



Energy Flow in the Garden Ecosystem

Grade 4

Standard

GPS.S3P1a, b, c, d;
NGSS.PS3A, B

Time

1.5 - 2 hours over 1 or 2 days

Supplies

(per team of students)

- owl pellet
- skewer, long toothpick or tweezers
- paper bowl
- bone chart
- mammal field guide or Web access
- Owl Pellet Dissection Lab Report
- Owl Pellet Bone Chart Grid
- magnifiers
- Soil Food Web poster or prints
- Bone Charts:
<http://captainplanetfoundation.org/bone-charts-for-owl-prey-species-identification/>

(per class)

- organism cards
- seats with role signs

(optional)

- sifters and strainers (for soil study)
- ladybugs or lacewings to release

Garden Connection

Students use owl pellets to understand energy flow in ecosystems and apply that knowledge to exploration of the soil food web in the garden.

Overview

4th grade students will learn about the flow of energy and matter in a garden ecosystem by playing the roles of producers, consumers and decomposers in a simulation activity; observing components of the soil food web in the garden; forensically dissecting an owl pellet to re-create a food web and an ecological pyramid from which energy flow can be calculated; and restoring balance to a garden ecosystem by removing non-native species or introducing beneficial predators to control pests.

Engaging Students

Students will participate in a simulation activity, playing the parts of organisms in an ecosystem and assigning themselves roles of producer, consumer, or decomposer. Their classmates will decide if they agree or disagree with the role selected, and argue from evidence regarding changes in classification.

Exploration

Teams of students will investigate what an owl ate by dissecting a pellet and identifying the bones, skull, and /or fur or feathers of prey inside. Students will then research what that prey animal(s) consumes, and what its prey consumes from level to level until a food chain or web can be diagrammed and labeled, including garden inhabitants. Given the formula for energy loss from one level to the next, students will calculate how much energy was present at each level of the pyramid. Students will screen garden soil to find soil organisms; observe their features; hypothesize whether they are predators or prey; and identify their place within a soil food web.

Explanation

Students will articulate which direction energy flows and how energy is lost at every level of an ecological system; and describe roles of organisms.

Environmental Stewardship

Students will select and complete a project to restore balance to an ecosystem by removing a non-native species or re-introducing a native.

Evaluation

A Lab Report and scoring rubric are provided to help assess student proficiency at diagramming and labeling a garden food web, identifying roles of organisms in an ecosystem, and accurately calculating energy at each level of an ecological pyramid.

Standards

Georgia Performance Standards in Science

S4L1. Students will describe the roles of organisms and the flow of energy within an ecosystem.

- Identify the roles of producers, consumers, and decomposers in a community.
- Demonstrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers.

Next Generation Science Standards

NGSS.LS2 Ecosystems: Interactions, Energy and Dynamics

5.LS2.A: Interdependent Relationships in Ecosystems

The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) therefore operating as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)

5. LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

Background Information

- Energy Pyramids explained by Learner.org: <http://www.learner.org/courses/essential/life/session7/closer5.html>
- AAAS recommendations for teaching Matter and Energy in Living Systems: <http://assessment.aaas.org/topics/ME#/>
- All things related to owls and owl pellets: <http://www.wbu.com/chipperwoods/photos/owls.htm>
- Soil Food Web, including posters to reprint: http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053865
[/detailfull/soils/health/biology/?cid=nrcs142p2_053868](http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053868)
- Student Misconceptions about Energy Flow: <http://www.learner.org/courses/essential/life/session7/ideas.html>
- Roles in energy pyramid: sun= source of all energy; plant = producer; first level consumer / herbivore = prey; second level consumer / carnivore or omnivore = both predator and prey; third level consumer / carnivore = predator; decomposer or scavenger.

Teacher Preparation

- Assemble the supplies and materials needed for the lesson
- Make copies of the Owl Pellet Dissection Lab Report (attached)
- Make copies of the Owl Prey Bone Chart www.biologycorner.com/resources/Owl_Pellet_Bone_Chart_grid.pdf
- Print a copy of each organism card and ecosystem role sign. Cut them apart.
- Tape the ecosystem role signs to benches or chairs set up in a straight line, á la Musical Chairs.
- Provide students with access to an Internet-connected computer and one of these web sites, when they can research owl prey: OR <http://www.enature.com/home/> OR have a classroom set of mammal field guides available.
- Print soil food web posters or hand-outs or display slide show: <http://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=1788&position=Promo>
- Identify possible environmental stewardship projects, such as the following:
 - Installing owl boxes and nesting places.
 - The Lost Ladybug Project <http://www.lostladybug.org/> as an extension.

PROCEDURES FOR LESSON ACTIVITIES

Engaging Students

“It’s Lonely at the Top” Ecosystem Role Play

Students will participate in a simulation, re-creating an ecosystem model by role-playing. Students each draw a card with the name of an organism to play and assign themselves the role of producer, consumer, or decomposer. Their classmates will decide if they agree with the role selected, and argue from evidence regarding proposed changes in that role.

- Optional: Display these web pages via smartboard to clarify which organisms are herbivores, carnivores, or decomposers: <http://www.qrg.northwestern.edu/projects/marssim/simhtml/info/whats-a-herbivore.html>
- Copy and cut apart the organism and role cards provided with this lesson.
- Set up the game as specified in the directions, attaching role cards to the back of chairs arranged in a line.
- Let students select organism cards and follow directions for play. Read directions provided with role and organism cards.
- Encourage classmates to challenge the roles other students select, and argue from evidence regarding proposed changes.

Exploration

Owl Pellet Dissection and Reconstruction of the Owl’s Food Web and Energy Pyramid

- Explain that student will be science detectives, using evidence to discover what an owl ate – and what its prey ate – in order to reconstruct the owl’s real-life food web and energy pyramid.
- Pass out the Owl Pellet Bone Chart, the Owl Pellet Dissection Worksheet, and one owl pellet to each pair / team of students, along with a paper bowl, water, a bamboo skewer or forceps, and gloves (optional - pellets are sterile): http://www.carolina.com/pdf/activities-articles/Owl_Pellet_Bone_Chart_grid.pdf
- Direct students to dissect the owl pellet, compare contents to bone chart, and determine what species the owl ate.
- Let students research the prey animal(s) found in the owl pellet and determine the diet of that prey from a field guide.
- Students should reconstruct the owl’s food chain or web to the garden (producer) level with Sun as energy source.
- After students have re-constructed the owl’s probable real-life food chain or web, show this short interactive web site to show that only 10% of energy in an organism is transferred to its consumer at the next trophic level: <http://igbiologyy.blogspot.com/2014/03/109-food-pyramids-of-numbers-biomass.html>
- Debrief the food web and energy pyramid reconstruction activities by asking students to explain their completed Lab Reports. Assess understanding and introduce resources listed under Background Information to address misconceptions. For example, energy pyramids are always – well – pyramidal. But pyramids of numbers are not: <http://igbiologyy.blogspot.com/2014/03/109-food-pyramids-of-numbers-biomass.html>

Soil Food Web

Students will explore the hidden soil food web by sifting soil in the garden and searching with a magnifier (hand lens) to find and identify animals; observing their characteristics and guessing whether they are predators or prey; and looking up their place in soil food web. Display or print copies of this soil food web from NRCS:

http://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_049822.jpg

Environmental Stewardship

Students will go on a non-native worm hunt in the garden and remove any large alien, invasive worms that eat native worms and cut roots of plants OR students will release beneficial organisms like ladybugs or lacewings, who keep the pest population in the garden under control organically. Note that is advisable to release beneficial organisms at sunset so that they will be assured of spending the night in the garden and may be less likely to fly away.

Extension

If releasing beneficial insects in the garden to restore a missing element from the ecosystem, consider engaging students in the Lost Ladybug Project citizen science research activities: <http://www.lostladybug.org/> Students search for, identify, and report ladybugs found in the garden and keep an eye out for rare and threatened species.

Ladybug wrangling tips:

- Luring native ladybugs to the garden: <http://pioneerthinking.com/gardening/luring-ladybugs-into-your-garden>
- Purchase native ladybugs or lacewings from vendors such as: **Insect Lore** <http://www.insectlore.com/>, **Beneficial Insectary** <http://www.insectary.com/>, or **BioBest**
 - Handling ladybugs: chill live ladybugs in the refrigerator (not freezer) to slow them down enough for observation

Another possible project- install owl nesting boxes.



Owl Pellet Dissection Lab Report

Name: _____

Pellet Length: _____

Pellet Width: _____

How many of the following bones did you find?

Humerus: _____

Femur: _____

Lower Jaw: _____

Skull: _____

Vertebrae: _____

Shoulder Blade: _____

Ulna/Radius: _____

Ribs: _____

Pelvic Bones: _____

Tibia/Fibia: _____

Draw a food web for this owl, based on the bones you discovered in its pellet.

- Add other organisms to the food web based on research to determine what the owl's prey typically eats.
- Continue backwards to include producers and the sun.
- Be sure that arrows showing energy flow between organisms point from the lower level (eaten) towards the upper level (eater)
- Include at least one garden plant or animal in this food web.

How many animals did this owl recently eat? _____

Why do you think so? What is your evidence? _____

What prey species did this owl eat? _____
Why do you think so? _____

Where do you think this owl was hunting? _____
Why do you think so? _____

What species of owl made this pellet? _____
Why do you think so? _____

Owl Pellet Lab Report Page 2

Name: _____



Ecological Pyramid

- Draw an ecological pyramid with the owl as third order consumer and its prey (discovered during pellet dissection) as a second order consumer. Add the other levels of organisms from the food web you drew. Be sure to include plants from the school garden in your pyramid.
- Assuming the solar energy reaching the garden is 72,000,000 kcal/m²/year, calculate the amount of energy available at each trophic level if only 10% of energy flows from one level up to the next. (Shortcut: remove the last zero from a number to get an amount that is 10%).
- Remember to include producers from the garden in your ecological pyramid!

Ecosystem Role Cards for "It's Lonely at the Top" Game

- Print out the Ecosystem Role Cards and Organism Cards and cut apart / make additional copies if necessary
- Arrange chairs in a line and tape Ecosystem Role Cards to seat backs
- Let students draw Organism cards
- Start the music (or hum) and have everyone walk around the chairs in the same direction. When the music stops, students sit on a chair with the correct Role card for their Organism
- Have students tell which Organism they are, and let the class decide if they are in the right Role. Students who challenge another student's choice of role should argue from evidence to convince the class of a different role.
- Collect Organism cards, shuffle, pass them out again, and play next round with one less chair

PRODUCER

PRODUCER

PRODUCER

PRODUCER

PRODUCER

PRODUCER

1ST LEVEL CONSUMER

2ND LEVEL CONSUMER

2ND LEVEL CONSUMER

2ND LEVEL CONSUMER

2ND LEVEL CONSUMER

TERTIARY CONSUMER

TERTIARY CONSUMER

TERTIARY CONSUMER

DECOMPOSER

DECOMPOSER

DECOMPOSER

DECOMPOSER

SCAVENGER

ECOSYSTEM ORGANISM CARDS FOR "It's Lonely at the Top" Game

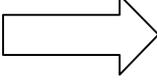
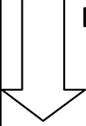
BLACKBERRY BUSH	SNAKE
ROBIN	HUMAN
TRUMPET VINE	STRAWBERRY PLANT
FROG	SALAMANDER
FISH	KELP
SHARK	WHALE
ALLIGATOR	SEAGULL
RABBIT	FOX
BEAVER	PENGUIN
COW	ELK
CORN	BUTTERFLY

GRASS	MOSS
OAK TREE	MILKWEED
KUDZU	DOGWOOD TREE
PUMPKIN PLANT	LIVERWORT
BROCCOLI PLANT	CARROT PLANT
JOE PYE WEED	WHEAT
HONEYSUCKLE VINE	BEE
DEER	OWL
SPIDER	FIELD MOUSE
SQUIRREL	CHIPMUNK
FERN	CRABAPPLE TREE
WORM	PILL BUG
BACTERIA	VULTURE
FUNGUS	MUSHROOM

Assessment for Energy Flow in the Garden Ecosystem

Name: _____

Date: _____

<p>Level of Mastery</p>  <p>Benchmark or Performance Measure</p> 	<p style="text-align: center;">Emerging</p>  <p style="text-align: center;">Not yet proficient 1 point</p>	<p style="text-align: center;">Competent</p>  <p style="text-align: center;">Partially proficient 4 points</p>	<p style="text-align: center;">Proficient</p>  <p style="text-align: center;">Mastered task 5 points</p>	<p style="text-align: center;">Total Points</p>
<p>Ecosystem role-playing simulation</p>	<p>n/a</p>	<p>n/a</p>	<p>Participated</p>	
<p>Owl pellet dissection</p>	<p>Dissected owl pellet</p>	<p>Dissected owl pellet, determined prey from bones, attempted food chain reconstruction with some flaws or lack of labels and arrows.</p>	<p>Dissected owl pellet, determined owl prey, researched prey animal's diet, reconstructed owl food web to producer level, sketched and labeled food chain on lab report with arrows pointing from producer level to consumer level, etc.</p>	
<p>Owl energy (ecological) pyramid</p>	<p>Pyramid drawn correctly but calculations unsuccessful.</p>	<p>Pyramid drawn correctly but energy calculated incorrectly at some levels or direction of energy flow incorrect.</p>	<p>Calculate the energy loss at every level of the pyramid, from sun to tertiary consumer and label these levels on a correctly drawn ecological pyramid, with arrows pointing from producer level upwards.</p>	
<p>Soil food web investigation</p>	<p>Sifted soil, did not identify creatures or discover their place in food web</p>	<p>Sifted soil and investigate creatures living in the garden; observed characteristics; did not predict whether predator or prey or find an organism's place in soil food web.</p>	<p>Sifted soil and investigate creatures living in the garden; observed characteristics; guessed whether predator or prey; found their place in soil food web.</p>	
<p>Environmental Stewardship</p>	<p>Engaged in activity but unable to articulate how it helps the earth</p>	<p>Removed invasive, non-native worms or plants from the garden OR released beneficial insects such as ladybugs or lacewings; explained benefit of work without referencing ecosystem</p>	<p>Removed invasive, non-native worms or plants from the garden OR released beneficial insects such as ladybugs or lacewings; articulated how this helps the Earth by restoring ecosystem balance</p>	