Recording microchiropteran bats

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Ultrasonic sound is defined as that which occurs above the threshold of human hearing, that is, above 20 kHz. Such sounds are given by small insectivorous bats known as microchiropteran or microbats. In order to hear and record these echo-location calls it is commonly believed that you need a bat detector. Not so! If you own a flash-card recorder such as Sound Devices 702, or Olympus LS-10, you can adjust the menu settings to capture ultrasonic sounds (up to almost 100 kHz with the Olympus, and up to almost 200 kHz with the Sound Devices). With your existing audio processing software you can lower the pitch of those sounds to hear them, and identify bat species by analysing sonograms of their calls.

bat frequencies and microphones

There are 75 microbat species in Australia, 29 of these occur in NSW and have calls below 80 kHz. All 29 species could be recorded on a Sound Devices 702 recorder, given the appropriate settings. My experiences show that Sennheiser MKH 20 microphones will record to at least 70 kHz. It is worth trying whatever microphone you have even if the specifications state a 20 kHz maximum. They may well go much higher. The Sony PCM D-50 has inbuilt microphones that are sensitive to 30 kHz.

recording

So where do we start? A still summer night might be a good time to try for bats, perhaps in your back garden or out in the bush. From the menu of your recorder set the sample rate to its maximum (e.g. 192 kHz for Sound Devices 702; 96 kHz for Olympus LS-10), plug in a microphone, and point it skywards. A 10-15 minute recording should give you some idea if there are any bats about. You won't be able to hear them just yet, but have faith and leave your recorder running, preferably with the microphone on a tripod.

checking the sound file

After a lot of experimentation on my iMac, I found that the spectrogram window in Izotope RX noise reduction software gave by far the best results for bat sonograms, compared to Raven, Amadeus and Audacity. In addition, in RX I was able to load a 15 minute stereo file and see the entire file in a single window, and could quickly check for the presence of any ultrasonic sounds (Figure 1). Having found some ultrasonic traces, I could then expand the file and make a note of where the bat sounds occurred, for later editing. To extract the bat call sequences I reverted to a dedicated audio editor, in this case the excellent and inexpensive Sound Studio 3 which could handle the high sample rates (Peak LE could not). I made mono files of the wanted sections, then imported those back into the Izotope RX sonogram window.

creating the sonograms

My intent was to match as closely as possible the proportions of the Anabat sonograms that are found in *Bat Calls of New South Wales*, so that I could more easily identify the species I had recorded. The gaps between the calls needed to be removed (select and cut in RX). Any sounds below 10 kHz can be set to silence (select and silence in RX). Expand the sonograms right out so that a 150 millisecond section is shown on the screen, and set the vertical kHz to 80 kHz. When you are happy with the various brightness and sharpness settings (and there are a lot of them, see Figure 8), make a screen shot of the relevant portion of the RX window. (RX does not have a sonogram 'save' function). RX sonograms will show as white traces on a black background. However it is an easy matter to 'invert' the image in Photoshop to show black traces on a white background (see figures 1-7).

analyzing the species

Once you have made your sonogram, bat calls can be keyed out using *Bat calls of New South Wales*, and *Key to the bat calls of the Top End of the Northern Territory*. These two very useful publications can be found for free as PDF files on the internet. I have printed out my copies and had them spiral bound for ready reference. Another useful reference is the book *Australian Bats*. The revised 2009 edition has sonograms of calls for all Australian bat species.

lowering the pitch

You can hear your ultrasonic sounds by slowing the speed of the recording using free programs such as Raven and Audacity. In Raven use the 'rate' setting for example at 0.1 or 0.05. Or in Audacity, change the sample rate setting to 16 kHz or less – click arrow on left hand side of the main window and go to 'Set Rate'. Audacity gives the better sound quality than Raven, and once you are happy with the rate setting you can then save the file ('Export as AIFF') in CD compatible quality of 44.1/16.

my examples

All of the microbat species that I am likely to find near my home in Capertee Valley give calls below 80 kHz, which means I will be able to do regular surveys using my existing recording equipment, confident that all species present will be recorded. So far I have found five species, two of which are classed as vulnerable. Figures 1-7 show four of the species I have found. Not illustrated is Gould's Wattled Bat. You can hear some of the slowed down calls on AudioWings CD # 23.tracks 74-83.

what next?

If you want to take you bat studies further you can buy or hire professional bat detection equipment. The excellent Anabat system from Titely Electronics Pty Ltd at Ballina in NSW costs around $4,000 and includes hardware and analysis software. Smaller bat detectors can be useful to tell you 'if there is anything out there' simply by having a quick listen before setting up your recorder (e.g. Batbox 'Baton' made in UK for 60 pounds.)

References and further reading:

Churchill, S., *Australian Bats*. 2009 revised edition, Reed New Holland

Milne, Damien J., *Key to the bat calls of the top end of the Northern Territory*, Parks and Wildlife Commission of the Northern Territory, 2002. (available in PDF format from http://batcall.csu.edu.au/abs/references/Milne2002NTBatCallKey1.01.pdf)

Pennay, M., Lay, B., Reinhold, L (2004), *Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville. (available in PDF format from http://www.nationalparks.nsw.gov.au/batcalls).

Software – Audacity, Raven and Izotope RX are compatible with both Macintosh and PC. Sound Studio 3 and Amadeus only work with a Mac.

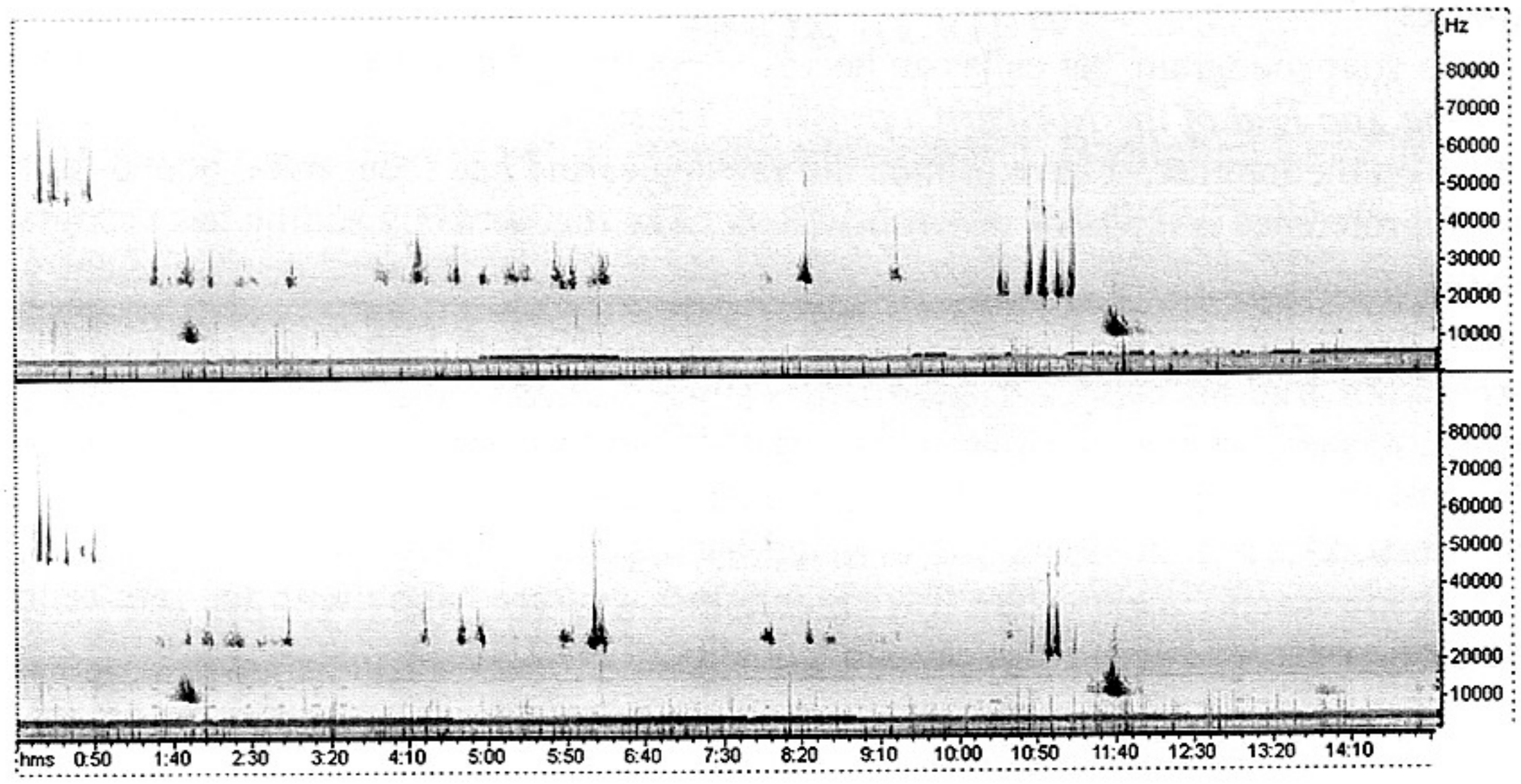

Figure 1. Fifteen minute scan in RX showing four different species of bats between 0-80 kHz. Highest pitch is Little Forest Bat. Between 1:40 and 10:00 is Southern Freetail Bat; 10:50 is Large-eared Pied Bat, and at 1:40 and 11:40 are two traces of the White-striped Freetail Bat. Sound below 10 kHz is general ambience of crickets, wallabies, frogs, and creaking iron roof.

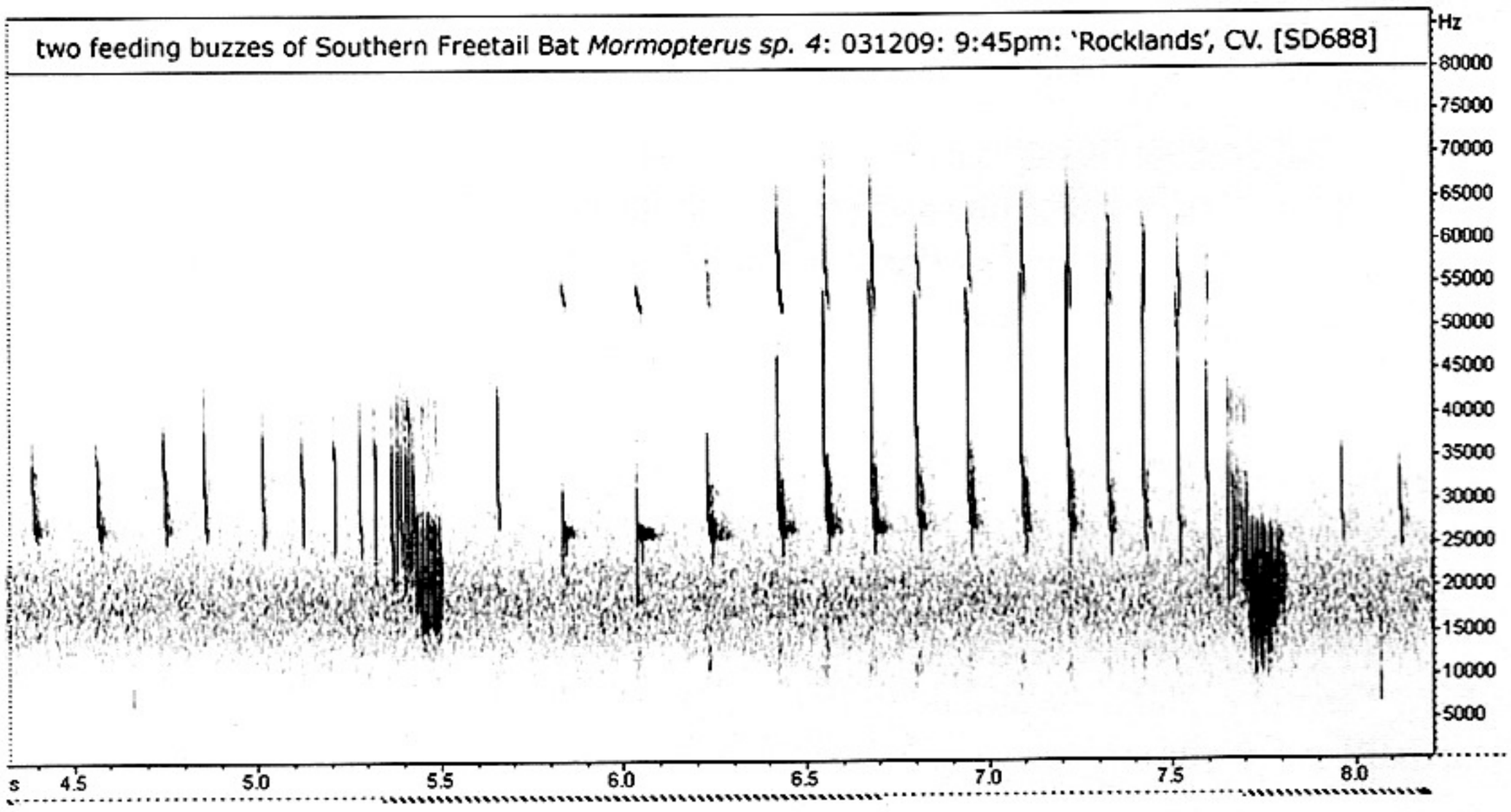

Figure 2. Eight second scan showing calls and two feeding buzzes of a Southern Freetail Bat, note how the calls speed up as the bat homes in on an insect.

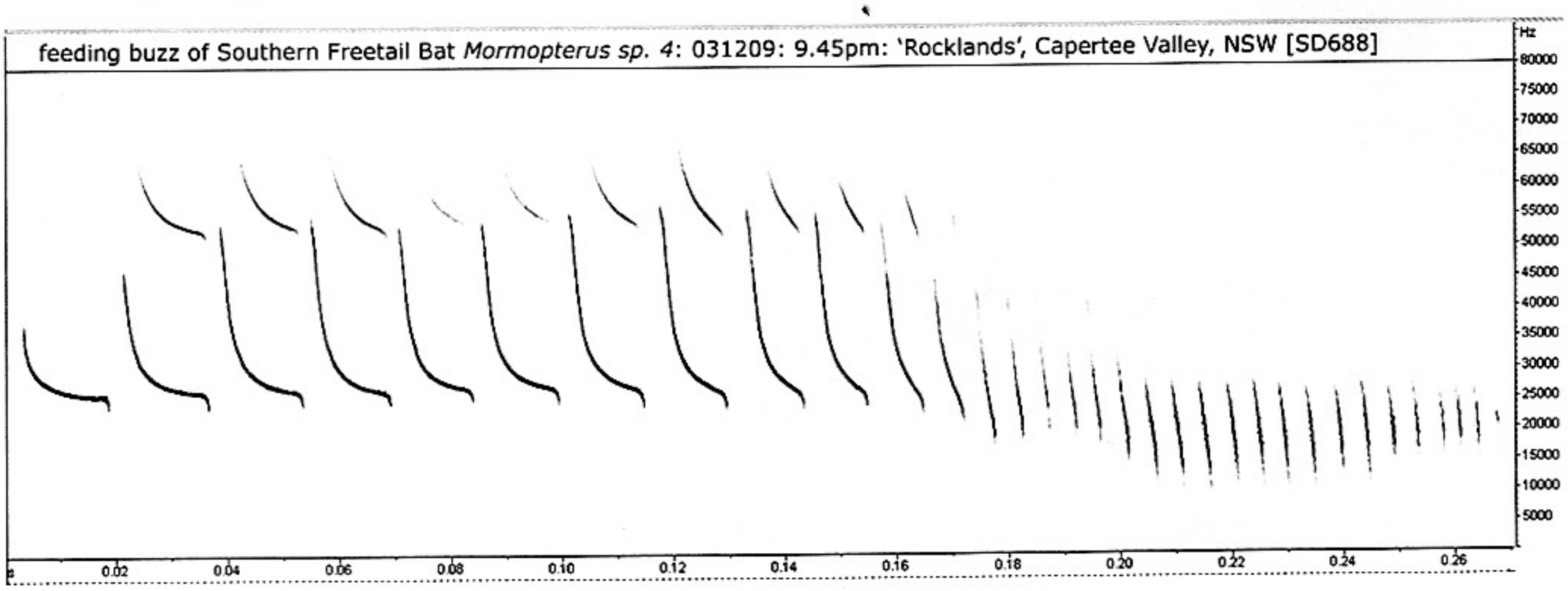

Figure 3. Quarter second scan (26 ms) showing more detail of a feeding buzz of Southern Freetail Bat. Spaces between calls have been shortened. Note the traces of harmonics between 50.5 and 60.5 kHz which is typical of the calls of this species. Note too how the calls become steeper before the feeding buzz..

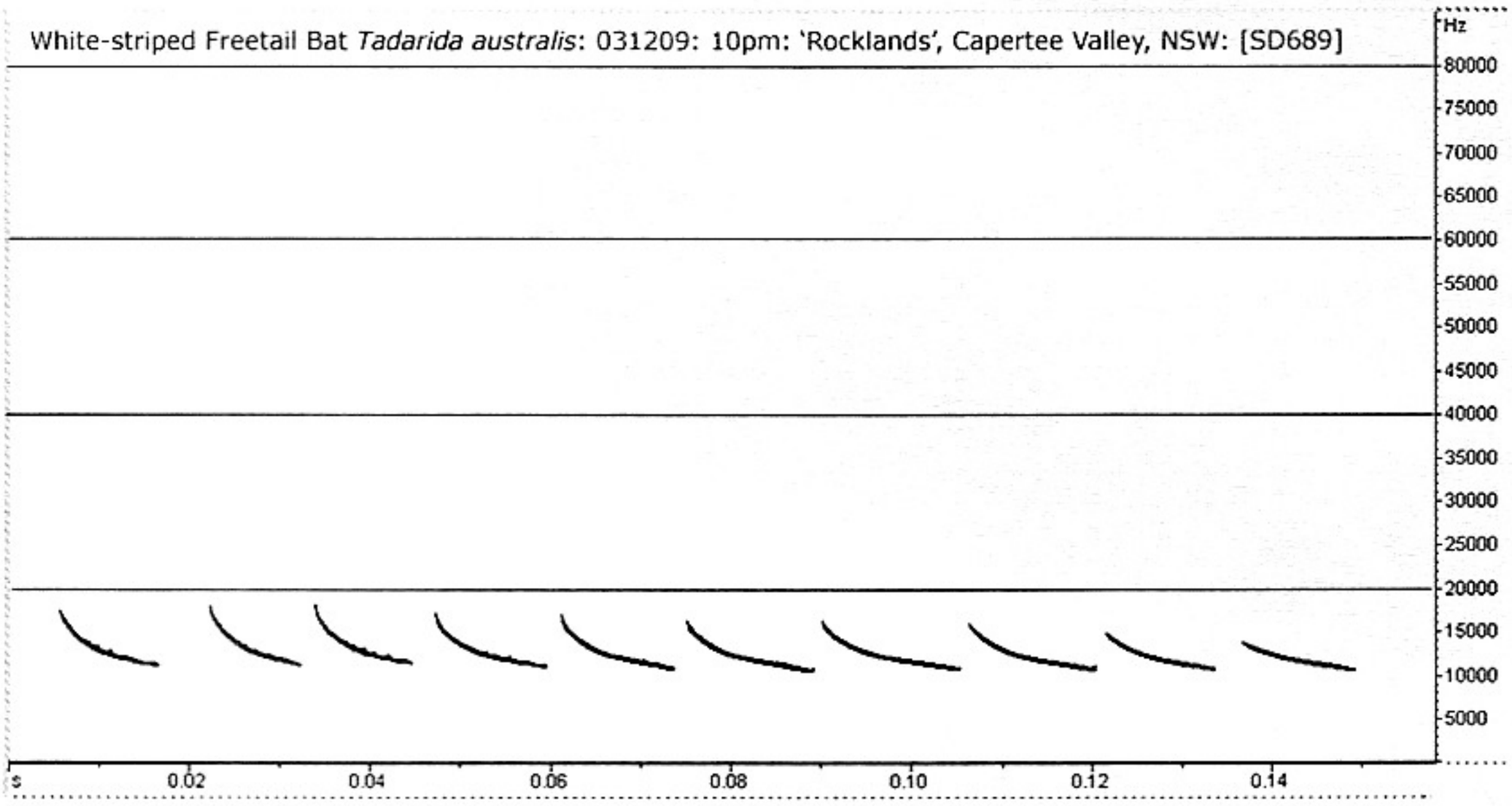

Figure 4.

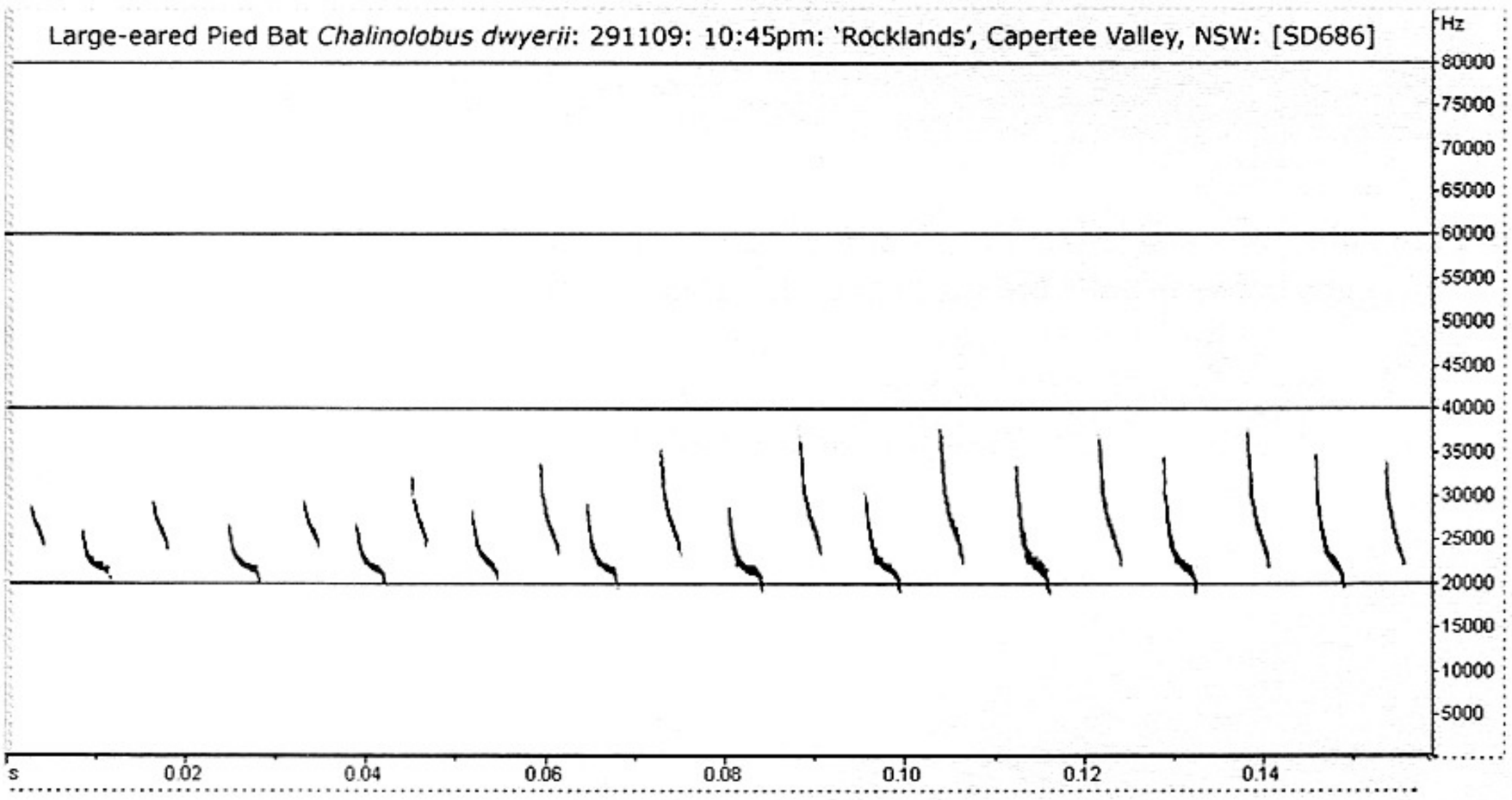

Figure 5.

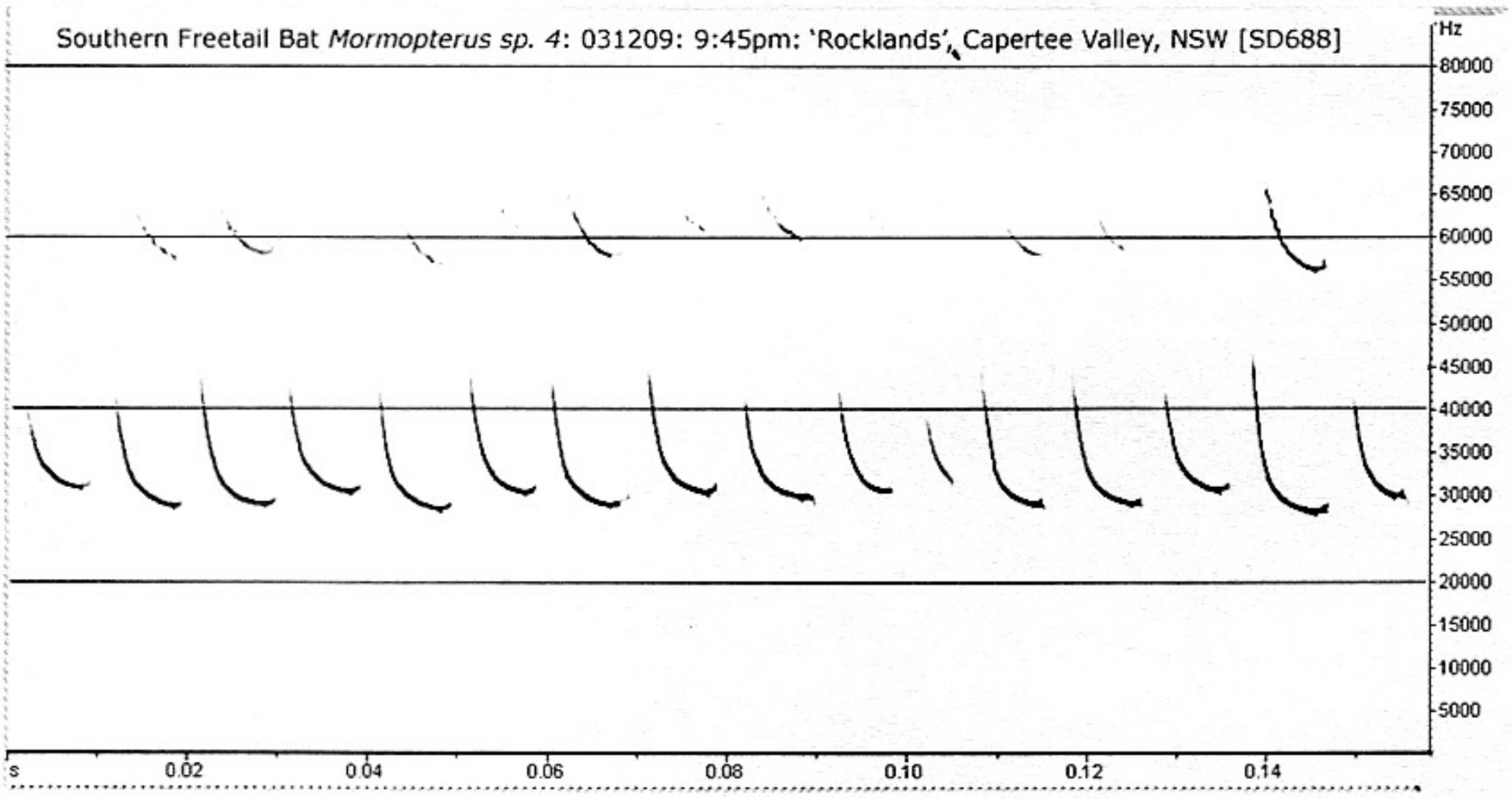

Figure 6.

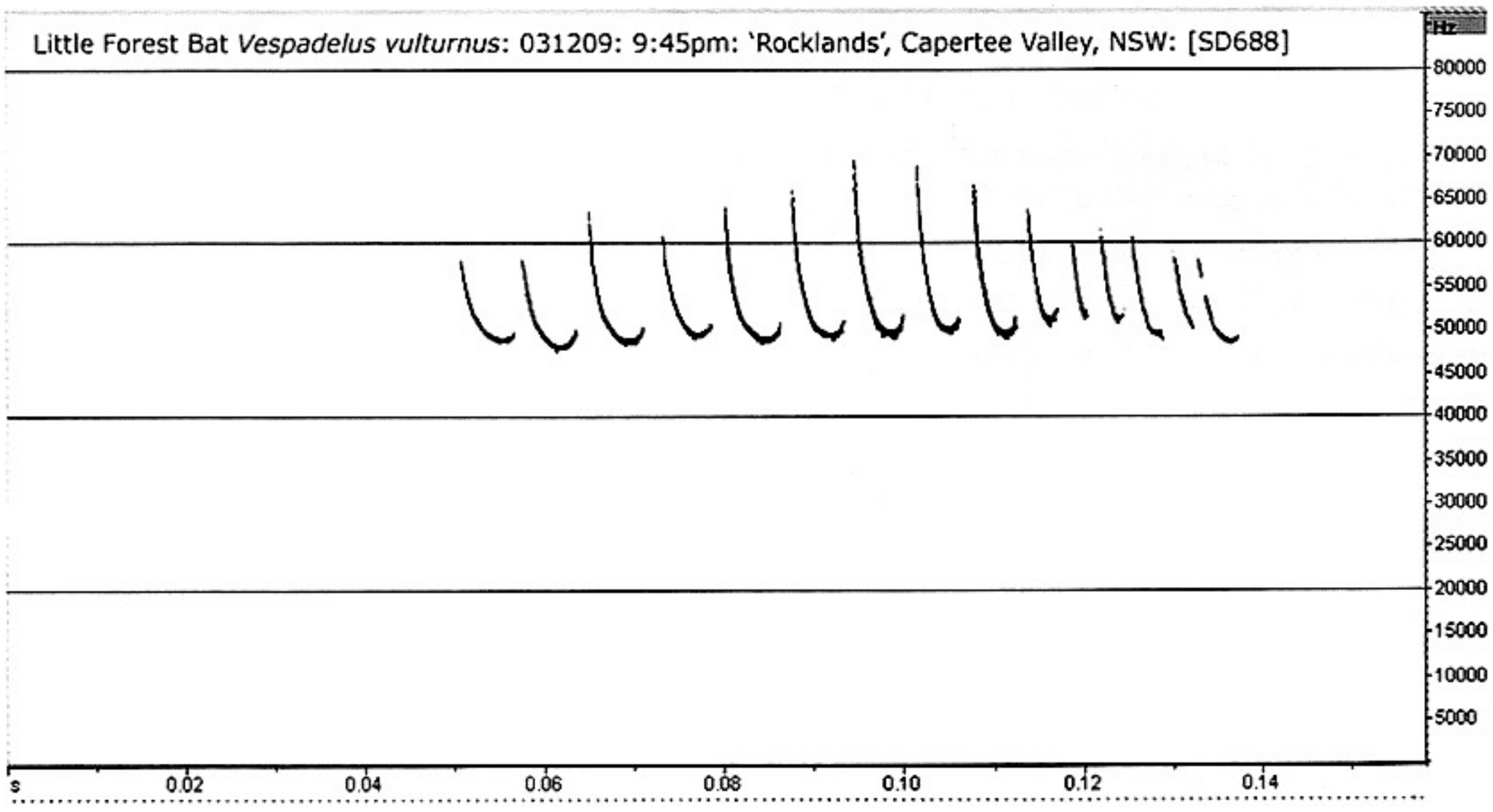

Figure 7.

Figure 4.
White-striped Freetail Bat has calls below 20 kHz that are audible to humans. Scale is 150 ms (one-sixth of a second), gaps between calls are shortened. In reality there are two calls per second and those with good hearing will hear the call as a regular 'pink-pink-pink'.

Figure 5.
Large-eared Pied Bat has calls above 20 kHz. The alternating pitch of the calls is a characteristic of the species. Scale is 150 ms, gaps between calls are shortened. In reality there are about six calls per second.

Figure 6.
Southern Freetail Bat has calls above 25 kHz. The harmonics which are characteristic of the species occur here between 55-65 kHz and have been 'tweaked' by 15 db so that they will show on the sonogram. Scale is 150 ms, gaps between calls are shortened. In reality there are about five calls per second.

Figure 7.
Little Forest Bat is the smallest of all Australian bats and has a high pitched call between 50 and 60 kHz. Scale is 150 ms, gaps between calls have been shortened, and in reality there are about 12 calls per second.

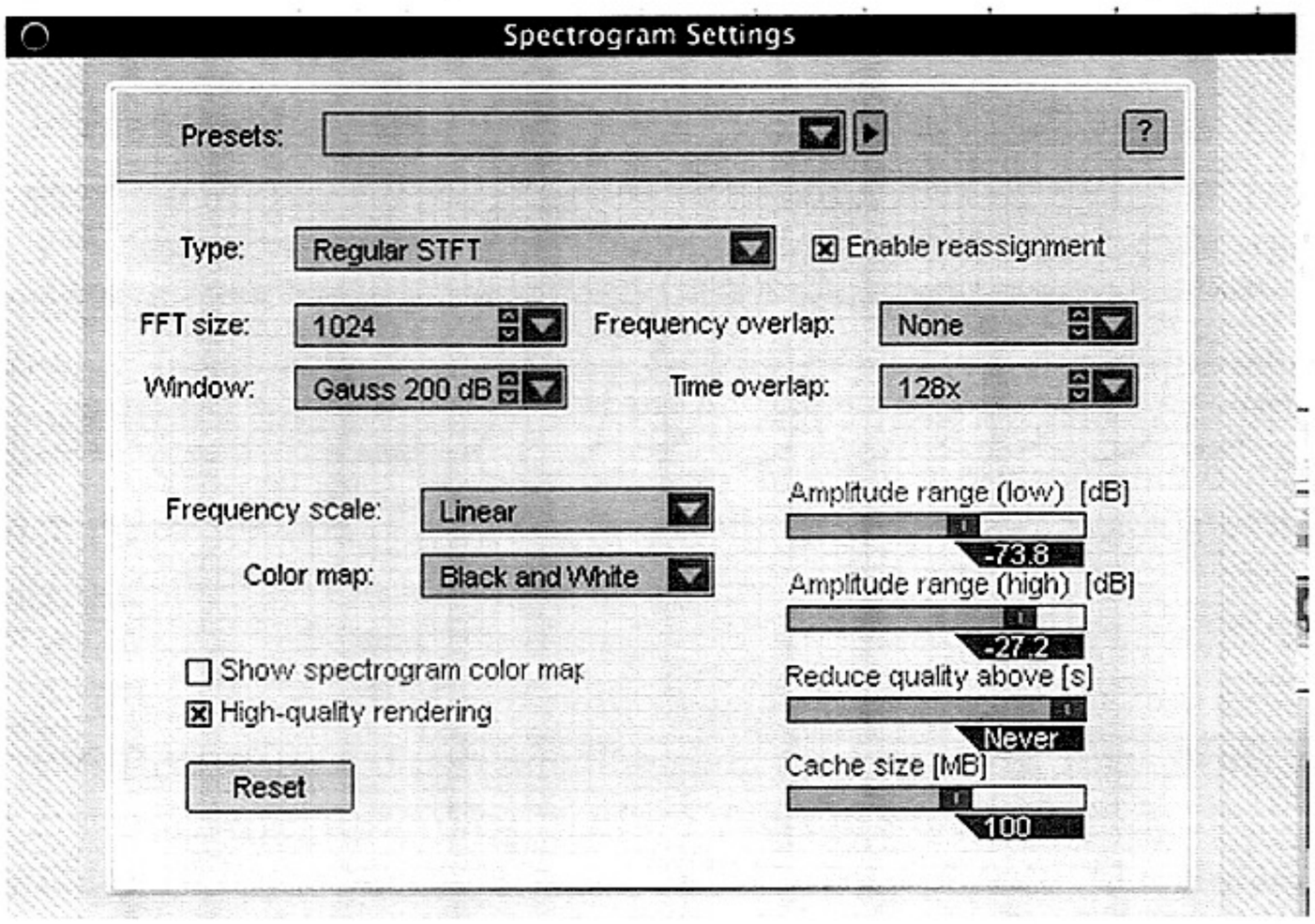

Figure 8. Spectrogram settings in Izotope RX - these were useful settings for my purposes. The amplitude settings were variable, basically the 2nd setting makes the sonogram more contrasty while the 1st setting is more to do with brightness.