distinguish the rhythmic, fluttering wings of insects from leaves and twigs oscillating in the wind.

Tuning in with a bat detector

The echolocation calls of most bat species are beyond the range of human hearing. A bat detector, however, can make these signals audible to humans. High intensity echolocation calls are especially conspicuous, providing people with an excellent way of "eavesdropping" on bats.

A bat detector microphone is sensitive to sound beyond the range of human hearing. The circuitry within the detector converts the input into signals audible to our ears and broadcasts it over a small speaker. Human beings are exceptional among mammals because they cannot hear a broad range of high frequency sounds. Like birds, reptiles, and amphibians, humans hear best at frequencies below five kilohertz (kHz); most of our conversations are conducted below three kHz. A bat detector permits you to eavesdrop on sounds in the 10 kHz to 200 kHz range, including those of other mammals and many insects.

In addition to being important research tools, bat detectors are also an excellent way to introduce people to bats during interpretive programs. Many bat enthusiasts use them for sheer enjoyment as well. With a bat detector, you can collect information about two aspects of animal sounds--the frequencies of the calls and the rates at which they are produced. By listening carefully, you also can gain information about the amount of energy the calls contain at different frequencies.

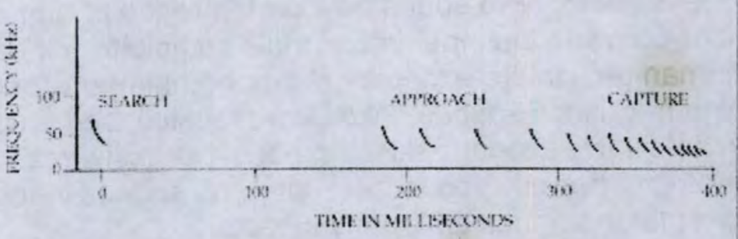
On a typical summer evening in many North American cities, you will hear bat echolocation calls when you tune the instrument to between 25 kHz and 60 kHz. In many areas, the bats producing these signals will be big brown bats (*Eptesicus fuscus*), a common species. These bats typically produce echolocation calls lasting from five to 10 milliseconds (ms=thousandths of a second). As you listen, notice that the rate at which bats are producing their calls varies according to the situation.

A big brown bat cruising along and looking for an insect produces a call every 50-100 ms (10-20 calls per second), but as it approaches its target it increases its call rate to 200 per ms, reducing the time between calls to about five ms. These high-pulse repetition rates occur either when the bat attacks an insect (a "feeding buzz"), or when it approaches an obstacle (a "landing buzz"). As the bat closes in on its target, notice how it shortens its individual calls. If you are listening in on 30 kHz, for example, the sound will change from a "putt" to a "click," reflecting the shorter calls and relative amounts of energy used at different frequencies.

Watching bats and insects around a bright streetlight will yield even more information, because you will be able to associate the bat's behavior with its calls. Watch as it chases a moth. Listen to the difference in the signals as it approaches, and then catches, its prey. Now close your eyes and listen. Chances are you will know what the bat is doing merely by the repetition rate of its calls.

Not all bat species will sound the same, and when you become proficient, you can often identify a species by the tone of its call, just as bird watchers identify birds by their songs. The degree of resolution depends on the bats, but in many places in North America, a bat detector giving tone-like chirps at 40 kHz signals a red bat (*Lasiurus borealis*), a tree-roosting species. Tick-like sounds at 40 kHz suggest a *Myotis*, a common genus that includes one of our most abundant bats, the little brown bat (*Myotis lucifugus*). Tone-like chirps at 20 kHz usually indicate a hoary bat (*Lasiurus cinereus*), another tree-rooster.

Echolocation is clearly one of the most fascinating aspects of the biology and behavior of bats. If you want the thrill of listening in, get a bat detector, find a light with a lot of insect activity, and tune in on the action! You will be richly rewarded.



With the aid of a bat detector, a bat's ultrasonic echolocation calls become audible to the human ear. This sonogram illustrates the timing and sequence of calls produced by a big brown bat as it searchs for, detects, and attacks a flying June beetle. Each call starts at a higher frequency and sweeps to a lower one. Note that as the bat closes in on its prey, it produces shorter calls at a more rapid rate, terminating in what is called a "feeding buzz." The entire sequence lasts less than a half a second.

Reprint from *BATS* Magazine Volume 9, No. 2. Summer 1991: 9-13

Taylor Ranch

From: "Jim Morris" <jemorris@ieee.org>
To: <tayranch@direcpc.com>
Sent: Monday, September 15, 2003 1:50 PM
Subject: Bat detection & identification

Holly,

It was great to again visit Taylor Ranch (my 5th visit) this summer and to see you and Jim. We spoke briefly about bat studies and I'd like to extend that discussion. Separately I'll be mailing some documentation that does not lend itself to email.

As I mentioned I purchased an AnaBat detector shortly after my visit in Aug. 2002. These detectors are normally used with a ZCAIM (Zero Crossing Analysis Interface Module) and some type of recording device. Katie Gillies used both a tape recorder and a laptop. Tape recorders tend to be problematic as you can read in the mailed material. Titley Electronics accordingly introduced a new ZCAIM in 2002 that records directly to removable memory chips (the same Compact Flash Memories used in many digital cameras) which eliminates the need for field tape recorders. For a full description see <http://www.titley.com.au/anabatcf.htm>. These new ZCAIM-CF Modules do a better job of recording and provide numerous additional functions (example simultaneously recording input from a GPS receiver). It is Titley's ZCAIM-CF that I purchased and have been using. Its cost is slightly greater than the earlier models but does not require one to buy a tape recorder.

Recording bat echolocation vocalizations is the easy part. Analysis is where time and effort is most needed. From what I've read there are two basic approaches to species identification from AnaBat recordings.

One approach is to analyze each recording using any one of the several similar software packages (Analook, Analyse for DOS, Analyze for Windows 95, etc.) and then compare screen images and parameters with a reference voucher recording such as contained in the library sold by O'Farrell. I believe that's the method Katie was using during my visit to Taylor.

A second approach is a more statistical method. I will not try to fully describe that approach since you can access an excellent tutorial and worked example online <http://members.ozemail.com.au/~jollys/>. In this method parameters are extracted as in the method above but entered into a statistical package (from SPSS) and compared to mean values for several species to produce specific probabilities that unknown belong to each of the voucher species. Mathematically this is solid statistics.

I'm looking to try to extend that methodology. Method One, above, compares an unknown to a single voucher example. Method TWO, above, rigorously compares each parameter to the mean values of that parameter for several species.

As I see it the various parameters of a given species probably vary considerably for a variety of causes, including the bat's age, gender, geographical region, activity etc. For example my initial look at the parameter fmax for *Eptesicus fuscus* shows a mean of 46.01kHz with a standard deviation of 13.3kHz. The variance of a particular parameter is also likely to be different for different species. For that reason I want to include both the mean values for the voucher files but also the expected variance.

I'll try to write a detailed outline of my approach as it evolves so as to allow for peer review. I'll need guidance, as I'm not a trained biologist. My first order of business is creating a database of reference AnaBat voucher calls for the species that I hope to identify. The greater number of calls in that data base the better statistically (but more work for me). I'd like to include all species found or likely to be found at Taylor Ranch. I've got one listings of bat species likely to be found in Idaho but would appreciate your input (or Katie's if available) as to the species you suspect, or know, reside in your area. The Univ. of New Mexico has online a wonderful database of AnaBat files many of which I've downloaded. I will need more, however, as not all species are included and for some species the numbers are not statistically significant.Once I know all the species of interest I plan to solicit files other researchers may have using the Batline message board.

I continue to entertain thoughts of flying in to Taylor in the late winter or early spring both to see the area in another season and to pursue a possible joint effort on bat detection and identification.

Jim Morris