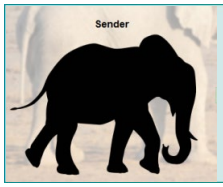

INTRODUCTION

This worksheet walks through the Click & Learn *How Animals Use Sound to Communicate*. You will explore three case studies of how animals use sound and hearing to communicate, and how aspects of these traits have been shaped by evolution.

PROCEDURE

Use the information in the Click & Learn to answer the following questions in the space provided. Questions are labeled with the sections and pages they are related to.

INTRODUCTION

Page 2: Communication Involves the Senses

1. For each type of signal, describe one advantage, one disadvantage, and an example of a situation where that signal would be important. One row has been filled in as an example.

Signal	Advantage	Disadvantage	Situation
Visual			
Auditory	Can be used to communicate at night, when it is too dark to see	Could be overheard by a predator, revealing the sender's location	Groups of frogs use calls to find mates
Olfactory			
Tactile			

Page 3: Can You Spot the Signals?

2. Watch the video and write down as many communication behaviors as you can identify (minimum of three) and the signals and senses involved. (Be as specific as you can.)

Page 4: Find Out How You Did

3. Watch the same video again, this time with the researcher's observations. How many of the behaviors were you able to identify? For each of the labeled behaviors, make a list of both the signal involved and the senses involved in each signal.

Behavior	Signal	Senses Involved

Page 5: Using Sound as a Signal

4. Keeping in mind that signals and senses have evolved by natural selection, write down your ideas about what advantages and disadvantages communicating with sound may have over communicating with the other senses.

Case Study 1 (Elephants: Long-Distance Communication)

Page 3: Advantages of Low-Frequency Sounds

5. Describe the advantages of using low-frequency sounds for communication. What aspect of an elephant's life makes it important to use low-frequency sounds?

Page 5: Can Elephants Also "Hear" Sounds Through the Ground?

6. What was the question that the scientist was exploring?

7. Describe how the elephants responded to the alarm call played back in the air.

8. Describe how the elephants responded to the alarm call played back by the shaker.

9. What could account for the difference in the elephants' responses?

Page 6: Detecting Ground Vibrations Through the Bones; Page 7: Bone Conduction

10. Describe another example of "hearing" by bone conduction. It could include your personal experience.

Page 9: Write Down Your Ideas

11. Write down your ideas for how the ability to communicate using low-frequency sounds may provide an adaptive advantage for survival and reproduction to elephants.

Case Study 2 (Birds: Species-Specific Courtship)

Page 1: Birds Produce a Variety of Sounds

12. What do you think the cardinal is trying to communicate with its song?

Page 2: Hearing Range of Birds Compared to Other Animals

13. How do the hearing ranges of birds compare to those of bats, elephants, and humans? What does this tell you about the evolution of the communication systems of birds and humans compared to those of bats and elephants?

Page 7: Reveal Species

14. How many individuals did you misclassify?

15. How difficult was sorting by song alone (*Page 5*) compared to sorting by song with a spectrogram (*Page 6*)? What does this tell you about human perception of birdsong?

Page 8: Write Down Your Ideas

16. Write down your ideas for how species-specific songs might provide an adaptive advantage in survival and reproduction.

Case Study 3 (Bats and Moths: Use of Ultrasound)

Page 1: Bats Produce Ultrasounds

17. How many calls did the bats make?

18. Some bat calls appear fainter in the spectrogram, and others appear brighter. What does this signify?

19. Estimate the frequency range (from low to high) of the most powerful portion of the bat call.

Page 4: What Is Echolocation?

20. What is the advantage of higher frequencies compared to lower frequencies for echolocation?

Page 6: Bats and Moths Are in an Evolutionary Arms Race

21. What are two ways described in the video that moths use to avoid predation?

22. What did the scientist conclude from the tethered moth experiments (tethering moths that do and do not make sound, then letting bats hunt them)?

23. By observing the bats' hunting behavior, what did the scientist conclude about the strategy the sound-making moth was using? Why?

Page 7: Write Down Your Ideas

24. Write down your ideas on how ultrasound provides an advantage to bats and moths in their particular habitat.

Sound Tutorial

25. Describe how the wavelength of sound and the frequency of sound are related.

26. What is the wavelength of a 1-kilohertz (kHz) sound traveling in water? Show your calculations.

27. Describe two ways by which a higher-frequency sound is attenuated as sound waves travel through forests. What implications do you think this has for the evolution of communication among forest-dwelling elephants?

28. Use the graph on *Page 20: Hearing Range of Different Animals* to answer the following questions.
    a. Calculate the wavelength of a sound in the middle of the human hearing range.

    b. Calculate the wavelength for a sound in the middle of the bat hearing range.

    c. Which of the two sounds would be more advantageous for detecting an insect with echolocation? Explain why, using the information on *Page 17: Wavelength and Sound Reflection* to support your answer.