



Population Regulation in the Serengeti

INTRODUCTION

Serengeti National Park in Tanzania of central Africa is a natural wonder, and research in the park has helped us learn about many important ecological processes. In this case study, you will watch clips from the short film [Serengeti: Nature's Living Laboratory](#), which explores the factors that regulate the park's animal populations. Throughout the activity, you will make predictions, analyze data, and answer questions related to the film. What you'll learn about the regulation of populations in the Serengeti can be applied to other populations throughout the world.

PROCEDURE

Answer the questions in the spaces provided. Some questions have spaces for both an "initial answer" and a "revised answer." Record your initial answer first, then discuss it with your classmates. If your answer changes, record your revised answer and explain why your ideas changed.

Many of these questions are meant to help you reflect on your current understanding at different points in the activity. You will *not* be penalized for wrong initial answers.

PART 1: Populations in Serengeti National Park

1. Serengeti National Park covers a large region (14,570 km²) in central Africa and is home to many species of animals. List some of the animals you would expect to find in the park.

Watch [video clip 1](#) (0:11–2:22) from *Serengeti: Nature's Living Laboratory*. This clip is narrated by Tony Sinclair, an ecologist who studies the Serengeti. One of the things that Sinclair wanted to know was what limited the size and growth of the Serengeti's animal populations.

1. Think about the animals you saw in the video clip and the factors that could limit the size and growth of their populations. Fill out Table 1 with your predictions as follows:
 - a. In the first column, list *at least five* factors that may limit these populations.
 - b. In the second column, label each factor as "bottom-up" or "top-down." Some factors may not fit cleanly into one category.
 - **Bottom-up** factors limit a population by reducing access to resources, such as food from species at lower trophic levels, nutrients, and space.
 - **Top-down** factors limit a population through deaths caused by disease or predators from species at higher trophic levels.
 - c. In the third column, label each factor as "density-dependent" or "density-independent." Again, some factors may not fit cleanly into one category.
 - **Density-dependent** factors depend on the population's size. They can limit a population by reducing individual survival, reproduction, or growth as the population gets larger.
 - **Density-independent** factors do not depend on the population's size. They are typically environmental factors such as weather.

Table 1. Factors that could limit the size and growth of populations.

Factor	Bottom-up or top-down?	Density-dependent or density-independent?

2. This case study focuses on two important herbivores in the Serengeti: buffalo and wildebeest. Their populations are strongly affected by certain bottom-up factors. Which of the following is a **bottom-up** factor that could impact the population sizes of these herbivores?
- predators, such as lions
 - parasites
 - rainfall
 - earthquakes

Initial answer and explanation:

Revised answer and explanation:

PART 2: What Happened to Migratory Wildebeest? (1958–1978)

Most wildebeest in the Serengeti are migratory, meaning that they migrate, or travel seasonally between different regions. Watch [video clip 2](#) (3:39–5:49), which describes what happened to the buffalo and migratory wildebeest populations starting in the early 1960s, after the elimination of a virus called rinderpest. Figure 1 shows the wildebeest population over this time period.

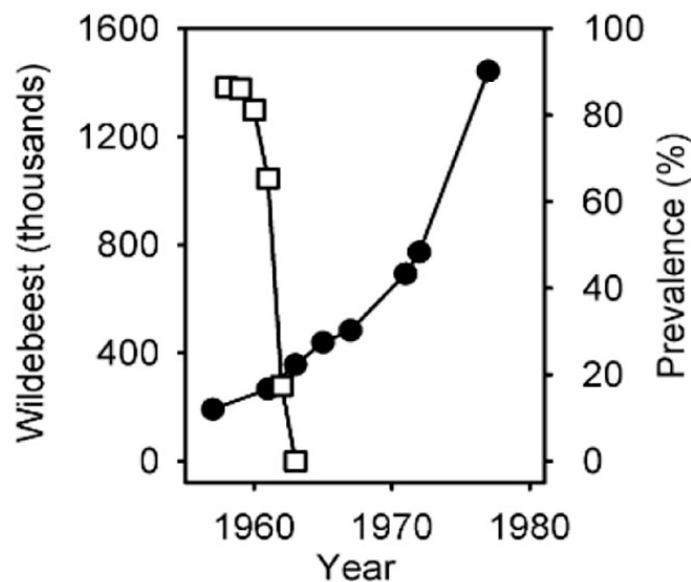


Figure 1. Number of wildebeest in the Serengeti and the percentage of wildebeest infected by rinderpest, from 1958 to 1978.

3. In Figure 1, which symbol (unshaded square or shaded circle) represents the number of wildebeest, and which represents the percentage (“prevalence”) of wildebeest with rinderpest? How do you know?
4. The elimination of rinderpest impacted the wildebeest population. What type of factor is rinderpest?
- density-independent, top-down
 - density-independent, bottom-up
 - density-dependent, top-down
 - density-dependent, bottom-up

Initial answer and explanation:

Revised answer and explanation:

5. Consider the growth curve of the wildebeest population shown in Figure 1. Which of the following best describes this type of growth?
- exponential
 - linear
 - logistic
 - geometric

Initial answer and explanation:

Revised answer and explanation:

6. Predict what would happen to the wildebeest population in the long term given this type of growth.

Initial answer and explanation:

Revised answer and explanation:

PART 3: What Happened to Migratory Wildebeest? (1958–2003)

Watch [video clip 3](#) (5:50–7:03), which explains what happened to the wildebeest population over time. Figure 2, which is an extended version of Figure 1, shows this population up until 2003.

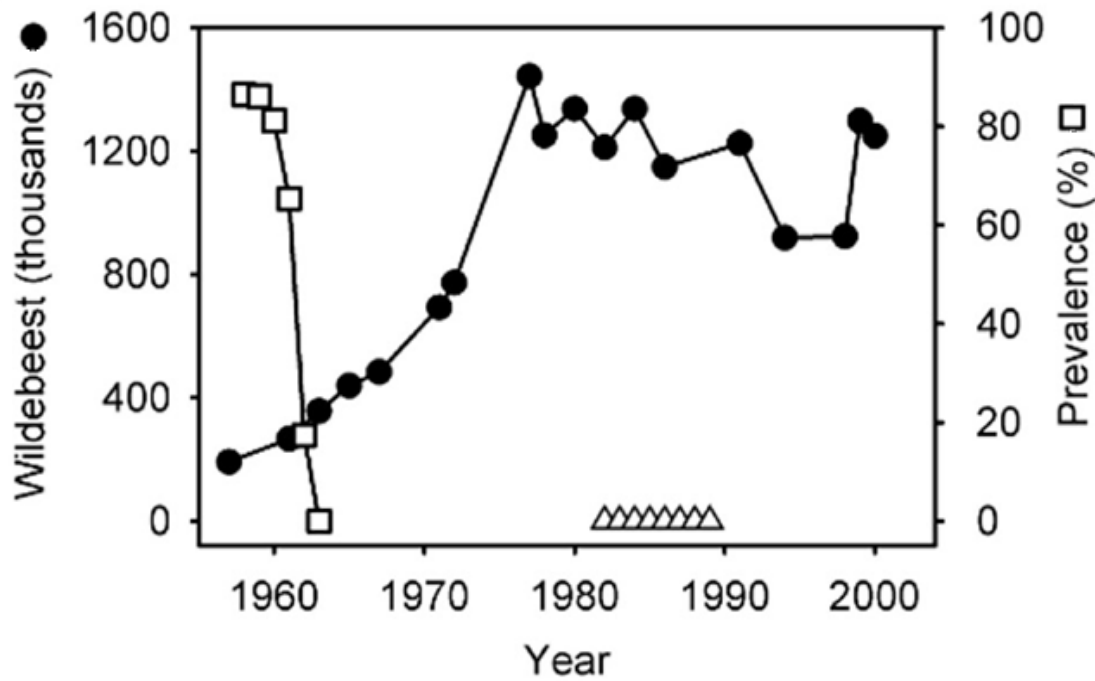


Figure 2. Number of wildebeest in the Serengeti (shaded circles, left y-axis) and the percentage of wildebeest infected by rinderpest (unshaded squares and triangles), from 1958 to 2003.

7. Consider the entire growth curve for the wildebeest population shown in Figure 2. Which of the following best describes this type of growth?
- exponential
 - linear
 - logistic
 - geometric

Initial answer and explanation:

Revised answer and explanation:

8. Based on Figure 2, what is the wildebeest population's approximate carrying capacity (the largest size of a population that the environment can support in the long run)?
- 800,000
 - 900,000
 - 1,300,000
 - 1,500,000

Initial answer and explanation:

Revised answer and explanation:

9. In 1958, the wildebeest population was relatively small due to rinderpest. What factors may have affected the size of the wildebeest population from around 1980 to 2000? Were these factors likely to be density-dependent or density-independent? Why?

PART 4: Nonmigratory versus Migratory Wildebeest

The data in Figures 1 and 2 are from migratory wildebeest. However, some wildebeest are nonmigratory, meaning that they stay in the same place year-round. You will now explore the factors that limit populations of *nonmigratory* wildebeest.

Figure 3 is from a study that examined the effects of predators on populations of nonmigratory Serengeti herbivores, including wildebeest.

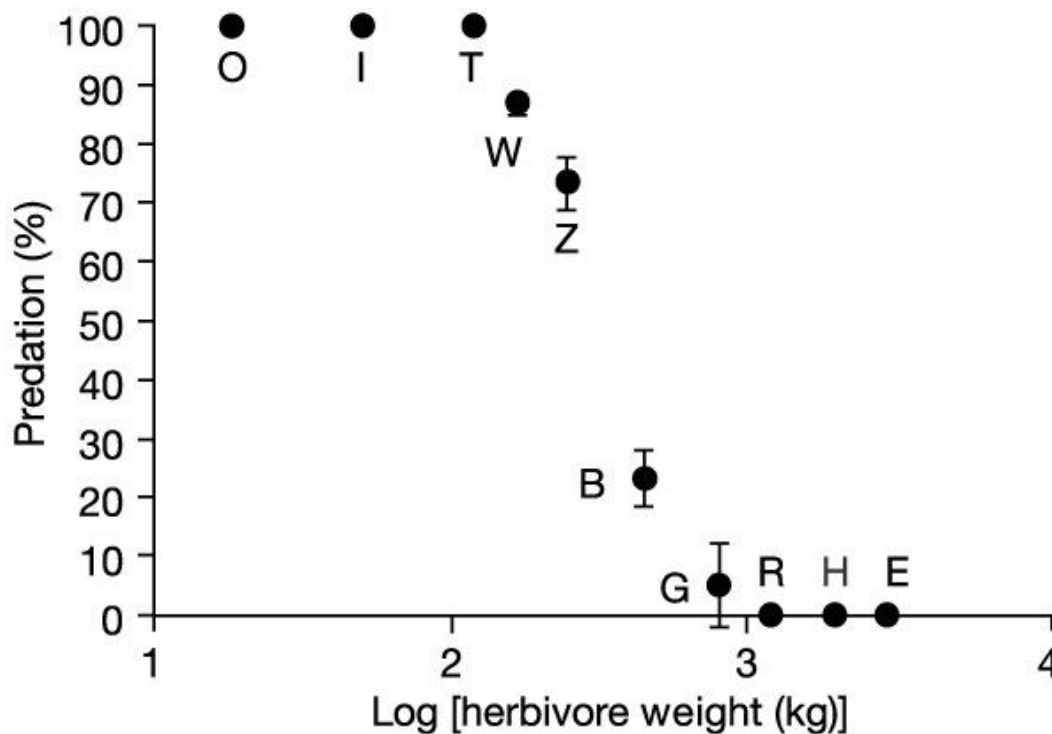


Figure 3. Percentages of nonmigratory adult herbivores in the Serengeti that die due to predation. The herbivore species shown are the oribi (O), impala (I), topi (T), wildebeest (W), zebra (Z), African buffalo (B), giraffe (G), black rhino (R), hippo (H), and African elephant (E). Error bars represent 95% confidence intervals.

10. What might explain the relationship between predation and herbivore weight shown in Figure 3?
11. Some of the herbivore populations in Figure 3 have very few deaths, if any, due to predation. What factors are likely to limit the sizes of these populations?

12. Approximately what percentage of nonmigratory wildebeest deaths are caused by predation?
- 100%
 - 85%
 - 45%
 - 25%

Initial answer and explanation:

Revised answer and explanation:

Watch [video clip 4](#) (11:44–14:18), which features Simon Mduma from the Tanzania Wildlife Research Institute.

Optional Question: Which of the following data best supports the idea that migratory wildebeest are limited by *bottom-up* factors?

- The population increases during the dry season.
- The bone marrow of dead wildebeests was translucent and gelatinous in the dry season.
- There were many animal markings on the bones.

Reflect on what you've learned about migratory and nonmigratory wildebeest populations. Then, watch [video clip 5](#) (21:38–27:37), which features Grant Hopcraft from the University of Glasgow. Use the information in the video and your reflection to answer the following questions.

13. Migratory wildebeest populations are limited mainly by factors that are:
- density-independent, top-down
 - density-independent, bottom-up
 - density-dependent, top-down
 - density-dependent, bottom-up

Initial answer and explanation:

Revised answer and explanation:

14. Nonmigratory wildebeest populations are limited mainly by factors that are:
- density-independent, top-down
 - density-independent, bottom-up
 - density-dependent, top-down
 - density-dependent, bottom-up

Initial answer and explanation:

Revised answer and explanation:

15. Explain why nonmigratory and migratory wildebeest populations are limited by different types of factors.
16. Wildebeest aren't the only animals that migrate in the Serengeti. What factors might limit migratory versus nonmigratory populations of other animals in the Serengeti, such as zebras? (*Hint: You may want to look at Figure 3 again.*)
17. Think of a population outside the Serengeti that you are familiar with, maybe one that lives near you. What factors do you think limit the size and growth of the population you chose? Why?