Wildebeest Populations

HOW TO USE THIS RESOURCE

The images for this resource, which shows a wildebeest herd on the Serengeti, can serve as a phenomenon to explore the key concepts described below.

The pedagogical practice of using phenomena to provide a context for understanding science concepts and topics is an implementation practice supported by the Next Generation Science Standards (NGSS). Phenomena are observable occurrences that students can use to generate science questions for further investigation or to design solutions to problems that drive learning. In this way, phenomena connect learning with what is happening in the world while providing students with the opportunity to apply knowledge while they are building it.

The “Implementation Suggestions” and “Teaching Tips” sections provide options for incorporating the images into a curriculum or unit of study and can be modified to use as a standalone activity or to supplement an existing lesson. The student handout includes reproductions of the images and the “Background Information” section.

Additional information related to pedagogy and implementation can be found on this resource’s webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

A. Population sizes are affected by a variety of factors, including disease, resource availability, and human impacts. The wildebeest herd found in the Serengeti is the largest herbivore herd on Earth; its population underwent logistic growth following the implementation of a comprehensive vaccination program that eradicated rinderpest, a viral disease.

B. Populations can be counted and monitored through a variety of methods. Wildlife managers use this information to decide if and when to manage populations.

BACKGROUND INFORMATION

Wildebeest are species of antelope found in southern Africa. The wildebeest herd in Serengeti National Park, Tanzania, is the largest herbivore herd on Earth. Scientists began monitoring the sizes of the Serengeti’s large mammal populations in the 1960s. Over the next few decades, they noticed something unusual: the wildebeest population was increasing at a rate much faster than before. The scientists determined that this increase was due to several factors. One factor was a vaccination program that eradicated rinderpest, a viral disease that kills wildebeest.

The rapid growth of the wildebeest population concerned wildlife managers, since rapid population growth sometimes damages ecosystems by using up food and other resources. The managers had to decide whether to control the wildebeest population or let it grow unchecked.

IMPLEMENTATION SUGGESTIONS

The following suggestions outline several options for incorporating the images into a unit of study as phenomena:

Engagement, establishing prior knowledge, and providing context:

- Begin the lesson by telling students that they’re going to be exploring a national park in Tanzania that is famous for its populations of animals, including animals they’re likely familiar with (elephants, lions, etc.) and animals they may be less familiar with.

  - Show the beginning (0:00–2:20) of the short film *Serengeti: Nature's Living Laboratory*, which introduces Serengeti National Park.
  - Depending on students' familiarity with the Serengeti, it may be helpful to show them the location of the Serengeti on a map, or to have them locate it using an online mapping tool or app.
  - Depending on students' familiarity with large herbivores, clarify that they'll be examining an image showing a population of animals (wildebeest) that live in the Serengeti.
- Show the image and ask students to make observations using the sentence stems "I notice...," "It reminds me of...," and "I wonder..."
  - This image is actually a screenshot of a scene in *Serengeti: Nature's Living Laboratory* (time 7:57). You may wish to point this out to students later, after reaching that scene in the film.
- Use a think-pair-share protocol to have students share their observations and questions about the image. Record class observations, noting when students make similar observations and drawing attention to the range of student-generated questions.
  - Students may observe that there are "a lot" of wildebeest, that the wildebeest appear to be the main animals in the image, and that they appear to be on a grassland.
  - Students may wonder what wildebeest are, what they eat, why there are so many of them, how their population is counted or monitored, and what the benefits and drawbacks of living in such large groups are.
  - If students don't generate questions related to population size or count, prompt them to consider how scientists could estimate the number of wildebeest living in the Serengeti.
- Have student groups brainstorm what information they would need to know about the wildebeest population in order to estimate its size.
  - Students may identify factors such as how many wildebeest are born or die in a given time period, if their density is uniform within the group, how their density varies within the Serengeti, etc.
  - If students need a simpler, more relatable example, put beans or other small objects on a large piece of paper or whiteboard. Have students consider how they could estimate the size of the "population" of beans.
  - As an extension, students could brainstorm more specific methods for determining the size of the wildebeest population. They may suggest a direct count (aerial survey, etc.), sampling one or several locations, or a mark-and-recapture method. Once students present their ideas, have them consider the benefits and drawbacks of each proposed method (accuracy, cost, feasibility over longer time periods, potential for undercount or overcount, etc.).
  - If you would like to have students engage in a more in-depth exploration of estimating population size, consider using the following BioInteractive resources: *The Great Elephant Census* video, the *Survey Methods* Click & Learn, or the "Modeling Animal Survey Methods" activity.
- Show another clip (2:20–4:56) of *Serengeti: Nature's Living Laboratory*, which introduces biologist Tony Sinclair's work in the Serengeti. It also describes the method he used to determine the size of the Serengeti's large mammal populations.
  - If you had students propose specific methods for counting wildebeest, they can compare their proposed methods to the one that Sinclair used.
- At this point, have students read the "Background Information" for the image. As students are reading, ask them to focus on the following:
  - What factor(s) mentioned in the "Background Information" affect wildebeest population size?
  - What does it mean to "eradicate" a disease?

- Ask students to return to the original image and to highlight/identify questions they asked about reasoning ("how" or "why" questions). They can rephrase some of their other questions to get at reasoning too. Example questions:
    - Why are there so many wildebeest in the Serengeti?
    - How has the wildebeest population changed over time?
    - What factors affect wildebeest population size? → How do biotic or abiotic factors affect wildebeest population size?
    - How many wildebeest are there? → How do scientists count the number of wildebeest?
        - Students may struggle with the idea that some "how" questions (such as the first question in the bullet above) do not get at reasoning, so it may be helpful to provide both examples and nonexamples for them.
- How do wildlife managers decide to control a population's growth or size?
- Have each student select one or two questions to share in a small group, and then have each group select one or two questions to share with the class. Note when students ask similar questions within their groups or when the groups have similar questions.
- Transition to the "Exploration, investigation, and assessment" section below by telling students they'll be exploring a subset of their questions through the following activities, particularly those questions related to factors affecting population size.

Exploration, investigation, and assessment:

- Exploration:
    - Ask students to build a simple mathematical model of how a population's size changes over time. Their model should include multiple rates (birth, death, etc.) that affect the population's size. It may be helpful to scaffold this task as follows:
        - Instruct students to focus on the change in the population size over a given time interval. Tell them that this can be mathematically represented by the notation ΔN, where the symbol Δ (delta) represents "change" and the variable N represents population size. (If students are familiar with differential equations, you may wish to use dN/dt instead.)
        - Tell students that ΔN is affected by the population's birth rate, which you'll represent with the variable B. Ask students how an increase in the birth rate (B) would affect ΔN; that is, whether it would increase or decrease the population's size.
        - Ask students to brainstorm what other *rates* could affect the population's size. Student responses should ideally include the rates for births and deaths (and potentially also immigration and emigration, though these are not included in the *Population Dynamics* Click & Learn below). Students may also identify factors that affect these rates, such as food availability or predation. If so, clarify the difference between the biotic and abiotic factors that affect these rates, and the rates themselves.
        - Ultimately, students' mathematical models should generally express the following: $\Delta N = B - D$, where B represents the birth rate and D the death rate.
- Investigation:
    - Have students use the *Population Dynamics* Click & Learn to explore the population models for exponential and logistic growth. The Click & Learn's accompanying worksheet includes several case studies in Gorongosa National Park and Serengeti National Park, the latter of which focuses on wildebeest.

        - This Click & Learn is most appropriate for advanced biology classes (AP, IB, and college courses) and will need to be scaffolded or heavily modified for introductory students.
        - Before, or in lieu of, introducing the model equations, it may be helpful to show example graphs and have students describe them qualitatively (including different phases of exponential and logistic growth). Consider producing several graphs with the same starting population size (N_0) and different growth rates (*r*), then asking students to compare the differences in population growth over time.
        - Students generally have an intuitive understanding of population carrying capacity. However, they may need support in understanding how growth rate changes as populations approach carrying capacity. It may be useful to discuss factors that could slow population growth as the population becomes bigger (competition, predation, disease, etc.).
    - Part 3 of the worksheet for the *Population Dynamics* Click & Learn presents a graph of the Serengeti's wildebeest and zebra population sizes over several decades. This graph is broken into three parts (**Figures 1a–c**) at the end of this document. Begin by showing students **Figure 1a**, which shows the populations slightly before and after 1960.
        - The vertical line on this graph indicates that in 1960, a vaccination program to eradicate rinderpest began. Rinderpest is a viral disease that kills certain hoofed mammals. Vaccines were given to domesticated cattle in the area, not to wildebeest or zebra directly.
        - Have students predict the effects of the vaccination program on both populations in Figure 1a, then discuss their answers with a partner.
        - Student answers may include that they expect both populations to increase, one to increase and one to remain stable, both to remain stable, etc.
    - Next, present students with **Figure 1b**, which shows the same wildebeest and zebra populations up until the mid-1970s.
        - Have students examine the graph and make statements using the sentence stems "I notice…," "I predict…," and "I wonder…"
        - Students may notice that the wildebeest population increased but the zebra population remained relatively unchanged.
        - Students may predict that, in later years, the wildebeest population will continue to grow exponentially and that the zebra population will remain relatively unchanged. Alternatively, they may predict that the zebra population will decline due to competition with the wildebeest, or that it will increase because it has a longer "lag time" for exponential growth than the wildebeest population.
        - Students may wonder why the wildebeest population is increasing — if it's due to the vaccination program, increased food availability, decreased death rate due to other factors, etc. — and what accounts for the differences between the wildebeest and zebra populations.
        - The "Assessment" section describes how to use this case study to assess student understanding of population dynamics.
    - Show another clip (4:56–6:46) of *Serengeti: Nature's Living Laboratory*, which ends with Sinclair discussing the vaccination program that led to a large increase in the Serengeti wildebeest population, and how wildlife managers grew concerned that the wildebeest could damage the park's ecosystem.
- Assessment:
    - Before showing students the final wildebeest and zebra graph (**Figure 1c**), ask them to consider the following question: "When the population of a species grows exponentially, what happens to populations of other species in the same area?"

        - Student answers may include that populations of species that compete for similar resources will decrease, but populations of species that prey on the exponentially growing species will increase.
    - Next, ask students to consider the following question: “If you were a Serengeti wildlife manager in the 1970s, what action, if any, would you take to control the growth of the wildebeest population?”
        - It may be helpful to begin by having students group themselves next to example actions. For example, post pieces of chart paper with actions such as “I would implement a program to cull wildebeest,” “I would implement a program to reduce the wildebeest birth rate,” “I would not take action to control the wildebeest population,” etc. Once students have gathered by the action they support, have the groups (or pairs within the groups) discuss why they chose that action and the benefits of that action. Challenge them to brainstorm a potential drawback of their action as well.
        - Ask student groups to share out. Alternatively, each student could find a partner who chose a different action. The partners can share the benefits and potential drawbacks of their actions, and see if they change their opinions based on the conversation.
        - Before moving on, consider having students write their responses to the question above as a formative assessment. They should include evidence from Figure 1b, as well as show an understanding of exponential and logistic growth.
    - Show students **Figure 1c**, which shows the wildebeest and zebra populations up until 2010. Have students complete the associated questions in Part 3 of the worksheet for the *Population Dynamics* Click & Learn, which assess student understanding of carrying capacity and logistic growth.
        - Depending on the level of the course, it may be helpful to eliminate, reword, or scaffold Question 6 of Part 3, which requires using the logistic differential equation.
    - Show another section (6:54–14:16) of *Serengeti: Nature’s Living Laboratory*, which discusses how scientists determined factors that regulated the Serengeti’s wildebeest population and the carrying capacity of that population.
        - Have students return to the actions they had proposed for controlling (or not controlling) the growth of the wildebeest population. Ask if they would change their decisions based on the new information from the film.
        - Students may change their initial responses based on the new evidence, or they may argue that the risk of letting the wildebeest population grow exponentially would have prompted them to still control the population.
        - Emphasize that wildlife managers will use the best evidence available to them to make decisions about population management. However, that evidence can be incomplete and their decisions, in retrospect, can have unintended consequences. As a result, it is important to continue monitoring populations and adjust management actions as needed based on new information.

- Extension:
    - Show the beginning of Chapter 3 (29:01–33:25) of *Serengeti: Nature’s Living Laboratory*, which explores how wildebeest affect other components of the Serengeti ecosystem. Extend student thinking by having them consider the effects of the increased wildebeest population on fire prevalence in the Serengeti.
    - Have students explore the Data Point activity “Serengeti Wildebeest Population Regulation.” This activity focuses on a graph similar to those that students have already examined and includes more discussion questions.

        - It may be helpful to provide students with the text included in the "Interpreting the Graph" section of the "Educator Materials." This text explains the relationship between rinderpest, wildebeest, grass, fire, and trees in more detail.
        - Ask students to consider how the growth of the Serengeti wildebeest population affects grasses, fires, and trees through the following prompts:
            - Create a model that includes rinderpest, wildebeest, grasses, fires, and trees. Draw arrows between the components to show positive or negative effects (rather than energy flow). Label the arrows with + or – to indicate positive or negative effects, respectively.
            - Using evidence from your model, explain how it is possible for a virus that infects wildebeest to affect tree density in the Serengeti.
    - Watch the last part (33:25–end) of *Serengeti: Nature's Living Laboratory*, which discusses other effects that wildebeest, as a keystone species, can have on their ecosystem. Have students update or revise their models based on the information in the film.

TEACHING TIPS

- Present students with the image first, before they read the background information.
- Background information may be edited to support student proficiency, course sequence, etc.
- The images may be projected in lieu of handouts.
- Printed images can be laminated for use in multiple classes.

CREDITS

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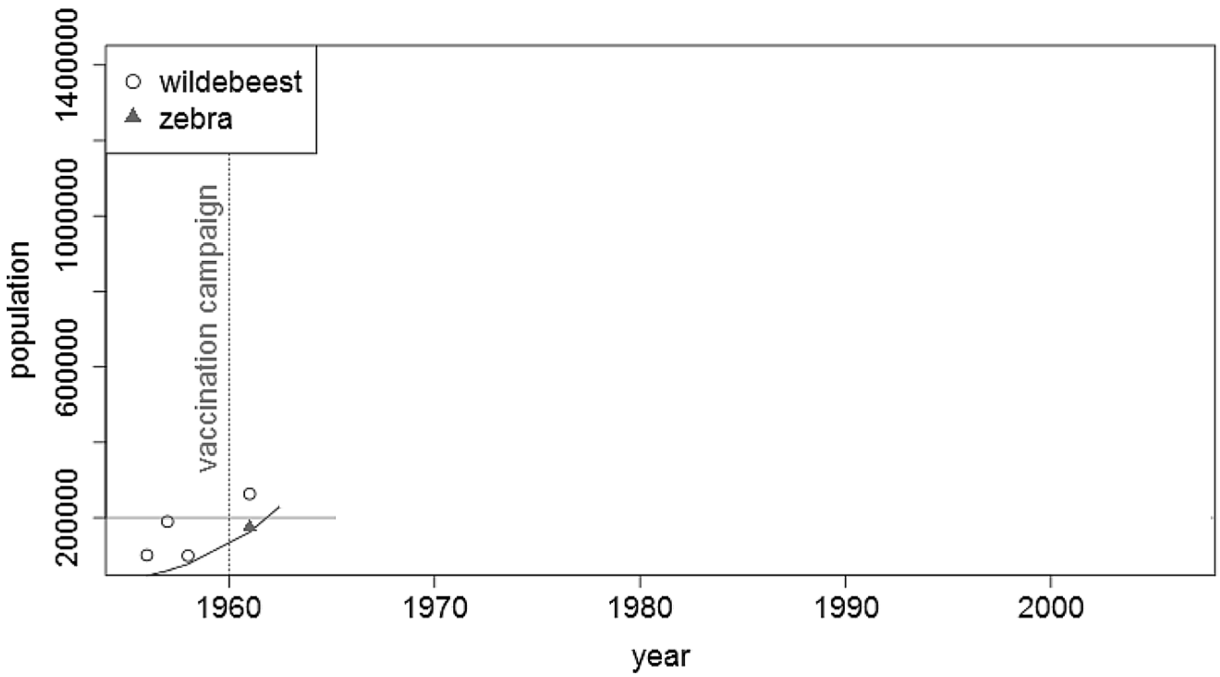

Figure 1a. Wildebeest and zebra populations in the Serengeti from the 1950s to the early 1960s.

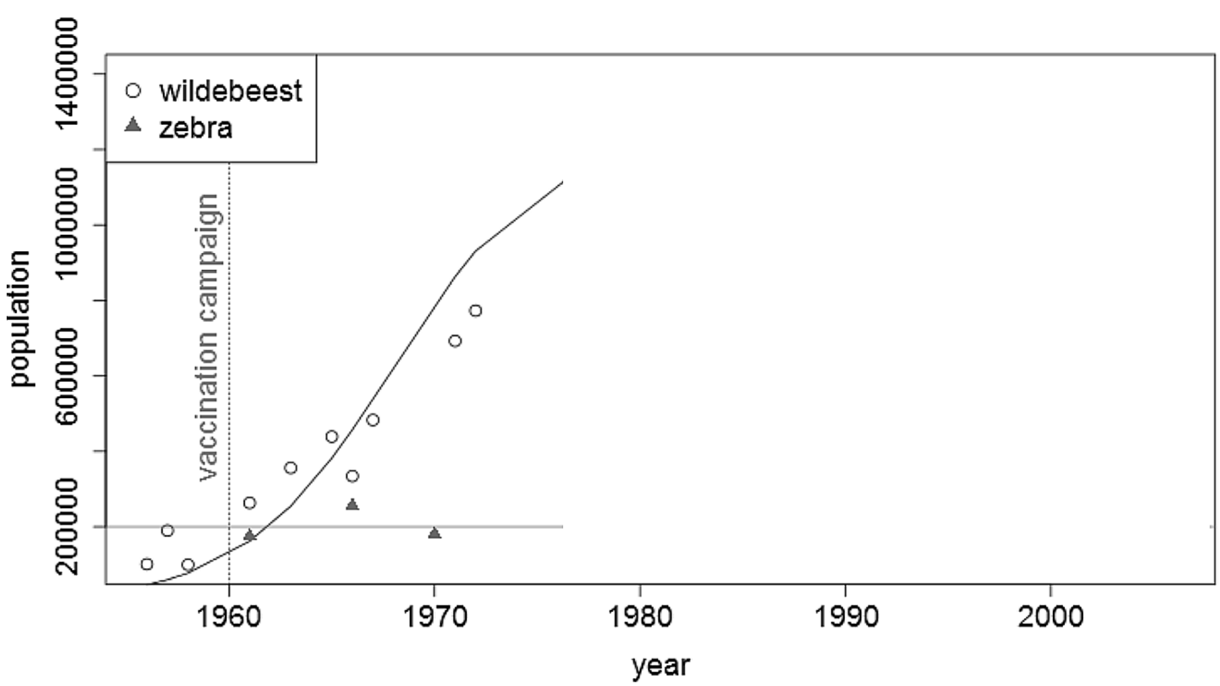

Figure 1b. Wildebeest and zebra populations in the Serengeti from the 1950s to the 1970s.

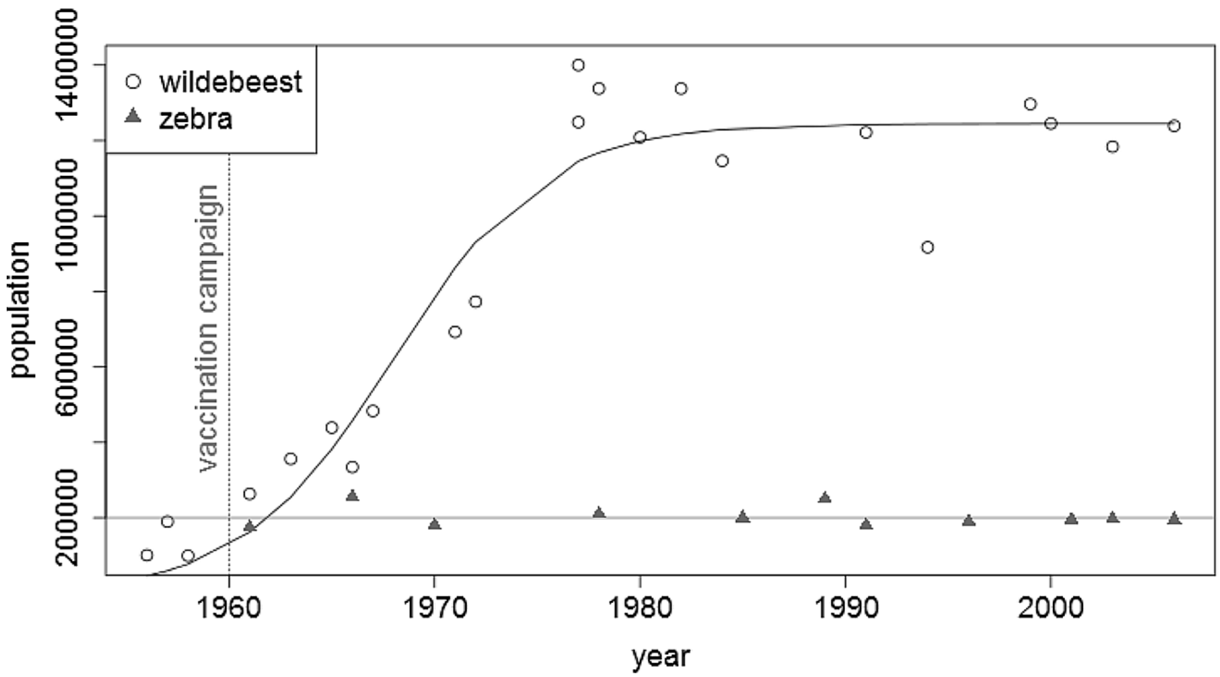

Figure 1c. Wildebeest and zebra populations in the Serengeti from the 1950s to 2010.