Past-paper walk-through

Clearcutting ▪ 5.2

eXercise

Questions in this set

- 2024 Set 2 Q1
- 2024 Set 2 Q2
- 2021 Set 1 Q3
- 2021 Set 2 Q2
- 2021 Set 2 Q3
- 2017 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

2024 Set 2 ▪ Q1

The following diagram shows how an area changed over time. The dominant vegetation in each stage is labeled in the diagram. Each roman numeral represents a stage in the ecological process.
[Diagram: A cross-section showing ecological succession over time, divided into six stages labeled with roman numerals I through VI, with a key showing "Bedrock" (dotted pattern) and "Soil" (solid gray). A horizontal arrow below labeled "Time" points left to right. The cross-section shows bedrock and soil layers progressively deepening from left (mostly exposed bedrock) to right (thick soil layer) as vegetation on top becomes progressively taller and denser. The six stages are labeled below the diagram:

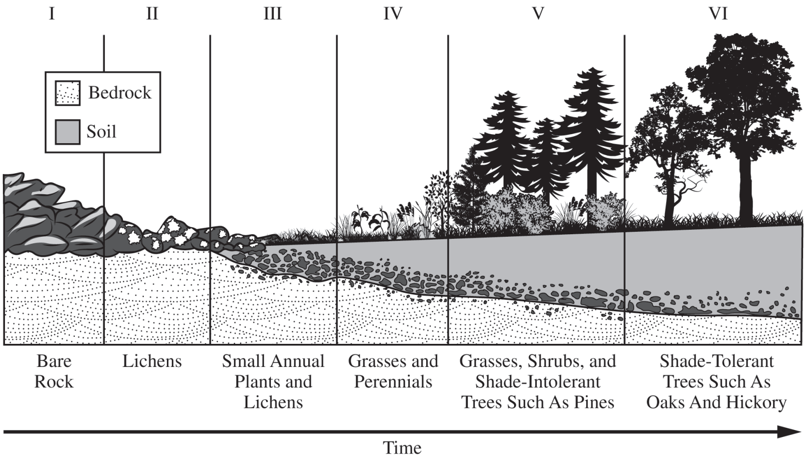
- Stage I: Bare Rock

Question 1

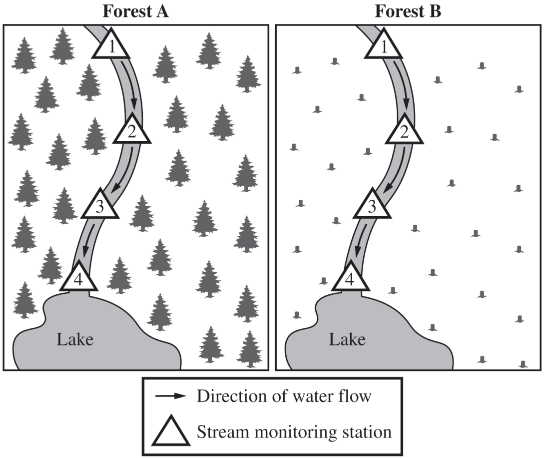
- Stage II: Lichens
- Stage III: Small Annual Plants and Lichens
- Stage IV: Grasses and Perennials
- Stage V: Grasses, Shrubs, and Shade-Intolerant Trees Such As Pines
- Stage VI: Shade-Tolerant Trees Such As Oaks And Hickory]

(a) Identify the ecological change over time illustrated in the diagram.

Question 1


I
II
III
IV
V
VI
Bedrock
Soil
Bare Rock
Lichens
Small Annual Plants and Lichens
Grasses and Perennials
Grasses, Shrubs, and Shade-Intolerant Trees Such As Pines
Shade-Tolerant Trees Such As Oaks And Hickory
Time

Question 1



Forest A
Forest B
1
2
3
4
Lake
1
2
3
4
Lake
Direction of water flow
Stream monitoring station

Question 1

2024 Set 2 ▪ Q1

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(b) Identify the stage in which pioneer species first appear.

Question 1

2024 Set 2 ▪ Q1

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(c) Describe how soil forms from stage II to stage III.

Question 1

2024 Set 2 ▪ Q1

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(d) Identify a cultural ecosystem service that may be provided by a mature forest.

Question 1

2024 Set 2 ▪ Q1

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(e) Researchers are interested in investigating the effect of the removal of trees on the water quality of nearby waterways. To conduct their experiment, the researchers locate two identical forest watersheds, both with a river running through them. Forest A is an intact forest and forest B is a clear-cut forest. Four stream monitoring stations are set up in each forest study area. Each station monitors a variety of water quality indicators, including water temperature, at various locations along the river. The experimental setup is shown in the following diagrams. The arrows shown in the rivers represent the direction of water flow. The triangles in the river show the location of the stream monitoring stations.

Question 1

[Diagram: Two side-by-side maps labeled "Forest A" and "Forest B", each showing a river flowing from the top of the map down to a "Lake" at the bottom, with 4 numbered triangular stream monitoring stations (labeled 1 at the top near where the river enters, 2, 3, and 4 near the lake) placed along the river's path. Arrows along the river indicate the direction of water flow, flowing downward toward the lake. Forest A is densely covered with many tree symbols (an intact forest). Forest B has only a few scattered tree symbols, showing that most trees have been cleared (a clear-cut forest). A legend below both maps indicates: an arrow icon = "Direction of water flow"; a triangle icon = "Stream monitoring station".]

Identify a testable hypothesis being investigated by the researchers.

Question 1

2024 Set 2 ▪ Q1

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(f) Identify the independent variable in the experiment.

Question 1

2024 Set 2 ▪ Q1

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Question 1

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(g) Describe the purpose of forest A in the experiment.

Question 1

2024 Set 2 ▪ Q1

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(h) Explain why the water temperature might change because of clear-cutting trees in forest B.

Question 1

2024 Set 2 ▪ Q1

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(i) After the experiment was completed, land developers constructed a golf course in the clear-cut area of forest B. To prepare the land, developers removed any remaining stumps and newly grown trees and began planting and fertilizing new grass. The researchers are interested in the effect the golf course may have on the water quality of the river. To monitor the river in forest B, the researchers repeated the experiment once the golf course had been constructed.
Explain why an indicator of water quality other than temperature could be altered by the golf course in forest B.

Question 1

2024 Set 2 ▪ Q1

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(j) Explain how the aquatic organisms living in the lake illustrated in the diagram of forest B are likely to be affected by the new golf course.

Solution 1

(a)

Mark scheme

- The diagram shows primary succession – the stepwise development of an ecosystem starting on bare rock/parent material with no pre-existing soil, progressing through stages to a mature community. Full credit for identifying 'primary succession.'

Solution 1

(b)

Mark scheme

- Pioneer species first appear in Stage II (labeled '2' in the diagram) – the stage where organisms like lichens, algae, or fungi first colonize the bare rock. Full credit for identifying stage II/2.

Solution 1

(c)

Mark scheme

- Soil forms from stage II to stage III through weathering and biological activity. Accept any one of: (1) wind/rain/weather erodes the rock/parent material; (2) wind/rain breaks rocks down into smaller particles; (3) pioneer species (lichens/algae/fungi) die off, adding small amounts of organic material to the forming soil; (4) pioneer species (lichens/algae/fungi) help break down the rock. Full credit for any one mechanism.

Solution 1

(d)

Mark scheme

- A cultural ecosystem service from a mature forest: any one of recreation, aesthetic enjoyment, spiritual use, ecotourism, or education. Full credit for naming one such non-material benefit.

Solution 1

(e)

Mark scheme

- A testable hypothesis for the experiment, e.g.: removal of trees/clear-cutting will lead to an increase/decrease in a water-quality indicator (temperature, turbidity, or dissolved oxygen) compared with the intact forest, OR the null form – clear-cutting will have no effect on water quality; equivalently, water quality will/will not change between stations. Full credit for any hypothesis stating a predicted increase/decrease/no-change relationship between clear-cutting (or station location) and a water-quality indicator.

Solution 1

(f)

Mark scheme

- Independent variable: presence or absence of clear-cutting (intact forest A vs. clear-cut forest B), equivalently the intact-or-clearcut status of the forest or the location of the stream monitoring stations. Full credit for identifying this manipulated/comparison variable.

Solution 1

(g)

Mark scheme

- Forest A (the intact forest) serves as the control – it lets researchers compare water quality (temperature/turbidity) in the clear-cut area (forest B) against an intact, unaltered baseline. Full credit for describing forest A's role as the control/comparison for forest B.

Solution 1

(h)

Mark scheme

- Water temperature in forest B is likely to increase after clear-cutting. Accept any one mechanism: (1) fewer/no trees to block sunlight from reaching the water, so it warms more; (2) additional sediment from erosion affects the water; (3) more direct sunlight reaches the water surface without the tree canopy. Full credit for any one causal explanation linking tree removal to warmer water.

Solution 1

(i)

Mark scheme

- A water-quality indicator besides temperature (e.g. dissolved oxygen, turbidity, or nutrients) could be altered by the golf course. Accept any one: (1) dissolved oxygen could decrease because fertilizer runoff causes algal blooms/eutrophication; (2) sedimentation/turbidity could decrease because grass reduces erosion compared with bare clear-cut land; (3) nitrates/phosphates could increase due to fertilizer runoff, driving algal growth/bloom. Full credit for any one linked mechanism.

Solution 1

(j)

Mark scheme

- Effect on aquatic organisms in the forest B lake from the new golf course. Accept any one: (1) organisms die off from lack of oxygen caused by decomposition of algae/eutrophication (from fertilizer runoff); (2) organisms survive at a higher rate because less sediment clogs their gills (grass reduces erosion versus clear-cut land); (3) organisms die off due to increased toxicity from pesticide runoff. Full credit for any one plausible, correctly reasoned effect.

Question 2

2024 Set 2 ▪ Q2

The following graph shows how global uses of habitable land have changed since 1700. [Bar chart titled "Land Use Changes on Earth, 1700-2018". Y-axis: "Percentage of Habitable Land" from 0% to 100% in increments of 20%. X-axis: "Year", with stacked bars shown for 1700, 1800, 1900, 1950, 2000, and 2018. Each bar is stacked (from bottom to top) with five categories per the legend: Forest (light gray), Crops (dark gray), Grazing (diagonal hatched pattern), Wild grasslands (white), Built-up land (black, thin sliver at the very top). Approximate stacked values read from the graph:

- 1700: Forest 53%, Crops 2%, Grazing 6%, Wild grasslands 38% (top reaches 100%), Built-up land negligible.
- 1800: Forest 51%, Crops 4%, Grazing 9%, Wild grasslands 36%, Built-up land negligible.

Question 2

- 1900: Forest 49%, Crops 8%, Grazing 16%, Wild grasslands 27%, Built-up land negligible.
- 1950: Forest 45%, Crops 12%, Grazing 31%, Wild grasslands 12%, Built-up land small sliver.
- 2000: Forest 39%, Crops 15%, Grazing 32%, Wild grasslands 13%, Built-up land small sliver.
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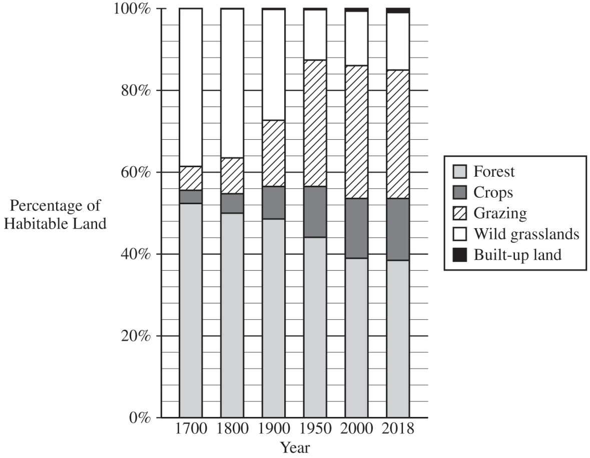
(a) Based on the data in the graph, identify the year with the highest percentage of forest.

Question 2



100%
80%
60%
40%
20%
0%
Percentage of Habitable Land
1700
1800
1900
1950
2000
2018
Year
Forest
Crops
Grazing
Wild grasslands
Built-up land

Question 2

2024 Set 2 ▪ Q2

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(b) Based on the data in the graph, describe the relationship between the land use changes in the wild grasslands and grazing from 1700 to 1950.

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2024 Set 2 ▪ Q2

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(c) Identify an environmental problem associated with overgrazing by livestock.

Question 2

2024 Set 2 ▪ Q2

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(d) A student hypothesized that the change in the percentage of forest from 1700 to 2018 has decreased atmospheric carbon dioxide concentrations. Explain whether the hypothesis is supported or refuted based on the data in the graph.

Question 2

2024 Set 2 ▪ Q2

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(e) Urban environments have accounted for an increasing percentage of land use within the last few decades.
Describe a water-related environmental problem associated with urbanization.

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2024 Set 2 ▪ Q2

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(f) Describe a potential response to mitigate the environmental problem identified in part (e).

Question 2

2024 Set 2 ▪ Q2

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Question 2

(g) Farmers who own large sections of cropland notice that bobcats, a medium-sized predatory forest cat, were present many years ago but are now virtually absent in the area. Instead, smaller mammal species now inhabit the area. Over time, the farmers have cleared nearly all of the forest on their property and converted it to farmland. Explain why there are fewer bobcats present on the farmland now compared to several decades ago.

Question 2

2024 Set 2 ▪ Q2

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Question 2

(h) The small mammal species are considered pests by the farmers. The farmers partner with a conservation group to increase the number of bobcats in the area. As a solution, the conservation group will introduce bobcats onto the few isolated patches of the original forested habitat left in the area. They can introduce only a small number of bobcats in each patch.

Describe a disadvantage of introducing only a small population of bobcats.

Question 2

2024 Set 2 ▪ Q2

The following graph shows how global uses of habitable land have changed since 1700. [Bar chart titled "Land Use Changes on Earth, 1700-2018". Y-axis: "Percentage of Habitable Land" from 0% to 100% in increments of 20%. X-axis: "Year", with stacked bars shown for 1700, 1800, 1900, 1950, 2000, and 2018. Each bar is stacked (from bottom to top) with five categories per the legend: Forest (light gray), Crops (dark gray), Grazing (diagonal hatched pattern), Wild grasslands (white), Built-up land (black, thin sliver at the very top). Approximate stacked values read from the graph:

- 1700: Forest 53%, Crops 2%, Grazing 6%, Wild grasslands 38% (top reaches 100%), Built-up land negligible.
- 1800: Forest 51%, Crops 4%, Grazing 9%, Wild grasslands 36%, Built-up land negligible.

Question 2

- 1900: Forest 49%, Crops 8%, Grazing 16%, Wild grasslands 27%, Built-up land negligible.
- 1950: Forest 45%, Crops 12%, Grazing 31%, Wild grasslands 12%, Built-up land small sliver.
- 2000: Forest 39%, Crops 15%, Grazing 32%, Wild grasslands 13%, Built-up land small sliver.
- 2018: Forest 38%, Crops 15%, Grazing 33%, Wild grasslands 13%, Built-up land small sliver.]

(i) Propose a solution to improve the chances that the bobcat reintroductions will be successful in reestablishing wild populations.

Question 2

2024 Set 2 ▪ Q2

The following graph shows how global uses of habitable land have changed since 1700. [Bar chart titled “Land Use Changes on Earth, 1700-2018”. Y-axis: “Percentage of Habitable Land” from 0% to 100% in increments of 20%. X-axis: “Year”, with stacked bars shown for 1700, 1800, 1900, 1950, 2000, and 2018. Each bar is stacked (from bottom to top) with five categories per the legend: Forest (light gray), Crops (dark gray), Grazing (diagonal hatched pattern), Wild grasslands (white), Built-up land (black, thin sliver at the very top). Approximate stacked values read from the graph:

- 1700: Forest 53%, Crops 2%, Grazing 6%, Wild grasslands 38% (top reaches 100%), Built-up land negligible.
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Question 2

- 1900: Forest 49%, Crops 8%, Grazing 16%, Wild grasslands 27%, Built-up land negligible.
- 1950: Forest 45%, Crops 12%, Grazing 31%, Wild grasslands 12%, Built-up land small sliver.
- 2000: Forest 39%, Crops 15%, Grazing 32%, Wild grasslands 13%, Built-up land small sliver.
- 2018: Forest 38%, Crops 15%, Grazing 33%, Wild grasslands 13%, Built-up land small sliver.]

(j) Justify the solution proposed in part (i) by describing an additional advantage, other than reestablishing the bobcat population near the farms.

Solution 2

(a)

Mark scheme

- The year with the highest percentage of forest is 1700 (the earliest year shown, before land conversion to grazing/agriculture/urban use). Full credit for identifying 1700.

Solution 2

(b)

Mark scheme

- From 1700 to 1950, the percentage/amount of wild grasslands decreased while the percentage/amount of grazing land increased – the two variables have an inverse relationship (as one goes down, the other goes up). Full credit for describing this inverse relationship.

Solution 2

(c)

Mark scheme

- An environmental problem from overgrazing by livestock: any one of loss of vegetation, soil erosion, desertification, sedimentation/turbidity in waterways, or soil compaction. Full credit for naming one such problem.

Solution 2

(d)

Mark scheme

- The hypothesis is refuted/disproved/not supported. The percentage of forest has decreased from 1700 to 2018, so the amount of photosynthesis/carbon sequestration by forests has also decreased – this would tend to increase, not decrease, atmospheric CO2, contradicting the hypothesis. Full credit for concluding 'refuted' with reasoning tied to the graph.

Solution 2

(e)

Mark scheme

- A water-related environmental problem from urbanization: any one of (1) increased runoff/flooding because urban areas have more impermeable surfaces; (2) decreased groundwater/saltwater intrusion because urban areas have many people and groundwater is overused; (3) increased water pollution because precipitation/runoff carries contaminants/pollutants/waste; (4) destruction of aquatic habitats from increased development/land-use change. Full credit for describing one such problem.

Solution 2

(f) Mark scheme

- A potential mitigation matched to the problem named in part (e): if increased runoff/flooding – use permeable road/parking materials, set aside green spaces/parks/conservation areas, or construct green roofs/rain gardens/stormwater retention ponds; if decreased groundwater/saltwater intrusion – permeable materials, groundwater conservation/management plans, protected recharge zones, or green roofs/rain gardens/retention ponds; if increased water pollution – encourage walking/biking, reduce home pesticide/fertilizer use, reduce road salt/de-icing chemical use, pick up trash/litter along waterways, or properly dispose of toxic chemicals; if destruction of aquatic habitats – create conservation

Solution 2

areas/preserves/wetlands or restore degraded aquatic habitats. Full credit for any response that logically mitigates the problem identified in (e).

Solution 2

(g)

Mark scheme

- Fewer bobcats are present on the farmland now because: (1) loss of forest habitat (cleared for farmland) has decreased resources such as food, shelter, mates, or migration routes; or (2) trapping/hunting has reduced the bobcat population. Full credit for either explanation.

Solution 2

(h)

Mark scheme

- A disadvantage of introducing only a small bobcat population: any one of (1) lower genetic diversity; (2) genetic bottlenecks leading to inbreeding/passing on negative traits; (3) greater vulnerability to disease or disturbances like wildfire; (4) less effective control of small mammal/pest populations than a larger population; (5) lower likelihood of survival. Full credit for any one such disadvantage.

Solution 2

(i)

Mark scheme

- A solution to improve reintroduction success: (1) increase connectivity/build habitat corridors so bobcats can safely mate, find food, and build dens; or (2) restore/reforest/preserve areas of bobcat habitat. Full credit for either proposal.

Solution 2

(j) Mark scheme

- An additional advantage of the proposed solution (beyond reestablishing bobcats), matched to the answer given in (i): if habitat corridors – they can be used by other species, increase biodiversity/population of other species, attract species beneficial to farmers (pest predators/pollinators), or reduce roadkill/vehicle collisions with wildlife; if restoring/reforesting/preserving habitat – restored habitat can be used by other species, restoration can increase biodiversity/improve air or water quality, or added trees improve aesthetic value, tourism, reduce erosion, or serve as a carbon sink. Full credit for any advantage consistent with the part (i) solution.

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$^2 per territory. Setup (1 point)$: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)$lotsthatmustbesetasidetosupportthegoalof275malewoodthrushterritories.Setup(1poi$

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

Question 2

2021 Set 2 ▪ Q2

Biodiversity around the world is changing as a result of anthropogenic influences. [World map titled "GLOBAL AMPHIBIAN SPECIES RICHNESS", drawn in an oval (Robinson-style) projection with latitude lines labeled 60°, 30°, 0°, 30°, 60° (top to bottom) and longitude lines labeled 180°, 120°, 60°, 0°, 60°, 120°, 180° (left to right). A legend "Number of species" shows four shading categories: diagonal hatching = 0-20 species; light gray = 21-50 species; medium gray = 51-100 species; black = 101-136 species. The map shows the darkest shading (101-136 species, highest richness) concentrated in a band along the equator (0°) in South America (the Amazon basin) and a small patch in central Africa; medium-gray shading (51-100 species) in a broader band around the tropics in South America, Central America, sub-Saharan Africa, and parts of Southeast Asia/South Asia (e.g., India, Myanmar/Thailand region); lighter shading (21-50 species) in a band through central Africa and parts of South America;

Question 2

and diagonal-hatch shading (0-20 species, lowest richness) at higher latitudes including North America, Europe, northern Asia/Russia, and most of Australia.]

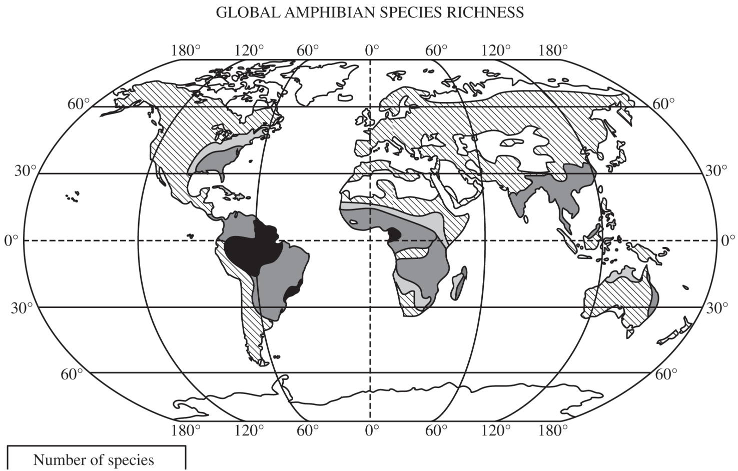
(a)(i) The map represents species richness of amphibians around the globe. Use the map to answer the following questions.

Identify the latitudinal range with the greatest amphibian species richness.

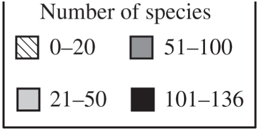
(a)(ii) Identify what biome this range most likely represents.

(a)(iii) Describe one reason amphibian species richness would tend to be highest in this region.

Question 2


GLOBAL AMPHIBIAN SPECIES RICHNESS
180°
120°
60°
0°
60°
120°
180°
60°
30°
0°
30°
60°
Number of species

Question 2



Question 2

2021 Set 2 ▪ Q2

Biodiversity around the world is changing as a result of anthropogenic influences.
[World map titled "GLOBAL AMPHIBIAN SPECIES RICHNESS", drawn in an oval (Robinson-style) projection with latitude lines labeled 60°, 30°, 0°, 30°, 60° (top to bottom) and longitude lines labeled 180°, 120°, 60°, 0°, 60°, 120°, 180° (left to right). A legend "Number of species" shows four shading categories: diagonal hatching = 0-20 species; light gray = 21-50 species; medium gray = 51-100 species; black = 101-136 species. The map shows the darkest shading (101-136 species, highest richness) concentrated in a band along the equator (0°) in South America (the Amazon basin) and a small patch in central Africa; medium-gray shading (51-100 species) in a broader band around the tropics in South America, Central America, sub-Saharan Africa, and parts of Southeast Asia/South Asia (e.g., India, Myanmar/Thailand region); lighter shading (21-50 species) in a band through central Africa

Question 2

and parts of South America; and diagonal-hatch shading (0-20 species, lowest richness) at higher latitudes including North America, Europe, northern Asia/Russia, and most of Australia.]

(b) There are many environmental threats facing amphibians today, such as deforestation. Describe one possible anthropogenic reason for deforestation.

Question 2

2021 Set 2 ▪ Q2

Biodiversity around the world is changing as a result of anthropogenic influences.
[World map titled "GLOBAL AMPHIBIAN SPECIES RICHNESS", drawn in an oval (Robinson-style) projection with latitude lines labeled 60°, 30°, 0°, 30°, 60° (top to bottom) and longitude lines labeled 180°, 120°, 60°, 0°, 60°, 120°, 180° (left to right). A legend "Number of species" shows four shading categories: diagonal hatching = 0-20 species; light gray = 21-50 species; medium gray = 51-100 species; black = 101-136 species. The map shows the darkest shading (101-136 species, highest richness) concentrated in a band along the equator (0°) in South America (the Amazon basin) and a small patch in central Africa; medium-gray shading (51-100 species) in a broader band around the tropics in South America, Central America, sub-Saharan Africa, and parts of Southeast Asia/South Asia (e.g., India, Myanmar/Thailand region); lighter shading (21-50 species) in a band through central Africa

Question 2

and parts of South America; and diagonal-hatch shading (0-20 species, lowest richness) at higher latitudes including North America, Europe, northern Asia/Russia, and most of Australia.]

(c)(i) Many factors influence biodiversity.

Explain how the species richness of an ecosystem influences its response to environmental stressors.

(c)(ii) Explain why amphibian biodiversity is declining globally, other than from deforestation.

Question 2

2021 Set 2 ▪ Q2

Biodiversity around the world is changing as a result of anthropogenic influences.

[World map titled "GLOBAL AMPHIBIAN SPECIES RICHNESS", drawn in an oval (Robinson-style) projection with latitude lines labeled 60°, 30°, 0°, 30°, 60° (top to bottom) and longitude lines labeled 180°, 120°, 60°, 0°, 60°, 120°, 180° (left to right). A legend "Number of species" shows four shading categories: diagonal hatching = 0-20 species; light gray = 21-50 species; medium gray = 51-100 species; black = 101-136 species. The map shows the darkest shading (101-136 species, highest richness) concentrated in a band along the equator (0°) in South America (the Amazon basin) and a small patch in central Africa; medium-gray shading (51-100 species) in a broader band around the tropics in South America, Central America, sub-Saharan Africa, and parts of Southeast Asia/South Asia (e.g., India, Myanmar/Thailand region); lighter shading (21-50 species) in a band through central Africa

Question 2

and parts of South America; and diagonal-hatch shading (0-20 species, lowest richness) at higher latitudes including North America, Europe, northern Asia/Russia, and most of Australia.]

(d)(i) Currently, wildlife species are going extinct at an alarming rate. To combat this threat, governments around the world have enacted legislation and signed treaties to protect species threatened by extinction.

Identify one specific piece of legislation that has been designed to protect species threatened by extinction.

(d)(ii) Explain how the requirements of the legislation identified in part (d)(i) specifically protect species threatened by extinction.

Question 2

2021 Set 2 ▪ Q2

Biodiversity around the world is changing as a result of anthropogenic influences.

[World map titled “GLOBAL AMPHIBIAN SPECIES RICHNESS”, drawn in an oval (Robinson-style) projection with latitude lines labeled 60°, 30°, 0°, 30°, 60° (top to bottom) and longitude lines labeled 180°, 120°, 60°, 0°, 60°, 120°, 180° (left to right). A legend “Number of species” shows four shading categories: diagonal hatching = 0-20 species; light gray = 21-50 species; medium gray = 51-100 species; black = 101-136 species. The map shows the darkest shading (101-136 species, highest richness) concentrated in a band along the equator (0°) in South America (the Amazon basin) and a small patch in central Africa; medium-gray shading (51-100 species) in a broader band around the tropics in South America, Central America, sub-Saharan Africa, and parts of Southeast Asia/South Asia (e.g., India, Myanmar/Thailand region); lighter shading (21-50 species) in a band through central Africa

Question 2

and parts of South America; and diagonal-hatch shading (0-20 species, lowest richness) at higher latitudes including North America, Europe, northern Asia/Russia, and most of Australia.]

(e)(i) A town is considering selling an undeveloped parcel of land along its border for residential developments. The square parcel of land consists of approximately 30% wetland and 70% pasture. The wetland runs through the middle of the property for its entire width and is home to three native frog species.

Propose a viable solution that will result in the protection of the native frog species while still allowing for maximum profit of the property development.

(e)(ii) Justify the solution proposed in (e)(i) by describing a potential advantage of the plan, other than frog protection.

Solution 2

(a)(i)

Mark scheme

- The greatest amphibian species richness occurs in the latitudinal range between the Tropic of Cancer and the Tropic of Capricorn (equivalently, roughly 30 degrees N to 30 degrees S, or more narrowly about 10 degrees N to 15 degrees S).

(a)(ii)

Mark scheme

- This latitudinal range most likely represents the tropical rainforest biome.

Solution 2

(a)(iii)

Mark scheme

- Amphibian species richness tends to be highest here because year-round rainfall and warm temperatures are the preferred conditions for amphibians, and greater biodiversity/higher net primary productivity (NPP) provides more habitat, food sources, and niches.

Solution 2

(b)

Mark scheme

- A possible anthropogenic reason for deforestation is human demand for agriculture, housing, firewood, or other forest products (e.g., medicine, food, lumber).

Solution 2

(c)(i)

Mark scheme

- An ecosystem with greater species richness/diversity is more resilient/resistant to environmental stressors, because even if some species are harmed, other species will survive and help restore/stabilize the ecosystem.

Solution 2

(c)(ii) Mark scheme

- Amphibian biodiversity is declining globally (aside from deforestation) for reasons such as: increasing water pollution (pharmaceutical pollution harming reproduction, pesticide pollution absorbed through the skin being toxic, endocrine disruptors such as atrazine altering reproductive development); pesticide use reducing insect food sources; microclimatic changes from global climate change (warmer/drier conditions, loss of wetlands) reducing available habitat; illegal amphibian trafficking removing individuals from populations; introduced invasive species competing for niche space; habitat fragmentation limiting range and access to resources; or fungal infections such as chytridiomycosis causing skin to dry out so amphibians cannot breathe. Any one such reason earns the point.

Solution 2

(d)(i)

Mark scheme

- One specific piece of legislation designed to protect species threatened by extinction: the Endangered Species Act (ESA), the Convention on International Trade in Endangered Species (CITES), or the Lacey Act.

Solution 2

(d)(ii) Mark scheme

- Explanation depends on the legislation named in (d)(i). ESA: lists endangered/threatened plant and animal species and prevents them from being killed or harmed; designates/protects critical habitat to promote survival and recovery; creates plans to restore populations to healthy sizes; identifies species as threatened before they become endangered. CITES: a global agreement that protects endangered/threatened plants and animals (including goods such as ivory, shark fins, or rhinoceros' horns) by banning/regulating their trade. Lacey Act: prohibits the trade of wildlife, fish, and plants that have been illegally taken, possessed, transported, or sold.

Solution 2

(e)(i)

Mark scheme

- A viable solution: move/transplant the frog populations to an adjacent undeveloped area before development; designate a portion of the wetland as a park/preserve; build wildlife corridors (land or bridges) across a portion of the wetland; restrict development within a minimum setback away from the wetland; or group/cluster the buildings together (build up, not out) to leave the wetland undisturbed.

Solution 2

(e)(ii) Mark scheme

- Justification depends on the solution proposed in (e)(i). Move/transplant frogs: only a one-time disruption during removal rather than continued disruption (e.g., population growth, fertilizer/pesticide use), and the developer gets the maximum amount of usable land. Park/preserve: more food and space availability increases wildlife survival rates; a nearby park/preserve is an educational/environmental draw that may let the developer charge higher rents; the wetland has aesthetic value for residents; and the preserved wetland helps prevent flooding. Wildlife corridors: other species are less affected by habitat fragmentation and can keep moving for food, shelter, and reproduction. Setback: creates a buffer zone that filters runoff into the wetland and adds resident privacy. Clustered/grouped

Solution 2

development: species are less affected by multiple habitat fragments because the apartments are developed in groups while wetlands are preserved.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(a) Describe why coal is considered a nonrenewable energy source.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(b) Describe one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(c) Describe one economic advantage of using natural gas, rather than coal, in producing electricity.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(d) When natural gas is used to heat homes, it can produce carbon monoxide gas, which can lead to carbon monoxide poisoning in humans. Propose a solution to reduce the incidence of carbon monoxide poisoning in humans.

Particulate matter is another common pollutant in emissions from vehicles, coal-fired power plants, and various other sources. One size of particulates, $PM_{2.5}$, presents a particular risk to human health.

Question 3

ATMOSPHERIC CONCENTRATION OF PARTICULATE MATTER IN 1990 AND 2016

Year	Average Annual Atmospheric Concentration of $PM_{2.5}$ ($\mu g/m^3$)
1990	85
2016	188

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(e) Calculate the percent change in the average annual $PM_{2.5}$ concentration in the air from 1990 to 2016. Show your work.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(f) Trees can remove $PM_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $PM_{2.5}$ is 2.3 kilograms per hectare. Calculate the decrease in $PM_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. Show your work.

Question 3

2021 Set 2 ▪ Q3

Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

(g) Research has shown that hospital admissions for cardiovascular problems increase 1

Solution 3

(a)

Mark scheme

- Coal is considered nonrenewable because it exists in a fixed/finite/limited amount – its natural formation rate is far slower than the rate at which it is consumed/combusted.

Solution 3

(b)

Mark scheme

- One environmental advantage of replacing a coal-fired plant with a natural-gas plant: natural gas combustion emits fewer greenhouse gases/less CO2; does not emit mercury/lead/cadmium/uranium; emits less NOx/SOx, reducing acid precipitation; produces less/no particulate matter/soot/smog; requires less habitat destruction/fossil-fuel use to transport than coal; avoids habitat destruction from impoundment of coal ash or coal slurry; or avoids the habitat destruction of strip mining/mountaintop removal used to extract coal.

Solution 3

(c) Mark scheme

- One economic advantage of natural gas over coal in producing electricity: pipeline transport of natural gas costs less than rail transport of coal; natural gas (methane) harvested from decomposition (landfills, wastewater treatment plants, biodigesters) costs less than coal; fewer health-related costs are linked to burning natural gas than coal; fewer pollution controls are needed for a natural-gas plant, lowering operating/construction/permitting costs; lower combustion-residue disposal costs than coal-burning plants; or natural-gas plants are more efficient (more electricity output per unit energy input), leading to lower fuel costs.

Solution 3

(d) Mark scheme

- A solution to reduce carbon monoxide poisoning: install/use/replace/update carbon monoxide detectors/alarms/sensors (or replace their batteries); perform regular maintenance on natural-gas furnaces so minimal carbon monoxide is produced and combustion products are properly vented/exhausted; create laws/regulations mandating carbon monoxide detectors in all homes; use PSAs, billboards, or other methods to educate the public about carbon monoxide poisoning; or change the home heating system to a method that does not involve combustion of a fuel that could produce carbon monoxide.

Solution 3

(e)

Mark scheme

- Percent change = [(188 micrograms/m^3 - 85 micrograms/m^3) / 85 micrograms/m^3] x 100 ~= 121% (accept 120% or 121.2%). One point for the correct setup (must include units and multiplication by 100 to yield a true percentage: (188-85)/85 x 100); one point for the correct numeric result (121%, 120%, or 121.2%).

Solution 3

(f)

Mark scheme

- Decrease in PM2.5 removal = (50,000 ha - 43,000 ha) x 2.3 kg/ha = 7,000 ha x 2.3 kg/ha = 16,100 kg (accept 16,000 kg). Equivalently: 50,000 ha x 2.3 kg/ha = 115,000 kg; 43,000 ha x 2.3 kg/ha = 98,900 kg; 115,000 kg - 98,900 kg = 16,100 kg. One point for the correct setup (must include units); one point for the correct numeric result (16,100 kg or 16,000 kg).

Solution 3

(g)

Mark scheme

- Increase in admissions = (0.23/0.10) x 0.01 x 7,390 admissions, equivalently (23%/10%) x 1% x 7,390 admissions ~= 169-170 more admissions (accept 169 or 170). One point for the correct setup; one point for the correct numeric result.

Question 3

2017 ▪ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(a)(i) The border between the two countries can be seen using satellite images because of the severe deforestation in Haiti.

Provide one reason why deforestation commonly occurs in a less developed country such as Haiti.

(a)(ii) Describe one realistic strategy to reduce deforestation in a less developed country.

Question 3

DEMOGRAPHIC DATA FOR HAITI

Measure	1995	2015
Fertility rate (number of children per woman)	5.2	2.7
Life expectancy (years)	55	64
Infant mortality (deaths per 1,000)	85	48

Question 3

2017 ▪ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(b) Deforestation can affect water quality. Identify one change that can occur in the water quality of streams within a watershed that has been deforested. Explain how deforestation can lead to this change.

Question 3

2017 ▪ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(c) Identify TWO environmental benefits, other than those related to water quality, of maintaining forest ecosystems.

The table below contains demographic data for Haiti in 1995 and 2015.

DEMOGRAPHIC DATA FOR HAITI

Measure	**1995**	**2015**
Fertility rate (number of children per woman)	5.2	2.7
Life expectancy (years)	55	64
Infant mortality (deaths per 1,000)	85	48

Question 3

2017 ▪ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(d) Identify and discuss one factor in a less developed country that could contribute significantly to a change in life expectancy, similar to what occurred in Haiti from 1995 to 2015.

Question 3

2017 ▪ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(e) Identify and discuss one economic or cultural factor in a less developed country that could contribute significantly to a change in the fertility rate, similar to what occurred in Haiti from 1995 to 2015.