

Fixing Sam's Review Packet: A Frog, a Pond and Eight Claims

Learning target: I can find the mistakes in another student's explanations of resources and population data, name the idea that went wrong, and rewrite each claim so it matches the evidence.

Error analysis

About 40 min

Individual

MS-LS2-1 · practice

MS-LS2-2 · supports

writing

data analysis

independent practice

Standards connections

MS-LS2-1 (practice, interpreting population and resource data, through correcting someone else's interpretation): Students use the Hollis Pond dataset (bluegill counts and insect-larva samples) as evidence to correct a forecast, a cause-and-effect claim and a carrying-capacity claim, and use the frog facts to correct a claim about how a resource affects an organism. Because the mistakes frame the reasoning, this builds the PE's practice rather than assessing it.

MS-LS2-2 (supports): One statement mistakes competition for fighting. Correcting it builds the accurate idea of competition for a shared limited resource, one of the interaction patterns this PE asks students to predict; the sheet does not ask for predictions across ecosystems.

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

Answers with reasoning

Facts Sam was given — The frogs. Wild poison dart frogs eat ants, mites, small beetles and millipedes from the rainforest floor, and some of those prey carry bitter chemicals called alkaloids. Frogs bred in zoos are fed fruit flies and crickets. Zoo-bred frogs have no alkaloids in their skin. Wild-caught frogs kept in zoos lose their alkaloids slowly. When researchers fed zoo frogs insects dusted with alkaloids, the same alkaloids appeared in the frogs' skin. **The pond.** Hollis Pond is a new farm pond. In Year 1 the owners stocked it with 40 bluegill, a small sunfish that eats mostly insect larvae and other tiny animals. No bass or other fish-eating fish live in the pond. Every summer a student team estimated the number of bluegill, counted the cattail stems along the shore, and took ten standard scoops of mud and weeds to find the average number of insect larvae per scoop.

Hollis Pond survey, Years 1-8 (teaching dataset)

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

Year	Bluegill (estimated)	Cattail stems along the shore	Insect larvae per scoop (average)
1	40	15	62
2	110	40	58
3	260	85	49
4	480	140	35
5	650	210	24
6	720	280	18
7	740	350	17
8	730	410	17

Simulated data for teaching; the pond and the numbers are invented. Year 1 shows the 40 fish that were stocked.

Sam's review packet

1. Zoo dart frogs are not poisonous because captivity makes them tame. In a zoo there are no predators, so the frogs' bodies stop making poison, since they don't need it anymore.
2. The bluegill's resources are insect larvae for food, oxygen dissolved in the water, warm water, and cattail stems where the young fish hide.
3. There are no bass in Hollis Pond, so nothing can stop the bluegill. The population went up by about 100 fish a year on average ($730 - 40 = 690$ fish in 7 years), so in Year 12 there will be about 1,100 bluegill.
4. From Year 2 to Year 3 the population grew by $260 - 110 = 150$ fish, so it grew by 150 percent.
5. My graph shows cattail stems and bluegill going up together from Year 1 to Year 6. So the cattails caused the bluegill to increase. If the owners plant more cattails, they will get more fish.
6. The insect larvae per scoop dropped from 62 to 17 while the number of bluegill went up. That fits the idea that the fish were eating down their own food supply.
7. When food got scarce, the bluegill competed by fighting. The biggest fish killed the smaller ones, and that is why the population stopped growing.
8. The carrying capacity of Hollis Pond is the insect larvae, because the larvae ran out.

Part A: Diagnose

1. Complete the table for all eight statements. If a statement is partly right, mark it 'incorrect' and name only the part that is wrong.

Answer: 1: incorrect; the frog does not make the poison, it stores alkaloids from its prey (and an individual does not lose a trait because it 'doesn't need it'). 2: incorrect; warm water (temperature) is a condition, not a resource. 3: incorrect; no predators does not mean no limit, and the straight-line forecast ignores the leveling off in Years 6-8. 4: incorrect; percent change must be divided by the starting number. 5: incorrect; two things rising together is a pattern, not proof of cause, and the pattern breaks in Years 6-8. 6: correct. 7: incorrect; competition is mostly using up a shared resource, not fighting, and the data show no killing. 8: incorrect; the larvae are the limiting resource and carrying capacity is a number of fish, and the larvae leveled off rather than ran out.

Why: Seven statements contain an error and statement 6 is a careful, evidence-based observation. Students who mark statement 3 as 'partly correct' because the arithmetic is right have read it closely, as long as they name the forecast as the error.

Also acceptable: Accept 'partly correct' for statement 3 if the forecast is identified as the problem. For statement 1, naming either mistake earns credit in Part A; q2 asks for both.

- Statements 1-5, 7 and 8 marked incorrect
- Statement 6 marked correct
- Each error named as an idea (condition versus resource, pattern versus cause, thing versus number), not just 'wrong'

Part B: Explain and rewrite

2. Statement 1: Sam's explanation has two separate mistakes. Name both, and use **one** of the frog facts to show that the poison depends on food, not on predators or tameness. Then rewrite the statement correctly in two or three sentences.

Answer: Mistake 1: Sam says the frog's body 'stops making' poison, but the frog never makes it; it collects alkaloids from the ants, mites and other prey it eats and stores them in its skin. Mistake 2: Sam says the poison disappears because the frog is tame and does not need it. Tameness is behavior and cannot change skin chemistry, and an individual animal does not lose a trait because it is no longer useful. Evidence: zoo frogs fed alkaloid-dusted insects stored those alkaloids in their skin, even though they were still tame and still had no predators, so food is what matters. Rewrite: 'Zoo dart frogs are not poisonous because their food, fruit flies and crickets, contains no alkaloids. Wild frogs get their poison from alkaloids in the prey they eat and store them in their skin. Zoo-bred frogs never take in those chemicals, and wild-caught frogs slowly lose the supply they brought with them.'

Why: The feeding experiment is the decisive fact because it changes only the food and the poison follows. Either the zoo-bred fact or the slow-loss fact supports the rewrite, but neither rules out tameness as cleanly.

Also acceptable: A student who says the second mistake is 'mixing up an individual changing with a species adapting over many generations' has named it precisely; give full credit.

- Names 'the frog does not make the poison; it comes from prey'
- Names the tameness or 'doesn't need it' reasoning as a second mistake
- Uses the feeding experiment (or another frog fact) as evidence
- Rewrite names the missing resource (alkaloid-carrying prey)

3. Statement 2: One item on Sam's list is not a resource. Name it, explain the test that shows it is not a resource, and rewrite the list.

Answer: Warm water is not a resource. Test: a resource is something organisms take in or use up so that less is left for others; one bluegill swimming in warm water does not leave less warmth for the next fish, so temperature is a condition. Rewrite: 'The bluegill's resources are insect larvae for food, oxygen dissolved in the water, and cattail stems where the young fish hide. Warm water is a condition that affects how fast they grow and when they spawn.'

Why: The 'used up?' test separates resources from conditions. Cattail stems are a resource because hiding places can be filled up.

Also acceptable: Accept water itself listed as a resource if a student adds it; the error is only the temperature item.

- Names warm water (temperature)
- Explains the used-up test
- Rewritten list keeps the three true resources and moves temperature to conditions

4. Statement 3: Sam's arithmetic is right, but the forecast is not. Calculate how much the population changed from Year 5 to Year 6, Year 6 to Year 7, and Year 7 to Year 8, and use those numbers to explain what Sam missed. Then write a better forecast for Year 12 and say what it depends on.

Answer: Year 5 to 6: $720 - 650 = +70$. Year 6 to 7: $740 - 720 = +20$. Year 7 to 8: $730 - 740 = -10$. The yearly gains shrank from 170 (Year 4 to 5) to 70, then 20, then a small drop, so the population has leveled off near 720-740. Sam averaged the fast early growth with the flat later years and assumed the line keeps going, which is predicting beyond the data and ignores that food, not predators, is limiting the fish. Better forecast: in Year 12 the pond will probably still hold about 700-750 bluegill, near its carrying capacity, as long as the larvae supply stays about the same; a change in the food supply (or a hot, low-oxygen summer) would move that number.

Why: The three differences are the numerical evidence of leveling off. A forecast near the plateau, with its condition stated, is the corrected reasoning.

Also acceptable: Accept a forecast of 'about 730' or 'between 700 and 760'. A student who adds that no predators can still hold a population at a resource limit has gone further.

- All three differences correct (+70, +20, -10)
- Explains that the population leveled off, so the average rate is misleading
- Forecast near 700-750 (or 'about the same as now')
- States what the forecast depends on (food supply or another resource)

5. Statement 4: Calculate the correct percent increase from Year 2 to Year 3. Show the formula and the division, round to the nearest whole percent, and say in one sentence what Sam forgot to do.

Answer: Percent change = $(\text{new} - \text{old}) \div \text{old} \times 100 = (260 - 110) \div 110 \times 100 = 150 \div 110 \times 100 \approx 136\%$. Sam forgot to divide the increase by the starting number (110); 150 is the number of new fish, not a percent.

Why: $150 \div 110 = 1.3636\dots$, so the increase is about 136 percent. A 150 percent increase from 110 would have produced 275 fish, not 260.

Also acceptable: Accept 136% or 136.4%.

6. Statement 5: Use the cattail and bluegill numbers from Years 6, 7 and 8 to show that the pattern Sam saw does not hold. Then explain why cattails and bluegill could rise together in Years 1-6 without one causing the other, and rewrite the statement.

Answer: In Years 6, 7 and 8 the cattail stems kept rising (280, 350, 410), but the bluegill stayed almost flat (720, 740, 730). If cattails controlled the number of bluegill, the fish should have kept increasing along with them. In Years 1-6 both rose because both were new populations spreading into a brand-new pond: cattails were spreading along the shore while the fish were multiplying, so the shared cause was time since the pond was built, not cattails acting on fish. Sam also gave no mechanism for how cattails would make more fish. The larvae column points to the real limit: larvae fell as fish rose and then leveled when the fish leveled. Rewrite: 'Cattail stems and bluegill both increased in Years 1-6 because both were filling a new pond. After Year 6 the cattails kept increasing but the bluegill did not, so cattails are not what sets the number of fish; the falling larvae count suggests food does.'

Why: The pattern breaks exactly where it would have to hold if Sam's cause were right. Naming a shared cause and the missing mechanism completes the correction.

Also acceptable: A student who notes that cattails could help a little by sheltering insects or young fish, but that the Years 6-8 data show they are not what limits the fish now, is reasoning well; give full credit.

- Cites Years 6-8 numbers for both cattails and bluegill
- Explains that both rose together for another reason (a new pond filling up over time)
- Notes that no mechanism was given, or points to the larvae as the better explanation
- Rewrite does not claim cattails cause bluegill increase

7. Statement 6 is sound. Explain why the words 'that fits the idea' are good scientific language here, and describe one test the student team could do in the pond to check whether the bluegill really are eating down the larvae.

Answer: 'That fits the idea' is careful because a pattern in a survey is consistent with an explanation without proving it; Sam is not claiming more than the data show. Test: put a few fine-mesh cages in the shallows that keep fish out but let insects in, and compare the larvae per scoop inside and outside the cages after a few weeks. If larvae rise inside the cages, the fish are eating them down. (Another test: add extra food to part of the pond, or compare with a similar pond that has far fewer bluegill.)

Why: A fish-exclusion cage changes one thing (whether fish can feed there) and measures the effect on the resource, which turns the pattern into evidence of cause.

Also acceptable: Accept any controlled comparison, such as two similar ponds with different numbers of bluegill sampled the same way.

- Explains that the wording claims a pattern consistent with an idea, not proof
- Describes a test that changes fish access to larvae (or the larvae supply) and measures the result, with a comparison

8. Statement 7: Explain what competition for food means for bluegill, why the population stopped growing even without anyone being killed, and what in the data does **not** support Sam's story. Rewrite the statement.

Answer: Competition for food means that every larva one bluegill eats is gone for all the others. As the fish population grew, the larvae per scoop fell from 62 to about 17, so each fish found less food. With less food per fish, fewer young survived and fish grew more slowly, so new fish were added only about as fast as old ones died, and the population leveled off. Nothing in the data shows fighting or killing: the larvae fell steadily as the fish rose, and the population did not drop sharply, it simply stopped rising. Rewrite: 'When larvae became scarce, each bluegill that ate a larva left less food for the others. With less food per fish, fewer young survived, so births and deaths balanced and the population stopped growing at about 730.'

Why: This repairs the 'competition means fighting' misconception: most competition is quiet use of a shared limited resource. The fish themselves may chase each other near nests, but that is not what the data show or what explains the leveling off.

Also acceptable: Accept 'the winners are the fish that find enough larvae to survive and reproduce, not necessarily the biggest.'

- Describes competition as using up a shared limited resource
- Links less food per fish to fewer surviving young or slower growth
- States that the data do not show fighting or killing
- Rewrite explains the leveling off without fighting

9. Statement 8: Sam mixed up two terms and also misread the larvae column. Fix both mistakes and rewrite the statement so it uses **limiting resource** and **carrying capacity** correctly, with a number.

Answer: Mistake 1: the insect larvae are the limiting resource (a thing), while the carrying capacity is a number: about 730 bluegill. Mistake 2: the larvae did not run out; they leveled off at about 17 per scoop. A resource limits a population when there is too little of it per individual, not only when it reaches zero. Rewrite: 'Insect larvae are the limiting resource for the bluegill in Hollis Pond. The pond's carrying capacity is about 730 bluegill, the number that the larvae supply can keep feeding year after year.'

Why: The thing-versus-number distinction is the vocabulary target; the 'ran out' error shows the student reading the data carelessly, since 17 per scoop is low but steady.

Also acceptable: Accept any carrying capacity from 720 to 740.

- Larvae named as the limiting resource
- Carrying capacity stated as a number near 720-740
- Notes that the larvae leveled off rather than reaching zero

Part C: Advice the owners can use

10. The pond owners read Sam's packet and plan to add 300 more bluegill and plant a lot more cattails 'to get more fish.' Write them a short note (4-6 sentences). Predict what will happen to the bluegill population after the extra fish are added, explain why using the words **competition** and **carrying capacity**, and tell them what would actually have to change for the pond to support more bluegill.

Answer: Model note: 'Adding 300 bluegill will not give you a pond with 1,030 fish for long. The pond's insect larvae can feed only about 730 bluegill, which is its carrying capacity. With 300 more fish, competition for larvae will be even stronger, so each fish will get less food, the fish will stay small, fewer young will survive and more fish will die, until the population falls back to about 730. Planting more cattails will not change that, because the data show the fish stopped increasing after Year 6 while cattails kept increasing. The pond could support more bluegill only if its food supply grew, meaning more insect larvae and other small animals for the fish to eat.'

Why: The note should apply the corrected ideas to a decision: stocking beyond the carrying capacity is followed by a fall back toward it, and only a change in the limiting resource raises the ceiling.

Also acceptable: A student who adds that crowded bluegill ponds often fill with many small, thin fish (stunting), or who suggests a test before a big change, is giving strong extra reasoning.

- Predicts the population falls back toward about 730 (not 1,030)
- Explains with competition for the limiting resource
- Uses carrying capacity correctly
- Says the food supply (larvae) would have to increase to raise the carrying capacity
- Rejects the cattail plan with the Years 6-8 evidence

Teacher notes

Each wrong statement matches one of the chapter's misconceptions: the frog makes its own poison and loses it when tame (1), temperature is a resource (2), no predators means no limit (3), a pattern proves cause (5), competition means fighting (7) and limiting resource confused with carrying capacity (8); statement 4 is a calculation error and statement 6 is correct, so students cannot simply mark everything wrong. All numbers were checked: Sam's average of $690 \div 7 \approx 98.6$ per year is right, which is why the forecast error is about reasoning, not arithmetic; the Years 5-8 changes are +70, +20 and -10; the correct percent increase is $150 \div 110 \times 100 \approx 136$ percent. The dataset is simulated. Real bluegill do eat some plant material and do defend nests, and crowded bluegill ponds without bass usually fill with small, slow-growing fish; this is why the key accepts 'the fish stay small' and does not claim that bluegill never chase one another. For statement 1, the frog facts are summarized from published feeding experiments with dendrobatid frogs; keep the discussion on diet as the source of the alkaloids and on the difference between an individual changing and a species adapting over generations. Collect q10 to see which students can apply carrying capacity to a decision before W9.

Scaffold offered to students: Four questions to ask of every statement

Check each statement with these questions in order. (1) Is something called a resource that organisms cannot use up? (2) Does the claim say 'because' or 'caused' without naming how one thing acts on the other? (3) Does it predict past the last data point as if the trend must continue? (4) Does it mix up a thing (a limiting resource) with a number (a carrying capacity)? For percent change, the formula is $(\text{new} - \text{old}) \div \text{old} \times 100$. Put a finger on the Years 5-8 rows of the table before you answer any question about the bluegill forecast.

Extension: Plant a mistake of your own

Write two new statements about Hollis Pond that each contain a different mistake not on Sam's page; for example, one that treats a sample average as an exact count, or one that predicts the Year 9 count without considering a hot summer that lowers oxygen in the water. Trade with a partner, diagnose each other's statements and rewrite them. Then decide together which of all ten mistakes would most mislead the pond owners, and explain why in a short paragraph.