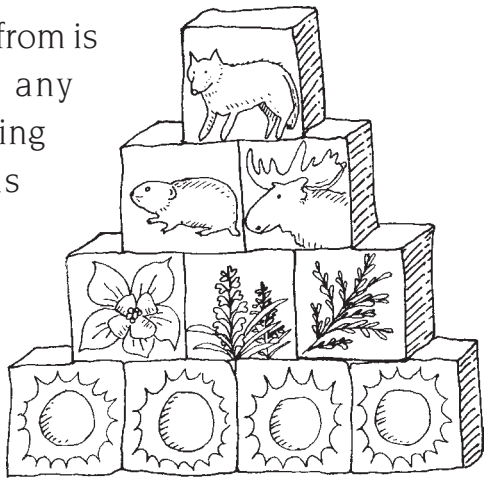
ECOSYSTEMS – Community Connections

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.*)



Section 2
ECOSYSTEM INSIGHTS

FOOD WEBS – *WHO EATS WHOM?*

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

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

Consumers. All other living things in an ecosystem depend on food manufactured by producers. Called **consumers**, they use a process called **cellular respiration** to convert the carbohydrates, fats and proteins found in plants or other animals into another form of energy that their cells can use (see INSIGHTS Section 1: "Energy").

Consumers are divided into four groups:

- **herbivores** (organisms that eat plants)
- **carnivores** (animals that eat other animals)
- **omnivores** (animals that eat both animals and plants)
- **detritivores** (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 an ecosystem are connected into a **food web –** the energy circulatory system of that ecosystem.

Energy. 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.

Minerals. Minerals are always passed along at each web intersection until the detritivores return them to the environment in their original form. The producers can use them again 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.

Plants are the main producers in forest and tundra ecosystems, while algae (including seaweeds) are the main producers in ocean ecosystems. Both plants and algae are important in wetlands. Some monerans are also producers.

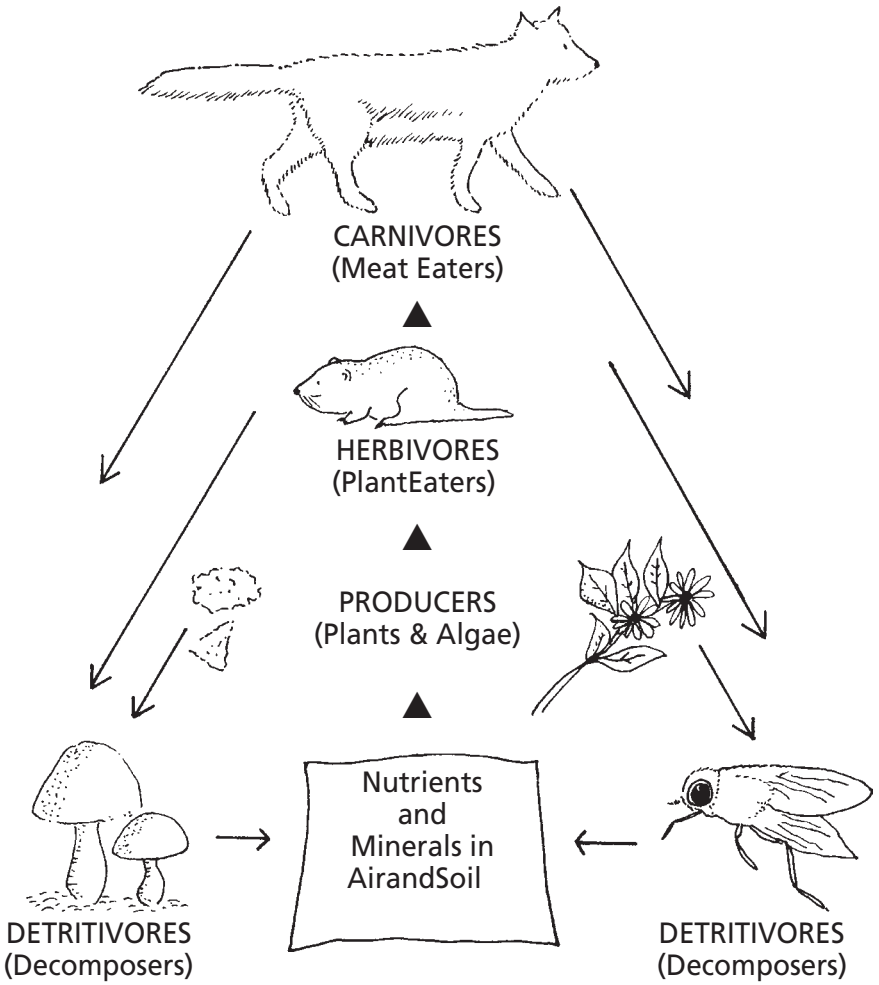
HERBIVORES EAT PRODUCERS

Herbivores are the next link in the food chain and come in all sizes. Moose, deer, and snowshoe hares receive all their nutrition from the stems, bark and leaves of plants. Caribou survive harsh winters by eating lichens. Red squirrels and pine grosbeaks prefer seeds.

Yet, these "common" wildlife examples are overwhelmed in number by the smallest herbivores – the millions of leaf-eating, wood-drilling, sap-sucking, twig-boring insects and other often overlooked invertebrates.

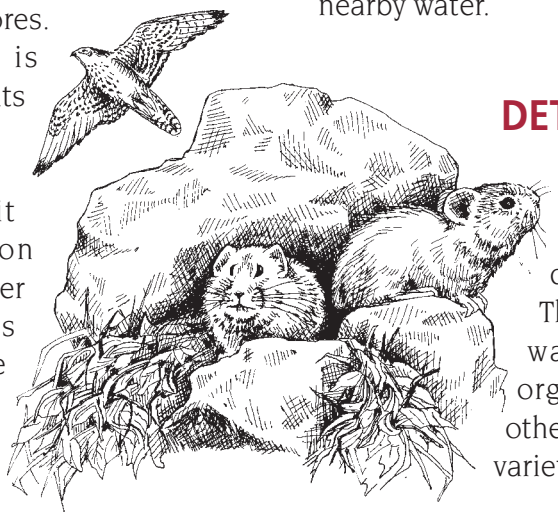
Each herbivore is adapted to eat specific kinds of plants and cannot live in an ecosystem or area where those plants are absent.

FOOD WEB



CARNIVORES EAT HERBIVORES – AND EACH OTHER

In the next link in the food chain, the plant-eating herbivores become food for carnivores (flesh-eaters). Owls, spiders, centipedes, woodpeckers, foxes, and wolves are examples of carnivores. Another name for carnivore is **predator**, one that kills and eats other living things.



Carnivores do not limit themselves to dining on herbivores. All will eat each other if the opportunity arises. This represents a second carnivore link on longer food chains.

Carnivores cannot survive without adequate populations of prey. So the numbers and kinds of herbivores in an ecosystem help to determine the presence and abundance of carnivores.

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

Last in a food chain – but certainly far from "least" – are detritivores, or decomposers. They obtain their energy by eating waste materials and dead organisms. They overshadow all other consumers in both number and variety.

Detritivores are a critical link in all ecosystems because they return all the minerals stored in the food chains to the soil for reuse by producers. Without detritivores, producers would soon run out of the minerals they need to make food, and an ecosystem would smother in tons of debris.

Bald eagles, crabs, ravens and other large creatures that **scavenge** dead animals are detritivores because they eat dead flesh. But the most important detritivores are tiny, extremely numerous – and ignored. These include animals that live in the soil, slime molds, many **fungi**, and hundreds of thousands of **microscopic organisms**.

(*For more information about the Five Living Kingdoms including Fungi, Protista, and Monera, Plants, and Animals see* INSIGHTS *Section 1, Elements of Ecosystems.*)

Animal detritivores eat more plants than moose! In one square mile of boreal forest, the mass of detritivores equals the body weight of 43 moose.

ECOLOGY FACTS - ALASKAN FOOD CHAINS AND WEBS

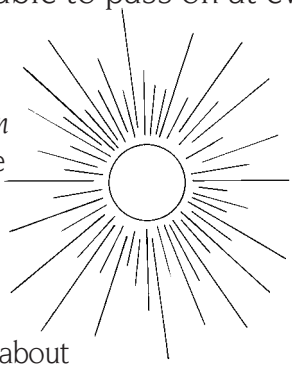
Six food chain examples for forest, tundra, wetland, and ocean are shown in bold letters. Make food webs by using the other foods of each living thing (listed in small letters below its name) to find other interconnections.

	PRODUCER	HERBIVORE	CARNIVORE 1	CARNIVORE 2	DETRITIVORE
FOREST	**1. White spruce**	**Red Squirrel** berries, mushrooms	**Marten** voles, bird eggs		**Mushroom** any dead plant
	2. Willow	**Snowshoe Hare** birch, grass, fireweed	**Lynx** voles, squirrels		**Raven** any dead animal
	3. Grass Seeds	**Red-backed Vole** berries, fireweed	**Boreal Owl** flycatcher, woodpecker		**Fly** any dead animal
	4. Lingonberry	**Pine Grosbeak** spruce and birch seeds	**Goshawk** squirrel, flycatcher,woodpecker		**Bacteria** any dead thing
	5. Fireweed	**Moth** flies, beetles	**Alder Flycatcher**	**Merlin** pine grosbeak	**Beetle** any dead animal
	6. White Birch	**Bark Beetles** spruce	**Downy Woodpecker** moth, berries		**Shelf Fungus** any dead wood
TUNDRA	**1. Lichen**	**Caribou** dryas, willow, sedge	**Brown Bear** sedge, grass, blueberry		**Bacteria** any dead thing
	2. Dryas	**Dall Sheep** willow, sunflower, sedge	**Wolf** caribou, marmot		**Raven** any dead animal
	3. Willow	**Redpoll** willow, sunflower, sedge	**Arctic Fox** singing vole, any dead animal		**Flies** any dead animal
	4. Grass	**Singing Vole** sedge, sunflower, dryas	**Short-tailed Weasel** redpoll		**Springtail** any dead wood
	5. Sunflower	**Butterfly** blueberry, mountain avens	**Golden Plover** flies, springtail, blueberry	**Jaeger** redpoll, vole	**Bacteria** any dead thing
	6. Sedge	**Marmot** grass, sunflower	**Wolverine** fox, any dead animal		**Mushroom** any dead plant
	7. Blueberry	**Willow Ptarmigan** willow, sedge	**Golden Eagle** marmot, weasel, sheep (lamb only)		**Fly** dead producers, protozoans
WETLAND	**1. Algae**	**Water Fleas** dead plants, protozoans	**Stickleback** midge, rotifer	**Common Loon** frog	**Bacteria** any dead thing
	2. Pondweed	**Pintail** algae, seeds of sedges	**Peregrine Falcon** phalarope		**Rotifer** dead producers, protozoans
	3. Algae	**Midge** algae, dead plants	**Wood Frog** flies, mosquitoes	**Sandhill Crane** stickleback, sedges	**Water Flea** any dead producer, rotifer
	4. Sedges	**Muskrat** pondweed	**Mink** stickleback, phalarope		**Bacteria** any dead thing
	5. Willow	**Moose** willow, sedge	**Wolf** muskrat, pintail		**Flies** any dead animal
	6. Algae	**Mosquito larvae** protozoans	**Red Phalarope** midge, water flea, rotifer	**Parasitic Jaeger**	**Protozoans** any dead material, algae
OCEAN	**1. Green Algae**	**Sea Urchin** kelp	**Sea Otter** crab, sculpin, sea star		**Tanner Crab** any dead animals
	2. Kelp	**Snails** green algae	**Sea Star** sea urchin, sea cucumber, shrimp		**Flatfish** dead animals, snails, fish
	3. Diatom (algae)	**Amphipod** other algae, kelp	**Sculpin** shrimp, sand lance	**Sea Anemone** sand lance, snails	**Shrimp** any dead material
	4. Sea Grass	**Brant** green algae	**Bald Eagle** herring, guillemot, dead animals		**Marine Worm** any dead plant, algae
	5. Brown algae	**Copepods** other algae, sea grass	**Sand Lance** amphipod, euphausids	**Pigeon Guillemot** sculpin, herring	**Sea Cucumber** any dead thing
	6. Red Algae	**Euphausids** other algae, diatoms	**Herring** copepods, sand lance	**Harbor Seal** sand lance, flatfish	**Gull** any dead animal

ECOLOGY FACTS - TRACK THE ENERGY

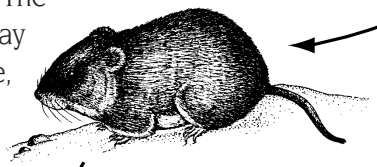
When living things consume food, they consume **energy** as well as mass. All living things use energy to move, respond to the environment, reproduce, grow, and keep warm. As a result, less energy is available to pass on at every link in a **food chain**.

WHO EATS WHOM?

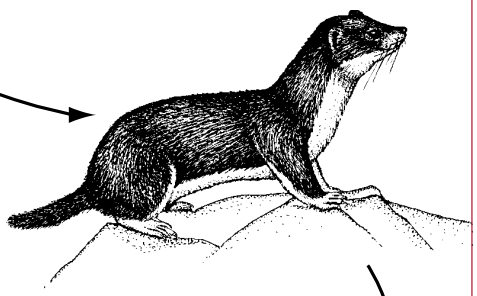


Producer. Through photosynthesis (*water, carbon dioxide, and* ***energy from the sun***), a spruce tree feeds itself and produces seeds in cones.

Herbivore. A vole eats fallen spruce cone seeds containing 1000 calories of energy. Although the vole uses most of this energy for moving about and for staying warm, some of the energy goes through the vole's digestive system as waste, and the rest (*about* 10% *of the original* 1000 *calories, or* 100 *calories*) is stored in the vole's tissues, ready to be passed on to the next consumer in the food chain.



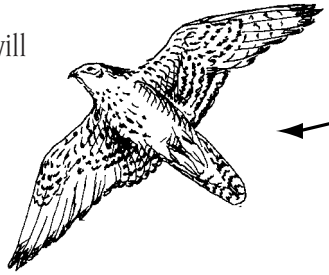
Carnivore. Suppose that the next **consumer** is a weasel who eats the vole. The 100 calories (10% *of the original* 1000 *calories*) from the spruce seeds stored in the vole's body are passed to the weasel. The weasel uses those calories to move, reproduce, and stay warm. Some calories from the vole are excreted as waste, and the rest (10% of the 100 calories) is stored in the weasel.



Second Carnivore. A hawk catches and eats the weasel. Only 10 of the original calories remain to used by the hawk. *Less energy is available to pass on at every link of a food chain. As a result, carnivores are less numerous than herbivores, and food chains rarely have more than four links.*

Detritivores. When the hawk dies, the 1 calorie of original energy that remained is used as the detritivores break down the body. They return only the minerals to the ecosystem.

Thanks to the Sun, new energy is on its way!



Producers (Again!). Green plants, algae, and some **monerans** will change the sun's energy and minerals from the nonliving surroundings into forms other living things can use.