Past-paper walk-through

Carrying Capacity ▪ 3.4

eXercise

Questions in this set

- 2025 Set 1 Q1
- 2021 Set 1 Q3

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.

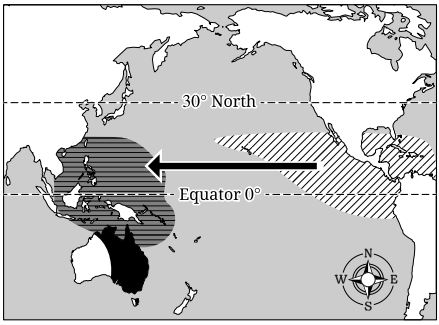
Question 1

2025 Set 1 ▪ Q1

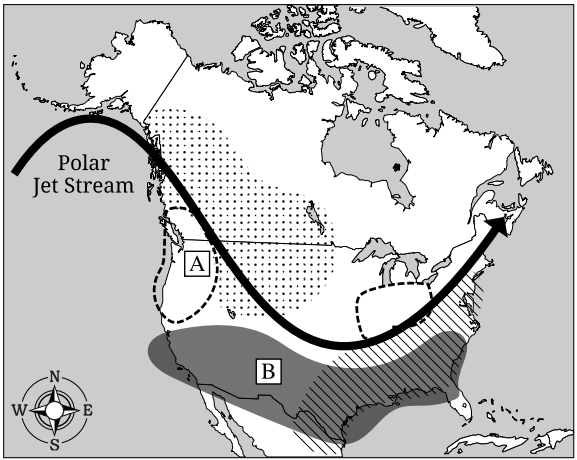
Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(a) Describe one reproductive strategy used by a K-selected species such as the chickadee.

Question 1


30° North
Equator 0°
N
W
E
S
Ocean water cooler than average
Ocean water warmer than average
Increased chance of precipitation
Stronger than normal trade winds

Question 1



Question 1

Site	Species A	Species B	Species C	Species D	Species E	Species F
Urban park	X			X	X	
Grassland	X	X	X	X		X

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(b) Based on the information provided, explain how a decrease in spider populations could affect a lower trophic level.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(c) Based on the data in Figure 1, identify the number of spiders per sample at 25% nonnative plants.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(d) Based on the data in Figure 1, describe the trend in the number of insects per sample in relation to the percentage of nonnative plants.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(e) Scientists hypothesized that the population of chickadees would be stable or growing with fewer than 25% nonnative plants. Describe one way that the data in Figure 2 support this hypothesis.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(f) Insect biodiversity is important to maintain ecosystem health. A group of students was interested in learning about factors that affect ant biodiversity. They located two study sites near their school: a frequently mowed urban park and an unmowed grassland. The students used traps designed to collect ants. They loaded 10 of these traps with the same food and placed them randomly at different locations within each site. Students collected the traps after 24 hours and counted the number of different ant species in each trap to determine species richness.

(f)(i) Identify a likely scientific question for the students' investigation of ant diversity.

(f)(ii) Identify the dependent variable in the students' investigation.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(g) The data from the student investigation of ant diversity are shown in the following table. An "X" in the table indicates that the species was present at that site.

Ant Species Present in an Urban Park and Unmowed Grassland

Site	**Species A**	**Species B**	**Species C**	**Species D**	**Species E**	**Species F**
Urban park	X			X	X	
Grassland	X	X	X	X		X

Question 1

(g)(i) Explain why the ant community of the unmowed grassland would be more likely to recover from a disturbance, such as a flood or fire, than the ant community in the mowed urban park would.

(g)(ii) Explain how the results of the investigation could have been altered if students had measured ant biodiversity at a paved playground rather than in the grassland.

Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

(h) Habitat fragmentation has impacts on a variety of species. Paved roads can lead to habitat fragmentation.

Describe one effect that a paved road in a forest can have on animal species such as deer or bears.

Solution 1

(a)

Mark scheme

- Describe one reproductive strategy of a K-selected species (e.g., chickadee). Any one of: provides considerable parental care for offspring; has few offspring; parents expend significant energy per offspring; individuals reproduce more than once in their lifetime (iteroparity); has a long gestation period/reaches reproductive maturity later.

Solution 1

(b)

Mark scheme

- Explain how a decrease in spider populations affects a lower trophic level: insects/insect populations would increase because they are no longer being preyed on/eaten as much by spiders; consequently plant populations would decrease because more insects are now eating the plants (a trophic cascade down through insects to plants).

Solution 1

(c)

Mark scheme

- From Figure 1, the number of spiders per sample at 25% nonnative plants is 2.0 (accept 2).

Solution 1

(d)

Mark scheme

- Trend in Figure 1: as the percentage of nonnative plants increases, the number of insects per sample decreases (equivalently, as nonnative plant percentage decreases, insects increase) — an inverse/negative relationship between nonnative plant percentage and insect abundance.

Solution 1

(e)

Mark scheme

- One way Figure 2 supports the hypothesis that chickadee populations are stable or growing below 25% nonnative plants: below this threshold, the population growth rate shown is at or above replacement level (positive growth), meaning enough reproduction is occurring to replace or grow the population.

Solution 1

(f)

Mark scheme

- This is background/stem text introducing the student investigation of ant biodiversity (10 baited traps placed randomly at a frequently mowed urban park and an unmowed grassland, collected after 24 hours, species counted). It is context for parts (i) and (ii) and carries no scoring point of its own.

Solution 1

(f)(i)

Mark scheme

- A likely scientific question for the investigation: "Does the number of species/species richness/biodiversity differ between an urban park and a grassland?" or "Does mowing affect the number of species/species richness/biodiversity?"

Solution 1

(f)(ii)

Mark scheme

- The dependent variable is the number of ant species / ant species richness / the presence-absence of different ant species observed at each site.

Solution 1

(g)

Mark scheme

- This presents the data table of ant species present (X) at the urban park vs. the unmowed grassland (species A-F). It is context for parts (i) and (ii) and carries no scoring point of its own.

Solution 1

(g)(i)

Mark scheme

- The unmowed grassland's ant community would more likely recover from a disturbance because, with a larger number of species, the grassland is more likely to have some species/individuals with adaptations that allow them to survive the disturbance; the grassland is more diverse, so the loss of any one species is less likely to cause collapse of the whole community/ecosystem.

Solution 1

(g)(ii)

Mark scheme

- If biodiversity had been measured at a paved playground instead of the grassland, the playground would show fewer species than the grassland/urban park, because the paved area is not suitable habitat for many ant species, and/or because humans could trample the ants/ant habitat there.

Solution 1

(h)

Mark scheme

- One effect of a paved road through a forest on animals such as deer or bears: animals can be hit by cars when trying to cross the road while hunting/migrating (roadkill); fragmentation can isolate individuals and reduce genetic diversity; noise pollution can damage hearing, cause stress, or mask sounds used to communicate/hunt; the road/noise can alter migratory routes or prevent movement to access resources; species that thrive in edge habitats might increase. Any one of these earns the point.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.
(a) Describe a characteristic of a specialist species that would make the specialist species more likely to be negatively affected by habitat fragmentation than a generalist species.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(b) A rapidly growing suburban municipality purchases nearby forested land and proposes a newly planned housing development, which would involve clear-cutting much of the area for the construction of single-family homes. While evaluating the land, the development committee discovers that development will encroach upon the habitat of a wood thrush population. The wood thrush is a solitary, territorial bird whose preferred habitat consists of large, intact densely forested areas. Wood thrush populations are also threatened by cowbirds. A cowbird lays her egg in an existing nest of a wood thrush. After the cowbird egg hatches, the cowbird pushes the unhatched wood thrush eggs out. The wood thrush parents raise the cowbird hatchling as their own.

Identify the symbiotic relationship between the wood thrush and the cowbird.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(c) Describe one ecological advantage of leaving areas of undeveloped forest in the development plan as compared to clear-cutting the property.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(d) Propose a solution that will minimize the effect of development on the resident population of wood thrush while still meeting the municipality's need for a housing development.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(e) A male wood thrush needs a minimum of 800 m^2 of territory for reproduction. The municipal development committee has set a biodiversity preservation target of 275 male wood thrush territories. **Calculate** the area that must be set aside to support the goal of 275 male thrush territories. **Show** your work.

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(f) A real estate developer wants to build houses on the property. The plan will support 1,000 lots with a lot size of $1,100$ m^2. The developer has proposed setting aside land equal to 10

Question 3

2021 Set 1 ▪ Q3

Habitat destruction and fragmentation can have many different effects on species.

(g) Calculate the percentage of each of the 1,000 lots that would need to be set aside in order to support the goal of 275 male wood thrush territories. **Show** your work.

Solution 3

(a) Mark scheme

- A characteristic of a specialist species that makes it more vulnerable to habitat fragmentation than a generalist species (accept one): specialists have a narrow ecological niche (compared to a generalist's broad niche), which is reduced even further by fragmentation; specialists have specialized adaptations and cannot adjust quickly to a changed/fragmented habitat, unlike generalists that adapt quickly; or specialists tend to have small populations with less genetic variation than generalist populations, which are larger and more genetically diverse, making specialists more vulnerable.

Solution 3

(b)

Mark scheme

- Identify the symbiotic relationship between the wood thrush and the cowbird: parasitism, specifically brood parasitism — the cowbird lays its eggs in the wood thrush's nest and uses the wood thrush as a surrogate parent to raise its hatchling, which benefits the cowbird and negatively affects the wood thrush.

Solution 3

(c) Mark scheme

- One ecological advantage of leaving areas of undeveloped forest instead of clear-cutting the property (accept one): since the habitat isn't clear-cut, it preserves some biodiversity by letting species survive in the remaining/fragmented forest areas; habitat fragmentation can benefit some generalist or edge species, whose populations may increase in edge habitat; buffer zones around conserved areas can reduce edge disturbance for specialist species; the remaining forest/trees reduce soil erosion; or the remaining forest helps with climate/cooling via transpiration and shade from trees.

Solution 3

(d) Mark scheme

- Propose a solution that minimizes the effect of development on the resident wood thrush population while still meeting the municipality's need for housing (accept one): leave wildlife corridors/crossings to prevent population isolation; include conservation easements in the plan that preserve species (and provide tax breaks for residents); create buffer zones near the development to separate it from wildlife habitat; create a mitigation plan that preserves land of similar quality elsewhere; cluster housing or build vertically to limit the development footprint; or incorporate common green spaces that promote wood thrush populations.

Solution 3

(e)

Mark scheme

- Calculate the area that must be set aside to support 275 male wood thrush territories at a minimum of 800 m^2 *perterritory*.*Setup*(1*point*) :275 territories $\times \frac{800\ \text{m}^2}{1\ \text{territory}}$. Calculation (1 point): $= 220{,}000\ \text{m}^2$.

Solution 3

(f)

Mark scheme

- Calculate the maximum number of male wood thrush territories created under the developer's proposal (1,000 lots of 1,100 m^2 *each*, *with* 10

Solution 3

(g)

Mark scheme

- Calculate the percentage of each of the 1,000 (1,100 m^2) *lots that must be set aside to support the goal of 275 male wood thrush territories. Setup (1 poi*

  100 (equivalently $\frac{275 \text{ territories} \times 10\%}{137.5 \text{ territories}} \times 100$). Calculation (1 point): $= 20\%$ of each lot.