

Healthy Ecosystems and the Services They Provide: Mastery Check

Learning target: I can show that I understand what ecosystem services are, how living things provide them, how a change in one part of an ecosystem can reach people, and how to evaluate competing solutions for keeping a service.

Retrieval and mastery check

About 35 min

Individual

MS-LS2-5 · assesses

MS-LS2-4 · practice

independent practice

writing

Standards connections

MS-LS2-5 (assesses, items q9, q12 and the synthesis q13): The synthesis asks each student to evaluate two competing solutions for maintaining an ecosystem service and biodiversity in a chosen case, with a criterion, a constraint and evidence, which is the PE as written; q9 and q12 check the evidence and value judgments that evaluation relies on.

MS-LS2-4 (practice): q6 and q10 check whether students can trace an effect of losing one population on others and recognize the evidence needed to argue for cause rather than pattern.

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

Answers with reasoning

Part A: Retrieval (items q1-q12)

1. Which of these is an ecosystem service?

2 pts

Answer: B. A wetland traps mud and extra nutrients before river water reaches a lake.

Why: Water purification by a wetland is work done by the ecosystem for people. A and C are human-built systems; D is something people do to help an ecosystem (stewardship), not a service the ecosystem provides.

Also acceptable: None.

2. Which example is matched with the correct kind of ecosystem service?

2 pts

Answer: C. Lumber for building houses: provisioning.

Why: Lumber is a product harvested from an ecosystem. Hiking is cultural, soil formation and nutrient cycling are supporting.

Also acceptable: None.

3. If animal pollinators disappeared, which crop's harvest would be affected least?

2 pts

Answer: D. Wheat.

Why: Wheat mostly pollinates itself; almonds, apples and squash depend heavily on animal pollinators.

Also acceptable: None.

4. Most almond varieties need cross-pollination. Explain what that means and why growers plant two varieties in alternating rows and bring in bees. 3 pts

Answer: Cross-pollination means a flower must receive pollen from a different plant; for most almond varieties it must come from a different, compatible variety, because the variety's own pollen cannot fertilize it. Growers plant rows of two compatible varieties that bloom at the same time, and bees carry pollen between the rows as they move from tree to tree for food.

Why: Self-incompatibility is why almonds depend so heavily on bees.

Also acceptable: Accept 'the tree's own kind of pollen does not work'.

- Pollen must come from a different variety
- Two varieties planted so pollen is available
- Bees carry pollen between them

Teaching numbers for q5 (teaching dataset)

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

Choice for keeping the town's water clean	Cost to build	Cost each year
Build and run a filtration plant	\$60 million	\$3 million
Protect the forested watershed (buy land, farm programs, monitoring)	\$0	\$1.5 million

Invented values for a made-up town, for teaching only.

5. Using the teaching numbers, find the total cost of each choice over 20 years and how much money protecting the watershed would save. 3 pts

Answer: Filtration plant: $\$60 \text{ million} + (\$3 \text{ million} \times 20) = \$60 \text{ million} + \$60 \text{ million} = \$120 \text{ million}$.

Watershed: $\$1.5 \text{ million} \times 20 = \$30 \text{ million}$. Savings: $\$120 \text{ million} - \$30 \text{ million} = \$90 \text{ million}$ over 20 years.

Why: Total cost = building cost + yearly cost $\times$ number of years.

Also acceptable: Accept the savings stated as 'the watershed costs one quarter as much'.

6. True or false: 'Losing the vultures in India could only affect other scavengers, not people.' Circle your answer and explain, tracing at least three links. 3 pts

Answer: False. With vultures gone, carcasses stayed and rotted; feral dogs and rats had more food and their numbers grew; more dogs meant more bites and more rabies risk for people; and studies found human death rates rose in districts that lost their vultures.

Why: Indirect effects travel through other populations to reach people.

Also acceptable: Accept germs from rotting carcasses getting into water as a link.

- Circles false
- At least three links from vultures to people
- Links are accurate

7. Nearly all Cavendish banana plants are genetic copies of one another. Explain why that makes them vulnerable to a new disease, and how wild bananas could help. 3 pts

Answer: Because the plants share the same genes, they share the same weaknesses: a disease that can infect one, such as Tropical Race 4, can infect them all, and there are no different individuals with traits to survive it. Wild bananas are genetically varied, and some carry disease-resistance genes that breeders or scientists can use to develop resistant bananas, so protecting wild populations and gene banks keeps those traits available.

Why: Genetic variation within a population is what lets some individuals resist a disease.

Also acceptable: None.

- Shared genes mean shared weakness
- Wild bananas vary and some resist disease
- Their traits can be used to develop resistant crops

8. Draw a side view of a beach with a vegetated sand dune between the ocean and a road. Show storm waves, label where plant stems and roots hold sand, and draw an arrow showing where sand from the dune can go during a big storm. 3 pts

Answer: A drawing with the ocean on one side, a beach, a dune with plants, and a road behind the dune. Storm waves hit the front of the dune. Labels show stems trapping blowing sand and roots holding sand inside the dune. An arrow shows sand from the dune front moving offshore (or along the beach) during the storm.

Why: Shows the dune as a sand store held by plants that gives up sand to the storm instead of letting waves reach the road.

Also acceptable: Accept sand shown building a sandbar offshore.

- Ocean, beach, dune, plants and road in order
- Stems or roots labeled holding sand
- Arrow shows sand moving offshore or down the beach in the storm

9. A town restored a sand dune instead of building a seawall. Which evidence would best show that the dune is maintaining an ecosystem service? 2 pts

Answer: B. Over five winters, the beach stayed about the same width and storm water reached the road less often.

Why: Only B measures the service itself (storm protection and keeping the beach) over time. A is appearance, C is cost, D is one season of visitor numbers.

Also acceptable: None.

10. Which evidence would best support the claim that losing vultures caused more human deaths in India? 2 pts

Answer: B. A comparison showing death rates rose after the drug spread in districts that had many vultures, but not in districts that never had many.

Why: A comparison group rules out causes shared by all districts; A shows only a correlation, and C and D do not test cause.

Also acceptable: None.

11. New York City's main water supply comes from a protected, mostly forested watershed. Why is the water still disinfected, and why can water that looks clear still be unsafe? 3 pts

Answer: The watershed removes most particles and many germs, but not all; wildlife and human activity can still add bacteria and viruses, so disinfection is a final safety step (and is required). Water can look clear because the particles big enough to cloud it are gone, while invisible bacteria, viruses and dissolved substances such as nitrate or some pesticides remain.

Why: Clarity measures particles, not safety.

Also acceptable: None.

- Watershed does not remove every germ
- Disinfection is a safety step
- Germs or dissolved substances can be invisible

12. Replacement cost is one way to estimate what an ecosystem service is worth. Give one reason it can make a service seem worth more than it is and one reason it can make a service seem worth less. 3 pts

Answer: Seems worth more: if nobody would actually build the substitute (for example, a town would accept dirtier water or buy water elsewhere), the substitute's price is larger than what people would really pay. Seems worth less: an ecosystem does many jobs at once (habitat, recreation, flood control, biodiversity) while a substitute does one, so pricing only one job leaves the others out; cultural values and future discoveries are not priced at all.

Why: Replacement cost is a useful but imperfect estimate of value.

Also acceptable: Accept 'a cheaper substitute might exist' as a reason for overstating.

- One valid reason for overstating
- One valid reason for understating

Part B: Synthesis (item q13)

13. Choose one problem from this chapter: almond pollination, coastal flooding, clean drinking water, vineyard pests or banana disease. In one paragraph, name the ecosystem service involved and its category, state one criterion and one constraint for a solution, compare two competing solutions using evidence, and say which one better maintains both the service and biodiversity, and why. 5 pts

Answer: Example (coastal flooding): 'The service is storm and erosion protection by dunes, a regulating service. One criterion is that storm water should reach the coast road no more than one day a winter; one constraint is a budget of \$3 million over five years. A seawall stops waves at first but cuts the beach off from its sand, so the beach in front narrows and waves overtop it more often over time, and nesting shorebirds lose their open sand. Restored native dunes are weaker in their first years, but they store sand that rebuilds after storms, keep a wide beach and provide habitat for plovers and native plants. The dunes better maintain both the service and biodiversity because they keep working and growing as the plants spread, while the seawall protects the road only by giving up the beach and its wildlife.'

Why: The synthesis must combine a service and its category, criteria and constraints, evidence about two solutions and a judgment about biodiversity.

Also acceptable: Equally strong answers use almond pollination (renting more honey bees vs planting native flower strips for wild bees), clean water (filtration plant vs watershed protection), vineyard pests (poison vs owl boxes and habitat) or bananas (one variety with quarantine vs diversified varieties and wild relatives).

- Names the service and its category correctly
- States a criterion and a constraint
- Compares two solutions with evidence or mechanisms
- Judges which better maintains the service and biodiversity, with a reason
- Accurate science

Teacher notes

Points: q1 2, q2 2, q3 2, q4 3, q5 3, q6 3, q7 3, q8 3, q9 2, q10 2, q11 3, q12 3, q13 5; total 36. The q5 numbers are invented and labeled; the real New York City figures are discussed in the chapter's accuracy notes and differ. Items q1, q3 and q11 test the chapter's accuracy corrections (services versus stewardship, grains are not pollinator-dependent, clear is not the same as safe). q6 and q10 revisit W3; q8 and q9 revisit W6; q7 revisits W8; q12 and q13 draw on W5, W9 and Lab 3. Score q13 with the criteria list; any of the five problems is acceptable.

Scaffold offered to students: Four questions to ask yourself

1. Who benefits? An ecosystem service benefits people and is done by the ecosystem.
2. Which living things or processes do the work (pollinators, decomposers, roots and soil, scavengers, predators, wild relatives)?
3. If one part changes, what changes next, and next after that?
4. When comparing solutions, what does each one do to the service and to biodiversity, and what does it cost?

Extension: Write the hardest question

Write one new multiple-choice item that tests the difference between a natural resource and an ecosystem service. Give four options, mark the correct one, and write one sentence for each wrong option explaining why a student might choose it. Then write one sentence explaining why stone and metals are natural resources but are not counted as ecosystem services.