NALEDI: A BABY ELEPHANT'S TALE
Education Outline

Naledi: A Baby Elephant's Story (USA, 90 min)

Trailer: https://vimeo.com/168811238
Website: http://www.vulcanproductions.com/our-work/naledi/

Naledi: A Baby Elephant's Tale tells the true story of a baby elephant born into a rescue camp in the Botswana wilderness. When she is suddenly orphaned at one month, the keepers and scientist looking after the herd become tireless surrogate mothers. Witnessing Naledi's birth and human caused struggles, inspires camp scientist Mike Chase to launch the most ambitious census ever of African elephants across the African continent as a last effort to help them survive. Now, he must race to defend an entire species while struggling to save a single life.

This film stands to help promote knowledge, and further, a worldwide ban on the sale of ivory.

The following *multimedia* science educational resources focus on elephants for the classroom, and include short videos, hands-on activities, and interactive modules. Based on actual research, the resources teach key biological concepts aligned to the Next Generation Science Standards. Filmmakers for *Naledi: A Baby Elephant's Story* have partnered with the Howard Hughes Medical Institute's BioInteractive (HHMI) to produce a number of resources for elephant learning in the classroom, much of which can be found in this outline and on the HHMI website: http://www.hhmi.org/biointeractive/elephants.

The Great Elephant Census
The Great Elephant Census found 352,271 African savanna elephants in 18 countries, down 30% in 7 years.

1. Counting Elephants

- Pioneering in both scale and technological innovation, the Great Elephant Census (GES) was carried out by national parks and wildlife staff in 18 countries with support from seven NGOs, totaling more than 90 scientists and 286 crew. A 10-member Technical Advisory Group established **standardized methodologies** and reviewed and validated survey results and reports. More than 90 percent of the GEC was done using evenly spaced sample counts – where a representative portion (generally 5-20 percent) of a landscape is surveyed and statistical modeling used to extrapolate findings to the whole area.
- Groups of 10 or more elephants were also photographed with GPS-enabled cameras.
- Extremely densely populated areas, or those with a few very large herds, were tallied through elephant-by-elephant total counts.
- A central database has been set to collect all raw data as soon as each flight was completed, so that for the first time, raw population data from across Africa are available for analysis to any researcher who receives permission from participating governments and survey implementers.
- The GEC not only counted live elephants, but dead ones, too. Spotters tallied elephant carcasses to identify **poaching hotspots**. While carcass counts must be considered with care because carcasses are easy to miss and carcass decay rates vary in different climates, a carcass ratio of more than 8 percent indicates poaching at a level high enough to cause a declining population.
- The GEC also counted other wildlife, livestock, and even presence of humans and houses. Like the elephant data, this information is available to inform researchers' understanding of the status of other species, and to look for relationships between these variables.

2. Factors Impacting Elephant Populations

- **Humans** have the largest impact on elephant populations
- *Why count elephants? Because they are disappearing from African landscapes, and humans—primarily poachers and consumers who buy ivory—are their greatest threat.*

3. Comparing Countries

- Africa is a vast, diverse continent. Explore the following graphs and timelines (found here: elephant-atlas.org) representing different factors in 15 of the 18 surveyed countries that could have contributed to the data collected by the Great Elephant Census. Additionally, many of these questions require more research, and we hope present and future scientists will utilize the **African Elephant Atlas** to explore the data further.

The Great Elephant Census Modeling Activity

- In this classroom activity, students will model two types of counting methods (sample counts and total counts) to determine population size. This hands-on activity models the sample counting method that was used in The Great Elephant Census. GEC was a large-scale aerial survey that counted elephants across the continent of Africa.
- The activity complements the Scientist at Work short film "The Great Elephant Census" (link: https://www.youtube.com/watch?v=imvehfydUpc) and *Naledi: A Baby Elephant's Story*.
- Please find GEC Activity Educator Guide, Student Activity along with the Elephant Census Activity Landscape, attached.

(visit http://www.hhmi.org/biointeractive/great-elephant-census-modeling-activity for further information)

Further Information and Links for the Classroom

-Visit https://we.tl/Lx5a7RefXp to download the following short films:
How to See Into an Elephant's Mind
Big Sister Becomes Mom
World's Greatest Poop
- Visit https://www.youtube.com/watch?v=KjDH_QZd0ok for ***Satao - The Death of a Great Tusker***

The final results for the **Great Elephant Census** show:

- Savanna elephant populations **declined by 30 percent** (equal to 144,000 elephants) between 2007 and 2014
- The current rate of decline is **8 percent per year, primarily due to poaching.** The rate of decline accelerated from 2007 to 2014
- **352,271 elephants were counted in the 18 countries** surveyed. This figure represents at least 93 percent of savanna elephants in these countries
- **Eighty-four percent** of the population surveyed was sighted in legally protected areas while 16 percent were in unprotected areas. However, high numbers of elephant carcasses were discovered in many protected areas, indicating that elephants are struggling both inside and outside parks

For further information on results, please visit:
http://www.greatelephantcensus.com/final-report

<u>Discussion Points for post-screening of *Naledi; A Baby Elephant's Tale*</u>

Opening Statement: "This is the bleakest time for elephants. The statistics on the plight of Africa's elephants is daunting. I am devoted to supporting new endeavors which provide meaningful science to help reverse this decline and to reduce variability in elephant population statistics." – **Paul G. Allen**, Philanthropist, co-founder of Microsoft, founder of Vulcan Inc., and constant asker of "What if…?" pushing people to challenge conventional thinking, collaborate across disciplines and reimagine what's possible.

1. After watching *Naledi: A Baby Elephant's Story*, what have you learned? And was there anything that surprised you?

2. Now that you have been exposed to the decline and threats faced by elephants, do you feel like this knowledge is empowering? Does it compel you to take action? What kind of actions can you take?

3. Was telling Naledi's story through film effective and/or powerful? Why or why not?

4. Elephants are part of the environment. The scientists, philanthropists, conservationists in the film are passionate about protecting elephants and the environments they are supposed to thrive in. Why do you find that the film focuses on census data specifically to make its point(s)?

5. What surprised you most about the method that the census is conducted in?

6. Would you recommend this film to family and friends? Why or why not?

OVERVIEW

African elephants are endangered. It is critically important to know how many elephants are left and where they are to guide conservation efforts. In this classroom activity, students will create a model of two different count methods: a sample count and a total count. Both of these methods are used for studying population sizes of wildlife.

INTRODUCTION

In the 1970s, researchers estimated that 1.3 million forest and savanna elephants thrived in over 35 countries in Africa. Since then, we know that populations of African elephants have been declining at an alarming rate due to habitat destruction and poaching fueled by the international ivory trade.

The Great Elephant Census, a large-scale aerial survey that counted elephants across the continent of Africa, recently determined that only 352,271 African savanna elephants remain. So how did researchers get at this number?

The researchers decided to conduct an aerial survey and they considered two options for counting: they could count every single elephant they saw while flying all over Africa, what's known as a total count, or use an alternative method called a sample count. A sample count involves dividing the survey areas into regions, called strata, of varying sizes. Surveyors then fly along the transect lines to estimate the number in that area, or stratum. Using this method, only elephants seen in the sections of the survey area are counted and used to determine elephant density in that area. These numbers are used to estimate the overall number of elephants based on a mathematical algorithm.

KEY CONCEPTS

- Estimating wildlife populations informs conservation and management strategies.
- Mathematical tools enable researchers to estimate populations.
- Different conditions can determine which counting methods are more appropriate for determining populations.

LEARNING OBJECTIVES

Students will be able to:

- differentiate between a sample and total count and identify the advantages and disadvantages of each
- collect data for both a sample count and total count for a population and calculate population densities
- analyze the variations in data

CURRICULUM CONNECTIONS

Curriculum	Standards
NGSS (April 2013)	LS2-2; LS2-6
Common Core (2010)	RST.11-12.7; SL8.1; SL9-10.1; SL11-12.1; MP.2; MP.4; MP.5
AP Biology (2012-13)	4.B.3; 4.C.3, Science Practice 1 and 2
IB Biology (2016)	HL Option G.1; G.3; G.4
AP Environmental Science (2013)	II.A; III.A; VII.C
IB Environmental Systems & Societies (2010)	1.1.10; 2.3.2; 4.2.6; 4.3.1

KEY TERMS

Census, sample count, total count, survey, average, density, distribution, modeling

TIME REQUIREMENTS

1 class period (50 minutes, some students may need additional time to finish answering questions)

SUGGESTED AUDIENCE

This activity is appropriate for high school biology (all levels including AP and IB), high school environmental science (all levels including AP and IB), and introductory college biology or ecology.

PRIOR KNOWLEDGE

Density, distribution, species, population, data analysis, modeling

MATERIALS

- African Landscape sheets: one preprinted landscape sheet per group of 2-3 students
- Lentils or split peas to represent elephants: approximately ½ teaspoonful (2.5 mL) per group
- Great Elephant Census Student Worksheet
- Calculator
- Ruler: 1 per student group if you choose to have students calculate areas
- For optional warm-up activity, one jar or beaker: prefilled with small items like beans, lentils, coins, or small candies to be displayed for whole class
- Not required, clear sheet protector: one per group of 2-3. Note: if unavailable, students should be careful when distributing lentils on the landscape sheet.

TEACHER TIPS

- Lentils or split peas are recommended because they have one flat side, which eliminates some bouncing. Other beans or small objects can also be used.
- Sheet protectors can be used to set up the activity so the lentils are stored between classes if you have multiple classes throughout the day. The lentils can be poured out into a cupped hand if it is easier for students to do the dropping technique of lentil distribution, then returned to the sheet protector.

- If you do not have sheet protectors, have a beaker of lentils and a ½ teaspoon at the front of the room and have one student from each group come up to get their lentils. Or you can count out 25-30 lentils per group ahead of time and place in cups.
- Some curricula require students to use the mark-recapture method of population sampling. If your students are familiar with that method, or you plan on doing it soon, discuss the differences in the methods and why different methods are more appropriate for different species and conditions. How well would mark-recapture work for the elephant census at this scale?

EXTENSION ACTIVITIES

- Density and distribution are concepts that can be explored further in this activity. Ask students to graphically represent the average density of their elephants on a landscape. Have them draw the elephants in a 5 cm × 5 cm square to illustrate density. Then, have them calculate the density based upon the **total count** (can be their group's total count or the class total count) and represent that density in a second square. Did each student draw the density the same way? Some may have used dots, some may have shaded in a percentage of area or used other methods. What influences animal distribution on a landscape? How might researchers account for different types of distribution?
- In the film, the researchers count the elephants by gender and age (adult versus juvenile). If you use different colors of lentils, you could model this by including different colored lentils for males (14 green lentils) and females (16 red lentils), or juveniles (17 green lentils) and adults (13 red lentils). Discuss why researchers would want to know the sex and/or ages of animals when determining population sizes. What issues might make it difficult to collect that data?

PROCEDURE

1. Distribute the student handout.
2. As an optional warm-up activity, display a jar full of beans, coins, or candy in the front of the room and have students guess how many items are in the jar. As a whole class, discuss challenges to knowing actual numbers in the jar and discuss different strategies students came up with to estimate the total number.
3. Instruct students to read the introduction paragraph of the Great Elephant Census student worksheet.
4. Have students complete the **T-chart** on their student data sheet to explore the advantages and disadvantages of sample counts versus total counts for estimating populations.
5. Show the 8-minute film **The Great Elephant Census**: http://www.hhmi.org/biointeractive/great-elephant-census
6. Explain to the class that they will be creating a model (simulation) of the elephant census to compare sample versus total count methods for studying wildlife population sizes.
   - Divide students into groups of two or three.
   - Pass out one elephant landscape sheet per group and an optional sheet protector.
   - Explain the parts of the sheet to the students (counting strips, transects, and total landscape area).

7. Have students calculate and record the transect and landscape areas. (If you are pressed for time, provide the calculated areas to students rather than having them complete the calculations.)

    Transect area: length × width for each counting strip and then multiply by 2 since there are two counting strips per transect area. Repeat the process for the second transect. **Total landscape area** (length × width) of entire sheet or colored portion of landscape sheet. If students calculate their own areas, allow for a small degree of error in their measurements.

    Area of each transect:

    Transect A: 19.3 cm × 1.7 cm = 32.81 cm^2

    Transect B: 23.9 cm × 1.7 cm = 40.63 cm^2

    Area of entire landscape:

    Entire landscape sheet = 22 cm × 28 cm = 616 cm^2

    Colored portion of landscape sheet 20.8 cm × 26.7 cm = 555.36 cm^2

8. Provide students with lentils.

    No sheet protector method: Place a beaker of lentils and a ½ teaspoon at the front of the room and have one student from each group come up to get their lentils. A level ½ teaspoon is roughly 25-30 lentils. Or count out 25-30 lentils per group ahead of time and place in cups.

    Sheet protector method: Pour ½ teaspoon (approximately 2.5 mL) of lentils into the sheet protector or into a cup for each group. This can be done ahead of time, or call table groups up to get lentils. There should be around 25-30 lentils per group, but do not reveal this number to the students.

9. Demonstrate how to disperse lentils on the landscape sheet.

    No sheet protector method: one person should cup the lentils in both hands about 10 cm above the landscape sheet and in one motion, pull their hands apart to distribute the lentils. Runaway lentils should be returned to the landscape sheet randomly.

    Sheet protector method: make sure the landscape sheet is in a sheet protector and hold it vertically while another student pours in lentils. Then hold the protector horizontally on a table with one hand holding the opening closed and rapidly shake or wiggle the setup for a few seconds to distribute lentils.

10. Each group should disperse the lentils. Tell students that if lentils bounce off of the landscape sheet, they should toss them back onto the sheet randomly.
11. Tell students that once they are dispersed they should not move the lentils until they are finished with their sample count and their total count.
12. As a class, establish the criteria for counting lentils within the transects. Examples include: don't pick up lentils as you count, and a lentil has to be all the way in the counting strip to be counted. Students then complete their counts in the transect areas. Students will do their sample counts first.
13. Students should record the numbers of lentils for each transect on their student worksheet.
14. To calculate the density of lentils for each transect:

$$\text{Density of lentils} = \frac{\text{number of lentils}}{\text{area of the transect}}$$

15. To calculate average density for an individual landscape:

$$\text{Average Density} = \frac{(\text{Transect A Density}) + (\text{Transect B Density})}{2}$$

16. To estimate the total number of elephants in an individual landscape:

    Total number of elephants = Average density × Area of the landscape

17. Now have students do a total count of their elephants. Students should count all of the lentils on their landscape sheet and record their data.
18. Students should answer question 13 on their worksheet. If you are short on time, students can move right to sharing their data and answer the question later.
19. Students should share their individual data with their classmates.
20. Students should clean up their workspace and answer the remaining questions.
21. Once students have the class data, they should calculate the total area for the class:
    Total area for the class = Landscape area calculated in Table 1 × the number of groups in the class
22. Students should calculate the estimated density of elephants for the class using the class **sample count** data: Total number of elephants from the sample count total calculated in Table 3 divided by the total area for the class.
23. Students should calculate the actual density of elephants for the class using the **total count** data: Total number of elephants from the total count column in Table 3 divided by the total area for the class.

The majority of answers for this worksheet are dependent on student results, but things to consider for several of the answers are addressed on the following pages.

Answers to selected questions on student worksheet:

18. How similar were the numbers between the sample and total counts for the whole class data? *Answers will vary, but generally the sample estimates of elephant numbers are higher than the total count.*

19. Is your individual sample count data or the class sample count data more similar to the actual count? Why do you think that is? *Answers will vary, but students might write about accuracy or sample size.*

20. When counting actual elephants across most of Africa, a total count could be less accurate than a sample count. Why do you think that could happen? *Answers will vary, but students might write about accuracy of the counting method or the fact that elephants move around, they can be spread out over long distances, they live in remote habitats, and they can be difficult to find.*

21. In the sample method, did any issues arise? If so, what did your group do to address the issues? *Answers will vary, but possible issues include the lentils clumping together, one transect was closer to the release of the lentils so it received more than the transect farthest away, and lentils on the line were counted by one person but not the other.*

22. What issues do you think researchers might encounter when sampling, and how would they address these issues? *Sampling methods have assumptions about how they are being implemented. For example, it is assumed that the lentils are randomly distributed, that there are no lentils migrating in or out of the population, etc. Scientists use a number of methods, and the assumptions have been identified for each method. If conditions exist that violate the assumptions, then the method isn't valid for that situation.*

24. How does this model represent how elephants are counted? *Answers will vary but may include that the distribution was not perfectly uniform; the lentils clumped together like elephants in herds do; the transects were defined like those in the film; students had to determine methodologies for standardization like when to count a lentil and when not to; and calculating the densities and estimating the total population was similar, although not exactly, like the film.*

25. How is this model not an accurate representation of what you saw in the film? *Answers will vary but may include that elephants have behaviors that can influence their distribution not reflected by lentils randomly moved about; researchers would rely on many more samples taken to offset the influence of outlying samples taken; more statistics are used to derive a more accurate estimate of population size; and the scale of the activity was off as the size of the lentils on the landscape does not reflect the size of elephants on the actual landscape.*

26. Discuss two modifications you could make to this model to better represent an elephant census across Africa. *Answers will vary and might offer some great insight into student understanding.*

RELATED RESOURCES

WildCam Gorongosa
http://www.hhmi.org/biointeractive/wildcam-gorongosa
Researchers in Gorongosa National Park use remote trail cameras to study the park's wildlife. You can contribute to this important research through WildCam Gorongosa, an online citizen science platform.

Measuring Biodiversity in Gorongosa
http://www.hhmi.org/biointeractive/measuring-biodiversity-gorongosa
In this activity, students will calculate species richness, evenness, and the Shannon diversity index for various habitat types using data from trail cameras in Gorongosa National Park.

Tracking Lion Recovery in Gorongosa National Park
http://www.hhmi.org/biointeractive/tracking-lion-recovery-gorongosa-national-park
See how scientists in Gorongosa National Park are using GPS satellite collars and motion-sensitive cameras to gather data about the recovery of the park's lion population.

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OVERVIEW

African elephants are endangered. It is critically important to know how many elephants are left and where they are to guide conservation efforts. In this classroom activity, you will explore the method researchers used to determine the size of the remaining population of African elephants.

Before starting, think about some of the methods you know about for counting population numbers—for example, the number of people in the United States or the number of birds in a park.

Optional warm-up activity

Look at the items in the jar in the front of the classroom. Make a prediction of the number of items in the jar. How many did you guess? _______________

What strategy did you use to derive the number above? What challenges does this strategy pose? *Note: Be prepared to discuss your strategy and challenges with the class.*

List one or two other strategies and their associated challenges discussed in class.

BACKGROUND

In the 1970s, researchers estimated that 1.3 million forest and savanna elephants thrived in over 35 countries in Africa. Since then, we know that populations of African elephants have been declining at an alarming rate due to habitat destruction and poaching fueled by the international ivory trade.

The Great Elephant Census, a large-scale aerial survey that counted elephants across the continent of Africa, recently determined that only 352,271 African savanna elephants remain. So how did researchers get at this number?

The researchers decided to conduct an aerial survey and they considered two options for counting: they could count every single elephant they saw while flying all over Africa, what's known as a total count, or use an alternative method called a sample count. A sample count involves dividing the survey areas into regions, called strata, of varying sizes. Surveyors then fly along the transect lines to estimate the number in that area, or stratum. Using this method, only elephants seen in the sections of the survey area are counted and used to determine elephant density in that area. These numbers are used to estimate the overall number of elephants based on a mathematical algorithm.

In this activity you will watch a short video about the Great Elephant Census and then simulate doing a sample count and total count and compare your results.

Procedures and Questions

Follow the instructions and complete the questions as you work through the activity.

1. In the chart below, list all advantages and disadvantages you can think of in using a sample count versus a total count for population estimates.

Survey Method	Advantage (+)	Disadvantage (-)
Sample count		
Total count		

2. Watch ***The Great Elephant Census***. http://www.hhmi.org/biointeractive/great-elephant-census
3. You and a partner will work together to model the method used to take the elephant census using lentils (or beans) and a landscape sheet. Look at the elephant landscape sheet and make sure you are familiar with the parts of the model.

4. Obtain your measurements for the landscape:
   a. Each transect has two counting strips (one on each side of the plane's flight path, represented by a dashed line).
   b. Measure the length of a counting strip in transect A. Record the value in the **length** column below.
   c. Measure the width of a counting strip in transect A. Now, multiply by 2 (multiplying by two will account for the two counting strips in the transect). Record this value in the **width** column below.
   d. Determine the area of transect A by multiplying the length by the width and record the value below.
   e. Repeat steps a-d above for transect B and record the values below.
   f. Determine the total landscape area by measuring the length and width of the landscape sheet and then multiplying these two measurements.

Area name	**Length (cm)**	**Width (cm)**	**Area (cm^2)**
Transect A			
Transect B			
Total Landscape			

Data Table 1: Transect and Total Landscape Area

5. Your teacher will describe how to obtain your elephants (lentils).
6. You will put the lentils on the landscape sheet using one of the methods below. Once you distribute your lentils, <u>*do not move them*</u> until you complete your total count.

   No sheet protector method: one person cups the lentils in both hands about 10 cm above the landscape sheet and in one motion, pulls their hands apart to distribute the lentils. Runaway lentils should be returned to the landscape sheet randomly.

   Sheet protector method: make sure the landscape sheet is in a sheet protector and hold it vertically while another student pours in lentils. Then hold the protector horizontally on a table with one hand holding the opening closed and rapidly shake or wiggle the setup for a few seconds to distribute lentils.

7. You will do a sample count first. Before you start counting, your class should agree on how to count the lentils within the counting strips so each group is doing it the same way.

8. Once you've counted the lentils for each transect, record the numbers in the data table below.
9. Calculate the density of lentils for each transect by dividing the number of lentils counted in the transect by the area of the transect and record in the data table below. *Don't forget to include your units of measurement throughout the activity.*

Transect	**Number of elephants spotted in transect**	**Elephant density in transect** $\frac{\text{number of elephants}}{\text{area of the transect cm}^2}$
A		
B		

Data Table 2: Elephant Densities from Sample Count

10. Calculate the average density for the transects (add densities from above and divide by 2) and record. Average density of elephants for transects: ___________________

11. Estimate the total number of elephants in the landscape by multiplying the average density by the area of the landscape. Record data: ___________

12. Now, do a total count for your landscape. Count all of the lentils on your landscape (the entire sheet). Record data: ___________

13. How similar were the numbers between the sample and total counts on your landscape?

14. Now, examine the whole class data. Record each group's data in Data Table 3: Class Data for Elephant Counts on the following page. Once you have data from all of the groups, add the numbers together to complete a total census for the class (can also be done using a spreadsheet).

	Group Number	Total number of elephants in sample count	Actual number of elephants from total count
Totals			

Data Table 3: Class Data for Elephant Counts

15. Calculate the total area for the class. Take the landscape area you calculated in Table 1 and multiply it by the number of groups in your class. ______________________

16. Calculate the estimated density of elephants for the class using the class **sample count** data. Take the total number of elephants from the sample count total calculated in Table 3 and divide it by the total area for the class. ___________________________

17. Calculate the actual density of elephants for the class using the **total count** data. Take the total number of elephants from the total column in Table 3 and divide it by the total area for the class. ___________________________

18. Look at the calculations above. How similar were the numbers between the sample and total counts for the whole class data?

19. Is your individual sample count data or the class sample count data more similar to the actual count? Why do you think that is?

20. When counting actual elephants across most of Africa, a total count could be less accurate than a sample count. Why could it be less accurate method?

21. In the sample count method, did any issues arise? If so, what did your group do to address the issues?

22. What issues do you think researchers might encounter when conducting a sample count and how would they address these issues?

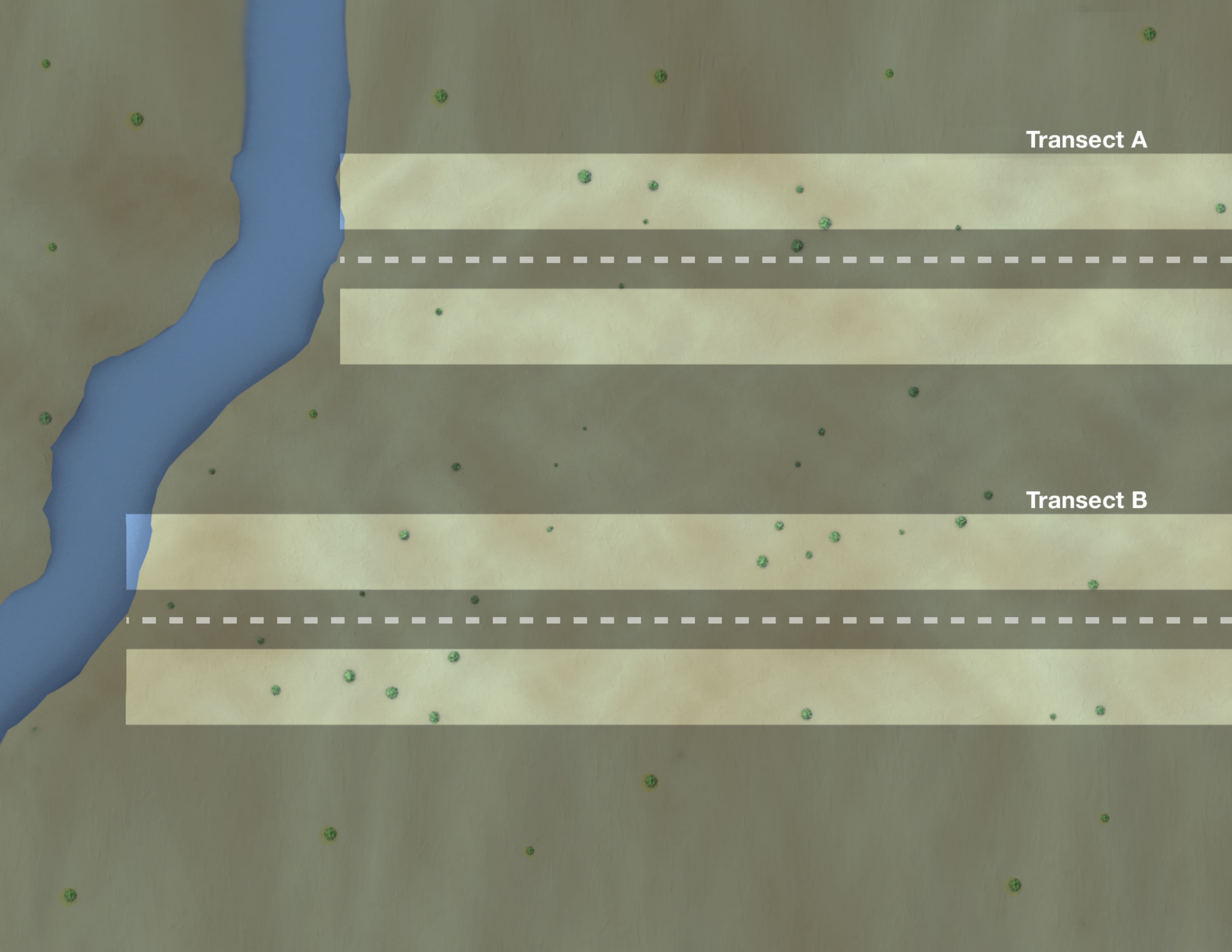
23. Revisit the survey method chart you completed on page 2. Now that you have watched the film and completed the activity, add additional advantages or disadvantages for the different methods.

Think about the model.

24. How does this model represent how elephants are counted?

25. How is this model not an accurate representation of what you saw in the film?

26. Discuss two modifications you could make to this model to better represent an elephant census across Africa.


Transect A
Transect B