



Developing an Explanation for Tuskless Elephants

OVERVIEW

Most African elephants have tusks, but typically about 6% of females in a population will never grow tusks. Adult males are very rarely found without tusks. However, in Gorongosa National Park in Mozambique, 50% of females over 20 years old are tuskless, and 33% of females between 10 and 20 years old are tuskless.

Why are there so many tuskless females in the Gorongosa elephant population? To answer this question, this activity leads students through three tasks:

- I. **Information Gathering.** To learn more about the problems facing African elephants and their recovery in Gorongosa National Park, students will watch and answer questions about two BioInteractive *Scientists at Work* videos: the first minute of [The Great Elephant Census](#) to learn about poaching, and the entire [Selection for Tuskless Elephants](#) video to complete the rest of the activity.
- II. **Scientific Explanation of Evolution by Natural Selection.** Using a “Scientific Explanation of Evolution by Natural Selection” chart, students will construct an explanation for the high incidence of tusklessness in the Gorongosa elephant population.
- III. **Argumentation.** Using evidence and reasoning from the previous tasks, students will develop an argument to answer the question “Will the trend toward an increased incidence of tusklessness in a population with heavy poaching lead to increased African elephant population sizes in the future?”

KEY CONCEPTS

- Human activities influence the abundance and distribution of living organisms, as well as the selective pressures on these organisms.
- Natural selection can shift the distribution of traits in a population. This is because organisms with an inherited trait that is advantageous in a particular environment tend to leave more offspring than do individuals lacking this trait.
- Scientific explanations and arguments consist of claims, supporting evidence, and logical reasoning that links the evidence to the claims.
- There may be more than one plausible argument that answers a scientific question.

STUDENT LEARNING TARGETS

- Use scientific observations to explain how a population changes over time due to human impacts.
- Explain how the selective pressures on a population may impact the frequencies of phenotypes in a population.
- Propose a claim supported by scientific evidence to explain an observation.
- Provide evidence-based reasoning to make a scientific argument.

CURRICULUM CONNECTIONS

Standards	Curriculum Connection
NGSS (2013)	HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5, MS-LS4-4
AP Bio (2015)	1.A.1, SP3, SP6
IB Bio (2016)	5.2
AP Env Sci (2012)	II.C, VII.C
IB Env Systems and Societies (2017)	3.2, 3.4
Common Core (2010)	ELA.RST.9-12.7, WHST.9-12.1; Math.MP.2
Vision and Change (2009)	CC1, CC5, DP1

KEY TERMS

adaptation, claim, evidence, inheritance, poaching, population, reasoning, selection, selective pressure, variation

TIME REQUIREMENTS

- One to two 50-min classroom periods or one 90-min block period is recommended. Time requirements may differ depending on computer/internet access.
- Some of the tasks may be assigned as homework; see “Teaching Tips” below.

SUGGESTED AUDIENCE

- High School: Biology (all levels), Environmental Science (all levels)
- College: Introductory Biology or Ecology

PRIOR KNOWLEDGE

Students should be familiar with:

- populations and ecosystems
- natural selection and its components (specifically variation, inheritance, differential survival and reproduction, and adaptation)

MATERIALS

- printed “Task I,” “Task II,” and “Task III” activity sheets
- [The Great Elephant Census](#) and [Selection for Tuskless Elephants](#) videos

TEACHING TIPS

- Several parts of the activity could be assigned as homework. For example, students could watch both videos and complete the questions for “Task I” on their own. Alternatively, students could watch [The Great Elephant Census](#) as homework, then complete the rest of the activity in class by working in small groups.
- For Question 4 of “Task I,” you may wish to provide students with the transcript of the *Selection for Tuskless Elephants* film, which can be downloaded from the [film’s resource page](#).
- For “Task II,” students will need to complete a “Scientific Explanation of Evolution by Natural Selection” chart. This is also referred to as a VIDA (Variation, Inheritance, Differential survival and reproduction, and Adaptation) chart. Students should be familiar with each of these terms and their descriptions.
- Students may wonder whether most Gorongosa females will be tuskless in the future. The frequency of an advantageous trait in a population typically increases due to natural selection, assuming that the selective pressure is constant. In the Gorongosa population, however, the selective pressure on tusklessness has changed over time. For example, poaching for tusks became less frequent after the civil war. So it is not guaranteed that the frequency of tusklessness will continue increasing in the future.
- Students may ask whether the effect of poaching on tuskless elephants is an example of natural selection or artificial selection. You may wish to discuss the pros and cons of using each term in this case. (For example, humans are often associated with artificial selection, but artificial selection usually refers to the selective breeding of desirable traits.) You may also introduce alternative terms such as “unnatural selection” ([Allendorf and Hard, 2009](#)).
- Students may ask whether it is possible for male African elephants to inherit tusklessness. Although scientists do not fully understand the genetic basis of tusklessness, tuskless males have been observed in some populations. This suggests that both males and females can inherit tusklessness under certain conditions.

ANSWER KEY

Task I: Information Gathering

1. Look up the definition of the term *poaching* and summarize your understanding of what it means in the space below.

Definitions will vary based on the source, but students should recognize that poaching is illegal hunting or fishing, either on private or protected land, or of a protected animal.

2. Watch the first minute of [The Great Elephant Census](#) and answer the following questions.

- a. What are the main threats to African elephant populations?

Habitat loss and poaching. (0:19)

- b. The estimated rate of elephant loss is 100 elephants per day. (0:39)

3. Research the location of the country of Mozambique. Draw an arrow pointing to Mozambique on the map.



By Tom-b (Own work) [CC0], via Wikimedia Commons

4. Watch the entire [Selection for Tuskless Elephants](#) video and answer the following questions.

- a. Joyce Poole is an expert in elephant communication and behavior. (0:20)

- b. What happened in Mozambique between 1977 and 1992? How did this event affect the size of Gorongosa National Park's elephant population?

There was a civil war, during which 90% of Gorongosa's elephant population was killed. (1:00)

- c. What is unusual about the elephant populations found in Gorongosa now?

A high proportion of the female elephants in Gorongosa are tuskless. (2:19)

- d. What are tusks? How does an elephant use its tusks?

Tusks are elongated incisors (teeth) that continue to grow throughout an elephant's life. (2:44) Elephants use their tusks to strip bark off trees and to dig holes for water and minerals. Male elephants also use their tusks to fight other males for females. (2:53)

- e. What would probably happen to a male elephant that doesn't have tusks?

The male could be severely wounded while fighting other males for access to females. (3:12)

Therefore, tusklessness in male elephants is a rare trait.

- f. What percentage of females are typically tuskless in an elephant population less affected by poaching?

About 2% to 6% of the female elephants are typically tuskless. (3:42)

- g. Tusklessness is an inherited trait. Tuskless females tend to have tuskless offspring. (4:36)

- h. Why were elephants with tusks targeted during the civil war in Mozambique?
Soldiers killed elephants for their ivory, which was sold to buy arms and ammunition. (4:06)
- i. What percentage of female elephants were tuskless in Gorongosa according to Poole’s surveys? Write your answers in the table below. *(4:44)*

	Civil War Survivors (20+ years old)	Offspring of Civil War Survivors (10-20 years old)
% tuskless females	<i>50%</i>	<i>33%</i>

- j. How many adult males without tusks have been found in Gorongosa National Park?
None. (4:53)
- k. Is the link between heavy poaching and a high incidence of tuskless females unique to Gorongosa? Cite evidence to support your response.
No, this link is not unique to Gorongosa. The Selous elephant population in Southern Tanzania and the Queen Elizabeth elephant population in Uganda also have high rates of poaching and tusklessness. (5:15)

Task II: Scientific Explanation of Evolution by Natural Selection

Write an explanation based on natural selection for the high incidence of tusklessness among female elephants in Gorongosa. Like all good scientific explanations, your explanation should include a *claim*, supporting *evidence*, and scientific *reasoning* to link the evidence to the claim. Use the **Scientific Explanation of Evolution by Natural Selection** chart below to organize the information you will use in your explanation.

Teaching Tip

The chart summarizes the evidence that students should gather from Task I. A successful explanation will include evidence of variation, inheritance, differential survival and reproduction, and adaptation. The explanation should also include the fact that selection differs between males and females, because males use their tusks to compete with other males for mates.

Condition	Description	Evidence
Variation	Individuals in a population or group differ in some trait of interest.	<ul style="list-style-type: none"> • <i>Although most African elephants have tusks, 2%–6% of the females in a typical population are tuskless.</i> • <i>Tuskless adult males exist but are very rare.</i>
Inheritance	<p>The variation in the trait of interest is at least partially inherited (passed from parents to offspring).</p> <p>The variation stems from random mutations and the recombination that accompanies sexual reproduction. The genetic variation may have arisen many generations in the past.</p>	<ul style="list-style-type: none"> • <i>Tuskless mothers tend to have tuskless offspring.</i> • <i>In Gorongosa, 30% of the female offspring of the civil war survivors (50% tuskless) are tuskless themselves.</i>
Differential survival and reproduction	More offspring are born than can survive, resulting in competition among individuals within a population. Some individuals with a particular trait are more likely to survive and/or have relatively more offspring compared to individuals that do not have that trait.	<ul style="list-style-type: none"> • <i>During the civil war in Mozambique, soldiers killed elephants with tusks in order to sell the ivory, so fewer elephants with tusks survived.</i> • <i>Once the war and poaching ended, elephants with tusks were more likely to survive because they could use their tusks to find water and food.</i>

	<p>Selection depends on the specific context of a species. Traits that are beneficial in one environment may cause problems in another environment.</p>	<ul style="list-style-type: none"> • <i>Males use tusks to fight other males for females. Males without tusks are more likely to be wounded, which makes them less likely to survive and reproduce.</i>
<p>Adaptation</p>	<p>The frequency of the trait that helps individuals survive or leave more offspring will increase in the population over time, as will the frequency of the alleles that affect the trait. This process can take many generations and extend over very long periods of time.</p>	<ul style="list-style-type: none"> • <i>In Gorongosa, 30% of the females between 10–20 years old (offspring of civil war survivors) are tuskless, which is much higher than the percentage of tuskless females in unpoached populations (2%–6%). This may be because tuskless females are more likely to survive if there is poaching.</i> • <i>High rates of tusklessness have also been found in other heavily poached elephant populations, such as the Selous population in Tanzania and the Queen Elizabeth population in Uganda.</i> • <i>No tuskless adult males have been found in Gorongosa. This may be because in males the selection for having tusks is stronger than for having no tusks.</i>

Task III: Argumentation

Develop an argument to answer the following question:

Will the trend toward an increased incidence of tusklessness in a population with heavy poaching lead to increased African elephant population sizes in the future?

Your argument should be 1 or 2 paragraphs in length. Like a scientific explanation, a strong argument includes a *claim* with supporting *evidence* and scientific *reasoning*. The argument may also address weaknesses in alternative claims.

Keep in mind that there may be more than one plausible argument. The goal of this task is to provide a strong, convincing explanation supported by relevant evidence, logical scientific reasoning, and current knowledge about elephants.

Teaching Tip

Using argumentation in the classroom:

1. Emphasize to students that scientists may interpret the same evidence differently. Therefore, engaging in scientific argumentation is a vital science practice.

Scientific argumentation includes generating an explanation supported by evidence and scientific reasoning, sharing the explanation with others for feedback, debating the validity of presented claims, and revising the explanation based on feedback from other scientists.

A productive way to get peer feedback is to do a gallery walk. Students read each other’s explanations and leave sticky notes with “I noticed” (statements of praise: “I noticed you used evidence from other areas with high poaching to support your claim.”) and “I wonder” statements (suggestions for improvement: “I wonder whether you have taken into account the role of tusks in female elephant survival.”). Students use these comments to revise and clarify their explanations.

2. If students generate conflicting explanations, it is time to engage in argumentation. Remind students that scientific argumentation is a civilized process of defending one's argument while asking probing questions regarding the alternative arguments. Students can be asked to write a rebuttal to conflicting explanations. A rebuttal would include identification of flaws in the alternative explanation and justification for why their explanation is more logical or reasonable.

Students will often modify their explanations during this process. This iterative process is an important part of the nature of science and should be encouraged. Students may recognize that more evidence is needed to support their claims.

Sample Student Response #1

Argument: A trend toward an increased incidence of tusklessness will result in *increased* population sizes in the future.

Claim: Tusklessness is beneficial to African elephant populations where heavy poaching is occurring. So, as tusklessness increases, elephant population sizes will also increase.

Evidence: Poachers kill elephants for their ivory tusks, so tuskless elephants are more likely to survive when there is heavy poaching. A high rate of tusklessness has been found in populations where heavy poaching has occurred, such as in Tanzania, Mozambique, and Uganda.

Reasoning: Although tusks provide some advantages to elephants, they are a major disadvantage in an environment with poachers. If a population has more tuskless elephants, poachers are less likely to kill elephants from that population. So more elephants in that population will survive.

Over time, more and more of the population will become tuskless due to natural selection. Poachers will become less and less likely to target this population. So the population's size will increase.

Sample Student Response #2

Argument: A trend toward an increased incidence of tusklessness will result in *decreased* population sizes in the future.

Claim: In the long term, tusklessness in African elephants is not beneficial to populations, even when heavy poaching is occurring. So, as tusklessness increases, elephant population sizes will decline.

Evidence: Although poachers kill elephants with tusks, elephants rely on their tusks for survival. Elephants use their tusks to strip bark off trees for food and to dig up water and minerals from the ground. Male elephants also use their tusks in competitions with other males for females.

Reasoning: Tuskless elephants are probably not as healthy as those with tusks, as they cannot eat bark off trees and are unable to dig for water and minerals. During harsh conditions such as droughts, elephants without tusks would be less likely to survive. Male elephants without tusks are also more likely to be injured during mating competitions. If too many males are injured or killed, there may be a decline in reproduction.

Over time, many of the tuskless elephants will die or be unable to reproduce, so the population's size will decrease.

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