

Resources in Living Systems: Mastery Check

Learning target: I can tell resources from conditions, use data to show how a resource's availability affects individual organisms and populations, calculate a carrying capacity, and explain competition, biomes and the levels of organization.

Retrieval and mastery check

About 35 min

Individual

MS-LS2-1 · assesses

MS-LS2-2 · practice

independent practice

writing

data analysis

Standards connections

MS-LS2-1 (assesses, analyzing data on food supply, chick growth and chick numbers, calculating a carrying capacity, and explaining effects of resource availability on organisms and populations): Items 3-7 and the synthesis ask students to interpret a dataset from years of abundant and scarce food, calculate a percent change and a carrying capacity, judge what evidence supports a cause-and-effect claim, and explain effects on both individual growth and population size. Together they produce direct evidence toward the PE as written.

MS-LS2-2 (practice, the competition pattern only): Item 8 asks students to predict competition between two seed-eating species in a new ecosystem, in plentiful and scarce years. One item on one interaction type builds toward the PE but does not assess it.

Purpose: assess · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

Part A: Retrieval (items 1-11)

1. Which of these is a **condition** rather than a resource for an oak seedling? 2 pts

Answer: C: The air temperature on a spring night.

Why: Temperature affects the seedling but is not taken in or used up; water, sunlight and soil nitrogen are all resources the seedling absorbs, and what one seedling uses is not available to its neighbors.

Also acceptable: None.

2. A tomato bed gets plenty of water and full sun, but its soil is low in nitrogen, and the plants are small and pale. What will most likely happen if the gardener doubles the water? 2 pts

Answer: B: Little will change, because nitrogen, not water, is the limiting resource.

Why: The plants already have plenty of water and light; the resource in shortest supply is nitrogen, so adding more of a resource that is not limiting does not raise growth. C is false (water does not add nitrogen; heavy watering can even wash nitrogen out of the soil) and D misclassifies water.

Also acceptable: None.

3. Suppose a fenced pasture grows 48,000 kg of forage a year that goats can eat without damaging the pasture, and each goat eats about 600 kg a year. (a) How many goats can the pasture support? (b) A drought cuts the forage by one quarter. What is the new carrying capacity? Show both calculations. 3 pts

Answer: (a) $48,000 \text{ kg} \div 600 \text{ kg per goat} = 80 \text{ goats}$. (b) One quarter of 48,000 kg is 12,000 kg, so $48,000 - 12,000 = 36,000 \text{ kg}$ remain; $36,000 \text{ kg} \div 600 \text{ kg per goat} = 60 \text{ goats}$. The carrying capacity falls from 80 to 60 goats.

Why: Carrying capacity here is the usable forage divided by the forage one goat needs. Cutting the limiting resource by a quarter cuts the carrying capacity by a quarter.

Also acceptable: Accept $48,000 \times 0.75 = 36,000$ for the drought step. Give 1 point for (a) and 2 for (b).

A seabird colony and its food supply, six years (teaching dataset)

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

Year	Small-fish index	Chicks raised per 100 nests	Average chick mass at 20 days (g)
1	80	72	610
2	95	78	640
3	30	25	430
4	60	60	560
5	20	15	400
6	90	75	630

Simulated data for teaching. The fish index is the average number of small fish (such as anchovies) caught per standard survey net near the colony. Chick mass is the average mass of chicks at 20 days old.

4. Which two years had the scarcest food? Describe what happened in those years to (a) individual chicks and (b) the number of chicks raised. Use numbers from the table for both. 3 pts

Answer: Years 3 and 5 had the scarcest food (fish index 30 and 20, compared with 60-95 in the other years). (a) Individual chicks grew less: average chick mass was 430 g and 400 g, compared with 560-640 g in the other years. (b) Far fewer chicks were raised: 25 and 15 per 100 nests, compared with 60-78 in the other years.

Why: MS-LS2-1 asks for effects on organisms and on populations; the dataset shows both falling in the scarce years.

Also acceptable: Comparing with a single good year (for example Year 2: 640 g and 78 chicks) is acceptable if the numbers are correct.

- Names Years 3 and 5 with their fish index values
- Chick mass numbers for the scarce years compared with other years
- Chicks raised numbers for the scarce years compared with other years

5. Calculate the percent change in chicks raised per 100 nests from Year 2 to Year 3. Show the formula and round to the nearest whole percent.

2 pts

Answer: Percent change = $(\text{new} - \text{old}) \div \text{old} \times 100 = (25 - 78) \div 78 \times 100 = -53 \div 78 \times 100 \approx -68\%$. Chicks raised fell by about 68 percent.

Why: $53 \div 78 = 0.679\dots$, so the decrease is about 68 percent; the base is Year 2 because the change is measured from Year 2.

Also acceptable: Accept -68% , a 68% decrease, or -67.9% .

6. A scientist claims that the fish supply **caused** the poor chick numbers in Years 3 and 5. Which additional evidence would best support that cause-and-effect claim?

2 pts

Answer: A: In Years 3 and 5, parents brought fewer fish to the nest per hour, and in a test, chicks given extra fish in those years grew to normal mass.

Why: A supplies the mechanism (less food delivered to chicks) and a test that changed only the food and produced normal growth. B is a competing explanation, not support for the fish claim. C restates the pattern already in the table rather than adding new evidence. D is irrelevant to Years 3 and 5.

Also acceptable: None.

7. True or false: 'If a population has no predators and no disease, it will keep growing for as long as the area exists.' Circle your answer and explain, using the term **carrying capacity**.

3 pts

Answer: False. Even with no predators or disease, every population depends on resources, and an area holds only so much of each. As the population grows, the resources per individual fall and competition for the limiting resource increases, so fewer young survive and more individuals die until births and deaths balance. The population levels off near the carrying capacity, the largest population the area's resources can support over time (or overshoots it and then falls, like the St. Matthew reindeer).

Why: This tests the chapter's central misconception. Full credit needs the verdict, the resource limit, and the carrying capacity used correctly.

Also acceptable: Any chapter example (bluegill leveling near 730, duckweed tubs near 300 and 120, Daphnia jars) used as evidence earns full credit.

- Marks false
- Explains that resources are limited and competition rises as numbers grow
- Uses carrying capacity correctly

8. Suppose two kinds of desert rodents live in the same valley and both eat seeds. One kind eats mostly large seeds and the other mostly small seeds. (a) Explain why these two species compete less than two species that eat exactly the same seeds. (b) Predict what happens to both populations in a drought year when the plants make very few seeds of any size, and explain why. 3 pts

Answer: (a) Because they eat mostly different sizes of seeds, each species takes less of the other's food, so what one eats leaves almost as much for the other; their use of the resource overlaps only a little. (b) In a drought year both populations shrink, because seeds of every size are scarce, so each individual finds less food, fewer young are raised and more animals die. Competition between the two species also becomes stronger, because hungry animals of both kinds eat whatever seeds they can find, so their diets overlap more.

Why: This is the yak-and-horse and zebra-and-wildebeest pattern in a new ecosystem: different use of a shared resource reduces competition, but scarcity squeezes both populations.

Also acceptable: Give full credit for (b) without the 'diets overlap more' point if the decline is explained through scarcity and competition.

- (a) explains less overlap in the resource used
- (b) predicts both populations decline
- (b) explains with less food per individual, fewer young or more deaths
- Notes that competition increases when the resource is scarce

9. Draw five nested shapes, one inside the next, to show the levels of organization from an organism to the biosphere. Label each level. For the first four levels, add one example from a city park. 3 pts

Answer: Five nested shapes, smallest inside: organism (one squirrel, or one oak tree); population (all the squirrels in the park); community (the squirrels, oak trees, lawn grass, crows, insects, and soil fungi and bacteria living in the park); ecosystem (that community plus the park's soil, water, air and sunlight); biosphere (every ecosystem on Earth, from deep rock to the high atmosphere).

Why: The levels must be in order, each inside the next, and the examples must match the definitions: a population is one species, a community is many species, and an ecosystem adds nonliving parts.

Also acceptable: Accept the textbook's four levels (no community) for 2 of 3 points if they are in order with correct examples. Any city-park organism works. 'Species' placed as a level is incorrect; a species is a kind of organism, not a place-based group.

- Five levels in the correct order and nested
- Each level labeled
- Examples for organism, population, community and ecosystem that fit the definitions
- The ecosystem example includes at least one nonliving part

10. A region at middle latitudes, far from the ocean, has hot summers, cold winters and about 400 mm of rain a year, falling mostly in spring and early summer. Which biome is it most likely to hold? 2 pts

Answer: B: Temperate grassland, such as a prairie or steppe.

Why: Middle latitude with hot summers and cold winters rules out the tropical rainforest and the boreal forest (which has cool, short summers), and a coral reef is an aquatic biome. About 400 mm of rain is enough for grasses but usually too little for a closed forest, which is the temperate grassland pattern.

Also acceptable: None.

11. In a clear lake, rooted water plants grow from the shore out to a depth of several meters and then stop, even though the mud in the deeper water holds plenty of nutrients. Name the resource that most likely limits how deep they grow, explain why it runs short with depth, and predict what would happen to the plants' depth limit if the lake became muddy. 2 pts

Answer: Light. Water absorbs and scatters sunlight, so less light reaches each meter deeper, and below a few meters there is too little for the plants to make enough food. If the lake became muddy, silt would block light closer to the surface, so the plants would grow only in shallower water and the depth limit would move toward the shore.

Why: In aquatic ecosystems light and nutrients are the usual limits; here the nutrients are present in the deep mud, so light is the limit.

Also acceptable: Accept 'sunlight' or 'light energy'.

- Names light
- Explains that water absorbs or scatters light so it decreases with depth
- Predicts a shallower limit in muddy water

Part B: Synthesis (item 12)

12. Write one paragraph (6-8 sentences) explaining how the availability of a resource affects (1) individual organisms and (2) populations. Use the poison dart frogs from the start of the chapter for (1), and for (2) use one population from this chapter (the St. Matthew reindeer, the duckweed tubs, the Daphnia jars, the Sage Flats pronghorn, the Hollis Pond bluegill, or the seabirds on this quiz). Use the terms **resource**, **limiting resource**, **competition** and **carrying capacity**, and cite at least one number as evidence. If you kept your first frog explanation from Worksheet 1, say one thing you now explain differently. 3 pts

Answer: Model paragraph: 'A resource is something an organism must take in from its surroundings, and how much of it is available affects both single organisms and whole populations. Poison dart frogs show the effect on individuals: they cannot make their alkaloid poison but take it from ants, mites and other prey, so a frog raised in a zoo on fruit flies never becomes poisonous even though it has plenty of food. At first I thought the zoo frogs lost their poison because they were safe; now I can say the missing resource is the alkaloid-carrying prey. For populations, the duckweed tubs are a good example. In the tub with nutrient solution the fronds grew from 10 to about 300, but in plain tap water they stopped near 120, because dissolved nutrients were the limiting resource. As the fronds multiplied, they competed for the same nutrients, light and surface space, so each plant got less and growth leveled off at the carrying capacity. When a limiting resource is scarce, individuals grow less and fewer survive and reproduce, and when it is abundant, the population can grow until it reaches a new, higher carrying capacity.'

Why: Grade on the required elements, not the example chosen. The paragraph must separate the effect on an individual (the frog's poison) from the effect on a population (numbers leveling at a carrying capacity) and support the population claim with at least one number.

Also acceptable: Any of the listed populations works. The sentence comparing with the W1 explanation is encouraged but not required for full credit, since some students will not have their W1 work.

- Explains the frog case as a resource (alkaloids from prey) changing an individual organism
- Explains a population example as numbers limited by a limiting resource
- Uses resource, limiting resource, competition and carrying capacity correctly
- Cites at least one number from a chapter dataset as evidence

Teacher notes

Points: q1 2, q2 2, q3 3, q4 3, q5 2, q6 2, q7 3, q8 3, q9 3, q10 2, q11 2, q12 3; total 30. Map to the learning targets: resource versus condition (q1, q2), competition (q7, q8), data and carrying capacity (q3-q7), pattern versus cause (q6), biomes and levels of organization (q9-q11), and the phenomenon (q12). The seabird dataset is simulated; it is built so that the two low-fish years show both lighter chicks and fewer chicks raised, the two effects in the MS-LS2-1 clarification. All numbers were recomputed: $48,000 \div 600 = 80$ goats; $36,000 \div 600 = 60$ goats; $(25 - 78) \div 78 \times 100 \approx -68$ percent. In q6, option C is the trap for students who still treat a repeated pattern as proof. q9 is the chapter's nesting-diagram evidence; accept the textbook's four-level ladder for partial credit but teach the community level. The synthesis asks students to revisit their Worksheet 1 frog explanation; return those papers before the quiz if you kept them, or let students skip that sentence. Expect q2 errors from students who think more of any resource always means more growth, and q7 errors from students who think only predators limit populations; both are worth reteaching before Lesson 21.

Scaffold offered to students: A support card (only if your teacher allows it)

Resource or condition? Ask: if one organism uses it, is there less for the next? Yes means resource; no means condition. Carrying capacity from a resource: usable resource $\div$ amount one individual needs, rounded down. Percent change: $(\text{new} - \text{old}) \div \text{old} \times 100$; a negative answer is a decrease. Levels of organization, smallest to largest: organism, population, community, ecosystem, biosphere. A cause-and-effect claim needs the pattern, a mechanism, and a check that nothing else explains it.

Extension: Write the thirteenth item

Write one new multiple-choice item for this quiz that tests the difference between a limiting resource and a carrying capacity, using an organism not mentioned in the chapter. Give four options, mark the correct answer, and for each wrong option write one sentence explaining what mistaken idea would make a student choose it. Then explain how your item could be changed into a short-answer item that shows even more of a student's thinking.