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SHORT NOTES

Choosing the ‘correct’ bat detector — a reply

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Fenton (2000) compared two bat call analysis systems, one based on time-expansion and spectral analysis (Pettersson D980 with BatSound Pro software, www.bahnhof.se/~pettersson/) and the other based on zero crossings analysis (ZCA — Anabat II detector with ZCAIM and Anabat6 software, www.titley.com.au/index.html). This author concluded that the Anabat system was significantly inferior and claimed it was insensitive, inaccurate, did not detect all species, and was not reliable for “species that vary the harmonic content of their echolocation calls.” He claimed that using Anabat resulted in “substantial sacrifice in the areas of sensitivity and accuracy of data obtained about echolocation calls.” We contend that there are serious flaws in Fenton’s approach, and that the value judgments he has made in comparing two very different systems profoundly misrepresents the real value of Anabat for the purposes for which most people would want to use it.

Sensitivity

Time-expansion and spectral analysis is inherently more sensitive than ZCA, just as a narrow band system using heterodyne down-conversion will be more sensitive than either. If sensitivity was the only issue, a heterodyne system should be preferred.

Greater sensitivity will allow the user to sample a larger volume of space with a single detector. In situations where bats are rare and pass by one at a time, this might be an advantage. However, the Anabat system has proven sufficiently sensitive for most purposes and, in practice, there often is not time to fully process even the Anabat data — a situation which would be greatly aggravated by the use of a time-expansion system.

In the case of time-expansion, the greater sensitivity is more than counterbalanced by the fact that it is possible to record bats only 7.5% of the time, assuming the detector is being constantly watched by an experienced observer (12 s of data every 160 s — Fenton, 2000). Even if we accept Fenton’s assertion that the time-expansion system is five times more sensitive than the ZCA, the latter would still detect 2.7 times as many bats in such a setting because it operates almost continuously (100% duty cycle).

We see no basis for Fenton's claim that differences in the sensitivity of the two systems will "further complicate the matter of natural variability" or that variability in the calls produced by bats can somehow combine with variations in detector sensitivity to "affect the quality of data." A very basic skill in effective use of any bat detector system is the ability to make the distinction between variation due to the bat and variation due to how well a call is received by the detector. The latter is not only affected by the sensitivity of the detector, but also by the distance between detector and bat, which is nearly always changing. No matter how sensitive a detector is, it will still detect many calls very poorly, since there will always be bats which are too far away to detect properly. The total range of variation in reception should not be expected to depend on detector sensitivity.

Although we would not be surprised, or disturbed, to find that Anabat detects only one fifth as many calls as the time-expansion system, we have no confidence in Fenton's quantification of this difference. Fenton's paper implies the presence of a clear dichotomy between calls detected and not detected. In reality, calls may be fully detected, not detected at all, or detected to any degree between these extremes, irrespective of the system being used. This author gives no criteria for determining when he considered a call to be detected, so his experiment cannot be replicated.

Furthermore, in the case of the calls he recorded outside a cave in Israel, Fenton used the Anabat set to a sensitivity of "one third." Because of the non-linear nature of the sensitivity control, the actual sensitivity could have been as low as one eightieth of its maximum potential. In our experience, such a setting would only be appropriate in extreme situations of insect or electromagnetic noise. There is no evidence of such noise in Fenton's own spectrograms made with the time-expansion system at the same time. This raises the question of whether or not the Anabat was working properly during this test. Even if it was, the circumstances must be regarded as extremely unusual, and not representative of typical usage.

Accuracy

One way to evaluate accuracy is to observe how reliably a tone of a known frequency is displayed. Fenton did not test this, but the point is easily demonstrated by observing that the Anabat calibration tone is always displayed at the same pixel position by the Anabat software. This means that the combined errors in the calibration tone and the ZCAIM clock never exceed plus or minus one part in 160. Accuracy of Anabat is not an issue.

Fenton drew conclusions about accuracy from measurements made on the same calls by the two different systems. Yet he provides no evidence that any inaccuracies he may have observed were due to the Anabat rather than the time-expansion system. This is of special interest, since the method he describes for measuring maximum and minimum frequencies, from the 'power spectrum' display in BatSound Pro, seem inherently error-prone, leaving the measures dependent on the distance between bat and detector, and also vulnerable to inclusion of energy from more than one harmonic. It would have been far more appropriate to have measured these parameters directly from the spectrogram display.

In any case, given his approach to making measurements, it is not surprising that Fenton reported inconsistencies from the Anabat system. It is completely inappropriate to use the "z key to 'clean up' the display" prior to making measurements, especially of maximum frequency and duration.

The likely result of such action would be to decrease the values found for both these parameters. Furthermore, the Anabat software has not been intended for parameter measurement since 1993, when the program Analook was introduced for data management, measurement and display. Analook is also distributed free with the Anabat hardware, and the program Anabat has long been intended only to be used for recording of new data.

We also question Fenton's choice of parameters to measure. There is no doubt that ZCA will give slightly different estimates for maximum and minimum frequency compared to spectral analysis, but these parameters are of little use for species identification, which is the role for which Anabat is intended. It would have been far more useful to compare Characteristic Frequency (Fc), which is the frequency at the end in time of the portion of the call with the lowest absolute slope, and Characteristic Slope (Sc) which is the slope of that same portion. These parameters can be measured with very little dependence on how well a call is detected, they should show a very close correspondence between the two systems being compared and they are of much greater value for species identification. They are also much easier to measure from the Anabat display because of its much higher resolution.

Missing Species

Any species that can be detected by the Pettersson D980 (or any other detector) can also be detected by the Anabat. In any situation, use of a more sensitive detector will potentially reveal more species, just as it should also reveal more individuals. Similarly, if you sample an area with mist nets, you might encounter more species if you used larger nets, but that doesn't mean that smaller nets can't be used effectively. Any bat detector system is only taking a sample, and whatever experimental design is employed must be appropriate to the tools being used.

Harmonics

Fenton claims that Anabat "is not reliable when used with species that vary the harmonic content of their echolocation calls". This is a very misleading claim. In calls with most of the energy in one, dominant harmonic, zero crossings detectors will always detect that one harmonic. In other species, the distribution of sound energy between two or more harmonics changes during the call, or there might be multiple harmonics at roughly equal intensities. In these cases, the harmonic structure is readily apparent to a competent Anabat user because different harmonics become dominant under different conditions. For example, *Rhynchonycteris naso* can be detected by Anabat on either the first or second harmonic, or both, and this fact assists identification of this species rather than hindering it (contra Fenton, 2000). Anabat users routinely make use of information presented about harmonics to aid in identification of many species.

Cost — Benefit

Most people using bat detectors are doing so to identify free-flying bats, and it is for this purpose that Anabat is intended, and for which it is highly optimized. Yet Fenton's cost-benefit analysis of Anabat versus time-expansion is heavily biased by his emphasis on the measurement of echolocation call parameters, as if that was the system's main purpose. In our experience, the call characteristics most important for species identification are readily determined to sufficient accuracy by mere visual inspection of the Anabat or Analook screen, and most users will have no need to make measurements, nor would they get any substantial benefit from doing so.

Those who use Anabat routinely for field survey work will appreciate that species identification is often not easy, but requires much experience and is greatly assisted by combining acoustic with visual observations. So far, there does not seem to be any evidence that the greater detail provided by spectral analysis is of any benefit to species identification, but if it is, a potential benefit would be that it could be used to fine-tune identification criteria used by Anabat.

There are many facilities offered by Anabat which simply cannot be duplicated using spectral analysis because of the latter's much greater requirements for storage space and processing time. For example, freely available software allows one to setup an Anabat with a computer that will begin recording bats every night at sundown and stop each morning at sunrise. We have operated such a station for the last 18 months without any interruptions or loss of data. After the first few weeks of operation, we only visited the site once a month to retrieve call files. In 2000, we recorded 339,791 bat calls in 33,408 files occupying just 42 MB of disk space. Using a prototype of software currently being developed for this purpose, we were able to scan the entire data set using filters developed in Analook to distinguish calls of specific types. A scan for 13 species, using a preliminary set of very conservative filters, took ten minutes and resulted in the identification of 12,500 calls. The software output was in the form of a spreadsheet detailing activity of each species for an entire year.

In comparing the two systems, Fenton made judgements about the relative values of unrelated features offered by each system. For example, he made subjective assessments of the relative importance of Anabat's lower sensitivity against its vastly superior data management capabilities. Fenton's evaluation of 'utility' and 'convenience' greatly understate the many practical reasons why Anabat is so well suited to acoustic identification of bats for both survey and field research purposes. Fenton's perception of the abilities of the two systems for species identification is skewed by his misuse of the Anabat system, and does not accord with our own extensive experience.

Finally, a far more useful comparison between bat detection and analysis systems would result from bringing together effective advocates for different systems, getting them to agree to a test protocol and ensuring that they could oversee the testing procedures. That way, each party could be confident their equipment was used to its maximum potential, and some validity could be attached to the conclusions reached.

Literature Cited

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