Circle of Life

Summary

Everything that organisms do in ecosystems--running, breathing, burrowing, growing--requires energy. Of all the factors that influence how an ecosystem functions, none is more important than the flow of energy. Where do organisms get their energy? How does this energy move within an ecosystem? Why are food chains rarely longer than three or four links? What is the difference between food webs and food chains?

Time Frame

4 class periods of 45 minutes each

Group Size

Large Groups

Life Skills

Thinking & Reasoning, Communication, Social & Civic Responsibility, Employability

Materials

- scissors
- glue
- magazines
- overhead of food webs and food chains
- owl food web
- owl pellets
- tweezers
- white paper
- Owl Food Web video (can be obtained from Mountain Home Biological)

Note: A great place to purchase owl pellets is Mountain Home Biological, P.O. Box 1142 White Salmon, Washington, 98672. 1-800-958-9629, http://www.gorge.net/business/mtnhome. Commercial owl pellets have been autoclaved and are safe. If you collect your own owl pellets make sure they are autoclaved before using them in class.

Background for Teachers

Energy flows into the biological world from the sun. Life exists on earth because photosynthesis makes it possible to capture some of the light energy from the sun and transform it into the chemical energy of organic molecules. These organic compounds compose what we call food. The amount of organic materials that the photosynthetic organisms of an ecosystem produce is called primary productivity.

Primary productivity determines the energy budget of an ecosystem. All of the organisms in an ecosystem are chemical machines driven by the energy captured in photosynthesis. The organisms that first capture energy, the producers, include plants, some kinds of bacteria, and algae. All other organisms in an ecosystem are consumers.

Ecologists assign every organism in an ecosystem to a trophic level which is determined by the organisms's source of energy. Energy moves from one trophic level to another. The lowest trophic level of any ecosystem is occupied by the producer: plants in most terrestrial ecosystems and algae and bacteria in aquatic ones. The second trophic level is herbivores. They are the primary consumers in ecosystems. The third level is secondary consumers. Flesh eating animals are called carnivores.

Animals that eat both are omnivores.
In every ecosystem there is a special class of consumers called detritivores, which includes fungal and bacterial decomposers, vultures and worms. Detritivores obtain their energy from the organic wastes and dead bodies that are produced at all trophic levels. Bacteria and fungi are known as decomposers because they cause decay.
A path of energy through the trophic levels of an ecosystem is called a food chain. In most ecosystems energy does not follow simple linear paths because animals feed at several trophic levels. This creates a complicated, interconnected path of energy called a food web.
Every transfer of energy within an ecosystem dissipates energy as heat. From a biological point of view, the amount of useful energy available to do work decreases as energy passes through an ecosystem. The loss of useful energy to heat limits how many trophic levels an ecosystem can support. Energy transfers between trophic levels are very inefficient. On average only 10 percent of the energy in any trophic level will be incorporated into the next level.

Intended Learning Outcomes

- Make observations.
- Use categories to classify.
- Use reference sources to obtain information.
- Describe relationships.
- Collect and record data.
- Analyze data and draw warranted information.
- Understand science concepts.
- Construct diagrams to describe data.

Instructional Procedures

INTRODUCTION
1. Ask a volunteer or two from the class to describe his or her breakfast or dinner. Write it on the board. You will use the data later.
2. Ask students why they eat. Channel their comments into a discussion about energy, the need for energy in biological systems, and that each time one organism eats another organism, a transfer of energy occurs. Make sure that the students understand the sun's role in all ecosystems. We can trace the paths that energy follows as it travels through an ecosystem by studying food chains, food webs, and trophic levels. Explain food chain, food web, and trophic levels to the students.
3. Use the data you collected in the introduction (about students' breakfast or dinner menu) to create examples of tropic levels on the computer or overhead. Discuss energy levels and consumers and producers. There is software that will show or let you explore food webs, animals in a web, etc. One that you might want to use here is: EYEWITNESS, Encyclopedia of Nature 2.0. DK Multimedia, 1-800-DKMM-575
4. Show the students a few food chains and then food webs. Explain the difference between chains and webs. Make sure the students understand that the energy comes from the sun but we don't put the sun in a food chain or web. Using the data the students gave you in the introduction, draw a food web. Have the students draw their own food web from their breakfast or dinner.
5. Have the students brainstorm organisms that can be found in an open field: ex - robin, hawk, snake, frog, grasshopper, mouse, and rabbit. Have students draw arrows to show who eats whom in this field ecosystem. Students often have trouble with the direction of the arrow. The arrow should point in the direction that the energy flows. Students should see the complexity of even a simple food web in which each predator can take more than one type of prey, and each type of prey can be exploited by several different species of predators.
6. Review producer, carnivore, omnivore and detritivore. On an overhead show several different food

chains. Have students identify the producers, carnivores, omnivores and detritivores. Ask what would the effect be if _____ were eliminated? Tell the students they are going to examine evidence of energy flow in a food chain. Owls, as predators, get their energy by eating rats, mice, birds, etc... Because only about 10 of the available energy is transferred from one trophic level to the next, owls must consume a large number of prey in order to get the energy they need to survive.

OWL PELLET DISSECTION

Have the students dissect an owl pellet and put together the skeletons of the rodents they find in the pellet. (The owl pellets come with an identification sheet that will enable students to label the various rodent bones they find in the pellet.)

1. Place a pellet on a white piece of paper.
2. Using dissecting tools, separate bones in the pellet from fur, feathers and other debris.
3. Clean the skulls as thoroughly as possible.
4. Do one of the following options:
    Option 1 - Identify the animal skulls using a magnifying glass and the diagrams of skeletons as a guide. Examine the teeth, especially the molars, and compare them to the illustrations to help with this identification. Count the number of individuals of each species of animal in the pellet.
    Option 2 - Combine the bones you found with those found by other students. Using diagrams, arrange the bones according to their position in the natural skeleton. Glue the bones to the paper and label all the different animals using the diagrams of skeletons as a guide.
    Option 3 - Combine the bones you found with those by other students. Using diagrams of skeletons, glue the bones together to form a complete, free standing skeleton. Compare the bones in your skeleton to those found in the skeletons of voles, birds, and humans.
5. To help students understand more about owls and their ecosystems, show 'The Barn Owl'. Running time 15 minutes.
6. Instruct the students to answer the following questions:
    Did you find different skulls in the pellet?
    What kinds of animals did the owl eat?
    How might the pellet look different in winter and summer?
    Why are the bones identify able and not crushed?
    What do we know about the digestive system of an owl based upon the pellets?
    How do owl pellets indicate that energy flows through an ecosystem?
    What are the limitations of looking at just one owl pellet?
    What is another name for 'pellet'?
    Besides owls, name two other birds which can form pellets.
    Give 2 reasons why there are more undamaged bones in an owl pellet than the pellets of other types of raptors.
    Of what significance is the study of owl pellets to the zoologist or ecologist?
    If a common barn-owl produces two pellets per day, estimate how much food the owl eats in a year?
    Make a diagram of a food web in which the owl is located at the highest trophic level and prey species of the owl are located intermediate in the web. Make certain to include all food relationships and connect the levels with arrows.

DISCUSSION

As a class, discuss the data the students collected by dissecting the owl pellet to create an owl food web. Emphasis should be placed on how the collective information (data from the entire class rather than just one student) is more useful that information collected by just one student. Students should realize that science is a collective endeavor, with multiple men and women working to gather and understand data. Data collected by many people is more likely to be accurate than data collected by a single investigator. Generalizations made from multiple data sources are more valid. Scientists work

together to make sense of the data they collect. What is accepted as scientific truth is determined by consensus among competent researchers in a scientific community. Help the students understand that by looking at the owl pellet data collected by the entire class, they have a much more accurate picture of owls' place in an ecosystem than they would if they were to consider just one pellet. Discuss the flow of energy through ecosystems inhabited by owls and their prey.

Extensions

1. Field activity: In a park, yard, or lot measure out a 1-square meter area. You may use sticks and string to mark off the area. Using glass jars or sealable plastic bags carefully collect plant and animal species. Use a field guide to identify the different species and then return the invertebrates to their original location. Draw a possible food chain or food web that includes the species you have collected.
2. Tell the following case study. Show a map and pictures of osprey. In the estuaries near Long Island Sound in the 1950's and 1960's, carnivorous birds of prey such as ospreys and eagles that fed on fish in the estuaries had high concentrations of the pesticide DDT in their bodies. But when the water in the estuary was tested, it had low concentrations of DDT. What accounted for such high levels of DDT in the birds? Poisons such as DDT that dissolve in fat can become more concentrated as they move up an aquatic food chain in a process called bioaccumulation. When the pesticide enters the water, small aquatic organisms such as algae and bacteria take in the poison. When fish eat the algae and bacteria, the poison is stored in the fat of the fish rather than diffusing back into the water. Each time a bird feeds on a fish, the bird accumulates more DDT in its fatty tissues. At Long Island Sound, DDT concentrations in fatty tissue were magnified almost 10 million times from the bottom to the top of the food chain in some estuaries. This bioaccumulation of toxins damages the carnivore at the top of the food chain. It may kill the carnivore, weaken its immune system, or impair its ability to reproduce successfully. High concentrations of DDT weaken the shells of bird eggs which causes the eggs to break and the chick embryos to die. This causes a tremendous drop in the population of the bird species.
The United States government recognized bioaccumulation as a major side effect of the use of DDT and in 1972 banned its sale except for emergency use. The aquatic food chains immediately started to recover. Unfortunately, the food chains are still not totally free of DDT. The pesticide breaks down very slowly in the environment. Also, DDT is still legal in some countries where it is used in large quantities. As a result, migratory birds may be exposed to DDT while wintering in Latin America or other locations outside the United States.
Question-- DDT does not dissolve readily in water. If it did, how would the bioaccumulation of the pesticide in organisms be affected? Suggest some specific measures that the United States could take to stop the DDT pollution that is still occurring.

Assessment Plan

Explain to the students that they will be making their own food webs. They can start looking for at least eight pictures out of magazines that will fit into their food web. If they are not sure what certain animals eat, they need to do some research so that their food webs are realistic. Instruct students to put together a realistic food web using at least 8 pictures from magazines. The food web must contain arrows that indicate the direction of energy flow through the ecosystem.
1. Assess students' food webs for accuracy. Use the food web assessment rubric.
2. Take students outside and give them five minutes to sketch an eight component food web that indicates the flow of energy in the ecosystem surrounding the school.

Bibliography

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Authors

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