

2023



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

## Sample Student Responses and Scoring Commentary Set 2

### **Inside:**

#### **Free-Response Question 2**

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

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

- 
- (a) Based on the information given, **identify** a body of water invaded by Asian carp that is labeled on the map. **1 point**

Accept one of the following:

- Mississippi River
- Lake Erie
- Missouri River
- Ohio River

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- (b) Based on the information shown in the map, **describe** the change in the distribution of Asian carp since their introduction in the 1970s. **1 point**

Accept one of the following:

- They are more widely distributed/found in most of the watershed/in a larger area than they were in the 1970s.
- They have moved up/down the Mississippi river.
- They have moved up the Missouri River/Ohio River.
- They have moved northwest and northeast up the rivers.

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- (c) **Describe** one impact the introduction of Asian carp could have on the ecosystem services provided by the Great Lakes region. **1 point**

Accept one of the following:

- Improved drinking water quality as carp consume algae.
  - Decreased recreational opportunities (boating/swimming) from the increased population of carp in the water interfering with activities.
  - Decreased fishing due to carp outcompeting native fish species.
  - Decreased drinking water quality as carp displace filter feeders like native mussels in the food chain/web.
  - Decreased algae population resulting in decreased photosynthesis and increased greenhouse gases/global warming/climate change.
  - Decreased algae population resulting in decreased photosynthesis and decreased oxygen production.
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- (d) Propose** a realistic solution to help reduce the spread of the Asian carp from their current distribution. **1 point**

Accept one of the following:

- Offer incentives for fishers to catch and kill carp.
- Encourage consumption of carp.
- Build fencing/netting between waterways.
- Use shock treatment (dispersal barrier system).
- Create/Use an Asian-carp specific poison/deterrent (carpicide, CO<sub>2</sub>, microparticles).
- Implement high-frequency sound deterrent system.
- Prohibit transfer of bait or ballast water from one body of water to another.

- (e) Justify** the solution proposed in part (d) by providing an additional advantage. **1 point**

Accept one of the following:

Solution proposed in part (d)	Justification of solution with additional benefit
Build fencing/netting between waterways.  Create/Use an Asian-carp specific poison/deterrent (carpicide, CO <sub>2</sub> , microparticles).  Implement high-frequency sound deterrent system.  Use shock treatment (dispersal barrier system).	<ul style="list-style-type: none"> <li>• Create jobs in the Great Lakes fishing industry.</li> <li>• Little to no harm to native animal/plant populations in watershed.</li> <li>• Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed.</li> <li>• Maintain revenue for existing fishing industry/tourism of Great Lakes.</li> </ul>
Encourage consumption of carp.	<ul style="list-style-type: none"> <li>• Increase revenue in the Great Lakes fishing industry/sale of carp.</li> <li>• Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed.</li> <li>• Provide new food source (domestically/internationally)/combat hunger issues worldwide.</li> <li>• Allow the return of native species resulting from less competition from the Asian carp.</li> </ul>

<p>Offer incentives for fishers to catch and kill carp.</p>	<ul style="list-style-type: none"> <li>• Create jobs in the Great Lakes fishing industry.</li> <li>• Increase revenue from the sale of Asian carp.</li> <li>• Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed.</li> <li>• Provide new food source (domestically/internationally)/combat hunger issues worldwide.</li> <li>• Allow the return of native species resulting from less competition from the Asian carp.</li> </ul>
<p>Prohibit transfer of bait or ballast water from one body of water to another.</p>	<ul style="list-style-type: none"> <li>• No harm to native animal/plant populations in watershed.</li> <li>• Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed.</li> <li>• Maintain revenue for existing fishing industry/tourism of Great Lakes.</li> </ul>

**(f) Identify** the primary consumer in the Great Lakes food chain. **1 point**

- Zooplankton

**(g) Describe** what the arrows in the aquatic food chain represent. **1 point**

Accept one of the following:

- The flow of energy/energy flow.
- The flow of matter/matter flow.

**(h) Describe** one possible effect of the introduction of the Asian carp on the Great Lakes food chain. **1 point**

Accept one of the following:

- There will be fewer zooplankton/macroinvertebrates/yellow perch/rainbow trout.
- There will be less food for other species at the same trophic level on the food chain.
- There will be less food for species that don't eat carp and are higher on the food chain.

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**(i)**     **Describe** one way that overfishing of blue pike illustrates the tragedy of the commons.     **1 point**

Accept one of the following:

- The blue pike are a shared resource that were depleted/went extinct due to unregulated access.
- The blue pike are a common resource that were depleted by fishers, maximizing profits/catching as many as possible.

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**(j)**     One potential solution to reduce overfishing is to use aquaculture. **Describe** one disadvantage of this solution.     **1 point**

Accept one of the following:

- Aquaculture contaminates water with excess organic waste/antibiotics.
- Fish that escape from facilities compete or breed with wild fish.
- Fish in aquaculture facilities can spread diseases to wild fish.
- The high density of fish in aquaculture facilities can lead to increased disease.
- Loss of jobs in the fishing industry.
- Excess pressure on fisheries/wild stocks used to create food pellets.
- Decrease in genetic diversity of farm raised fish.
- Habitat degradation from conversion of ecosystems to fish farms.
- Overuse of antibiotics in farmed fish (create antibiotic resistant bacteria that can be harmful to humans).

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**Total for question 2    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.

2. a) A body of water invaded by the Asian carp is Lake Erie.
- b) The distribution of asian carp has moved along waterways (Mississippi river, as an example) to both north and south of US. Therefore, they are now in parts of northern water ways instead of the south (where they were introduced).
- c) Asian carp could eat up many algae, which removes the regulating ecosystem service of algae in the carbon cycle. Algae has a role of storing atmospheric  $CO_2$  and reducing it to oxygen. Asian carp eating them up will decrease the amount of algae able to perform in the carbon cycle, which can lead to more carbon dioxide in the air and the increased greenhouse gas effect.
- d) A realistic solution to reduce the spread of Asian carp is to governmentally fund the removal of such species by giving cash rewards to those who fish this species.
- e) An additional advantage of funding the fishing/subsidizing is it can ~~stimulate the economy by~~ provide a greater food source as more asian carp are caught. This can ~~provide~~ help communities low on food allowing better living conditions while simultaneously removing the invasive carp.

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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.

- f) The primary consumer in the Great Lakes food chain is zooplankton.
- g) The arrows represent the transfer of energy from the consumption of ~~biomas~~ organisms. For example, the arrow pointing from Algae to zooplankton shows a transfer of energy to the zooplankton from algae for its daily survival.
- h) One effect of introducing asian carp in Great Lakes food chain is that they'll eat up most of the algae, which decreases food for zooplankton, which feeds on algae, which also decreases subsequent food sources along the chain. The decrease in Algae will cause a chain reaction of decreased food availability in the chain, which ultimately decreases the population of all other species along this chain, which are zooplankton, macroinvertebrates, yellow perch, and rainbow trout.
- i) Overfishing of the Blue pike is example of tragedy of the commons because individual fishers are selfishly using up the shared resource, ~~of the~~ blue pike, which ultimately made it go extinct and now no one can fish it.

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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.

5) One potential solution to reduce overfishing is aquaculture, and the disadvantage of using this is it can ~~produce a large concentration of waste in the aquaculture~~ ~~increase the spread of disease between the fish because of how~~ contaminate the water by producing large concentrations of waste in a single area. This waste that flows away from the aquaculture site can cause eutrophication and also negatively influence the water quality outside, killing other ecosystems.

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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) Missouri River
- b) Since the 1970s, the Asian carp distribution has greatly expanded in every direction but it has mostly spread north.
- c) Asian carp can disrupt the habitat of other organisms that are living in the Great Lakes resulting in the decline of that species.
- d) A bio-control can be introduced that can help reduce the population and spread of Asian carp, but they must be careful that the species chosen to control it doesn't become an invasive species as well and further disrupt the ecosystem.
- e) This new species introduced to control the population and spread of Asian carp will require minimal mechanical effort to remove the carp, and can introduce a solution at a much quicker rate than other control methods.
- f) zooplankton
- g) The arrows in the aquatic food chain represent the transfer of energy from one organism to the next.
- h) The Asian Carp could provide competition for the zooplankton and reduce the zooplankton population because of the now lack of algae the Asian carp is causing. This would then impact the whole food chain because if there is less zooplankton to consume, there will be less macroinvertebrates and so on as you go up the food chain.
- i) The Great Lakes is a place where ~~many~~ people can go to commercially fish blue pike, serving as a common resource. When people fish however much they want to make more profit because it doesn't cost them anything and there are no immediate impacts seen from it, the population of blue pike will decrease. Eventually, this overfishing got too out of control resulting in the depletion of blue pike and showing a prime example of the

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.

tragedy of the commons and what can happen to a resource that is freely available to many people.

j) One disadvantage of this solution is disease can be spread more rampantly with aquaculture because there are so many aquatic animals in a smaller space and they are generally less biodiverse.

Page 4

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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 Mississippi River was invaded.
- B.) Asian carp disruption has significantly increased and now disturbs many other bodies of water.
- C.) Asian carp could improve eutrophication in the Great Lakes.
- D.) Introducing another species, such as a predator to the Asian carp, would allow the population to be further controlled.
- E.) An additional advantage would be that the amount of eggs produced could be decreased.
- F.) Zooplankton is the primary consumer.
- G.) The arrows represent the relationships between each creature and their prey. Each arrow points to the sea creature will be eaten by.
- H.) The introduction of Asian carps on the food chain would ~~give~~ ~~be~~ ~~also~~ decrease the available food for zooplankton and likely cause a decrease in their population.
- I.) The overfishing of blue pike illustrates tragedy of the commons because humans overstepped their boundaries with the creature and fished so many of them that none remained surviving.
- J.) One disadvantage of aquaculture is that the fish are living in their unnatural habitat and being bred inorganically.

Page 3

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## Question 2

**Note:** Student samples are quoted verbatim and may contain spelling and grammatical errors.

### Overview

The intent of this question was for students to analyze the environmental problem of the introduction of Asian carp to the United States and propose a solution for containment of the invasive species. Students were also asked to analyze the components of a food chain and, lastly, were asked to apply their understanding of the tragedy of the commons to an alternative to commercial fishing, aquaculture.

In part (a) students were asked to identify a labeled body of water invaded by Asian carp [Science Practice 2 Visual Representations], and in part (b) students were asked to describe how this distribution had changed since their introduction in the 1970s [Science Practice 2 Visual Representations].

In part (c) students were asked to describe how the environmental concept represented in the diagram related to broader environmental issues, in this case, an impact on an ecosystem service provided by the Great Lakes region [Science Practice 2 Visual Representations and Topic 2.2 Ecosystem Services]. Part (d) asked the students to propose a realistic solution to help reduce the spread of the Asian carp from their current distribution [Science Practice 7 Environmental Solutions and Topic 9.8 Invasive Species], and part (e) asked the students to justify an additional advantage linked to their solution in part (d) [Science Practice 7 Environmental Solutions].

Part (f) presented students with a simplified Great Lakes food chain and asked them to identify the primary consumer [Science Practice 2 Visual Representations, Topic 1.9 Trophic Levels, and Topic 1.11 Food Chains and Food Webs]. In part (g) students were asked to describe what the arrows represented on the food chain [Topic 1.10 Energy Flow and the 10% Rule]. In part (h) students were asked to demonstrate an understanding of disturbance to the food chain by describing an impact to the Great Lakes chain by the introduction of the Asian carp [Topic 1.11 Food Chains and Food Webs].

In part (i) students were asked to describe how the overfishing of the Great Lakes endemic blue pike that led to their extinction is an example of the tragedy of the commons [Topic 5.1 The Tragedy of the Commons]. In part (j) students were asked to describe one disadvantage of aquaculture as a solution to overfishing [Science Practice 7 Environmental Solutions and Topic 5.16 Aquaculture].

### Sample: 2A

#### Score: 10

One point was earned in part (a) for identifying “Lake Erie” as a body of water invaded by Asian carp. One point was earned in part (b) for describing “asian carp has moved along waterways ... to both north and south of US” as the change in the distribution of Asian carp. One point was earned in part (c) for describing “Asian carp eating them up will decrease the amount of algae able to perform in the carbon cycle, which can lead to more carbon dioxide in the air and the increased greenhouse gas effect.” One point was earned in part (d) for proposing the solution to reduce the spread of Asian carp as “governmentally fund the removal of such species by giving cash rewards to those who fish this species.” One point was earned in part (e) for justifying the solution in part (d) with the additional

**Question 2 (continued)**

advantage of “provide a greater food source as more asian carp are caught.” One point was earned in part (f) for identifying “zooplankton” as the primary consumer in the food chain. One point was earned in part (g) for describing “the transfer of energy.” One point was earned in part (h) for describing how the carp will “eat up most of the algae, which decreases food for the zooplankton” which “ultimately decreases the population of all other species along this chain” as one effect the Asian carp has on the Great Lakes food chain. One point was earned in part (i) for describing how “individual fishers are selfishly using up the shared resource ... made it go extinct” as a way that overfishing blue pike illustrates the tragedy of the commons. One point was earned in part (j) for describing how aquaculture “contaminate the water by producing large concentrations of waste ... that flows away from the aquaculture ... can cause eutrophication” as a disadvantage of aquaculture as a solution to reduce overfishing.

**Sample: 2B****Score: 7**

One point was earned in part (a) for identifying “Missouri River” as a body of water invaded by Asian carp. One point was earned in part (b) for describing “the Asian carp distribution has greatly expanded in every direction” as the change in the distribution of Asian carp. No point was earned in part (c). No point was earned in part (d). No point was earned in part (e). One point was earned in part (f) for identifying “zooplankton” as the primary consumer in the food chain. One point was earned in part (g) for describing “the transfer of energy.” One point was earned in part (h) for describing “The Asian Carp could provide competition for the zooplankton and reduce the zooplankton population because of the now lack of algae” as one effect the Asian carp has on the Great Lakes food chain. One point was earned in part (i) for describing the blue pike as a “common resource” where people “fish however much they want to make more profit” resulting in the “depletion of blue pike” as a way that overfishing blue pike illustrates the tragedy of the commons. One point was earned in part (j) for describing how “disease can be spread more rampantly” because “there are so many aquatic animals in a smaller space” as a disadvantage of aquaculture as a solution to reduce overfishing.

**Sample: 2C****Score: 4**

One point was earned in part (a) for identifying “Mississippi River” as a body of water invaded by Asian carp. One point was earned in part (b) for describing the change in the distribution of Asian carp as “significantly increased and now disturbs many other bodies of water.” No point was earned in part (c). No point was earned in part (d). No point was earned in part (e). One point was earned in part (f) for identifying “zooplankton” as the primary consumer in the food chain. No point was earned in part (g). One point was earned in part (h) for describing that the Asian carp “would decrease the available food for zooplankton and likely cause a decrease in their population” as one effect the Asian carp has on the Great Lakes food chain. No point was earned in part (i). No point was earned in part (j).