GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

LESSON PLAN

SYMBIOSIS

GRADES 6-8

SUMMARY

Students will critically read scientific texts adapted for classroom use to obtain scientific information in order to describe patterns of interactions between organisms across different ecosystems.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

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

Science & Engineering Practices	Connections to Classroom Activity
Obtaining, evaluating, and communicating information	• Small student groups are provided a food web and short reading adapted for classroom use with information about interactions within a particular ecosystem. Students record relationship interactions on an organizer to describe patterns within that ecosystem.

Disciplinary Core Ideas	Connections to Classroom Activity
LS2.A: Interdependent Relationships in Ecosystems Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	• Student groups share their findings about patterns of interactions in six different ecosystems and conclude that although the species varied, the same patterns of interactions can be found in each ecosystem. Students identify these interactions as predatory, mutualistic, parasitic, commensalistic, and/or competitive.

Cross Cutting Concepts	Connections to Classroom Activity
Patterns	• Students use patterns of interactions within ecosystems to identify the impact of cause-and-effect relationships on organisms in an ecosystem.

DURATION

45 min.

MATERIALS

- Ecosystem food webs information sheet and readings
- Symbiotic Relationships organizer
- Science notebook or paper
- Pen or pencil

ENGAGE

Ask students if they think that zombies really exist on Earth. Have students watch the video "Killer Zombie Fungus" stopping at 2:40 min. Have students jot down ideas in their science notebooks about why this type of relationship occurs and if they think it is unique to tropical forest ecosystems. Tell students that we refer to interactions between different organisms in an ecosystem as symbiosis and that these interactions can be helpful (+), harmful (-), or have no effect (0). Have students use these symbols (+, -, and 0) to describe the relationship between the Cordyceps fungus (+) and ants (-). Tell students that they are going to look for patterns in different ecosystems to identify cause-and-effect relationships among organisms to help us **figure out why relationships that are harmful persist and if these relationships are found only in some ecosystems.**

EXPLORE

Working in groups of four, give each group a reading for a different ecosystem. Tell students to use the food web diagram and the text to identify as many interactions between different organisms as they can and record them on the Symbiotic Relationships organizer.

EXPLAIN

Have students share the patterns they found in each ecosystem. Ask students, "What seems to be true of our findings across the ecosystems examined? What can we conclude? What new questions do we have? Can someone remind us of the question we are trying to answer?" *(Why do relationships that are harmful persist in an ecosystem? Are these relationships found only in some ecosystems?)*

Tell students to do the following:

1. Note the types of symbiosis and identify them on their organizer. (Record on the line under the symbols in the first column.)
2. Jot down possible impacts on the relative number of organisms in their group's ecosystem as a result of the different interactions as they watch the Generation Genius video and Dr. Jeff shares examples.

WATCH THE GENERATION GENIUS SYMBIOSIS VIDEO AS A GROUP

After watching the video, have students share how they named each type of relationship on their organizer. In their ecosystem small groups, each student should examine a different interaction, predict possible effects on the relative number of different organisms, and share his or her predictions with the group. Ask students, "Which of the symbiotic interactions seem the least harmful? Use an example to support your thinking. Which symbiotic interactions seem the most harmful? Use an example to support your thinking."

Wrap up the discussion by asking, "What are some things we think we can say at this point about our lesson phenomenon, Cordyceps and ants, and why harmful relationships persist in an ecosystem? What is our evidence for these ideas (these explanations)?"

- Although the species vary, the same patterns of symbiotic relationships exist across multiple ecosystems.
- Symbiotic relationships are crucial for maintaining balance in ecosystems.

ELABORATE

Perhaps the most hostile ecosystems on Earth are the hydrothermal vents along the mid-ocean ridges on the ocean floor. Despite the extreme temperatures and pressures, toxic minerals, and lack of sunlight, the species living there are thriving. Have students use the Woods Hole Oceanographic Institution Hydrothermal Vent Basics interactive to identify the symbiotic relationships; compare the patterns with those of the other ecosystems they explored; and construct an argument, using qualitative evidence and scientific reasoning, about whether the patterns of interactions are similar to those of other ecosystems and how they help organisms survive in such harsh environments.

EVALUATE

There are multiple ways to assess your students' understanding of this topic. The exit ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

EXTENSION

More advanced students can create a simulation to test changes in interactions between organisms in a specific ecosystem using the Sage Modeler from Concord Consortium. Students can generate empirical data that can be used to support their answer to this lesson's question.

ECOSYSTEM FOOD WEBS

Marine (Intertidal Zone) Food Web

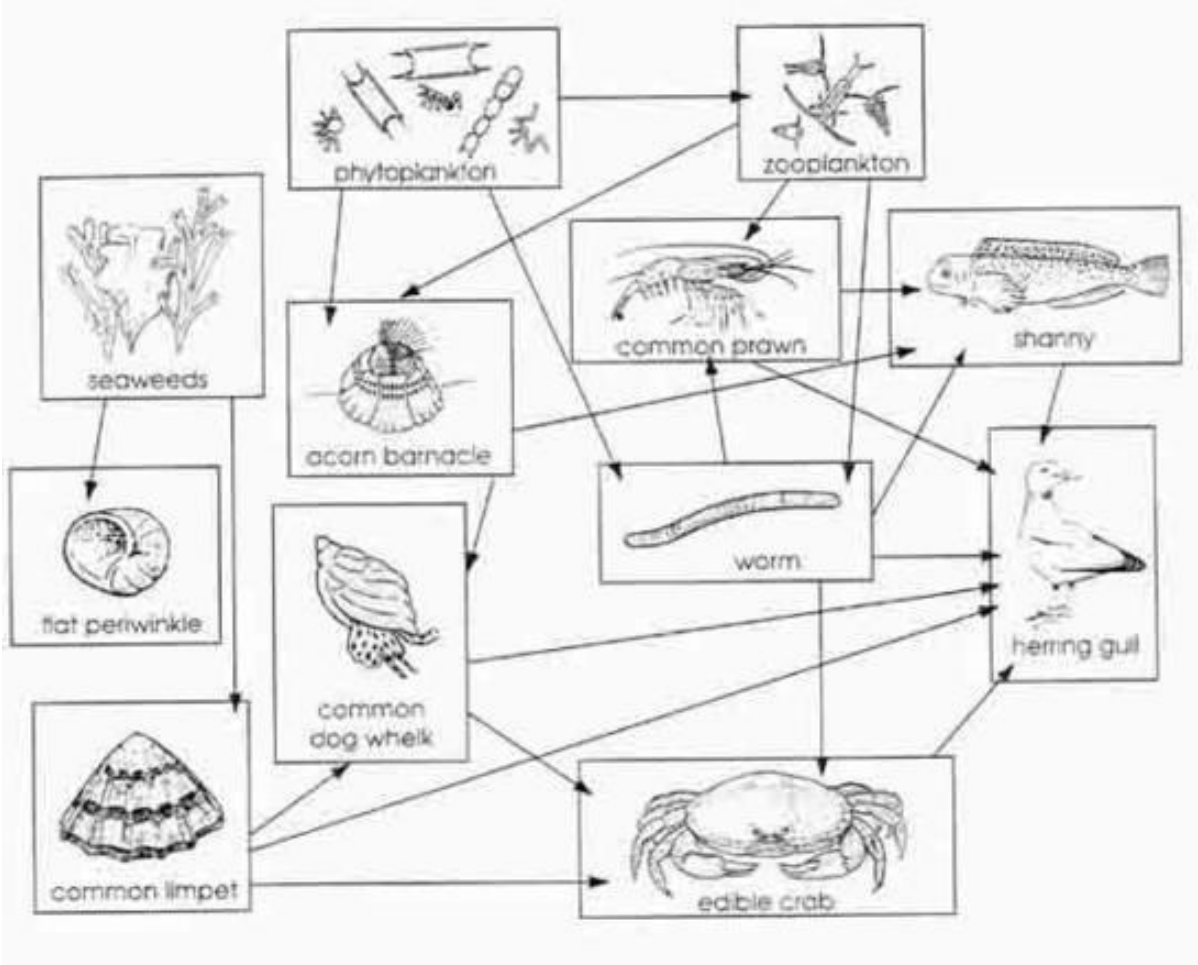


Illustration source: https://intertidalproject.weebly.com/food-web-and-symbiotic-relationships.html

Above is a food web of the intertidal zone. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The herring gull is the top **predator** in this ecosystem. Its **prey** are the edible crab, the common limpet, the common dog whelk, the worm, the common prawn, and the shanny. The flat periwinkle is a **herbivore** because it only eats the seaweed, which is a plant. The shanny, however, is a **carnivore** because it only eats the worm, acorn barnacle, and common prawn, which are all animals. The acorn barnacle is an **omnivore** because it eats both plants and animals. The phytoplankton is a plant, and the zooplankton is an animal. Some organisms are **scavengers**, which means they feed on the carcasses of dead animals. **Decomposers** feed on organic waste and break it down into inorganic material that can be used by producers. Limpets, a type of gastropod, survive off of coralline crust algae, known as Clathromorphum. The limpet gets a constant source of food, and the algae benefits from its surface being cleaned. Without the constant cleaning from the limpet, Clathromorphum would suffocate and different types of bacteria would take its place. Snails attach themselves to plants in the tidal pools to keep safe. This keeps the snails from being caught in waves and being pushed up further on the shore and being pulled out to sea. The plant life seems unaffected.

Grassland (Savanna) Food Web

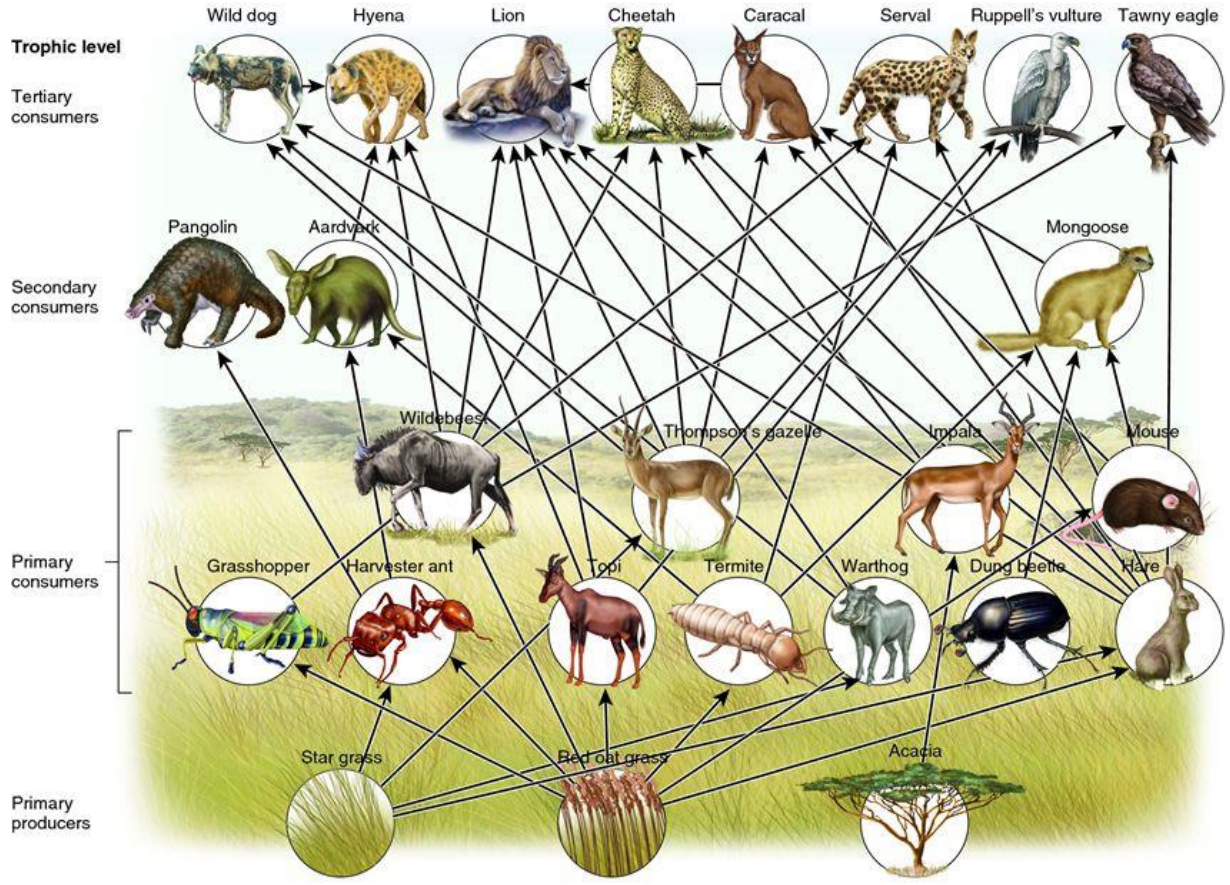
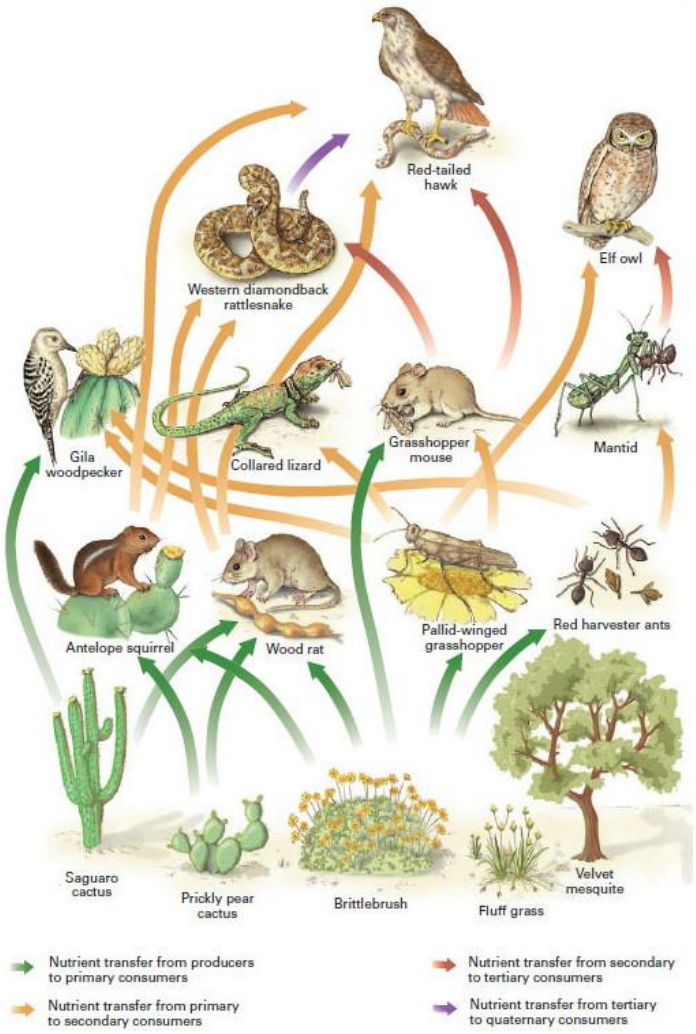


Illustration source: savannabiomeassignment.weebly.com

Above is a food web of a grassland (savanna) ecosystem. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The lion is the top **predator** in this ecosystem. Its **prey** are wildebeest, gazelle, impala, warthog, and topi. The grasshopper, harvester ant, topi, termite, warthog, rabbit, wildebeest, gazelle, and impala are **herbivores** because they only eat grasses or the Acacia tree, which are plants. The wild dog, hyena, lion, cheetah, caracal, serval, tawny eagle, mongoose, pangolin, and aardvark, however, are **carnivores** because they only eat grasshoppers, harvester ants, topi, termites, warthogs, rabbits, mice, mongooses, aardvarks, wild dogs, cheetah, or caracal, which are all animals. The wildebeest is an **omnivore** because it eats both plants and animals. The star grass, red oat grass, and Acacia tree are plants. Some organisms, like the Ruppell's vulture and hyena, are **scavengers**, which means they feed on the carcasses of dead animals. **Decomposers**, like dung beetles, feed on organic waste and break it down into inorganic material that can be used by producers. Ants form hives in the hollow thorns of the Acacia tree and feed on its nectar. Whenever impalas try to eat leaves from the Acacia tree, the ants swarm and irritate them, causing the impalas to leave. Lions prey on a wide range of animals, and the hyena eats what remains without harming the lion. Ticks live on the blood of topi, wildebeest, gazelle, and impala, often causing them to be sickly. Bacteria in the guts of termites and gazelles do not harm them and allow them to digest the cellulose from plants, while the bacteria acquire food from their hosts.

Desert Food Web



Above is a food web of a desert ecosystem. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The red-tailed hawk is the top **predator** in this ecosystem. Its **prey** include antelope squirrels, wood rats, grasshopper mice, and the western diamondback rattlesnake. The antelope squirrel, wood rat, pallid-winged grasshopper, red harvester ants, and Gila woodpecker are **herbivores** because they only eat Saquaro cactus, prickly pear cactus, brittlebrush, fluff grass, and mesquite, which are all plants. The collared lizard, mantid, elf owl, western diamondback rattlesnake, and red-tailed hawk, however, are **carnivores** because they only eat antelope squirrel, wood rat, collared lizards, red harvester ants, and pallid-winged grasshoppers, which are all animals. The antelope squirrel is an **omnivore** because it eats both plants and animals. The Saquaro cactus, prickly pear cactus, brittlebush, fluff grass, and velvet mesquite are plants. Some organisms, like ravens, vultures, and coyotes (not shown) are **scavengers**, which means they feed on the carcasses of dead animals. **Decomposers**, like ants, feed on organic waste and break it down into inorganic material that can be used by producers. The Gila woodpecker eats bugs and cactus berries. It excavates holes in the Saquaro cactus but does not harm the cactus. Bees pollinate cacti flowers, and coyotes scatter seeds in their scat. The gopher snake (not shown) makes its home in burrows dug by desert rats. In the Mojave desert of the United States, wasp lay eggs in the case of eggs laid by the praying mantis. When the wasp's eggs hatch, its larvae start feeding on the eggs of the praying mantis and make their way out. Coyotes are often weakened by fleas that feed on their blood.

Forest Ecosystem

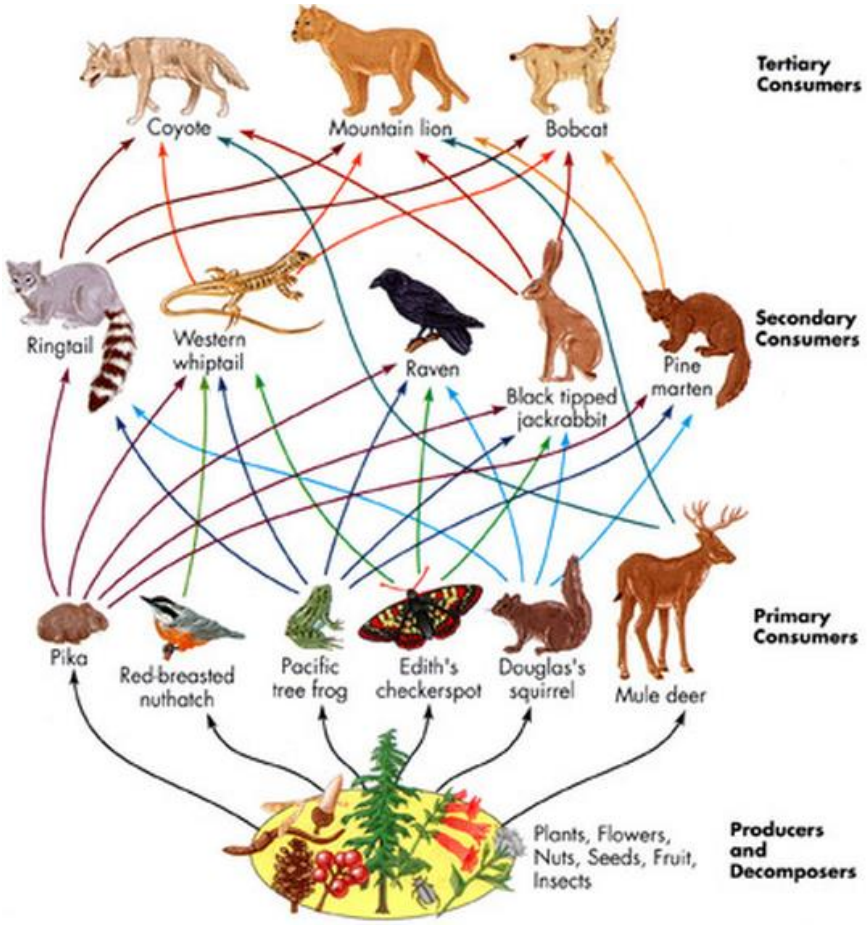


Illustration source: https://temperatedeciduousforests101.weebly.com/food-web.html

Above is a food web of a forest ecosystem. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The mountain lion and bobcat are top **predators** in this ecosystem. Their **prey** are ringtails, western whiptails, blacktipped rabbits, pine martens, and mule deer. The pika, red-breasted nuthatch, Douglas's squirrel, and mule deer are **herbivores** because they only eat plants, flowers, nuts, seeds, and fruit, which are all plants. The Pacific tree frog, ringtail, western whiptail, raven, black tipped rabbit, pine marten, coyote, mountain lion, and bobcat, however, are **carnivores** because they only eat pika, red-breasted nuthatch, Pacific tree frogs, Edith's checkerspot, Douglas's squirrel, insects, ringtail, western whiptail, and black-tipped jackrabbits, which are all animals. The Edith's checkerspot is an **omnivore** because it eats both plants and animals. There is a diversity of plants in the forest, including a range of trees, bushes, and herbaceous plants. Some organisms, like the opossum, buzzards, roaches, and crows (not shown) are **scavengers**, which means they feed on the carcasses of dead animals. **Decomposers**, like bacteria, ants, termites, millipedes, and earthworms, feed on organic waste and break it down into inorganic material that can be used by producers. A gall wasp can cause a plant to produce a gall (abnormal growth) in order to create a source of food and shelter in which its larvae develop. The plant suffers wasted energy and nutrients that go into the extra growth. Many bracket fungi destroy the tree they live on, which in turn provides dead material that decomposers must have to survive. Moss often grows on trees to stay shaded but does not harm the tree. Most forest mammals suffer from ticks that can weaken them or infect them with viruses that cause diseases. Cuckoos lay their eggs in the nests of smaller birds. Many birds and bees feast on pollen and benefit the plant by spreading pollen over the forest floor.

Lake Erie Ecosystem

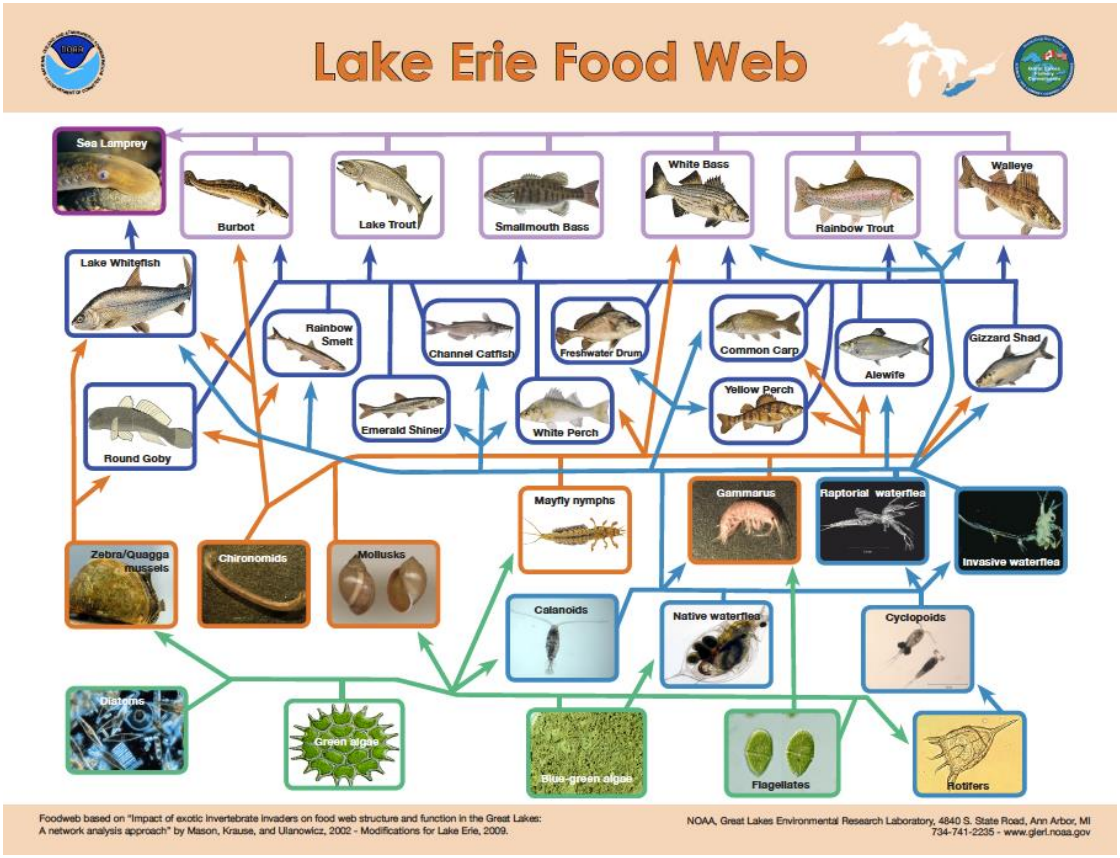


Image source: https://www.glerl.noaa.gov/res/projects/food_web/food_web.html

Above is a food web of the Lake Erie ecosystem. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The rainbow trout and walleye are top **predators** in this ecosystem. Their **prey** are shad, perch, carp, alewife, and waterfleas. The mussels, mollusks (snails), catanoids, mayfly nymphs, gammanus, and waterfleas are **herbivores** because they only eat algae, blue-green algae, diatoms, and flagellates, which are all plants. All of the fish shown, however, are **carnivores** because they only eat other fish, mussels, mollusks, chironomids, mayfly nymphs, waterfleas, gammanus, and cyclopods, which are all animals. The young of several fish species and catenoids are **omnivores** because they eat both plants and animals. There is a diversity of plants in the lake ecosystem, including diatoms, green algae, blue-green algae, and flagellates. Some organisms, like the rotifers, are **scavengers**, which means they feed on detritus (waste). **Decomposers**, like bacteria, worms, and snails, feed on organic waste and break it down into inorganic material that can be used by producers. Sea lamprey are cartilaginous, jawless fish that feed on the body fluids of other fish. Many nematodes (roundworms) are often found in most of the fish species and may be responsible for killing many of the perch. Mollusks attach themselves to plants to more efficiently filter bacteria and algae from the water without harming the plants. Mussels are filter-feeders that remove large quantities of plankton and provide a place for algae and insect larvae to attach.

Arctic (Tundra) Ecosystem

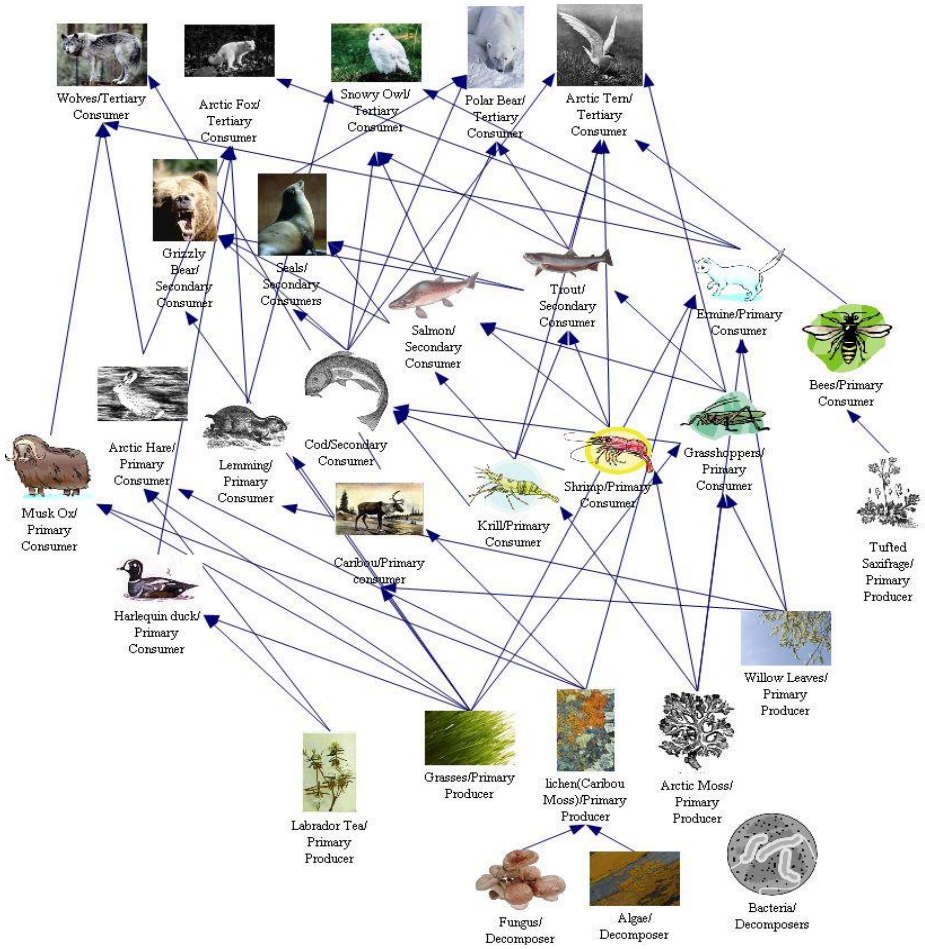


Illustration source: http://cougarbiology.pbworks.com/w/page/9016288/Tundra%20Group%20B

Above is a food web of the arctic ecosystem. Within it are a variety of species that all obtain their food in different ways. A **consumer** is anything living that cannot produce its own food. All animals are consumers because we are unable to make our own food. Plants, however, are **autotrophs** and are capable of producing their own food through photosynthesis.

The polar bear is the top **predator** in this ecosystem. Its **prey** are seals, salmon, trout, and cod. The musk ox, arctic hare, lemming, harlequin duck, krill, shrimp, and grasshoppers are **herbivores** because they only eat Labrador tea, grasses, lichens, Arctic moss, and willow leaves, which are all plants. The polar bears, Arctic fox, snowy owl, Arctic tern, seal, salmon, trout, and cod, however, are **carnivores** because they only eat other fish, krill, shrimp, and grasshoppers, which are all animals. The young of several fish species and catenoids are **omnivores** because they eat both plants and animals. Plants, in the arctic, include willows, Labrador tea, grasses, lichens, Arctic moss, and tufted saxifrage. Some organisms, like the Arctic fox, Arctic wolves, snowy owl, and other birds not shown, are **scavengers**, which means they feed on dead animals. **Decomposers**, like bacteria, fungi, and some algae, feed on organic waste and break it down into inorganic material that can be used by producers. A range of worms have been found in caribou muscles and brains that weaken them along with warbles that contain larvae of the warble fly. Seals are often found with masses of roundworms in their lungs. Lichens dominate the tundra as the primary producer and may be covered in ice and survive for up to three years. Lichens are composed of algae that provide food through photosynthesis and a fungus that retains water and attaches to the rocky surface of the tundra. Arctic foxes follow caribou to find food. The caribou dig up the soil while grazing and expose small mammals that the fox eats. Mosquitoes can appear in swarms so thick that they can turn the sky gray and suffocate caribou. Male mosquitoes feed on nectar and water, but females feed on the blood of birds, caribou, polar bears, and other warm-blooded animals.

SYMBIOTIC RELATIONSHIPS IN _____

Directions: Use the food web and informational text to identify relationship types between different organisms in that ecosystem. Record the names of the organisms in the row for their relationship type. For example, in the + and – row, we would record the Cordyceds fungus as Species A and the ant as Species B. There may be several examples for each relationship type.

Relationship Type	Species A	Species B
+ and + _____		
+ and 0 _____		
+ and - _____		
- and – _____		