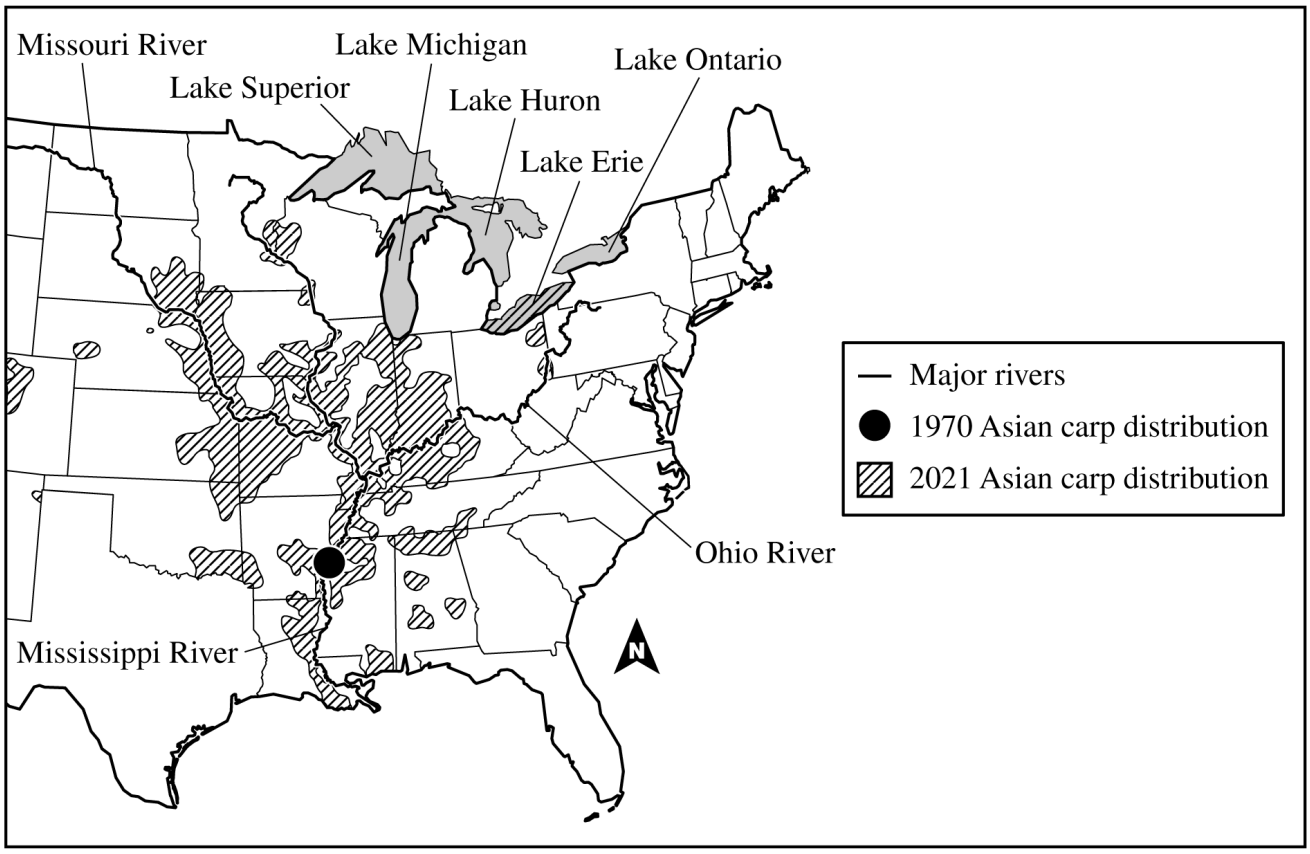
2. Asian carp were first introduced in the southern United States in the 1970s by fish farmers wanting to control algal growth in fish ponds. Asian carp can eat up to 40% of their body weight in algae each day, and a female carp can produce up to 1 million eggs every year.

Distribution of the Asian Carp in the United States



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

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

The Great Lakes are a group of five major freshwater inland lakes that all share the same watershed.

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

(d) **Propose** a realistic solution to help reduce the spread of the Asian carp from their current distribution.

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

The following is an example of a simple food chain in the Great Lakes.

Algae → Zooplankton → Macroinvertebrates → Yellow perch → Rainbow trout

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

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

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

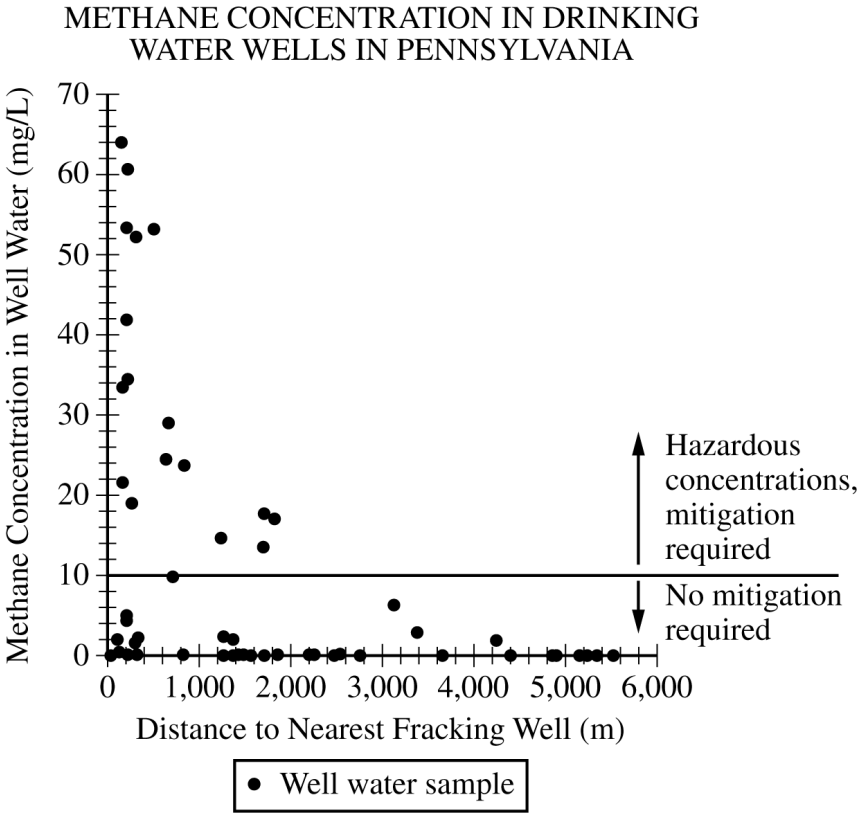
The blue pike, a fish that was endemic to the Great Lakes, was commercially fished from the late 1800s until their population crashed in 1958. In 1970, the species was declared to be extinct.

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

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

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

2. Developments in advanced hydraulic fracturing (fracking) technologies have allowed the total oil and gas production in the United States to increase rapidly.



(a) The graph shows the methane concentration in drinking water from home wells and the distance to the nearest fracking well in Pennsylvania.

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

(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.

(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.

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

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

(b) The volume of water used for oil and gas extraction is 28 times greater than it was fifteen years ago. Much of the water used for oil and gas extraction comes from groundwater sources in arid or semiarid regions. This increased use of water for fracking may mean that less water is available for local use.

(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.

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

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

(c) In addition to water quality issues caused by fossil fuel extraction, air quality can also be negatively affected by combustion of oil and natural gas.

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

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

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.