Responses to frequently asked questions about elephants and infrasound

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What is infrasound?

Infrasound is sound below the level of human hearing. The frequency of a sound is measured in Hertz (Hz) and the infrasonic range is generally considered to be between 1 and 20 Hz.

What sort of frequency spectrum is found in an infrasonic elephant call?

Elephants make a variety of vocalizations including rumbles, screams, and trumpets. Rumbles are low-frequency calls, often falling partially or entirely in the infrasonic range. Most elephant rumbles consist of a fundamental frequency between 5-30Hz with audible harmonics or overtones. With distance, the upper harmonics attenuate at a greater rate than the lower ones. A good working range for capturing elephant rumbles with their harmonics, is 5-250 Hz. The lowest call we have measured for forest elephants was at 5Hz; from savannah elephants, 14Hz.

Is infrasound emitted by all elephants?

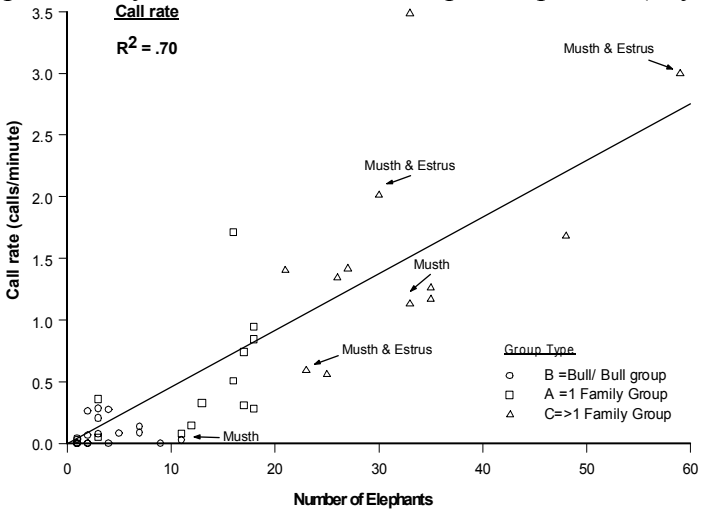
Yes. Researchers have recorded infrasonic calls in captive Asian elephants (Payne, Langbauer & Thomas1986), African savannah elephants (Poole, Payne & Langbauer 1988) and African forest elephants (Elephant Listening Project research in Central and West Africa).

Under what circumstances or conditions do animals emit infrasonic rumbles?

Most elephant rumbles are rich in infrasound; many of these contain frequencies high enough to be audible to humans. Elephants make these calls when coordinating family and larger group behaviors, when competing for resources and/or dominance, and when attracting mates and announcing reproduction (Poole, Payne & Langbauer, 1988). Females with young are most vocal as confirmed by Katy Payne's data from Amboseli park in Kenya and Etosha park in Namibia. The vast majority of infrasonic calling took place in family groups; bull groups were relatively silent. There is, however, still much to be learned about the functions of elephant calls.

How often will an elephant use infrasonic calls?

Females vocalize more frequently than males; the rate of vocalization in both males and females is highly variable and dependent on social circumstances. We know from data gathered in Namibia and the Central African Republic, that the rate of calling increases predictably with the number of elephants present (Payne et al, 2003).



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How far do infrasonic elephant calls travel?

The lower the frequency of a sound, the longer its sound wave. Low frequency sounds can therefore travel farther without being absorbed or reflected by the environment. Intensity of elephant calls varies widely from very soft calls made between mothers and their adjacent infants to the very loud calls made by females announcing their availability. Playback experiments demonstrated that savanna elephants responded to each others' loud vocalizations over distances of at least 2 kilometers. Because playbacks were only broadcast at half the amplitude of the strongest elephant calls in their sample, the authors estimated the actual range as at least 4 kilometers (Langbauer, Payne et al, 1991). The calling area may be expanded by as much as an order of magnitude during temperature inversions in the evening and night (Larom et al, 1997). Preliminary results from our recent work with forest elephants suggest that powerful forest elephant calls travel roughly the same distances through the dense forest. The fact that elephant calls can travel several kilometers enables elephant societies to coordinate movements over large areas.

How do you record infrasonic calls?

In order to pick up calls in the infrasonic range (1-20Hz), you must have equipment that is sensitive to these low sounds (microphone, preamplifier and recording device). Many commercial products are not designed to pick up sound outside of the human hearing range and have a severe roll-off in sensitivity on the low-end of the frequency scale. A technical support person from the product's company can usually provide you with information on component sensitivity. We have used a number of different systems over the years as summarized below.

Autonomous Recording Units

We currently use a specialized unit called an ARU (Autonomous Recording Unit) developed by engineers in the Cornell University Bioacoustics Research Program. It consists of a small microphone mounted on a signal conditioning board that connects to a more generalized filter amplification board. The output from the filter amplification board then feeds into a circuit that converts the analog signal into a digital one and then stores the data to a laptop hard drive. The unit runs off of a car or truck battery (or a few lantern batteries). These units allow us to set the sampling rate as we wish (typical CD-quality sound is recorded at a sampling rate of 44.1kHz). Although high sampling rates capture a wide range of frequencies (e.g. birds and elephants on the same recording) large sampling rates also produce large files. For elephant rumbles, we are only interested in the low frequencies and can therefore sample at a much lower rate for much longer amounts of time. We have successfully sampled at 2000Hz for a continuous unmanned 3 months with these units. ARUs are not commercially available at this time. For more information about technical details you can go to our website: *http://birds.cornell.edu/BRP/ARUTerrestrial.html*.

Commercially available digital recording system

For situations where we just want to record for a few minutes or hours at a high-sampling rate, we currently use a digital recording system of off-the-shelf components. One bonus of true digital recording is that the recordings can easily be transferred to a computer for analysis and archiving to CD. If you are considering buying a system to record infrasound, make sure to talk with the provider's technical support staff to make sure all components are sensitive to frequencies in the infrasonic range (1-20Hz).

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The products listed below are by no means the only effective components available and with the speed of technology development these days, there are probably some superior products out already.

- A pair of Earthworks QTC-1 microphones
- A Sound Devices MP-2 preamplifier
- A Nomad Jukebox digital player/recorder (Another good alternative is using a DAT recorder such as the TASCAM DAP1. The only drawback is that if you later would like to convert the DAT tape to digital files the process involves a real-time transfer.)

Analog recording system

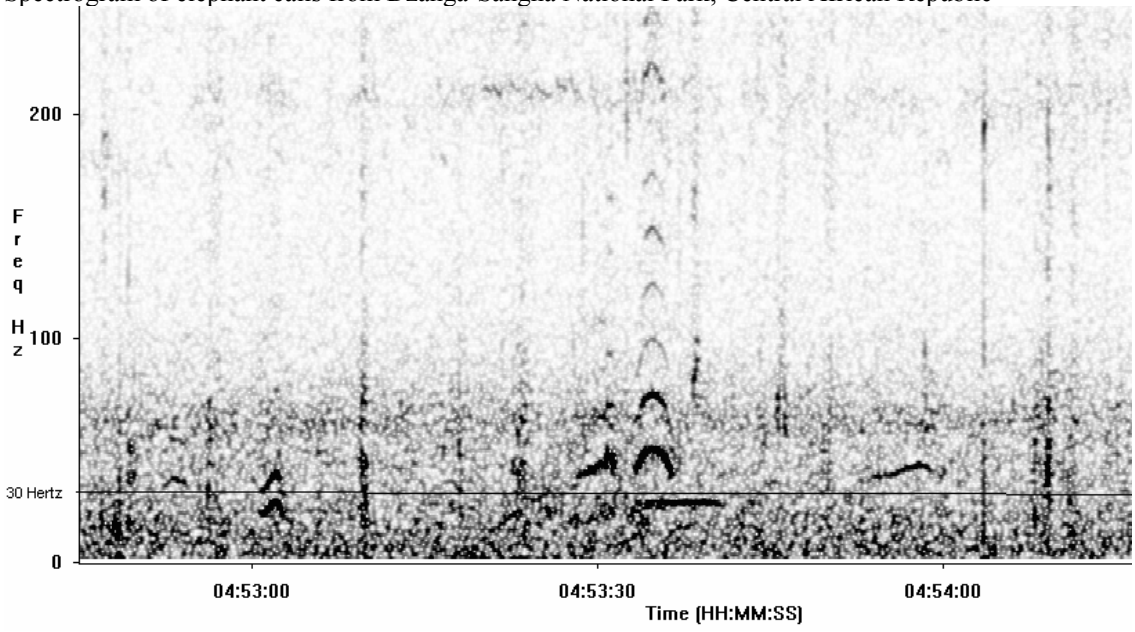
Katy Payne's discovery in 1984 that elephants produced infrasonic calls was made with an analog system including a Nagra IV SJ reel-to-reel recorder and a Bruel & Kjaer (B&K) 4133 microphone.

How do you analyze infrasonic calls if you can't hear them?

One way to discover if you have recorded infrasonic elephant calls is to speed up the recording, raising all the frequencies in the recording to a level that you can hear them. Typically, if you speed up a recording containing infrasonic elephant calls 3 times, you will easily be able to hear them.

Sounds can also be represented visually using spectrograms. Spectrograms graph frequency on the y-axis, time on the x-axis and represent loudness of sound by the darkness of the display. We create spectrograms using the Raven software developed by the Cornell University Bioacoustics Research Program. More information about this software is available on the website: *http://birds.cornell.edu/brp/Raven.html*.

Spectrogram of elephant calls from Dzanga-Sangha National Park, Central African Republic



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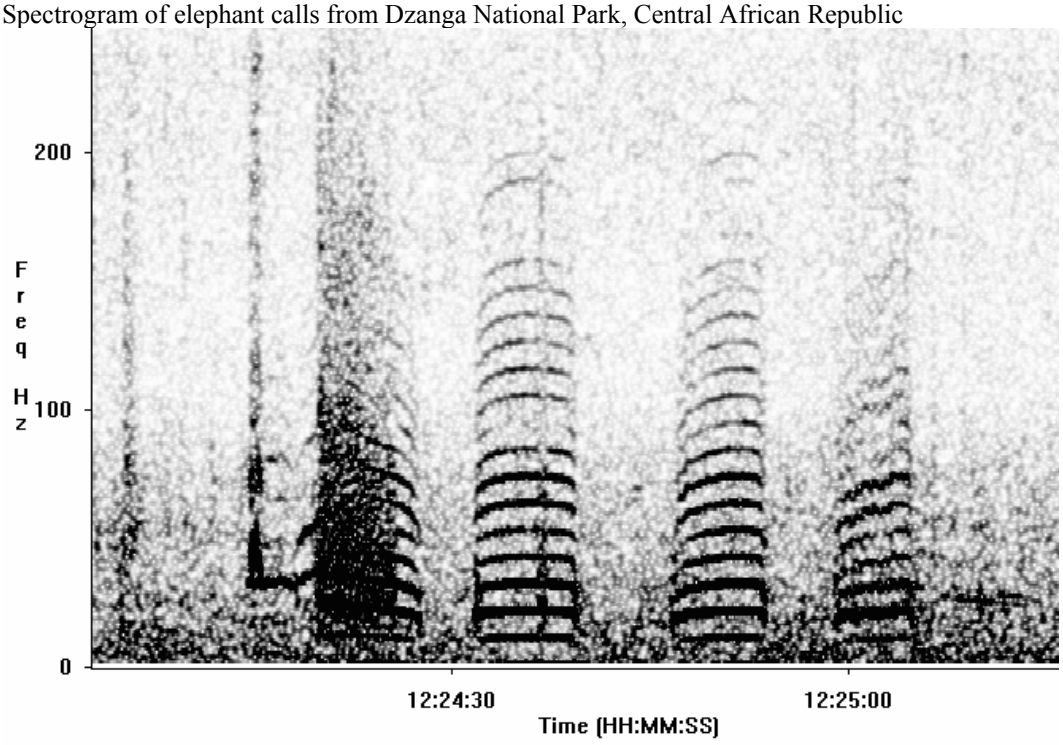
Spectrogram of elephant calls from Dzanga National Park, Central African Republic



Is there a unique feature of infrasonic elephant calls which distinguishes them from other infrasound that may be recorded (for example from wind, other animals etc.)?

The structure of elephant rumbles are quite varied, but readily recognizable. Our team has scanned months of audio data in spectrogram format and clipped over 17,000 elephant calls. Our criteria for detection of an elephant call involved searching for a roughly eyebrow-shaped signal between 1-250 Hz and lasting between 2-10 seconds. The other infrasonic noise we encountered was broadband wind or thunder, which often obscures elephant infrasound. As seen in the spectrograms below, motorized vehicles and planes have signals that are easy to distinguish from elephant calls.

Elephant Calls from Kakum National Park , Ghana

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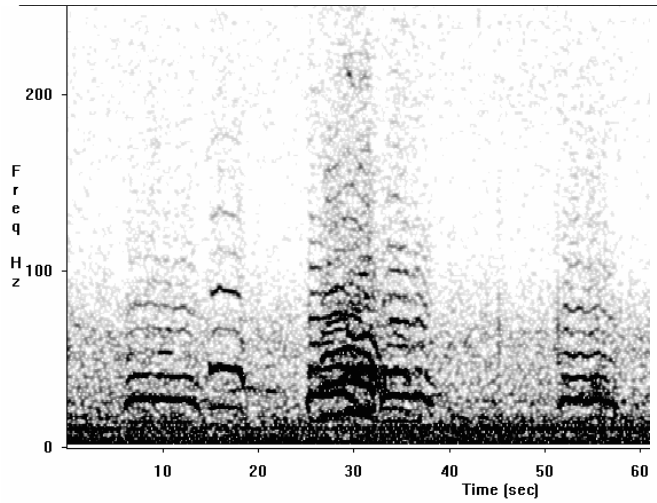
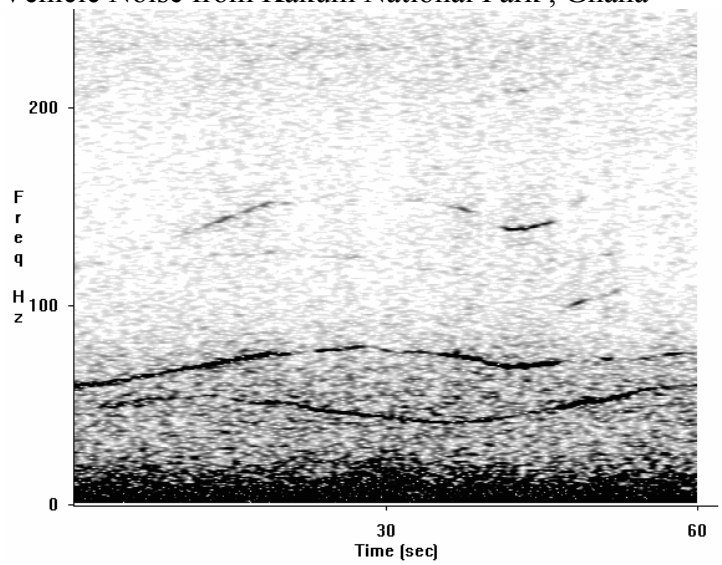


Vehicle Noise from Kakum National Park , Ghana



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