Past-paper walk-through

Biodiversity ▪ 8.6

eXercise

Questions in this set

- 2026 Q6
- 2024 Q4
- 2023 Q3
- 2022 Q5
- 2021 Q5
- 2014 Q5

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 6

2026 ▪ Q6

Many raptors in Africa are top predators and keystone species in their ecosystems. Raptor population sizes have been declining in recent years.

Scientists studied the relationship between the conversion of the raptors' natural habitat into farmland and the population sizes of raptors in those regions. They compiled raptor population size data from three different regions of Africa: Region 1, Region 2, and Region 3. In each of the regions, the scientists compared the annual percent change in the raptor population size in areas that were protected from farming (protected) with the annual percent change in areas where farming occurred (unprotected). Their results are shown in the box and whisker plot.

Median Annual Percent Change in the Population Size of Raptors in Protected and Unprotected Areas

Question 6

[Box-and-whisker plot; y-axis "Annual Percent Change in Population Size" from -14.0 to 6.0 in increments of 2.0; x-axis groups: Region 1, Region 2, Region 3, each with two boxes (white = Protected area, gray = Unprotected area); a dashed horizontal reference line at $y = 0$.

Region 1 - Protected area: whiskers from about -5.0 to 0.8, box (IQR) from about -2.3 to -0.8, median line at about -1.7. Region 1 - Unprotected area: whiskers from about -10.3 to 0.2, box from about -8.2 to -2.3, median line at about -4.3.

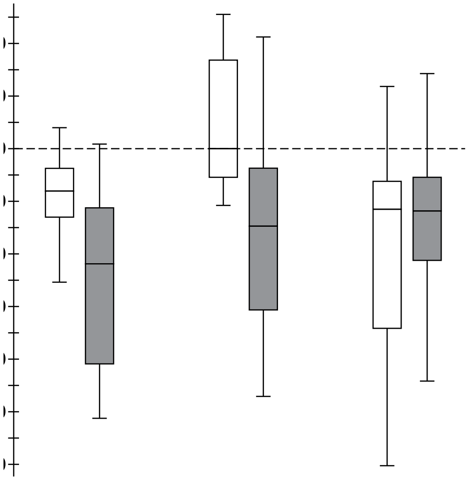
Region 2 - Protected area: whiskers from about -2.2 to 5.2, box from about -1.2 to 3.4, median line at about 0.0. Region 2 - Unprotected area: whiskers from about -9.4 to 4.3, box from about -6.1 to -0.8, median line at about -3.0.

Region 3 - Protected area: whiskers from about -12.1 to 2.3, box from about -7.0 to -1.2, median line at about -2.3. Region 3 - Unprotected area: whiskers from about -8.8 to 2.9, box from about -4.2 to -1.1, median line at about -2.4.]

Question 6

(a) Based on the box and whisker plot, **identify** the median annual percent change in population size in the unprotected area of Region 2.
(b) Based on the box and whisker plot, **identify** the region and area that experienced the greatest median annual percent change in population size.
(c) Researchers hypothesize that if farming is eliminated in Region 2, there will no longer be a decline in the raptor population size. Based on the data in the box and whisker plot, **evaluate** the researchers' hypothesis.
(d) Based on the information provided, **explain** why ecosystem resilience in unprotected areas may decline over time.

Question 6



Question 4

2024 ▪ Q4

The common wild oat is native to regions of Europe and Asia but is an invasive species in central California grasslands. In California, the common wild oat has almost completely replaced some species of native bunchgrass. Researchers found that aphids, a type of small insect that often carries plant viruses, have a much higher reproductive rate in grasslands that include the common wild oat than in grasslands composed of only native bunchgrass species. Additionally, the viruses carried by the aphids appear to affect only the native bunchgrasses and not the common wild oat. Native bunchgrasses infected by the virus have much higher death rates than do native bunchgrasses that are not infected.

(a) Describe the change in the resilience of an ecosystem when there is a decrease in the number of species.

Question 4

(b) Explain how the addition of the common wild oat affects the number of native bunchgrass plants that can be supported by the California grasslands ecosystem.
(c) Researchers suggest adding ladybugs, predators of aphids, to the California grasslands. **Predict** the effect of adding ladybugs on the abundance of the native bunchgrass population.
(d) Justify your prediction in part (c).

Solution 4

(a)

Mark scheme

- The resilience of the ecosystem will decrease when the number of species decreases.

Solution 4

(b)

Mark scheme

- Accept either: the addition of the wild oat limits the resources available to native bunchgrass, resulting in a decrease in bunchgrass population size; or the addition of the wild oat enables the aphid population to increase (more aphids feeding on/carrying viruses) and increases bunchgrass exposure to plant viruses, resulting in a decrease in the native bunchgrass population size (since infected bunchgrass has a much higher death rate).

Solution 4

(c)

Mark scheme

- The native bunchgrass population will increase in abundance if ladybugs are added.

Solution 4

(d)

Mark scheme

- Adding ladybugs (predators of aphids) will decrease the number of aphids, which will decrease the transmission of/infection by the plant viruses that raise bunchgrass death rates — so fewer bunchgrass plants die of infection and the native bunchgrass population increases.

Question 3

2023 ▪ Q3

Sand lances of the genus *Ammodytes* are small fish that function as keystone organisms in several coastal ecosystems. These sand lances are prey fish that support organisms at higher trophic levels. Scientists performed experiments to examine how sand lance populations are likely to be affected by the rising temperatures and CO_2 levels associated with climate change.

Sand lance embryos typically develop and mature into adult fish at low temperatures (approximately $5°C$) and stable, low CO_2 levels (approximately 400 μatm). Over the course of two years, the scientists measured the survival rate of sand lance embryos allowed to develop and mature in a laboratory at three different temperatures, $5°C$, $7°C$, and $10°C$, with the level of CO_2 maintained at 400 μatm, 1,000 μatm, and 2,100 μatm for each temperature.

Question 3

(a) Describe the effect of increased biodiversity on the resilience of an ecosystem in a changing environment.
(b) **Justify** the scientists' selecting $5°$C as the lowest temperature and 400 μatm as the lowest CO_2 level in their study of sand lance embryo survival.
(c) State a null hypothesis for the experiment.
(d) The scientists claim that a reduction in the population size of the *Ammodytes* sand lances will affect the stability of the entire coastal ecosystem. Provide reasoning to **support** the scientists' claim.

Solution 3

(a)

Mark scheme

- Increased biodiversity increases the resilience of an ecosystem in a changing environment — i.e., an ecosystem's resilience (ability to recover from or withstand disturbance/change) is greater when biodiversity is higher.

Solution 3

(b)

Mark scheme

- 5°C and 400 atm CO_2 were chosen because they represent the normal/current environmental conditions under which sand lance embryos typically develop and mature; using these as the baseline lets the researchers use them as a basis of comparison to evaluate the effects of increases in temperature and CO_2 (i.e., climate-change-associated changes) on embryo survival relative to current, unaltered conditions.

Solution 3

(c)

Mark scheme

- A null hypothesis for the experiment (any one of): climate change (increased temperature and/or CO_2) will have no effect on sand lance embryo survival/development or on the size of sand lance populations; equivalently, there will be no difference in sand lance embryo survival rates/development measured at the different (or all) temperatures and CO_2 levels tested.

Solution 3

(d)

Mark scheme

- Reasoning to support the claim (either): a reduction in sand lance population size will have a negative effect on organisms at other trophic levels because sand lances serve as a food source (prey) for many other species — fewer sand lances means less food/energy available for predators; or, there would be reduced energy transfer to higher trophic levels, destabilizing the coastal food web/ecosystem since sand lances are a keystone prey species.

Question 5

2022 ▪ Q5

The following models represent all the interacting species in two different communities with some of the same species and feeding relationships. These models assume that both communities have the same initial biomass. The models can be used to understand the effects of human activities on the communities.

[Figure 1: two food-web diagrams side by side, "Community A" and "Community B", arranged in four horizontal trophic-level rows (top to bottom): Tertiary Consumers (TC), Secondary Consumers (SC), Primary Consumers (PC), Primary Producers (PP). Community A: PP1, PP2, PP3 at the base; arrows go PP1→PC1, PP1→PC2, PP2→PC2, PP2→PC3, PP3→PC3, PP3→PC4; then PC1→SC1, PC2→SC1, PC2→SC2, PC3→SC2, PC3→SC3, PC4→SC3; then SC1→TC1, SC2→TC1, SC2→TC2, SC3→TC2. Community B: PP1 and PP3 at the base (no PP2); arrows go PP1→PC2, PP3→PC3; then PC2→SC2, PC3→SC2; then SC2→TC2.]

Question 5

Figure 1. Models of two different communities with some of the same species

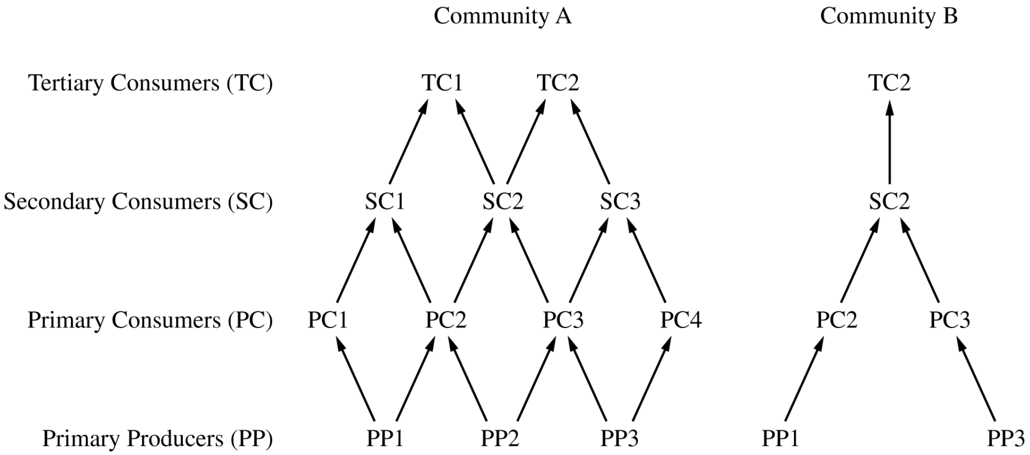
(a) Describe a characteristic of a community that makes a species invasive in that community but not invasive in a different community.

(b) Explain why removing species PP1 will have a greater effect on community B than on community A.

(c) An invasive species (INV) that eats individuals of species SC2 is introduced into community B. Using the template in the space provided for your response, for community B, indicate the feeding relationship for this invasive species by correctly placing INV to represent the invasive species and an arrow to represent the feeding relationship within community B.

(d) Explain how human activities that add toxins to the soil could change a community with many species at each trophic level, such as community A, into a community with few species at each trophic level, such as community B.

Question 5



Community A
Community B
Tertiary Consumers (TC)
Secondary Consumers (SC)
Primary Consumers (PC)
Primary Producers (PP)
TC1
TC2
SC1
SC2
SC3
PC1
PC2
PC3
PC4
PP1
PP2
PP3
TC2
SC2
PC2
PC3
PP1
PP3

Solution 5

(a)

Mark scheme

- A species is invasive in a community where there are no/reduced natural predators of the species, no/reduced competitors of the species, or no/reduced diseases to which the species is susceptible - conditions that may not hold in a different community, where the species is therefore not invasive.

Solution 5

(b)

Mark scheme

- Removing species PP1 has a greater effect on community B than on community A because in community B there will be decreases in PC2, SC2, and TC2 (PC2, SC2, and PC3), whereas in community A, PC2 has alternative food sources (other primary producers, PP2/PP3) to rely on. More generally, with fewer/less diverse primary producers (and primary consumers) there are fewer paths for energy to move through community B, so with fewer species/feeding interactions/less diversity, community B is less resilient to future environmental change.

Solution 5

(c)

Mark scheme

- On the Community B diagram, INV should be added in a position horizontally aligned with TC2 (i.e. at the tertiary-consumer level), with an arrow drawn from SC2 pointing to INV, representing that the invasive species (INV) feeds on SC2.

Solution 5

(d)

Mark scheme

- Human activities that add toxins to the soil could eliminate primary producers, which reduces species diversity at higher trophic levels; alternatively, the toxins could biomagnify up the food chain, becoming more concentrated and toxic at higher trophic levels and reducing species diversity there - either mechanism could transform a many-species-per-trophic-level community like A into a few-species community like B.

Question 5

2021 ▪ Q5

Annual plants complete their life cycle, including germination, seed production, and death, within one year. *Ambrosia trifida* (giant ragweed) is an annual plant that readily colonizes any land that has had a disturbance such as plowing. The plant is considered an invasive species in regions outside of its native range. In a particular region, the seeds of *A. trifida* germinate from early March through the end of the summer, while the seeds of other annual plants require warmer soil temperatures and thus germinate from late April through the end of the summer.

Researchers studied the influence of *A. trifida* on the biodiversity of other annual plant species that grow in the same field. In early spring, the researchers marked off identical plots of land in a field that had been plowed the previous fall and not replanted with new crops. All plants that grew on one half of the plots were left untouched (Figure 1A), while all germinating *A. trifida* seedlings were removed from the other half of the

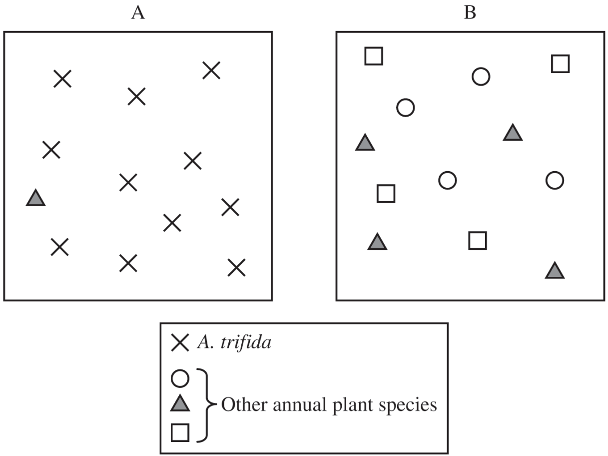
Question 5

plots throughout the spring and summer (Figure 1B). In late summer, the researchers counted and identified all plants that grew in the plots. The distribution of plants is represented by the symbols in Figures 1A and 1B.
[Figure 1: Two square plots side by side, labeled A and B, each representing one experimental plot; each symbol represents 10 individual plants. Plot A (untouched) contains 10 “X” symbols (*A. trifida*) and 1 filled triangle (other annual plant species), scattered across the plot. Plot B (A. trifida removed) contains 3 open squares, 3 open circles, and 3 filled triangles (all “other annual plant species”), scattered across the plot, and no “X” symbols. Legend: X = *A. trifida*; open circle, filled triangle, and open square (bracketed together) = “Other annual plant species”. Caption: “Figure 1. Representations of plant identity and distribution in experimental plots in late summer. Each box represents one typical experimental plot, and each symbol represents 10 individual plants.”]

Question 5

(a) Describe a cause of logistic growth of the ragweed population.
(b) Based on the representation in Figure 1, **explain** why the scientists claim that plot B would be more resilient than plot A in response to a sudden environmental change.
(c) In a third group of plots, the researchers removed all seedlings of all plants that germinated before June 1. All plants that germinated after June 1 were left untouched. Using the template in the space provided for your response and the symbols shown in Figure 1, **represent** the expected plant species that would be found in this third group of plots three months later. Draw no more than 12 symbols. Assume all other environmental conditions are the same as for the initial study described.
(d) Explain how an invasive species such as ragweed affects ecosystem biodiversity, as illustrated in Figure 1.

Question 5



Solution 5

(a)

Mark scheme

- A cause of logistic growth of the ragweed population (accept either): a factor becomes limiting, causing the population size to stabilize; or a density-dependent factor such as space, sunlight, herbivory, phosphorus, or nitrogen becomes limiting, and the population stabilizes (approaching carrying capacity).

Solution 5

(b)

Mark scheme

- Plot B would be more resilient than plot A in response to a sudden environmental change because plot B has much greater species diversity than plot A does (a more diverse community is less likely to be devastated entirely by a change that affects only some species, and can recover/re-establish more readily).

Solution 5

(c) Mark scheme

- This is a draw/represent task graded on content, not a text answer: the student's diagram (12 symbols) must include all four plant types shown in the Figure 1 key — the X symbol (A. trifida) and the three 'other annual plant species' symbols (circle, filled triangle, square). Rationale: because A. trifida germinates from early March through the end of summer and the other annual species germinate from late April through the end of summer, both A. trifida and the other species still have individuals that germinate after June 1 (the cutoff for seedling removal in this third treatment), so all four symbol types are still expected to be present three months later.

Solution 5

(d)

Mark scheme

- Explanation must describe a process/relationship and state that biodiversity decreases. Accept any of: there are no predators of the invasive species, so its population grows faster and reduces biodiversity; the invasive species germinates earlier, uses up resources, and reduces biodiversity; the invasive species outcompetes other species and reduces biodiversity (consistent with Figure 1, where plot A — with A. trifida left in — has only A. trifida present, while plot B — with A. trifida removed — retains multiple other species).

Question 5

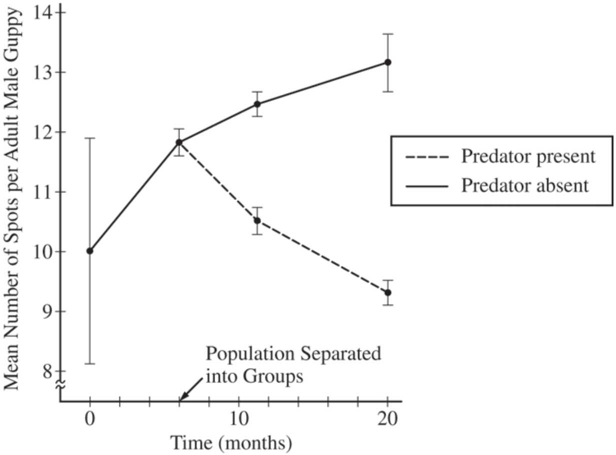
2014 ▪ Q5

Genetically modified crops have been developed that produce a protein that makes the plants resistant to insect pests. Other genetic modifications make the crops more resistant to chemicals that kill plants (herbicides).

(a) Describe TWO potential biological risks of large-scale cultivation and use of such genetically modified plants.

(b) For each of the risks you described in part (a), **propose** a practical approach for reducing the risk.

Question 5



Mean Number of Spots per Adult Male Guppy
14
13
12
11
10
9
8
0
10
20
Time (months)
Population Separated into Groups
Predator present
Predator absent

Solution 5

(a)

Mark scheme

- 2 points maximum, 1 point per described risk (describe TWO). Accepted risks include: unknown human/other-animal health risk from consuming GM proteins; disruption within the food chain; developed resistance in pest species; spread of genetic modifications to non-GM plants; GM plants out-competing native species; reduced numbers of pollinators; loss of biodiversity; use of herbicides harming non-target species; invasive disease wiping out the monoculture.

Solution 5

(b) Mark scheme

- 2 points maximum, 1 point per box, for a practical mitigation matched to each risk named in part (a) — mitigation must be practical for the risk given; proposing non-use of GM plants is acceptable for any risk. Example pairings: health risk $\rightarrow$ testing/labeling product packaging or isolating animals from crops; disruption within food chain $\rightarrow$ interspersing GM plants with non-GM plants in culture or providing an alternative food source; developed pest resistance $\rightarrow$ increased use of effective pesticides, introducing pest predators, further engineering the GMO for more resistance protein, or rotating GM and non-GM crops; spread of genetic modification $\rightarrow$ containing pollen of GM plants or disabling GM plants' ability to produce viable seeds; GM plants out-competing native species $\rightarrow$

Solution 5

containing/isolating GM plants or disabling viable-seed production; reduced pollinators or loss of biodiversity $\rightarrow$ contain/isolate GM plants or intersperse GM with non-GM plants; herbicide harm to non-target species $\rightarrow$ rotate GM and non-GM crops or use organic/alternative herbicides; invasive disease wiping out monoculture $\rightarrow$ intersperse GM plants with non-GM plants in culture.