

2024



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# AP<sup>®</sup> Environmental Science

## Scoring Guidelines Set 2

**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**

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

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

- 1700

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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. **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.

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**(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

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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. **1 point**

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

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

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

**Total for question 2 10 points**

**Question 3: Analyze an Environmental Problem  
and Propose a Solution Doing Calculations****10 points**

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**(a) Identify** a typical type of plant that would be used in a desert-tolerant landscaping. **1 point**

Accept one of the following:

- Cactus/cacti
- Succulent plants
- Drought-tolerant plants

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**(b) Justify** the removal of landscaping and lawns that use grasses not native to the local area **1 point**  
by describing an additional advantage, other than reducing the amount of water needed for irrigation.

Accept one of the following:

- Native desert plants support habitat/provide food for local/native wildlife.
- Less mowing leads to decreased yard maintenance time/costs.
- Desert tolerant plants need less fertilizer/pesticide.
- Creates jobs for landscapers to remove/replace turf.
- Decreased use of gas-powered yard tools reduces air pollution/noise pollution/gasoline consumption.

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**(c) Describe** how a prescribed burn would reduce the severity and spread of forest fires. **1 point**

Accept one of the following:

- Prescribed burns/they remove undergrowth, decreasing fuel/flammable material.
- Prescribed burns/they thin forests/create a fire break, reducing the spread of fires.

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**(d) Describe** a disadvantage of a prescribed burn in a forested ecosystem. **1 point**

Accept one of the following:

- Reduces habitat for wildlife/can harm or displace animals.
  - Releases carbon dioxide, which contributes to climate change.
  - Releases particulates/air pollutants, which worsens air quality.
  - Runoff following a prescribed burn can degrade water quality.
  - Reduces competition, which helps invasive species spread/expand.
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**(e)** **Calculate** the number of million acre-feet (maf) of water currently in Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate number of million acre-feet (maf) of water currently in the lake:

Accept one of the following:

- $25.16 \text{ maf} \times 36\%$
- $25.16 \times 0.36$

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One point for the correct calculation of the number of million acre-feet (maf) of water currently in the lake: **1 point**

Accept one of the following:

- 9.0576
- 9.058
- 9.06
- 9.1

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**Total for part (e)** **2 points**

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**(f)** The watershed of the Upper Colorado River contributes an average of 9.60 maf of water to Lake Powell annually. The melted mountain snow found in the watershed contributes 50% of the average river flow into Lake Powell. In 2021, the river flow was 36% of the annual average. Assuming that all resources to that flow contributed with the same proportions as in prior years, **calculate** the amount of water (in million acre-feet) that was contributed by the melted mountain snow in 2021. **Show** your work. **1 point**

One point for the correct setup to calculate amount of water in million acre-feet that was contributed by the melted mountain snow:

Accept one of the following:

- $9.60 \text{ maf} \times 36\% \times 50\%$
- $9.60 \text{ maf} \times 0.36 \times 0.5$
- $9.60 \times 0.36 \times 0.5$

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One point for the correct calculation of the amount of water in million acre-feet: **1 point**

Accept one of the following:

- 1.728
- 1.73
- 1.7

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**Total for part (f)** **2 points**

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- (g) The average household in the United States consumes  $5.0 \times 10^4$  gallons of water in a year. **Calculate** the number of households that could be supported for one year by the average flow of 9.60 maf of water into Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate the number of households that could be supported for one year by the average watershed flow:

Accept one of the following:

- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{1 \text{ maf}} \times \frac{1 \text{ household}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \times \frac{3.26 \times 10^{11}}{5.0 \times 10^4}$

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One point for the correct calculation of the number of households: **1 point**

Accept one of the following:

- 62,592,000
- $6.2592 \times 10^7$

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**Total for part (g) 2 points**

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**Total for question 3 10 points**