

# Fixing Jordan's Argument About the Pine Creek Dam

**Learning target:** I can find the errors in a fictional student's argument about an ecosystem change, explain why each is wrong, and rewrite the argument so that the evidence actually supports it.

Error analysis

About 40 min

Individual

MS-LS2-4 · practice

MS-LS2-1 · supports

writing

independent practice

## Standards connections

**MS-LS2-4** (practice, evaluating empirical evidence supporting arguments about changes to ecosystems, named in the clarification statement): Students judge whether a two-year before-and-after comparison supports a cause, bring in a comparison stream and more years, and rewrite the argument with a mechanism. Evaluating the evidence behind an argument builds directly toward the PE; the full argument is assessed in W6.

**MS-LS2-1** (supports): The rewrite explains the trout decline through a resource the dam changed, cold water rich in oxygen, using the resource-population link from Lesson 20.

**Purpose:** practice · **Time:** about 40 minutes · **Format:** individual

## Answers with reasoning

### The situation

Pine Creek is a cold mountain stream. In the spring of 2015 a small dam was finished across it to store water for irrigation, and the stretch just above the dam became a slow, warm reservoir. Jordan's class has a survey reach in that stretch. Cedar Creek, 3 kilometers away, is similar in size, elevation and forest cover, and it has no dam. Every September since 2011, volunteers have counted rainbow trout in a reach of each creek, and every July they have recorded the water temperature.

1. Before the dam, Pine Creek was in perfect balance, and its trout population never changed.
2. In 2014 we counted 64 trout and in 2016 we counted 22. This proves that the dam caused the trout to decline.
3. The dam changed a living part of the ecosystem, because trout are living things.
4. The dam destroyed the Pine Creek ecosystem. Nothing lives there now.
5. Western pond turtles moved into the reservoir from a nearby pond after 2016, so they are an invasive species.
6. If the dam is removed, the creek will go back to exactly the way it was within a year.

**Other notes from Jordan's class** — Since the dam was built, the survey reach has had more dragonfly larvae and water striders, a few western pond turtles, and far fewer stonefly larvae. Western pond turtles are native to this region; these ones walked over on their own from a pond 400 meters away. Rainbow trout need cold water with plenty of dissolved oxygen, and warm water holds less dissolved oxygen than cold water.

### Rainbow trout counts and July water temperature, 2011 to 2020 (teaching dataset)

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

| Year | Pine Creek trout | Pine Creek July water (°C) | Cedar Creek trout | Cedar Creek July water (°C) |
|------|------------------|----------------------------|-------------------|-----------------------------|
| 2011 | 58               | 14                         | 61                | 14                          |
| 2012 | 71               | 15                         | 66                | 14                          |
| 2013 | 52               | 14                         | 55                | 15                          |
| 2014 | 64               | 15                         | 63                | 14                          |
| 2015 | 40               | 18                         | 58                | 15                          |
| 2016 | 22               | 21                         | 49                | 15                          |
| 2017 | 18               | 22                         | 60                | 14                          |
| 2018 | 15               | 22                         | 57                | 15                          |
| 2019 | 12               | 23                         | 62                | 14                          |
| 2020 | 14               | 22                         | 59                | 15                          |

Simulated data for teaching. The Pine Creek dam was finished in spring 2015. Cedar Creek has no dam. Trout are counts in the same reach of each creek every September.

## Part A: Diagnose

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1. Complete the table for all six of Jordan's statements. A statement that is partly right still counts as needing a fix; name the part that is wrong.

**Answer:** 1. Incorrect: ecosystems are dynamic systems; Pine Creek's trout varied from 52 to 71 before the dam. 2. Partly correct: the counts are real and a decline did happen, but two years cannot prove a cause; there is no comparison creek, no record of normal variation, and no mechanism. 3. Incorrect: the dam changed physical components (water speed, depth and temperature); the trout population is a biological component that responded. 4. Incorrect: the ecosystem changed but did not die; still-water animals such as dragonfly larvae, water striders and pond turtles increased. 5. Incorrect: the turtles are native and arrived on their own; an invasive species is one that people moved into a new area and that spreads and causes harm. 6. Incorrect: recovery after a disturbance takes years of succession, and the creek may not return to exactly its old state.

**Why:** Each statement carries a different chapter misconception: a balanced, unchanging nature; a pattern taken as proof; physical versus biological components; change equated with destruction; 'new species' equated with 'invasive'; recovery as quick and exact.

*Also acceptable: Accept 'incorrect' for statement 2 if the student explains that the word 'proves' makes the whole statement wrong.*

- All six judged correctly (statement 2 as partly correct)
- Each error named in a phrase that matches the chapter idea

## Part B: Explain and rewrite

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2. Statement 1: Use the 2011 to 2014 rows to show that Pine Creek's trout numbers changed even before the dam. Then rewrite the statement using the term **dynamic system**.

**Answer:** Before the dam, Pine Creek's counts were 58, 71, 52 and 64, so the population rose and fell by as many as 19 trout from one year to the next. Rewrite: 'Pine Creek is a dynamic system: its trout population rose and fell from year to year even before the dam, so a change between two years is not surprising by itself.'

**Why:** The point is that change is normal in ecosystems; what needs explaining is a change larger or longer-lasting than the normal ups and downs.

*Also acceptable: Accept any accurate rewrite that drops 'perfect balance' and 'never changed'.*

- Uses at least two pre-dam counts to show variation
- Rewrite uses 'dynamic system' correctly

3. Statement 2: Calculate the average trout count for 2011 to 2014 and for 2017 to 2020 in **both** creeks, and the percent decrease in each. Use  $(\text{before} - \text{after}) \div \text{before} \times 100$ . Show your work.

**Answer:** Pine Creek before:  $(58 + 71 + 52 + 64) \div 4 = 245 \div 4 = 61.25$ . After:  $(18 + 15 + 12 + 14) \div 4 = 59 \div 4 = 14.75$ . Decrease:  $(61.25 - 14.75) \div 61.25 \times 100 = 46.5 \div 61.25 \times 100 = 75.9$  percent. Cedar Creek before:  $(61 + 66 + 55 + 63) \div 4 = 245 \div 4 = 61.25$ . After:  $(60 + 57 + 62 + 59) \div 4 = 238 \div 4 = 59.5$ . Decrease:  $(61.25 - 59.5) \div 61.25 \times 100 = 1.75 \div 61.25 \times 100 = 2.9$  percent.

**Why:** The two creeks started with the same average, so the difference after the dam (about 76 percent versus about 3 percent) is large and clear.

*Also acceptable: Accept 76 percent and 3 percent. Students who use 2015 or 2016 in the 'after' average will get somewhat different numbers; the question specifies 2017 to 2020 so that the transition years are left out.*

4. Statement 2, continued: Name two things Jordan's 2014-versus-2016 comparison was missing, and explain how the full table supplies them. Is 'proves' the right word? Suggest a better one.

**Answer:** Missing: (1) a comparison creek without a dam; Cedar Creek supplies it, and its trout stayed near 60 (61.25 before, 59.5 after). (2) Enough years to see normal variation; the table shows four years before and six after, and Pine's counts stayed low for five years in a row. Jordan's chosen year, 2016, was also a low year at Cedar (49), so the two-year comparison exaggerated the drop. (A mechanism is also missing; see q5.) 'Proves' claims more than science can give; better words are 'supports' or 'is strong evidence that'.

**Why:** This item names the features of a strong argument from slide 22: with-and-without, repetition over time, and a mechanism, plus careful wording.

*Also acceptable: Accept 'other possible causes are not ruled out' as one missing element if the student says Cedar Creek is how the table rules them out.*

- Names two missing elements (comparison site, more years, or mechanism)
- Explains how the table supplies them, with at least one number
- Replaces 'proves' with 'supports' or similar

5. Statement 3: Which components of the creek did the dam actually change? Use the temperature columns and the notes, and explain how that change could reach the trout population.

**Answer:** The dam changed physical components: it made the water slower and deeper, and July water in Pine Creek warmed from 14 to 15 °C before the dam to 18 °C in 2015 and 21 to 23 °C from 2016 on, while Cedar Creek stayed at 14 to 15 °C. Warm water holds less dissolved oxygen, and trout need cold, oxygen-rich water, so the change in a physical component reduced a resource the trout depend on. The trout population, a biological component, responded. Fewer stonefly larvae, which live in fast, cold water and are trout food, may add to the effect.

**Why:** This separates the component that changed first (physical: temperature, speed, depth) from the population that responded, which is exactly the framing of MS-LS2-4.

*Also acceptable: A student who says 'the dam changed both, the physical part first and then the living part' has the right idea.*

- Names temperature (and speed or depth) as physical components the dam changed
- Uses the temperature numbers
- Explains the oxygen or cold-water mechanism linking the change to trout

6. Statement 4: Use the class notes to rewrite this statement so that it is accurate.

**Answer:** Rewrite: 'The dam changed Pine Creek from a cold, fast stream into a slow, warm reservoir. Populations that need cold, fast water, such as trout and stonefly larvae, declined, while still-water animals such as dragonfly larvae, water striders and western pond turtles increased.'

**Why:** A change that hurts some populations and helps others is a change in the kind of ecosystem, not its destruction.

*Also acceptable: Accept any accurate rewrite that names winners and losers.*

- Says the ecosystem changed rather than died
- Names at least one population that declined and one that increased

7. Statement 5: Explain why the turtles are not an invasive species, using what the term actually means.

**Answer:** An invasive species is one that people moved, on purpose or by accident, into an area where it did not live before, and that then spreads and harms native populations. Western pond turtles are native to this region, and these individuals walked over on their own from a nearby pond. They are native animals moving into new habitat that the reservoir created.

**Why:** Both parts of the definition fail: they were not moved by people, and they are not outside their native range.

*Also acceptable: Accept 'they are a new population in the reach, not an invasive species'.*

- States the definition (moved by people, spreads, causes harm)
- Applies it: native and arrived on their own

8. Statement 6: Explain why removing the dam would not return the creek to its old state within a year. Use the ideas of **succession** and **resilience**.

**Answer:** Removing a dam is itself a disturbance, and recovery after it happens through succession, which takes years. Sediment trapped behind the dam has to wash downstream or be stabilized, the old reservoir bed has to be colonized by plants, banks need years to grow shrubs and trees that shade the water, and trout and stoneflies must move back in from other stretches. Resilience describes how well an ecosystem bounces back; even a resilient creek needs time, and the creek may settle into a state that is not exactly the one before 2015.

**Why:** This corrects two ideas at once: that recovery is fast and that succession always rebuilds the original ecosystem.

*Also acceptable: Accept a description of secondary succession on the exposed reservoir bed as the core of the answer.*

- Says recovery takes years, not one
- Uses succession (plants and animals returning in stages) correctly
- Uses resilience correctly and notes the result may differ

## Part C: Rewrite the whole argument

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9. Rewrite Jordan's argument so that a scientist would accept it. Include: a claim about what the dam changed and which populations responded; at least three pieces of evidence from the table, including Cedar Creek and more than two years; a mechanism that explains the trout change; and one thing that is still uncertain.

**Answer:** Model: Claim: Building the Pine Creek dam warmed and slowed the water above it, and as a result the trout population in that stretch declined while still-water animals increased. Evidence: (1) Before the dam (2011 to 2014), Pine Creek and Cedar Creek both averaged 61.25 trout. (2) From 2017 to 2020, Pine Creek averaged 14.75 trout, a 75.9 percent decrease, while Cedar Creek averaged 59.5, a decrease of only 2.9 percent. (3) Pine Creek's July water warmed from 14 to 15 °C to 21 to 23 °C from 2016 on, while Cedar Creek stayed at 14 to 15 °C. (4) Pine's counts stayed low every year from 2016 to 2020, longer than any dip before the dam.

Mechanism: warm water holds less dissolved oxygen, and trout need cold, oxygen-rich water, so the dam reduced a resource the trout depend on; stonefly larvae, a trout food, also declined. Uncertainty: we counted only one reach in each creek, and we did not measure oxygen directly, so we cannot yet say how much of the decline is from oxygen, from warmth itself, or from the dam blocking trout from moving up and down the creek.

**Why:** Full credit requires all four required parts. The claim must name the physical change and the population response, the evidence must include Cedar Creek and multiple years, the mechanism must connect temperature or oxygen to trout, and the uncertainty must be real.

*Also acceptable: Accept a claim limited to trout if the evidence and mechanism are strong. Accept other genuine uncertainties, such as fishing pressure or a disease that might affect only Pine Creek.*

- Claim names the physical change and at least one population response
- At least three pieces of evidence with numbers, including Cedar Creek and more than two years
- A mechanism linking warm, slow water to trout
- One genuine uncertainty or limit
- No overclaiming words such as 'proves', 'destroyed' or 'never'

## Teacher notes

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Jordan and both creeks are fictional and the dataset is simulated. The temperature-oxygen mechanism is accurate: cold water holds more dissolved oxygen, and trout are a classic cold-water species; reservoirs behind small dams commonly warm in summer. The data were built so that both creeks have the same pre-dam average (61.25), which makes the comparison in q3 clean, and so that Cedar Creek also dips in 2016, which shows how Jordan's choice of years exaggerated the effect. Each numbered statement targets one chapter misconception, listed in the q1 reasoning. Students who missed exit-ticket question 3 (the single before-and-after graph) should revisit this sheet before writing W6. The Elwha River dams in the extension were removed between 2011 and 2014; salmon reached upstream habitat within a few years, but the river, its sediment and its banks were still changing a decade later, which is a useful real example for q8.

### Scaffold offered to students: Four questions to ask of any argument

For each of Jordan's statements, ask: (1) Is there a comparison place without the change? (2) Are there enough years to see normal ups and downs? (3) Is there a reason, a mechanism, that explains how the change reaches the population? (4) Does every word fit the evidence, or does a word like 'never', 'proves', 'destroyed' or 'exactly' claim more than the data show? A statement that fails any of these needs a fix.

For q3, add the four values and divide by 4, then subtract and divide by the 'before' average.

### **Extension: A real dam removal**

Between 2011 and 2014, two large dams were removed from the Elwha River in Washington State, the largest dam removal project in the United States at the time. Find out what scientists measured afterward (salmon returning upstream, sediment moving down to the coast, plants growing on the old lake beds). Write a short paragraph explaining whether the Elwha's recovery supports or challenges your answer to q8, and name one kind of evidence the scientists used that Jordan's class could copy at Pine Creek.