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AP<sup>®</sup>

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

## Sample Student Responses and Scoring Commentary Set 1

### **Inside:**

#### **Free-Response Question 1**

- Scoring Guidelines**
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**Question 1: Design an Investigation****10 points**

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- (a) (i) **Identify** the area with the greatest nest success rate, based on the information in the diagram. **1 point**

Accept one of the following:

- Area A
- Site/area upstream from the factory

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- (ii) **Identify** the dependent variable in the study. **1 point**

- Turtle nesting success

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- (iii) Based on the information provided, **identify** a likely scientific question for the study. **1 point**

Accept one of the following:

- Does mercury content in the turtle’s habitat affect common snapping turtle nest success?
- Does mercury content in the turtle’s habitat affect the location/site of common snapping turtle nests?

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- (iv) **Describe** why researchers measured mercury levels in locations upstream from the factory. **1 point**

Accept one of the following:

- The upstream locations acted as a control group in the study.
- The site was used to compare with the high mercury turtle nests downstream.

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- (v) There are plans to remove trees and other vegetation along the riverbank. **Explain** how this modification could affect the location and number of successful turtle nests in Area B. **1 point**

Accept one of the following:

- With more open area closer to the river, turtles don’t have to travel as far to build nests, leading to exposure to higher levels of mercury near the river, decreasing the number of successful nests.
- With less vegetation to remove the mercury/heavy metals/endocrine disruptors/pesticides, there will be increased concentrations in the soil, decreasing the number of successful nests.
- Soil erosion along the stream would increase, which would make it more difficult for turtles to build nests there and decrease the number of successful nests.
- With less vegetation and reduced shade, the soil temperature will increase/moisture will decrease, decreasing the number of successful nests.

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**Total for part (a) 5 points**

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**(b) (i) Describe** how a persistent pollutant, such as mercury, can negatively affect an organism. **1 point**

Accept one of the following:

- The mercury/persistent pollutant could bioaccumulate in the tissues of organisms because the pollutants do not easily break down and can accumulate over time.
- Mercury is a neurotoxin, which can disrupt an animal's nervous system/neuron functioning.
- The mercury/persistent pollutant disrupts regular functioning of an animal's brain/kidneys/liver/immune system/reproductive system and can lead to death.

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**(ii) Describe** how a persistent pollutant, such as mercury, can negatively affect an ecosystem. **1 point**

Accept one of the following:

- A toxin can biomagnify in the food chain impacting top predators that will have a very high concentration of the pollutant.
- The death of top predators in a food chain leads to a trophic cascade.
- Reproductive success of individual organisms can decrease from exposure to the pollutant, altering the ecosystem's food webs/trophic levels and decreasing its stability/resulting in a decline in biodiversity.

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**(iii) Researchers measured methylmercury in a location downstream from the factory. 1 point**

**Explain** how methylmercury could be present in the stream.

- Mercury is likely released into the stream by the factory as a waste product. Bacteria/microorganisms in the water/sediments then convert the mercury into methylmercury.

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**(iv) Researchers claimed that the soil nearest to the river has higher levels of mercury than the field has, and those elevated levels have affected the nesting success for turtles. 1 point**

**Explain** how the pattern shown in the diagram supports or refutes this claim.

Accept one of the following:

- The nests near the river in Area B where there is mercury are not successful, but the nests further away are successful. This supports the claim that the high concentration in the soil negatively affects the nesting success.
- There are fewer total nests/successful nests in Area B closer to the river than in Area A indicating that the mercury in the soil has negatively affected the nesting success. This supports the claim.

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

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- (c)** The turtle study was conducted in an agricultural area. **Describe** how a specific agricultural practice changes the soil in an area. **1 point**

Accept one of the following:

- Tilling/plowing softens/loosens soils and/or removes organic matter or leads to erosion.
- Monocropping removes nutrients and/or moisture from soil.
- Use of synthetic fertilizers disrupts the soil chemistry in areas used for agriculture.
- Irrigation can lead to waterlogging, erosion, and/or salinization of soils.
- Slash and burn removes vegetation and upper organic layers of the soil/adds nutrients to the soil.
- Use of industrialized machinery (harvesters, plows, planters) compacts soil.
- Use of polycultures/cover cropping with nitrogen-fixing plants can add nutrients to soil.
- Use of manure/organic fertilizer can increase moisture content of the soils.

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**Total for part (c) 1 point**

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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.

- a) Area A has the greatest nest success rate
- aii) The dependent variable is ~~the~~ the number of successful & unsuccessful turtle nests
- aiii) A scientific question for this study is: how might ~~mercury~~ ~~pollutants~~ pollutants like mercury affect turtle nesting sites?
- aiv) The researchers measured mercury levels in locations upstream from the factory to serve as a control variable. ~~By~~ It also served as a comparison & confirmed that mercury levels do indeed have an impact on turtle nesting.
- av) Removing trees & vegetation along the river bank could increase soil erosion & heat up surrounding water. This is because trees have roots which help keep soil in place & leaves to provide shade in the water. ~~By~~ These modifications could decrease the number of successful turtle nests in Area B because the nests may end up being carried away due to soil erosion.
- bi) Persistent pollutants can negatively affect an organism because it can bioaccumulate in their body. This means that as time goes on, the amount of the persistent pollutant inside an organism will continue to build up, which may lead to bad health effects, & possibly kill the organism.
- bii) Persistent pollutants can negatively ~~for~~ affect an ecosystem because it can biomagnify in the ecosystem's food web. In Biomagnification, ~~the amount of the pollutant~~ as we move up the food chain, higher-~~level~~ trophic organisms will have a

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huge buildup of the persistent pollutant. Because of biomagnification, apex predators & tertiary consumers will have higher levels of these pollutants, which ~~they~~ can kill them. This disturbs the food web of the organism & ~~can~~ allow secondary consumers to grow / overpopulate, eating off the primary producers. This will decrease the biodiversity & species evenness of the ecosystem.

biii) Methylmercury could be present in the stream because the mercury that came from the factory could have reacted with methyl. that came from soil erosion and runoff from a nearby city.

biv) The pattern in the diagram ~~shows~~ supports the claim because if you look at area B in the diagram, the only spots where the turtle nests were unsuccessful were those bordering the ~~river~~ area near the river. Those in the inner part (field) were successful, ~~where~~ <sup>and</sup> we can infer that it's due to lower mercury levels in the fields. Similarly, the soil nearest to the river in area B ~~had~~ only had unsuccessful nest sites, which can be attributed to high mercury levels due to the proximity of the river.

c) Tilling changes the soil ~~can~~ in an area by loosening it up / breaking it apart. ~~that~~ Breaking up the soil makes the top soil very loose & susceptible to ~~can~~ runoff during rain or being blown away.

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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.

① (a) (i) Upstream in area A has the greatest nest success rate.

(ii) dependent variable is ~~total~~ successful turtle nests / unsuccessful turtle nests.

(iii) How does the pollution from the chemical factory impact the success rate of turtle nests upstream and downstream?

(iv) They measured these levels upstream to know if the chemical factory maybe was not the leading cause of unsuccessful turtle nesting, and maybe it was an unknown source affecting them.

(v) Removing these trees can cause an increase in soil erosion ~~and~~ runoff into the stream. This would make conditions bad as it would decrease dissolved oxygen levels in the water from increased turbidity and heat accumulation. This could create bad water conditions for turtles in the stream in area B and cause them to relocate their resting sites.

② (b)

(i) Mercury can bioaccumulate in an organisms tissue over time, causing an increase in that pollutant in their fatty tissue. ~~and~~ This can lead to negative health effects on that organism.

(ii) Mercury can also biomagnify. This means that it can become more concentrated in organisms as it moves up in trophic levels. As secondary

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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.

consumers eat primary consumers, that mercury ~~can~~ can then buildup in their tissues. Then ~~the~~ tertiary consumers can get higher concentrations of that mercury because it's been accumulating as it rises in the trophic levels. Which is why it affects an entire ecosystem as it travels through the food chain, bringing negative health effects as well.

(iii) Methylmercury can be present in the stream because the mercury pollutants from the factory are converted to methylmercury in the water by bacteria.

(iv). The diagram supports this because the turtle nesting sites closest to the river in Area B were all unsuccessful. This shows that the soil nearest to the river does have more mercury and it is affecting turtle nesting.

(c) Tilling in agriculture affects soil as it aerates the soil, it breaks up, and decreases organic matter content on the top soil. This negatively impacts soil health and can lead to soil erosion.



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

Question 1

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a.

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

i. Area B

ii. Success of a turtle nest

iii. Are turtle nests more successful upstream or downstream from a chemical factory that is a known source of aqueous mercury pollution?

iv. Researchers measured mercury levels upstream from the factory to compare ~~the levels~~ them to the levels downstream from the factory. This is done to identify the correct location or reason of the mercury levels downstream. It ~~to~~ serves as a constant to the experiment as no external variables are added (like the mercury).

v. Removing trees + other vegetation along the river bank would further decrease the amount of successful turtle nests in Area B. Not only would Area B be affected by mercury pollution but also sediment pollution. When removing veg. / trees in a river bank, you are allowing the soil to erode easier as there are no more roots to keep the soil in place. This causes the sedimentation to interfere with the water quality of the river, causing turbid waters, but also a loss of habitat for the turtle nests / turtles.

b. i. Mercury + other persistent pollutants are fat-soluble, meaning they do not easily pass through the body, causing them to travel through the trophic levels as more + more POPs ~~are~~ bio accumulate ~~to~~ ~~biomagnify~~ in organisms + biomagnify through the food web. This neg. impacts organisms because some <sup>persistent</sup> POPs, like mercury, are endocrine disruptors + can interfere with an organism's hormones. Mercury, for example, affects pregnancies + may cause birth defects.

ii. POPs persistent pollutants like mercury are fat-soluble and are stored in the fats of organisms + do not pass through. As ~~predators eat prey~~ organisms are consumed by other organisms, those organisms are also consuming

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

bii.....

the ~~PPs~~<sup>PPs</sup> in their bodies. This causes the ~~PPs~~<sup>PPs</sup> to bioaccumulate in organism's bodies and then biomagnify through the food web causing the climax predator of a food chain to have a lot of ~~PPs~~<sup>PPs</sup> in them. ~~PPs~~<sup>PPs</sup> may contain endocrine disruptors like PCB's, mercury, lead which can affect an ecosystem by disrupting reproductive processes of an organism.

iii. methyl mercury could be present in a stream downstream from the factory because mercury in itself isn't dangerous but ~~when~~<sup>when</sup> it completes a reaction ~~and~~<sup>with water</sup> combined with water forming methylmercury which is an endocrine disrupting pollutant. Because the stream flows down ward, mercury is carried downstream from the factory. ~~and the rea~~<sup>mercury then combines with</sup> mercury then ~~combines with~~<sup>goes through a reaction</sup> ~~creates~~<sup>creates</sup> methylmercury with  $H_2O$  + forms methylmercury.

iv. The pattern in the diagram supports the claim that the soil nearest to the river has higher levels of mercury than the field has. This is because in both areas A + B, the unsuccessful turtle nests are closer to the stream than the successful turtle nests. This is because the stream is polluted with mercury and affects the land that is closest to it.

C. The agricultural practice of crop rotation changes the soil in an area by improving the soil quality. When changing the crops used every season, you're preventing soil exhaustion.

## 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 of the distribution of turtle nests on a river and to identify components of a scientific experiment. Students were asked to explain concepts related to bioaccumulation, biomagnification, and the formation and effects of mercury. Students were also expected to convey an understanding of the impact of agricultural techniques on soils.

In part (a) students were expected to demonstrate their ability to read and interpret information provided in a diagram [Practice 2 Visual Representations]. They were then asked to use the information provided to identify various parts of scientific experiments and explain the result of modifications to the experiment [Practice 4 Scientific Experiments].

In part (b) students were asked to describe the effect of mercury at both the organism and ecosystem level and how methylmercury is formed [Practice 1 Concept Explanation, Topic 8.2 Human Impact on Ecosystems, Topic 8.7 Persistent Organic Pollutants, and Topic 8.8 Bioaccumulation and Biomagnification]. In addition, they were asked to explain how a claim about how the impact of mercury on turtle nest success was supported or refuted using information provided in the diagram [Practice 2 Visual Representations].

In part (c) students were asked to explain the impacts of agricultural practices on soil [Topic 5.4 Impact of Agricultural Practices].

### Sample: 1A

#### Score: 9

One point was earned in part (a)(i) for identifying “Area A” as the area with greatest nest success rate. One point was earned in part (a)(ii) for identifying “number of successful and unsuccessful turtle nests” as the dependent variable. One point was earned in part (a)(iii) for identifying “[H]ow might pollutants like mercury affect turtle nesting sites?” as the scientific question. One point was earned in part (a)(iv) for describing “mercury levels in locations upstream from the factory to serve as a control variable.” One point was earned in part (a)(v) for explaining, “Removing trees & vegetation along the river bank could increase soil erosion. ... These modifications could decrease the number of successful turtle nests in Area B because the nests may end up being carried away due to soil erosion.” One point was earned in part (b)(i) for describing, “the amount of the persistent pollutant inside an organism will continue to build up.” One point was earned in part (b)(ii) for describing, “In Biomagnification, as we move up the food chain, higher trophic organisms will have a huge build up of the persistent pollutant.” No point was earned in part (b)(iii). One point was earned in part (b)(iv) for explaining that the claim was supported because “the only spots where the turtle nests were unsuccessful were those bordering the area near the river. ... in area B.” One point was earned in part (c) for describing, “Tilling changes the soil in an area by loosening it up/breaking it apart.”

**Question 1 (continued)****Sample: 1B****Score: 7**

One point was earned in part (a)(i) for identifying “[A]rea A” as the area with greatest nest success rate. One point was earned in part (a)(ii) for identifying the “successful turtle nests/unsuccessful turtle nests” as the dependent variable. No point was earned in part (a)(iii). The response does not specifically include the pollutant mercury. No point was earned in part (a)(iv). No point was earned in part (a)(v). One point was earned in part (b)(i) for describing that mercury “can bioaccumulate in an organisms tissue over time. Causing an increase in that pollutant in their fatty tissue.” One point was earned in part (b)(ii) for describing, “Mercury can also biomagnify. This means that it can become more concentrated in organisms as it moves up in trophic levels.” One point was earned in part (b)(iii) for explaining that “mercury pollutants from the factory are converted to methylmercury in the water by bacteria.” One point was earned in part (b)(iv) for explaining that the claim was supported because “the turtle nesting sites closest to the river in Area B were all unsuccessful.” One point was earned in part (c) for describing, “Tilling in agriculture affects soil as it aerates the soil, it breaks up, and decreases organic matter content on the top soil.”

**Sample: 1C****Score: 4**

No point was earned in part (a)(i). One point was earned in part (a)(ii) for identifying “success of a turtle nest” as the dependent variable. One point was earned in part (a)(iii) for identifying “Are turtle nests more successful upstream or downstream from a chemical factory that is a known source of aqueous mercury pollution?” No point was earned in part (a)(iv). The response refers to the upstream measurements as a constant rather than a control. No point was earned in part (a)(v). The sedimentation from erosion is not the factor that lead to difficulty in building turtle nests. One point was earned in part (b)(i) for describing mercury as “endocrine disruptors & can interfere with an organism’s hormones.” One point was earned in part (b)(ii) for describing “and then biomagnify through the food web causing the climax predator ... to have a lot of PPs in them.” No point was earned in part (b)(iii). No point was earned in part (b)(iv). The response indicates that unsuccessful nests were located next the river in area A as well as area B. No point was earned in part (c).