

2023

AP[®]



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 2

Inside:

Free-Response Question 1

- Scoring Guidelines**
- Student Samples**
- Scoring Commentary**

Question 1: Design an Investigation**10 points**

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- (a) Based on the data in the graph, **identify** the average number of species found in technically restored piles 16–25 years after restoration started. **1 point**

Accept one of the following:

- 8
- 9

-
- (b) Based on the data in the graph, **describe** the relationship between the average number of species and age of the spontaneous restoration piles. **1 point**

Accept one of the following:

- The number of species increases with age of piles.
- The average number of species increases as the years since restoration increase.
- There is a direct/positive relationship/correlation between the two variables.

-
- (c) Using the data in the graph, **make a claim** that supports or refutes the hypothesis that the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles. **1 point**

- The spontaneously restored areas support more plant species, which provides habitat, food, and/or shelter for animal species.

-
- (d) **Describe** a characteristic of a plant species that would have been present in the spontaneous restoration piles from years 1 to 5. **1 point**

Accept one of the following:

- A description of a characteristic of pioneer or generalist species such as:
 - Able to grow with little/poor soil
 - Able to grow in soil with low organic matter/low nutrients
 - Able to grow in full sunlight
 - Able to colonize an area quickly
 - Able to grow in a wide range of habitats

-
- (e) **Explain** how the return of plant life would have been altered in the spontaneous piles if the mining had taken place in the tundra rather than in temperate forests. **1 point**

Accept one of the following:

- It would be slower because it is colder/growing season is shorter/there is less rain.
 - It would include plants that are native to the tundra not the temperate forests.
 - It would reflect the lower species diversity found in the tundra.
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- (f)** **Identify** the scientific question for the investigation. **1 point**
- Accept one of the following:
- Does the presence of vegetation affect the amount/appearance of runoff?
 - Does the presence of soil covering affect the amount/appearance of runoff?
 - Does the presence of different materials affect the amount/appearance of runoff?
-
- (g)** **Identify** a dependent variable in the experiment. **1 point**
- Accept one of the following:
- Water collected
 - Runoff volume
 - Water appearance
-
- (h)** **Explain** how the results of the experiment would likely have been altered if the soil had contained a higher percentage of sand, which has the largest particle size of the components of loam. **1 point**
- Accept one of the following:
- The amount/volume of water collected/runoff would decrease because more water would infiltrate into the soil.
 - The water collected could be clearer as the sand particles settle faster.
-
- (i)** **Describe** one ecological impact that could result from the drainage from mine waste into nearby waterways. **1 point**
- Accept one of the following:
- Acidic/low pH runoff could be outside the range of tolerance of some species.
 - Acidic/low pH runoff could lead to disease/death of some species.
 - Heavy metals in runoff can accumulate/biomagnify in wildlife leading to disease/death.
 - Soils may run off into nearby waterways and could increase turbidity/sedimentation outside the range of tolerance of some species.
 - Soils may run off into nearby waterways and could increase turbidity/sedimentation leading to disease/death.
-

(j) **Describe** one strategy to reduce the drainage from mine waste into waterways downstream from mines. **1 point**

Accept one of the following:

- Vegetation can be planted, reducing sediments/heavy metals flowing into streams.
- Mine waste can be covered with soil/plastic/concrete.
- Mine waste can be covered with lime or other alkaline substances.
- Mine waste can be removed to another location that cannot run off into waterways.
- Water can be diverted to avoid contact with mining waste.
- Contaminated water can be treated to reduce acidity.
- Contaminated water can be treated to remove heavy metals.
- Mine waste can be disposed underwater.
- Mine waste drainage can be diverted into holding basins.

Total for question 1 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.

1(a) 9 species

(b) As the age increased, the average number of species increased.

(c) Spontaneously restored piles ~~increase~~ have an increase in animal species over time because animals feed off of ~~the~~ plants, so when the plant species increase, so do animal species, whereas since technically restored piles don't have as many plant species, they won't have as many animal species either.

(d) A plant would have been small as it wouldn't have had time to grow into a bigger plant in the 1-5 year time span.

(e) the return of plant life would have taken longer since the cold temperatures and harsh climate of the tundra would have only allowed ^{a few} sparse plants to grow, and only in the summer, since in winter the ground ^{too} would be frozen for plants to grow.

(f) what is the most efficient ^{and effective} ~~material~~ material when trying to limit runoff.

(g) mL of water collected.

(h) the water collected from all three trays would have decreased because the higher percentage of sand would allow for more water infiltration into the soil since the particles are bigger.

(i) increased levels of lead and mercury from the mine drainage could ~~bioaccumulate in~~ biomagnify in organisms in the ecosystem, resulting in ~~lead~~ being in all trophic levels, causing health problems such as brain damage in organisms.

(j) establishing stretches of permeable surfaces like green spaces between water sources and mines would allow the water to infiltrate into the soil.

Page 2

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

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 average number of species found in technically restored piles 16-25 years after restoration started was 8.

(b) As more years passed, the number of plant species found in spontaneous restoration piles increased. The increase was steady, and about 2-4 new species were found every 5 years.

(c) This hypothesis is correct, after 35 years the average number of species in spontaneous piles was about double the number in technical piles. Technical restoration piles had an average of 8 species while spontaneous piles had 16-17 species.

(d) A plant found in a spontaneous restoration pile from years 1-5 would have been easily adaptable ~~since~~ since it was so early on in the process.

(e) The return of plant life would've taken longer in the Tundra because plants can't grow as easily in those conditions. Plants wouldn't have much nutrients, sunlight, or ~~the~~ warm weather, making it hard for them to grow.

(f) ~~Does wheatgrass or small wood chips help limit runoff?~~ Does wheatgrass or small wood chips help limit runoff?

(g) The dependent variable is ~~the dependent variable~~ what mixture is inside of the different trays.

Page 2

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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.

(h) If ^{more} sand was used, more water would be able to pass through and be collected. This is because sand is more permeable and has smaller particles than soil or clay.

(i) One ecological impact that could result from runoff is eutrophication in nearby waterways. Excess nutrients may be carried into the water, causing eutrophication which causes algae blooms.

(j) One strategy would be to add more vegetation in between the mines and waterways. This vegetation would soak up a lot of the runoff before it reaches the waterways.

Page 3

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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) There was an average of 8 plant species found in technically restored piles 10-25 years after restoration.
- B) The average number of plant species in spontaneous restoration piles. Slightly increases as the age increases.
- C) I agree with the hypothesis because the spontaneous restoration piles contain a greater average of plant species which would increase biodiversity and attract more animals to those piles to use the plants as food sources. The technically restoration piles don't have as much plants, so as a result, it wouldn't attract as many animals.
- D) An example of a characteristic would be that it's roots wouldn't be strongly implanted in the ground due to it's short time being there.
- E) The return of plant life would've taken longer if it was in the tundra due to the change in environment like water/precipitation and the temperature.
- F) Does the particles in soil affect the amount and appearance/quality of runoff water?
- G) What the trays of soil were each seeded with
- H) The experiment would've been altered because sand has a larger particle size and high porosity so the water would've circulated through it faster and more easily, leading to more water being collected

Page 2

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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.

- i) one ecological impact would be that the nearby waterways would be negatively impacted and polluted to be worse quality ~~the~~ affecting humans and animals, that use that water's healths.
- j) one strategy would be ~~the~~ to monitor and regulate the mining companies from adding the mine waste to those waterways.

Page 3

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

Question 1

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 diagram representing the number of plant species in various overburden piles and to identify components of a scientific experiment. Students were asked to explain concepts of ecological biodiversity and succession and their relationship to various biomes. Students were also asked to explain how soil composition may affect runoff from soil and to describe ecological impacts on mine waste on local waterways.

In part (a) students were asked to demonstrate their ability to read data provided in a graph [Science Practice 5 Data Analysis]. In part (b) students were asked to describe the relationship between the age of overburden piles and number of plant species [Science Practice 5 Data Analysis].

In part (c) students were asked to interpret experimental data and results and to make a claim in relation to a given a hypothesis addressing the relationship between the number of plant species and animal species found in overburden piles [Science Practice 5 Data Analysis].

In part (d) students were asked to describe a characteristic of plant species that may be present in recently constructed waste piles [Science Practice 1 Concept Explanation and Topic 2.7 Ecological Succession and 2.4 Ecological Tolerance]. In addition, in part (e) students were asked to relate changes in succession to terrestrial biomes in which they take place [Science Practice 1 Concept Explanation and Topic 1.2 Terrestrial Biomes].

In part (f) students were asked to identify a scientific question from the description of an experiment on how soil covering can affect water runoff [Science Practice 4 Scientific Experiments and Topic 4.2 Soil Formation and Erosion]. Part (g) asked students to identify the dependent variable in the scientific experiment [Science Practice 4 Scientific Experiments]. In part (h) students were asked to explain how changing the composition of the soil in the experiment may have changed the results in the experiment [Science Practice 4 Scientific Experiments and Topic 4.3 Soil Composition and Properties].

In part (i) students were asked to describe an ecological impact of drainage from mine waste into nearby waterways [Science Practice 1 Concept Explanation and Topic 8.2 Human Impacts on Ecosystems]. Part (j) asked students to describe a strategy to reduce mine waste drainage into waterways [Science Practice 7 Environmental Solutions and Topic 8.2 Human Impacts on Ecosystems].

Sample: 1A

Score: 9

One point was earned in part (a) for identifying “9” as the average number of species. One point was earned in part (b) for describing, “As the age increased, the average number of species increased.” One point was earned in part (c) for making a claim that “spontaneously restored piles have an increase in animal species over time because animals feed off of plants, so when the plant species increase, so do

Question 1 (continued)

animal species.” No point was earned in part (d). One point was earned in part (e) for explaining “the return of plant life would have taken longer since the cold temperatures ... of the tundra.” One point was earned in part (f) for identifying “what is the most efficient and effective material when trying to limit runoff” as the scientific question for the investigation. One point was earned in part (g) for identifying “water collected.” One point was earned in part (h) for explaining “the water collected ... would have decreased because the higher percentage of sand would allow for more water infiltration into the soil since the particles are bigger.” One point was earned in part (i) for describing “increased levels of lead ... causing health problems such as brain damage.” One point was earned in part (j) for describing “establishing stretches of permeable surfaces like green spaces between water sources and mines would allow the water to infiltrate into the soil” as a strategy to reduce the drainage from mine waste.

Sample: 1B**Score: 5**

One point was earned in part (a) for identifying “8” as the average number of species. One point was earned in part (b) for describing, “As more years passed, the number of plant species found in spontaneous restoration piles increased.” No point was earned in part (c). No point was earned in part (d). One point was earned in part (e) for explaining “The return of plant life would’ve taken longer in the Tundra because plants ... wouldn’t have much ... sunlight, or warm weather.” One point was earned in part (f) for identifying “Does wheatgrass or small wood chips help limit runoff?” as the scientific question for the investigation. No point was earned in part (g). No point was earned in part (h). No point was earned in part (i). One point was earned in part (j) for describing “add more vegetation in between the mines and waterways. This vegetation would soak up a lot of the runoff” as a strategy to reduce the drainage from mine waste.

Sample: 1C**Score: 3**

One point was earned in part (a) for identifying “8” as the average number of species. One point was earned in part (b) for describing, “The average number of plant species in spontaneous restoration piles ... increases as the age increases.” One point was earned in part (c) for making a claim that “the spontaneous restoration piles contain greater average of plant species ... and attract more animals ... to use the plants as food sources.” No point was earned in part (d). No point was earned in part (e). No point was earned in part (f). No point was earned in part (g). No point was earned in part (h). No point was earned in part (i). No point was earned in part (j).