

When the Coyotes Left: A Claim-Evidence-Reasoning Case

Learning target: I can use population data from two neighboring sites to argue that removing one population changed others through direct and indirect effects, and explain my reasoning with a food web model.

Claim, evidence, reasoning

About 45 min

Individual

MS-LS2-4 · practice

MS-LS2-3 · supports

writing

data analysis

Standards connections

MS-LS2-4 (practice): Students construct an argument from patterns in population data that a change to a biological component (removing coyotes) affected other populations. The data are simulated, so this builds the practice rather than producing evidence with real empirical data.

MS-LS2-3 (supports): The reasoning section asks students to explain the pattern using the food web as a model of how matter and energy move from grass to jackrabbits to coyotes, which is the model this PE develops.

Purpose: practice · **Time:** about 45 minutes · **Format:** individual

Answers with reasoning

The scenario

Dry Creek Ranch and Oak Flat Ranch sit side by side in the foothills, with the same soil, the same grasses and the same weather. In spring 2018 the owner of Dry Creek began trapping and removing coyotes to protect newborn lambs. Oak Flat did nothing. A county biologist had been surveying both ranches since 2016, so she kept going. Each spring she drove a 10-kilometer route and counted coyotes, walked a 1-kilometer line and counted black-tailed jackrabbits, and measured the percent of ground covered by living grass in ten sample plots.

Food web facts for both ranches — Grasses are the main producers. Black-tailed jackrabbits eat grass; an adult can eat close to its own mass in green plants each week. Coyotes eat jackrabbits (their main prey here), as well as ground squirrels and mice. Nothing on these ranches hunts coyotes. Rainfall in the six years was close to average every year and nearly identical on the two ranches.

Spring surveys on two neighboring ranches, 2016-2021 (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Dry Creek: coyotes per 10 km	Dry Creek: jackrabbits per km	Dry Creek: grass cover (%)	Oak Flat: coyotes per 10 km	Oak Flat: jackrabbits per km	Oak Flat: grass cover (%)
2016	6	4	62	5	5	60
2017	5	5	60	6	4	61
2018	2	9	55	5	5	59
2019	1	16	41	6	4	58
2020	1	21	33	5	6	57
2021	1	19	30	5	5	59

Simulated data for teaching. Coyote removal at Dry Creek began in spring 2018. Oak Flat is the comparison site with no removal.

Warm-up: organize the evidence

1. At Dry Creek, by how many times did the jackrabbit count change from 2017 to 2020? By how many percentage points did grass cover change over the same years? Show both calculations.

Answer: Jackrabbits: $21 \div 5 = 4.2$, so the count rose a little more than 4 times. Grass cover: $60\% - 33\% = 27$ percentage points lower in 2020 than in 2017.

Why: Both calculations use the Dry Creek columns only. The jackrabbit change is a ratio; the grass change is a difference in percentage points.

Also acceptable: Accept 'about 4 times' and '27 points' or 'dropped by 27'.

2. Describe what happened to jackrabbits and grass cover at Oak Flat between 2016 and 2021. Why does the biologist need Oak Flat at all?

Answer: At Oak Flat, jackrabbits stayed between 4 and 6 per km and grass cover stayed between 57 and 61 percent; neither showed a trend. Oak Flat is the comparison (control) site: because it shares weather, soil and grasses with Dry Creek, any change that appears only at Dry Creek is more likely caused by the one thing that differed, the coyote removal.

Why: The control site is what lets the argument rule out weather and other shared causes.

Also acceptable: Accept 'it is the control' with a reason.

- States that Oak Flat values stayed roughly flat with numbers
- Explains Oak Flat as a comparison that rules out shared causes

3. Draw the three-organism food chain for these ranches with arrows (grass, jackrabbits, coyotes). Label which pair of populations would show a direct effect of removing coyotes and which would show an indirect effect.

Answer: Grass → jackrabbits → coyotes (arrows point to the eater). Direct effect: coyotes and jackrabbits (coyotes eat jackrabbits). Indirect effect: coyotes and grass, passed through the jackrabbit population.

Why: The chain is the model the reasoning section will use; arrow direction and the two labeled pairs are the checks.

Also acceptable: A student who adds ground squirrels and mice as other coyote prey is correct; the labels must still be right.

- Arrows run from food to eater
- Direct effect labeled on the coyote-jackrabbit link
- Indirect effect labeled between coyotes and grass through jackrabbits

Your argument

Answer: Claim: Removing coyotes from Dry Creek caused the jackrabbit population to rise sharply and, as a result, caused the grass cover to fall. Evidence: (1) Coyotes at Dry Creek fell from 5 per 10 km in 2017 to 1 in 2019 and stayed at 1 through 2021, while Oak Flat coyotes stayed at 5 or 6 every year. (2) Jackrabbits at Dry Creek rose from 5 per km in 2017 to 9 in 2018, 16 in 2019 and 21 in 2020, more than 4 times higher, while Oak Flat jackrabbits stayed between 4 and 6. (3) Grass cover at Dry Creek fell from 60 percent in 2017 to 41 percent in 2019 and 33 percent in 2020, while Oak Flat stayed between 57 and 61 percent. (4) Timing: coyotes dropped first (2018), jackrabbits were already up the same spring and kept climbing, and the big grass drop came the following year (2019). Reasoning: In the food web, coyotes eat jackrabbits, so fewer coyotes means fewer jackrabbits are eaten and more survive to breed; that is a direct effect, and it explains why jackrabbits rose right after removal began. Jackrabbits eat grass, so more jackrabbits remove more grass; coyotes never touch grass, so the grass decline is an indirect effect that reaches the grass through the jackrabbit population. The grass lagged a year because the jackrabbit population had to grow before its grazing could remove a large share of the cover. Oak Flat had the same rain and the same grasses but no removal, and its jackrabbits and grass did not change, so weather or soil cannot explain the Dry Creek pattern; only the coyote removal differed. The pattern matches the model's prediction for removing a predator from a three-level chain.

Why: This is the solved model response. Full credit requires a cause-and-two-effects claim, three or more pieces of evidence with years and numbers including the Oak Flat comparison and the timing, and reasoning that labels the direct and indirect effects, explains the lag, and uses the control site.

Also acceptable: A student who claims only the jackrabbit effect can earn partial credit on the claim and full credit on the evidence if the grass numbers are still cited. A claim that the grass drop caused the jackrabbit rise reverses cause and effect and contradicts the timing.

- Claim names the coyote removal as cause and both the jackrabbit rise and the grass decline as effects
- At least three evidence items with years and values
- Evidence includes an Oak Flat comparison and a timing statement
- Reasoning labels the jackrabbit change direct and the grass change indirect
- Reasoning explains the one-year lag and the role of the comparison site

4. Jackrabbit counts at Dry Creek dipped from 21 to 19 in 2021 while coyotes stayed at 1. Suggest one food-web reason for the dip, and say what data from 2022 would support your suggestion.

Answer: With grass cover down to 30 percent, the jackrabbits may be running short of food, so fewer survive or breed; a shrinking food supply limits the population even without predators. Supporting 2022 data would show jackrabbits falling further while grass stays low (or begins to recover as grazing pressure eases), with coyotes still at 1.

Why: This connects the chapter to resource limits (MS-LS2-1) and shows that effects run both ways along an arrow.

Also acceptable: Accept disease or crowding as a reason if the student says what 2022 data would show; accept 'jackrabbits begin to fall and grass begins to recover.'

- Gives a food-web reason tied to grass as food
- Names a 2022 pattern that would support it

5. A rancher says, 'The grass died because 2019 and 2020 were dry years.' Use one specific comparison from the table to show why the data do not support that explanation.

Answer: Oak Flat had the same rain in 2019 and 2020, yet its grass cover stayed at 58 and 57 percent while Dry Creek's fell to 41 and 33 percent. If dry years caused the loss, both ranches would have lost grass; only the ranch that removed coyotes did.

Why: The control comparison is the direct refutation; the scenario also states rainfall was near average and identical.

Also acceptable: Accept the scenario's statement that rainfall was close to average as an additional point, but the table comparison must be present.

- Cites Oak Flat grass values for 2019 or 2020
- Explains that shared weather cannot explain a change at one site only

Scoring rubric

Criterion	4 • Exemplary	3 • Proficient	2 • Developing	1 • Beginning
Claim	States the cause (coyote removal) and both effects (jackrabbits up, grass down) in one clear statement about Dry Creek.	States the cause and one effect clearly; the second effect is missing or vague.	States an effect without the cause, or reverses cause and effect.	No claim, or a claim unrelated to the data.
Evidence	Three or more specific pieces of evidence with years and values, including an Oak Flat comparison and a statement about timing.	Three pieces with numbers, but the comparison site or the timing is missing.	One or two pieces, or evidence described without numbers.	Evidence missing, invented, or contradicting the table.
Reasoning	Uses the food web to label the jackrabbit change as direct and the grass change as indirect, explains the one-year lag, and uses Oak Flat to rule out other causes.	Labels direct and indirect effects correctly and links evidence to claim, but omits the lag or the control-site argument.	Restates the evidence or uses the effect terms incorrectly.	No reasoning, or reasoning that ignores the food web.

Scientific language and accuracy	Uses population, producer, consumer, direct effect and indirect effect correctly; no scientific errors; distinguishes percentage points from percent change.	Terms mostly correct; one minor slip.	Several terms used loosely (for example, calling the grass decline a direct effect).	Scientific language absent or consistently wrong.
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Teacher notes

The data are simulated and designed so that the control site is essential: the Dry Creek pattern alone could be blamed on weather, which is the rancher's claim in q5. The one-year lag between the jackrabbit rise and the grass decline is deliberate and is the hardest part of the reasoning; prompt students to ask what has to happen before grazing can lower cover. The 2021 jackrabbit dip previews resource limits (MS-LS2-1). The scenario resembles real predator-removal studies but is not one; do not present it as a documented case. The coyote-jackrabbit-grass chain is a simplification: real coyotes eat many prey, which the extension begins to address.

Scaffold offered to students: Three-row evidence chart

On scrap paper, make a chart with three rows (coyotes, jackrabbits, grass) and two columns (Dry Creek, Oak Flat). In each cell write the 2017 value, the 2020 value, and an arrow showing up, down or flat. Every cell that shows a change at Dry Creek but not at Oak Flat is a piece of evidence. Copy the numbers into your Evidence box with the years.

Extension: Add the ground squirrels

Coyotes also eat ground squirrels, and ground squirrels compete with jackrabbits for the same grass. Suppose the biologist adds a squirrel count and finds that squirrels rose in 2018 and 2019 at Dry Creek but then fell in 2020 and 2021. Write a paragraph explaining both the rise and the later fall using direct and indirect effects, and explain why adding a fourth population makes the argument about grass stronger, not weaker.