



# Bat Detector Information Pack

## The Basics

There are four types of bat detector:

### 1. Heterodyne

- Heterodyne detectors are **tuneable** – you select the frequency range to listen to. This makes them the best detectors for immediate identification of bats in the field.
- They work by filtering the inaudible bat sound with an ultrasonic signal from the detector, and producing the audible difference between the two sounds.
- Sounds can be recorded onto a recorder, but recordings **cannot** be used with sound analysis software to generate sonograms as frequency information is not retained.
- They are the **cheapest** of the detectors and are simple to use, making them ideal for beginners.

### 2. Frequency Division

- Frequency division detectors **detect all frequencies**, so there is no need to tune in to a specific frequency and you don't miss any bats.
- They work by outputting a single sound wave for every ten waves (if divided by 10) in the original call, thereby making the calls audible by reducing the frequencies by a factor of ten, while still enabling you to hear the calls in real-time.
- Sounds can be recorded and analysed with sound analysis software but some information is lost.
- They are generally **low to mid-price**, but cheaper versions tend not to retain amplitude information.

### 3. Time Expansion

- Like frequency division detectors, time expansion detectors **detect all frequencies**.
- They work by digitally recording a short snatch of sound (e.g. 1 second), then playing it back at a slower speed, resulting in very high quality recordings and retention of the same information as the original call. However, recording is not continuous as calls are not detected during the playback period, so snapshots of calls are sampled.
- Sounds can be recorded and used with sound analysis software. They enable a very detailed analysis of the sound and a clearer sonogram when compared to frequency division.
- They are among the most **expensive** of the detectors.

### 4. Full Spectrum, Real-time Sampling

- Like frequency division and time expansion detectors, full spectrum, real-time sampling detectors **detect all frequencies**.
- They sample at very high rates to capture all signal information and output it in real-time – so you get the detail of call structure as with time expansion, but also the real-time continuous monitoring as with frequency division.
- Sounds can be recorded and used with sound analysis software. They enable a very detailed analysis of the sound and a clearer sonogram when compared to frequency division.
- They are generally more **expensive** than frequency division and time expansion detectors.

### Additional note

- Some detectors feature more than one type of sound conversion. For example, some frequency division detectors have a heterodyne mode as well, and some feature three models of sound conversion.

There are a number of factors to consider when choosing a bat detector. These include:

- **Price**
- **Microphone and frequency range:** Microphones determine the sensitivity of the bat detector. Piezo – best at mid frequencies (~45kHz), MEMS – mid frequencies (40-60kHz), Electret – lower frequencies (<30kHz), and Capacitance – higher frequencies (>80kHz). You will still be able to detect other frequencies, but the distance from which you can detect them will vary. Detectors with more than

one microphone are best, because they will be sensitive at more than one frequency (e.g. Pettersson D100 overleaf). All European species are detectable within the range 20-120kHz.

- **Bandwidth:** How many kHz either side of your tuned frequency on which you can hear calls (heterodyne). A wider bandwidth reduces the chances of missing species you are not tuned into, while a narrower bandwidth makes it easier to discern the difference between bats calling at similar frequencies.
- **Design:** size, display (LED/LCD), controls on side or top (side-controls easier for single-handed operation).

The following is a guide to some of the detectors that are available on the market at the present time and their main features. It is not intended as a review and prices should only be used as a guide as they may change over time or between suppliers. BCT do not recommend any specific type or model of detector.

## Heterodyne Bat Detectors (Summary, in price order)

| Model                                      | Approx cost  | Microphone (type & no.)    | Frequency range | Bandwidth           | Batteries                         | Size (mm) | Speaker | Design features/ other factors  |
|--|--------------|----------------------------|-----------------|---------------------|-----------------------------------|-----------|---------|---|
| <b>Magenta MkII Kit</b>                    | £40          | unknown                    | unknown         | 16kHz<br>(± 8kHz)   | 1 x 9V<br>(PP3)                   | 145x80x34 | Y       | Requires soldering & electronics skills & the ability to understand circuit diagrams.                               |
| <b>Semafor UF-140</b>                      | £46          | unknown                    | 10-140kHz       | unknown             | 1 x 9V<br>(PP3)                   | 145x60x45 | Y       |   |
| <b>Semafor UF-220</b>                      | £55          | unknown                    | 10-220kHz       | unknown             | 1 x 9V<br>(PP3)                   | 145x60x45 | Y       |   |
| <b>Ciel CDB 105 R2 Mono</b>                | £60          | Electret (1)               | 18-120kHz       | 10kHz<br>(± 5kHz)   | 1 x 9V<br>(PP3)                   | 140x64x31 | Y       | Integrated LED torch. ('BATZ' model also available-same spec. aimed at children)                                    |
| <b>Magenta Bat4</b>                        | £62          | Electret (1)               | 15-130kHz       | 9kHz<br>(± 4kHz)    | 4 x AAA                           | 145x80x34 | Y       | LED torch. Large frequency dial with top illumination. Side controls for single-handed operation. Wrist strap.      |
| <b>Ciel CDB 103 R3 Stereo</b>              | £90          | Electret (2)               | 15-130kHz       | 10kHz<br>(± 5kHz)   | 1 x 9V<br>(PP3)                   | 170x75x40 | Y       | LED display. Wrist strap.   |
| <b>Magenta Bat5</b>                        | £95          | Electret (1)               | 10-130kHz       | 9kHz<br>(± 4kHz)    | 4 x AAA                           | 135x72x27 | Y       | LCD display with backlighting. Inbuilt LED torch. Side controls for single-handed operation. Wrist strap.           |
| <b>Ciel CDB 101 R3 Stereo</b>              | £120         | Electret (2)               | 15-130kHz       | 10kHz<br>(± 5kHz)   | 1 x 9V<br>(PP3)                   | 170x75x40 | N       | LCD display. External speaker can be added. Wrist strap.  |
| <b>Ciel CDP 102 R3 Professional Stereo</b> | £150         | Electret (2)<br>- external | 15-130kHz       | 13kHz<br>(± 6.5kHz) | External<br>9-12V<br>DC<br>Source | 125x75x40 | N       | Boxed (for mounting and long-term surveys). Stereo/dual option-can observe 2 frequencies at same time. LCD display. |
| <b>Mini-3</b>                              | £155         | Electret (1)               | 15-160kHz       | 8kHz<br>(± 4kHz)    | 2 x AA                            | 147x65x40 | Y       | Large illuminated tuning dial.  |
| <b>Batbox IIID</b>                         | £156-<br>165 | Electret (1)               | 19-125kHz       | 16kHz<br>(± 8kHz)   | 1 x 9V<br>(PP3)                   | 125x69x32 | Y       | Digital LCD display with backlight. Side controls. Wrist strap.   |

| Model                               | Approx cost | Microphone (type & no.)  | Frequency range | Bandwidth     | Batteries    | Size (mm) | Speaker | Design features/ other factors  |
|-------------------------------------|-------------|--------------------------|-----------------|---------------|--------------|-----------|---------|---|
| <b>Ciel BM1 Professional Stereo</b> | £170        | Electret (2)             | 15-130kHz       | 10kHz (±5kHz) | 1 x 9V       | unknown   | N       | Clock, temp & humidity sensor. Bat counter. Can categorise frequency into 3 different ranges for counting different spp. Wrist strap. |
| <b>Batscanner</b>                   | £187        | Electret (1)             | 15-120kHz       | unknown       | 3 x AAA      | 120x65x27 | Y       | Adjusts automatically to detected frequency. LED display.   |
| <b>SSF Bat2</b>                     | £215        | MEMS(1)                  | 15-130kHz       | 10kHz (±5kHz) | 4 x AA       | 185x65x28 | Y       | In addition to heterodyne function, also uses frequency division to monitor all frequencies & reports peak frequency.                 |
| <b>Pettersson D100</b>              | £220        | Electret (1) & Piezo (1) | 10-120kHz       | 8kHz (± 4kHz) | 1 x 9V (PP3) | 113x71x33 | Y       | Backlit frequency control.  |
| <b>Pettersson D200</b>              | £280        | Electret (1)             | 10-120kHz       | 8kHz (± 4kHz) | 1 x 9V (PP3) | 119x60x25 | Y       | Fully backlit LCD display. Side controls – easy to adjust.  |

## Broadband Bat Detectors

### Frequency Division Detectors (Summary, in price order)

| Model                             | Approx cost | Division Factor | Microphone      | Freq. range                            | Amplitude retaining | Batteries                           | Size (mm) | Design features/ other factors   |
|-----------------------------------|-------------|-----------------|-----------------|--|---------------------|-------------------------------------|-----------|--|
| FREQUENCY DIVISION ONLY           |             |                 |                 |  |                     |                                     |           |  |
| <b>Ciel CDB 205 Mono</b>          | £60         | 10              | Electret (1)    | 18-120kHz                              | N                   | 1 x 9V (PP3)                        | 140x64x31 | LED torch.   |
| <b>Batbox Baton</b>               | £80         | 10              | Electret (1)    | 20-120kHz                              | Y                   | 1 x 9V (PP3)                        | 165x46x34 | Comes with BatScan sound analysis software. Very simple design & easy single-handed operation.   |
| <b>Anabat SD2 and PDA package</b> | £2,090      | 8,16,32         | Capacitance (1) | 4-200kHz                               | N/A                 | 4 x AA (internal) or 12V (external) | 155x90x45 | Designed for unattended long-term monitoring. CF & GPS compatible. PDA with pre-loaded software. Does not retain amplitude so analysis based largely on call structure and frequency parameters. |
| FREQUENCY DIVISION AND HETERODYNE |             |                 |                 |  |                     |                                     |           |  |
| <b>Ciel CDB 305 R2 Dual</b>       | £100        | 10              | Electret (1)    | 18-120kHz<br>Bandwidth: 10kHz (± 5kHz) | N                   | 1 x 9V (PP3)                        | 140x65x40 | Wrist strap.   |
| <b>Ciel CDB 301 R3 Advanced</b>   | £200        | 10              | Electret (2)    | 15-120kHz<br>Bandwidth: 10kHz (± 5kHz) | Y                   | 1 x 9V (PP3)                        | 170x75x35 | Backlit LCD display. Separate microphones for each function. Commentary button enabling note-taking. Wrist strap.  |
| <b>Batbox Duet</b>                | £255-280    | 10              | Electret (1)    | 17-125kHz<br>Bandwidth: 16kHz (± 8kHz) | Y                   | 1 x 9V (PP3)                        | 125x69x32 | Large LED display & control for single-handed operation. Wrist strap.  |

| Model                  | Approx cost | Division Factor | Microphone   | Freq. range                                 | Amplitude retaining | Batteries    | Size (mm) | Design features/ other factors   |
|------------------------|-------------|-----------------|--------------|---|---------------------|--------------|-----------|--|
| <b>Pettersson D230</b> | £450        | 10              | Electret (1) | 10-120kHz<br>Bandwidth:<br>8kHz<br>(± 4kHz) | Y                   | 1 x 9V (PP3) | 119x60x25 | LCD Display.<br>Comment switch.<br>Wrist strap.  |
| <b>U30</b>             | £630        | 10,20,40        | unknown      | 15-200kHz                                   | Y                   | 2 x AA       | 147x65x40 | Miniature 'ultra-low-noise' microphone.  |
| <b>Dodoultra*</b>      | unknown     | 10              | unknown      | 10-125kHz                                   | unknown             | 2 x AA       | 147x89x25 | Het/frequency shift. In f.s. mode, is a broadband detector & displays peak. F.s. output can be recorded through headphone socket. LCD Display. |

\*NB this detector uses frequency shift instead of frequency division. The signal is digitally processed to reduce the frequencies by ten with less loss of information.

### Time Expansion Detectors (Summary, in price order)

| Model                         | Approx cost | Expansion Factor | Microphone            | Freq. range                   | Batteries                   | Size (mm)  | Design features/ other factors   |
|-------------------------------|-------------|------------------|-----------------------|-------------------------------|-----------------------------|------------|--|
| TIME EXPANSION ONLY           |             |                  |                       |                               |                             |            |  |
| <b>Tranquility Transect</b>   | £470        | N/A              | Capacitive            | 10-160kHz                     | 4 x AA                      | 145x95x45  | Hands-free (worn around neck). No speaker.   |
| TIME EXPANSION AND HETERODYNE |             |                  |                       |                               |                             |            |  |
| <b>Tranquility III</b>        | £755        | 10,32,64         | Capacitive            | 12-160kHz                     | 4 x AA (& internal battery) | 155x95x52  | LED display. Internal digital recorder. 10.24sec memory.                                   |
| <b>Pettersson D240x</b>       | £1160       | 10               | Advanced Electret (1) | 10-120kHz<br>8kHz<br>(± 4kHz) | 1 x 9V (PP3)                | 119x60x25  | LCD Display. Comment switch. Storage time 3.4, 1.7 or 0.1sec. Automatic or manual trigger. |
| <b>ECO-Mega</b>               | £1555       | 10,32,64         | Capacitor             | 12-160kHz                     | 4 x AA                      | 170x110x40 | 25.6sec memory. Voice commentary. Time tag-30min intervals. Back-to-back recording.        |

### Time Expansion, Frequency Division, Heterodyne and Full Spectrum Sampling

| Model                    | Approx cost               | Frequency/ Expansion Factor   | Microphone      | Freq. range | Batteries   | Size (mm) | Design features/ other factors  |
|--------------------------|---------------------------|-------------------------------|-----------------|-------------|---|-----------|---|
| <b>Batbox Griffin</b>    | £1500-1550                | 8,10,16 (FD)<br>16 (TE)       | Electret        | unknown     | AA  | unknown   | Built in recording. Date, time, temp & light reading levels. Programmable menu-driven function set-up. Can record continuously (up to a max file length of one hour) for full spectrum, real-time sampling.             |
| <b>Pettersson D1000x</b> | £4350<br>(built to order) | From 1 (original speed) to 30 | Capacitance (1) | 10-200kHz   | Internal batteries or external power supply 6-10V | 170x80x35 | Built-in recording. 16-bit recording system using compact flashcard as storage. Manual or level-triggering modes. Comments recording mode. TE factor of 1 (for real-time full spectrum sampling) to 30 can be selected. |

## Full Spectrum, Real-time Bat Recorders (long-term, unattended monitoring)

| Model   | Approx cost  | Microphone   | Freq. range  | Batteries                                       | Size (mm)  | Design features/ other factors  |
|---|--|--------------|--|---|------------|---|
| <b>Batcorder</b>  | (Email <a href="mailto:info@ecoobs.com">info@ecoobs.com</a> for quote) | Electret (1) | 16-150kHz)   | 4 x AA  | unknown    | Analyses microphone signal in real-time & discriminates between bat calls & other sound signals. Autonomous long-term monitoring. Independent recording device & software built to co-operate with the hardware.  |
| <b>Song Meter SM2 Ultrasonic 384 kHz Digital Field Recorder</b> | £995   | SMX-US       | Up to 190kHz   | 4 x D   | unknown    | Designed for long-term deployment. Records frequencies up to 192kHz. Sufficient for monitoring nearly all spp. present in Europe. Second channel can be used with conventional SMX-II microphone to record other wildlife at scheduled times, though not simultaneously with ultrasonic monitoring. |
| <b>Song Meter SM2 Ultrasonic 192kHz Digital Field Recorder</b>  | £995   | SMX-US       | Up to 190kHz   | 4 x D   | unknown    | Designed for long-term deployment. Records frequencies up to 96kHz. Widely used in North America. Two channels double monitoring potential & can record simultaneously.   |
| <b>Batlogger</b>  | £1535  | Electret (1) | 10-150kHz  | 3.7V<br>4600mAh<br>Li-Ion<br>12 V DC<br>charger | 155x80x38  | Manual or automatic recording. Integrated GPS. Coordinates & temperature recorded with each sound recording. <b>Free</b> BatExplorer analysis software.   |
| <b>Pettersson D500x</b>   | £1795  | Electret (1) | N/A<br>Sampling rates: 44.1, 300, and 500kHz (optim. for 500kHz) | 4 x AA or external power supply                 | 184x172x52 | Detects & records ultrasound in real-time. Aimed for long-term unattended recording of bat calls. 4 slots for CompactFlash memory cards with total capacity of 128GB. Triggering system allowing device to start recording as sound is detected.  |

## Manufacturers and suppliers (details correct at time of going to print)

Alana Ecology Ltd: [www.alanaecology.com](http://www.alanaecology.com) The Old Primary School, Church Street, Bishop's Castle, Shropshire, SY9 5AE Tel: +44 (0)1588 630173 Email: [sales@alanaecology.com](mailto:sales@alanaecology.com).

Anabat SD1

Batbox: III-D, Baton, Duet, Griffin

Magenta: MKII Kit, Bat4, Bat5

Mini-3

Pettersson D100, D200, D230, D240x, D500x, D1000x

Batbox Ltd: [www.batbox.com](http://www.batbox.com) 2A Chanctonfold, Horsham Road, Steyning, West Sussex, BN44 3AA

Tel: 01903:816298 Email: [info@batbox.com](mailto:info@batbox.com)

Batbox III-D, Baton, Duet

Bat Management: [www.batmanagement.com](http://www.batmanagement.com) **US-based** – email for a UK quote [sales@batmanagement.com](mailto:sales@batmanagement.com)

Pettersson D200, D500x (only available here), D1000x

**Bat Planet:** [www.batplanet.co.uk](http://www.batplanet.co.uk) C/o Yarwood Ltd, Treefield Industrial Estate, Gelderd Road, Leeds LS27 7JU

Email: [sales@batplanet.co.uk](mailto:sales@batplanet.co.uk)

Full range of Ciel detectors (not including CDP 302), Belfry bat detector

**Bioquip:** [www.bioquip.net](http://www.bioquip.net)

Batbox III-D and Duet

Full range of Ciel detectors (not including CDP 302)

**Courtpan:** <http://courtpan.gnxt.net> 3 Suffolk Street, Cheltenham, GL50 2DH Tel: 01242 570123

Email: [courtpan@gxn.co.uk](mailto:courtpan@gxn.co.uk)

Tranquillity Transect, Tranquillity III, ECO-Mega

**Dodotronic:** [www.dodotronic.com](http://www.dodotronic.com) Via de Gasperi 5, 00040, Castel Gandolfo, RM, Italy

Email: [info@dodotronic.com](mailto:info@dodotronic.com)

Dodoultra

**EcoObs:** [www.ecoobs.com](http://www.ecoobs.com) Contact via online contact form <http://www.ecoobs.com/cnt-contact.html>

Batcorder

**Elekon AG:** <http://www.elekon.ch/en/batlogger/products/> Cheerstrasse 16, CH-6014, Lucerne, Switzerland

Tel: +41 41 250 40 40 Email: [mail@elekon.ch](mailto:mail@elekon.ch)

Batlogger, Batscanner

**Green witch:** [www.green-witch.com](http://www.green-witch.com) (search for bat detectors) Tel: 01954 211 288.

Batbox: III-D, Baton, Duet, Griffin (available to pre-order)

**Magenta Electronics Ltd:** [www.magenta2000.co.uk](http://www.magenta2000.co.uk) 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST

Tel: 01283 565435 Email: [sales@magenta2000.co.uk](mailto:sales@magenta2000.co.uk)

Magenta: MKII Kit, Bat4, Bat5

**NHBS:** <http://www.nhbs.com/> 2-3 Wills Road, Totnes, Devon, TQ9 5XN Tel: 01803 865913

Email: [customer.services@nhbs.co.uk](mailto:customer.services@nhbs.co.uk).

A range of detectors including SSF Bat2

**Pettersson Elektronik AB:** [www.batsound.com](http://www.batsound.com) **Sweden-based** – email for a UK quote [info@batsound.com](mailto:info@batsound.com)

Full range of Pettersson detectors (except D500x)

**Semafor:** <http://www.semafor.co.uk/bat-detector.html> Email: [enquiries@semafor.co.uk](mailto:enquiries@semafor.co.uk) (for a catalogue)

Semafor UF-140, UF-220

**Titley Electronics:** [www.titley.com.au](http://www.titley.com.au) **Australia-based** – can be shipped to UK. Email: [info@titley.com.au](mailto:info@titley.com.au)

Anabat SD1 and SD2

**Ultra Sound Advice:** <http://www.ultrasoundadvice.co.uk> 27 Merton Hall Road, Wimbledon, London SW19

3PR Tel: 020 8287 4614 Email: [sales@soundadvice.co.uk](mailto:sales@soundadvice.co.uk)

Mini3 Detector, U30 Detector

# Sound Analysis Software

A selection of software packages for analysing bat echolocation calls recorded using a broadband bat detector (time expansion or frequency division) are listed here (with some of the more frequently used ones at the start). We do not recommend specific packages, but BCT training courses in sound analysis cover the following: BatSound, BatScan, Wavesurfer, and TF32.

- **Adobe Audition v 3.0.** is a substantial package that calculates all the start/end/peak frequencies of a pulse for you and allows you manipulation sounds. It can also convert batches of mp3 or other formats to WAV format quickly. You can also listen to heterodyne separate from the FD channel on Duet recordings. Audition v 3.0 is available as a **30 day try-out** and the full package is \$350. Web site <http://www.adobe.com/uk/products/audition/>
- **Avisoft** at [www.avisoft.com](http://www.avisoft.com) offers a **free download** of a minimal program called SAS Lab Lite (5.7 MB) for very basic editing and generation of spectrograms. The full Avisoft has a whole range of functions although it takes time to learn how to use them all.
- **Bat Scan**, available from [www.batbox.com](http://www.batbox.com), comes with a selection of sample files so that you can compare your own recordings. It costs £17 (plus VAT and delivery) and is a simplified version of Spectrogram. In general it is faster and easier to use than BatSound, but does not have all of the functions. It is designed to be used with frequency division recordings. Follow-up service and advice is good. It is also available from Alana Ecology [www.alanaecology.com](http://www.alanaecology.com) at £30 (including VAT).
- **BatSound** is the original software developed by Pettersson especially for use with ultrasonic bat calls and is generally considered to be the industry standard. It is available directly from Pettersson (<http://www.batsound.com/?p=34>), and also from Alana Ecology ([www.alanaecology.com](http://www.alanaecology.com)). Costs start at around £275 for a single user licence, and more for multiple licences. BatSound has a nice big window for sonograms and an easy to use toolbar with shortcut buttons that operate on a mouse click for common functions. It also has lot of additional functions and newer versions have improved settings. The help files are generally well-structured and easy to use. Newer versions also allow you to import mp3 files directly into BatSound and to manage recordings from the D500x. You can download an **evaluation version of the latest software for free** from the Pettersson website.
- **TF32** is a **free** programme designed for speech analysis. A user manual is available from <http://www.medsch.wisc.edu/~milenkvc/tools.html> and a sound analysis instruction booklet from BCT.
- **Wavesurfer** is another completely **free** program available from <http://www.speech.kth.se/wavesurfer>. This was developed for speech analysis and you need to establish your own spectrogram parameters and save them. Therefore, you need to know a little about the terminology (FFTs, etc.) or you can look at the **ibats** website for instructions written by Dr Jon Russ (<http://www.ibats.org.uk/page.aspx?tabid=256>).
- **Cool Edit Pro 2.1**, produced by Syntrillium, has been taken over and is now sold as Adobe Audition. However, the old version is available as a **free download** from <http://www.softpedia.com/progDownload/Cool-Edit-Pro-Download-2076.html> (18.20MB) for a **21-day free trial** in which you can analyse 10ms calls. The spectrogram and oscillogram cannot be viewed simultaneously.

There are also a number of programs that have been developed in the USA and/or are designed to work with Apple Macs, although most of these have not been tested.

- **Sonobat v 2.5.5** is a program developed in the USA. It includes an auto-trigger recording function developed especially for the D240x set up to trigger automatically and allowing remote recording to a digital recorder. It allows you to look at reference calls in the same window next to a call that you are trying to identify. Reference calls are automatically adjusted to match the time and frequency scale of the one you are looking at. Analysis functions are plentiful including definition of low/high frequencies, bandwidth, duration, heel, slope, characteristic frequencies, harmonics and automatic

calculation of the inter-pulse interval. The program costs US\$320. There is a **free downloadable demo** of v2.4 for Mac and PC (<http://www.sonobat.com>).

- **bcAnalyze 1.0** is a programme designed to work with real-time recordings of bat calls. To be used with recordings from the Batcorder system (<http://www.ecoobs.com/cnt-bcAnalyze.html>). A call finding algorithm quickly finds calls within the recording. A license costs €140 (+VAT) and runs for 30 days in trial mode. System requirement is a Mac running Mac OS X 10.5.
  
- The Bioacoustics Research Programme at **Cornell Laboratory of Ornithology** developed a well-respected sound program called **Canary** some time ago. It is **free** to download, but unfortunately only runs on Mackintosh ( <http://www.birds.cornell.edu/brp/software/canary-information>). The user manual includes background information about how spectrograms are created and analysed. If you are willing to delve into some physics, it can help you to use other sound analysis programs more effectively. Relevant sections (available from <http://www.birds.cornell.edu/brp/software>) are Appendix A: Digital Representation of Sound and Appendix B: A Biologists Introduction to Spectrum Analysis.
  
- The new sound analysis software from **Cornell University**, called ‘**Raven**,’ is available from <http://www.birds.cornell.edu/brp/raven/Raven.html>. There are two options – Raven v 1.4, and Raven Lite which is **free**. The full version is able to display any number of sound files simultaneously, with each file in its own window. It has other features that allow you to easily measure, compare and edit parts of different sequences and sounds. The Raven Lite version has the ability to view only a single spectrogram at one time. Both versions are available for Mac OSX or PC. The full version is US \$400 (\$100/year for students).