Past-paper walk-through

Persistent Organic Pollutants (POPs) ▪ 8.7

eXercise

Questions in this set

- 2025 Set 2 Q1
- 2024 Set 1 Q1
- 2022 Set 1 Q1

Reading the mark scheme

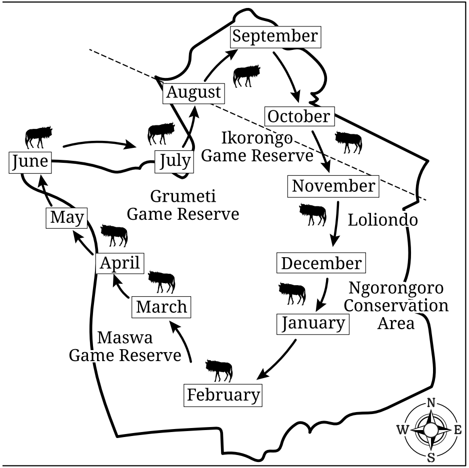
- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner 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 2 ▪ Q1

Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.
(a) Based on the data in the graph, **identify** the number of Common Tern breeding pairs in 1995.

Question 1

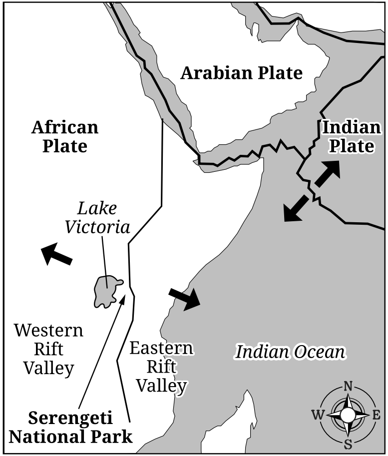


September
August
October
Ikorongo
Game Reserve
June
July
November
Grumeti
Game Reserve
Loliondo
May
April
December
Ngorongoro
Conservation
Area
March
January
Maswa
Game Reserve
February
N
W
E
S

Question 1

Year	Increase in Sea Level (m)	Location A	Location B	Location C	Location D
1	0.05	1	5	3	4
2	0.08	2	4	3	6
3	0.10	6	7	5	5
4	0.12	5	7	7	7
5	0.15	7	8	9	8

Question 1


Arabian Plate
African Plate
Indian Plate
Lake Victoria
Western Rift Valley
Eastern Rift Valley
Indian Ocean
Serengeti National Park
N
W
E
S

Question 1

2025 Set 2 ▪ Q1

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

(b) Based on the data in the graph, **describe** the trend in the number of Common Tern breeding pairs from 1995 to 2008.

Question 1

2025 Set 2 ▪ Q1

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

(c) A group of students hypothesized that sea level rise will lead to an increase in Common Tern populations. **Describe** one way that the data in the graph refute this hypothesis.

Question 1

2025 Set 2 ▪ Q1

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

(d) Explain how climate change can lead to sea level rise.

Question 1

2025 Set 2 ▪ Q1

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

(e)(i) Wading birds are a group of large-bodied birds that inhabit coastal wetlands all over the world. Researchers monitored the number of wading bird species at four coastal locations experiencing rising sea levels over a 5-year period. The data are shown in the following table.

Sea Level Rise and Number of Wading Bird Species at Four Coastal Locations

Year	Increase in Sea Level (m)	Location A	Location B	Location C	Location D
1	0.05	1	5	3	4
2	0.08	2	4	3	6
3	0.10	6	7	5	5
4	0.12	5	7	7	7
5	0.15	7	8	9	8

Question 1

i. **Identify** a hypothesis that researchers are likely investigating in the wading bird study.

(e)(ii) ii. **Identify** the dependent variable in this study.

Question 1

2025 Set 2 ▪ Q1

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

(f) One year after the completion of the study of wading bird species described in Part E, locations A and B experienced an increase in the concentration of PCBs, known to be a persistent organic pollutant, running off into the water.

If the researchers repeated their study, **explain** how this environmental change could affect the results of the study.

Question 1

2025 Set 2 ▪ Q1

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

(g) Describe a regulating ecosystem service that can be provided by wetlands.

Question 1

2025 Set 2 ▪ Q1

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

(h) Since 1990, there has been an increase in urbanization around the coastal wetlands that wading bird communities inhabit. Most of these bird species eat fish and locate prey visually while walking through shallow water. An increase in sediment was discovered in a wetland located near an urban area.

Explain how increased sediment might lead to a change in the size of the wading bird populations.

Question 1

2025 Set 2 ▪ Q1

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

(i) Describe an environmental problem, other than an increase in sediment, that can occur in wetlands that is associated with increased urbanization and development.

Solution 1

(a)

Mark scheme

- 1400. This is the number of Common Tern breeding pairs read directly from the graph in 1995. 1 point for identifying 1400 (or a value clearly consistent with reading the graph at 1995).

Solution 1

(b)

Mark scheme

- The number of breeding pairs varies year to year but shows an overall decrease from 1995 to 2008 (equivalently: the number of breeding pairs decreases over this period). 1 point for correctly describing the overall downward trend.

Solution 1

(c)

Mark scheme

- The data refute the hypothesis because they show the opposite relationship: the data suggest that a rise in sea level is associated with a decrease in the number of breeding pairs, i.e. as sea level rises, fewer breeding pairs will likely lead to smaller populations (not the increase the students hypothesized). 1 point for describing this inverse relationship.

Solution 1

(d)

Mark scheme

- Climate change leads to sea level rise because increasing global temperatures cause melting of glaciers/land-based ice sheets, which adds water to the oceans, and/or because increasing global temperatures cause thermal expansion of ocean water. 1 point for either mechanism.

Solution 1

(e)(i)

Mark scheme

- A reasonable hypothesis for the wading bird study: if sea level rises, wading bird diversity/species richness will decrease (or will increase; or sea level rise will/will not affect wading bird diversity/species richness; or wading bird diversity/species richness is correlated with sea level rise). 1 point for stating a testable if/then (or correlational) hypothesis relating sea level rise to wading bird species richness/diversity.

Solution 1

(e)(ii)

Mark scheme

- The dependent variable is the number of wading bird species (species richness of wading birds) at each location. 1 point for identifying species richness/number of wading bird species as the measured (dependent) variable.

Solution 1

(f)

Mark scheme

- If PCB concentration increased at locations A and B, repeating the study would likely show a decrease in wading birds, because PCBs (a persistent organic pollutant) biomagnify/concentrate in higher trophic levels, can bioaccumulate in fatty tissue, are toxic and can kill or sicken birds when ingested, and/or cause eggshell thinning, developmental deformities, or reproductive problems. 1 point for any one valid PCB mechanism linked to a decline in wading birds.

Solution 1

(g)

Mark scheme

- A regulating ecosystem service provided by wetlands: wetlands filter/purify/improve water quality; wetlands provide flood regulation/erosion control; or wetlands store/sequester carbon. 1 point for any one correct regulating service.

Solution 1

(h)

Mark scheme

- Increased sediment (turbidity) can reduce the ability of wading birds, which locate prey visually, to see prey/food/fish, reducing their hunting success; sediment can also negatively impact organisms in lower trophic levels (e.g., reducing light infiltration decreases primary producers), which reduces food/energy available to the wading birds and could shrink their population size. 1 point for a valid mechanism linking increased sediment to a change in wading bird population size.

Solution 1

(i) Mark scheme

- An environmental problem (other than increased sediment) linked to urbanization/development near wetlands: construction projects reducing/fragmenting wetland habitat; runoff of fertilizers/wastewater effluent causing eutrophication (decreasing dissolved oxygen and killing fish); runoff of litter killing animals via ingestion/entanglement; more impervious surfaces (roads/buildings/sidewalks/parking lots) increasing flooding; runoff of heavy metals/pesticides killing or weakening organisms; noise/light pollution disrupting hunting, migration, or behavior; oil runoff blocking light and preventing photosynthesis; or increased water use lowering groundwater and drying up wetlands. 1 point for any one valid problem.

Question 1

2024 Set 1 ▪ Q1

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Dissolved Oxygen and Biological Oxygen Demand in a Stream Ecosystem

[Diagram: a cross-section of a stream divided into five vertical zones (A through E) labeled left to right, with "Direction of Streamflow" arrow pointing right along the bottom axis. The y-axis (unlabeled numerically) ranges from "Low" at the bottom to "High" at the top, showing two curves: a solid line for "Dissolved oxygen" and a

Question 1

dashed line for "Biological oxygen demand". Common fish/macroinvertebrate species listed above each zone:

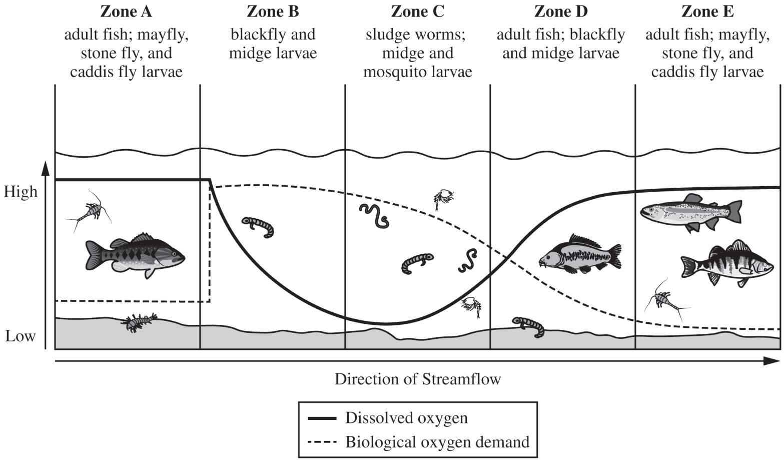
- Zone A: adult fish; mayfly, stone fly, and caddis fly larvae
- Zone B: blackfly and midge larvae
- Zone C: sludge worms; midge and mosquito larvae
- Zone D: adult fish; blackfly and midge larvae
- Zone E: adult fish; mayfly, stone fly, and caddis fly larvae

Question 1

Curve behavior: In Zone A, dissolved oxygen is High (solid line flat at top) and biological oxygen demand is Low (dashed line flat at bottom). Moving into Zone B, dissolved oxygen (solid line) drops sharply from High to Low while biological oxygen demand (dashed line) rises sharply from Low to High. In Zone C, dissolved oxygen remains Low (solid line near bottom) while biological oxygen demand remains High (dashed line near top), with the two curves close together at their extremes. Moving into Zone D, dissolved oxygen (solid line) rises back up from Low to High while biological oxygen demand (dashed line) falls back down from High to Low. In Zone E, dissolved oxygen is High (solid line flat at top) again and biological oxygen demand is Low (dashed line flat at bottom), mirroring Zone A.]

(a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen.

Question 1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adult fish; mayfly, stone fly, and caddis fly larvae
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Zone C
sludge worms; midge and mosquito larvae
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Zone E
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High
Low
Direction of Streamflow
Dissolved oxygen
Biological oxygen demand

Question 1

2024 Set 1 ▪ Q1

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Question 1

- Zone B: blackfly and midge larvae
- Zone C: sludge worms; midge and mosquito larvae
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Curve behavior: In Zone A, dissolved oxygen is High (solid line flat at top) and biological oxygen demand is Low (dashed line flat at bottom). Moving into Zone B, dissolved oxygen (solid line) drops sharply from High to Low while biological oxygen demand (dashed line) rises sharply from Low to High. In Zone C, dissolved oxygen remains Low (solid line near bottom) while biological oxygen demand remains High (dashed line near top), with the two curves close together at their extremes. Moving into Zone D, dissolved oxygen (solid line) rises back up from Low to High while biological oxygen demand (dashed line) falls back down from High to

Question 1

Low. In Zone E, dissolved oxygen is High (solid line flat at top) again and biological oxygen demand is Low (dashed line flat at bottom), mirroring Zone A.]

(b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen.

Question 1

2024 Set 1 ▪ Q1

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Question 1

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Question 1

Low. In Zone E, dissolved oxygen is High (solid line flat at top) again and biological oxygen demand is Low (dashed line flat at bottom), mirroring Zone A.]

(c) Based on the information in the diagram, **identify** the zone where there is most likely point-source water pollution discharged into the stream.

The research team is interested in investigating the relationship between dissolved oxygen levels and macroinvertebrate species richness in the stream. Researchers counted the number of macroinvertebrate species in zones A, B, and C during the summer months. The researchers selected zone A to serve as the control in the investigation.

Question 1

2024 Set 1 ▪ Q1

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(d) Identify the dependent variable in the researchers' investigation.

Question 1

2024 Set 1 ▪ Q1

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Question 1

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(e) Identify a testable hypothesis for the researchers' investigation.

Question 1

2024 Set 1 ▪ Q1

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Low. In Zone E, dissolved oxygen is High (solid line flat at top) again and biological oxygen demand is Low (dashed line flat at bottom), mirroring Zone A.]

(f) Describe the reason the researchers selected zone A to serve as the control in the investigation.

The researchers decided to repeat their data collection during the winter months.

Question 1

2024 Set 1 ▪ Q1

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(g) Explain how the modification to collect data in the winter months could alter the results of the investigation.

Stream ecosystems are affected by point-source organic pollution in a variety of ways.

Question 1

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(h) Describe the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream.

Question 1

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Question 1

Low. In Zone E, dissolved oxygen is High (solid line flat at top) again and biological oxygen demand is Low (dashed line flat at bottom), mirroring Zone A.]

(i) Identify an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream.

Question 1

2024 Set 1 ▪ Q1

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(j) Explain how persistent organic pollutants can affect higher trophic levels in an aquatic food web.

Solution 1

(a)

Mark scheme

- Zone C has the lowest level of dissolved oxygen (based on the diagram).

Solution 1

(b)

Mark scheme

- Biological oxygen demand (BOD) and dissolved oxygen (DO) are inversely related: as BOD increases, DO decreases (equivalently, as DO increases, BOD decreases).

Solution 1

(c)

Mark scheme

- Zone B is where point-source water pollution is most likely discharged into the stream (based on the diagram).

Solution 1

(d)

Mark scheme

- The dependent variable is the number of macroinvertebrate species (macroinvertebrate diversity / macroinvertebrate species richness) — the researchers measured this in response to dissolved oxygen level.

Solution 1

(e)

Mark scheme

- A testable hypothesis relates dissolved oxygen level to macroinvertebrate species number, e.g.: 'As dissolved oxygen levels increase, the number of macroinvertebrate species increases' (or the inverse: as DO decreases, species number increases; or a general statement of a direct/inverse relationship between DO and macroinvertebrate species number). A null hypothesis of no relationship is also acceptable.

Solution 1

(f)

Mark scheme

- Zone A was chosen as the control because it is upstream from the pollution/organic waste source, so it is not affected by (not impacted by) the discharge — its dissolved oxygen levels reflect conditions unaffected by the pollution, giving a baseline for comparison.

Solution 1

(g)

Mark scheme

- Collecting data in winter could alter the results because: (1) cold water holds more dissolved oxygen, which could increase the number of species; or (2) colder temperatures may fall below the tolerance range of some organisms, decreasing the number of species; or (3) lower light levels in winter reduce plant photosynthesis, which lowers dissolved oxygen and could decrease the number of species.

Solution 1

(h)

Mark scheme

- Raw sewage introduces nutrients (and/or organic matter) that increase the bacteria population (more food source), and/or raw sewage directly contains bacteria that increases the bacteria population size in the stream.

Solution 1

(i)

Mark scheme

- Any abiotic factor other than dissolved oxygen and organic pollution that affects bacteria population size, e.g.: temperature, pH, light/sunlight, turbidity/sediment, salinity, or nitrate/phosphate concentration.

Solution 1

(j)

Mark scheme

- Persistent organic pollutants (POPs) bioaccumulate/biomagnify in the tissues of organisms at higher trophic levels because those organisms consume prey that have already accumulated the pollutants, so pollutant concentration increases up the food web (often concentrating in fatty tissue); this can cause effects such as neurological toxicity in top predators.

Question 1

2022 Set 1 ▪ Q1

Common snapping turtles, *Chelydra serpentina*, are primarily aquatic, but they lay their eggs on land. Researchers are interested in understanding the impact of pollution on turtle nesting sites. The researchers examined nesting sites at two agricultural areas along the floodplain of a river upstream and downstream from a chemical factory that is a known source of aqueous mercury pollution. Turtle eggs, soil, and vegetation samples taken from areas around turtle nests downstream from the chemical factory showed high levels of mercury in a previous study. Mercury was not detected in samples taken upstream from the chemical factory.

[Diagram: "DISTRIBUTION OF TURTLE NESTS ALONG RIVER." A map shows a river winding from top to bottom with an arrow labeled "Direction of Flow" pointing downstream. A "Chemical Factory" sits beside the river partway down, with a "Discharge Pipe" emptying into the river at that point. Along the riverbank are

Question 1

forested strips labeled “Forest Area” (trees drawn as small pine-tree and round-tree icons). “Area A” is a region upstream of the chemical factory’s discharge point (bounded by dashed lines), shown with many nest markers clustered together: a mix of filled circles ( ) labeled “Successful turtle nest” and X marks ( ) labeled “Unsuccessful turtle nest” in the legend — Area A shows a dense cluster of both successful ( ) and unsuccessful ( ) nests close together in the forest area. “Area B” is a region downstream of the chemical factory’s discharge point (bounded by dashed lines), shown with a sparser, more scattered mix of successful ( ) and unsuccessful ( ) nest markers, with unsuccessful ( ) nests appearing more numerous/closer to the river relative to successful ( ) nests, which sit farther back. Legend box: “ Successful turtle nest” and “ Unsuccessful turtle nest.”]

(a)(i) Identify the area with the greatest nest success rate, based on the information in the diagram.

Question 1

(a)(ii) Identify the dependent variable in the study.

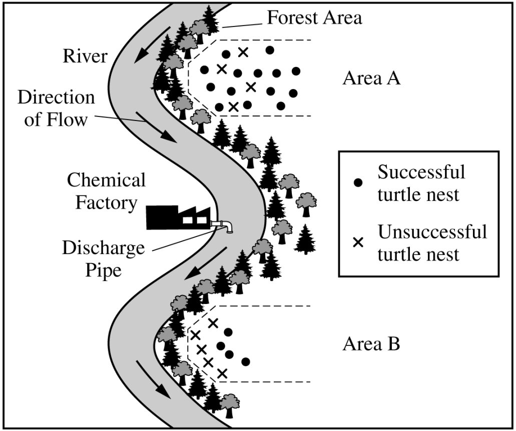
(a)(iii) Based on the information provided, **identify** a likely scientific question for the study.

(a)(iv) Describe why researchers measured mercury levels in locations upstream from the factory.

(a)(v) There are plans to remove trees and other vegetation along the river bank. **Explain** how this modification could affect the location and number of successful turtle nests in Area B.

Question 1

DISTRIBUTION OF TURTLE NESTS ALONG RIVER



Question 1

2022 Set 1 ▪ Q1

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Question 1

factory's discharge point (bounded by dashed lines), shown with many nest markers clustered together: a mix of filled circles ( ) labeled "Successful turtle nest" and X marks ( ) labeled "Unsuccessful turtle nest" in the legend — Area A shows a dense cluster of both successful ( ) and unsuccessful ( ) nests close together in the forest area. "Area B" is a region downstream of the chemical factory's discharge point (bounded by dashed lines), shown with a sparser, more scattered mix of successful ( ) and unsuccessful ( ) nest markers, with unsuccessful ( ) nests appearing more numerous/closer to the river relative to successful ( ) nests, which sit farther back. Legend box: " Successful turtle nest" and " Unsuccessful turtle nest."]

(b)(i) Mercury can affect organisms and ecosystems in many ways. **Describe** how a persistent pollutant, such as mercury, can negatively affect an organism.

(b)(ii) **Describe** how a persistent pollutant, such as mercury, can negatively affect an ecosystem.

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(b)(iii) Researchers measured methylmercury in a location downstream from the factory. **Explain** how methylmercury could be present in the stream.
(b)(iv) Researchers claimed that the soil nearest to the river has higher levels of mercury than the field has, and those elevated levels have affected the nesting success for turtles. **Explain** how the pattern shown in the diagram supports or refutes this claim.

Question 1

2022 Set 1 ▪ Q1

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Question 1

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(c) The turtle study was conducted in an agricultural area. **Describe** how a specific agricultural practice changes the soil in an area.

Solution 1

(a)(i)

Mark scheme

- Area A (the site/area upstream from the factory) has the greatest nest success rate.

(a)(ii)

Mark scheme

- The dependent variable is turtle nesting success.

Solution 1

(a)(iii)

Mark scheme

- A likely scientific question: Does mercury content in the turtle's habitat affect common snapping turtle nest success? (Alternatively: Does mercury content in the turtle's habitat affect the location/site of common snapping turtle nests?)

Solution 1

(a)(iv)

Mark scheme

- The upstream locations acted as a control group in the study, used to compare against the high-mercury turtle nests found downstream.

Solution 1

(a)(v) Mark scheme

- Removing riverbank vegetation could affect nesting as follows (any one): with more open area closer to the river, turtles don't have to travel as far to nest, so they are exposed to higher mercury levels near the river, decreasing the number of successful nests; with less vegetation to take up/remove mercury (heavy metals/endocrine disruptors/pesticides), concentrations in the soil increase, decreasing successful nests; soil erosion along the stream increases, making nest-building harder and decreasing successful nests; or with less vegetation/shade, soil temperature increases and moisture decreases, decreasing successful nests.

Solution 1

(b)(i)

Mark scheme

- A persistent pollutant like mercury can harm an organism because it bioaccumulates in tissues (it does not break down easily and accumulates over time); mercury is a neurotoxin that disrupts the nervous system/neuron functioning; or it disrupts normal functioning of the brain/kidneys/liver/immune system/reproductive system and can lead to death.

Solution 1

(b)(ii)

Mark scheme

- A persistent pollutant can harm an ecosystem because it biomagnifies up the food chain, giving top predators very high concentrations (which can cause a trophic cascade if predators die off); or because decreased reproductive success in exposed organisms alters food webs/trophic structure and reduces biodiversity/ecosystem stability.

Solution 1

(b)(iii)

Mark scheme

- Mercury is likely released into the stream by the factory as a waste product; bacteria/microorganisms in the water and sediments then convert the inorganic mercury into methylmercury.

Solution 1

(b)(iv)

Mark scheme

- The diagram supports the claim: nests close to the river in Area B, where mercury levels are high, are not successful, while nests farther from the river are successful — supporting the claim that elevated soil mercury reduces nesting success. (Alternatively: Area B, closer to the river, has fewer total/successful nests than Area A, further supporting the claim.)

Solution 1

(c) Mark scheme

- Any one specific agricultural practice and its soil effect: tilling/plowing loosens/softens soil and/or removes organic matter, leading to erosion; monocropping removes nutrients and/or moisture; synthetic fertilizer use disrupts soil chemistry; irrigation can cause waterlogging, erosion, and/or salinization; slash-and-burn removes vegetation and upper organic soil layers (though it can add nutrients); heavy machinery use compacts soil; polyculture/cover cropping with nitrogen-fixing plants adds soil nutrients; or manure/organic fertilizer use increases soil moisture content.