

## 5.1: Ecosystem Products and Services Reading

In Lessons 2 and 3 (and perhaps Lesson 4) you studied models and simulations of ecosystems that were like real ecosystems in many ways. They showed how **carbon cycles** in ecosystems, moving from one pool to another through processes such as photosynthesis and cellular respiration. They also showed how **energy flows** through ecosystems as it is transformed from sunlight to chemical energy in organic materials to energy that organisms use for their functions and ultimately to heat.<sup>1</sup> Figure 1 shows how carbon cycles and energy flows.

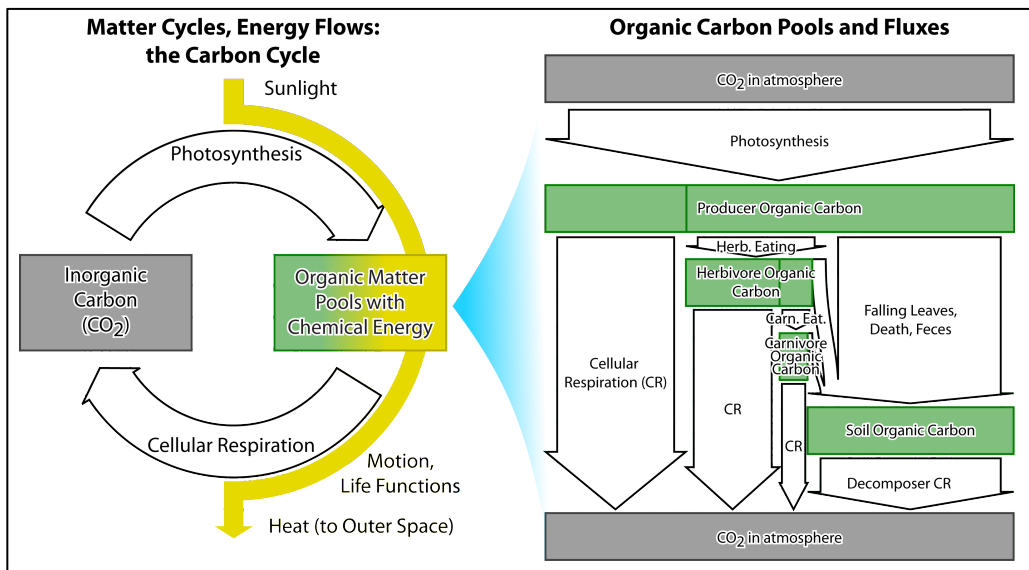


Figure 1: How carbon cycles and energy flows in ecosystems

But here is one important thing about real ecosystems that we didn't discuss in Lessons 2, 3, or 4. In those lessons we talked about *closed systems*: all the carbon atoms stayed inside the system and moved back and forth between the organic and atmospheric carbon pools. Real ecosystems are *open systems*: Carbon atoms enter and leave them all the time. Figure 2 shows the difference:

<sup>1</sup> If you studied Lesson 4, you worked with Carbon Flux Models of closed ecosystems that were like real ecosystems in a lot of ways. They showed:

- **Carbon fluxes** measuring how many kilograms of carbon per year move from one carbon pool to another.
- How a **balance of carbon fluxes** determines whether each carbon pool becomes larger over time, becomes smaller, or stays the same (only if the carbon flux in and the flux out are exactly equal)
- How **carbon pools in ecosystems can stabilize** when fluxes change according to the size of the pools.
- How **seasons and disturbance** can change ecosystems by affecting carbon pools, carbon fluxes, or the photosynthesis limit.

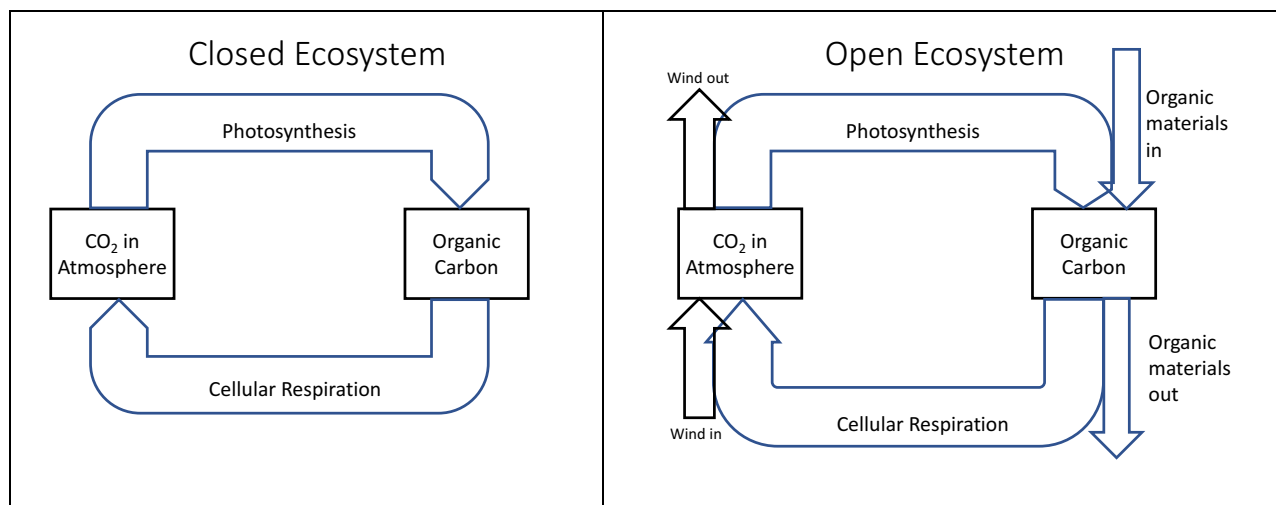


Figure 2: Closed vs. open ecosystems

In Lesson 5 you will study different kinds of open ecosystems. You will learn how materials entering and leaving ecosystems provide humans with **ecosystem products and services**, including the food, water, and air that we depend on for life. Finally, you will look at different ways that **humans manage ecosystems** to get more products and services, and at how human management involves tradeoffs among different ecosystem services.

### **How does carbon enter and leave ecosystems?**

Materials enter and leave natural ecosystems all the time. Every time the wind blows, carbon dioxide enters the ecosystem on one side and leaves it on the other. Other materials also come into and out of ecosystems with flowing water, moving animals, and blowing leaves. So carbon cycles within ecosystems, but carbon also moves into and out of ecosystems.

One of the main ways that materials move into and out of ecosystems is through **human management**. We manage ecosystems such as farms and forests so that we can take out materials we need, such as food and wood. In this lesson you will be studying managed ecosystems and the services that they provide.

### **Ecosystem products and services**

Once upon a time, the Earth's ecosystems were mostly natural—humans were herbivores and carnivores who lived in ecosystems and did not disturb them very much. Humans lived by taking advantage of the natural processes that had evolved in ecosystems over millions of years.

But today humans affect every ecosystem on Earth. Most of the Earth's ecosystems—farms, ranches, forests, lawns, cities—are actively managed by humans. We have a name—**ecosystem products and services**—for the ways that ecosystems provide humans with many different things that we need.

**Ecosystem products** are materials that we take out of ecosystems for our use. Here are some examples:

- **Food:** All the food that we eat comes from managed ecosystems, such as farms, ranches, aquatic ecosystems, and forests. Two of the ecosystems that you study in Lesson 5—farms and ranches—are ecosystems that humans manage to provide more food.
- **Water:** Most of the water that we drink and depend on to grow crops flows through ecosystems before it comes to us. Those ecosystems can improve or harm water

quality. You will also study an ecosystem in this lesson—the Catskill-Delaware forest—that humans manage to provide clean drinking water.

- *Wood* comes from forests that we log. We make other products such as paper from wood.
- *Fibers* such as cotton, wool, and linen also come from ecosystems. We use those fibers to make many of our clothes, carpets, and curtains.

**Ecosystem services** are ways that ecosystems help us to survive even when we are not taking products out of them.

- *Oxygen production and carbon sequestration*: All the oxygen in our atmosphere was produced by ecosystems at some time. Today we depend on ecosystems to take CO<sub>2</sub> out of the air and store the carbon in organic matter. Scientists call this *carbon sequestration*. (There is about three times as much carbon in the organic matter of the Earth's ecosystems as in the CO<sub>2</sub> of the atmosphere.)
- *Climate regulation*: By sequestering carbon, ecosystems reduce global climate change. Ecosystems can also moderate wind and rainfall.
- *Places to live and work*: All of our cities and suburbs are modified ecosystems that provide us with shelter, transportation, and places to work.
- *Biodiversity-related services*: We depend on the plants, animals, and decomposers for many different services. Bats and birds eat mosquitoes that cause disease. Other insects pollinate plants and eat insects that destroy crops. Fungi provide antibiotics.
- *Natural beauty*: Parks and gardens are ecosystems that we manage for their beauty and to connect us with nature.

**Tradeoffs among ecosystem services.** “There’s no such thing as a free lunch.” We manage ecosystems to provide products and services, but every product and service comes with a price. For example, when we manage a system to maximize food production (for example, crop yield), we often sacrifice other products or services like clean water when crop fertilizer leaks into the streams near farm fields. When we manage a system to maximize one product rather than in a way that balances many ecosystem products and services, the organisms in that system often become a less diverse community (fewer insect species can survive there and, therefore, fewer bird species that feed on insects, etc.). In the next activity you will explore how we manage ecosystems to get products and services, as well as the tradeoffs among these products and services.