Energy Flows

Real World Ecosystems
Activity
Grade Level: 5-8

Main Objectives

Learners will re-enact energy flow through a simplified ecosystem by assuming roles, moving around, and passing cards from person to person. This will reinforce several important ideas in ecology in a way that will appeal to learners who respond well to physical interactivity.

Learning Outcomes

By the end of this activity, learners will:

- Define the term "trophic level"
- Describe the flow of energy through a simple ecosystem
- Identify producers and various consumer levels in any food web
- Explain why not all the energy embodied in a group of organisms at one trophic level is not passed to the next trophic level

Length of Activity

1 hour

Materials List

Internet-enabled device and printer
Energy Flows Backgrounder
Energy Flows Learner Worksheet
Energy Flows Learner Worksheet Answer Key
200 pieces of paper (referred to as 'cards')
Pencils, one per learner
Pin-on or self-adhesive name tags
Felt pen
Plastic pail, marked "waste"

Procedure

Step 1: Backgrounder

a. In groups or individually, review the Energy Flows Backgrounder.
b. As learners are finishing up their reading, be sure to remind them to discuss amongst themselves the "Think About" questions at the end of the backgrounder.

Step 2: Worksheet

a. Provide the learners with the worksheet and have them answer the questions as a take-home assignment, or in class.
b. Answers to the worksheet questions can be found in the answer key.

Step 3: Activity

a. Prepare name tags for the learners. You will need to identify 4 groups: Plants, Deer, Wolves, and Decomposers. Rough numbers of each learner in each group appears as an example below:
    - Plants: 25 learners
    - Deer: 8 learners
    - Wolves: 3 learners
    - Decomposers: remainder of the class
b. Clear a space in the middle of the room.
c. Introduce the activity. Tell learners they will be modelling energy transfer in a natural ecosystem.
d. Divide your class into groups according to your proportions. Learners will assume these

roles in a very simple food chain. Be sure they have their name tags. Explain that if they are alive, they stand up, and if during the activity they get eaten or die, they sit down on the floor or at a desk.

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Step 4: Trophic Level One: Primary Production

a. Have the plants stand in a line along one side of the space. Give them all 200 cards. Inform your learners that these cards represent all the chemical energy stored in the tissues of the plants.
b. Question: How do plants get this energy in the first place? *They capture sunlight with chlorophyll, and use the energy to manufacture sugar from water and carbon dioxide. The process is called photosynthesis.*

Step 5: Trophic Level Two: Consumption by Herbivores

a. Now, tell the deer to go feed on the plants. As they do, they are to collect 2 cards each (for a total of approximately 50 cards). Explain that this represents the amount of available food eaten by the deer. The deer are to mark their cards with a "D" to signify the energy they have obtained from the plants. The remaining cards held by the plants are to go into the waste bucket.
b. Question: In nature, what happens to plant material that does NOT get eaten by herbivores? *Most of it decomposes. Bacteria and fungi break the plant material down, using it as food. They combine oxygen with the sugars from the plant material which yields carbon dioxide, water, and energy. The process is called respiration.*
c. So, the remaining plant energy cards must be passed to the bacteria, and the plants can all sit down, because they've either been eaten, or have died.

Step 6: Trophic Level Three: Predation by Carnivores

a. Next, tell the wolves that they can now go and kill and eat some deer. The wolves need to get energy from the deer, so they must collect 2 chips each. Since this is not a real ecosystem, the deer are not to try to escape or fight.
b. Question: In real ecosystems, what happens to all the chemical energy stored in deer tissues if it is not eaten by carnivores? *Only a small proportion of the total biomass in herbivores goes to feeding predators. Most of it is decomposed by bacteria and other decomposers, and scavengers.*
c. When the wolves have finished feeding, the deer will pass their remaining chips to the bacteria.

Step 7: Trophic Level Four: Decomposition

a. Now it's the bacteria's turn. They get to collect all the cards from the wolves.
b. Question: Why do all the energy units collected by the wolves go to the bacteria? *Wolves are considered "top predators", meaning there are no other predators that regularly kill and eat wolves. Most wolves die from starvation, disease, and from attacks by other wolves. Their remains are fed upon by scavengers and decomposers.*
c. The decomposers now have all the energy cards.

Step 8: Analysis and Worksheet

a. Have the learners sort all the cards into piles, and count them:
    - Blank cards represent energy captured by plants that was not consumed by herbivores;
    - Cards marked "D" representing energy captured by deer, but not passed on to the next trophic level;
    - Cards marked with "D" and "W", representing energy passed to wolves from deer
b. Record the numbers in the blank spaces in the worksheet.

Step 9: Analysis Questions

Ask these questions after tallying up the cards

a. How large a difference was there between the original amount of energy captured by the plants, and the amount of energy that was captured by the wolves?
b. This activity shows that a lot of plant biomass is needed to support a single wolf. Wolves are highly territorial. How does this relationship affect the size of a wolf pack's territory? What factors would you predict would be important in the size of territories wolves must try to defend? *In fact, wolf pack territories are determined in part based on how many prey animals can be found inside the territory. This is in turn dependent on the density of plant food. A poor-quality range will support fewer deer or other prey species, and therefore even fewer wolves. On the other hand, wolf packs can survive on small territories if those areas have rich vegetation, and can support large populations of prey species. The farther north one goes, the sparser the vegetation generally, and therefore, the larger the territories occupied by wolf packs.*

Tips and Extensions

- As an alternative to the initial activity introducing learners to the idea of ecosystem stability, you could introduce the idea of energy loss through an ecosystem by demonstrating the "rule of 10." In this activity, demonstrate the effects of having only 10% of the initial energy available from a trophic level being transferred to the next trophic level. Start by distributing a clean, clear drinking glass to each of 5 learners picked randomly. Using some generic carbonated soda, fill the glass of one of the learners. Have that learner pour a 10^{th} of the soda from his or her glass into the glass of another learners. Have that learner pour a 10^{th} of the soda received into the glass of a learner who has not yet received any soda. Repeat the procedure of pouring a 10^{th} of the contents of the glass until each of the 5 learners has received some soda. Ask all of the learners in the class to respond to the question: "If you were thirsty, would you have enough soda to quench your thirst?" Allow time for learner responses. Learners may observe that you still have soda left that could be distributed (or you may point this out), but inform them that for real ecosystems most of the energy (soda in this case) that is available is lost to our use. At this point pour the remainder down the drain to make the point. If you want to be less wasteful, you may save the soda for later use, but if you really want to make the point don't allow the learners to have any!

Comprehension

When learners have finished reading the Energy Flows Backgrounder and have answered the questions from the worksheet, you may want to check their understanding of the concepts by discussing with the class the following questions:

- What is the basic difference between a producer and a consumer?
- In what ways are carnivores and detritivores similar to each other? In what way are they different?
- Why is a food web a better way to represent an ecosystem than a food chain?
- Why do pyramids of biomass get smaller towards the top?