AP® Environmental Science

Sample Student Responses and Scoring Commentary Set 2

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Free Response Question 1

- ☑ **Scoring Guideline**
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Question 1: Design an Investigation   10 points

(a) (i)	**Identify** the scientific question that resulted in the data presented in the graph.	**1 point**

Accept one of the following:

- What is the relationship between slope and annual erosion rate for four different land use types?
- Does crop rotation/tilling/not tilling/using cover crops on various slopes increase/decrease/change erosion rates?

(ii)	**Identify** the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil.	**1 point**

- Crop rotation

(iii)	**Describe** the effect of adding a cover crop compared to using the no-till method.	**1 point**

Accept one of the following:

- Adding a cover crop reduces the annual rate of soil erosion compared to using the no-till method.
- Adding a cover crop allows planting on greater sloped land before reaching tolerable loss as compared for the no-till method.

(iv)	**Identify** one natural mechanism of soil erosion.	**1 point**

Accept one of the following:

- Moving/flowing water
- Rainfall
- Wind

	Total for part (a)	**4 points**

(b) (i)	**Identify** the dependent variable stated in the hypothesis.	**1 point**

Accept one of the following:

- The amount of sediment discharge
- The amount of sediment run-off

(ii)	**Describe** one way to add a control to improve the design of the study.	**1 point**

Accept one of the following:

- Add a plot that is bare/does not have straw bales or grass (no ground cover).
- Measure sediment discharge/runoff prior to placing straw bales or planting grass compared to discharge after the bales/grass are in place (pre-/post-tests).

(iii)	**Identify** one variable that was not discussed that could affect the results of the study.		**1 point**

Accept one of the following:

- Slope of the plots
- Amount of rainfall
- Composition of the roads
- Distance of the plots from road/stream
- Size of the plots
- Type of soil at the plots
- When the data are collected at the plots (how quickly after rainfall)

(iv)	Based on the data in the table above, **make a claim** about the stated hypothesis.		**1 point**

Accept one of the following:

- The stated hypothesis is rejected as more sediment resulted from straw bale plots (plot A) than grass planted plots (plot B).
- The data in the table shows that the grass is more effective at reducing sediment runoff. The hypothesis should be rejected.

Total for part (b)	**4 points**

(c) (i)	**Describe** the type of survivorship curve expected for these fish species.		**1 point**

Accept one of the following:

- Low survival rate in early life, followed by increased chances of survival as the organism matures.
- Most offspring die at a very young age and few reach maturity.

(ii)	**Explain** why the input of sediment to a stream can negatively affect reproduction of fish that lay their eggs in the gravel of the streambed.		**1 point**

Accept one of the following:

- Sediment can cover/bury eggs, which reduces the amount of oxygen, causing them to die.
- Sediment takes away usable habitat/space resulting in fewer areas for them to lay eggs causing fewer eggs to survive.
- Sediments can carry toxic/poisonous chemicals, which can negatively impact the eggs and decrease egg survival.
- An increase in sediment can increase the water temperature and result in less dissolved oxygen/too warm water, which can decrease the viability of the eggs that have already been laid.
- Sediment can increase water turbidity, which decreases fish navigation/ability to forage/efficiency of oxygen use which decreases the amount of eggs laid.

Total for part (c)	**2 points**
Total for question 1	**10 points**

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

~~a.i) The scientific question that resulted in the data presented in the graph is: what is the effect of four different agricultural practices and percent slope on annual erosion?~~
~~i.) The agricultural~~
~~i.) The effect~~

a. i) The scientific question that resulted in the data presented in the graph is "what is the effect of percent slope on annual erosion for four agricultural practices?"

aii) The agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil is crop rotation.

aiii) The no-till method by itself has a higher than tolerable loss of soil at a slope ~~per~~ percent higher than around 7%. With the addition of cover crop the higher than tolerable loss of soil doesn't occur until around 11%. In addition the no-till method with cover crop stays consistently below the erosion level of no-till by itself; therefore, no till with cover crop is much more effective at reducing soil erosion, than no-till by itself. Adding a cover crop decreases erosion.

aiv.) One natural mechanism of soil erosion is rainfall.

b. i) The dependent variable stated in the hypothesis is the amount of sediment run-off.

bii) The experimenters could add a control group by getting a third plot of land near a road under construction

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

and not putting any method to reduce run-off there. This would create a measure to compare the other two methods too and improve the design of the study.

biii) A variable that was not discussed and could affect the results of the study is the slope of the different plots.

biv) Because turbidity is measured by the depth at which a submerged object can no longer be seen, the planted grass was more effective because it took 28 cm until the object couldn't be seen in comparison with only 12 cm for the straw bale plots; therefore, the stated hypothesis is incorrect because the straw bales do not reduce more sediment run-off than planted grass does. The opposite is true.

C. i) Because fish lay several (hundreds) of eggs at a time and provide no parental care it can be assumed they display a Type III survivorship curve with a very few surviving initially, a drop down, and then a stabilizing of the ones that do survive. It is expected these fish species show a survivorship curves that decreases quickly then flattens out.

cii) An increase in sediment equals an increase in turbidity. Turbidity increasing means there is less albedo so the water absorbs more sun and thus the temprature increases. Warmer waters have less dissolved oxygen and thus fish may not be healthy enough to reproduce, due to a lack of oxygen.

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

a) i) How does the slope of an area ~~affected~~ and tillage practice affect the amount of soil erosion?

ii) Crop rotation is the agricultural practice that could be used on an area w/ a slope of 15% without creating soil erosion exceeding the limit of tolerable loss,

iii) The addition of a cover crop as compared to a no till with no cover crop leads to a slower rate of increase in soil erosion and ultimately less soil erosion as slope increases.

iv) 1 natural mechanism of soil erosion is the depletion of nutrients in the soil. It has a tendency to increase by tons as the % slope of the area increases,

b) i) The dependent variable is the amount of sediment discharge from each plot.

ii) A way to add control to the study is to measure a third plot, which has no treatment of erosion prevention, to compare the results with the 2 other plots. This 3rd plot would serve as a control group.

iii) One variable that could affect the results is the ~~location~~ location of each plot ~~~~. This is a confounding variable because, though both plots are near a road under construction, they may not be on the same slope which can affect soil erosion & lead to higher sediment discharge & runoff.

iv) It was found that plot B, which was planted with grass, was more effective at reducing sediment run-off compared to plot A, which was covered with straw bale.

Question 1   **Question 2**   **Question 3**
●   ○   ○

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

C) i) An N survivorship curve. ☺

ii) The sediment can negatively impact fish reproduction as higher amounts of sediment decrease the availability of oxygen in the water & can lead to hypoxic conditions. The sediment may lead to an increase in ~~algae~~ *algae*, which once decomposed by bacteria will greatly decrease Oxygen availability (Eutrophication!) due to aerobic processes.

Page 3

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

A(i) The scientific question was: What are the effects of different agricultural practices and slopes on annual erosion rates.

(ii) Crop rotation is the agricultural practice that can be used at 15% slope but does not go above the level of tolerable loss.

(iii) When adding a cover crop, anual erosion decreases compared to using the no-till method. On the graph, cover crop only leads up to about 20 annual erosion tons/acre. While the no-till method goes all the way up to 30 annual erosion tons/acre.

B (i) The dependent variable is whether straw bales reduce more sediment than planted grass.
~~(ii) The independent variable is~~

(ii) changing the temperature the grass and straw bales grow in is one way to add a control.

(iii) One variable that could effect the results is: where are the straw bales and grass being grown? What the climate/weather conditions are may effect the experiment results.

(iv) The hypothesis that straw bales reduce more sediment ~~from~~ run-off than planted grass is true/correct.

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

C(i) A logistic curve is the type of survivorship curve expected.

(ii) If the input of sediment increases/decreases too much, the fish will not be able to lay their eggs there. If this happens the fish will have to migrate to a new area or else their population will start to decrease.

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 identify components of a scientific experiment and to explain concepts related to agricultural practices and soil erosion. Students were expected to convey an understanding of the sedimentation of waterways.

In part (a) students were expected to demonstrate their ability to answer questions about the effect of four common agricultural practices on the annual soil erosion rates at various land slopes based on data provided in a graph [Practice 5-Data Analysis, Practice 1-Concept Explanation, Topic 5.4 Impacts of Agricultural Practices]. In part (b) students were asked to identify and evaluate various parts of an experiment focused on decreasing sediment run-off from disturbed land [Practice 4-Scientific Experiments, Topic 4.2 Soil Formation and Erosion, Topic 8.2 Human Impacts on Ecosystems]. In addition, after being presented with data from the experiment, students were asked to make a claim about a presented hypothesis. In part (c) students were asked to describe the survivorship curve of fish species living in streams affected by sediment [Topic 3.3 Survivorship Curves] and asked to explain the effects of sediment run-off on the reproductive ability of these fish [Practice 7-Environmental Solutions, Topic 8.2 Human Impacts on Ecosystems].

Sample: 1A
Score: 10

One point was earned in part (a)(i) for identifying the scientific question "what is the effect of percent slope on annual erosion for four agricultural practices?" One point was earned in part (a)(ii) for identifying "crop rotation" as the agricultural practice. One point was earned in part (a)(iii) for describing "no till with cover crop is much more effective at reducing soil erosion than no-till by itself." One point was earned in part (a)(iv) for identifying "rainfall" as a natural mechanism of soil erosion. One point was earned in part (b)(i) for identifying "the amount of sediment run-off" as the dependent variable. One point was earned in part (b)(ii) for describing one way to "add a control group [is] by getting a third plot of land near a road under construction and not putting any method to reduce run-off there." One point was earned in part (b)(iii) for identifying "the slope of the different plots" as one variable that was not discussed that could affect the results of the study. One point was earned in part (b)(iv) for making a claim that "the stated hypothesis is incorrect because the straw bales do not reduce more sediment run-off than planted grass does." The response supports the claim with "the planted grass was more effective because it took 28 cm until the object couldn't be seen in comparison with only 12 cm for the straw bale plots." One point was earned in part (c)(i) for describing "fish lay several (hundreds) of eggs at a time and … they display a Type III survivorship curve with very few surviving initially, a [population] drop down, and then a stabilizing of the ones that do survive." One point was earned in part (c)(ii) for explaining, "An increase in sediment equals an increase in turbidity [which] means there is less albedo so the water absorbs more sun and … the temperature increases. Warmer waters have less dissolved oxygen and … fish may not be healthy enough to reproduce, due to a lack of oxygen."

Question 1 (continued)

Sample: 1B
Score: 6

One point was earned in part (a)(i) for identifying the scientific question "how does the slope of an area and tillage practice affect the amount of soil erosion?" One point was earned in part (a)(ii) for identifying "Crop rotation" as the agricultural practice. One point was earned in part (a)(iii) for describing, "The addition of a cover crop as compared to a no till with no cover crop leads to … less soil erosion." No point was earned in part (a)(iv). One point was earned in part (b)(i) for identifying "the amount of sediment discharge" as the dependent variable. One point was earned in part (b)(ii) for describing "A way to add [a] control to the study is to measure a third plot, which has no treatment of erosion prevention." One point was earned in part (b)(iii) for identifying "one variable that could affect the results is the location of each plot … because … both plots … may not be on the same slope." No point was earned in part (b)(iv). No point was earned in part (c)(i). No point was earned in part (c)(ii).

Sample: 1C
Score: 3

One point was earned in part (a)(i) for identifying the scientific question "What are the effects of different agricultural practices and slopes on annual erosion rates." One point was earned in part (a)(ii) for identifying "Crop rotation" as the agricultural practice. One point was earned in part (a)(iii) for describing, "When adding a cover crop, anual erosion decreases compared to using the no-till method." No point was earned in part (a)(iv). No point was earned in part (b)(i). No point was earned in part (b)(ii). No point was earned in part (b)(iii). No point was earned in part (b)(iv). No point was earned in part (c)(i). No point was earned in part (c)(ii).