

Question 2: Analyze an Environmental Problem and Propose a Solution

10 points

A	Based on the information in Figure 1, identify the type of plate boundary that runs beneath Serengeti National Park. Acceptable identification point: Divergent (boundary)	Point 01
B	Based on the information provided, identify the dominant biome within the Serengeti. Examples of acceptable responses may include the following: - Savanna - Tropical grassland	Point 02
C	Wildebeest give birth to their young when new grasses are growing. Based on the information in Figure 2, identify the location in the Serengeti where wildebeest are most likely to give birth. Examples of acceptable responses may include the following: - Grumeti Game Reserve - The west/northwestern side/edge (of Serengeti National Park)	Point 03
D	Explain why resource partitioning allows for the coexistence of the wildebeest and the gazelle in the Serengeti. Examples of acceptable responses may include the following: (Resource partitioning) reduces the (negative) impact of competition for (limited) resources. (Resource partitioning) allows species to use (limited) resources in different ways/places/at different times.	Point 04
E	Describe one way the proposed highway shown in Figure 2 could negatively affect the wildebeest population in the Serengeti. Examples of acceptable responses may include the following: - Building the highway would fragment/destroy habitat/food/resources. - The highway could prevent/reduce/disturb migration. - Wildebeest could be hit/killed by vehicles. - Noise pollution could cause stress/change migratory routes.	Point 05

F **Propose** a solution to the negative effect created by the planned highway described in part E. **Point 06**

Examples of acceptable responses may include the following:

Problem in part E	Realistic Potential Solution
Building the highway would fragment/destroy habitat/food/resources.	- Construct a habitat corridor over/under the highway - Construct the highway over/above the habitat - Relocate the highway north/outside of the migratory path - Expand the national park/create additional protected habitat
The highway could prevent/reduce/disturb migration.	- Relocate the highway north/outside of the migratory path - Construct a habitat corridor over/under the highway
Wildebeest could be hit/killed by vehicles.	
Noise pollution could cause stress/change migratory routes.	- Install a sound barrier to mitigate noise pollution - Relocate the highway north/outside of the migratory path

G **Describe** a characteristic of an invasive species, such as the spotted knapweed, that allows them to outcompete native species. **Point 07**

Examples of acceptable responses may include the following:

- They have many offspring/reproduce quickly/mature early/invest minimal energy in each offspring (tend to be r-selected).
- They can feed on/use many different types of resources.
- They can survive in conditions outside their normal habitat/have a wide range of tolerance (tend to be generalists).

H **Justify** the use of crop rotation as an environmental solution by providing an additional advantage, other than controlling pest populations. **Point 08**

Examples of acceptable responses may include the following:

- Improved soil fertility/soil structure/soil quality
- Increased nutrient cycling/reduction in fertilizer use
- Reduced soil erosion
- Increased food security/crop yield
- Increased biological activity (in the soil)

I **Describe** an environmental problem associated with controlling pest populations with large amounts of pesticide. **Point 09**

Examples of acceptable responses may include the following:

- Pesticides can harm/kill nontarget species.
- Pests can develop resistance to the pesticide.

J **Propose** a solution to controlling pests, other than pesticides or crop rotation. **Point 10**

Examples of acceptable responses may include the following:

- Use biocontrol/intercropping/natural predators
- Trap insects/use mechanical controls to eliminate the pests
- Use genetically modified crops that are pest resistant

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(a) Based on the data in the graphs, **identify** the amount of land required to produce 1 kilogram of chicken protein. **1 point**

- 50 m²

(b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle. **1 point**

- Type III

(c) **Explain** why the reproductive strategy of the darkling beetle is an advantage for using mealworms as an alternative protein source for the rapidly growing human population. **1 point**

Accept one of the following:

- Darkling beetles reproduce quickly, which allows for a large amount of protein to be produced in a short period of time.
- Darkling beetles have many offspring, which allows for a large amount of protein to be produced in a short period of time.

(d) Based on the data in the graphs, **explain** whether producing 1 kilogram of chicken protein or 1 kilogram of pork protein would cause less environmental damage. **1 point**

Accept one of the following:

- Chicken production has a lower global warming potential than pork production, so it would cause less environmental damage because chicken production releases less greenhouse gas.
- Chicken production has a lower land use than pork production, so it would cause less environmental damage because there would be less deforestation/habitat destruction/soil erosion/fossil fuel use.

(e) Based on the data in the graphs, **explain** why the production of 1 kilogram of beef protein has a different impact on global warming than the production of 1 kilogram of protein from any of the other animals studied would have. **1 point**

Accept one of the following:

- Beef has a larger impact because methane has a high global warming potential.
- Beef has a larger impact because methane is a greenhouse gas.
- Beef requires more land use, which results in loss of forests/habitat/grasslands leading to release of CO₂/reduction in carbon storage.

- (f) **Describe** how water quality can be altered by cattle grazing that occurs near a stream or river. **1 point**

Accept one of the following:

- Cattle cause erosion, which increases sedimentation/turbidity in water.
- Cattle feces can add nutrients/nitrogen/phosphorus to waterways.
- Cattle feces may contaminate waterways with bacteria.

- (g) **Propose** a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze. **1 point**

Accept one of the following:

- Practice rotational grazing/alternate grazing parcels.
- Eat a diet with less meat/beef.
- Fence/barricade the riparian zone.
- Provide other water sources for the cattle.

- (h) Crop production can cause soil erosion. **Describe** a sustainable agricultural practice used to reduce soil erosion. **1 point**

Accept one of the following:

- Switch crops to perennial plants.
- Plant crops on terraces.
- Implement contour plowing/farming.
- Use no-till farming/cover crops.

- (i) **Justify** the use of the sustainable practice described in part (h) by describing an additional advantage, other than the reduction of soil erosion. **1 point**

Accept one of the following:

Solution proposed in (h)	Justification of solution with additional advantage other than the reduction of soil erosion
Switch to perennial plants	• Reduces the use of fossil fuels. • Reduces the cost of farming. • Increases/maintains carbon storage in soils. • Preserves habitats for organisms in soils.
Plant crops on terraces	• Allows areas to be farmed that are otherwise too steep. • Sediments and other contaminants settle out behind the terrace ridge reducing the amount of soil that runs off. • Increases groundwater absorption.
Implement contour plowing/farming	• Allows areas to be farmed that are otherwise too steep. • Increases groundwater absorption.
Use no-till farming/cover crops	• Reduces the use of fossil fuels. • Reduces the cost of farming. • Increases/maintains carbon storage in soils. • Preserves habitats for organisms in soils. • Cover crops can be used as green manure.

- (j) Crop production around the world is affected by climate change. **Describe** how crop production could be negatively affected by climate change. **1 point**

Accept one of the following:

- Crop production/yields could decrease because of:
 - Increased drought
 - Increased flooding
 - Increased insect infestation from warmer temperatures
 - Increased temperature
 - Changes in seasonal rain patterns (or temperatures)
 - Expansion of geographic range of invasive pests/species
 - Climate may be outside range of tolerance of crops

Total for question 2 10 points

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- (a) (i) Based on the data in the graph, **identify** the habitat type with the greatest number of lizards. **1 point**

- Clearings, Gardens

- (ii) Based on the data in the graph, **describe** the relationship between the lizard numbers observed on islands with and without mongoose populations. **1 point**

Accept one of the following:

- Lizard populations are smaller on islands where mongooses are present than on mongoose-free islands.
- Lizard populations are larger on mongoose-free islands than on islands where mongooses are present.
- The relationship between lizard number counted and mongoose population is an inverse relationship.

Total for part (a) 2 points

- (b) Based on the theory of island biogeography, **describe** the characteristics of an island with the greatest species diversity. **1 point**

- A large island that is located near the mainland will contain the greatest species diversity.

Total for part (b) 1 point

- (c) (i) **Describe** one environmental problem caused by invasive animal species. **1 point**

Accept one of the following:

- Invasive species outcompete native species for resources, causing food web disruptions/trophic cascades/habitat loss.
- Invasive species outcompete/prey on native organisms, decreasing biodiversity/reducing population size of native species.

- (ii) Invasive species are often pests. **Make a claim** that proposes one way to control pest species. **1 point**

Accept one of the following:

- Introduce biological controls, like natural predators of the species, to reduce the number of pests.
- Use chemical controls, such as pesticides, to kill off pests.
- Use manual/mechanical methods to remove plant species.
- Trap/hunt animal species and kill/remove them from the area.

- (iii) **Justify** the solution proposed in (c)(ii) by providing an additional benefit of the solution. **1 point**

Accept one of the following:

Solution proposed in (c)(ii)	Justification of solution with additional benefit
Introduce biological controls like natural predators of the species to reduce the number of pests	• Method least likely to harm other species because the pest species can be specifically targeted • Harmful synthetic chemicals are not introduced into the environment
Use chemical controls, such as pesticides, to kill off pests	• Quick/efficient method to reduce/eliminate pest species
Use manual/mechanical methods to remove plant species	• Method least likely to harm other species because the pest species can be specifically targeted • Harmful synthetic chemicals are not introduced into the environment • Financial gain from selling killed pest organisms
Trap/hunt animal species and kill/remove them from the area	• Method least likely to harm other species because the pest species can be specifically targeted • Harmful synthetic chemicals are not introduced into the environment • Financial gain from selling killed pest organisms

Total for part (c) 3 points

- (d) (i) **Identify** a provisioning ecosystem service provided by primary forests. **1 point**

Accept one of the following:

- Timber/lumber/wood
- Medicine
- Food

- (ii) Based on the data in the graph, **explain** how replacing primary forests with sugarcane fields may have affected the number of lizards counted on the mongoose-free Pacific islands. **1 point**

Accept one of the following:

- The cleared land is preferred habitat for the lizards, which led to increased numbers of lizards in the sugar cane fields compared to the forests.
- The cleared land has fewer predators, which led to increased numbers of lizards counted in the sugar cane fields compared to the forests.
- The cleared land has more food for the lizards, which led to increased numbers of lizards in the sugar cane fields compared to the forests.

- (iii) The long-term use of monocultures in commercial sugarcane farming is one cause of the ecological damage. **Describe** one problem associated with monocultures. **1 point**

Accept one of the following:

- Decreased genetic diversity of monoculture species
- Decreased species diversity
- Increased susceptibility of monoculture to disease/pests
- Depletion of nutrients from soil
- Increased use of irrigation water/fertilizer/pesticide

Total for part (d) 3 points

- (e) **Describe** an advantage of crop rotation using legumes on soil fertility. **1 point**

Accept one of the following:

- Improved nitrogen fixation in the soil
- Less nitrogen-based fertilizers required

Total for part (e) 1 point

Total for question 2 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.

- (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.

- (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