

If One Partner Changes: A Jigsaw on Interaction Rules

Learning target: I can work with a team to classify real interactions from evidence, write rules that predict what happens to one partner when the other partner's population changes, and apply those rules to an ecosystem none of us has studied.

Collaborative investigation

About 50 min

Jigsaw

MS-LS2-2 · practice

collaboration

discussion

writing

Name _____

Date _____

Period _____

Directions

Work in home groups of four. Step 1, expert round (10 minutes): each member takes one expert set of three cards (Set A: cards 1-3; Set B: cards 4-6; Set C: cards 7-9; Set D: cards 10-12) and meets with students from other groups who hold the same set. Together, rate each partner on each card and agree on what happened when one partner's numbers changed. Step 2, home round (25 minutes): return to your home group, teach your set, and complete the rule table and the Granite Basin predictions. Step 3, individual round (15 minutes): answer Part C alone, without help from the group.

You will need: One set of twelve cards per home group, cut apart and sorted into Sets A-D, The Granite Basin change cards (one copy per group), This worksheet for each student, Pencils

Twelve evidence cards: what happened when one partner changed

1 Card 1 (Set A): Sea otters, urchins and kelp, California coast

Sea otters dive for purple sea urchins and eat them. The urchins graze giant kelp. Fur hunters killed nearly all of California's sea otters by the early 1900s. On reefs where the otters were gone, urchins multiplied and chewed the kelp down to bare rock. A small group of otters survived along the Big Sur coast; as it spread, urchins became scarce on those reefs and kelp forests grew back.

2 Card 2 (Set A): Wolves and moose, Isle Royale

On Isle Royale, an island in Lake Superior, wolves are the moose's only large predator, and moose are most of the wolves' food. Over sixty years of counts, wolf numbers often rose a few years after moose numbers rose and fell a few years after moose numbers fell, though disease and hard winters also moved both lines. When disease and inbreeding left only two wolves in the late 2010s, the moose population grew quickly.

3 Card 3 (Set A): Deer and young oaks, oak woodland

Deer browse the leaves and shoots of young oak trees, usually without killing them. Ecologists in many oak woodlands have fenced small plots so that deer cannot enter. After several years, fenced plots hold far more young oaks tall enough to escape browsing than unfenced plots nearby, where the young oaks stay short and are bitten back every year.

4 Card 4 (Set B): Yucca and yucca moth, southwestern deserts

A female yucca moth gathers pollen from one yucca flower, flies to another, lays her eggs inside its seed chamber and presses pollen onto the flower so that seeds form. Her caterpillars eat some of the seeds and leave the rest. The moth caterpillars eat nothing but yucca seeds, and no other insect pollinates these yuccas. Yuccas planted in gardens on other continents flower but set no seed unless people pollinate them by hand.

5 Card 5 (Set B): Figs and fig wasps, warm regions worldwide

Each kind of fig tree is pollinated by its own kind of tiny wasp. A female wasp crawls into a young fig, which is really a closed cluster of flowers, pollinates the flowers and lays eggs in some of them. Her young grow up inside, eating a few developing seeds, and the new females fly off carrying pollen. In the 1880s and 1890s, California farmers planted a Turkish fig whose young fruit kept dropping off; the crop succeeded only after its wasp was brought from the Mediterranean and settled in 1899.

6 Card 6 (Set B): California poppies and their many visitors, grassland

California poppies are visited by many different kinds of bees, beetles and flies. Each visitor gets pollen or a place to rest in the warm flower and carries some pollen to the next poppy. Ecologists find that a flower served by many kinds of visitors usually keeps setting seed when one kind of visitor becomes rare, because the others fill in. A flower that depends on a single kind of visitor is hit much harder.

7 Card 7 (Set C): Winter ticks and moose, New England forests

Winter ticks climb onto moose in autumn and drink their blood all winter; one moose can carry tens of thousands. In years when autumn is long and snow comes late, tick numbers boom, and many moose calves are too weakened by blood loss to survive until spring. In years with fewer ticks, more calves survive. Each winter tick spends its whole feeding life on a single large mammal, such as a moose, deer or elk, and cannot develop without one.

8 Card 8 (Set C): Gray whales and gray whale barnacles, Pacific Ocean

One kind of barnacle settles only on the skin of gray whales and nowhere else. The adult barnacles filter tiny food from the water as the whale swims along its migration route. Scientists have not measured any harm or benefit to the whales from carrying them. Because the barnacle lives on no other surface, the number of places it can live depends on how many gray whales there are.

9 Card 9 (Set C): Cattle egrets and grazing animals, pastures

Cattle egrets are small white herons that walk beside grazing cattle, horses and wild grazers, catching grasshoppers and other insects that the grazers' feet flush from the grass. Egrets feeding beside grazers catch more food with fewer steps than egrets feeding alone. The grazers show no measured gain or loss. Over the last 150 years, as cattle ranching spread, cattle egrets spread from Africa to the Americas, including California, and became common wherever there were pastures.

10 Card 10 (Set D): Barred owls and spotted owls, Pacific Northwest and northern California forests

Barred owls spread west from eastern North America during the 1900s and now share old forests with northern spotted owls. Both hunt flying squirrels, woodrats and other small mammals, and both need big trees with nest sites; the larger barred owls drive spotted owls out of their territories. In a large experiment, barred owls were removed from some study areas. Spotted owls there nearly stopped declining, while in comparison areas where barred owls stayed, spotted owls kept declining.

11 Card 11 (Set D): Starlings and bluebirds, parks and farmland

European starlings, released in New York in 1890, spread across North America. They nest in tree holes, as bluebirds do, and there are only so many holes; starlings are larger and take over many of them, and both species spend time and energy fighting for holes. Volunteers have put up thousands of bluebird nest boxes with entrance holes too small for a starling. Along these 'bluebird trails', bluebird numbers rose.

12 Card 12 (Set D): Yellow starthistle and native plants, California grassland

Yellow starthistle, a spiny weed from the Mediterranean, now covers millions of acres of California grassland. Its deep roots use up soil water in summer, leaving less for native grasses and wildflowers growing in the same soil. Where land managers have controlled starthistle, more water stays in the soil and native plants can increase. Where native perennial grasses are thick, starthistle seedlings have a harder time getting started.

Part A: Expert round (one set per person)

1. Your expert set: _____. For each of your three cards, name the two main partners, rate the effect on each (+, – or 0) and name the interaction. Then write one sentence describing what happened to one partner when the other partner's numbers changed.

Part B: Home group task

1. Each expert teaches the group their three cards in two minutes or less: the partners, the codes, and what happened when one partner changed.
2. Together, fill in one row of the rule table for each interaction type. Every rule must name at least one card as its evidence.

3. Check each rule against the cards from the other sets. If a card breaks a rule, rewrite the rule (card 6 is a good test for the mutualism row).
4. Read the four Granite Basin change cards. For each one, decide which interaction is involved, then use your rules to predict what happens.
5. Before Part C, make sure every member can explain one rule and one Granite Basin prediction without notes.

2. Group answer: complete the rule table.

Code (+, -, 0)	If the first partner becomes scarce, the second partner usually...	If the second partner becomes scarce, the first partner usually...	Evidence card(s)
Predation (first: predator; second: prey)			
Parasitism (first: parasite; second: host)			
Commensalism (first: the partner that gains; second: the unaffected partner)			
Mutualism (the two partners)			
Competition (the two competitors)			

Granite Basin change cards (a high Sierra lake and meadow; teaching scenario) – Change 1. Trout stocked in the lake decades ago eat the tadpoles of mountain yellow-legged frogs. Managers remove every trout from the lake. **Change 2.** Clark's nutcrackers bury whitebark pine seeds in autumn and dig most of them up to eat later; the seeds they forget sprout into new pines, and pine seeds are the nutcrackers' main winter food. A disease kills many of the whitebark pines. **Change 3.** Two kinds of bumblebees gather nectar from the same few meadow flowers, and there is not enough nectar for both. A cold spring kills most of one kind. **Change 4.** Yosemite toads shelter from midday heat in the side tunnels of Belding's ground squirrel burrows; as far as scientists can tell, the squirrels are not affected. A disease kills most of the ground squirrels, and their burrows slowly collapse.

3. Group answer: predict the effect of each Granite Basin change.

Interaction and codes	Prediction (which species, up or down) over the next few years	Rule from your table that you used
Change 1		
Change 2		
Change 3		
Change 4		

Part C: Individual accountability (complete alone)

4. Explain the rule your expert set taught the group, using one card from your set as evidence. Include the interaction's code.

5. Fleas live in the fur and burrows of California ground squirrels in a park and drink the squirrels' blood. A dry year cuts the squirrel population in half. Predict what happens to the flea population over the next year, and name the interaction and the rule you used.

6. The commensalism rule works in only one direction. Using the code + 0 and cards 8 and 9, explain why a change in the host matters to the commensal partner but a change in the commensal partner does not matter to the host.

7. The cards came from oceans, islands, deserts, forests, grasslands and pastures, and almost no species appeared twice. Explain why your group could still write one set of rules that works in all of them. Then use one rule to predict a change in an ecosystem none of the cards describes, such as a coral reef, the Arctic tundra or a city park: name the two partners (real or described in general terms), the interaction, the change and your prediction.

8. Rules can give wrong predictions. Using card 2 or card 6, describe one condition that makes a rule less reliable, and explain how a scientist should word a prediction because of it.

Start every card with two arrows

For each card, draw two boxes with the partners' names and two arrows between them. On the arrow from A to B, write what A does to B (+, – or 0); on the arrow back, write what B does to A. Then underline the sentence on the card that says what happened when one partner's numbers changed, and write 'up' or 'down' beside the other partner. Your rule is that sentence turned into an 'If..., then...' statement: 'If the predator becomes scarce, then the prey usually...'

A rule for three species

Card 1 links three species: otters eat urchins and urchins eat kelp. Write a rule for what happens to the kelp when the otters change, and test it against card 3 (what happens to young oaks when deer change) and Granite Basin Change 1 (what might happen to the insects the frogs eat when trout are removed). Explain why an effect that passes through a middle species can be harder to predict than a direct one, and name one thing that could stop the effect from reaching the third species.