Life in a Food Chain

Overview: Students understand the flow of energy in an ecosystem.

Keywords: Food web, food chain, trophic levels, energy flow,

Age / Grade Range: 5th-6th Grade students

Background: Energy that flows through ecosystems begins with the plants. Since plants can photosynthesize they support the animals living in the ecosystem. Functioning as the base, plants transfer energy from the sun throughout an ecosystem. Only 10% transfers from each predator/prey interaction and that distributes the sun's energy.

Sagebrush deserts are host of pygmy rabbits, an endemic species found in the sagebrush near Boise[1]. These rabbits solely subsist on sagebrush in the winter and sagebrush is the primary food source during summer months. These rabbits are assisted by the sagebrush adaptations that allow sagebrush to photosynthesize in winter; even under snow[2].

Ecosystems do not go dormant during winter and the sagebrush/pygmy rabbit interaction highlights this. Since the rabbit has access to food, the short tail weasel also has access to food as they prey upon pygmy rabbits.

This activity will show that even in winter, ecosystems can thrive.

Next Generation Science Standards

5-PS3-1: Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Common Core: **5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

[1] http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A0GG

[2] http://www.ncbi.nlm.nih.gov/pubmed/17082988

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SL.8.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

MP.2: Reason abstractly and quantitatively**.**

Goals:

Students will model an ecosystem and energy flow through a tag game.

Guiding Question
How does energy flow in an ecosystem?

Objectives:

Students will understand that all energy comes from the sun
Students will be able to understand that without plants and photosynthesis ecosystems would collapse
Students will be able to trace the flow of energy through an ecosystem

Materials:

Multicolored bandanas indicating trophic levels
4x colored flags to mark a boundary
6-9 Sun cards or an additional flag color
Paper strips cut 11.5in x 1in per student
Stapler/tape
Several colored markers of the same type for each student in each trophic level.
White board/data sheet

Set up:

Find an open area for students to run around on that can have markers setup in it. The area should be a square approximately 20 feet by 25 feet. Take into account the terrain, if there is snow or sand reduce the size of the field since the students will be restricted in their movement.

Classroom Time:

15-30 minutes

Overview:

1. Arrange field to play on
2. Have students put a paper wrist band
    a. Chaperones can help tape the paper on students wrists
3. Chose a ratio of plants, short tailed weasels, and red tail hawks to have based on the group size
4. Pass out the game cards, colored bandanas and markers
5.Reveiw game rules
    a. What to do when tagged.
        i. Plants mark themselves when tagging the sun and mark rabbits when tagged
        ii. Rabbits mark weasels when tagged
        iii. Weasels mark hawks when tagged

6. Play game for 3-5 minutes
7. At the end of the game each student tallies up their marks
8. Debrief
    a. Discuss the number of tallies each trophic level had
    b. Discuss how much energy from the sun travels up the food chain

Introduction (Engage):

Note: Text in "quotations" signifies suggested dialogue to engage students in and is not intended to be a script. Use your best judgment when delivering these lessons.

Activity (Explore):

"This is a tag simulation game, you will be representing different parts of a small ecosystem. First, notice the different colored flags at the edge, those mark the boundary of the ecosystem, you must remain in the ecosystem. I'm going to pass out a paper wrist band, wrap it around your wrist and I'll tape/staple it on. (Hand out paper strips, you can have the chaperone help tape/staple)

"The flags inside the ecosystem represent daylight from the sun. If you are plant, you will be 'tagging' these flags. When you do you will use the marker I give you to give yourself a tally mark. This signifies how many times you have 'eaten' the sun. Once you have tagged a flag as a plant, crouch down by your flag and count to two, then you can get back into the game."

"If you are a pygmy rabbit, you will be hunting the plants. Every time you tag a plant, the plant will give *you* a mark from their marker, this indicates how many times you've eaten plants. After you have eaten crouch down and count to five before resuming your hunt. You are 'digesting'. Also in this ecosystem there happens to be short tailed weasels."

"Weasels will be hunting pygmy rabbits only. Weasels, if you tag a rabbit, the rabbit will use their marker and give you a tally mark. When you have 'eaten' a rabbit crouch down and count to 12 before hunting other rabbits. Lastly we have an apex predator in our ecosystem, a red tailed hawk! This predator can eat both rabbits AND weasels."

"If you are tagged by the red tailed hawk, give them a tally mark. Once you have eaten red tail, you will need to return to your nest and count to 20 before resuming your hunt. Only successful predators need to crouch down, this includes plants 'feeding' from the sun. If you are crouched down or are giving someone else a tally you immune to predation. " (The red tail hawk role can be taken by yourself, chaperone or really excited student)

<u>*Optional:*</u>
"*We will run this simulation for ___ minutes, during this time, plants you will need ____ many tally marks by the of the simulation, rabbits _____, weasels ____*

and red tailed hawks _____ ." (These blanks will be determined by you and the time you have available to play. The rest of the blanks are determined by the number of minutes you play. These numbers will depend on the conditions of the play field, the activity level of students and the amount of students. For every minute of play you want the students to have the following estimated tally marks; Plants, eight per minute, Pygmy rabbits five per minute, short tailed weasels three per minute, red tailed hawk two per minute. The games should between 2-5 minutes in length. To simulate a health ecosystem, there should be several plants, fewer rabbits, even fewer weasels and one red tailed hawk. The number of students for each trophic level depends on the field group size. This activity requires at least seven students in a field group, this activity can be done with other field groups as well)

(You can randomly decide to assign students to each trophic level. When you do hand them an identifying bandana so students can identify which color is preying on them. Tie the bandana on the arm of the students not the neck, since it would pose as a choking hazard while playing the game. If students ask if there is guarding of someone who is crouched down, the answer is yes! Guarding must be done at arm distance to give the prey item a chance to escape. It happens in the real world so it can happen in the simulation. However it is good to note to the students that anyone who does wait for a crouched student to pop back up they will lose the chance to tag other people)

(Allow the students to spread out and let them play for the time you allotted. At the of the game, have students total their tally marks on their wrist. Record the numbers on a white board so everyone can see the total number gathered and how many survived, there should be a trend of plants having the highest tallies followed by rabbits all the way up the food chain. This illustrates where most energy is in an ecosystem)

<u>Optional:</u>
You can use a hula hoop to designate a safe zone for the pygmy rabbits and for weasels to add a layer of complexity to the simulation. This will provide students with the option of being safe from predation while still being faced with the challenge of finding food.

Explanation

"So where does the hawk get its energy to survive? The weasel? The pygmy rabbits? The plants? (Field answers)

If you did the optional minimum number:
"How many got the minimum number of resources to survive? (Field answers)

"All the energy that the hawk receives can be traced to the sun. How much

energy do you think is transferred between predator and prey? (Field answers, 10%) Only 10% is available for the animal to 'freely' use, the rest is needed for maintaining health, keeping the body warm, and the organ systems running. That 10% can go into fat storage or other activities like hunting. If the plants had 100 units of energy, how much of that sun energy is transferred into the pygmy rabbit? (10 units of energy) Into the weasel from the bunny? (1 unit) Into the red tailed hawk? (0.1 units) Although the amount seems small, this energy can be traced all the way back to the sun."

"Which begs the question, what would happen to this ecosystem if the plants were removed? Why are plants so important? What do they do with sunlight? (Field answers) Sagebrush is a plant that can photosynthesize year round which provides a energy source to those who can digest it. Pygmy rabbits are animals whose diet almost exclusively feeds on sagebrush. Short tailed weasels are active all year around. During winter they are adapted to have a white fur coat. (Place emphasis on the ability that sagebrush has to photosynthesize in winter allowing it be a viable energy source for sagebrush ecosystems.)

Elaboration/Content Tie-In:

Optional:
"These conditions were done with summer in mind, in winter there is less light, but the energy demand is the same. So for simplicity, let's say in winter the time period is half of summer. Divide your tally count in half, would you have made it in winter with the same energy requirements?

What happened if we saw that the rabbits had more tallies than the plants? What would you say has happened to the ecosystem?"

This activity can be related to Ecology concepts and Energy Values

Ecology concepts:
Food chains, Food webs, Ecosystem disturbances, Trophic levels, Energy transfer in an ecosystem.

Energy values:
This lesson could be adapted by replacing one 'sagebrush' with grasses. Provide a different marker but same bandana. Tally marks from the grasses contain half as much energy from the sagebrush plants. This can lead to how different plants have different energy yields

Evaluation:

Write a story about your experience as a part of the ecosystem and events that happened to you. Feel free to use emotions to paint us a picture of how you felt about the simulation.

Additional resources:

See Appendix G for materials