

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 graph, **identify** the year with the highest percentage of forest. **1 point**

- 1700

(b) Based on the data in the graph, **describe** the relationship between the land use changes in the wild grasslands and grazing from 1700 to 1950. **1 point**

Accept one of the following:

- The percentage/amount of wild grasslands has decreased, and the percentage/amount of grazing (land) has increased.
- The two variables have an inverse relationship.

(c) **Identify** an environmental problem associated with overgrazing by livestock. **1 point**

Accept one of the following:

- Loss of vegetation
- Soil erosion
- Desertification
- Sedimentation/turbidity in waterways
- Soil compaction

(d) A student hypothesized that the change in the percentage of forest from 1700 to 2018 has decreased atmospheric carbon dioxide concentrations. **Explain** whether the hypothesis is supported or refuted based on the data in the graph. **1 point**

- The hypothesis is refuted/disproved/not supported. The percentage of forest has decreased, so the amount of photosynthesis/carbon sequestration has decreased.

(e) **Describe** a water-related environmental problem associated with urbanization. **1 point**

Accept one of the following:

- Increased runoff/flooding because urban areas have more impermeable surfaces.
- Decreased groundwater/saltwater intrusion because urban areas have many people/groundwater is overused.
- Increased water pollution because precipitation/runoff can carry contaminants/pollutants/waste.
- Destruction of aquatic habitats from increased development/land use changes.

- (f) **Describe** a potential response to mitigate the environmental problem identified in part (e). **1 point**

Accept one of the following:

Environmental problem identified in part (e)	Potential response to mitigate environmental problem
Increased runoff/flooding	- Use permeable road/parking lot materials. - Set aside green spaces/parks/conservation areas. - Construct green roofs/rain gardens/storm water retention ponds/basins.
Decreased groundwater/saltwater intrusion	- Use permeable road/parking lot materials. - Establish groundwater conservation/management plans. - Set aside green spaces/parks/conservation areas in recharge zones. - Construct green roofs/rain gardens/storm water retention ponds/basins.
Increased water pollution	- Encourage walking/biking or other methods of transportation. - Reduce use of home pesticides/fertilizers. - Reduce use of road salts/de-icing chemicals. - Pick up trash and litter along waterways. - Dispose of toxic chemicals (for example, used oil and household cleaners).
Destruction of aquatic habitats from increased development/land use changes	- Create conservation areas/preserves/wetlands to protect aquatic habitats. - Restore degraded aquatic habitats.

- (g) **Explain** why there are fewer bobcats present on the farmland now compared to several decades ago. **1 point**

Accept one of the following:

- Loss of forest habitat has led to a decrease in resources/food/shelter/ mates/migration.
- Trapping/hunting has reduced the bobcat population.

- (h) **Describe** a disadvantage of introducing only a small population of bobcats. **1 point**

Accept one of the following:

- Small populations have lower genetic diversity.
- Genetic bottlenecks can lead to inbreeding/passing on negative traits.
- Small populations are more vulnerable to diseases/disturbances like wildfire.
- Small populations do not control small mammals/pests as well as large populations.
- Small populations are less likely to survive.

- (i) **Propose** a solution to improve the chances that the bobcat reintroductions will be successful in reestablishing wild populations. **1 point**

Accept one of the following:

- Increase connectivity/build habitat corridors (so bobcats can safely mate/find food/build dens).
- Restore/reforest/preserve areas of bobcat habitat.

- (j) **Justify** the solution proposed in part (i) by describing an additional advantage, other than reestablishing the bobcat population near the farms. **1 point**

Accept one of the following:

Solution proposed in part (i)	Justification of the proposed solution by stating an advantage
Increase connectivity/build habitat corridors (so that bobcats can safely mate/find food/build dens)	- Habitat corridors can be used by other species. - Habitat corridors would increase biodiversity/population of other species. - Habitat corridors can attract other species that might be beneficial for farmers (such as predators of pests and/or pollinator species). - Habitat corridors could help decrease road kills/the frequency of car accidents with wildlife.
Restore/reforest/preserve areas of bobcat habitat	- Restored habitat can be used by other species. - Restoration/reforestation/preservation could increase diversity/improve air quality/improve water quality. - An increase in the number of trees will improve aesthetic value/enhance tourism/reduce erosion/serve as a carbon sink.

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