Past-paper walk-through

Impacts of Urbanization ▪ 5.10

eXercise

Questions in this set

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- 2025 Set 1 Q2
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- 2015 Q1
- 2014 Q2

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 3

2026 ▪ Q3

The following information applies to parts A, B, C, D, E, and F.
Ocelots are small wildcats that were previously found in 25 counties in Texas where shrubland is prevalent. As a result of land use changes, only 74 ocelots remain in 4 counties in Texas today. Rodents such as pocket mice are the main source of food for ocelots, but ocelots also prey on other small animals such as snakes and lizards.

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

(a) Identify one environmental consequence that could result from having a smaller population of ocelots.

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

(b) Calculate the percent change in the number of Texas counties where ocelots have been found historically as compared to today. **Show** your work.

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2026 ▪ Q3

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

(c) Researchers expect the ocelot population to grow at a constant rate of 2.8% per year. **Calculate** the number of years it will take for the ocelot population to double based on a constant rate of growth. **Show** your work.

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

(d) Pocket mice eat plants in the shrubland, while snakes are carnivores. **Explain** why the amount of primary production energy available to ocelots would change if ocelots ate only carnivores such as snakes and not pocket mice.

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

(e) Ocelots need 720 grams of food per day. Pocket mice weigh an average of 43 grams each. If the ocelot diet consists of 46% pocket mice by weight, **calculate** how many pocket mice an ocelot would need to consume in one day, assuming each mouse weighs the average amount. **Show** your work.

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

(f)(i) As urbanization has increased in southern Texas, motor vehicle collisions have become the main cause of death in ocelots, which poses an added threat to the remaining ocelots.

Propose a realistic solution to reduce the number of ocelots killed by vehicles.

(f)(ii) Justify the solution proposed in part F (i) by explaining an additional advantage, other than reducing the number of ocelots killed by vehicles.

Question 2

2025 Set 1 ▪ Q2

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Figure 1 shows temperature and precipitation patterns associated with one phase of this phenomenon in the equatorial Pacific Ocean. Figure 2 shows the associated temperature and precipitation patterns that occur over North America.

Figure 1. Effects of Changes in Sea Surface Conditions in Equatorial Pacific Ocean

[Map of the equatorial Pacific Ocean region spanning from Africa/the Indian Ocean on the left to Australia and the western coast of South America on the right, with dashed horizontal reference lines at “30° North” and “Equator 0°”. A large hatched region (diagonal lines, labeled in the legend as “Ocean water cooler than average”) covers the

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western/central Pacific Ocean around and south of Australia and Indonesia. A large solid-shaded region (labeled "Ocean water warmer than average") lies to the west of the hatched region, overlapping the Indian Ocean/Indonesia area. A solid black patch (labeled "Increased chance of precipitation") sits over Australia. A bold horizontal arrow points from right (near South America) to left (toward Indonesia/Australia) along the Equator, labeled "Stronger than normal trade winds". A compass rose (N/S/E/W) is shown in the lower right. Legend: (diagonal hatch) = Ocean water cooler than average; (grey fill) = Ocean water warmer than average; (black fill) = Increased chance of precipitation; ← (bold arrow) = Stronger than normal trade winds.]

Figure 2. Polar Jet Stream and Climate Conditions in North America

[Map of North America showing a thick curved arrow labeled "Polar Jet Stream" that dips from the northwest, curves down over the western/central United States, and rises

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back up toward the northeast (Atlantic Canada), with an arrowhead at the northeast end. A region labeled "A" (dashed-outline circle, dotted fill pattern) is located over the northwestern/western Canada-US border area. A dotted-fill band (same pattern as region A, labeled in the legend as "Increased chance of precipitation") stretches along the path under the jet stream curve across the northern/central US. A region labeled "B" (dashed-outline box, solid grey fill) sits over the south-central/southeastern United States, within a larger grey-shaded band (labeled "Decreased chance of precipitation"). A diagonally hatched region (labeled "Warmer than average") covers the southeastern United States. A compass rose (N/S/E/W) is shown in the lower left. Legend: (dotted outline/fill) = Increased chance of precipitation; (solid grey fill) = Decreased chance of precipitation; (dotted fill, different pattern) = Cooler than average; (diagonal hatch) = Warmer than average.]

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(a) Identify the sea surface condition for the eastern equatorial area of the Pacific Ocean illustrated in Figure 1.

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(b) Based on the information in Figure 1, identify the climate phenomenon associated with the sea surface conditions shown in the equatorial area of the Pacific Ocean.

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(c) Based on the information in Figure 2, describe a difference in climate patterns between the regions A and B.

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(d) Increases in regional precipitation can lead to increased flooding in certain locations. Describe one reason why there is an increased risk of flooding in urban areas during extended periods of precipitation.

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(e) Propose a realistic solution a city could implement to decrease the risk of flooding in urban areas.

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(f) Justify the solution proposed in part E by providing an additional advantage other than a reduction in the risk of flooding.

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(g) Terrestrial biomes are primarily determined by temperature and precipitation patterns. Describe one difference between the climate of a temperate seasonal forest and that of a savanna.

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(h) Droughts are one environmental problem that can affect the frequency and severity of forest fires. Identify the ecological process that occurs following a forest fire that leaves the soil intact.

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(i) Describe one way burning forests contribute to atmospheric pollution.

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the northern/central US. A region labeled "B" (dashed-outline box, solid grey fill) sits over the south-central/southeastern United States, within a larger grey-shaded band (labeled "Decreased chance of precipitation"). A diagonally hatched region (labeled "Warmer than average") covers the southeastern United States. A compass rose (N/S/E/W) is shown in the lower left. Legend: (dotted outline/fill) = Increased chance of precipitation; (solid grey fill) = Decreased chance of precipitation; (dotted fill, different pattern) = Cooler than average; (diagonal hatch) = Warmer than average.]

(j) Describe one sustainable forestry practice that could be used to reduce the occurrence or severity of forest fires.

Solution 2

(a)

Mark scheme

- The sea surface condition in the eastern equatorial Pacific shown in Figure 1: ocean water is cooler than average.

Solution 2

(b)

Mark scheme

- The climate phenomenon associated with these cooler-than-average equatorial Pacific sea surface conditions is La Niña.

Solution 2

(c)

Mark scheme

- Difference in climate patterns between regions A and B (Figure 2): Region A has an increased chance of precipitation while Region B has a decreased chance of precipitation — i.e., Region A will be wetter while Region B will be drier.

Solution 2

(d)

Mark scheme

- One reason for increased flood risk in urban areas during extended precipitation: impervious/paved surfaces (parking lots, roads, buildings, sidewalks) increase runoff and reduce infiltration/absorption; urban areas also have less vegetation, further reducing infiltration/absorption.

Solution 2

(e)

Mark scheme

- A realistic city solution to decrease urban flood risk: use permeable pavement; or plant vegetation/establish parks/create rain gardens/build green roofs; or install retention ponds/stormwater basins.

Solution 2

(f) Mark scheme

- Justify the part-E solution with an advantage beyond flood reduction, matched to the chosen solution. Permeable pavement: increased recharge of nearby aquifers/groundwater; decreased pollution in runoff. Vegetation/parks/rain gardens/green roofs: absorbs pollutants; stores carbon dioxide/produces oxygen; decreases erosion; increases/restores wildlife habitat and biodiversity; reduces the urban heat island effect; improves aesthetic enjoyment/quality of life; creates landscaping/park-maintenance jobs. Retention ponds/stormwater basins: decreased pollution in runoff; increased habitat/biodiversity.

Solution 2

(g)

Mark scheme

- One climate difference between a temperate seasonal forest and a savanna: temperate seasonal forests have a cooler climate with a stronger/colder winter and four distinct seasons, and receive more annual precipitation (spread throughout the year), whereas savannas are warmer with a distinct rainy season and dry season and do not have four distinct seasons.

Solution 2

(h)

Mark scheme

- The ecological process that occurs following a forest fire that leaves the soil intact is secondary succession.

Solution 2

(i)

Mark scheme

- One way burning forests contributes to atmospheric pollution: burning trees releases CO2, CO, NOx, particulate matter, and/or VOCs into the atmosphere.

Solution 2

(j)

Mark scheme

- One sustainable forestry practice to reduce the occurrence/severity of forest fires: prescribed burns (remove excess fuel/dead leaves/underbrush); brush removal (removes excess fuel); selective cutting (creates a fire break); agroforestry, where ground crops that might otherwise become fuel are harvested/removed.

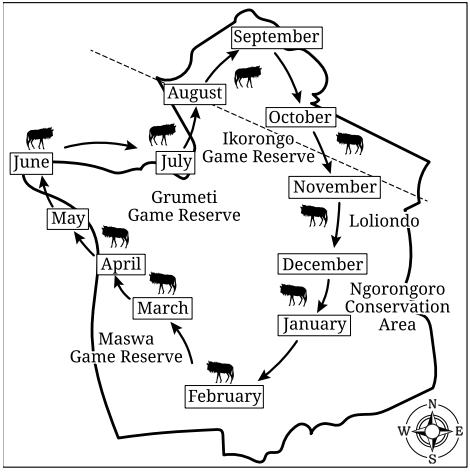
Question 1

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.

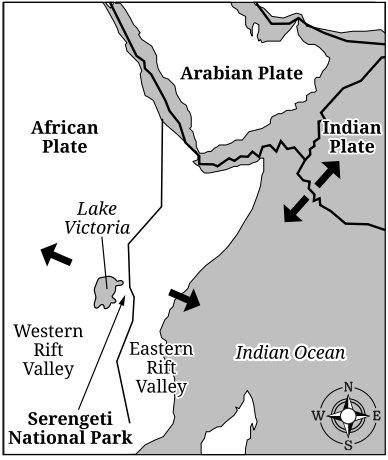
Question 1


September
August
October
Ikorongo
Game Reserve
June
July
November
Grumeti
Game Reserve
Loliondo
May
April
December
March
Ngorongoro
Conservation
Area
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 2

2025 Set 2 ▪ Q2

Serengeti National Park is located in Tanzania, Africa. The park is located in a valley along a tectonic plate boundary called the East African Rift. Figure 1 shows the East African Rift and other plate boundaries near the east coast of Africa.

Figure 1. Tectonic Plate Movement near East Coast of Africa

[Map figure showing tectonic plates near the east coast of Africa. Labels: "Arabian Plate" (north-central), "African Plate" (west), "Indian Plate" (east), "Lake Victoria" (small lake, west, with an arrow pointing away from it/west), "Western Rift Valley" and "Eastern Rift Valley" (two branching rift lines running north-south through the African Plate), "Serengeti National Park" (marked at the point where the Western and Eastern Rift Valleys meet), "Indian Ocean" (to the east). Bold arrows show direction of plate movement: one arrow points west/away from Lake Victoria area, one arrow points southeast from the rift valley junction, and a double-headed arrow (pointing

Question 2

both directions, apart) is shown at the boundary between the Arabian Plate and the Indian Plate. A compass rose (N/E/S/W) is in the bottom right. Legend: wavy line = Plate boundaries; solid line = East African Rift; bold arrow = Direction of plate movement.]

Serengeti National Park contains a variety of tropical habitats but is dominated by wide-open lands that include a variety of grass species with scattered trees and shrubs. Most grass growth occurs after the March through May rainy season. Many of the park's herbivores, such as wildebeest and zebra, migrate through the park in an annual cycle following the growth of new grass (Figure 2).

Figure 2. Annual Migration of Wildebeest in Serengeti National Park

[Circular diagram showing the annual wildebeest migration route around Serengeti National Park, with a wildebeest icon and arrows connecting labelled month boxes in a loop: June → July → August → September → October (near "Ikorongo Game

Question 2

Reserve") → November (near "Loliondo") → December (near "Ngorongoro Conservation Area") → January → February → March → April (near "Maswa Game Reserve") → May → back to June. "Grumeti Game Reserve" is labelled near June/July. A dashed line labelled "Proposed location for new highway" crosses the northern part of the park near August/September. A solid line marks the "Serengeti National Park boundary." A compass rose (N/E/S/W) is in the bottom right. Legend: arrow = Wildebeest migration route; wildebeest icon = Wildebeest; dashed line = Proposed location for new highway; solid line = Serengeti National Park boundary.] Respond to parts A, B, C, D, E, F, G, H, I, and J.

(a) Based on the information in Figure 1, **identify** the type of plate boundary that runs beneath Serengeti National Park.

Question 2

2025 Set 2 ▪ Q2

Serengeti National Park is located in Tanzania, Africa. The park is located in a valley along a tectonic plate boundary called the East African Rift. Figure 1 shows the East African Rift and other plate boundaries near the east coast of Africa.

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Question 2

Legend: wavy line = Plate boundaries; solid line = East African Rift; bold arrow = Direction of plate movement.]

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Question 2

highway" crosses the northern part of the park near August/September. A solid line marks the "Serengeti National Park boundary." A compass rose (N/E/S/W) is in the bottom right. Legend: arrow = Wildebeest migration route; wildebeest icon = Wildebeest; dashed line = Proposed location for new highway; solid line = Serengeti National Park boundary.]

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

(b) Based on the information provided, **identify** the dominant biome within the Serengeti.

Question 2

2025 Set 2 ▪ Q2

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Question 2

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

(c) Wildebeest give birth to their young when new grasses are growing. Based on the information in Figure 2, **identify** the location in the Serengeti where wildebeest are most likely to give birth.

Question 2

2025 Set 2 ▪ Q2

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

(d) The Serengeti has two primary types of grasses: long and short. The two grass types provide similar levels of nutrition for animals. Wildebeest primarily consume long grasses, while other herbivores such as gazelle consume the short grasses. These two similar species coexist in Serengeti National Park.

Explain why resource partitioning allows for the coexistence of the wildebeest and the gazelle in the Serengeti.

Question 2

2025 Set 2 ▪ Q2

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

(e) The Tanzanian government plans to build a highway across the northern portion of the Serengeti, as shown in Figure 2.

Describe one way the planned highway shown in Figure 2 could negatively affect the wildebeest population in the Serengeti.

Question 2

2025 Set 2 ▪ Q2

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

(f) Propose a solution to the negative effect created by the planned highway described in part E.

Question 2

2025 Set 2 ▪ Q2

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highway" crosses the northern part of the park near August/September. A solid line marks the "Serengeti National Park boundary." A compass rose (N/E/S/W) is in the bottom right. Legend: arrow = Wildebeest migration route; wildebeest icon = Wildebeest; dashed line = Proposed location for new highway; solid line = Serengeti National Park boundary.]

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

(g) Many organisms live in grasslands. One weed species, the spotted knapweed, was introduced at one location in North America in the 1890s and is currently found throughout the rangelands of the western United States. The spotted knapweed poses several environmental problems in North America. Farmers often use crop rotation to control populations of pests like the spotted knapweed. A more traditional method of controlling pests involves spraying pesticides.

Describe a characteristic of an invasive species, such as the spotted knapweed, that allows them to outcompete native species.

Question 2

2025 Set 2 ▪ Q2

Serengeti National Park is located in Tanzania, Africa. The park is located in a valley along a tectonic plate boundary called the East African Rift. Figure 1 shows the East African Rift and other plate boundaries near the east coast of Africa.

Figure 1. Tectonic Plate Movement near East Coast of Africa

[Map figure showing tectonic plates near the east coast of Africa. Labels: "Arabian Plate" (north-central), "African Plate" (west), "Indian Plate" (east), "Lake Victoria" (small lake, west, with an arrow pointing away from it/west), "Western Rift Valley" and "Eastern Rift Valley" (two branching rift lines running north-south through the African Plate), "Serengeti National Park" (marked at the point where the Western and Eastern Rift Valleys meet), "Indian Ocean" (to the east). Bold arrows show direction of plate movement: one arrow points west/away from Lake Victoria area, one arrow points southeast from the rift valley junction, and a double-headed arrow (pointing both directions, apart) is shown at the boundary between the Arabian Plate and the Indian Plate. A compass rose (N/E/S/W) is in the bottom right.

Question 2

Legend: wavy line = Plate boundaries; solid line = East African Rift; bold arrow = Direction of plate movement.]

Serengeti National Park contains a variety of tropical habitats but is dominated by wide-open lands that include a variety of grass species with scattered trees and shrubs. Most grass growth occurs after the March through May rainy season. Many of the park's herbivores, such as wildebeest and zebra, migrate through the park in an annual cycle following the growth of new grass (Figure 2).

Figure 2. Annual Migration of Wildebeest in Serengeti National Park

[Circular diagram showing the annual wildebeest migration route around Serengeti National Park, with a wildebeest icon and arrows connecting labelled month boxes in a loop: June → July → August → September → October (near "Ikorongo Game Reserve") → November (near "Loliondo") → December (near "Ngorongoro Conservation Area") → January → February → March → April (near "Maswa Game Reserve") → May → back to June. "Grumeti Game Reserve" is labelled near June/July. A dashed line labelled "Proposed location for new

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

(h) Justify the use of crop rotation as an environmental solution by providing an additional advantage, other than controlling pest populations.

Question 2

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

(i) Describe an environmental problem associated with controlling pest populations with large amounts of pesticide.

Question 2

2025 Set 2 ▪ Q2

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Serengeti National Park contains a variety of tropical habitats but is dominated by wide-open lands that include a variety of grass species with scattered trees and shrubs. Most grass growth occurs after the March through May rainy season. Many of the park's herbivores, such as wildebeest and zebra, migrate through the park in an annual cycle following the growth of new grass (Figure 2).

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

(j) Propose a solution to controlling pests, other than pesticides or crop rotation.

Solution 2

(a)

Mark scheme

- Divergent (boundary) - the plate boundary running beneath Serengeti National Park (part of the East African Rift) is a divergent boundary. 1 point for identifying it as divergent.

Solution 2

(b)

Mark scheme

- The dominant biome within the Serengeti is savanna (tropical grassland). 1 point for identifying savanna/tropical grassland.

Solution 2

(c)

Mark scheme

- Wildebeest are most likely to give birth in the Grumeti Game Reserve, i.e. the west/northwestern side/edge of Serengeti National Park, where new grasses are growing (per Figure 2). 1 point for identifying this location.

Solution 2

(d)

Mark scheme

- Resource partitioning allows wildebeest (which eat long grasses) and gazelle (which eat short grasses) to coexist because it reduces the negative impact of competition for limited resources - each species uses the shared, limited resource (grass) in a different way (different grass types), so they are not competing directly for the exact same food source. 1 point for explaining this reduced-competition mechanism.

Solution 2

(e)

Mark scheme

- One way the planned highway could negatively affect the wildebeest population: building the highway would fragment/destroy habitat, food, or resources; the highway could prevent, reduce, or disturb migration; wildebeest could be hit/killed by vehicles; or noise pollution from the highway could cause stress or change migratory routes. 1 point for any one valid negative effect.

Solution 2

(f) Mark scheme

- A realistic solution must correspond to the problem identified in part E. If habitat fragmentation/destruction was described: construct a habitat corridor over/under the highway, construct the highway over/above the habitat, relocate the highway north/outside the migratory path, or expand the national park/create additional protected habitat. If migration disturbance or vehicle strikes was described: relocate the highway north/outside the migratory path, or construct a habitat corridor over/under the highway. If noise pollution/stress was described: install a sound barrier to mitigate noise pollution, or relocate the highway north/outside the migratory path. 1 point for a solution that logically addresses the specific problem given in part E.

Solution 2

(g)

Mark scheme

- A characteristic of an invasive species (such as spotted knapweed) that allows it to outcompete native species: it has many offspring/reproduces quickly/matures early/invests minimal energy per offspring (tends to be r-selected); it can feed on/use many different types of resources; or it can survive in conditions outside its normal habitat/has a wide tolerance range (tends to be a generalist). 1 point for any one valid characteristic.

Solution 2

(h)

Mark scheme

- An additional advantage of crop rotation (besides pest control): improved soil fertility/soil structure/soil quality; increased nutrient cycling/reduced need for fertilizer; reduced soil erosion; increased food security/crop yield; or increased biological activity in the soil. 1 point for any one valid additional advantage.

Solution 2

(i)

Mark scheme

- An environmental problem from controlling pests with large amounts of pesticide: pesticides can harm/kill nontarget species, or pests can develop resistance to the pesticide (leading to a pesticide treadmill). 1 point for either problem.

Solution 2

(j)

Mark scheme

- A solution to controlling pests other than pesticides or crop rotation: use biocontrol/intercropping/natural predators; trap insects/use mechanical controls to eliminate pests; or use genetically modified crops that are pest resistant. 1 point for any one valid alternative solution.

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:

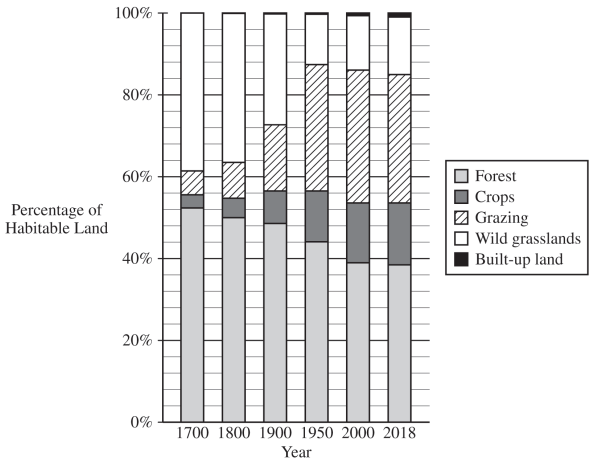
- 1700: Forest 53%, Crops 2%, Grazing 6%, Wild grasslands 38% (top reaches 100%), Built-up land negligible.
- 1800: Forest 51%, Crops 4%, Grazing 9%, Wild grasslands 36%, Built-up land negligible.

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.]

(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.

Question 2

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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.

Question 2

2024 Set 2 ▪ Q2

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

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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

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

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(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

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(a) Describe how urbanization leads to the formation of urban heat islands.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(b)(i) Urban heat islands have been linked to a variety of environmental problems. **Propose** a reasonable solution that could help lower the temperature increases caused by urban heat islands.

(b)(ii) Justify the solution proposed in part (b)(i) by providing one additional benefit other than reducing temperatures in urban heat islands.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(c)(i) Urban areas are increasingly using solar energy to generate electricity for residences and businesses. As a result of improved technology, the efficiency of solar panels has changed over time. In 1992 a solar cell had a maximum efficiency of 15.9%. In 2017 a solar cell prototype capable of 44.5% efficiency was produced. **Calculate** the percent change in efficiency from the 1992 cell to the 2017 cell. **Show** your work.

(c)(ii) The average home in the United States uses 12,900 kWh of electricity per year. The local power company is raising the cost of purchasing electricity from $0.11 per kWh to 0.13 per kWh. Assuming a home uses the average kWh of electricity in one year, **calculate** the change in electricity cost for one year for the homeowner. **Show** your work.

Question 3

(c)(iii) The roof of a typical house in the United States receives a total of four hours of sunlight per day that can be converted by solar panels into electricity. A house has 30 solar panels on its roof, and each panel generates a maximum output of 300 watts. **Calculate** how many kWh can be produced by the system at maximum output in one calendar year. **Show** your work.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(d) Explain why the Northern Hemisphere receives more solar energy from the Sun between June and August than the Southern Hemisphere receives between June and August.

Solution 3

(a)

Mark scheme

- Urbanization forms heat islands because: urban buildings block wind currents, raising local temperatures; urban materials/structures (roads, sidewalks, buildings) absorb and hold heat; urban areas have fewer trees, so less shade/transpiration raises temperatures; or urban areas have many vehicles/air conditioners/machinery producing waste heat.

Solution 3

(b)(i)

Mark scheme

- A reasonable solution to lower urban heat island temperatures: plant green roofs/vegetation/increase green space; use cool/reflective/lighter-colored roofing and surfaces; increase the efficiency of waste-heat-producing systems (vehicles, air conditioners); or decrease the use of such systems.

Solution 3

(b)(ii) Mark scheme

- Justification must give one additional benefit (besides reducing temperature) matched to the proposed (b)(i) solution — e.g. green roofs/vegetation: provide food crops, create wildlife habitat, slow/capture stormwater runoff, insulate buildings (lower heating/cooling costs), give aesthetic/recreational value, or filter/remove air pollution and carbon. Cool/reflective surfaces: reflect solar energy or reduce energy consumption, lowering cooling costs. Increased efficiency of waste-heat systems: decreases CO2 production (reduces climate change) or reduces energy costs. Decreased use of such systems: decreases CO2 production, decreases vehicle-related air pollution, or reduces energy costs.

Solution 3

(c)(i)

Mark scheme

- Percent change = ((44.5% - 15.9%)/15.9%) x 100, equivalently (44.5/15.9 - 1) x 100 179.9% (accept 180%). 1 point for the correct setup (must include multiplying by 100); 1 point for the correct final value (179.9% or 180%).

Solution 3

(c)(ii)

Mark scheme

- Change in cost = 12,900 kWh x $(0.13-0.11)$/kWh, equivalently (12,900 kWh x $0.13/kWh$) $-$ $(12,900 kWh x 0.11/$kWh) $= 1,677-1,419 =$ $258 increase for the year. 1 point for the correct setup (must include units); 1 point for the correct fi$

Solution 3

(c)(iii)

Mark scheme

- kWh produced = 30 panels x 300 watts/panel x (1 kW/1,000 watts) x 4 hours/day x 365 days/year = 13,140 kWh per year at maximum output. 1 point for the correct setup; 1 point for the correct final value (13,140 kWh per year).

Solution 3

(d)

Mark scheme

- During June through August the Northern Hemisphere is tilted toward the Sun, so it receives more direct solar energy per unit area than the Southern Hemisphere does during the same months; the Northern Hemisphere also has more hours of daylight/sunlight during this period.

Question 1

2022 Set 2 ▪ Q1

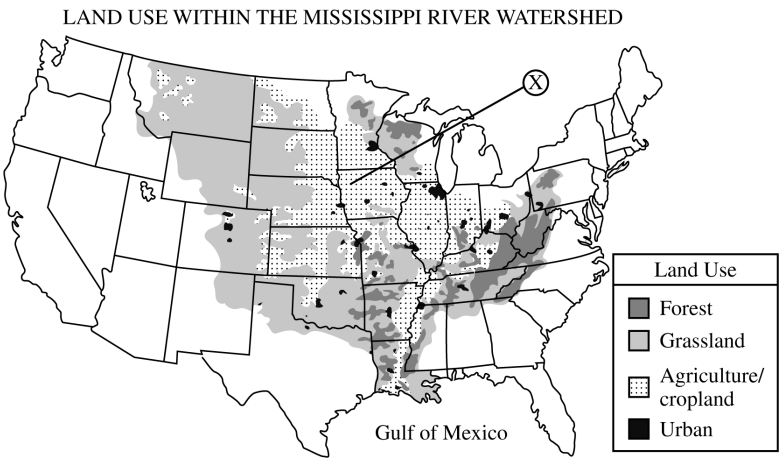
The dead zone in the Gulf of Mexico occurs every summer when winter snow melts and spring rain flows into the Mississippi River. Recent studies have shown that both the total area covered by algae and the depth of the algal mass in the dead zone are increasing.

[Map titled "LAND USE WITHIN THE MISSISSIPPI RIVER WATERSHED": a map of the continental United States showing the Mississippi River watershed shaded by land use type, with the Gulf of Mexico labeled at the bottom. A point labeled "X" is marked in the upper-central part of the watershed (near the Great Lakes region), connected by a line from the map. Legend "Land Use": Forest (dark gray shading), Grassland (light gray shading), Agriculture/cropland (dotted/stippled shading), Urban (solid black shading, scattered small patches throughout the watershed, especially clustered in the east and around the Great Lakes).]

Question 1

(a)(i) Various land use practices can have different effects on the waters that surround a dead zone.
Identify the land use that covers the least amount of area in the Mississippi River watershed, based on the diagram.
(a)(ii) Describe one way that the land use practice at location X in the diagram could contribute to the dead zone in the Gulf of Mexico.
(a)(iii) Describe one way that urban areas in the Mississippi River watershed could contribute to the dead zone in the Gulf of Mexico.

Question 1


LAND USE WITHIN THE MISSISSIPPI RIVER WATERSHED
X
Gulf of Mexico
Land Use
Forest
Grassland
Agriculture/ cropland
Urban

Question 1

2022 Set 2 ▪ Q1

The dead zone in the Gulf of Mexico occurs every summer when winter snow melts and spring rain flows into the Mississippi River. Recent studies have shown that both the total area covered by algae and the depth of the algal mass in the dead zone are increasing.

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Question 1

(b)(i) The dead zone in the Gulf of Mexico has both economic and environmental effects for coastal communities.
Describe how a dead zone affects marine organisms living in the Gulf of Mexico.
(b)(ii) Describe one economic effect on communities along the Gulf of Mexico that can result from the presence of the dead zone.
(b)(iii) Describe one factor that causes the area of the dead zone in the Gulf of Mexico to increase in the summer months.

Question 1

2022 Set 2 ▪ Q1

The dead zone in the Gulf of Mexico occurs every summer when winter snow melts and spring rain flows into the Mississippi River. Recent studies have shown that both the total area covered by algae and the depth of the algal mass in the dead zone are increasing.

[Map titled "LAND USE WITHIN THE MISSISSIPPI RIVER WATERSHED": a map of the continental United States showing the Mississippi River watershed shaded by land use type, with the Gulf of Mexico labeled at the bottom. A point labeled "X" is marked in the upper-central part of the watershed (near the Great Lakes region), connected by a line from the map. Legend "Land Use": Forest (dark gray shading), Grassland (light gray shading), Agriculture/cropland (dotted/stippled shading), Urban (solid black shading, scattered small patches throughout the watershed, especially clustered in the east and around the Great Lakes).]

Question 1

(c)(i) Researchers want to examine the effect of riparian vegetation buffers on water quality in streams in agricultural areas. Researchers will measure the water nutrient concentrations over the course of one year. The study sites are located 100 meters downstream from areas either with or without riparian vegetation buffers.
Identify a testable hypothesis for the study.
(c)(ii) Describe a control that the researchers could use in the study.
(c)(iii) Identify one water quality test, other than measuring nitrates or phosphates, that the researchers could use to evaluate how riparian vegetation buffers affect water quality.
(c)(iv) During the investigation, researchers discovered that some of the land next to one of the streams with a riparian vegetation buffer is going to be converted from cornfields into a large-scale concentrated animal feeding operation. **Explain** one way that this change in land use could alter the results of the study.

Solution 1

(a)(i)

Mark scheme

- Urban — urban land use covers the least area of the Mississippi River watershed shown in the diagram.

Solution 1

(a)(ii)

Mark scheme

- Any one way land use at location X could contribute to the dead zone: fertilizer applied to croplands washes into streams/rivers and feeds algae growth once it reaches the Gulf; concentrated animal feeding operations (CAFOs) generate large amounts of organic waste that moves into streams and rivers, feeding algae growth in the Gulf; treated or untreated (overflow) sewage released from wastewater treatment plants feeds algae growth in the Gulf.

Solution 1

(a)(iii)

Mark scheme

- Any one way urban areas could contribute to the dead zone: wastewater treatment facilities in urban areas may release nutrients in treated wastewater and/or overflows that flow into the Gulf; impervious surfaces in urban areas increase runoff of lawn fertilizers or high-phosphate detergents that move onto pavement and flow into the Gulf.

Solution 1

(b)(i)

Mark scheme

- Any one effect: many organisms are forced to migrate or die because of low dissolved oxygen levels in the water (hypoxia); many organisms are forced to migrate or die because algal blooms block sunlight from reaching submerged aquatic vegetation.

Solution 1

(b)(ii)

Mark scheme

- Any one economic effect: decreased fish catch / decreased income for the fishing industry; decreased tourism / lower tourism revenues; increased fuel costs for fishing vessels that must travel farther to find fish, decreasing income/profits; increased costs for consumers due to a limited supply of fish.

Solution 1

(b)(iii)

Mark scheme

- Any one factor: increased runoff of nitrates/phosphates/potassium from fertilizer used during the growing season increases algal growth in summer; increased precipitation/snowmelt/water volume carries more fertilizer runoff from urban or agricultural areas, increasing algal growth; higher water temperatures in summer decrease dissolved oxygen concentration (warm water holds less DO than cold water); increased runoff of fertilizer or high-phosphate detergents used in urban areas increases algal growth in summer.

Solution 1

(c)(i)

Mark scheme

- Any testable hypothesis of the form: if riparian vegetation buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be lower (or higher, or the same) than in areas without riparian buffers.

(c)(ii)

Mark scheme

- The control is stream sites located 100 meters downstream from areas WITHOUT riparian vegetation buffer zones.

Solution 1

(c)(iii)

Mark scheme

- Any one water quality test other than nitrates or phosphates: turbidity; total suspended solids (TSS); dissolved oxygen; water temperature; fecal coliform; conductivity; pH; biological oxygen demand (BOD).

Solution 1

(c)(iv) Mark scheme

- Any one explanation: water quality would decline from increased nutrients/coliform bacteria in runoff because animal waste near the new CAFO is high in nutrients/coliform bacteria; water quality would decline from increased turbidity/total suspended solids because particles from animal waste enter the stream / streambed disruption increases; water quality would decline from increased water temperature because the increased turbidity/suspended solids absorb more sunlight/heat; water quality would decline from increased conductivity because of increased water temperature/dissolved salts near the CAFO; water quality would decline from antibiotics/veterinary drugs present in runoff from livestock operations (not used on the original cornfield crop). This

Solution 1

confounds the study because conditions change at the riparian-buffer site independent of the buffer treatment itself.

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.

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.]

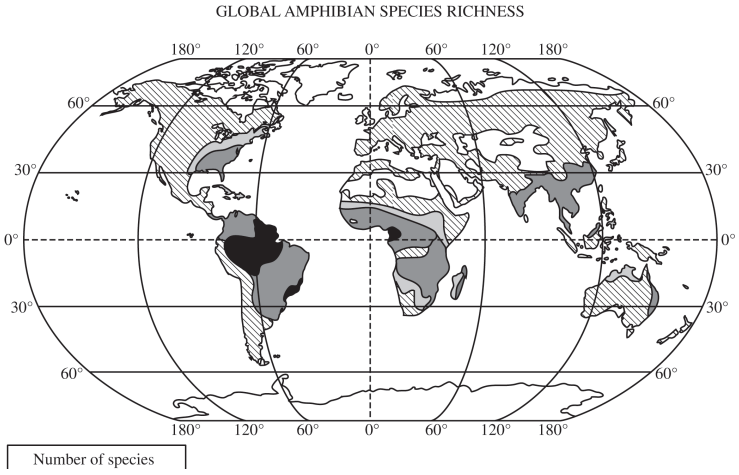
(a)(i) The map represents species richness of amphibians around the globe. Use the map to answer the following questions.

Identify the latitudinal range with the greatest amphibian species richness.

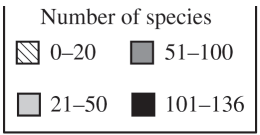
(a)(ii) Identify what biome this range most likely represents.

(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 1

2019 ▪ Q1

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SPRING PIPING PLOVER NESTING SITES ON ASSATEAGUE ISLAND, VIRGINIA

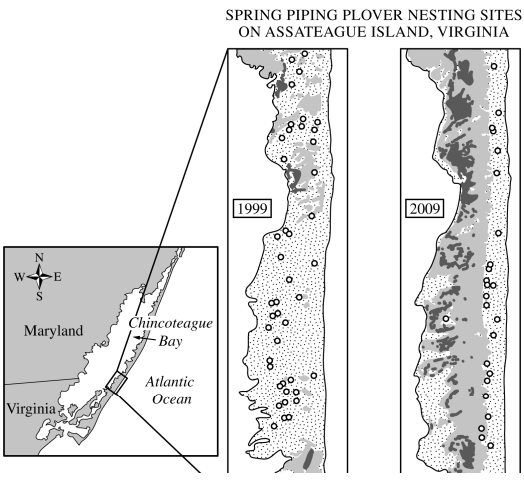
Question 1

[Two side-by-side maps of the barrier island Assateague Island, Virginia, labelled "1999" and "2009", each showing the shoreline with symbols marking piping plover nest locations. A small inset locator map at left shows Maryland and Virginia with Chincoteague Bay, the Atlantic Ocean, and a compass rose (N, S, E, W), with a box indicating the zoomed-in region of Assateague Island. Legend: hatched/dotted pattern = Unvegetated sand; light gray = Sparsely vegetated sand; dark gray = Densely vegetated sand; open circle (o) = Piping plover nest. The 1999 map shows nests scattered mainly in the unvegetated/sparsely vegetated (lighter) areas along the shoreline, with relatively little densely vegetated (dark gray) area. The 2009 map shows a similar shoreline but with a much larger area of densely vegetated (dark gray) sand covering the interior of the island, and nests still concentrated in the narrower band of unvegetated/sparsely vegetated sand along the coast.]

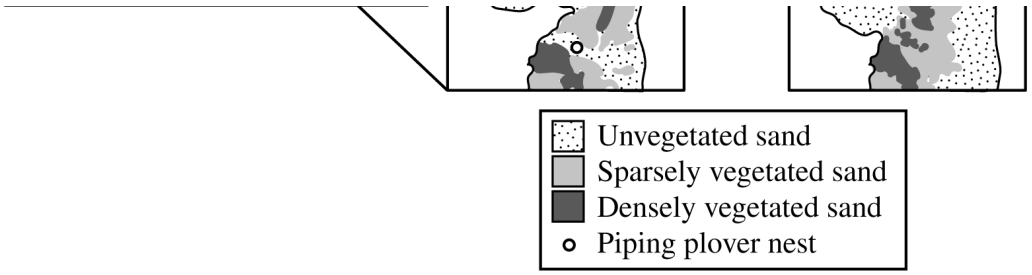
Question 1

Approximately 40% of the United States population resides in coastal areas, such as areas near Assateague Island, where sea level rise and shoreline erosion is occurring.
(a)(i) Use the maps provided to answer the following questions.
Identify the preferred nesting habitat for piping plovers.
(a)(ii) Describe the change in the number of piping plover nests on Assateague Island between 1999 and 2009.
(a)(iii) Describe one likely reason for the change in the number of piping plover nests between 1999 and 2009.

Question 1


SPRING PIPING PLOVER NESTING SITES
ON ASSATEAGUE ISLAND, VIRGINIA
1999
2009
N
W
E
S
Maryland
Virginia
Chincoteague
Bay
Atlantic
Ocean

Question 1


Unvegetated sand
Sparsely vegetated sand
Densely vegetated sand
Piping plover nest

Question 1

2019 ▪ Q1

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Approximately 40% of the United States population resides in coastal areas, such as areas near Assateague Island, where sea level rise and shoreline erosion is occurring.

(b)(i) Coastal species are affected by more than just natural events.

Question 1

Special beach restrictions can help piping plovers during nesting season. Describe one restriction that could reasonably be implemented to help prevent the destruction of plover nests by human actions.

(b)(ii) In addition to providing habitat for piping plovers, barrier islands (and closely related landforms) are important for other reasons. Explain one way that these features help to preserve and protect the environment in coastal regions.

(b)(iii) Identify one human action that directly threatens coastal habitats and describe one impact on species, other than the piping plover, that use the habitat.

Question 1

2019 ▪ Q1

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Approximately 40% of the United States population resides in coastal areas, such as areas near Assateague Island, where sea level rise and shoreline erosion is occurring.

(c) Identify one economic impact on coastal communities that has resulted from rising sea levels.

Question 1

2019 ▪ Q1

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Approximately 40% of the United States population resides in coastal areas, such as areas near Assateague Island, where sea level rise and shoreline erosion is occurring.

(d) Describe TWO methods that may be used locally to protect coastal communities from rising sea levels.

Solution 1

(a)(i)

Mark scheme

- Preferred nesting habitat for piping plovers: unvegetated sand / sandy areas / open sandy beaches / washovers. Full credit for identifying any one of these habitat types.

Solution 1

(a)(ii)

Mark scheme

- The number of piping plover nests decreased by almost half (about 43%) between 1999 and 2009 — from 44 nests in 1999 to 25 nests in 2009 (a decrease of 19 nests). Full credit for correctly describing this decrease (exact numbers not required).

Solution 1

(a)(iii)

Mark scheme

- One likely reason: the preferred nesting habitat (unvegetated sand) was reduced — either because of a decrease in unvegetated sandy areas, or because of an increase in vegetation/revegetation of the island. Full credit for identifying either cause of habitat loss.

Solution 1

(b)(i)

Mark scheme

- One reasonable restriction to prevent destruction of plover nests by human actions, e.g.: post warning signs/fencing/barrier tape/boardwalks around the nesting area; place wire enclosures/other barriers over active nests; limit specified recreational activity on beaches with plover nests (prohibit kite flying, fireworks, etc.); implement motor vehicle restrictions (limit times, size of vehicles, raking, etc.); require pets to remain indoors or on leashes. Full credit for any one reasonable restriction.

Solution 1

(b)(ii)

Mark scheme

- One way barrier islands help preserve/protect the coastal environment, e.g.: they block/buffer wind and/or waves, mitigating beach erosion; they reduce storm surge, protecting the interior coastline from flooding; they block/buffer waves and create wetland ecosystems/pools that serve as habitat for many species (fish, turtles, migratory birds); they trap sediments/pollutants in wetland habitats/marsh grasses, filtering the water. Full credit for any one correct explanation.

Solution 1

(b)(iii) Mark scheme

- 2 points — 1 point for identifying a human action that directly threatens coastal habitats, 1 point for describing a matching impact on a coastal species other than the piping plover. Acceptable paired examples: Tourism/Recreation → beachgoers step on/crush nests, unleashed pets disrupt nesting/survival, vehicles disrupt nesting/survival, litter attracts predators/harbors pathogens, sunscreen washes off and is toxic to coral/marine organisms; Coastal Development → loss of suitable habitat, noise/light pollution disrupts nesting/migration/survival, food/garbage attracts predators/harbors pathogens; Littering/Solid Waste Disposal → species get tangled in trash, or ingest trash which fills/blocks the respiratory/digestive tract; Offshore Oil Drilling → spilled oil coats coastal marine organisms impacting

Solution 1

survival, or is toxic if ingested; Commercial Fishing $\rightarrow$ dredging/trawling destroys coral/habitat for bottom-dwelling organisms, overharvesting decreases populations, species get trapped in fishing gear. Award 1 point for a valid human action, 1 point for a correctly linked impact on a non-plover species.

Solution 1

(c) Mark scheme

- One economic impact on coastal communities from rising sea levels, e.g.: decrease of tourist revenue; decrease of property value; increase in damage to property/land/infrastructure requiring repair or replacement; increase in insurance costs; loss of agricultural land or aquaculture operations resulting in financial loss; loss of fish nurseries in wetland areas leading to less revenue for commercial fisheries; increase in jobs in infrastructure/construction to repair damaged structures/properties; increase in costs associated with preventative measures (building sea walls, raising buildings, etc.). Full credit for any one valid economic impact.

Solution 1

(d) Mark scheme

- Describe TWO methods that may be used locally to protect coastal communities from rising sea levels, 1 point per correct distinct method (max 2), e.g.: raise structures to reduce/prevent water damage; move/build structures back from the beach (setbacks) to reduce/prevent water damage; install pumps to reduce flooding; build structures such as sea walls to protect the area from wave action/storm surge/flooding/erosion; plant vegetation along the shoreline to decrease erosion; replenish sand to address erosion problems or increase beach width; build jetties/groins to act as a barrier from waves.

Question 1

2015 ▪ Q1

Read the article below and answer the questions that follow.

[Newspaper clipping: "The Floridian Daily", dated May 21, 2013]

The small community located on the edge of the magnificent wetlands of Florida's Everglades was the site of a press conference today where Governor Gayle Moss announced that the restoration of the Everglades is successfully underway. She noted that the Everglades ecosystem has suffered threats to its water quality, water quantity, and habitats in recent decades. Moss noted that intensive urban and agricultural development in adjacent areas has diverted substantial amounts of freshwater resources and impaired water quality. Governor Moss then emphasized that the preservation and enhancement of the Everglades, key goals of the restoration program, are absolutely essential for the continued environmental and economic health of the state. She closed the press conference by saying, "The Everglades is a gem not only for Florida but for

Question 1

the entire world. Each of us has the responsibility to do our part to preserve this magnificent resource."

(a) Describe how TWO human activities, other than those that result in anthropogenic climate change, have resulted in a decrease in the amount of freshwater flowing into the Everglades ecosystem.

Question 1

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Question 1

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Question 1

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(b) In addition to water quantity problems, the Everglades is faced with a variety of water quality issues. For example, phosphorus concentrations in the Everglades have increased since the 1960s.

(b)(i) Describe how one specific human activity contributes to increased phosphorus levels in the Everglades.

(b)(ii) Explain one way in which an increase in phosphorus levels can adversely affect the Everglades ecosystem.

(b)(iii) Describe one step that could be taken to reduce phosphorus inputs from the activity you identified in part (i).

Question 1

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Question 1

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(c) Climate change could have a variety of impacts on water quantity, water quality, and habitat. For EACH of these three factors, identify and describe one specific example of an impact on the Everglades likely to result from climate change.

Question 1

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Question 1

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(d) The article states that Governor Moss believes that the "preservation and enhancement of the Everglades, key goals of the restoration program, are absolutely essential for the continued environmental and economic health of the state."

(d)(i) Describe one way that restoring water quantity and water quality in the Everglades is expected to improve the structure and function of the ecosystem.

(d)(ii) Describe one way that restoring the Everglades is expected to provide economic benefits to Florida.

Question 2

2014 ▪ Q2

Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city's sanitary sewer system, the storm water and sewage flow together to the Fremont Wastewater Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant's capacity, and the overflow bypasses the FWTP. The untreated overflow is discharged into Fremont Creek along with the treated waste.

Recently parts of Fremont received 5 cm of rain in 60 minutes. The storm caused widespread flooding in the northeast section of town. Especially hard hit was the Shoppes at Fremont shopping center.

Use the data from the table below to answer the questions that follow. Show all calculations.

Question 2

| Fremont Water Data | |—| | The shopping center's parking lot is 200 meters long and 100 meters wide. | | Fremont has an area of 10 km^2. | | Impervious surfaces cover 20 percent of Fremont's area. | | The FWTP typically treats $5{,}000$ m^3 of domestic sewage per day. | | The FWTP has the capacity to treat $10{,}000$ m^3 of combined sewage and storm water per day. |

(a) Identify TWO specific pollutants in storm-water runoff that degrade the quality of surface water.

Question 2

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Question 2

2014 ▪ Q2

Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city's sanitary sewer system, the storm water and sewage flow together to the Fremont Wastewater Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant's capacity, and the overflow bypasses the FWTP. The untreated overflow is discharged into Fremont Creek along with the treated waste.

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Fremont's area. | | The FWTP typically treats $5{,}000$ m^3 of domestic sewage per day. | | The FWTP has the capacity to treat $10{,}000$ m^3 of combined sewage and storm water per day. |
(b) Calculate the volume of water (in m^3) that runs off the Shoppes at Fremont parking lot after a 5 cm rainfall event. Assume that all the water that falls on the parking lot runs off.

Question 2

2014 ▪ Q2

Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city's sanitary sewer system, the storm water and sewage flow together to the Fremont Wastewater Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant's capacity, and the overflow bypasses the FWTP. The untreated overflow is discharged into Fremont Creek along with the treated waste.

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(c) Calculate the volume of storm-water runoff (in m^3) generated in all of Fremont by the 5 cm rainfall event. Assume that only the impervious surfaces generate runoff.

Question 2

2014 ▪ Q2

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(d) Assume that all the runoff that you calculated in part (c) is captured by the storm sewers in one day. Calculate the volume of untreated water (in m^3) that bypasses the plant as a result of the storm. (Note that the plant still receives $5{,}000$ m^3 of domestic sewage per day.)

Question 2

2014 ▪ Q2

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(e) Describe TWO ways that the volume of storm-water runoff can be reduced.

Question 2

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(f) Describe one environmental problem (other than pollution from runoff and from untreated sewage) that results from having extensive paved areas.