TUNDRA FOOD CHAIN RELAY *(MODIFIED FOR ADEED)*

INSTRUCTIONS

Overview:

Students become familiar with tundra animals and food chain connections while actively engaged in a relay game.

Objectives:

The student will:

- become familiar with tundra animals; and
- learn about tundra food chain connections.

Targeted Alaska Grade Level Expectations:

Science

[6] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transation of matter and energy by organizing a food web using familiar plants and animals.

[6] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

Vocabulary:

carnivore – animals that eats other animals

commensalism – a relationship in which one organism takes something of need from another organism, where the second organism neither benefits nor harms it.

consumer – a living thing that can only survive by consuming other plants, animals, or organisms

detritivore – organisms that eat dead or decaying material

food chain – a community of organisms where each member is eaten in turn by another member

food web – the energy circulatory system of an ecosystem

herbivore – organisms that eat plants

mutualism – the relationship between two different species of organisms that are interdependent; each gains benefits from the other

nonliving – a thing which never has been, nor ever will be alive

omnivore – an animal that eats both other animals and plants

parasitism – the relationship between an organism called a parasite, that lives in or on a host (another animal or plant). the parasite gains nourishment from the host without benefiting or killing the host

producer – a plant or organism that produces energy from non-living things, such as sunlight.

symbiosis – the relationship between two organisms that provide benefits to each other without any negative impact on either organism.

Materials:

- Nonliving things, tundra plants, and tundra animals from the *Alaska Ecology Cards*
- STUDENT INFORMATION SHEET: "Tundra Ecosystems - Community Connections"

Activity Procedure:

1. Divide the class into equal groups. Draw a starting line. Lay the Alaska Ecology Cards out on one side of a large playing area. Explain that the objective is for each team to assemble a tundra food chain. This should include something from the **nonliving environment**, a **producer**, an **herbivore**, a **carnivore**, and a **detritivore**.

2. One student in each team must run (skip, hop, or walk) to the other end of the playing area to find and bring back one wildlife card to his group. The next team player cannot leave until the previous player has returned with a card.
3. The team may keep the card if it connects with a card that their team already holds. (Hint: Look for an organism that eats the object listed on the previously selected card.) If the organism does not fit into the food chain, it must be returned to the card pile by the next runner.
4. Whenever a team has a complete food chain, they yell out "Food Chain." If the food chain is complete and correct, the team earns 10 points. The teams return their cards to the card pile, and another round starts.
5. If the food chain is incomplete or incorrect, the team loses five points, and the game resumes where it left off. To increase the level of difficulty, remove the cards that are already connected in each round.
6. Ask students to explain how this game is different from real food chains.

VARIATION: If you play this game inside your classroom, ask the students to move creatively as they collect their cards. *For example, students can walk like various animals as they return their cards.*

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7. Discussion question (after one or more of the complementary activities).

   (a) Ask students to predict what living things would be affected if the nonliving environment of the tundra were changed. Suggest examples such as if a marsh became polluted or if the air became polluted, how could this affect living things in the immediate and distant areas?

   (b) How would various changes in the tundra ecosystem affect the living things in it? What if plant or mosquito populations declined severely? What if precipitation dramatically increased or decreased? What if annual temperature patterns changed? To what extent does one change impact the entire ecosystem?

   (c) The changes just mentioned would impact the tundra ecosystem. Ask students to discuss how other ecosystems would be changed in other, distant places.

This lesson adapted with permission from Alaska Department of Fish and Wildlife's *Alaska's Tundra and Wildlife* curriculum. (2001).

ENERGY TRANSFER - THE BASICS OF ALL LIFE

Energy Transfer – the basics of all life

Where the next meal comes from is a constant priority in any organism's life. The following pages trace how energy is transferred in ecosystems and how materials are recycled. (Recycling in ecosystems is not just an option, but is critical to continued survival.)

Food Webs - Who Eats Whom?

[see the "5 Living Kingdoms" fact sheets in INSIGHTS, Section 1, and the Alaska Ecology Cards for species illustrations.]

A plant is exquisitely equipped to convert the nonliving – air, water, minerals, and sunlight – into food for itself and others. Plants and algae that make food from nonliving materials are called producers.

The other living things in the tundra that depend on food manufactured by producers are called **consumers**. Consumers divide into four groups: **herbivores** (animals that eat plants), **carnivores** (animals that eat other animals), **omnivores** (animals that eat both other animals and plants), and **detritivores** (animals and other organisms that eat dead or decaying material). The pathway of energy and minerals from the nonliving environment, through producers, to consumers, and back again through detritivores creates a food chain. All the food chains of a tundra

The pathway of **energy** and **minerals** from the nonliving environment, through producers, to consumers, and back again through detritivores creates a **food chain.** All the food chains of an ecosystem are connected into a **food web** – the energy circulatory system of that ecosystem.

Energy Lost and Found: At each intersection in the web, some energy is returned to the nonliving environment as heat. That energy is not passed on and cannot be reused by living things. The lost energy is replaced during photosynthesis by the capture of energy from the sun.

Mineral Recycling: Minerals are always passed along at each web intersection until the detritivores return them to the environment in their original form, where producers can use them to make new food.

Producers Convert Raw Materials

Using the process of **photosynthesis,** producers combine energy from sunlight with carbon dioxide from the air and minerals from water, soil, and rocks to produce the sugars and oxygen that help all other living things survive. They are the first living link in all food chains.

Tundra producers are unique among producers in the world. Because lack of light (from darkness or snow cover), cold temperatures, and lack of moisture, they can only function for a few months each year. Ironically, this means that tundra producers are also tundra inhibitors – slowing and limiting the flow of energy and minerals through the ecosystem. [Detritivores are another **limiting factor**; see below.]

Scientists measure this flow of energy and minerals by determining the weight of carbon that is "fixed" or changed into living material by producers each year. Basically, the measurement is the dry weight of all new growth – leaves, roots, flowers, seeds – produced each year.

Low Productivity in Tundra: On average, all tundra producers together make only one-tenth to one-third as much food each year as producers in forest ecosystems. As a result, tundra consumers are limited by a shortage of food unless they migrate elsewhere for part of the year

Herbivores Eat Producers

Some of the largest and smallest tundra wildlife are herbivores. Caribou and lemmings receive all their nutrition from plants. A caribou, however, must roam great areas of lowland tundra and migrate to obtain enough food to sustain its body mass. Geese, also migrants, are tundra herbivores in the summer when plants are at their peak production.

Compared with forest ecosystems, relatively few plant-eating invertebrates occur in either alpine or lowland tundra environments. The tundra has herbivorous bumblebees, moths, butterflies, and a few sawflies, but these consume much less green vegetation than do vertebrate herbivores. In alpine tundra, voles, pikas, marmots, Dall sheep, and mountain goats are the main plant consumers.

Carnivores Eat Herbivores – and Each Other

Tundra herbivores are prey of tundra carnivores such as wolves, wolverines, arctic foxes, weasels, jaegers, snowy and short-eared owls, gyrfalcons, and golden eagles. All will eat each other if the opportunity arises.

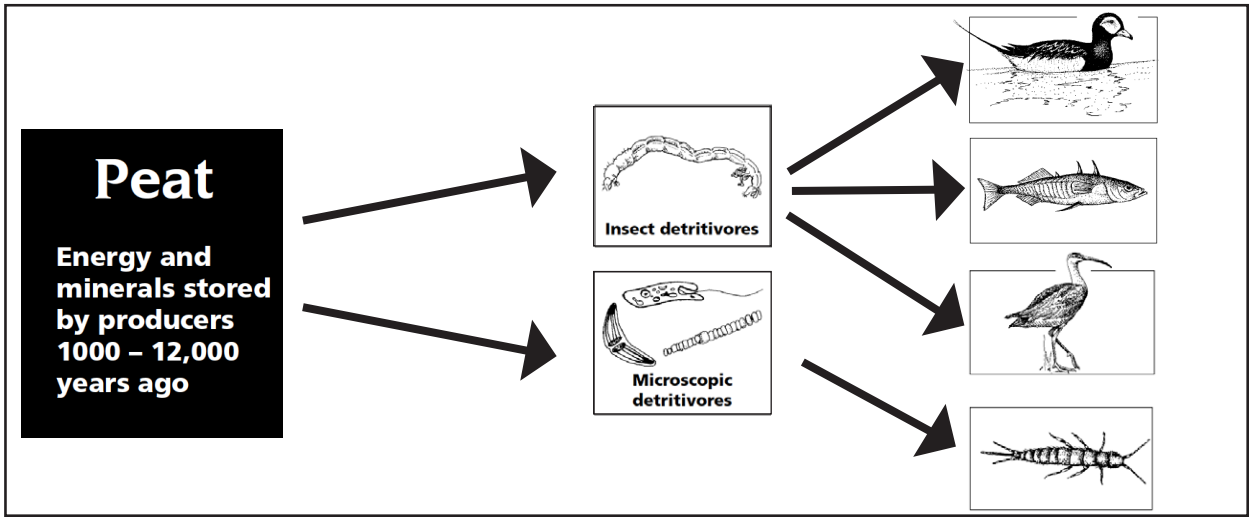
Flocks of small, insect-eating shorebirds that migrate to the tundra to nest are major carnivores in the ecosystem despite the relative scarcity of insect herbivores. Goslings and ducklings also rely on insects for a protein boost during their first few weeks of life while the parent geese and ducks eat plants and algae. The insect-eating invertebrates in tundra ecosystems include some predatory crane flies, spiders, and ground and rove beetles.

Carnivores cannot survive without adequate populations of prey. Thus, the numbers and kinds of herbivores on the tundra determine, in part, the presence and abundance of carnivores.

Carnivores also influence the numbers and kinds of herbivores on the tundra. If a population of herbivores grows too large, the animals may eat all their food supply and starve. Maintaining healthy populations of carnivores reduce the chance of such herbivore population explosions and crashes. When a population explosion does occur, carnivores lessen the impact on plants.

Opportunistic Omnivores

Food in an ecosystem can be scarce, especially for big eaters. Therefore, consumers that eat a variety of foods have a better chance of survival. Bears are good examples. They eat roots, grasses, herbs, and berries as well as small and large mammals, insects, fish, and carrion. With an omnivorous diet, bears are well-adapted to food is available. Chickadees and many other birds eat plant seeds as well as insects. Waterfowl young gain their initial growth from aquatic insects before turning to marsh vegetation later in the summer.



Mosquitoes are infamous for their abundance in Alaska. Both male and female mosquitoes sip plant nectar as herbivores, but the female is omnivorous. She needs a blood meal from a warm-blooded animal to produce the eggs she will lay on the surface of any nearby water.

Detritivores Reuse and Recycle

The greatest number and variety of consumers in any ecosystem are the detritivores that eat dead things and waste materials. They are very important to the tundra because they return all the minerals stored in the food chains to the soil for reuse by tundra plants. Without detritivores, producers would soon run out of the minerals they need to make food. Some well-known animals such as ravens are detritivores. But the most important detritivores are tiny, extremely numerous – and ignored. The most visible detritivores are tiny animals without backbones (invertebrates) – **enchytraeid worms, springtails, mites**, the **larvae** of many kinds of flies, and **nematodes**.

Near Barrow, Alaska, scientists found the following invertebrates in an area of 1.09 square yards (1 square meter):

- 50,000 to 5 million nematodes
- 10,000 to 100,000 enchytraeid worms
- 10,000 to 80,000 mites
- 24,000 to one half million springtails
- 40,000 rotifers
- 15,000 tardigrades
- 700 fungus gnat larvae
- smaller numbers of other insect larvae
- Nearly all of these lived within 2 inches (5 centimeters) of the soil surface.

These small animals eat much of the food produced by tundra plants. Despite their numbers, they cannot keep up with task of digesting all the organic material, especially under the rugged climatic conditions of the tundra. Completing the digestive team are **fungi, monerans**, and **protists**, nonanimal detritivores. In tundra, fungi are more important and more prolific decomposers than are the microscopic bacteria of the monerans and protists. Fungi are well adapted to acidic soils. The majority of monerans and protists are detritivores and, although not as active under tundra conditions, play a role in creating soil.

Tundra Dilemma – too cold to rot

All the work of tundra detritivores is limited by the climate and the environmental conditions. Living in the top 2 inches (5 centimeters) of soil or on the surface, they are chilled from below by the permafrost and can be active only during the few short summer months.

Tundra detritivores do not break down all the new material produced each year. This slows the flow of energy and minerals through the ecosystem and limits tundra productivity. Much of the nitrogen, phosphorus, and calcium that could be returned to the soil for use by producers remains in accumulated detritus. This impoverishes the soil and, in turn, limits the growth of many tundra producers.

Detritus Food Chains

Dead, partially decayed material, called **detritus**, accumulates in tundra ecosystems. In alpine tundra, wind and water erosion carry away much of the excess. But in flat areas of lowland tundra, particularly in the Arctic, centuries of accumulation have created thick layers of detritus called **peat** – a storehouse of energy and minerals.

Many tundra food chains are based on dead organic material in ponds, lakes, and exposed peat.

Although detritivores break down waste materials and return energy and minerals to the nonliving surroundings, they incorporate some of the food (energy and minerals) they consume into their bodies. Many carnivores, including certain insects, ducks, shorebirds, and fish, get the energy and minerals they need by feeding on detritivores.

Essentially, these consumers are living off energy and minerals stored by tundra producers in the past. If peat layers have been exposed or eroded into lakes, the consumers in peat-based food chains are actually supported by producers that lived 1000 to 12,000 years ago!

Tundra Poster Key