

2023



AP[®] Environmental Science

Free-Response Questions Set 2

ENVIRONMENTAL SCIENCE

SECTION II

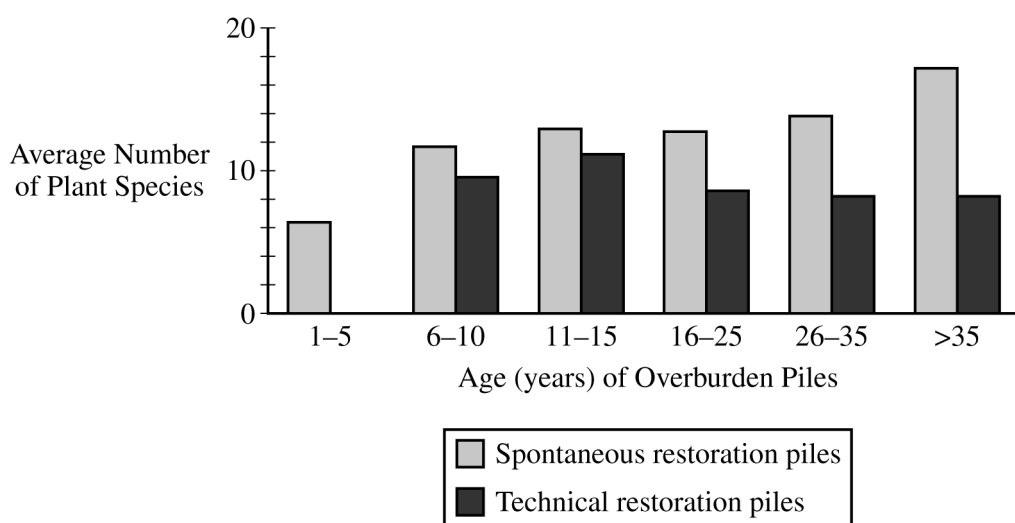
Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Two restoration methods designed to reclaim the overburden piles removed from open pit coal mines in temperate forests of eastern Europe were studied over several years. The first method was spontaneous restoration, where the soil and rock were dumped in noncompacted, random piles and not replanted with vegetation. The second method was technical restoration, where the land was leveled by heavy machinery, organic material was added, and eight plant species were added. Technical restoration started 5 years after the piles were formed, so no bar is included in the 1–5 year range in the graph.

Number of Plant Species in Spontaneous and Technically Restored Overburden Piles over Time



- (a) Based on the data in the graph, **identify** the average number of species found in technically restored piles 16–25 years after restoration started.
- (b) Based on the data in the graph, **describe** the relationship between the average number of species and the age of the spontaneous restoration piles.

Scientists hypothesized that after 35 years, the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles.

- (c) Using the data in the graph, **make a claim** that supports or refutes the hypothesis that the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles.
- (d) **Describe** a characteristic of a plant species that would have been present in the spontaneous restoration piles from years 1 to 5.
- (e) **Explain** how the return of plant life would have been altered in the spontaneous piles if the mining had taken place in the tundra rather than in temperate forests.

Limiting runoff on disturbed land improves soil and water quality. To model water runoff, students set up three large plastic trays and filled each tray with loam soil to 1 centimeter below the edge. Loam soil is a balance of sand, silt, and clay soil. One tray was seeded with wheatgrass and grown for 30 days, one tray was covered with small wood chips, and one tray was soil only. Five hundred milliliters of water was sprinkled evenly onto the soil surface of each tray. All three trays were placed on a slight slope, and water that ran off the surface was collected. The results are shown in the following table.

Tray	Water Collected (mL)	Water Appearance
Wheatgrass grown in soil; no small wood chips	190	Clear
Small wood chips covered soil; no wheatgrass	300	Transparent; light brown
Soil only; no wheatgrass or small wood chips	360	Cloudy; dark brown

- (f) **Identify** the scientific question for the investigation.
- (g) **Identify** a dependent variable in the experiment.
- (h) **Explain** how the results of the experiment would likely have been altered if the soil had contained a higher percentage of sand, which has the largest particle size of the components of loam.

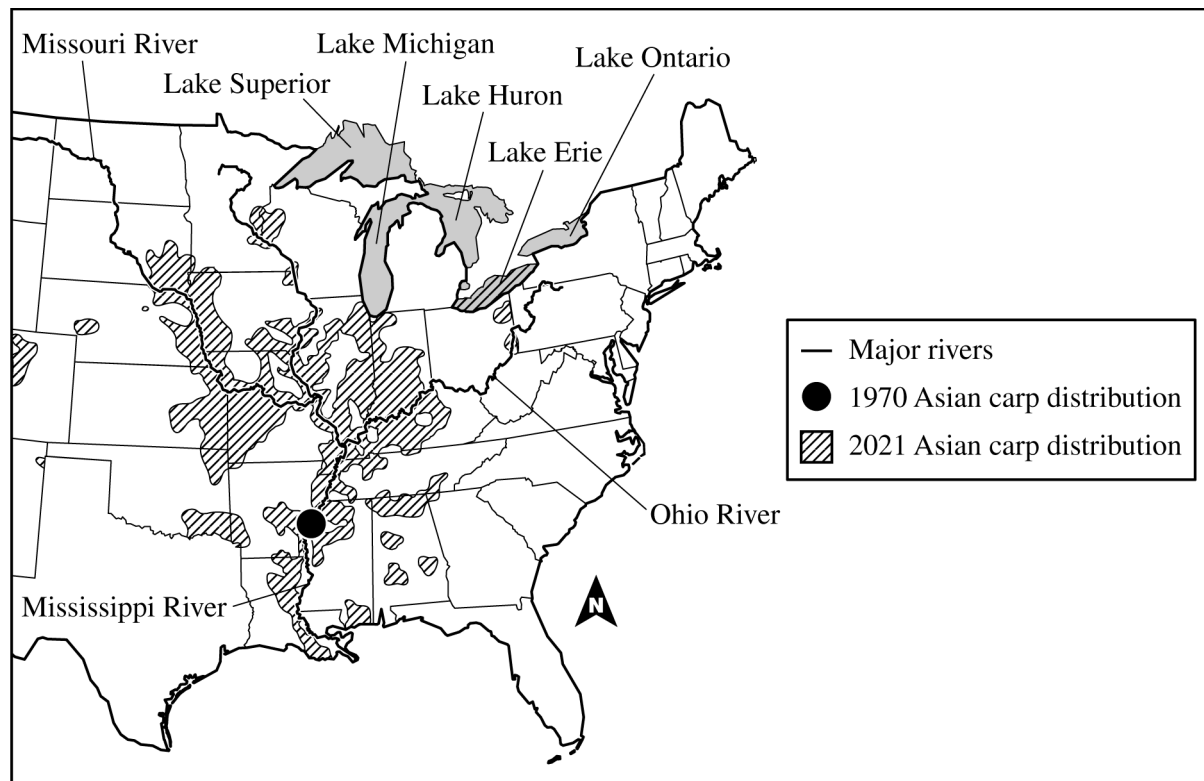
Runoff from mining waste can also affect water quality.

- (i) **Describe** one ecological impact that could result from the drainage from mine waste into nearby waterways.
- (j) **Describe** one strategy to reduce the drainage from mine waste into waterways downstream from mines.

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. 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.

3. Human activities generate large amounts of solid waste, including organic waste. The decomposition of organic waste in landfills can result in the release of methane into the atmosphere.

(a) **Describe** one environmental problem associated with the release of methane into the atmosphere.

There are biological and physical factors that can affect the decomposition of the solid waste in a landfill and the release of methane in the atmosphere.

(b) **Describe** one factor that could affect the decomposition of the solid waste in a landfill.

(c) **Propose** a solution to decrease the amount of methane released from landfills into the atmosphere.

(d) **Justify** the solution proposed in part (c) by describing an additional advantage, other than decreasing the amount of methane released from landfills.

Another anthropogenic activity that releases methane is raising beef cattle. In 2021, 31.2 million beef cattle were raised in the United States.

(e) The average cow releases 150 liters of methane per day. **Calculate** the amount of methane that was released by all beef cattle raised in the United States in 2021. **Show** your work.

Another environmental concern with raising beef cattle for food is that it is not as efficient as growing crops for food.

(f) A typical beef cow needs 11.8 kilograms of food per day, and each hectare of cattle pasture produces 26.2 kilograms of grasses. **Calculate** the number of hectares of pasture that would be needed to support all beef cattle raised in the United States for one day. **Show** your work.

(g) The average American consumes 2,250 kilocalories of food per day. Beef cattle can produce 2.7 million kilocalories per hectare of land. Corn can produce 30.4 million kilocalories per hectare of land. **Calculate** how many more American people could be fed if 150 hectares of land was used to grow corn instead of raising beef cattle. **Show** your work.

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.

STOP

END OF EXAM