The FUTURES Channel®

MOVIE GUIDE

MOVIE NUMBER 2001

The Disappearing Call of the Wild

The Movie:

Archiving and analyzing over 2,000 hours of rainforest sounds, bio-acoustician Bernie Krause measures the decline of species as habitats disappear. Featured: Bernie Krause, bio-acoustician. *(Movie length: 2:43)*

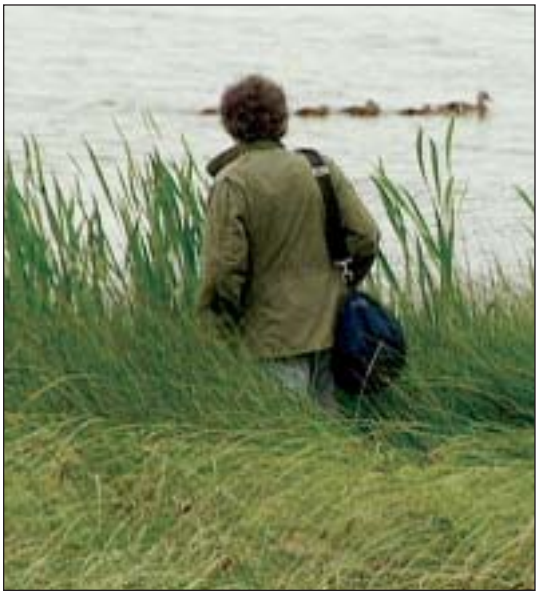
Background:

Conservation scientists estimate that each year tens of thousands of species disappear from the Earth. Half of all the types of plant and animal life on Earth are found in tropical rainforests, which are also disappearing at an alarming rate.

Loss of a species means the loss of a particular combination of genes which represents a unique ability to survive in an environment. The less diverse the gene pool of life on Earth, the more vulnerable that life is to environmental changes and the evolution of new viruses.

The first step in protecting species is to identify them—not necessarily an easy task in a dense rainforest, or any wilderness area for that matter. However, where seeing an animal or insect may be very difficult, hearing it is often another matter, and thus enters the science of bioacoustics—literally, "the sounds of life".

Curriculum Connections:



Measurement (speed, conversion) 1

The speed of sound in water is much faster than in air: around 1,500 meters/second, compared to 340 meters per second. Low frequency sounds, such as are made by whales, can travel great distances underwater. If a blue whale in the Pacific makes a sound that travels 3,000 miles across the ocean, how long does the sound take to make that journey?

Algebra (patterns) 2

Species do not exist in isolation; they depend on one another. Suppose you start with 1,101 different animal species. Assume that for every species that becomes extinct each year, two other species become extinct the following year. If one species becomes extinct in the first year, how many years would it take to reduce the number of species to less than 100? (First, guess the answer; then calculate it.)

Measurement (speed, frequency and wavelength), Algebra (using formulas) 3

Sound is a vibration of air. Its pitch is determined by how fast the vibration takes place, which is called frequency. As the vibration travels through the air, it creates alternating regions of slightly higher and slightly lower density; the distance from one region of high density to the next is the wavelength of the sound.

Wavelength and frequency are related by this formula:

$$\lambda\nu = C^*$$

λ = wavelength, in meters

ν = frequency, in cycles per second

C = speed, in meters per second

The speed of sound is not always the same, since it is affected by the temperature of the air and other factors, but it is around 340 meters per second. This means that the A about middle C on a piano, with a frequency of 440 meters per second, has a wavelength of around 77 centimeters.

Find the wavelengths of the frequencies of sounds emitted by these animals. How do the wavelengths relate to the animals' sizes?

Animal	Frequency
Elephant	30 cycles per second
Howler monkey	400 cycles per second
Ladder-backed woodpecker	4,000 cycles per second

*Traditionally in mathematics and science, the wavelength of a vibration is represented by the Greek letter lambda (λ), the frequency is represented by the Greek letter nu (ν), and its speed of travel is represented by the English letter c.

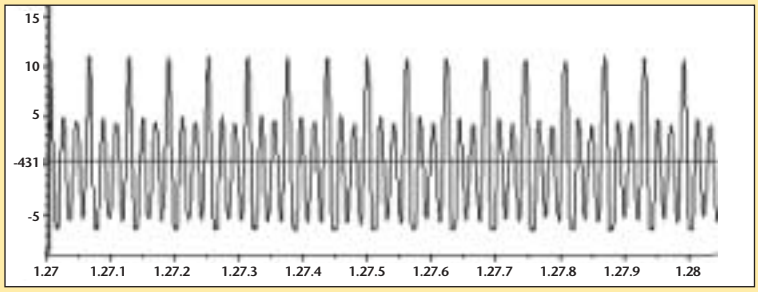
Decimals, Algebra (coordinate graphing) 4

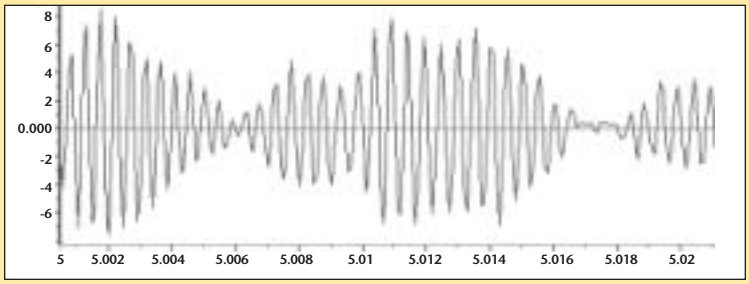
Look at these graphs of various sound vibrations, and see if you can match them to the animals that made them:

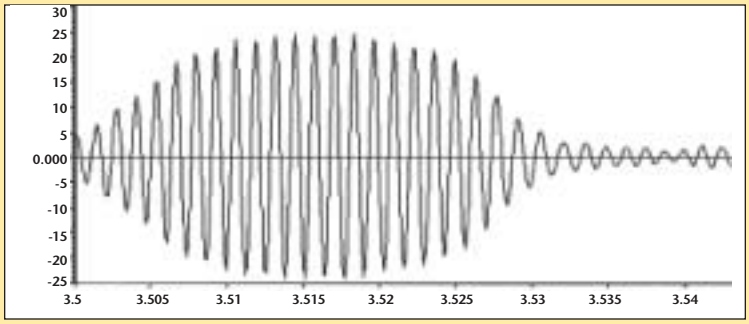
a) Screech owl, characteristic frequency about 900 cycles per second

b) Blue whale, characteristic frequency about 50 cycles per second

c) Bearded seal, characteristic frequency about 2,000 cycles per second







Logarithms

5

The loudness of sound is measured in comparison to a standard intensity, which is at the threshold of human hearing. The unit of comparison is the "Bel", which is equal to the logarithm, base 10, of the ratio of the sound's intensity to that standard intensity.

Thus a sound which is 100 times louder than the standard threshold intensity of sound would have a loudness of 2 Bels:

$$\text{Bels} = \log_{10}\left(\frac{\text{intensity of sound being measured}}{\text{intensity of threshold sound}}\right)$$
$$= \log_{10}(100)$$
$$= 2$$

Usually, sound engineers use smaller units of comparison, called decibels (abbreviated dB).

$$\text{dB} = 10 \cdot \log_{10}\left(\frac{\text{intensity of sound being measured}}{\text{intensity of threshold sound}}\right)$$

A sound which is 100 times the standard threshold intensity of sound is, therefore, equal to 20 decibels.

$$\text{dB} = 10 \cdot \log_{10}(100)$$
$$= 10 \cdot 2$$
$$= 20$$

a) An elephant can make a sound as loud as 100 decibels. How many times louder than the threshold sound intensity is this?

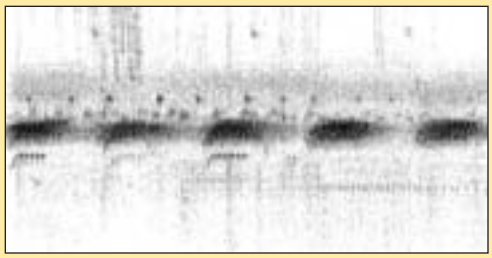
b) Bats emit sounds in the range of 60 decibels (about the level of human conversation) to 110 decibels. How many times louder is the loudest bat sound compared to the quietest? (Hint: Compare both to the threshold sound intensity.)

c) Suppose you are 10 feet away from a bird which you can hear singing at a volume of 40 dB. Every time you double your distance from the bird, the loudness of the sound is reduced by 6 dB. About how far away would you have to get to reduce the level of sound to that of the human threshold (which is 0 dB)?

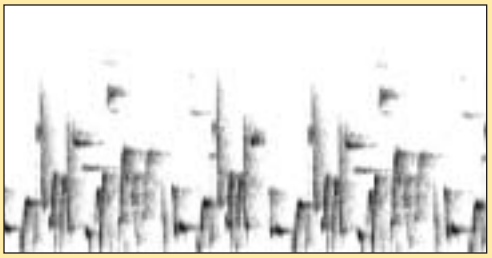
Algebra (patterns)

When an animal makes a sound, that sound has many frequencies, with each frequency having a particular intensity. Bioacousticians use computers to create images that represent all of those frequencies and intensities; these images are called *spectrograms.*

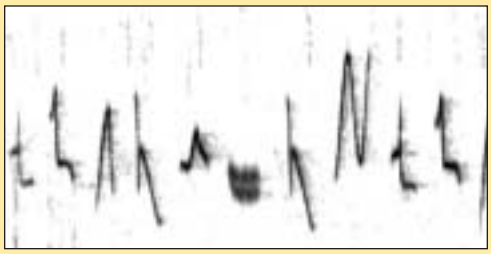
Below are spectrograms for four species of animal in Costa Rica. The fifth spectrogram is an image of the sound made by three of the animals at the same time, as you might hear it in the wild. Can you tell which animal can NOT be heard in the fifth spectrogram?



Tree frog



Wood wren



Robin

Howler monkey

Three animals together

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Cheetahs, #2006	To help save an endangered species like the cheetah, you must start by understanding its behavior.
Bats, #2007	Bats are an essential and fascinating part of the ecology of many environments.