

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

A **Describe** one reproductive strategy used by a K-selected species such as the chickadee. **Point 01**

Examples of acceptable responses may include the following:

- (K-selected species) provide considerable parental care for offspring.
- (K-selected species) have few offspring.
- (The parents) expend significant energy for each offspring.
- (Individuals) reproduce more than once in their lifetime.
- (K-selected species) have a long gestation period/reach reproductive maturity later.

B Based on the information provided, **explain** how a decrease in spider populations could affect a lower trophic level. **Point 02**

Examples of acceptable responses may include the following:

- Insects/insect populations would increase because the insects are not being preyed on/eaten as much.
- Plants/plant populations would decrease because the number of insects that eat plants will increase.

C Based on the data in Figure 1, **identify** the number of spiders per sample at 25% nonnative plants. **Point 03**

Examples of acceptable responses may include the following:

- 2.0
- 2

D Based on the data in Figure 1, **describe** the trend in the number of insects per sample in relation to the percentage of nonnative plants. **Point 04**

Examples of acceptable responses may include the following:

- As nonnative plant percentage/percent increases, the number of insects decreases.
- As nonnative plant percentage/percent decreases, the number of insects increases.
- They have an inverse/indirect/negative relationship.

E Scientists hypothesized that the population of chickadees would be stable or growing with fewer than 25% nonnative plants. **Describe** one way that the data in Figure 2 support this hypothesis. **Point 05**

Examples of acceptable responses may include the following:

- Below this level/With fewer than 25%, the growth rate is at/above replacement level.
- Below this level/With fewer than 25%, enough reproduction is occurring to replace the population.
- Below this level/With fewer than 25%, the population growth rate is positive.

F	(i) Identify a likely scientific question for the students' investigation of ant diversity. Point 06 Examples of acceptable responses may include the following: - Does the number of species/species richness/biodiversity differ between an urban park and a grassland? - Does mowing affect the number of species/species richness/biodiversity?
	(ii) Identify the dependent variable in the students' investigation. Point 07 Examples of acceptable responses may include the following: - Number of ant species - Ant species richness - Presence/absence of different ant species
G	(i) Explain why the ant community of the unmowed grassland would be more likely to recover from a disturbance, such as a flood or fire, than the ant community in the mowed urban park would. Point 08 Examples of acceptable responses may include the following: - With a larger number of species, the grassland is more likely to have some species/individuals with adaptations that allow them to survive. - The grassland is more diverse, so the loss of one species is less likely to cause a collapse (of the whole ecosystem).
	(ii) Explain how the results of the investigation could have been altered if students had measured ant biodiversity at a paved playground rather than in the grassland. Point 09 Examples of acceptable responses may include the following: (The playground) would have fewer species (than the grassland/urban park) because the paved area is not suitable habitat for many ant species. (The playground) would have fewer species (than the grassland/urban park) because humans could trample the ants/ant habitat.
H	Describe one effect a paved road in a forest can have on animal species such as deer or bears. Point 10 Examples of acceptable responses may include the following: - Animals can get hit by cars when trying to cross the road/hunt/migrate. - Fragmentation can lead to isolation of individuals/loss of genetic diversity. - Noise pollution can damage hearing/cause stress/mask the sounds used to communicate/hunt. - The road/noise pollution can cause changes in migratory routes/prevent movement of animals (to access resources). - Species that thrive in edge habitats might increase.

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

A Based on the data in the graph, **identify** the number of Common Tern breeding pairs in 1995. **Point 01**

Acceptable identification point:

- 1400

B Based on the data in the graph, **describe** the trend in the number of Common Tern breeding pairs from 1995 to 2008. **Point 02**

Examples of acceptable responses may include the following:

- The number of breeding pairs varies but shows an overall decrease.
- The number of breeding pairs decreases.

C A group of students hypothesized that sea level rise will lead to an increase in Common Tern populations. **Describe** one reason the data in the graph refute this hypothesis. **Point 03**

Examples of acceptable responses may include the following:

- The data suggest that a rise in sea level will decrease the number of breeding pairs.
- As sea level rises, fewer breeding pairs will likely lead to smaller populations.

D **Explain** how climate change can lead to sea level rise. **Point 04**

Examples of acceptable responses may include the following:

- Increasing global temperatures results in melting glaciers/land-based ice sheets.
- Increasing global temperatures causes ocean water expansion.

E **(i) Identify** a hypothesis that researchers are likely investigating in the wading bird study. **Point 05**

Examples of acceptable responses may include the following:

- If sea level rises, wading bird diversity/species richness will decrease.
- If sea level rises, wading bird diversity/species richness will increase.
- Sea level rise will/will not affect wading bird diversity/species richness.
- Wading bird diversity/species richness is correlated with sea level rise.

(ii) Identify the dependent variable in this study. **Point 06**

Examples of acceptable responses may include the following:

- Number of wading bird species
- Species richness of wading birds

F	If the researchers repeated their study, explain how this environmental change could affect the results of the study. Examples of acceptable responses may include the following: • There would be a decrease in wading birds because PCBs tend to magnify/concentrate in higher trophic levels. • There would be a decrease in wading birds because PCBs can bioaccumulate (in fatty tissue). • There would be a decrease in wading birds because PCBs are toxic/kill birds/make birds sick when ingested. • There would be a decrease in wading birds because of eggshell thinning/developmental deformities/reproductive problems caused by PCBs.	Point 07
G	Describe a regulating ecosystem service that can be provided by wetlands. Examples of acceptable responses may include the following: • (Wetlands) filter/purify/improve water (quality). • (Wetlands) provide flood regulation/erosion control. • (Wetlands) store/sequester carbon.	Point 08
H	Explain how increased sediment might lead to a change in the size of the wading bird populations. Examples of acceptable responses may include the following: • (Increased sediment) can reduce the ability of wading birds to see prey/food/fish. • (Increased sediment) can reduce/increase the ability of wading birds to hunt. • (Increased sediment) negatively impacts organisms in lower trophic levels, reducing food/energy for the wading birds. • Reduced light infiltration can decrease the (number of) primary producers, resulting in less energy for higher trophic levels.	Point 09
I	Describe an environmental problem, other than an increase in sediment, that can occur in wetlands that is associated with increased urbanization and development. Examples of acceptable responses may include the following: • Construction projects can reduce/fragment wetland habitats. • Runoff of fertilizers/wastewater effluent can lead to eutrophication, (decreasing DO and killing fish). • Runoff of litter can kill animals when ingested/tangled. • More impervious structures/roads/buildings/sidewalks/parking lots can lead to flooding. • Runoff of heavy metals/pesticides can kill/weaken organisms when absorbed/ingested. • Noise/light pollution can disrupt hunting/migrating/behavior. • Runoff of oil can block light, preventing photosynthesis. • Increased water use can decrease the amount of groundwater/cause wetlands to dry up.	Point 10

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

(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.
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(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