

What Sets the Limit? A Twelve-Ecosystem Evidence Jigsaw

Learning target: I can work with a team to sort evidence from many ecosystems by what limits or shapes the organisms there, find the patterns that repeat on land and in water, and use them to predict what limits life in a new place.

Collaborative investigation

About 50 min

Jigsaw

MS-LS2-2 · practice

MS-LS2-1 · practice

collaboration

discussion

reading

Name _____

Date _____

Period _____

Directions

Work in home groups of four. Step 1, expert round (12 minutes): each member takes one expert set of three cards (Set A: cards 1-3, life on land; Set B: cards 4-6, life in water; Set C: cards 7-9, two species and one resource; Set D: cards 10-12, a resource and the bodies of individuals). Meet with the students from other groups who hold the same set, agree on what limits or shapes the organisms on each card, and answer Part A. Step 2, home round (22 minutes): return to your home group, teach your three cards in two minutes or less each, then complete the group record and Part B together. Every member must be able to explain any row of the group record. Step 3, individual (12 minutes): answer Part C alone, without help from the group.

You will need: One set of twelve cut-apart cards per home group, This worksheet for each student, Pencil, Highlighter (optional) for marking evidence sentences

Twelve evidence cards from real ecosystems (teacher cuts these apart)

1 Card 1: Desert wildflowers after a wet winter

In the Colorado Desert of southern California, the seeds of annual wildflowers can wait in the soil for years. After a winter with soaking rains spread over several weeks, millions sprout at nearly the same time and whole hillsides turn orange, purple and yellow; Anza-Borrego Desert State Park had famous blooms like this in 2017 and 2019. After a dry winter, only a scattered few come up, even though the sunlight and the soil are the same.

2 Card 2: Coast redwoods and summer fog

Coast redwoods grow naturally only in a narrow strip along the Pacific coast, from the southwest corner of Oregon to southern Monterey County in California. Summers there bring almost no rain, but fog rolls in off the ocean on many days. Fog droplets collect on the needles and drip to the ground, and the trees can also take some fog water in directly through their needles. Researchers measuring one redwood forest found that fog drip supplied about a third of all the water the ground received in a year.

3 Card 3: Treeline in the high Sierra Nevada

On the highest slopes of the Sierra Nevada, forests thin out and stop at a line called the treeline. Above it, snowmelt keeps parts of the soil wet and summer sunlight is strong, yet no trees grow, only low grasses, cushion plants and wildflowers. The growing season there lasts only about two months, and nights can freeze even in July. Scientists who compare treelines around the world find that they sit where the growing season is too cold for trees to build new wood.

4 Card 4: How deep can a lake plant grow?

In a clear mountain lake, rooted water plants and bottom-dwelling algae can grow many meters down, because enough sunlight reaches the lake floor. In a muddy lake, where stirred-up silt clouds the water, the same kinds of rooted plants grow only in a narrow band of shallow water near the shore. In both lakes the plants have water all around them and nutrients in the mud.

5 Card 5: Fertilizer and a green lake

After heavy spring rains wash fertilizer from farm fields into a lake, the water can turn pea-soup green within a few weeks as algae multiply into a bloom. Fertilizer adds nitrogen and phosphorus, nutrients the algae need. When the bloom dies, bacteria that break down the dead algae use up much of the oxygen dissolved in the deeper water, and fish living there can die.

6 Card 6: Coral reefs in shallow, clear, warm water

Reef-building corals have single-celled algae living inside their tissues. The algae make food from sunlight and share much of it with the coral. Coral reefs grow mostly in shallow, clear, warm tropical seas, and mud washed from the land that clouds the water slows their growth. When the water stays a degree or two hotter than its usual summer maximum for several weeks, the corals expel their algae and turn white, which is called bleaching. If the heat lasts, many of the corals die.

7 Card 7: Two barnacles, one rocky shore

On a rocky shore in Scotland, two barnacle species live attached to the rocks. One lives high on the shore, where the falling tide leaves the rocks dry for hours; the other lives lower down. Young barnacles of the upper species also settle on the lower rocks, but there the lower species grows faster and crowds them out, smothering, undercutting and crushing them. When an ecologist scraped the lower species off some rocks, the upper species survived lower on the shore.

8 Card 8: Zebras and wildebeest on the Serengeti

On the Serengeti plains of East Africa, huge herds of zebras and wildebeest graze the same grasslands. Zebras tend to eat the taller, tougher grass stems, while wildebeest tend to eat the shorter, leafier grass, and herds often move across the plains with zebras ahead and wildebeest following. In the dry season, when grass is short and scarce everywhere, both herds must travel long distances to find enough to eat.

9 Card 9: Two kinds of Paramecium in one tube

In the 1930s the Soviet biologist Georgy Gause grew two species of Paramecium, single-celled organisms that eat bacteria. Grown in separate tubes, each given the same small amount of food every day, each species increased and then leveled off. Grown together in one tube with that same daily food, one species grew and held its numbers while the other declined until it disappeared from the tube.

10 Card 10: Acorn woodpeckers in a lean year

Acorn woodpeckers in California's oak woodlands live in family groups that store thousands of acorns in holes drilled into a 'granary' tree, then eat them through the winter and spring. Researchers in Carmel Valley have followed these groups for decades. In years when the oaks produce few acorns, many groups skip nesting and fewer young are raised; after a big acorn year, more groups breed and the population grows.

11 Card 11: Starving urchins on bare rock

Off the coast of Northern California, bull kelp forests shrank sharply after 2014, when a marine heat wave and a disease that killed most of the sea stars that eat urchins struck at about the same time. Purple sea urchins multiplied and ate much of the remaining kelp, leaving stretches of bare rock called urchin barrens. Urchins in a barren survive by scraping thin films off the rock, but they are starving: they hold very little of the egg-making tissue that fills a well-fed urchin in a kelp forest.

12 Card 12: Why flamingos are pink

Flamingos are pink because of red and orange pigments called carotenoids in the algae and tiny shrimp they eat; the birds deposit the pigment in their feathers as the feathers grow. Flamingo chicks are gray. In zoos, flamingos fed a diet with no carotenoids grow pale, nearly white feathers, so zoo keepers add carotenoids to their food.

Three questions for every card — (1) **What limits or shapes the organisms?** Name one specific thing. (2) **Is it a resource or a condition?** A resource is taken in or used up, so there is less for others (food, water, light, nutrients, space). A condition affects organisms but is not used up (temperature, how salty or acidic the water is). If it is a resource, is it biotic (living or from living things) or abiotic? (3) **What does it change?** Where a species can live, how many individuals there are, or the bodies of individuals (their growth, color or health).

Part A: Expert round (one set per person)

1. Your expert set: _____. For each of your three cards, answer the three questions in the box above, and copy the one sentence from the card that is the best evidence for your answer to question 1. Then write one sentence that says what your three cards have in common.

Part B: Home group task

1. Each expert teaches their three cards in two minutes or less, reading the evidence sentence aloud.
2. As a group, fill in one row of the group record for each card. If the group disagrees about a row, write both answers and the reason for each.
3. Lay the twelve cards in two piles: cards where a **resource** is the main story and cards where a **condition** matters. Some cards belong in both piles; place them between the piles.
4. Answer q2, q3 and q4 together. Write the group's answer, not just one person's.
5. Choose one member to explain the q2 rule to the class; your teacher may call on any member instead.

Group record (fill in)

Card	What limits or shapes the organisms?	Resource (biotic or abiotic) or condition?	What it changes: where they live, how many, or individual bodies	Competition shown? (within a species, between species, or not shown)
Card 1				
Card 2				
Card 3				
Card 4				
Card 5				
Card 6				
Card 7				
Card 8				
Card 9				
Card 10				
Card 11				
Card 12				

- 2.** Group answer: Write a two-part rule that predicts what usually limits plant and algae growth **on land** and **in water**. Support each part with two cards. Then name the card that does not fit either part of your rule neatly, and explain why.

3. Group answer: Cards 7, 8 and 9 all show competition between species. For each card, name the shared resource. Then explain why the competitors on two of the cards could not keep living in the same place, while the competitors on the third card could.

4. Group answer: Card 6 involves both a resource and a condition. Name each one, and explain why you need both to explain where coral reefs grow. Then find one other card that involves both, and name its resource and its condition.

Part C: Individual accountability (complete alone)

A new ecosystem. Along the California coast in spring and summer, steady winds push surface water away from the shore, and cold water rises from the deep to replace it. This rising deep water, called upwelling, carries nitrogen and other nutrients that have built up in the deep, dark water. Sunlight is strong at the surface both near shore and far out at sea. Where upwelling is strong, phytoplankton (drifting, single-celled algae) multiply, small fish such as anchovies that eat them grow plentiful, and seabirds and sea lions feed on the anchovies. In some years the winds are weak and little deep water rises.

5. In the upwelling story, what is the limiting resource for the phytoplankton? Say whether it is biotic or abiotic, explain why sunlight is **not** the limiting resource here, and name the card that works most like this one.

6. Predict what happens to the phytoplankton, the anchovies and seabird chicks in a year when upwelling is weak. Trace the chain of causes, and say whether the effect on the chicks would show up in their **numbers**, their **bodies**, or both.

7. Cards 3 and 4 both describe a line beyond which plants stop growing. Explain why one line is set by a condition and the other by a resource.

8. Card 12 and the poison dart frogs from earlier in this chapter tell the same kind of story, while card 10 tells a different kind. Explain what kind of story each one is, using the words **resource**, **organism** and **population**.

Sentence starters for experts and teachers

Use these when you teach your cards: 'On this card, the organisms are _____. The thing that limits or shapes them is _____. It is a (resource / condition) because _____. The evidence sentence is _____. It changes (where they live / how many there are / their bodies).' If you are stuck on resource versus condition, ask: 'If one organism uses it, is there less left for the next one?' If yes, it is a resource.

Write card 13

Research one California ecosystem not on the cards (for example a vernal pool, a desert spring, Mono Lake, or a chaparral slope after a fire) and write a thirteenth card in the same style: four or five sentences, real facts only, and no answer given away. Then write the group-record row for your card on the back, and name one source you used. Trade cards with another group and check whether they fill in the row the way you intended.