OBJECTIVES| Use a food web to identify producers, consumers, and decomposers. Understand the pathway of energy transfer through trophic levels and the reduction of available energy at successive trophic levels. Increase awareness of a portion of the life history of a variety of organisms in the longleaf pine ecosystem.

MATERIALS & RESOURCES| Colored pencils and rulers, photocopy of two-page student worksheet, and the PowerPoint with images of the species involved in the food web activity.

IMPLEMENTATION| One to two class periods, with discussion, varying on depth of discussion and additional background information needed for your class.

We recommend having the provided PowerPoint slideshow with images of the organisms included in this lesson running on a screen in the classroom when students enter. This is included to help engage students in learning more about the species associated with the longleaf pine ecosystem. Have students seen these species before? Do they know that they are local to our Red Hills region? Do they know what they eat? They will learn about these species and how they are interconnected in a food web.

The student worksheet includes background information and a procedure for the activity that teachers can review with the class to get them started. The procedure allows students to develop their own color code for the secondary and tertiary consumers in their food webs to encourage them to make decisions about their model and to appropriately label their choice. Teachers can certainly decide to standardize the colors for secondary and tertiary consumers, if that is a better choice for your class.

The PowerPoint slide show includes a slide with all of the food chains from the first page of the student worksheet. This slide can be displayed on the screen during the student activity so students don't need to flip the worksheet back and forth as much to complete their food web on the second page.

A completed version of the student worksheet page two (food web and analysis questions) is included as the last page of this teacher guide.

EXTENSION & DISCUSSION IDEAS| These ideas are offered to stimulate discussion at the end of the lesson or provide content for more complex projects or assignments.

- Have students select one of the species in the food web exercise as the topic of a more detailed review of their habitat needs and diet. This could be assigned between the two class periods that students are working on the class activity to provide more depth and discussion as they work on their web, or at the end so students can explore the species that was most interesting to them.
- Discuss the dung beetle in more depth at the end of the lesson. There are many species of dung beetles in the world. However, the Punctuate Gopher Tortoise Onthophagus Beetle (*Onthophagus polyphemi polyphemi*) is only known to form associations with gopher tortoise burrows. The beetle provides a valuable service by removing dung from the burrows and reducing other parasites. The student's food webs likely show the flow of energy from the gopher tortoise to the beetle (as indicated in the simple food chain provided), but is this really what is happening? Is the beetle acquiring energy from the tortoise in the same way the Cooper's hawk acquires energy from the bobwhite quail? Dung beetles are actually detritivores, meaning they get energy from waste matter. One way to think of this is that the tortoise has collected the energy from plants, consumed most of it, but is passing through some remaining energy in its feces. This is also a good topic to point out to students that food webs are a model of the ecosystem, and you can't capture all of the variation in the ecosystem in a model. However, it can still be a valuable tool.

- Some students may take note of the fact that some of the species in the food web have feeding positions at more than one trophic level depending on the specific food chain you follow. Advanced classes may explore the idea of fractional trophic levels. This concept utilizes a formula with inputs for the different trophic levels that an organism feeds at to produce a fractional trophic level that helps to capture the varied diets of a given species. For example, humans have been calculated to have a fractional trophic level of 2.21. Resources are available on the internet to further explore this topic.
- Have students keep a log of their daily food consumption and create their own food web or pyramid.

FOLLOW-UP ASSESSMENT ITEMS

- Which of the following is another term for a *secondary consumer*?
  A. autotroph B. carnivore C. commensal D. herbivore

- Examine the diagram to the right. Which of the following is a correct placement of a species from the longleaf pine ecosystem?
  A. longleaf pine tree at the fourth trophic level
  B. lubber grasshopper at the third level
  C. gopher tortoise at the second trophic level
  D. humans at the first trophic level

Correct answers *A secondary consumer can be called a carnivore.*
A gopher tortoise is an herbivore and placed on the second trophic level.

STANDARDS ALIGNMENT

Georgia Standards of Excellence

- Addresses SB5b. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.
  b. Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.
  - Arranging components of a food web according to energy flow.
  - Comparing the quantity of energy in the steps of an energy pyramid.
- Supports and/or reviews SB5a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.
  (Clarification statement: Factors include population size, carrying capacity, response to limiting factors, and keystone species.)
- Addresses portions of SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.

Florida Next Generation Sunshine State Science Standards (NGSSS)

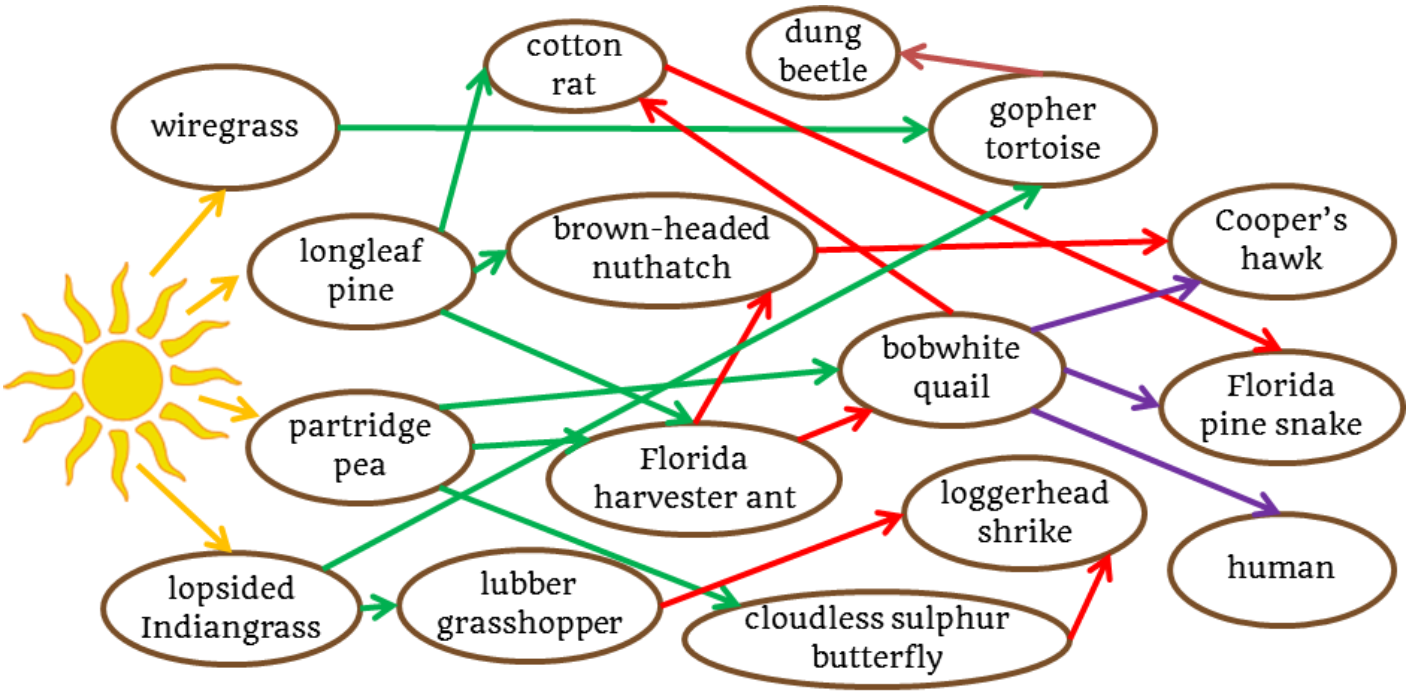
- Addresses SC.912.L.17.9 Use a food web to identify and distinguish producers, consumers, and decomposers. Explain the pathway of energy transfer through trophic levels and the reduction of available energy at successive trophic levels.
- Review opportunity for SC.912.E.7.1 Analyze the movement of matter and energy through the different biogeochemical cycles, including water and carbon.

Next Generation Science Standards

- Disciplinary Core Idea: LS2.B Cycles of Matter and Energy Transfer in Ecosystems
  - Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher

levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

- Cross Cutting Concept: Energy and Matter- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4) Energy drives the cycling of matter within and between systems. (HS-LS2-3)
- Science and Engineering Practices: Developing and Using Models- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.
  - Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)



Analysis

1. How many of the food chains include any plant material? All 11 chains provided include plant material.
2. Name the producers in your food web. Wiregrass, longleaf pine, partridge pea, and lopsided Indiangrass are the producers in this food web.
3. Organisms that eat only plant material are herbivores. List the herbivores based on your food web.
   Gopher tortoise, Florida harvester ant, lubber grasshopper, and cloudless sulphur butterfly are all herbivores. Students could get tripped up by the dung beetle, as it eats the feces of a herbivore. It is actually considered a detritivore, or one that consumes waste material from another organism. See the extension section of the teacher guide for ideas about discussing the dung beetle.
4. Organisms that eat both plants and animals are omnivores. List the omnivores based on your food web.
   Cotton rat, brown-headed nuthatch, and bobwhite quail are the omnivores based on the food web. However, students can certainly include humans as omnivores based on their own knowledge.
5. What is represented by the arrows that you drew in the food web?
   Energy, or energy and matter
6. What is the ultimate source of the energy in this longleaf pine ecosystem? The sun
   Draw yellow arrows from this ultimate source of energy to each producer.
7. Generally, only about 10% of the energy in one trophic level is transferred to the next trophic level. Most energy is lost as heat while an organism goes about meeting its needs. If you start with 100% of the available energy in a longleaf pine seed, what percent of that original energy in the seed is available to the Cooper's hawk?
   Only 0.1% of the original energy in the pine seed is available to the Cooper's hawk in the fourth trophic level. 100% in first, 10% in second, 1% in third, and 0.1% in fourth trophic level
8. We know that all organisms have a lifespan and die. With this in mind, what group of organisms is NOT represented in this food web? Decomposers. This group is mentioned in the objective as a cue to help students. Again, the dung beetle could be a source of questions, as detritivores can be considered decomposers. This would be a very sharp observation by students and great opportunity to further discuss.
9. What might happen to the Florida pine snake population if there were less bobwhite quail? Basic answer: The population would decrease due to less food/energy sources. More complex answer: The population of pine snakes could decrease, or the snake could shift feeding habits to include more brown-headed nuthatch eggs or cotton rats. Extra points if a student notes that shifting to feed at a lower trophic level means more energy is available.