Activity 3.6: Telling the Ecosystems Story

We live in a world of ecosystems. Forests and meadows and deserts are ecosystems. Farms and ranches and gardens are ecosystems, too. There are ecosystems under the water in ponds, rivers, and oceans. The food we eat, the air we breathe, and the water we drink all come to us from ecosystems.

So, this unit is about understanding ecosystems:

- How are they are structured?
- How do they transform matter and energy?
- How they change over time?
- How do they make it possible for us humans to live on Earth?

You are in the middle of learning to tell a story that answers these questions. Let's review the parts of the story you learned in Lessons 1, 2, and 3, and look forward to the parts of the story that you will learn to tell in Lessons 4 and 5.

Lessons 1, 2, and 3: Carbon Cycles, Energy Flows

In the Lessons 1, 2, and 3 you learned to answer three of the Large Scale Four Questions about ecosystems. Here's a story that ties them all together, organized around the names of the questions: carbon pools, carbon cycling, and energy flow.

Carbon Pools

When we look at an ecosystem, we don't see carbon pools at first. We see plants, animals, and fungi. We see water and soil, and we know the air is there. We want to tell a story about ecosystems that focuses especially on carbon, so the first step in telling that story is *finding the carbon.*

We started by focusing on the carbon that's easiest to see in an ecosystem: Plants and animals, which are made of large and small organic molecules. We started by grouping the plants and animals according to the different roles that they play in ecosystems: *producers, herbivores,* and *carnivores.*

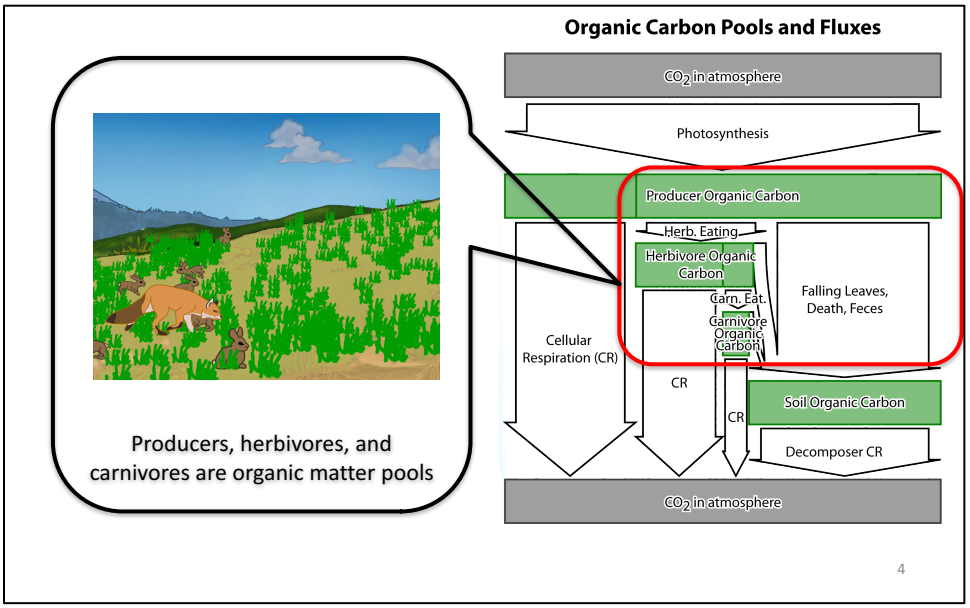

Figure 1: Carbon pools in ecosystems

You used the Meadow Simulation to investigate these carbon pools, and you found some interesting patterns:

- **The organic matter pyramid:** There's a consistent pattern in the size of these pools. The producer pool is much larger than the herbivore pool, and the herbivore pool is much larger than the carnivore pool. We can see that pattern in real-world ecosystems such as farms and forests. In most ecosystems:
    - It's easy to see the plants.
    - It's not too hard to find herbivores such as squirrels, deer, and most insects.
    - It's pretty hard to find the carnivores such as snakes, hawks, and foxes. They are rare because their carbon pool is the smallest.
- **Different amounts of organic matter in different ecosystems:** Most of the ecosystems we see have an organic matter pyramid, but there are huge differences in the total amount of organic matter. For example, rain forests have way more organic matter than deserts.
- **Stability and change:** In the Meadow Simulation, the size of the pools sometimes changes very fast at first, but if you don't change the system, the pools eventually settle into a stable pattern—the organic matter pyramid.

Carbon Cycles

Investigating the Meadow Simulation showed some patterns in carbon pools, but it didn't explain *why* those patterns happen. In Lesson 3 you learned about a scientific model of carbon cycling that explained why. That model included:

- **Invisible carbon pools:** Plants and animals are the visible carbon pools in ecosystems. But to explain how carbon moves through ecosystems, you also have to consider the *invisible* carbon pools:
    - Carbon in the atmosphere, in carbon dioxide gas.
    - Soil organic carbon: The dead leaves, plants, and animals—and the decomposers that use them for food—that are on the ground or hidden in the soil.
- **Two big carbon pools:** Ecosystems have two big carbon pools:
    - CO_2 in the atmosphere and
    - Organic carbon molecules in producers, consumers, decomposers, and soil organic carbon
- **Carbon cycling:** When you played and discussed the Carbon Dice Game, you learned to use carbon-transforming processes in producers, consumers, and decomposers to explain how carbon cycles in ecosystems
    - *Photosynthesis* in producers is the only process that creates organic carbon from CO_2 in the atmosphere. All the organic carbon in ecosystems started as glucose that producers made through photosynthesis.
    - *Biosynthesis and digestion* are the processes (along with *eating, defecation, and death*) that move organic carbon among the different small organic carbon pools.
    - *Cellular respiration* is the process that producers, consumers, and decomposers all use to get energy from food. This process changes organic carbon back in to CO_2.

Energy Flows

Carbon cycles in ecosystems. Does energy cycle, too?

NO! Energy flows through ecosystems.

- All the ecosystems that we study get their energy from sunlight that is transformed into chemical energy by photosynthesis.
- The chemical energy is passed from producers to consumers and decomposers with organic matter.
- Producers, consumers, and decomposers all use the chemical energy for their life functions, the release it as heat back into the environment.

Summing it up: You have seen Figure 2 below. It shows how carbon cycles and energy flows in every ecosystem.

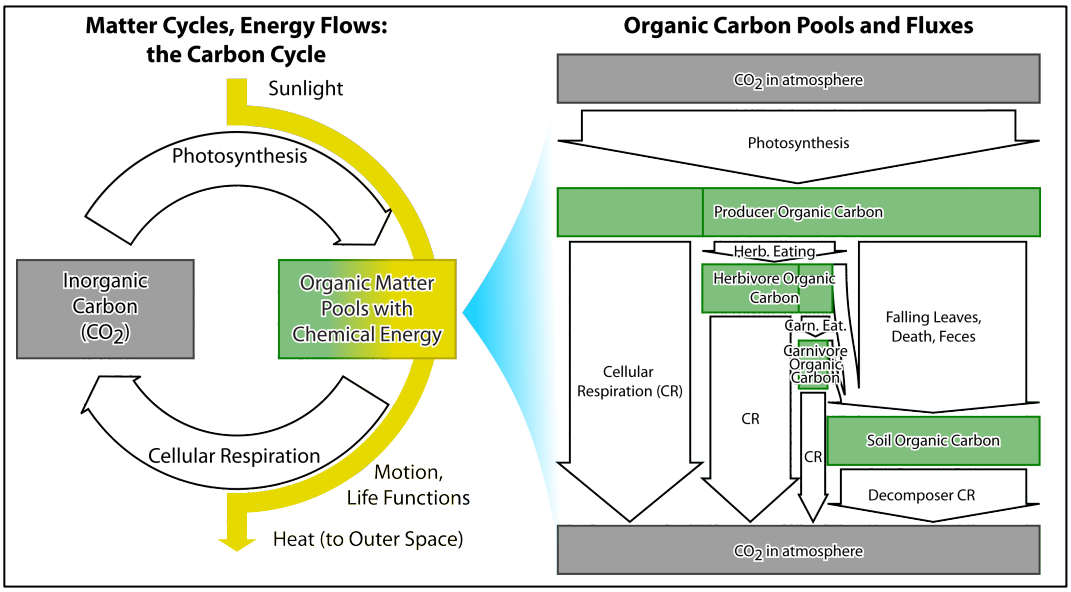

Figure 2: How carbon cycles and energy flows in ecosystems

Finishing the Story: Lessons 4 and 5

What's left to learn about ecosystems? A lot!

There's no way that anyone could ever learn everything that scientists have figured out about ecosystems, so we can't ever really finish our scientific story of ecosystems. But here's a brief overview of what you will study in Lessons 4 and 5.

Lesson 4: Stability and Change in Ecosystems

In Lessons 1, 2, and 3 you learned to answer the first three of the Large Scale Four Questions for ecosystems: The Carbon Pools Question, the Carbon Cycling Question, and the Energy Flow Question. Lesson 4 focuses on the last question: The Stability and Change Question.

Like most natural ecosystems, the Meadow Simulation that you studied in Lesson 2 *stabilizes* over time. In Lesson 4 you will use the idea of **carbon fluxes** (how fast carbon moves from one pool to another) to explain how carbon pools can stay stable, and how they can change over time. You will also learn more about **limits to growth**—how photosynthesis limits how large carbon pools in an ecosystem can grow.

Disturbances such as floods, fires, or droughts can change ecosystems. You will study how disturbances affect carbon pools, carbon fluxes, and carrying capacity, and how you can use these ideas to explain patterns of change in ecosystems.

Lesson 5: Human Management and Ecosystem Services

In Lesson 5 you will learn more about **ecosystem services**—how ecosystems provide humans with the food, water, and air we need to survive. You will also study how humans **manage ecosystems** such as farms and ranches so that they will supply more of the products and services we need, and of how managing ecosystems to provide more of one product can cause problems for the ecosystems and for us.