Anthony Barnosky and Kaitlin Maguire Measure Mammal Extinctions at the John Day Fossil Beds

hhmi | BioInteractive

Scientists at Work
Educator Materials

OVERVIEW

This worksheet complements the short video "Anthony Barnosky and Kaitlin Maguire Measure Mammal Extinctions at the John Day Fossil Beds" from the *Scientists at Work* series. The *Scientists at Work* series is intended to provide insights into the daily work of scientists that builds toward discoveries. The series focuses especially on scientists in the field and what motivates their work.

KEY CONCEPTS AND LEARNING TARGETS

- Scientists collect evidence from the natural world and examine it and interpret it using logic.
- The scientific process is based on observations, experimentation, and testing.
- The practice of science involves presenting ideas that can be tested, repeated, and verified.
- Modern scientific research is often collaborative, requiring expertise across disciplines.
- Studying Earth's history provides context for us to understand current environmental conditions and trends. It allows us to connect the past with the present.

CURRICULUM CONNECTIONS

Standards	Curriculum Connections
NGSS (2013)	MS-LS4-1, MS-ESS1-4, MS-ESS3-3, HS-LS4-5
AP Biology (2015)	1.C.1, SP2, SP5
AP Environmental Science (2013)	I.A, III.A, VII.C
IB Biology (2016)	C.3, C.5
IB Environmental Systems and Societies (2017)	2.1, 3.2, 3.3
Common Core (2010)	ELA.RST.6-7; ELA.WHST.6-7 Math. 6.RP.3, 6.EE.7, 7.RP.2, 7.EE.3, A-REI.3, MP2, MP3

KEY TERMS

biodiversity, earth and environment, earth history, ecology, evolution, scientific methodology, scientific process, paleobiology

TIME REQUIREMENTS

Approximately one 45-min class period.

SUGGESTED AUDIENCE

- Middle school life or earth science
- High school environmental science (all levels including AP and IB)
- High school biology (all levels including AP and IB)

PRIOR KNOWLEDGE

Students should understand ratios and proportions and be familiar with solving simple algebraic equations.

MATERIALS

- Calculator

TEACHING TIPS

Students should read through the worksheet before watching the film.

QUESTIONS

1. Describe what Drs. Barnosky and Maguire are attempting to measure in the John Day Fossil Beds.
   The normal or background rate of extinction for mammals.

2. Explain why it is important to understand the normal rate of extinction over millions of years of Earth history.
   To get a better understanding of what is going on today.

3. The film mentioned that the researchers had a special permit to work in the John Day Fossil Beds National Monument. Provide two reasons why this is an important science practice.
   To protect public lands from unlicensed fossil collectors and to make sure that fossils collected are properly studied.

4. Dr. Maguire collected rocks near where the specimen was found. Why was this an important step in the research process?
   The rocks contain volcanic minerals that can be used to date the specimens found in nearby layers.

5. Provide two reasons why teeth are an important part of a mammal specimen to analyze.
   They preserve well in the fossil record and they are useful for identifying specimens.

6. Technology has changed the way researchers communicate and collaborate. Describe how Dr. Barnosky's team communicated and shared data with other scientists.
   Data from millions of fossils can be compiled into databases to get an accurate picture of how often species go extinct.

7. Biological research involves collaboration across disciplines. How does this film illustrate the collaborative nature of science?
   Paleontologists discover and identify fossils, geologists help them date the specimens, and computer scientists design large databases and other tools to compile and compare all the data.

8. The narrator states in the film, "Species are going extinct way too quickly." Then Dr. Barnosky states, "In as little as three centuries, you would lose three out of four species you are familiar with." Describe three conservation biology strategies that might be used to slow down this rate of extinction.
   Answers will vary but may include: stop destroying habitat, build wildlife corridors, assisted reproduction, mitigate climate change, and stop directly killing animals.

9. If you were doing the research in the film, what is another scientific question you would like to try to answer?
   Answers will vary.

10. Working with data:

Extinction rates are expressed in units of extinctions per million species-years (E/MSY). For a given analysis, species-years can be calculated by multiplying the number of species in the study by the number of years being considered. For example:

20 bird species × 100,000 years = 2,000,000 species-years or 2 MSY
similarly,
2,000 bird species × 1,000 years = 2,000,000 species-years or 2 MSY

a. Considering that about 5,500 mammalian species live on Earth today, how many species-years are represented by the last 100 years?

$$\mathbf{5,500}\ \boldsymbol{species}\ \times\ \mathbf{100}\ \boldsymbol{years} = \mathbf{550,000}\ \boldsymbol{species\text{–}years}\ \boldsymbol{or}\ \mathbf{0.55}\ \boldsymbol{MSY}$$

b. The normal rate of extinction for mammals is 1.8 E/MSY. How many extinction events would you expect to have occurred over the last 100 years (i.e., for the MSY calculated in 10a)?

$$\frac{\mathbf{1.8}\ \boldsymbol{extinctions}}{\mathbf{1,000,000}\ \boldsymbol{species\text{–}years}} = \frac{\boldsymbol{x}}{\mathbf{550,000}\ \boldsymbol{species\text{–}years}}$$

$$\boldsymbol{x} = \mathbf{0.99} \approx \mathbf{1}\ \boldsymbol{extinction}$$

c. According to the International Union for Conservation of Nature (IUCN), 43 mammals have become extinct in the past 100 years. How does that number compare to the expected number calculated in 10b?

43 >> 1, so the observed extinction rate is much higher than the expected rate.

d. In November of 2014, the IUCN listed 1,199 mammals as threatened. If all those mammals went extinct in the next 100 years, what would be the extinction rate in E/MSY and how does that number compare to the expected rate? (Hint: Assume 5,500 species for the total number of mammals.)

$$\frac{\mathbf{1,199}\ \boldsymbol{extinctions}}{\mathbf{550,000}\ \boldsymbol{species\text{–}years} = \frac{\boldsymbol{x}\ \boldsymbol{extinctions}}{\mathbf{1,000,000}\ \boldsymbol{species\text{–}years}}}$$

$$\boldsymbol{x} = \mathbf{2,180}\ \boldsymbol{E/MSY}$$

This rate is much, much higher than the expected rate and could lead to a mass extinction.

AUTHOR
Ann Brokaw, Rocky River High School, Ohio
Edited by Mark Nielsen, PhD, HHMI