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

(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.

(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.

(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_2, 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_2, microparticles). Implement high-frequency sound deterrent system. Use shock treatment (dispersal barrier system).	• Create jobs in the Great Lakes fishing industry. • Little to 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.
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/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.

(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**