

African Lions: Modeling Population Growth

Date: _____

Subject: Biology
Grade: 9-10

Topic: Ecology - Populations
Designer: Sara Remsen

Stage 1 – Desired Results

Lesson Overview: This activity examines exponential and logistic growth and asks students to analyze the factors that influence population growth by interpreting data. The activity is intended for high school Biology students who have a basic understanding of functions, specifically 9th and 10th grade Biology students. By the end of the activity, students will be able to distinguish between exponential and logistic growth, identify carrying capacity, distinguish between density-dependent and density-independent limiting factors, apply the population models to data sets, and determine carrying capacity from population data. Students will also apply their knowledge of population growth to the human population on Earth.

Standards Addressed:

- HS-LS2-1.** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Enduring Understanding:

Ecology is the study of the interactions between organisms and their environment. A population is a group of organisms and the number of individuals in that population may change depending on the environment. Populations may fluctuate year to year but we can predict their growth using mathematical models. The two types of mathematical models are exponential growth and logistic growth. Exponential growth occurs in the absence of any limiting factors and the rate of growth continues to increase over time. Logistic growth occurs in the presence of limiting factors. Limiting factors are divided into density-dependent and density-independent and determine carrying capacity, which is the

Essential Questions:

- What factors can influence how populations change over time?
- What is the difference between exponential and logistic growth?
- How can we apply population models to real data?
- What inferences can we make about the human population?

maximum number of individuals an environment can support.	
Students will need to know: <ul style="list-style-type: none"> Levels of organization, including organism, population, and ecosystem Interactions of biotic and abiotic factors (basic) Simple mathematical functions and relationship between x and y (modeling) 	Students will be able to: <ul style="list-style-type: none"> Distinguish between exponential and logistic growth Identify carrying capacity Distinguish between density-dependent and density-independent limiting factors Apply models to real data sets Make inferences about new data sets, such as human population on Earth

Stage 2 – Assessment Evidence

Performance Tasks: In this activity: <ul style="list-style-type: none"> Students make predictions about population growth Students distinguish between examples of density-dependent and density-independent factors Students compare their predictions to real data Students apply mathematical models to real population sets Students make inferences about human population growth based on what they have learned about lions 	Other Evidence: <ul style="list-style-type: none"> To be decided by the teacher.
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Stage 3 – Learning Plan

Lesson Procedure: <u>Many Days Before:</u> Students should be introduced to the concept of Ecology and the interactions of organisms and their environment. <u>Day Of:</u> Students will use computers for this activity.	Required Materials: <ul style="list-style-type: none"> Computers for each student or pair of students
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Possible Discussion Questions for Students:

1. What do you think will happen to the lions in the future?
2. What type of new limiting factors could be introduced?
3. Why do we use mathematical models when we look at real data?

Sample Answers to Discussion Questions:

1. Answers may vary. The population may increase to pre-1963 carrying capacity, the population may stabilize, another disease might wipe them out, etc.
2. Poaching, safari tourism, a new disease, a drought, a fire, a disease that affects other animals but in turn affects the lions.
3. Models help us predict the future of a population. If we can describe all the real data with a formula or a function, then we might be able to predict what happens more accurately, especially if we know about the limiting factors.

Additional Background

Research on the fragile population of Ngorongoro Crater Lions

After the decline in 1963, the lion population increased again and remained fairly stable until 1983, when they declined again. According to Bernard Kissui and Dr. Craig Parker's research, "Disease appears to be the only factor that has held the crater Lion population below its carrying capacity for the past 10 years." Although many diseases threaten lions, canine distemper virus (CDV), which normally affects dogs, has been a particular menace to the big cats. Kissui Parker admits that researchers are not entirely sure what has caused this increase in levels of disease, but he and others suggest it could be due to the fact that there are many more humans in the area now, and with them come domestic dogs that carry CDV. Another theory is that disease outbreaks could be exacerbated by climate change. In the last 10 years East Africa has suffered many more droughts and floods, which seem to coincide with bouts of disease. "The weather in East Africa was more variable in the 1990s than in the 1970s and 1980s, and all four lion die-offs coincided with drought and flood. The 1962 [stable fly] plague coincided with heavy floods that immediately followed a severe drought in 1961...and the 2001 CDV epidemic followed the drought of 2000." [More about their research can be found at <http://www.ntz.info/gen/n00481.html>.]