Unit 8 Progress Check: FRQ

1. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Scientists analyzed data collected over a period of years in a game reserve in South Africa to test the hypothesis that competition with lions limits the abundance of leopards in the same community. The game reserve encompasses a variety of habitats, from open grassland to wooded areas around rivers and streams. It contains most of the indigenous mammal species and an adequate availability of their prey. For the most part, the leopards and lions show similar habitat preferences in the reserve.

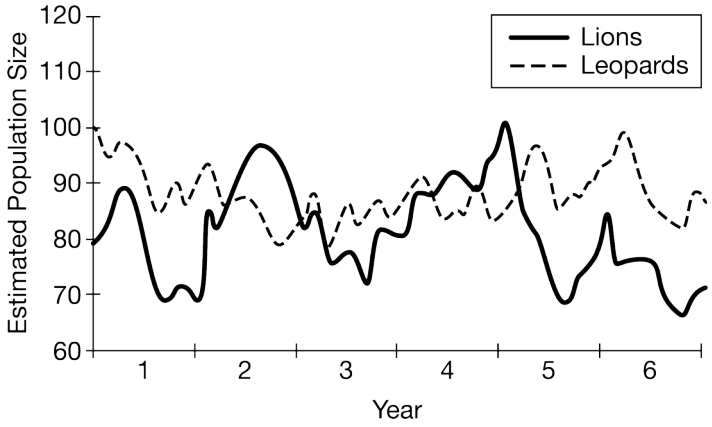
The mass of the average lion is about three times that of the average leopard. The scientists analyzed several factors that might influence the abundance of each population, including the sizes of the animals preyed on by each species (Table 1).

Table 1. The dietary composition of leopards and lions according to the sizes of their prey animals

Size of Prey Animal	Percent of Leopards' Prey ($\pm 2\mathrm{SE}_{\bar{x}}$)	Percent of Lions' Prey ($\pm 2\mathrm{SE}_{\bar{x}}$)
Small	34 ± 2	3 ± 1
Medium	63 ± 3	23 ± 2
Large	3 ± 1	36 ± 4
Very large	0	38 ± 3

Because competition with lions might affect the population size of the leopards, the scientists also analyzed data on the lion and leopard population sizes in the game reserve (Figure 1).

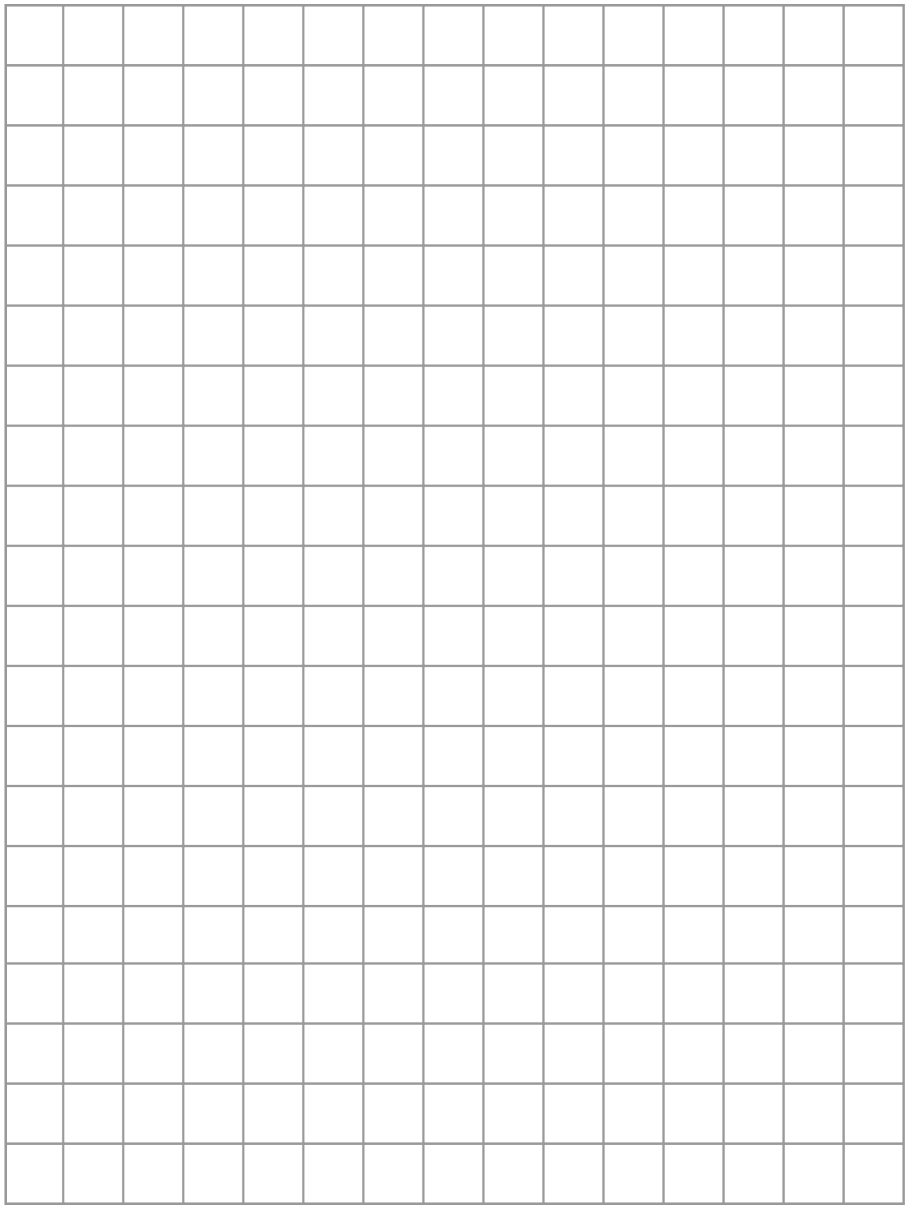
Figure 1. The total number of individuals in the leopard and lion populations over a six-year period



Unit 8 Progress Check: FRQ

(a) **Describe** what scientists mean when they refer to an ecological community such as that shared by the leopards and lions.

(b) Using the template, **construct** an appropriately labeled graph to represent the data in Table 1. Based on the data, **determine** the most common size of the leopards' prey animals and the most common size of the lions' prey animals.



(c) Based on the data in Figure 1, **describe** whether or how the size of the leopard population appears to have been affected by the lion population over the period for which data were analyzed. The scientists also estimated the consumed biomass of the prey animals of the leopards and lions. They estimated that the lions annually ate a total of approximately 175,000 kg of prey animals. This included approximately 110,000 kg of very large animals. **Calculate**, to the nearest whole number, the percent of the total biomass eaten by the lions that is composed of very large animals.

Unit 8 Progress Check: FRQ

(d) Based on the data in Table 1 and the biomass of the very large animals eaten by the lions, **predict** the likely effect on both the lions and leopards if the availability of the very large animals becomes limiting in the reserve. After analyzing the data, the scientists claim that the leopards and lions coexist in the reserve through the use of niche partitioning. Use evidence from the data provided to **support the scientists' claim**.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that an ecological community refers to all of the interacting populations in a defined habitat. (Additional information: Of particular interest in describing the structure of a community is the species diversity, all of the different species present, and the species composition, the total number of organisms of each species.)

Part B (i)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1	2	3 ✓

The sketched bars meet all of the criteria below.

- ☐ Correct axis labeling
- ☐ Correct scale and unit
- ☐ Correctly plotted bar graph

The y-axis should be labeled "Percent of Prey." The x-axis should be labeled "Size of Animal Prey."

Part B (ii)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that medium-sized animals are the leopards' most common prey. It also indicates that based on error bars, large and very large animals are equally likely to be the lions' most common prey.

Part C (i)

Unit 8 Progress Check: FRQ

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that there are fluctuations, but overall the leopard population size appears to have been unaffected by the lion population size. (Additional information: At different time points, only one of the two populations increased or decreased in size, and at other time points, they both increased or decreased in size. Therefore the best conclusion is that the two population sizes changed independently of each other.)

Part C (ii)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the percent of the total biomass that is composed of very large animals is 63%.
$110,000/175,000 = 0.63 = 63\%$

Part D (i)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that 38% of the prey animals of the lions make up 63% of the consumed biomass, so if the availability of the very large animals becomes limiting, the leopards and lions will start to compete for prey (and this will be especially true of the medium-sized prey).

Part D (ii)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that for the most part, the leopards and lions rely on prey animals of different size and so do not compete for food. (The population data suggest that their population sizes have remained fairly constant over time, also suggesting that they are not in direct competition.)

Unit 8 Progress Check: FRQ

2. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Glucose is the preferred carbon source for *Escherichia coli* bacteria. Researchers isolated *E. coli*-M, a strain of *E. coli* with a single mutation that inactivates a key enzyme in one of the three glycolytic pathways *E. coli* bacteria use to break down glucose. In an initial experiment to study the effect of the mutation on glucose utilization and ATP production by the bacteria, the researchers add 2×10^4 *E. coli*-M bacteria to 400 mL of a growth medium that contains glucose. To measure the rate of bacterial growth, they monitor the optical density of the culture as a measure of the bacterial concentration over time.

(a) **Describe** why monitoring the growth rate of the *E. coli*-M bacteria is a useful indicator of the effect of the glycolytic enzyme mutation on the bacteria.

(b) **Identify** the most appropriate control the researchers should use when determining whether the mutation affects the growth rate of the *E. coli*-M bacteria.

(c) **Predict** the growth rate pattern of the *E. coli*-M bacteria when they are initially added to the growth medium if the mutation does not interfere with glucose utilization.

(d) **Provide reasoning** to justify your prediction.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that if the mutation interferes with glucose breakdown, less ATP will be available to the cells. The change in ATP availability will reduce the growth rate and population size of the bacteria.

Part B

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the researchers should set up and monitor the growth rate of an identical culture of wild-type *E. coli* that lack the mutation.

Part C

Unit 8 Progress Check: FRQ

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the *E. coli*-M bacteria will (initially) exhibit exponential growth.

Part D

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the growth medium should initially contain a concentration of nutrients including glucose that far exceeds the requirements of the relatively small inoculum of bacteria.