CSI AFRICA: TRACKING IVORY POACHERS
TEACHER GUIDE TO ACTIVITY

INTRODUCTION

This data analysis activity is designed to accompany the annotated research paper "Genetic assignment of large seizures of elephant ivory reveals Africa's major poaching hotspots," by Dr. Samuel Wasser and colleagues. In this activity, students analyze data from the scientists' research to identify the type of elephants slaughtered in a poaching event and to support claims about the location of the slain elephants. The data used in this activity are available on the Dryad Digital Repository: http://dx.doi.org/10.5061/dryad.435p4, except for the genotypes of the seized ivory tusks.

KEY CONCEPTS AND LEARNING OBJECTIVES

- Variation (differences) in stretches of DNA can be used to identify individual organisms.
- Biological techniques such as the polymerase chain reaction and gel electrophoresis can be used to generate genetic profiles for individuals and populations.
- Scientists use empirical data and mathematical models to estimate allele frequencies in different populations across a geographic range.

Students will be able to:

- describe how the process of DNA profiling or fingerprinting works.
- use patterns in elephant DNA profiles to identify the type of elephant that was the source of the seized ivory.
- use data in a genetic reference map to find the likely source of elephant ivory samples.

TIME REQUIREMENT

One 50-minute classroom period, if students have read the annotated paper ahead of time.

MATERIALS

- 1 copy of "DNA Profiling—How It Works" (optional) per student
- 1 copy of "Locating the Source of Ivory—Procedure" (optional) per student
- 1 copy of the "Map of Africa" handout per student
- 1 copy of the "Allele Frequency Data for Three Different Regions" handout per student

TEACHING TIPS

This activity can be accomplished by students individually or in pairs. Decide whether or not your students will benefit from the two optional readings "DNA Profiling—How It Works" and "Locating the Source of Ivory—Procedure" and make copies accordingly. You may also want to explore HHMI BioInteractive's Click and Learn "CSI Wildlife" that is based on the same annotated paper available at http://www.hhmi.org/biointeractive/csi-wildlife and use it to supplement this activity.

ANSWER KEY

2. **Note that some of the definitions are given in the annotated paper. Students should provide answers in their own words instead of simply copying the definitions from the paper.**

   a. Genotype:

   The genetic makeup of an organism. Can also refer to the two alleles inherited for a particular gene. In this activity, the second definition is emphasized.

   b. Microsatellite:

   A highly variable region of DNA in which a set of DNA sequences of two to five base pairs in length is repeated multiple times.

   c. Allele:

   One of two or more alternative forms of a DNA region that arise by mutation and are found at the same place on a chromosome.

   d. DNA locus (plural “loci”):

   The specific location of a DNA sequence on a chromosome.

   e. Allele frequency:

   The relative frequency of a gene variant (i.e. an allele) at a particular locus in a population. Allele frequencies are expressed as a fraction or as percentage.

3. Compare the data from your PCR amplification with the data in Figure 1. What type of elephant was the source of your tusk? Provide evidence to support your claim.

   Students should recognize that all the alleles for forest elephants are between 140 and 169 bp in length, whereas the alleles for savanna elephants are all larger than 200 bp. The alleles from the seized tusk are 145 and 147 bp long, supporting the claim that the seized tusks came from forest elephants.

4. Read “Locating the Source of Ivory — Procedure” and ask your boss (teacher) any questions you still have.

   Decide beforehand if you want students to complete the optional reading. You may also want to discuss the procedures with students.

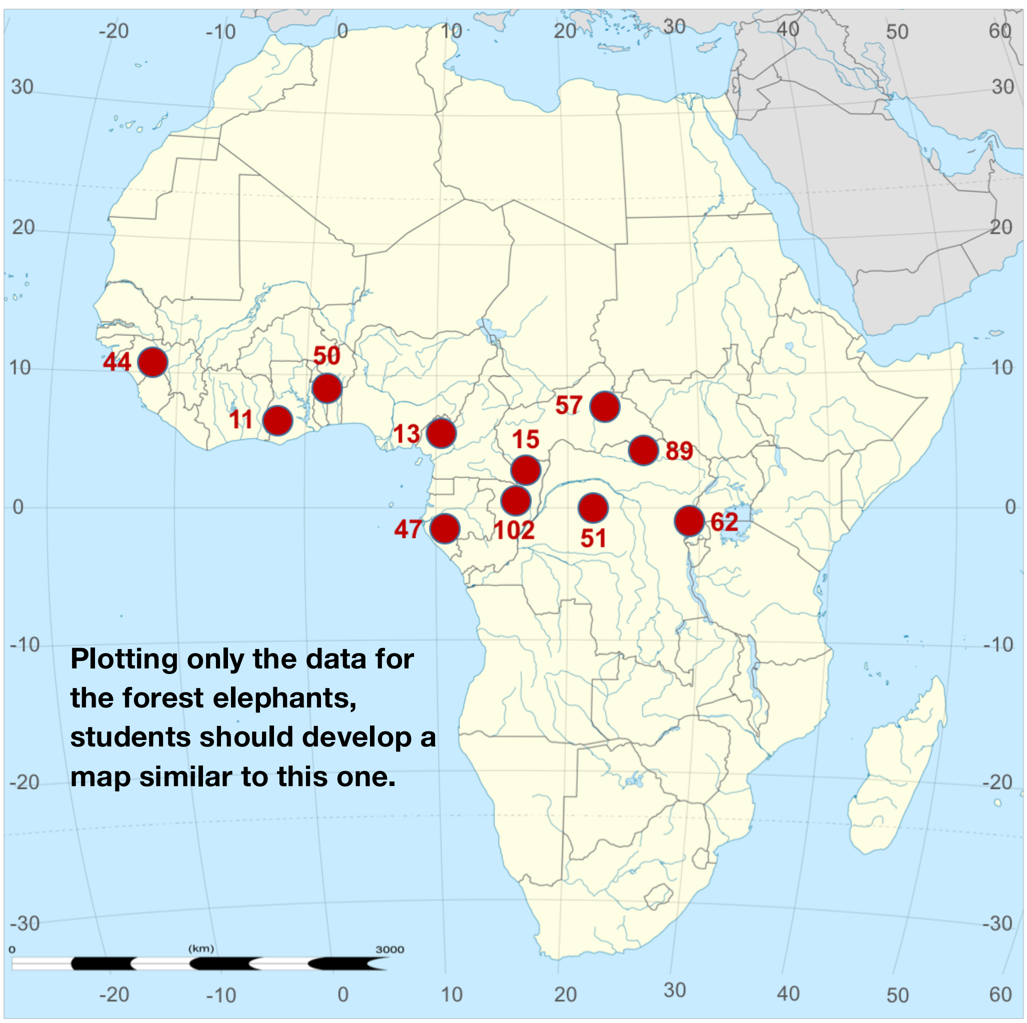
5.a. Using Figure 1 above, decide which of the samples in Table 2 are from forest and which are from savanna elephants. Enter your answers into the table.

Table 2. Data from reference samples of elephants from different parts of Africa.

Location #	Genotype from one elephant at the location for FH 127 (bp)	Latitude (degrees)	Longitude (degrees)	Forest or Savanna Elephant?
3	249, 269	-3.2	35.6	**Savanna**
7	239, 243	-0.4	36.6	**Savanna**
8	249, 249	8.1	14.0	**Savanna**
10	249, 271	5.5	36.3	**Savanna**
11	149, 151	6.3	-3.0	**Forest**
13	151, 157	5.0	9.5	**Forest**
15	145, 145	2.8	16.4	**Forest**
19	237, 237	11.3	14.8	**Savanna**

30	239, 263	-12.9	33.5	**Savanna**
44	151, 153	9.7	-12.1	**Forest**
46	219, 237	11.1	19.5	**Savanna**
47	145, 149	-2.0	9.9	**Forest**
50	159, 161	8.7	1.1	**Forest**
51	151, 151	-1.2	21.0	**Forest**
53	277, 277	-1.6	30.7	**Savanna**
57	145, 151	7.5	20.2	**Forest**
62	145, 153	-1.5	29.5	**Forest**
72	239, 239	-8.6	30.4	**Savanna**
89	151, 157	4.5	24.7	**Forest**
102	153, 157	0.6	15.6	**Forest**
113	237, 271	-12.6	30.2	**Savanna**

b. Plot each sample ***for only the type of elephant you identified in Step 3 (forest <u>or</u> savanna)*** on the handout "Map of Africa" using the latitude and longitude values. […]



Map. Geographical location of the forest elephant populations used to make a reference map. *(Courtesy of Eric Gaba/Wikimedia Commons)*

6. […] Use the same approach to calculate the allele frequencies for locus **FH 39**. Further details are in the "Locating the Source of Ivory— Procedure."

Table 4. Calculated allele percentages for the seized ivory for FH 39

Allele size (# bp)	Number of times allele appeared in seized ivory	Allele frequency in seized ivory (in %)
229	0	**0/10*100 = 0%**
231	1	**1/10*100 = 10%**
233	0	**0/10*100 = 0%**
235	0	**0/10*100 = 0%**
237	3	**3/10*100 = 30%**
239	3	**3/10*100 = 30%**
241	1	**1/10*100 = 10%**
243	0	**0/10*100 = 0%**
245	1	**1/10*100 = 10%**
247	0	**0/10*100 = 0%**
249	1	**1/10*100 = 10%**
Total # alleles	10	----

7. Use the data from Step 6 and the allele frequency data on the "Allele Frequency Data for Three Different Regions" handout to make a claim about which suspect is most likely to be involved in poaching the elephants that were the source of the seized ivory.

Students should try to match the frequency of alleles of certain lengths (i.e. bp numbers) found in the seized ivory with those present in the different regions where the three suspects were located.

Suspect C is most likely to have been involved. Evidence from FH 67 is the low percentage of the 91 bp allele, and the relatively high percentage of the 93 bp allele. Evidence from the FH 39 allele is the low percentages of the 233, 235, and 247 bp alleles, the high percentage of the 239 bp allele, and the close match of the percentage of the 237 bp allele.

8. What makes you confident that you have helped identify the correct suspect as the ivory poacher?

Students should mention the fact that the frequency of alleles with certain number of base pairs in the region where suspect C was located were very similar to the frequency of these alleles in the seized ivory.

9. What evidence would make you more confident in pinpointing the geographic location of the seized ivory?

More microsatellite loci could be analyzed for each sample. It would also be better to sample more elephants from each location to increase confidence that the populations'

genetic profile is accurate. You could then also compare a larger number of poached ivory samples to the more accurate genetic profile.

In the annotated paper, Wasser and his colleagues used 16 different microsatellite regions for many of the reference elephant populations. They also sampled many more individuals, and for the seized ivory, they analyzed 73 tusks per seizure and used their average for comparison.

10. How does the location of your seized tusks compare with the “hotspots” for elephant poaching described by Wasser and colleagues in their paper?

If students plot the location of Suspect C on their map of Africa, they will notice that this location overlaps with the hotspot of forest elephant poaching that Wasser and his colleagues identified in their study.

See figure 3 of the annotated paper for a direct comparison.

REFERENCE

Wasser, S. K., Brown, L., Mailand, C., Mondol, S., Clark, W., Laurie, C., and Weir, B. S. (2015). Genetic assignment of large seizures of elephant ivory reveals Africa’s major poaching hotspots. Science, 349, 84-87.

Data samples taken from Dryad Digital Repository http://dx.doi.org/10.5061/dryad.435p4.

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