ANSWER KEY. Answers and explanations appear after each question, marked by a bar at the left. Answers written in table cells are in italics.

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Communities and Biodiversity Study Guide

Biology | ANSWER KEY

Show your work with units. Use complete sentences when a question asks you to explain.

Key relationships	**Percent change** = (new − old) ÷ old × 100	**Amount left after a decrease** = start × (1 − percent ÷ 100)	**Percentage points** = difference between two percents	**Species richness** = number of different species (count kinds, not individuals)

Part 1. Biodiversity and Ecosystem Services

1. Students sample two ponds of the same size with the same net, for the same time (sample data).

Pond A	**Count**	**Pond B**	**Count**
Snail	22	Snail	61
Water strider	14	Midge larva	33
Mayfly nymph	9		
Caddisfly larva	6		
Dragonfly nymph	5		

(a) Find the species richness and the total number of individuals in each pond.

(b) A classmate says Pond B is more diverse because it had more animals. Do you agree? Explain. Then find the percent change in richness from Pond A to Pond B.

(a) **Pond A: richness 5, 56 individuals. Pond B: richness 2, 94 individuals.**

(b) **Disagree.** Richness counts kinds, not individuals; Pond A has more species (5 vs 2), even though Pond B has more animals (94 vs 56). Percent change: (2 − 5) ÷ 5 × 100 = **−60%**.

2. (a) Classify each benefit of a coastal mangrove forest as a provisioning, regulating, supporting, or cultural service.

Benefit	**Type of ecosystem service**
(1) People catch shrimp that grow among the roots.	***Provisioning***
(2) Roots trap mud and keep coastal water clear.	***Regulating***
(3) Tourists pay for kayak and birdwatching trips.	***Cultural***
(4) Fallen leaves decompose and recycle nutrients.	***Supporting***

(b) Storm waves are 1.5 m tall at the outer edge of the mangroves and 0.3 m tall after passing through 500 m of mangroves (sample data). Find the percent change in wave height. Which type of service is this?

(b) (0.3 − 1.5) ÷ 1.5 × 100 = **−80%**. Reducing storm damage is a **regulating** service (like flood control).

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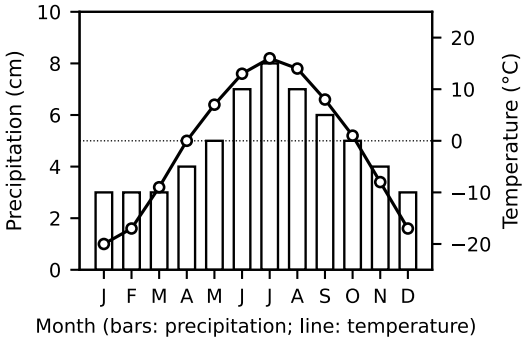
Part 2. Terrestrial Biomes

3. The climograph shows sample data for Site D. Monthly values, January to December: temperature −20, −17, −9, 0, 7, 13, 16, 14, 8, 1, −8, −17 °C; precipitation 3, 3, 3, 4, 5, 7, 8, 7, 6, 5, 4, 3 cm.

(a) Find the average yearly temperature and the total yearly precipitation.

(b) Use the ranges below to choose the best-fit biome. Explain why the other two do not fit.

Biome	Temperature	Precipitation
Boreal forest	−5 to 5 °C	30 to 85 cm
Tundra	below about −5 °C	15 to 50 cm
Temperate grassland	0 to 20 °C	25 to 75 cm



(a) Sum of monthly temperatures = −12 °C; −12 °C ÷ 12 = **−1.0 °C**. Precipitation: 3 + 3 + 3 + 4 + 5 + 7 + 8 + 7 + 6 + 5 + 4 + 3 = **58 cm**.

(b) **Boreal forest**: −1.0 °C and 58 cm are inside both of its ranges. Tundra is colder (below −5 °C), and grassland starts at 0 °C, so −1.0 °C is too cold for it.

4. Students bury identical bags of dead leaves at a tundra site and at a temperate forest site. After one year, the tundra bags lost 8% of their mass and the forest bags lost 45% (sample data).

(a) How many times faster did the leaves break down in the forest? Explain the difference using decomposers and climate.

(b) Predict which soil holds more undecayed dead plant matter. Explain.

(c) Boreal forest trees have needle-shaped leaves and a cone shape. Explain how one of these traits is an adaptation to the climate.

(a) 45% ÷ 8% ≈ **5.6 times faster**. **Decomposers work faster where it is warmer; cold (and permafrost) slows decomposition in the tundra.**

(b) **The tundra soil**, because dead matter builds up when it breaks down slowly. (c) Any one: **a cone shape sheds heavy snow so branches do not break; needle leaves lose less water in cold, dry winters.**

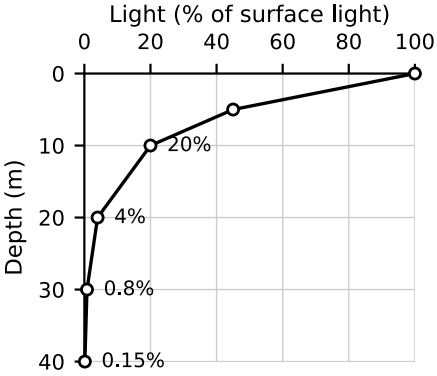
Part 3. Aquatic Ecosystems

5. The graph shows how much surface light reaches different depths in a clear lake (sample data). Assume producers here need at least 1% of surface light for photosynthesis.

(a) About how deep is the photic zone? Explain using the data.

(b) A water plant is rooted at 8 m and another at 35 m. Which can grow? Explain.

(c) Explain why the deep water of this lake depends on food that is made near the surface.



(a) **Between 20 and 30 m**: light is 4% at 20 m but only 0.8% at 30 m, below the 1% producers need.

(b) **The plant at 8 m** (about 20 to 45% light, in the photic zone). At 35 m it is in the **aphotic zone**, with too little light. (c) **No photosynthesis happens below the photic zone, so deep organisms eat dead matter and organisms that sink or swim down from above.**

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6. (a) Students measure salinity at four stations from a river out to the sea (sample data). Classify each station as fresh water, estuary, or ocean.

Station	Salinity (ppt)	Type of water
1	0.2	***Fresh water***
2	6	***Estuary***
3	19	***Estuary***
4	35	***Ocean***

(b) At a coastal station, surface nitrate was 0.5 units in a calm week and 12 units during a week of strong winds blowing away from shore (sample data). How many times greater was it in the windy week? Explain the cause and its effect on phytoplankton.

> (b) 12 ÷ 0.5 = **24 times greater**. **The wind pushed surface water away, and cold, nutrient-rich deep water rose to replace it (upwelling). More nutrients in sunlit water let phytoplankton grow.**

Part 4. Competition and Niche Partitioning

7. Two meadow grasses are grown in pots, alone or together. The table shows the mass of one plant after 8 weeks (sample data).

	Grown alone (g)	Grown together (g)	Percent change
Grass X	12.0	9.0	***-25%***
Grass Y	10.0	2.0	***-80%***

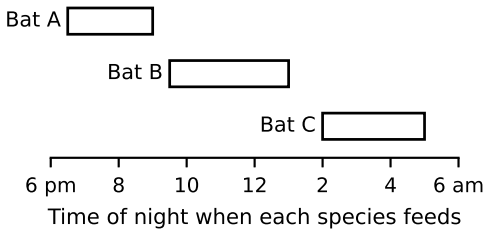
(a) Complete the table.

(b) Which grass is the stronger competitor? Is the competition between the two grasses intraspecific or interspecific? Use the data to explain.

> (a) X: (9.0 − 12.0) ÷ 12.0 × 100 = −25%. Y: (2.0 − 10.0) ÷ 10.0 × 100 = −80%.
>
> (b) **Grass X**: competition lowered both, but X lost only 25% of its mass while Y lost 80%. It is **interspecific**, because the two plants are different species competing for the same light, water, and nutrients.

8. Three bat species hunt over the same field. The model shows when each one feeds, and the table shows its main food (sample data).

Species	Main food
Bat A	Small moths
Bat B	Beetles
Bat C	Small moths



(a) Which two species eat the same food? How does the model show that they partition this resource?

(b) Two bats of species A fight over one roost. Two bats, one of species A and one of species C, chase the same moth. Classify each kind of competition.

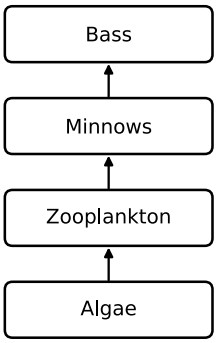
> (a) **Bats A and C** both eat small moths, but **A feeds early in the evening and C feeds before dawn**, so they use the resource at different times and compete less.
>
> (b) **Same roost, species A: intraspecific. A and C chasing a moth: interspecific.**

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Part 5. Predators, Prey, and Keystone Species

9. Scientists compare lakes with and without bass, a fish that eats minnows (sample data).

Measurement	With bass	Without bass
Minnows per net	12	85
Zooplankton per L	40	9
Algae (µg chlorophyll per L)	3	18
Water clarity (m)	4.0	1.2



(a) Find the percent change in zooplankton from the lakes with bass to the lakes without bass.

(b) Use the food chain to explain why the water is cloudier without bass. What is this kind of chain of effects called?

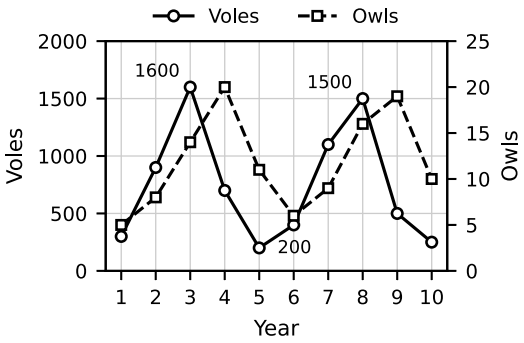
> (a) (9 − 40) ÷ 40 × 100 ≈ **−77.5%**.
> (b) **Without bass, minnows increase (12 to 85), eat more zooplankton (40 to 9), so fewer zooplankton graze algae, and algae increase (3 to 18), making the water cloudier (4.0 m to 1.2 m). This is a trophic cascade.**

10. The graph shows a vole population and the owls that eat them (sample data).

(a) In which years did each population peak? How many years after the voles did the owls peak?

(b) Find the percent change in voles from year 3 to year 5.

(c) Explain why the owl peaks come after the vole peaks.



> (a) **Voles: years 3 and 8. Owls: years 4 and 9. One year later.** (b) (200 − 1,600) ÷ 1,600 × 100 = **−87.5%**.
> (c) **Plenty of voles feed more owls, so the owl population grows after the voles do. More owls eat more voles, the voles fall, and then the owls run short of food and decline.**

Part 6. Symbiosis

11. (a) Classify each relationship as mutualism, commensalism, or parasitism.

Relationship	Type
(1) Clownfish hide in a sea anemone and chase away fish that eat the anemone.	***Mutualism***
(2) Mistletoe grows into a tree branch and takes water and nutrients.	***Parasitism***
(3) Egrets eat insects stirred up by grazing cattle; the cattle are not clearly helped or harmed.	***Commensalism***

(b) Rhizobia are bacteria that live in bean root nodules. Bean plants were grown with and without rhizobia (sample data): in low-nitrogen soil, 1.8 g without and 3.6 g with; in high-nitrogen soil, 4.0 g without and 3.7 g with. Find the percent change for each soil. Is the relationship the same in both soils? Explain.

> (b) Low N: (3.6 − 1.8) ÷ 1.8 × 100 = **+100%**. High N: (3.7 − 4.0) ÷ 4.0 × 100 = **−7.5%**. **No.** The bacteria help the plant a lot when nitrogen is scarce, but when nitrogen is plentiful the plant gains nothing and is slightly smaller, so the relationship is classified by its effect under each condition.

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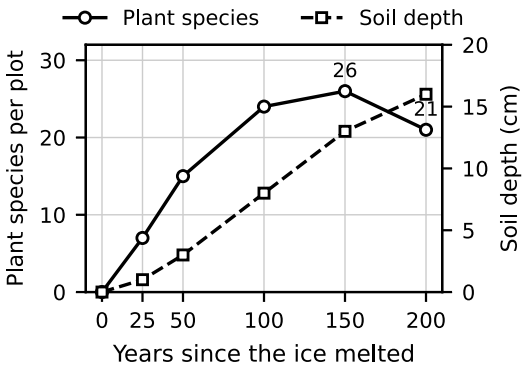
Part 7. Ecological Succession

12. A glacier melted back, leaving bare rock. The graph shows sample data for plots of different ages.

(a) Is this primary or secondary succession? Use the soil data to explain.

(b) Find the percent change in plant species from year 150 to year 200.

(c) The first organisms on the rock were lichens and mosses. What are these called, and how do they help the species that come later?



(a) **Primary**: soil depth starts at 0 cm, so soil had to form first. (b) $(21 - 26) \div 26 \times 100 \approx$ **−19.2%**.

(c) **Pioneer species.** They break down rock and add dead matter, building soil that later plants need.

13. After a forest fire, plant cover reached 50% in 6 years. On a new lava flow nearby, it took 120 years (sample data).

(a) How many times longer did the lava flow take? Explain the difference.

(b) A student says the burned forest will return to exactly the same community it had before the fire. Use the current view of succession to respond.

(a) 120 ÷ 6 = **20 times longer**. **The burned forest kept its soil, seeds, and roots (secondary succession); the lava had no soil, so soil had to form first (primary succession).**

(b) **Not necessarily. Communities keep changing, and the outcome depends on climate, soil, and chance, such as which seeds arrive first or another disturbance.**

Part 8. Human Impacts on Biodiversity

14. (a) Name the main threat to biodiversity in each case.

Case	Threat
(1) Zebra mussels from Europe arrive in a lake on boat hulls and spread.	***Invasive species***
(2) As summers warm, a mountain wildflower is found only at higher elevations.	***Climate change***
(3) Elephants are killed for ivory faster than the population can replace them.	***Overharvesting***
(4) Pesticide runoff kills insects in a stream.	***Pollution***

(b) Threats often act together. Explain how one pair of these threats could make a population decline faster than either one alone.

(b) Any reasonable pair, for example: **a population already reduced by overharvesting has fewer individuals left to recover from a warmer climate, so the two together push it down faster.**

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15. Before zebra mussels arrived, a lake had 40 native mussels per m^2. Ten years later it had 6 native mussels and about 3,000 zebra mussels per m^2 (sample data).

(a) Find the percent change in native mussels.

(b) Write a claim about the cause of the decline, with evidence and reasoning. What other evidence would make the claim stronger?

> (a) $(6 - 40) \div 40 \times 100 =$ **−85%**.
>
> (b) **Claim: the invasive zebra mussels likely caused the decline. Evidence: native mussels fell from 40 to 6 per m^2 while zebra mussels rose to about 3,000 per m^2. Reasoning: an invasive species spreads and harms natives, for example by competing for food or space.** Stronger evidence: **a nearby lake without zebra mussels where natives did not decline**, or data showing zebra mussels attached to native mussels.

Part 9. Conservation and Restoration

16. Salamanders cross a road each spring to reach a breeding pond, and 600 were killed per year. A town adds tunnels under the road and low fences that guide animals to them. Deaths fall by 72% (sample data).

(a) About how many salamanders are now killed per year?

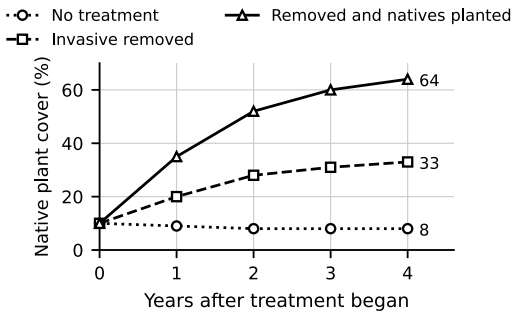
(b) The fences also block turtles that cannot find the tunnels. Name two things to consider when evaluating this solution, and describe how the town could test and improve it.

> (a) $600 \times (1 - 0.72) = 600 \times 0.28 =$ **about 168 per year**.
>
> (b) Any two: **effectiveness, cost, side effects (such as blocking turtles), effects on people. Keep counting road deaths and tunnel use for each species, then refine the design, for example with more or wider tunnels, and test again.**

17. A grassland is invaded by a non-native plant. Scientists try two treatments and keep untreated plots for comparison (sample data).

(a) After 4 years, how many percentage points higher was native cover in the "removed and natives planted" plots than in the "invasive removed" plots?

(b) Which treatment worked best? Use claim, evidence, and reasoning. Why are the untreated plots needed?



> (a) $64\% - 33\% =$ **31 percentage points**.
>
> (b) **Claim: removing the invasive and planting natives worked best. Evidence: cover rose from 10% to 64%, compared with 33% for removal only and 8% with no treatment. Reasoning: removing the cause of harm helps, and planting natives speeds recovery.** The untreated plots show what happens without any treatment, so the change can be credited to the treatments.

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