

2024



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# AP<sup>®</sup> 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)** **Identify** the ecological change over time illustrated in the diagram. **1 point**

- Primary Succession

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**(b)** **Identify** the stage in which pioneer species first appear. **1 point**

- II/2

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**(c)** **Describe** how soil forms from stage II to stage III. **1 point**

Accept one of the following:

- Wind/rain/weather can erode the rock/parent material.
- Wind/rain can break down rocks.
- Pioneer species (lichen/algae/fungi) die off adding small amounts of organic material.
- Pioneer species (lichens/algae/fungi) help break down rocks.

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**(d)** **Identify** a cultural ecosystem service that may be provided by a mature forest. **1 point**

Accept one of the following:

- Recreation
- Aesthetic enjoyment
- Spiritual use
- Ecotourism
- Education

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**(e)** **Identify** a testable hypothesis being investigated by the researchers. **1 point**

Accept one of the following:

- The removal of trees/clear-cutting will lead to an increase/decrease in water quality (temperature/turbidity/dissolved oxygen).
- The removal of trees/clear-cutting will have no effect on water quality (temperature/turbidity/dissolved oxygen).
- Water quality (temperature/turbidity/dissolved oxygen) will increase/decrease between stations.
- Water quality (temperature/turbidity/dissolved oxygen) will not change between stations.

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**(f)** **Identify** the independent variable in the experiment. **1 point**

Accept one of the following:

- Presence or absence of clear-cutting
  - Intact or clearcut forest
  - Location of stream monitoring stations
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**(g)**      **Describe** the purpose of forest A in the experiment. **1 point**

Accept one of the following:

- Forest A/A/It is included so the researchers can compare the temperature/turbidity/water quality in clear-cut areas (forest B) to intact areas.
- Forest A/A/It acts as a control so researchers can compare intact areas/Forest A to clear-cut areas/Forest B.

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**(h)**      **Explain** why the water temperature might change because of clear-cutting trees in forest B. **1 point**

Accept one of the following:

- Water temperature will increase because there will be no/fewer trees to block the sunlight.
- Water temperature will increase because there will be additional sediment from erosion.
- Water temperature will increase because more sunlight will reach the water surface.

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**(i)**      **Explain** why an indicator of water quality other than temperature could be altered by the golf course in forest B. **1 point**

Accept one of the following:

- There could be a decrease in dissolved oxygen because fertilizer runoff leads to algal blooms/eutrophication.
- There could be a decrease in sedimentation/turbidity because the grass will decrease erosion compared to the clear-cut land.
- There could be an increase in nitrates/phosphates due to fertilizer runoff resulting in algal growth/bloom.

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**(j)**      **Explain** how the aquatic organisms living in the lake illustrated in the diagram of forest B are likely to be affected by the new golf course. **1 point**

Accept one of the following:

- Aquatic organisms would die off from a lack of oxygen created by the decomposition of algae/eutrophication.
- Aquatic organisms would survive at a higher rate because there is less sediment to suffocate them/clog their gills.
- Aquatic organisms would die off due to increased toxicity from pesticide runoff.

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**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) The ecological change happening over time is the populating of a new area by pioneer species who lead the way for other organisms to populate it, growing in diversity.

b) The first pioneer species appear in stage II.

c) Lichens break down rock and other ~~organic~~ material, forming soil into small fragments, combining with organic material to form soil. Other plants then can move in and join the process.

d) Mature forests provide cultural ecosystem services by providing campgrounds ~~where~~ and natural areas which hunters campers, and others use.

e) ~~Clear-cutting~~ surrounding forests will result in a ~~higher sediment level and~~ lower water quality ~~in~~ a forest watershed.

f) The independent variable is the presence of the forest, whether it is clear-cut or not.

g) Forest A serves to be compared to forest B in how its presence correlates to the water quality of a nearby watershed. The researchers can measure water variables where there is no clear-cutting.

h) Water temperature might change due to the clear-cutting of forest B because it would allow more solar energy to hit the water, increasing heat. The forest provides tree cover and shade to the river, and without it the water will receive more sun light and solar energy. This would increase the water's temperature.

Page 2

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

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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) The level of chemicals and nutrients could increase in the water ~~as~~ as a result of the golf course. Golf courses often use a lot of herbicides and fertilizer to maintain their flawless, green ~~fields~~ courses. Heavy watering and runoff will bring chemicals and nutrients used on the soil and grass and into the river, decreasing water quality.

j) Aquatic organisms living in the lake could experience an algal bloom and major die-off as a result of the golf course. Nutrients that runoff from the golf course's soil and grass and into the river would collect in the lake, resulting in eutrophication. This would lead to a major increase in algae populations called an algal bloom which blocks sunlight from hitting aquatic photosynthesizers, dropping the oxygen levels. Then, when the algae die, microorganisms ~~decompose~~ ~~the algae~~ decompose the algae, using up the rest of the oxygen and killing most life in the lake.

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.

d) we can see how biodiversity is increasing and net productivity increases

b) Pioneer species first appear in stage II

c) Lichens break down the rocks and provide nutrients to the soil when they die. The soil in stage III is composed of rock debris and lichen remains that have been decomposed

~~d) A native forest could be a place for campers to travel, a location for a park~~

A native forest could be a place for campers to travel or a location for a park

e) The testable hypothesis being investigated is whether the removal of trees affects the water quality of nearby water ways

f) The independent variable is whether the forest is intact or clear-cut

g) Forest A serves as a control group

h) Since there are no trees to provide shade in forest B,

Page 2

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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.

h) ~~contd.~~ the waterway will be exposed to more sunlight, raising the water temperature

i) Runoff from the grass on the golf course could contain salt, increasing the salinity of the waterway when they come into contact

j) The aquatic organisms are not likely used to the increased salinity of the water coming from the river, so many organisms could die due to the sudden change in environmental conditions

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) The ecological change over time illustrated in the diagram is primary succession.
- b) The pioneer species first appears in stage II.
- c) Soil forms between stages II and III by the introduction of nutrients from lichens.
- d) A cultural ecosystem service that may be provided by a mature forest is mutualism - the trees of the forest protect wildlife via shelter, and said wildlife protects trees via preventing invasive species.
- e) A testable hypothesis would be: If trees are removed, then water quality will decrease.
- f) The independent variable in this experiment is the flow of water.
- g) The purpose of Forest A is to demonstrate a possible relationship between an intact forest and the quality of river water.
- h) The water temperature might change in Forest B due to clearcutting because there are no more trees to block winds from the river, leading to a decrease in temperature.
- i) An indicator of water quality could be altered by the golf course in Forest B by depriving the river of nutrients it had from tree roots.
- j) Aquatic organisms will be affected by the new golf course in Forest B by a decrease in population due to the aforementioned deprivation of nutrients.

Page 2

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## 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 an understanding of primary succession and the formation of soil during primary succession. Students also needed to demonstrate the experimental design aspects of an independent variable, a control, and writing a testable hypothesis in the context of clear-cut and intact forests along water quality.

In parts (a–d), students were asked to use a diagram to identify the type of succession and the stage at which pioneer species appeared [Science Practice 2 Visual Representations and Topic 2.1 Ecological Succession]. Students were also asked to describe how soil formation happened during primary succession [Science Practice 1 Concept Explanation and Topics 2.1 Ecological Succession and 4.2 Soil Formation and Erosion]. Finally, students were asked to identify a cultural ecosystem service that may be provided by a mature forest [Topic 2.2 Ecosystem Services].

In parts (e–h), students were asked to identify and describe aspects of an experimental design that compared forested and clear-cut areas [Science Practice 4 Scientific Experiments]. Students were also asked to explain how clear-cutting would impact water temperature [Science Practice 1 Concept Explanation and Topic 5.2 Clearcutting].

In parts (i–j), students were asked to explain how water quality (other than temperature) and aquatic organisms would be impacted if a golf course were built on clear-cut land. [Science Practice 1 Concept Explanation and Topics 8.2 Human Impacts on Ecosystems and 8.5 Eutrophication].

### Sample: 1A

#### Score: 8

No point was earned in part (a). 1 point was earned in part (b) for identifying “stage II.” 1 point was earned in part (c) for describing “Lichens break down rock.” 1 point was earned in part (d) for identifying “providing campgrounds.” 1 point was earned in part (e) for identifying “Clear-cutting surrounding forests will result in a lower water quality.” 1 point was earned in part (f) for identifying “the presence of the forest, whether it is clear-cut or not.” 1 point was earned in part (g) for describing “forest A serves to be compared to forest B ... can measure water variables where there is no clear-cutting.” 1 point was earned in part (h) for explaining “The forest provides tree cover and shade to the river, and without it the water will receive more sun light and solar energy. This would increase the water’s temperature.” No point was earned in part (i). 1 point was earned in part (j) for explaining “Nutrients that runoff ... resulting in eutrophication. Then when algae die, microorganisms decompose the algae, using up the rest of the oxygen and killing most life in the lake.”

### Sample: 1B

#### Score: 5

No point was earned in part (a). 1 point was earned in part (b) for identifying “stage II.” 1 point was earned in part (c) for describing “Lichens break down the rocks.” 1 point was earned in part (d) for identifying “a place for campers.” No point was earned in part (e). 1 point was earned in part (f) for identifying “whether the forest is intact or clear-cut.” No point was earned in part (g). 1 point

### Question 1 (continued)

was earned in part (h) for explaining “there are no trees to provide shade ... the waterway will be exposed to more sunlight, raising the water temperature.” No point was earned in part (i). No point was earned in part (j).

**Sample: 1C**

**Score: 3**

1 point was earned in part (a) for identifying “primary succession.” 1 point was earned in part (b) for identifying “stage II.” No point was earned in part (c). No point was earned in part (d). 1 point was earned in part (e) for identifying “If trees are removed then water quality will decrease.” 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).