

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

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- (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, CO₂, 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 jobs in the Great Lakes fishing industry.
Create/Use an Asian-carp specific poison/deterrent (carpicide, CO ₂ , microparticles).	• Little to no harm to native animal/plant populations in watershed.
Implement high-frequency sound deterrent system.	• Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed.
Use shock treatment (dispersal barrier system).	• Maintain revenue for existing fishing industry/tourism of Great Lakes.
Encourage consumption of carp.	• Increase revenue in the Great Lakes fishing industry/sale of carp. • Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. • Provide new food source (domestically/internationally)/combat hunger issues worldwide. • Allow the return of native species resulting from less competition from the Asian carp.

Offer incentives for fishers to catch and kill carp.	• Create jobs in the Great Lakes fishing industry. • Increase revenue from the sale of Asian carp. • Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. • Provide new food source (domestically/internationally)/combat hunger issues worldwide. • Allow the return of native species resulting from less competition from the Asian carp.
Prohibit transfer of bait or ballast water from one body of water to another.	• No harm to native animal/plant populations in watershed. • Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. • Maintain revenue for existing fishing industry/tourism of Great Lakes.

(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/macrobenthos/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.

(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.

(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).

Total for question 2 10 points

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- (a) (i) Based on the data in the graph, **identify** the highest methane concentration found in well water in Pennsylvania. **1 point**

- 64 mg/L

- (ii) Based on the data in the graph, **describe** the relationship between the concentration of methane in well water and the distance to a fracking well. **1 point**

Accept one of the following:

- Methane concentration decreases as distance from the fracking well increases.
- Methane concentration increases as distance from the fracking well decreases.
- There is an inverse/nonlinear relationship/negative correlation between the two variables.

- (iii) Based on the data in the graph, **identify** the minimum safe distance that a new water well should be located from an existing fracking well. **1 point**

Accept any value between:

- 1,800 – 2,200 meters

- (iv) **Explain** how fracking fluid is used to access oil and natural gas in sedimentary rock, such as shale, during the fracking process. **1 point**

Accept one of the following:

- Fracking fluid is injected/pumped into the well under high pressure, opening rock fissures, releasing oil and natural gas.
- Sand grains in the fracking fluid hold the newly formed cracks/fractures open to allow the oil and natural gas to flow up the well.

- (v) **Identify** one negative geologic effect in an area where hydraulic fracturing (fracking) occurs. **1 point**

Accept one of the following:

- Earthquakes/seismic activity
- Ground subsidence/sinkholes

Total for part (a) 5 points

- (b) (i) The use of groundwater for fracking is an example of individuals using a shared resource for their own self-interest. **Identify** the environmental concept illustrated by this example of overuse of a shared resource. **1 point**

- Tragedy of the Commons

- (ii) **Describe** one environmental problem that may result from increased use of groundwater for fracking in arid or semiarid regions. **1 point**

Accept one of the following:

- Loss of habitat/productivity in spring-fed ecosystems as springs dry up
- Loss of habitat/productivity/degraded water quality in streams and estuaries fed by groundwater discharge
- Soil erosion as vegetation dies as a result of lowered water table and roots no longer hold soil
- Desertification as a result of lowered water table

- (iii) **Describe** how overuse of coastal groundwater supplies can result in water that is unsuitable for human consumption. **1 point**

- The ocean water flows into aquifers (saltwater intrusion), contaminating the aquifer with saltwater.

Total for part (b) 3 points

- (c) (i) **Make a claim** for a realistic governmental action to improve air quality by reducing consumption of oil. **1 point**

Accept one of the following:

- Increase fuel economy standards for motor vehicles.
- Invest in renewable energy resources.
- Use tax incentives to encourage sales of hybrid/electric vehicles.
- Subsidize projects that increase the use of public transportation/walking/cycling.
- Create tax incentives for companies offering work-from-home options.
- Increase gasoline tax/reduce oil subsidies.

- (ii) **Justify** the action proposed in part (c)(i) by stating a potential environmental advantage of that action, other than slowing global climate change. **1 point**

Accept one of the following:

Governmental action proposed in (c)(i)	Justification of the action proposed by stating a potential environmental advantage
Increase fuel economy standards for motor vehicles	• Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain • Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations

	Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Invest in renewable energy resources	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Use tax incentives to encourage sales of hybrid/electric vehicles	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Subsidize projects that increase the use of public transportation/walking/cycling	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Create tax incentives for companies offering work-from-home options	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater

	depletion/contamination from fracking/drilling operations Decreased oil consumption which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Increase gasoline tax/reduce oil subsidies	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Total for part (c) 2 points	
Total for question 2 10 points	