

Name: _____

Investigating human-induced unnatural selection in African elephants (*Loxodonta africana*)

Watch the HHMI BioInteractive video “Selection for Tuskless Elephants”

(<https://www.hhmi.org/biointeractive/selection-tuskless-elephants>)



Summary

Working in Gorongosa National Park, Mozambique, Dr. Joyce Poole and colleagues made a striking observation: many female elephants lack tusks.

SCIENTISTS AT WORK:(Duration: 06 min 39 sec)

 Play Short Film

After you watch the video, work with your partner to answer the following:

1. Describe how the population of elephants in the video changed over time.
2. What phenotypic changes did the researcher notice in the population over time.
3. What has driven the changes in the population of elephants?
4. Given the changes in the population, do you think tusklessness is a heritable trait? Explain your reasoning.

5. The table to the right summarizes a recent census of the Gorongosa elephants by Dr. Joyce Poole.

Table 1. Tusklessness in the registered elephants in Gorongosa National park, Mozambique.

Sex	N	Tuskless	% Tuskless
Male	54	0	0%
Female	81	41	51%

a. Is tusklessness more common in male or female elephants?

b. Compare and contrast the advantages and disadvantages of having tusks in the absence and presence of poachers.

	Advantages of having tusks	Disadvantages to having tusks
In the absence of poachers		
In the presence of poachers		

c. Are the advantages/disadvantages you identified in part b. the same or asymmetric in males and females? Explain.

d. Provide a hypothesis to explain the pattern observed in Table 1.

6. If you were to go back to this population in 100 years, predict how frequent tusklessness would be if...
 a. there was no poaching...

b. there was another extreme poaching event...

Justify your reasoning:

How have other African elephant populations changed in response to poaching?

As Joyce Poole mentioned, there are many other populations of elephants on the African continent and they may have also experienced similar selective pressures due to poaching as the populations in Gorongosa. To further investigate these effects, we will examine data comparing historical and contemporary populations of elephants along the Kenya-Tanzania border. The populations in Kenya and Tanzania are among the largest on the African continent, according to a recent census by Chase *et al.* (2016). Similar to the Gorogosa populations, these populations have experienced poaching and have suffered recent population declines (Chase *et al.* 2016).



Figure 1. Photo from tusk harvest in the 1880s (Robert H Milligan, New York Public Library)

16/12/42

RUFFIELD UNIT OF TROPICAL ANIMAL ECOLOGY - ELEPHANT DATA

Date: 5/7/66 Locality: West end of Tanga Hill. Number: 701
 Sex: ♀
 Herd Composition: 697-705 Age:

Measurements:	Weights:
Total body length	Hind leg
Crown-rump length	Stomach, full/empty
Occiput - tail	Stomach fill
Occiput - tail → 7'11"	Intestine, full/empty
Tail	Intestine fill
S. height (st.) → 7'4 1/2"	Kidneys, + fat
S. height (C.)	Kidneys, - fat
Girth x 1/2	Temporal gland
Forefoot diam R/L	Brain
Hindfoot diam R/L	Pituitary
Forefoot circum.	Adrenals, R/L
Hindfoot circum.	Thyroid
Toenails, fore R/L	Heart
Toenails, hind R/L	Lungs & trachea
Tusks, lip - tip	Liver
Tusks, total length	Spleen
Tusks circum.	Tusks R/L

8 1/2 5

Figure 2. Example of historical records of elephant morphology used by Chiyo *et al.* (2015)

Chiyo *et al.* (2015) investigated changes in populations of *Loxodonta africana* located along the Kenya-Tanzania border between the 1960s and the 2000s. Rather than observing tusklessness like Dr. Poole, Chiyo *et al.* (2015) examined evidence of subtler changes in tusk morphology over time due to poaching. They used Historical records to collect height (estimated to the shoulder), tusk length, and tusk circumference from approximately 600 elephants that were culled in Tsavo East National Park (Kenya) and Mkomazi National Park (Tanzania) between 1966 and 1968. Figure 2 is an example of the historical records used in the study (for more information see: <http://ufdc.ufl.edu/AA00013409/00007>). Contemporary data were collected from live animals that were translocated from southern Kenya to Tsavo East National Park (2005), Masai Mara National Reserve (2011), and Meru National Park (2013).

7. Given what you have learned about the long-term impacts of poaching on elephant populations, make a prediction about changes in tusk size from the 1960s population to the 2010s population Chiyo *et al.* (2015) surveyed.

I expect that the elephants in the 1960s had... (circle one) **larger** **smaller**
 ... tusks compared to elephants measured in the 2000s, **because:**

8. Together we are going to analyze data Chiyo *et al.* (2015) used in their study (available from Dryad Data Repository). We will first open the file in Radiant, which is a graphical user interface written in R. We are going to access Radiant through QUBES, an NSF-funded consortium focused quantitative skill development in biology education.

- Go to QUBES, qubeshub.com, and set-up an account (it is free).
- Once you are logged in, go to the Resources page by clicking on the Resources tab at the top.
- Search for Radiant.
- Click on Radiant software from the search return



Resources Community Services

Find software

Search

Radiant

Software (On-site) 5 Aug 2017 Contributor(s): Drew LaMar

Radiant is an open-source platform-independent browser-based interface for business analytics in R.... **Radiant** was developed by Vincent Nijs.... com/[radiant-rstats](#)/[radiant](#)/issues.... [ucsd.edu](#). Documentation: [https://radiant-rstats.io/docs/Vincent Nijs...](https://radiant-rstats.io/docs/Vincent%20Nijs...)

<https://qubeshub.org/resources/radiant>

Radiant

Business analytics using R and Shiny.

Launch Tool

Version **0.8.7.1** - published on 05 Aug 2017

Open source: [license](#) | [download](#)

[View All Supporting Documents](#)

- Launch the tool
- The tool will open with a data file (not your file) already loaded. It should look like this:

The screenshot shows the Radiant web interface. On the left, there are panels for 'Datasets' (showing 'diamonds'), 'Load data of type:' (showing 'rda'), and 'Save data to type:' (showing 'rda'). The main area displays a table of diamond data with columns: price, carat, clarity, cut, color, depth, table, x, y, z, date. Below the table, it says '10 of 3,000 rows shown. See View-tab for details.' The title of the data is 'Diamond prices'.

price	carat	clarity	cut	color	depth	table	x	y	z	date
580	0.32	VS1	Ideal	H	61.00	56.00	4.43	4.45	2.71	2012-02-26
650	0.34	SI1	Very Good	G	63.40	57.00	4.45	4.42	2.81	2012-02-26
630	0.30	VS2	Very Good	G	63.10	58.00	4.27	4.23	2.68	2012-02-26
706	0.35	VVS2	Ideal	H	59.20	56.00	4.60	4.65	2.74	2012-02-26
1080	0.40	VS2	Premium	F	62.60	58.00	4.72	4.68	2.94	2012-02-26
3082	0.60	VVS1	Ideal	E	62.50	53.70	5.35	5.43	3.38	2012-02-26
3328	0.88	SI1	Ideal	I	61.70	56.00	6.14	6.18	3.80	2012-02-26
4229	0.93	SI1	Premium	E	61.40	57.00	6.34	6.23	3.86	2012-02-26
1895	0.51	VVS2	Very Good	G	63.40	57.00	5.09	5.06	3.22	2012-02-26
3546	1.01	SI2	Good	E	63.90	58.00	6.31	6.37	4.05	2012-02-26

- Change the dataset by loading your datafile, 'Elephant Morphometrics and Tusk Size.csv' into Radiant.
 - Change Load data type to csv
 - Click on Browse to select your file from your computer
 - Leave all default settings (Header and Str. as factor checked, Separator: Comma, Decimal: Period)
- You should now see your new dataset in Radiant (example below)

Years.of.sample.collection	Elephant.ID	Sex	Estimated.Age..years.	shoulder.Height.in..cm
1966-68	12	f	0.08	102.00
1966-68	34	f	0.08	89.00
1966-68	162	f	0.08	89.00
1966-68	292	f	0.08	92.00
1966-68	11	f	0.25	133.00
1966-68	152	f	0.25	100.00
1966-68	264	f	0.25	93.00
1966-68	263	f	0.50	108.00
1966-68	266	f	0.50	108.00
1966-68	217	f	1.00	124.00

10 of 777 rows shown. See View-tab for details.

Datasets:

Elephant Morphometrics and Tusk Size

Add/edit data description

Rename data

Load data of type:

csv

Header Str. as Factor

use read.csv

Maximum rows to read:

Separator:

Comma Semicolon

Tab

Decimal:

Period Comma

Browse... Elephant Morphome

Upload complete

- The data file has tusk length (cm), tusk circumference (cm), shoulder height (cm) for elephants from two time points, 1966-1968 and 2005-2013.

8. Use the Visualize tab to explore relationships between variables within your dataset.

- Use the pull-down menus (triangles) to create figures easily and quickly.
- You can make scatter, bar, box, and line plots (and more). After you chose a plot type, you can identify your variables of interest.
- Here is an example of a scatter plot where color was used to indicate year.

Datasets:

Elephant Morphometrics and Tusk Size

Filter data

Pause plotting

Plot-type:

Scatter

Y-variable:

shoulder.Height.in..cm (numeric)

Tusk.Length.in.cm (numeric)

Tusk.Circumference...in.cm (numer

X-variable:

Sex (factor)

Estimated.Age..years. (numeric)

shoulder.Height.in..cm (numeric)

Facet row

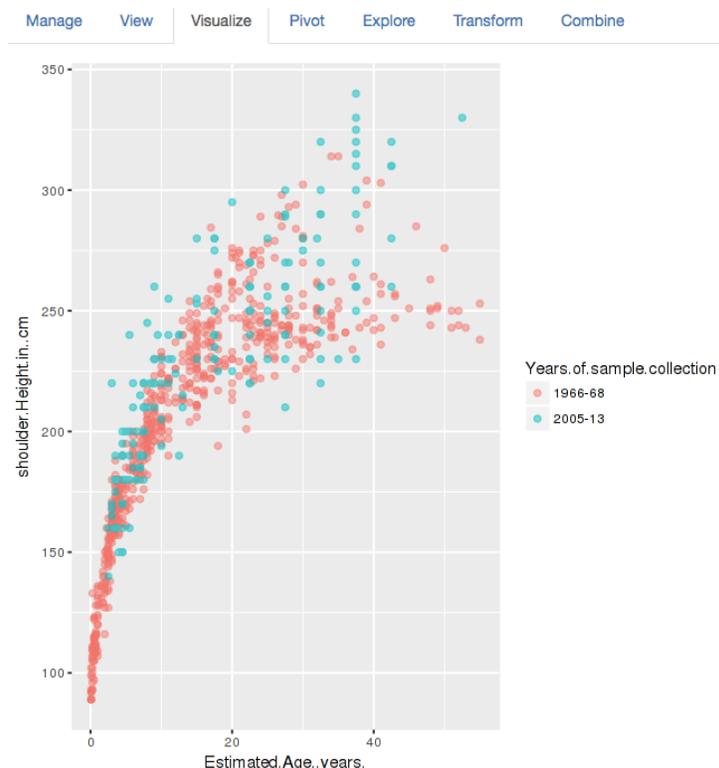
None

Facet column

None

Color

Years.of.sample.collection {factor}



- Working with your partner, use the Visualize tool to explore the dataset and create a figure using the data. Answer the following about the figure you created:
 - What plot type did you create?
 - Why did you choose that particular plot type?
 - What variables did you compare?
 - What did you learn?



- Save your plot by clicking on the Report Results icon at the bottom.
- This will take you to a R Markdown file that will include the R code to generate your figure. Change the title of your figure by editing the blue writing, then Knit the report (click the Knit report button).

No file chosen

```

1- ## Comparing height and age of elephants
2-
3- ```{r fig.width=7, fig.height=6, dpi = 96}
4- visualize(dataset = "Elephant Morphometrics and Tusk Size", xvar =
5- "Estimated.Age.years.", yvar = "shoulder.Height.in.cm", type = "scatter", color =
6- "Years.of.sample.collection", custom = FALSE)
  
```

- Your figure will appear after you knit the report. Write a figure caption for your figure below:

9. Compare your results with another group.

a. What did you learn from the other group?

b. What would you like to investigate further?

10. Further investigate your dataset by generating summary statistics about tusk length, tusk circumference, and shoulder height using the Explore tab (back in Data view). An example of some data exploration is below, this is just to show you how to use the tool. Your summary data will include other statistics.

Years.of.sample.collection	variable	n	mean	min	max	sd
1966-68	shoulder.Height.in..cm	605	204.339	89	314	49.308
2005-13	shoulder.Height.in..cm	172	230.686	140	340	43.764

- Fill in the table below using information you collected from the Explore tab.

Year	Sex	Average tusk length (cm)	Average tusk width (cm)	Average height (cm)
1966-1968	Male			
1966-1968	Female			
2005-2013	Male			
2005-2013	Female			

- Save the table you created in Radiant. Again, go to the Report Results icon. It will take you to your R Markdown file. Knit the report again and it will now have both your figure and table.
- Save your report (click on Save report) to your computer.

? Knit report Auto paste Switch tab HTML Save report Choose File No file chosen

11. Recall from the video that the researchers focused on the importance of tusks. Using your analyses, answer the following questions.

- In general, which population (1966-1968 or 2005-2013) had longer tusks on average?
- Did males or females typically grow longer tusks? Are these results expected? Why or why not?
- Does the difference in average body size strongly correlate with differences in tusk length over time? What does this suggest about selective pressure on tusk size?

12. Are your results from the Chiyo *et al.* (2015) data expected when taking into consideration the observations from other populations of elephants (like the Gorongosa population) and what you predicted earlier in the activity? Why or why not?

13. Consider the evolutionary effects of poaching on elephants.

- a. Do the changes in tusk length over time in males and females suggest that selection acts the same or differently on males and females? Explain.

- b. When considering sexual selection, do you think males are likely the competitive sex (typically competing with other males to gain access to more mates) or the choosy sex (where they have access to ample mates and only chose specific females to mate with)? Justify your answer.

14. Conclusions:

- a. What are the short and long-term impacts of these changes on elephant populations?

- b. While poaching may affect phenotypic changes in tusk length, is the population decline of concern? Why or why not?

References:

Chase, M. J., S. Schlossberg, C. R. Griffin, P. J. C. Bouché, S. W. Djene, P. W. Elkan, S. Ferriera, F. Grossman, E. M. Kohi, K. Landen, P. Omondi, A. Peltier, S. A. F. Selier, and R. Sutcliffe. 2016. Continent-wide survey reveals massive decline in Africa savannah elephants. *PeerJ*, 4:e2354

Chiyo, P. I., V. Obanda, and D. K. Korir. 2015. Illegal tusk harvest and the decline of tusk size in the African elephant. *Ecology and Evolution*, 5 (22): 5216-5229.

Chiyo PI, Obanda V, Korir DK. 2015. Data from: Illegal tusk harvest and the decline of tusk size in the African elephant. Dryad Digital Repository. <https://doi.org/10.5061/dryad.h6t7j>