

Question 1: Design an Investigation**10 points**

(a) **Identify** the ecological change over time illustrated in the diagram. **1 point**

- Primary Succession

(b) **Identify** the stage in which pioneer species first appear. **1 point**

- II/2

(c) **Describe** how soil forms from stage II to stage III. **1 point**

Accept one of the following:

- Wind/rain/weather can erode the rock/parent material.
- Wind/rain can break down rocks.
- Pioneer species (lichen/algae/fungi) die off adding small amounts of organic material.
- Pioneer species (lichens/algae/fungi) help break down rocks.

(d) **Identify** a cultural ecosystem service that may be provided by a mature forest. **1 point**

Accept one of the following:

- Recreation
- Aesthetic enjoyment
- Spiritual use
- Ecotourism
- Education

(e) **Identify** a testable hypothesis being investigated by the researchers. **1 point**

Accept one of the following:

- The removal of trees/clear-cutting will lead to an increase/decrease in water quality (temperature/turbidity/dissolved oxygen).
- The removal of trees/clear-cutting will have no effect on water quality (temperature/turbidity/dissolved oxygen).
- Water quality (temperature/turbidity/dissolved oxygen) will increase/decrease between stations.
- Water quality (temperature/turbidity/dissolved oxygen) will not change between stations.

(f) **Identify** the independent variable in the experiment. **1 point**

Accept one of the following:

- Presence or absence of clear-cutting
- Intact or clearcut forest
- Location of stream monitoring stations

(g)	Describe the purpose of forest A in the experiment.	1 point
	Accept one of the following: • Forest A/It is included so the researchers can compare the temperature/turbidity/water quality in clear-cut areas (forest B) to intact areas. • Forest A/It acts as a control so researchers can compare intact areas/Forest A to clear-cut areas/Forest B.	
(h)	Explain why the water temperature might change because of clear-cutting trees in forest B.	1 point
	Accept one of the following: • Water temperature will increase because there will be no/fewer trees to block the sunlight. • Water temperature will increase because there will be additional sediment from erosion. • Water temperature will increase because more sunlight will reach the water surface.	
(i)	Explain why an indicator of water quality other than temperature could be altered by the golf course in forest B.	1 point
	Accept one of the following: • There could be a decrease in dissolved oxygen because fertilizer runoff leads to algal blooms/eutrophication. • There could be a decrease in sedimentation/turbidity because the grass will decrease erosion compared to the clear-cut land. • There could be an increase in nitrates/phosphates due to fertilizer runoff resulting in algal growth/bloom.	
(j)	Explain how the aquatic organisms living in the lake illustrated in the diagram of forest B are likely to be affected by the new golf course.	1 point
	Accept one of the following: • Aquatic organisms would die off from a lack of oxygen created by the decomposition of algae/eutrophication. • Aquatic organisms would survive at a higher rate because there is less sediment to suffocate them/clog their gills. • Aquatic organisms would die off due to increased toxicity from pesticide runoff.	

Total for question 1 10 points

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

(a) Based on the information in the diagram, **identify** the temperature range of the water through which the majority of the adult manatee's daily movement occurs. 1 point

- 13–19°C

(b) Large groups of manatees are often observed in shallow waters near the waste water released by the electrical power plant during the winter. Based on the information in the diagram, **identify** a characteristic of the power plant waste water that would attract the manatees. 1 point

Accept one of the following:

- The waste water/It is warm.
- The waste water/It is between 24–26°C.

(c) Based on the information in the diagram, **describe** a potential negative impact of the waste water released by the power plant on other aquatic species. 1 point

Accept one of the following:

- Warming of the water near where the waste water/it is released reduces the amount of dissolved oxygen available for aquatic organisms to use/breathe.
- Warming of the water near where the waste water/it is released could impact the survival/health of species with a range of tolerance for the original/lower water temperatures.
- Warming of the water near where the waste water/it is released could alter/affect the timing of reproductive cycles for aquatic species.

(d) (i) **Describe** a characteristic of the manatees that increases their vulnerability to the recent decline of seagrasses. 1 point

Accept one of the following:

- They eat seagrass/are herbivores, so they would have less food/starve.
- They require a lot of energy to survive, so they would have less food/starve.
- They inhabit warm water, so they would need to travel to colder waters/further to find food/seagrass.
- They have a low reproductive/maturation rate, so they would take longer to recover from loss of food source.

(d) (ii) **Describe** the change in energy flow through the trophic levels that occurs when there is a significant loss of seagrasses. 1 point

Accept one of the following:

- Less energy will flow/is available to organisms in higher trophic levels.
- Less energy from the Sun is stored by producers.

Total for part (d) 2 points

(e) (i)	Propose a solution to reduce nutrient or sediment pollution in an estuary that is surrounded by urban development.	1 point
	Accept one of the following:	
	• Replace existing pavement with permeable pavement. • Add vegetation where it will intercept runoff. • Reduce fertilizer use in the area. • Install barriers/Construct fences where they will intercept runoff. • Improve wastewater treatment plants in the area.	
(e) (ii)	Justify the solution proposed in part (e)(i) by providing an additional advantage of reduced nutrients in an estuary, other than one related to manatees.	1 point
	Accept one of the following:	
	• Reduces eutrophication. • Increases biodiversity/species richness. • Improves water clarity. • Increases ecotourism. • Reduces cost of water treatment. • Increases profits for commercial fisherman.	
	Total for part (e)	2 points
(f)	Describe how summertime weather conditions can increase the frequency of photochemical smog.	1 point
	Accept one of the following:	
	• Sunlight is more intense/there is more sunlight in summer, and more primary pollutants/nitrogen oxides/NO_x react in sunlight. • Summertime temperatures are warmer than other seasons, and chemical reactions occur more quickly in warmer temperatures. • Trees release more VOCs in summer leading to more reactions that form photochemical smog.	
(g)	Identify one ecological problem that results from exposure to photochemical smog.	1 point
	Accept one of the following:	
	• Causes respiratory problems/eye irritation in animals. • Reduces photosynthesis. • Slows/Inhibits/Stunts plant growth. • Increases the susceptibility of plants to pests and disease.	

(h) **Describe** a potential disadvantage of using hydrogen fuel cells to power automobiles. **1 point**

Accept one of the following:

- High cost to manufacture automobiles that use hydrogen fuel cells.
- Obtaining hydrogen requires a lot of energy/may consume more energy than the hydrogen fuel can produce.
- Hydrogen is explosive/flammable (may catch fire).
- Lack of infrastructure (such as fueling stations) for hydrogen fuel.
- Obtaining hydrogen often uses fossil fuels.
- Hydrogen must be obtained by separating it from natural gas or water.

Total for question 2 10 points

Question 1: Design an Investigation**10 points**

- (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. **1 point**

Accept one of the following:

- 8
- 9

- (b) Based on the data in the graph, **describe** the relationship between the average number of species and age of the spontaneous restoration piles. **1 point**

Accept one of the following:

- The number of species increases with age of piles.
- The average number of species increases as the years since restoration increase.
- There is a direct/positive relationship/correlation between the two variables.

- (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. **1 point**

- The spontaneously restored areas support more plant species, which provides habitat, food, and/or shelter for animal species.

- (d) **Describe** a characteristic of a plant species that would have been present in the spontaneous restoration piles from years 1 to 5. **1 point**

Accept one of the following:

- A description of a characteristic of pioneer or generalist species such as:
 - Able to grow with little/poor soil
 - Able to grow in soil with low organic matter/low nutrients
 - Able to grow in full sunlight
 - Able to colonize an area quickly
 - Able to grow in a wide range of habitats

- (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. **1 point**

Accept one of the following:

- It would be slower because it is colder/growing season is shorter/there is less rain.
- It would include plants that are native to the tundra not the temperate forests.
- It would reflect the lower species diversity found in the tundra.

(f) **Identify** the scientific question for the investigation. **1 point**

Accept one of the following:

- Does the presence of vegetation affect the amount/appearance of runoff?
- Does the presence of soil covering affect the amount/appearance of runoff?
- Does the presence of different materials affect the amount/appearance of runoff?

(g) **Identify** a dependent variable in the experiment. **1 point**

Accept one of the following:

- Water collected
- Runoff volume
- Water appearance

(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. **1 point**

Accept one of the following:

- The amount/volume of water collected/runoff would decrease because more water would infiltrate into the soil.
- The water collected could be clearer as the sand particles settle faster.

(i) **Describe** one ecological impact that could result from the drainage from mine waste into nearby waterways. **1 point**

Accept one of the following:

- Acidic/low pH runoff could be outside the range of tolerance of some species.
 - Acidic/low pH runoff could lead to disease/death of some species.
 - Heavy metals in runoff can accumulate/biomagnify in wildlife leading to disease/death.
 - Soils may run off into nearby waterways and could increase turbidity/sedimentation outside the range of tolerance of some species.
 - Soils may run off into nearby waterways and could increase turbidity/sedimentation leading to disease/death.
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- (j) **Describe** one strategy to reduce the drainage from mine waste into waterways downstream from mines. **1 point**

Accept one of the following:

- Vegetation can be planted, reducing sediments/heavy metals flowing into streams.
- Mine waste can be covered with soil/plastic/concrete.
- Mine waste can be covered with lime or other alkaline substances.
- Mine waste can be removed to another location that cannot run off into waterways.
- Water can be diverted to avoid contact with mining waste.
- Contaminated water can be treated to reduce acidity.
- Contaminated water can be treated to remove heavy metals.
- Mine waste can be disposed underwater.
- Mine waste drainage can be diverted into holding basins.

Total for question 1 10 points

Question 1: Design an Investigation**10 points**

- (a) (i) **Identify** the land use that covers the least amount of area in the Mississippi River watershed, based on the diagram. **1 point**

- Urban

- (ii) **Describe** one way that land use practice at location X in the diagram could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Fertilizer used on croplands is washed into the streams and rivers in the watershed and feeds the growth of algae once it reaches the Gulf.
- Concentrated animal feeding operations generate large amounts of organic wastes that can move into streams and rivers, feeding the growth of algae once it reaches the Gulf.
- Treated or untreated (overflows) sewage released from wastewater treatment plants feeds the growth of algae once it reaches the Gulf.

- (iii) **Describe** one way that urban areas in the Mississippi River watershed could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Wastewater treatment facilities in urban areas may release nutrients in treated wastewater and/or overflows, with this effluent flowing into the Gulf.
- Impervious surfaces in urban areas can increase the movement/runoff of lawn fertilizers or high-phosphate detergents that move onto pavement areas and flow into the Gulf.

Total for part (a) 3 points

- (b) (i) **Describe** how a dead zone affects marine organisms living in the Gulf of Mexico. **1 point**

Accept one of the following:

- Many organisms are forced to migrate or will die as a result of low dissolved oxygen levels in the water.
- Many organisms are forced to migrate or will die as a result of algal blooms that block sunlight from reaching underwater plants (submerged aquatic vegetation).

- (ii) **Describe** one economic effect on communities along the Gulf of Mexico that can result from the presence of the dead zone. **1 point**

Accept one of the following:

- Decreased fish catch/decreased income for fishing industry
- Decreased tourism/lower tourism revenues
- Increased fuel costs for fishing vessels that need to travel farther to locate fish, therefore there will be a decrease in income/profits for fishing industry
- Increased costs for consumers as a result of a limited supply of fish

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- (iii) **Describe** one factor that causes the area of the dead zone in the Gulf of Mexico to increase during the summer months. **1 point**

Accept one of the following:

- Increased runoff of nitrates/phosphates/potassium from fertilizer used during the growing season leads to increased algal growth in the summer months.
- Increased precipitation/snowmelt/water volume carries more fertilizer runoff from urban or agricultural areas leading to increased algal growth.
- Higher water temperatures in the summer decrease the concentration of dissolved oxygen as warm water does not hold as much dissolved oxygen as cold water.
- Increased runoff of fertilizer or high-phosphate detergents used in urban areas leads to increased algal growth in the summer months.

Total for part (b) 3 points

- (c) (i) **Identify** a testable hypothesis for the study. **1 point**

Accept one of the following:

- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be lower than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be higher than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will remain the same in areas with and without riparian buffers.

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- (ii) **Describe** a control that the researchers could use in the study. **1 point**

- Stream sites that are 100 meters downstream from areas without riparian buffer zones

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- (iii) **Identify** one water quality test, other than measuring nitrates or phosphates, that the researchers could use to evaluate how riparian vegetation buffers affect water quality. **1 point**

Accept one of the following:

- Turbidity
 - Total suspended solids (TSS)
 - Dissolved oxygen
 - Water temperature
 - Fecal coliform
 - Conductivity
 - pH
 - Biological oxygen demand (BOD)
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- (iv) During the investigation, researchers discovered that some of the land next to one of the streams with a riparian vegetation buffer is going to be converted from cornfields into a large-scale concentrated animal feeding operation. **Explain** one way that this change in land use could alter the results of the study. **1 point**

Accept one of the following:

- There would be a decline in water quality from increased nutrients/increased coliform bacteria in the runoff because there is animal waste in the areas near concentrated animal feeding operations that are high in nutrients/coliform bacteria.
- There would be a decline in water quality from increased turbidity/increased total suspended solids in the streams near the concentrated animal feeding operations because particles from animal wastes enter the stream/there is increased disruption of the stream bed from animals in the water.
- There would be a decline in water quality from increased water temperature because the increased turbidity/suspended solids in streams near the concentrated animal feeding operations absorb sunlight/heat.
- There would be a decline in water quality from increased conductivity because there is increased water temperature/increase dissolved salts in streams near concentrated animal feeding operations.
- There would be a decline in water quality from antibiotics/veterinary drugs in runoff near the concentrated animal feeding operations because antibiotics/drugs are used in livestock operations but not to grow crops.

Total for part (c) 4 points
Total for question 1 10 points
