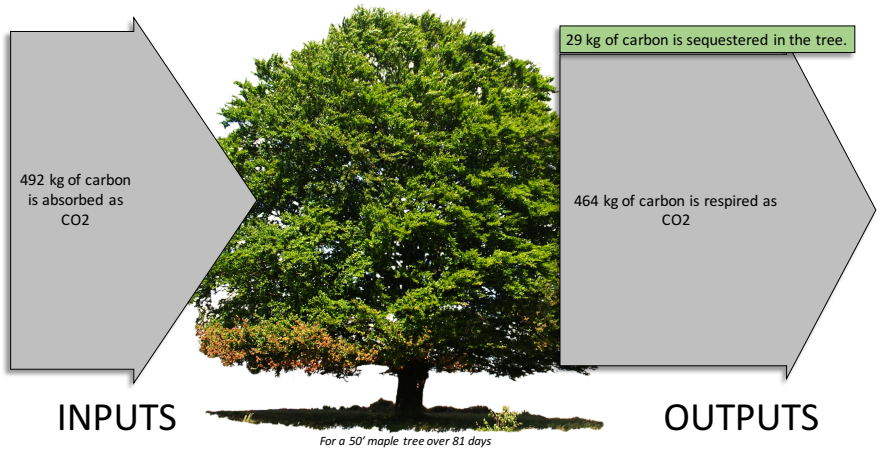


Figure 2: Many cold, clear streams run through the forest, providing habitat for trout and other aquatic animals and drinking water for New York city.

Carbon Pools and Fluxes in the Forest

Trees are the key feature of forests and the primary producer in these ecosystems. Let's consider a single tree. On average, a fifty-foot tall Sugar Maple tree *(Acer saccharum)* removes 492 kg of inorganic carbon atoms from the air during photosynthesis over the summer. All that carbon has to go somewhere. Through the process of respiration, about 464 kg of carbon atoms are released back into the atmosphere. What happens to the remaining 29 kg of carbon? These carbon atoms become part of the organic matter in the tree as it grows. Deciduous trees like Sugar Maples also shed their leaves in the fall, meaning some of these carbon atoms are added



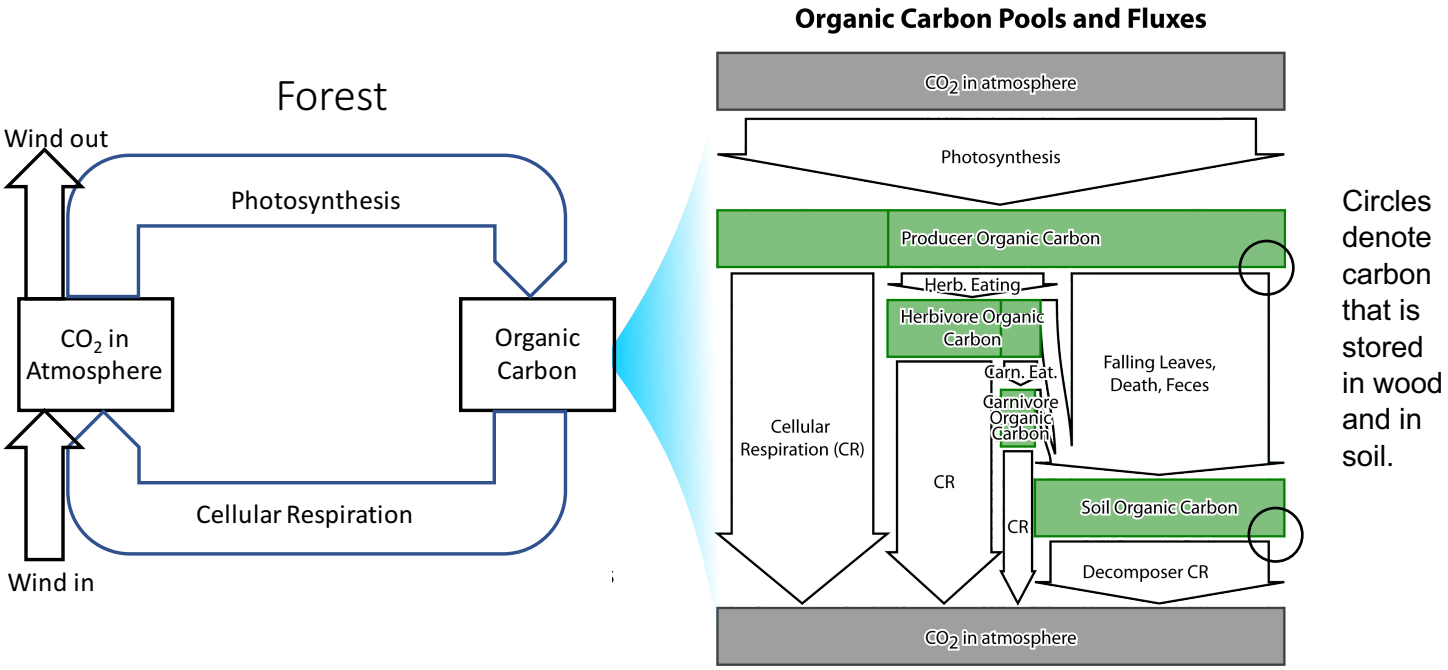
to the soil organic carbon pool. Since more carbon atoms are removed from the atmosphere by photosynthesis in trees than are respired back into the atmosphere, growing trees sequester carbon.

Let's think about the whole forest. The pictures of the forest above show evidence of carbon pools and fluxes. Can you identify them? Incredibly, forests contain nearly 70% of the cycling organic carbon on earth! The diagram below shows the carbon pools and fluxes for a forest.

Carbon pools. The visible carbon pools are mostly *organic carbon pools,* including producers (all the trees and other plants), consumers, all the animals, and decomposers (fungi and bacteria). There is a lot of organic carbon in these visible pools—about 23,000 kg/acre.

But there is even more carbon sequestered in carbon pools that we can't see in the photos. Much of this is *soil organic carbon*—all the plant roots, dead leaves, plants, and animals, bacteria, and fungi in the soil—about 45,000 kg/acre. There is also *carbon dioxide* in the air and dissolved in the water of the forest.

Carbon fluxes. Carbon is also constantly moving among the pools of the forest. A few of those fluxes are visible, such as when animals eat the leaves of plants. But many other fluxes are invisible, such as photosynthesis in the leaves of plants and cellular respiration in the cells of producers, consumers, and decomposers.



Circles denote carbon that is stored in wood and in soil.

From our Sugar Maple example, we know fluxes in the forest are not completely balanced. The trees in the forest are still growing, so the photosynthesis flux is a little larger than the cellular respiration flux. This means that the organic carbon pool is slowly getting larger as the trees grow and soil organic carbon builds up. In the forest flux diagram above, the *circles* represent the carbon that is stored in the wood of the trees and in the soil.

Think about the forest as an open ecosystem (left side of the above diagram). The wind blowing out of the forest has a little less carbon dioxide than the wind blowing in, as photosynthesis removes carbon dioxide from the air and releases oxygen that we can breathe!

There isn't much organic carbon naturally going into or coming out of this forest ecosystem. Sometimes, though, humans take a lot of organic carbon out of forests, when they log the forests and take out wood.

Ecosystem Products and Services from the Forest

Human management. Humans manage the Delaware/Catskill forest mostly by protecting it. They keep out roads, houses, and hotels. They do not allow farms and control domestic animals. These management practices allow the forest's natural processes to continue. *Humans protect natural pools and fluxes so that the ecosystem will keep water clean.*

Forest products and services. The forest provides many different ecosystem services. Let's focus in the main ones:

- *Water: Very important.* The water that comes from this particular forest is exceptionally pure and flavorful. The rain water that falls in the watershed filters through soil, sand, and the roots of all the trees and other plants. It fills the streams and the reservoir that supplies drinking water to New York City.
- *Carbon sequestration:* The forests of the world store a *lot* of carbon: more than 800 billion tons! The Catskill/Delaware forest is doing its part, as it moves atmospheric CO_2 into its organic matter every year.
- *Other ecosystem services.* The forest also provides other services. It provides habitat for many different plants and animals, including birds and predatory insects that eat mosquitoes and other harmful insects. Additionally, evaporation from trees cools the air and the forest is a beautiful refuge for people to visit nature.

Tradeoffs: What services does the forest NOT provide? When we manage ecosystems to produce some products and services, it always means that we get less of others. Here are some other products and services that humans could get from the Catskill/Delaware forest, but do not.

- *Food:* The forest provides food for the animals that live in it, but not much food for humans. Using the forest land to grow plants and animals for human food would cause sediment, nutrients, and pesticides to enter the water, so the managers do not allow people to cut down the forest for human food production.
- *Wood:* The forest could also provide more wood, but cutting down trees and removing them would pollute the water with sediment.
- *Space for living and recreation:* Homes or hotels in the forest area can also increase sediments in the water and other kinds of pollution.

Digging Deeper: Where You Can Learn More about Forests and Their Ecosystem Services

To learn more about forests and the ecosystem services that they provide:

- Read about how New York City spent $660 million to preserve the watershed's forests rather than build a $4 billion water treatment plant to do the same thing (http://www.nytimes.com/1997/05/20/science/how-much-is-nature-worth-for-you-33-trillion.html).
- Read about how New York City gets water from the Catskill/Delaware forest https://nyti.ms/2jRSmqf and view a map of the forest location: http://www.nyc.gov/html/nycwater/html/drinking/reservoir.shtml
- Information on the history of the Catskill forests: http://catskillcenter.org/the-catskills/

- Read about forest biodiversity and ways to protect forests https://extension.psu.edu/forest-biodiversity-understanding-biological-health-in-our-forests
- To learn more about how forests grow and mature: video on ecological succession: https://www.youtube.com/watch?v=V49IovRSJDs
- To learn more about how much carbon forests sequester and how forests affect climate change: https://theconversation.com/explainer-how-much-carbon-can-the-worlds-forests-absorb-14816