HOW DOES ENERGY PASS THROUGH AN ECOSYSTEM?

Overview

In this lesson, students will demonstrate the interconnectivity between species in an ecosystem.

Objectives

On successful completion of this lesson, students will be able to:

- identify examples of consumers and producers; and
- diagram a food web and illustrate how energy flows through it.

Alaska Standards

Alaska Science Standards / Alaska Science Grade Level Expectations

[4] SC3.1 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by identifying examples of living and non-living things and the relationship between them (e.g., living things need water, herbivores need plants).

[4] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by identifying a simple food chain of familiar plants and animals, diagramming how energy flows through it; describing the effects of removing one link.

[5] SC3.1 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by diagramming how matter and energy are transferred within and between living and nonliving things.

[5] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by organizing a simple food chain of familiar plants and animals that traces the source of the energy back to sunlight.

Alaska Cultural Standards

[B] Culturally knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life. Students who meet this cultural standard are able to:

[B.2] make effective use of the knowledge, skills, and ways of knowing from their own cultural traditions to learn about the larger world in which they live.

[D] Culturally knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning. Students who meet this cultural standard are able to:

[D.1] acquire in-depth cultural knowledge through active participation and meaningful

interaction with Elders.

[D.4] gather oral and written history information from the local community and provide an appropriate interpretation of its cultural meaning and significance.

[E] Culturally knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:

[E.1] recognize and build upon the interrelationships that exist among the spiritual, natural, and human realms in the world around them, as reflected in their own cultural traditions and beliefs as well as those of others.

[E.2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

4th grade sequence #3: Ecosystems

5th grade sequence #4: Ecosystems

Materials

- Large skein of yarn (2 if the class is large)
- Scissors
- Hole-punch
- Construction paper
- Drawing or writing paper
- Pencils
- Colored pencils
- Table of Alaska Living and Non-Living Things

Additional Resources

- Alaska Department of Fish and Game, Ecology Activities. Available at: http://www2.gi.alaska.edu/STEP/lessons_database/lessons/scan/scandfg_35_LifeScience_SpinningAYarnAboutEcosystems.pdf.
- Alaska Department of Fish and Game, Alaska Wildlife Curriculum. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=curricula.awc.
- HSP IV: Ch. 5, Lessons 1–3
- HSP V: Ch. 5, Lesson 2; Ch. 6, Lessons 1, 2

Activity Preparations

1. Using the Table of Alaska Living and Non-Living Things identify one organism / non-living thing for each student in your class. In addition to the Sun (non-living thing), be certain that you choose at least one of each type (producer, herbivore [consumer], carnivore [consumer], omnivore [consumer], and detritivore). Use the table to ensure that you have chosen organisms that depend on one another.

Note: From the list choose living things that can be identified in your area. This will help students become more aware of the various species in the area. If possible learn the local names of each living and non-living thing. Help students learn the language by using the local language term.

2. Make the name cards for each organism / non-living thing you have identified.
   a. Write one organism name on each card — large enough for students to read from 10 feet away.
   b. Hole punch the top two corners of each name card
   c. Use the yarn to create a lanyard for each name card

Note: Alternatively, plan enough time for students to make their own name cards. If students are creating their own name tags, they may wish to draw a picture of the organism or non-living thing.

3. Reserve the remainder of the yarn for the class activity.

Whole Picture

Alaska Native culture-bearers have long believed that all things are intricately connected. "The science of ecology, the study of the interactions between living things and their environments, circles back to the ancient wisdom found in the rich oral traditions of American Indian stories. Time and again the stories have said that all of the living and non-living parts of the Earth are one and that people are a part of that wholeness. Today, Western ecological science agrees" (J. Bruchac, 1989, cited in Kawagley, 2006, p. 12). Both culture-bearers and scientists believe that disturbances to one element in the web can have dire effects on other components.

For Alaska Natives, this connectivity is important not only to the natural world, but in the spiritual world, as well. The importance of maintaining balance among the natural, human, and spiritual worlds is frequently seen in creation stories. One such story concerns Raven — who is said to be the creator. "Some say that the creative force took the form of the Raven to make the world so that the Yupiaq will never think that they are above the creatures of the earth. How can they be when their creator is a creature of earth?" (Kawagley, 2006, p. 17-18). Raven, therefore, plays an important role in helping people maintain balance between the spiritual and natural worlds. Importantly, Western scientists, too, recognize the raven as a crucial element in the web; it is an important detritivore — one who eats dead things and thereby helps them return to the earth, replenishing it with minerals to start anew.

Both Alaska Natives and Western scientists have noticed that climate change is already starting to impact the delicate balance. "The western Alaska coast supports an … impressive variety of

animals and fish … Far from viewing their environment as the insentient provider of resources available for the taking, [Alaska Natives] continue to this day to view it as responsive to their own careful action and attention" (Fienup-Riordan, 1994, p. 14). Like many other indigenous peoples around the globe, Alaska Natives do not view humans as standing apart from the natural world. Instead, the "human being is a participant-observer in this universe" (Kawagley, 2006, p. 17). To this end, maintaining balance in the natural world promotes balance in the spiritual world and vice versa.

Note: You may wish to include "human" in your web activity to better illustrate this important detail.

Some elders believe that the reason so many changes are happening in the natural world is because the spiritual world is out of balance. "Elders attribute environmental change not only to human action — wasteful fishing, burning fossil fuels — but to human interaction. To solve the problems of global warming, elders maintain that we need not only to change our actions but to correct our fellow humans. They encourage youth today to attend to traditional qanruyutet, believing that if their values improve, correct actions will follow" (Fienup-Riordan and Rearden, 2012, p. 321). However, George Noongwook, a respected Siberian Yupik hunter from Savoonga, thinks differently: "We cannot change nature, our past, and other people for that matter, but we can control our own thoughts and actions and participate in global efforts to cope with these global climate changes. That I think is the most empowering thing we can do as individuals" (Krupnik & Jolly, 2002, p. 189).

Western Scientists are likewise interested in the delicate balance of species. One area of particular interest is the Bering Sea — "home to 266 species of phytoplankton, 300 species of zooplankton, 450 species of fish and invertebrates, 38 species of seabirds and 25 marine mammals" (Alaska Marine Conservation Council, slide 11). Scientists have already begun to document changes in the timing of seasonal phytoplankton blooms, changes that can dramatically affect the entire ecosystem. While phytoplankton may seem too small to be significant, the trickle-down is resulting in changes for fish, marine mammals, and sea birds. In other words, the impacts are being felt by predator populations further up the food chain, including humans.

Plankton, though tiny, are crucial to the entire food chain. Phytoplankton, key producers, use sunlight and nutrients in the water to create energy. They are then either eaten by zooplankton (or other marine species, like the bowhead whale), or they die and sink to the bottom, where they provide nutrients for animals like the crab and the other animals who eat them, like pollock and gray whale. Small but important fish, like the herring, eat both zooplankton and the smaller fish that feed on them. In turn, larger fish and sea mammals, like seals, eat the herring. Finally, up on land, the polar bear and the human depend on well-fed seals for their own survival. As hard as it may be to believe, the polar bear might have a difficult time surviving if something happened to the phytoplankton. Without the phytoplankton, the entire system would be disturbed (Alaska Marine Conservation Council, slide 26).

This marine ecosystem example is just one of many that illustrates the interconnectedness of all things. In this lesson, students will participate in an activity to physically demonstrate a similar food web.

HOW DOES ENERGY PASS THROUGH AN ECOSYSTEM?

Vocabulary

carnivore an animal that eats other animals (e.g., a weasel that eats voles).

consumer plants and animals that depend on other plants and animals for food; other than producers, all living things in an ecosystem are considered consumers (e.g., salmon).

detritivore small organisms that eat dead or decaying plants and animals — they reuse and recycle; they return minerals to the system (e.g., mushrooms).

ecosystem a group of both living organisms and nonliving components interacting as a system in their environment

herbivore an animal or plant that eats only plants (e.g., a vole that eats seeds from spruce cones).

omnivore an animal that eats both plants and animals (e.g., bear).

producer plants and algae that make food from non-living materials through photosynthesis (e.g., a spruce tree).

Activity Procedure

1. Divide the class into six groups: Non-living things, producers, herbivores, carnivores, omnivores, and detritivores.
2. Assign each student an organism or non-living thing (provide them with name tags).
3. In their groups, have students work together to determine how they are connected to other living and non-living things. Students can make a list on the back of their name card. (For example: a caribou eats lichen (almost exclusively in winter), sedges, and grasses, and needs water and minerals to survive. In turn, they are eaten by wolves, bears, and humans!).
4. After all students have completed this task, have the class mingle and "introduce" themselves as their element.
5. Instruct students to form a circle.
6. Give the ball of yarn to the sun, instructing the student to proclaim what other elements depend on it for survival (e.g., "I am the sun, and all plants need me in order to survive and reproduce.")
7. Holding the end of the yarn, the sun then passes the ball of yarn to any plant (e.g., lichen). If the student wishes to pass the ball of yarn across the circle, they must be sure the other student is paying attention and ready to catch the ball.
8. As each student receives the ball of yarn, s/he announces what s/he represents and how s/he is connected to another element (e.g., "I am a moose and I eat willow." OR "I am a willow and I depend on the sun for survival."). After the announcement, the student should loosely wrap the yarn around a finger and then pass the ball to the element s/he named. Remind students to be respectful and caring of one another — they should not

pull on the yarn at any time (this will tighten the loops around other students' fingers).

9. Continue building the web in this manner until all students are holding AT LEAST two connections. Strive to gain as many connections as possible. If you have a small class, continue until each student has made several connections.
10. Remaining connected, ask students to explain what they notice (all living and non-living things are connected).
11. Ask students to predict what they think would happen if one element was removed from the web (it would immediately affect some other elements and have a trickle-down effect on others).
12. Choose one member of the web and ask students to identify which elements would be directly affected by its loss (elements connected directly to it); what secondary would be affected (elements connected to the first connection); and what tertiary elements would be affected by a loss of the original element (elements connected to the second connection). To better illustrate this, have the chosen student drop his / her connections and step out of the circle. If connected students are only connected to that original element, they too must leave the circle; if they have other connections, they may stay. For dramatic affect, be sure to choose key elements to remove (noted in the Table of Alaska Living and Non-Living Things).
13. Experiment with "what-ifs" in the food chain. For example, remove a migratory animal. Students then must rearrange the web, modifying their connections.
14. Students rewind the yarn, working backward on their connections; then return to their seats.
15. Instruct students to reflect on the activity by writing or diagraming the interconnections illustrated in the activity, including what happens if the web is broken or a member goes missing.

Extension Activities

1. Invite students to discuss with an elder or family member how certain aspects of the ecosystem in their area are changing. How are these changes impacting life in the village? Have students share their stories.
2. If possible, invite an elder or culture-bearer to the classroom who can speak to changes they have witnessed. Are certain species disappearing? How are these disappearances affecting other species? Are there new species in the area? What impacts are these having?
3. Work with a language coach, culture-bearer, or elder to learn the local names of plants and animals used in the activity.
4. Ask students to consider the spiritual connections that certain animals and plants may have in their community. Is there a way to work these elements into the web?

Answers

Students should discover that all parts of an ecosystem are connected to all other parts. If one part disappears, it will have either a direct or indirect effect on the other components of the system.

References

Alaska Marine Conservation Council. "How is Global Climate Change Affecting Alaska's Marine Ecosystems and Resources?" Slide presentation. Retrieved from: http://www.akmarine.org/our-work/address-climate-change/climate-effects-alaska.

Fienup-Riordan, Ann. (1994). Boundaries and Passages: Rule and Ritual in Yup'ik Eskimo Oral Tradition. Norman and London, University of Oklahoma Press.

Fienup-Riordan, Ann, and Alice Rearden. (2012). Ellavut: Our Yup'ik World and Weather. Continuity and Change on the Bering Sea Coast. Seattle and London: University of Washington Press.

Kawagley, Angayuqaq Oscar (2006). A Yupiaq Worldview: A Pathway to Ecology and Spirit. Long Grove: Waveland Press.

Krupnik, Igor, and Daynna Jolly. (2002). The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change. Arctic Research Consortium of the United States and Smithsonian Institution Presses.

Resources

Table of Alaska Living and Non-Living Things (Following Page)

Note: This table is not comprehensive, but includes species that students are likely to be familiar with. Feel free to add other species that are found in your local area — be sure to identify what they eat and what they are eaten by.

Elements marked in **bold** are crucial links in the food web. Their disappearance would have a disastrous effect on the entire food chain. Note that all living things depend on sunlight.

Plant/ Animal/ Thing	Type	Directly depends on	Needed by
lichen	plant (producer)	sunlight, air, water	caribou
sedge	producer	sunlight, air, water	vole, caribou, redpoll, ptarmigan
blueberry	producer	sunlight, air, water, animals that spread its seed	bear, ptarmigan, fox
willow	producer	sunlight, air, water, redpoll (spreads seed)	redpoll, vole, ground squirrels, marmot
mushroom	detritivore	any dead plant matter	all plants
fly	detritivore	any dead producer	all animals, all plants
mosquitoes	carnivore	any animal	salmon, birds, dragonflies
bacteria	detrivore	any dead thing	all plants and animals
vole	herbivore (consumer)	grasses, seeds, sedges, willow	fox, wolf, bear
redpoll	herbivore (consumer)	willow, sunflowers, sedges, mosquitoes, flies	Jager, Gray Jay, squirrel
raven	detritivore	any dead animal	all animals
ptarmigan	herbivore (consumer)	berries, willow, sedge	fox, wolf, flies
Arctic fox	omnivore (consumer/ detritivore)	vole, redpoll, berries, any dead animal	wolf, bear, flies, raven, mosquitoes
moose	herbivore (consumer)	willow, grasses, algae	wolf, raven, flies, mosquitoes
caribou	herbivore (consumer)	lichen, willow, sedge, grasses	wolf, raven, flies, mosquitoes
bear	omnivore (consumer)	blueberry, salmon, seeds, grasses, caribou, moose	flies, raven, bacteria
wolf	carnivore (consumer)	caribou, moose, voles	flies, raven, bacteria
herring	omnivore (consumer)	copepods, plankton	salmon, whale, seal, sea birds, cod
copepods	herbivore (consumer)	algae	salmon, herring, sea birds
algae	producer	sunlight, air, water	copepods, snails, sea urchins, plankton
sunlight	non-living thing	n/a	all living things
air	non-living thing	all plants	all living things
water	non-living thing	n/a	all living things
nutrients	non-living thing	bacteria, mushrooms, other detritivores	all living things