

A sea otter is floating on its back in the water, surrounded by kelp. The otter's head is above water, and it is looking towards the camera. The water is dark blue, and the kelp is brown and green. The otter's fur is dark brown and wet.

CHAPTER 21 OF 29 · RESOURCES IN ECOSYSTEMS

Chapter 21: Interactions Among Organisms

Lesson 21: How do species affect each other, and why do the same patterns appear in every ecosystem?

Angela's Wand · Bring Science Alive! 7th Grade Integrated

PHENOMENON

The tree that feeds its own bodyguards

A bullhorn acacia grows fat hollow thorns and leaks sugary nectar from its leaf stalks. The tree cannot eat that sugar, and hollow thorns do not help it grow. Yet a colony of fierce ants moves into the thorns, drinks the nectar, and swarms out stinging whenever anything touches a branch. The acacia stands untouched while nearby trees are stripped bare. Why would a tree pay to feed ants?

- Notice: what does the tree give, and what does it get?
- Notice: what do the ants give, and what do they get?
- Wonder: what happens to the tree if the ants vanish? To the ants if the tree dies?
- Predict: is this a friendship, or is each side acting for itself?





LEARNING TARGETS

What you will be able to do

- 1 Rate an interaction as plus, minus or zero for each partner and name its type.
- 2 Explain how predator and prey populations push each other up and down, with a delay.
- 3 Predict how a change in one population ripples to the others it interacts with.
- 4 Explain why the same five patterns appear in ecosystems with none of the same species.
- 5 Write criteria and constraints for a design problem that involves wildlife, and compare designs.

Five ways two species can meet



One eats the other: **predation** (+ for the eater, – for the eaten).



One lives on or in the other and drains it: **parasitism** (+ –).



Both need the same scarce resource: **competition** (– –).



Both gain: **mutualism** (+ +).



One gains, the other shows no measurable change: **commensalism** (+ 0).





Predation: getting food from another living thing

- A predator gets food by eating all or part of another living organism, the prey.
- In this lesson that includes plant eaters: a deer browsing a seedling is a predator of that seedling.
- Carnivores eat mostly animals. Herbivores eat mostly plants. Omnivores regularly eat both.
- Hunting predators usually kill their prey; grazers usually leave the plant alive but weaker.
- Every ecosystem on Earth has all three kinds, even when the species are completely different.

VOCABULARY IN CONTEXT

Three words for one kind of interaction

predation: An interaction where a predator gets food by eating all or part of another living thing. *A sea otter cracking open a sea urchin, and a sea urchin chewing through a kelp stalk, are both predation.*

predator: The organism that does the eating. Hunters count, and in this lesson so do grazers and browsers. *A desert tortoise is a predator of spring wildflowers.*

prey: The organism that gets eaten, whether it is an animal, a plant or a microbe. *For a Cooper's hawk in a city park, pigeons are prey.*





CHECK FOR UNDERSTANDING

Quick check: which kind of predator?

A coyote living near a Los Angeles canyon eats rabbits and ground squirrels, but also fallen figs, avocados from yards and food from unsecured trash. Which word fits best?

A. Carnivore

B. Herbivore

C. Omnivore

D. Parasite

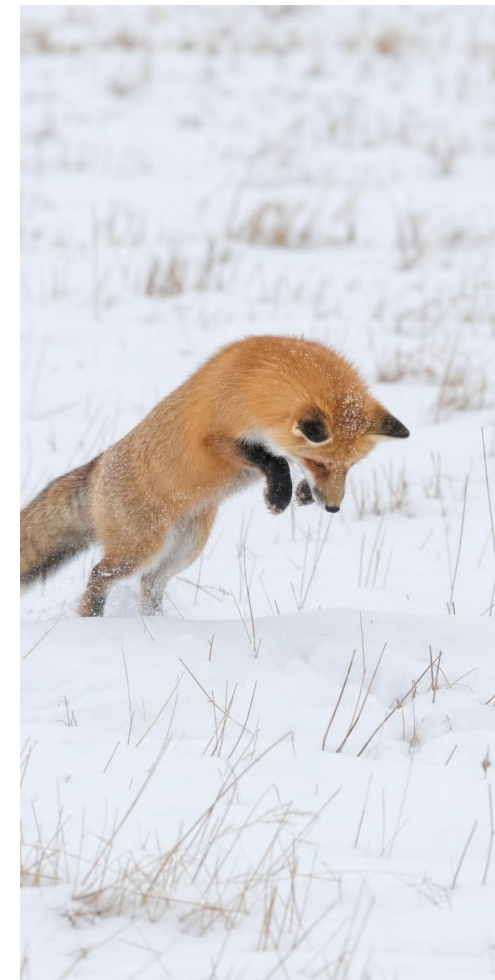
MODEL

Foxes and voles: a teaching graph of two linked populations

Model: Vole and fox counts in a 12-year teaching dataset



x: Year · y: Population size (count)



*Invented numbers for teaching.
Notice that the fox peak (year 6)
comes two years after the vole
peak (year 4).*

Reading the cycle as cause and effect

- More prey means more food, so more predators survive and raise young (after a delay).
- More predators eat more prey, so the prey population falls.
- Fewer prey means predators starve or fail to breed, so the predator population falls.
- Fewer predators means more prey survive, so the prey population rises again.
- Each arrow takes time, which is why predator peaks trail prey peaks.



The predator-prey loop

Model: A repeating cause-and-effect loop

- 1 Prey population rises → (takes a season or more)
- 2 Predators find more food; predator population rises later → (takes a season or more)
- 3 Heavy predation; prey population falls → (takes a season or more)
- 4 Predators go hungry; predator population falls → (takes a season or more)
- 5 Light predation; prey population recovers → (and the loop repeats) (back to the start)

Every arrow takes time, so the predator line always trails the prey line.





THINK, PAIR, SHARE

Discuss: is the predator-prey cycle a law?

- Moose: winter ticks, deep snow, summer heat, the amount of young forest to browse.
- Wolves: disease, inbreeding on a small island, ice bridges that let new wolves arrive.
- The pattern is real, but it is one cause among several, not a rule that works alone.

On Isle Royale, moose numbers fell in the early 2000s and wolf numbers fell a few years later. Is predation the only thing that moved those lines? What else could push a moose or wolf population up or down?

CHECK FOR UNDERSTANDING

Quick check: which comes first?

A biologist graphs a hawk population and the population of the ground squirrels it eats, over fifteen years. If the two are linked by predation, which pattern should she expect?

- A. Hawks peak first, then squirrels peak a year or two later.
- B. Squirrels peak first, then hawks peak a year or two later.
- C. Both peak in the same year, every time.
- D. Squirrels rise and fall while hawks stay the same.





REAL-WORLD CONNECTION

California connection: otters, urchins and kelp

Along the Central Coast, from Monterey Bay south, sea otters eat purple sea urchins. Urchins eat giant kelp, chewing through the stalks near the seafloor. Where otters hunt, urchins stay scarce and kelp forests grow tall enough to shelter fish, crabs and abalone. Where otters are gone, urchins multiply, mow the kelp down, and leave 'urchin barrens' of bare rock. Three species, two predation links, one pattern.

Mutualism: both partners gain

- Acacia and ants: sugar and shelter for the ants; stinging guards and vine removal for the tree.
- Yucca and yucca moth: the moth pollinates the flower and lays eggs; its larvae eat a few seeds.
- Sea turtle and cleaner fish: the fish eat algae off the shell; the turtle stays clean and healthy.
- Lichen: a fungus shelters an alga or cyanobacterium, which makes sugar for both.
- Some partners cannot live apart, so if one population falls, the other can fall with it.





Living on another organism: what is the effect?

- Commensalism: one partner gains, the other shows no measurable change (+ 0).
- Example: barnacles ride a whale to new feeding water; the whale seems unaffected.
- Parasitism: one partner lives on or in the other and takes resources from it (+ -).
- Example: ticks drink blood from a moose; most moose survive, but a heavy load can kill a calf.
- The test is the effect on the host, not where the organism lives.

VOCABULARY IN CONTEXT

Three relationships, decided by the effect on each partner

mutualism: An interaction in which both species gain something that helps them survive or reproduce. *Bees get nectar from clover in a park lawn, and the clover gets pollinated.*

commensalism: An interaction in which one species gains and the other shows no measurable gain or loss. *A burrowing owl nests in a burrow that a ground squirrel dug and abandoned.*

parasitism: An interaction in which one species lives on or in a host and takes resources from it, weakening but usually not killing it. *Feather lice chew the feathers of a pigeon, which then loses more heat in winter.*



The plus-minus-zero grid

Model: Five interactions, rated by the effect on each species

Mutualism (+ +):	Both gain. Acacia and ants; yucca and yucca moth; fungus and alga in a lichen.
Commensalism (+ 0):	One gains; the other shows no measurable change. Barnacles on a whale; lichen on oak bark.
Predation (+ -):	One eats all or part of the other. Otter and urchin; urchin and kelp; deer and seedling.
Parasitism (+ -):	One lives on or in the other and drains it. Tick and moose; lice and pigeon; mistletoe and oak.
Competition (– –):	Both need the same scarce resource and each gets less. Starlings and bluebirds for nest holes.

The species change from ecosystem to ecosystem; these five codes do not.





Competition: both lose, even when one wins

- Two species need the same limited resource: food, nest holes, light, space.
- Each gets less than it would alone, so both populations are minus.
- Starlings usually win nest holes from bluebirds, but defending holes costs starlings too.
- Competition is a pattern from Lesson 20; here it is one of the five interaction codes.
- Managers can reduce a competitor to help a species they want to protect.

CHECK FOR UNDERSTANDING

Quick check: name that interaction

Mistletoe grows on an oak branch and sinks root-like strands into the wood to take water and minerals. Branches beyond it grow slowly and may die back. Which interaction is this?

A. Predation

B. Parasitism

C. Commensalism

D. Mutualism





THINK, PAIR, SHARE

Discuss: is zero ever really zero?

- What would you measure: swimming speed, energy use, skin damage, number of calves?
- If barnacles cost the whale even a little, the label would move toward parasitism.
- If barnacles somehow helped, for example by armoring the skin, it would move toward mutualism.
- Zero means 'no effect we can measure', and labels follow the evidence.

Commensalism gets a 0 for the host. How could a scientist show that a whale carrying hundreds of kilograms of barnacles is truly unaffected? What would change the label if they measured it?

Same patterns, different species

- Kelp forest: otter eats urchin; urchin eats kelp; young rockfish shelter in the kelp canopy.
- Mojave Desert: tortoise eats wildflowers; Joshua tree and yucca moth; mistletoe on catclaw acacia.
- City park: hawk eats pigeons; starlings and bluebirds compete; lice on pigeons; lichen on oaks.
- Rainforest: jaguar eats peccary; leafcutter ants farm a fungus; hummingbirds compete.
- No species in common, yet the same five codes appear in each place.



Task: predict the ripple at High Mesa Preserve

High Mesa Preserve exists to protect kit foxes, but their numbers are falling. Use the interaction table to predict what would happen to kit foxes if coyotes were reduced, and name one other action that should help.

Interaction (teaching scenario)	Effect on kit fox	Effect on the other species	Type
Kit foxes eat kangaroo rats	+	– (kangaroo rat)	predation
Coyotes hunt the same kangaroo rats	–	– (coyote)	competition
Coyotes kill kit foxes they catch	–	+ (coyote)	predation
Fleas live in kit fox fur and drink blood	–	+ (flea)	parasitism
Kit foxes den in burrows badgers dug and left	+	0 (badger)	commensalism
Kangaroo rats eat grass seeds	0 (not directly)	rat +, grass –	predation



Simulated data for practice.
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MISCONCEPTION CHECK

True or false? Remove the predators and the prey will thrive

"The best way to help a deer population in a park is to remove every predator, because then no deer will be killed and the herd will grow and stay healthy."

True or false? Explain your reasoning.



Monitoring wolves: criteria versus constraints

Model: What the Yellowstone tracking tool had to do, and what limited it

Criteria (what success requires)	Constraints (what limits the design)
Shows whether each released wolf is alive	Cost of equipment and staff time
Shows whether wolves stay in the park or leave	Must not change how wolves hunt, travel or breed
Works across more than 3,400 square miles of mountains	Wolves move in packs over hundreds of square miles
Gives data accurate enough to count the population	Rough terrain and winter weather limit where people can go

Scientists chose radio collars with unique signals, read by handheld antennas and from aircraft.





Design brief: shield the frog listener

- Biologists count pond frogs by recording their calls with a sensor near the water.
- A highway on one side drowns out the calls, so the counts are useless.
- Design a shield that cuts highway noise reaching the sensor but leaves the pond side open.
- Criteria you will measure: highway noise drop, frog sound kept, stability in a bump test.
- Constraints: kit credits, build time, size, nothing touching the sensor or crossing the pond line.

The manager's toolkit: using patterns to act

- To help a species, look at every interaction it has and find the minus signs.
- Reduce a predator, a competitor or a parasite, or add prey or partners: each changes a sign.
- Every change ripples: fewer coyotes means more kangaroo rats and maybe less grass seed.
- Monitor the population before and after, or you cannot tell whether the plan worked.
- The same toolkit works in a kelp forest, a desert or a park, because the patterns are shared.





PUTTING IT TOGETHER

Putting it together

- Every interaction between two species can be rated + – 0 for each partner: five patterns.
- Predators and prey push each other up and down, with the predator trailing the prey.
- Mutualists gain together; commensals ride for free; parasites drain a living host.
- The species change from kelp forest to desert to park, but the five patterns do not.
- Precise criteria and constraints let people monitor and manage populations without harming them.

EXIT TICKET

Exit ticket

- Rate the acacia and its ants with + – 0 symbols, name the interaction, and say what each partner gets.
- A fox peak comes two years after a vole peak. Explain the delay in one sentence.
- Lice on a pigeon and lichen on an oak both live on a host. Which is parasitism, and how do you know?
- Write one criterion and one constraint from the frog-sensor shield and label which is which.

