

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

(a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen. **1 point**

- Zone C/C

(b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen. **1 point**

Accept one of the following:

- As biological oxygen demand increases, dissolved oxygen decreases.
- As biological oxygen demand decreases, dissolved oxygen increases.
- As dissolved oxygen increases, biological oxygen demand decreases.
- As dissolved oxygen decreases, biological oxygen demand increases.

(c) Based on the information in the diagram, **identify** the zone where there is likely point-source water pollution discharged into the stream. **1 point**

- Zone B/B

(d) **Identify** the dependent variable in the researchers' investigation. **1 point**

Accept one of the following:

- The number of macroinvertebrate species
- Macroinvertebrate diversity
- Macroinvertebrate species richness

(e) **Identify** a testable hypothesis for the researchers' investigation. **1 point**

Accept one of the following:

- As dissolved oxygen levels increase, the number of macroinvertebrate species increases.
- As dissolved oxygen levels decrease, the number of macroinvertebrate species increases.
- There is a direct/inverse relationship between dissolved oxygen levels and the number of macroinvertebrate species.
- There is no relationship between biological oxygen demand and macroinvertebrate biodiversity.

(f)	Describe the reason the researchers selected zone A to serve as the control in the investigation.	1 point
	Accept one of the following:	
	• Zone A/A/It is upstream from the source of pollution/organic waste/discharge/change. • Zone A/A/It would not be affected by the source of pollution/organic waste/discharge/change. • Zone A/A/It has levels of dissolved oxygen that are not impacted by the source of pollution/organic waste/discharge/change.	
(g)	Explain how the modification to collect data in the winter months could alter the results of the investigation.	1 point
	Accept one of the following:	
	• Cold water will have more dissolved oxygen, which could increase the number of species. • Colder water may be below the range of tolerance for some of the organisms, which could decrease the number of species. • Lower light levels in the winter decrease plant activity/photosynthesis, which lowers dissolved oxygen levels, which could decrease the number of species.	
(h)	Describe the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream.	1 point
	Accept one of the following:	
	• Raw sewage contains nutrients that could increase the population of bacteria. • Raw sewage contains bacteria that could increase the population size.	
(i)	Identify an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream.	1 point
	Accept one of the following:	
	• Temperature • pH • Light/Sunlight • Turbidity/Sediment • Salinity • Nitrate/Phosphate	

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- (j) **Explain** how persistent organic pollutants can affect higher trophic levels in an aquatic food web. **1 point**
- Accept one of the following:
- Persistent organic pollutants/Pollutants can bioaccumulate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
 - Persistent organic pollutants/Pollutants can accumulate/concentrate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
 - Persistent organic pollutants/Pollutants can bioaccumulate in organisms at higher trophic levels because of higher fat content in their tissues.
 - Organisms at higher trophic levels can experience neurological toxicity because persistent organic pollutants bioaccumulate.
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Total for question 1 10 points

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

- (a) Pesticide use has advantages, disadvantages, and unintended consequences on human health. **Describe** one benefit to human health that can result from the use of pesticides. **1 point**

Accept one of the following:

- Control disease vectors, such as mosquitos, ticks, rats, mice that can spread diseases to humans/between humans.
- Reduce exposure to stinging insects that carry disease.
- Increased food production leads to decreased famine/increased availability of food, improving human health.

Total for part (a) 1 point

- (b) **Identify** one way chemical pesticides can enter the human body. **1 point**

Accept the following:

- Inhalation/Breathing (in aerosols and powders)
- Drinking water contaminated by runoff (from farms, yards, golf courses, etc.)
- Consumption of food (pesticide residue on or in food eaten by consumers)
- Dermal absorption/through skin during application of pesticide

Total for part (b) 1 point

- (c) (i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population. **1 point**

- 1975

- (ii) **Describe** the change in the number of crop insect pests in the cotton fields over time. **1 point**

Accept one of the following:

- From 1960 to 2015 the number of pests captures increased from 700 to 1100.
- The number of pests was high before the pesticide was used, then it dropped dramatically after the first application and then increased again over time.
- The number of pests went from 2 captured in 1975 to 1100 captures in 2015.

- (iii) **Explain** how the change in the cotton-crop pesticide effectiveness between the initial application in 1975 and the latest application in 2015 illustrates genetic resistance in pests, based on the data in the table. **1 point**

Accept one of the following:

- Over time the number of pests that are killed decreases (more pests are found in traps), and more pesticide has to be applied (increased grams per hectare) because the pests that are resistant to the pesticide survive and reproduce, passing along resistance to the pesticide.
- The data in the table illustrates the pesticide treadmill, where each year more pesticide has to be applied, and fewer pests die because following the application only pests with resistance to the pesticide survive and reproduce.
- Pesticide effectiveness following the initial application in 1975 decreased over time. Regardless of whether application quantities were constant (1975-1985) or increased (1990-2015), the number of pests captured steadily increased because an increasing number of surviving pests had genetic resistance to the pesticide.

Total for part (c) 3 points

- (d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife. **2 points**

Accept two of the following:

- The pesticide may contaminate soil/water having a negative impact on organisms.
- The pesticide may bioaccumulate in the body of the organisms.
- The pesticide may biomagnify in the food web/chain of the organisms.
- There may be an increase in the population of non-target organisms unaffected by the pesticide that will have new areas of habitat available to them.
- There could be a decrease in predator species, so prey species will grow rapidly.
- Endocrine disruption leading to reproductive/development abnormalities.
- Chemicals disrupt signaling/communication in bees.
- Lead to thinning of eggshells/developmental abnormalities in organisms.
- Eliminates food supply; disrupts food chain for other species.

Total for part (d) 2 points

- (e) (i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation. **1 point**

Accept one of the following:

- The process of growing different crops in succession on the same piece of land.
- The process of growing different crops in the same area during different seasons.
- The process of harvesting one crop followed by the planting of a different crop in the same area.

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- (ii) **Propose** one reasonable method, other than crop rotation, to reduce the use of pesticides in agricultural practices while still maintaining a high crop yield. **1 point**

Accept one of the following:

- Use integrated pest management to control the insect crop pest.
- Use a method of pest control that employs a variety of biological, physical, and chemical methods to control the insect crop pest.
- Reduce stubble/crop residues in fallow fields that can harbor the insect crop pest.
- Apply the pesticide when the insect crop pest is most susceptible.
- Use intercropping rather than a monoculture to reduce the amount of habitat for the pests.
- Use pest-resistant genetically modified organisms.

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- (iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans. **1 point**

Accept one of the following:

- Reduction in pesticide residue in food/reduction of pesticide ingested by humans.
- Economic benefits to humans including:
 - Less money spent on pesticides
 - Increased profit for farmers from crops
 - Less equipment required/less labor required to spray fields with pesticides
- Reduction in the number of workers exposed to pesticides/Improved health in agricultural workers from reduced pesticide exposure.

Total for part (e) 3 points

Total for question 2 10 points

Question 2: Analyze an Environmental Problem and Propose a Solution**10 points****(a) (i) Identify** the latitudinal range with the greatest amphibian species richness.**1 point**

Accept one of the following:

- Between the Tropic of Cancer and the Tropic of Capricorn
- The range between 30 degrees N and 30 degrees S latitude
- The range between 10 degrees N and 15 degrees S latitude

(ii) Identify what biome this range most likely represents.**1 point**

- Tropical Rainforest

(iii) Describe one reason amphibian species richness would tend to be highest in this region.**1 point**

Accept one of the following:

- More rainfall/warm temperatures year-round are the preferred conditions for amphibians.
- Greater biodiversity/higher NPP provides more habitat/food sources/niches.

Total for part (a) 3 points**(b)** There are many environmental threats facing amphibians today, such as deforestation.**1 point****Describe** one possible anthropogenic reason for deforestation.

- Human demand for agriculture/housing/firewood/forest products (medicine/food/lumber).

(c) (i) Explain how the species richness of an ecosystem influences its response to environmental stressors.**1 point**

- An ecosystem with greater species richness/diversity is more resilient/resistant to environment stressors because some species will survive helping to restore/stabilize the ecosystem.

(ii) Explain why amphibian biodiversity is declining globally, other than from deforestation. **1 point**

Accept one of the following:

- Increasing water pollution including:
 - Pollution from pharmaceuticals that cause reproductive harm/decrease reproductive success.
 - Pesticide pollution that is absorbed via the skin and is toxic to amphibians leading to death.
 - Endocrine disruptors (such as atrazine) can alter reproductive development leading to decreased number of successful offspring.
- Pesticide use reduces food sources for amphibians (insects), leading to decreasing population size.
- Microclimatic changes from overall global climate change (e.g., warmer, drier conditions in previously cool, moist areas, loss of wetlands) decreases available habitat leading to a decline in population size.
- Illegal amphibian trafficking removes species from an area leading to a decline in population sizes.
- Introduction of invasive species that compete for niche space leading to a decline in population sizes.
- Habitat fragmentation from human activity would limit range/reduce the ability to access resources, decreasing survival.
- Fungal infections (such as Chytrid) cause their skin to dry out, and they cannot breathe.

Total for part (c) 2 points

(d) (i) Identify one specific piece of legislation that has been designed to protect species threatened by extinction. **1 point**

Accept one of the following:

- Endangered Species Act (ESA)
 - Convention on the International Trade of Endangered Species (CITES)
 - Lacey Act
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- (ii) **Explain** how the requirements of the legislation identified in part (d)(i) specifically protect species threatened by extinction. **1 point**

Accept one of the following:

Legislation identified in (d)(i)	Explanation of requirements that specifically protect species threatened by extinction
Endangered Species Act (ESA)	- Lists endangered/threatened plant and animal species and prevents them from being killed or harmed. - Designates/protects critical habitat to promote survival and recovery of listed species. - Creates plans to restore populations to healthy sizes. - Identifies species that are threatened before they become endangered to provide protections.
Convention on the International Trade of Endangered Species (CITES)	A global agreement that protects endangered/threatened plants and animals (including goods such as ivory, shark fins, or rhinoceros' horns) by banning/regulating the trade of these species.
Lacey Act	Prohibits the trade of wildlife, fish, and plants that have been illegally taken, possessed, transported, or sold.

Total for part (d) 2 points

- (e) (i) **Propose** a viable solution that will result in the protection of the endemic frog species while still allowing for maximum profit of the property development. **1 point**

Accept one of the following:

- Move/transplant the frog populations to an adjacent undeveloped area prior to development.
- A portion of the wetland can be designated as a park/preserve.
- Wildlife corridors (land/bridges) can be built/created on a portion of the wetlands.
- Restrict development within a minimum setback away from the wetland.
- Project developers can group buildings together/can build up, not out.

- (ii) **Justify** the solution proposed in (e)(i) by describing a potential advantage of the plan, other than frog protection. **1 point**

Accept one of the following:

Solution proposed in (e)(i)	Justification of how solutions offer potential advantages, other than frog protection
Move/transplant frogs	- Developers will only have a one-time disruption during the removal but will not have to deal with continued disruptions (such as increasing human population, increasing use of fertilizer/pesticides). - Developer will have the maximum amount of land available.
Designate as a park/preserve	- By protecting areas, animal species will have more food and space availability increasing survival rates. - Potential educational/environmental draw of living near a park/preserve may allow the developer to charge higher rents for the apartments. - There is aesthetic value of the wetland and its species for the people that live there. - The preserved wetland area will help prevent flooding.
Use of wildlife corridors	- By establishing corridors, the other species will also not be as greatly affected by multiple habitat fragments. - The animal species can continue to move back and forth for food, shelter, and reproduction by way of the habitat corridors.
Setback	- By establishing setbacks, a buffer zone will be created between the development and the wetland area, filtering runoff into the wetland. - A buffer zone will add privacy for residents between the two developments.
Project development	By developing the apartments in groups/clusters and leaving preserved wetlands, the species will not be as affected by multiple habitat fragments.

Total for part (e) 2 points

Total for question 2 10 points