

2024



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 2

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Free-Response Question 2

- Scoring Guidelines**
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Question 2: Analyze an Environmental Problem and Propose a Solution **10 points**

(a) Based on the data in the graph, **identify** the year with the highest percentage of forest. **1 point**

- 1700

(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. **1 point**

Accept one of the following:

- The percentage/amount of wild grasslands has decreased, and the percentage/amount of grazing (land) has increased.
- The two variables have an inverse relationship.

(c) **Identify** an environmental problem associated with overgrazing by livestock. **1 point**

Accept one of the following:

- Loss of vegetation
- Soil erosion
- Desertification
- Sedimentation/turbidity in waterways
- Soil compaction

(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. **1 point**

- The hypothesis is refuted/disproved/not supported. The percentage of forest has decreased, so the amount of photosynthesis/carbon sequestration has decreased.

(e) **Describe** a water-related environmental problem associated with urbanization. **1 point**

Accept one of the following:

- Increased runoff/flooding because urban areas have more impermeable surfaces.
 - Decreased groundwater/saltwater intrusion because urban areas have many people/groundwater is overused.
 - Increased water pollution because precipitation/runoff can carry contaminants/pollutants/waste.
 - Destruction of aquatic habitats from increased development/land use changes.
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- (f)** **Describe** a potential response to mitigate the environmental problem identified in part (e). **1 point**

Accept one of the following:

Environmental problem identified in part (e)	Potential response to mitigate environmental problem
Increased runoff/flooding	<ul style="list-style-type: none"> • Use permeable road/parking lot materials. • Set aside green spaces/parks/conservation areas. • Construct green roofs/rain gardens/storm water retention ponds/basins.
Decreased groundwater/saltwater intrusion	<ul style="list-style-type: none"> • Use permeable road/parking lot materials. • Establish groundwater conservation/management plans. • Set aside green spaces/parks/conservation areas in recharge zones. • Construct green roofs/rain gardens/storm water retention ponds/basins.
Increased water pollution	<ul style="list-style-type: none"> • Encourage walking/biking or other methods of transportation. • Reduce use of home pesticides/fertilizers. • Reduce use of road salts/de-icing chemicals • Pick up trash and litter along waterways. • Dispose of toxic chemicals (for example, used oil and household cleaners).
Destruction of aquatic habitats from increased development/land use changes	<ul style="list-style-type: none"> • Create conservation areas/preserves/wetlands to protect aquatic habitats. • Restore degraded aquatic habitats.

- (g)** **Explain** why there are fewer bobcats present on the farmland now compared to several decades ago. **1 point**

Accept one of the following:

- Loss of forest habitat has led to a decrease in resources/food/shelter/ mates/migration.
- Trapping/hunting has reduced the bobcat population.

(h) Describe a disadvantage of introducing only a small population of bobcats. **1 point**

Accept one of the following:

- Small populations have lower genetic diversity.
- Genetic bottlenecks can lead to inbreeding/passing on negative traits.
- Small populations are more vulnerable to diseases/disturbances like wildfire.
- Small populations do not control small mammals/pests as well as large populations.
- Small populations are less likely to survive.

(i) Propose a solution to improve the chances that the bobcat reintroductions will be successful in reestablishing wild populations. **1 point**

Accept one of the following:

- Increase connectivity/build habitat corridors (so bobcats can safely mate/find food/build dens).
- Restore/reforest/preserve areas of bobcat habitat.

(j) Justify the solution proposed in part (i) by describing an additional advantage, other than reestablishing the bobcat population near the farms. **1 point**

Accept one of the following:

Solution proposed in part (i)	Justification of the proposed solution by stating an advantage
Increase connectivity/build habitat corridors (so that bobcats can safely mate/find food/build dens)	<ul style="list-style-type: none"> • Habitat corridors can be used by other species. • Habitat corridors would increase biodiversity/population of other species. • Habitat corridors can attract other species that might be beneficial for farmers (such as predators of pests and/or pollinator species). • Habitat corridors could help decrease road kills/the frequency of car accidents with wildlife.
Restore/reforest/preserve areas of bobcat habitat	<ul style="list-style-type: none"> • Restored habitat can be used by other species. • Restoration/reforestation/preservation could increase diversity/improve air quality/improve water quality. • An increase in the number of trees will improve aesthetic value/enhance tourism/reduce erosion/serve as a carbon sink.

Total for question 2 10 points

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- a) The year with the highest percentage of forest was 1700.
- b) From 1700 to 1950, much of the wild grasslands were converted to grazing areas. This is ~~the~~ due to the increase in population, meaning more livestock is needed meaning more land is needed for grazing. Wild grasslands rapidly decreased from 1700 to 1950, while grazing land rapidly increased.
- c) An environmental problem with overgrazing by livestock is soil erosion. Plants are important to prevent soil erosion. When land becomes overgrazed, the plants are dead and the roots cannot hold the soil together, resulting in erosion.
- d) The student's ~~hypothesis~~ hypothesis is ~~refuted~~ ~~is~~ refuted based on the data. From 1700 to ~~the~~ 2018, the amount of land that was forests has decreased. This would lead to an increase in atmospheric carbon dioxide. This is due to the fact that forests act as carbon sinks, holding ~~carbon~~ and storing carbon dioxide. With less forests, the stored carbon is released into the atmosphere. In addition, with less trees and forests, less photosynthesis is occurring, meaning less carbon dioxide is being taken out of the air.
- e) A water-related environmental problem ~~is~~ associated with urbanization is runoff. ~~Since cities are~~ With urbanization, much of the ground is covered in asphalt. Water cannot penetrate through this, leading to increased runoff, especially when it rains. This runoff collects pollutants, which damage ecosystems.

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Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

f) A potential response is to add more green spaces to the city. By doing this, the water has a place to enter the ground from and penetrate into the soil. This would help reduce the runoff issue. ~~Another potential response is to have green top roofs. These roofs~~

g) There are fewer bobcats present now due to the extensive habitat loss they experienced. With much less habitat, the bobcats carrying capacity likely greatly decreased. This is due to the fact that with much less habitat, the resources bobcats need to survive was greatly decreased, meaning less bobcats can live in the area.

h) A disadvantage of introducing only a small population of bobcats is that there would be little genetic diversity over time.

i) A solution would be to connect the patches of forest. By connecting the patches, all the different bobcats could mate, increasing genetic diversity.

j) Another advantage is that by connecting the patches of forest, it will increase biodiversity. By making the patches of forest connected, there is more habitat available. This will help increase the biodiversity of the surrounding area. In addition, it could help prevent erosion.

Page 3

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Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

a) The year with the highest percentage of forest was 1700.

b) From 1700 to 1950, as the percentage of habitable land used for grazing increased, the percentage of habitable land that was wild grassland tended to decrease. For instance, the use of habitable land for grazing increased from about ~~2%~~ 6% in 1700 to about 30% in 1950; however, ~~the use of~~ ~~habitable~~ land that was wild grassland decreased from about 38% in 1700 to about 13% in 1950.

c) Overgrazing by livestock can lead to soil erosion.

d) This hypothesis is refuted based on the data in the graph, because the percentage of habitable land that was forest decreased from about 52% in 1700 to about 38% in 2018. Decreased levels of forest would lead to higher atmospheric carbon dioxide concentrations rather than lower concentrations because forests are a carbon ~~sink~~ sink.

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Question 1

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Question 3

Begin your response to each question at the top of a new page. Do not skip lines.

e) A water related environmental ~~problem~~ problem associated with urbanization is ~~water pollution~~ water pollution in nearby bodies of water.

f) A potential response to the pollution of nearby bodies of water is the implementation of wastewater management facilities.

g) There are fewer bobcats present on the farmland now compared to several decades ago because the farmers changed the habitat to farmland, which was outside of bobcats' range of tolerance. In other words, the habitat was no longer suitable for the needs of bobcats.

h) A disadvantage of only introducing a small population of bobcats is that, with lower numbers and less genetic diversity, the population will not be very resistant to sudden changing conditions and may die off.

i) To improve the chances that the bobcat reintroductions will be successful, the conservation group could establish wildlife corridors between the patches of forested habitat left. This would assist the bobcat populations by providing more habitat and resources

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Question 1



Question 2



Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

as well as connecting the small bobcat groups in each patch.

j) An additional advantage to wildlife corridors other than reestablishing bobcat populations is improving biodiversity in the area, as the species in the previously isolated patches are connected to one another.

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Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- a) ~~1700s~~ 1700s is the year with the highest percentage of forest.
- b) The relationship between the land use changes in the wild grasslands & grazing from 1700 to 1950 shows a ~~an~~ increase in grazing every year on the data, but ~~as~~ as the grazing increases the wild grasslands decrease.
- c) An environmental problem that is associated with overgrazing by livestock is not having any grass & plants for your livestock until it grows back which can take time.
- d) This hypothesis is refuted because in the graph it does not talk about or give you information on atmospheric carbon dioxide concentration.
- e) A water related environmental problem associated with urbanization is making sure the water is clean & that the stream / flow can make it through the urban area.
- f) A potential response to mitigate the environmental problem could be having the water run through a purifier so that once the water reaches the urban area, the water is cleaner and safer to drink.
- g) There are fewer bobcats present on the farmland now, because the forest is all cleared out leaving nothing for the bobcats to eat or want to live in.
- h) A disadvantage of introducing only a small number of bobcats, ~~the case~~ is that they may not be able to fully start over in ~~a~~ a new environment because they are missing

Page 4

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Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

their large population.

i) I think a solution to improve the chances of the bobcats reintroduction will be successful will be if you start off by adding in a couple of them, and everyday adding a couple more so ~~at one point~~ at the end all of the bobcats will be together and liking the reestablished wild population.

j) An additional advantage of reintroducing the bobcats to a new wild population, is being able to keep an eye out on the bobcats and knowing that they won't leave and kill your livestock or harm any of your crops.

Page 5

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Question 2

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

The intent of this question was for students to demonstrate their ability to interpret a graph of land use changes from 1700–2018 and consider the implications of those changes in different scenarios. This question focused on broad topics such as the carbon cycle, water resources, and ecosystem dynamics. Concepts such as photosynthesis, urbanization, the hydrologic cycle, water pollution, conservation, and wildlife population dynamics were relevant.

In parts (a–c) students were asked to interpret the graph showing land use change over time and identify the year with the highest percent of forest cover, describe the relationship between wild grassland and grazing land uses from 1700–1950, and identify an environmental problem associated with overgrazing [Science Practice 5, Data Analysis and Topics 5.4 Impacts of Agricultural Practices, 4.3 Soil Formation and Erosion and 9.10 Human Impacts on Biodiversity].

In part (d) students were asked to evaluate a hypothesis about atmospheric carbon dioxide concentrations over time and explain whether the hypothesis is supported or refuted. The students needed to use information from the graph and discuss the hypothesis in the context of land use change and photosynthesis or the carbon cycle [Science Practice 5 Data Analysis and Topics 5.2 Clearcutting, 1.4 The Carbon Cycle, and 9.4 Increases in the Greenhouse Gases].

In parts (e) and (f) students were expected to describe an environmental problem related to water that is caused by urbanization and described a response to mitigate the problem [Science Practice 7 Environmental Solutions and Topics 1.7 The Hydrologic Cycle, 5.10 Impacts of Urbanization, and 5.13 Methods to Reduce Urban Runoff].

In parts (g) and (h) students were required to explain why there are fewer bobcats present on farmland than in the past and described a disadvantage of introducing a small population of bobcats [Science Practice 1 Concept Explanation and Topics 2.3 Island Biogeography, 3.4 Carrying Capacity, 3.5 Population Growth and Resource Availability, and 9.10 Human Impacts on Biodiversity].

In part (i) students were asked to propose a solution to improve the likelihood of successfully reintroducing bobcats and reestablishing a wild population. In part (j), students were asked to justify their proposed solution by describing an additional advantage of the solution that is not related to reestablishing bobcats [Science Practice 7 Environmental Solutions and Topics 2.3 Island Biogeography, 3.4 Carrying Capacity, 3.5 Population Growth and Resource Availability, and 9.10 Human Impacts on Biodiversity].

Sample: 2A

Score: 10

1 point was earned in part (a) for identifying “1700.” 1 point was earned in part (b) for describing that “Wild grasslands rapidly decreased ... while grazing land rapidly increased.” 1 point was earned in part (c) for identifying “soil erosion.” 1 point was earned in part (d) for explaining “The ... hypothesis is refuted ... the amount of land that was forests has decreased. This ... lead to an increase

Question 2 (continued)

in atmospheric carbon dioxide. This is due to the fact that forests act as carbon sinks.” 1 point was earned in part (e) for describing “ground is covered in ... asphalt ... Water cannot penetrate through this. Leading to increased runoff.” 1 point was earned in part (f) for describing “add more green spaces.” 1 point was earned in part (g) for explaining “with much less habitat, the resources bobcats need to survive was greatly decreased.” 1 point was earned in part (h) for describing “there would be little genetic diversity.” 1 point was earned in part (i) for proposing “connect the patches of forest.” 1 point was earned in part (j) for justifying “it will increase biodiversity.”

Sample: 2B**Score: 7**

1 point was earned in part (a) for identifying “1700.” 1 point was earned in part (b) for describing “percentage of habitable land used for grazing increased, the percentage of habitable land that was wild grassland tended to decrease.” 1 point was earned in part (c) for identifying “soil erosion.” 1 point was earned in part (d) for explaining “hypothesis is refuted ... Decreased levels of forest would lead to higher atmospheric carbon dioxide concentrations ... because forests are a carbon sink.” No point was earned in part (e). No point was earned in part (f). No point was earned in part (g). 1 point was earned in part (h) for describing “less genetic diversity.” 1 point was earned in part (i) for proposing “establish wildlife corridors.” 1 point was earned in part (j) for justifying “improving biodiversity in the area.”

Sample: 2C**Score: 3**

No point was earned in part (a). 1 point was earned in part (b) for describing that “as the grazing increases the wild grasslands decrease.” 1 point was earned in part (c) for identifying “not having any grass & plants.” No point was earned in part (d). No point was earned in part (e). No point was earned in part (f). 1 point was earned in part (g) for explaining “the forest is all cleared out leaving nothing for the bobcats to eat.” No point was earned in part (h). No point was earned in part (i). No point was earned in part (j).