AIRGUN ARRAY AND DEPTH TRANSPONDER SIGNATURES AS MIGHT BE HEARD BY ODONTOCETI

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1INTRODUCTION

In [1], I tried to simulate the effects on a human diver of an airgun array pulse. The airgun array pulse is an oscillatory pressure signature produced by a an array of airguns firing simultaneously. Film sequences of a single airgun firing can be found at [5].

In this paper, using actual measurements of an airgun array pulse and depth transponder, I simulate these sounds as they might be heard by odontoceti taking into account published audiogram data for these species. The data used is a far-field recording of an airgun array signature and the depth transponder carried out by the IFRC in 2003. The field records contain a million samples at 0.0000128s. sampling interval and contain an airgun pulse, two 18 kHz depth transponder pulses and a measure of the background noise. The airgun pulse part of the recording is shown as Figure 1.

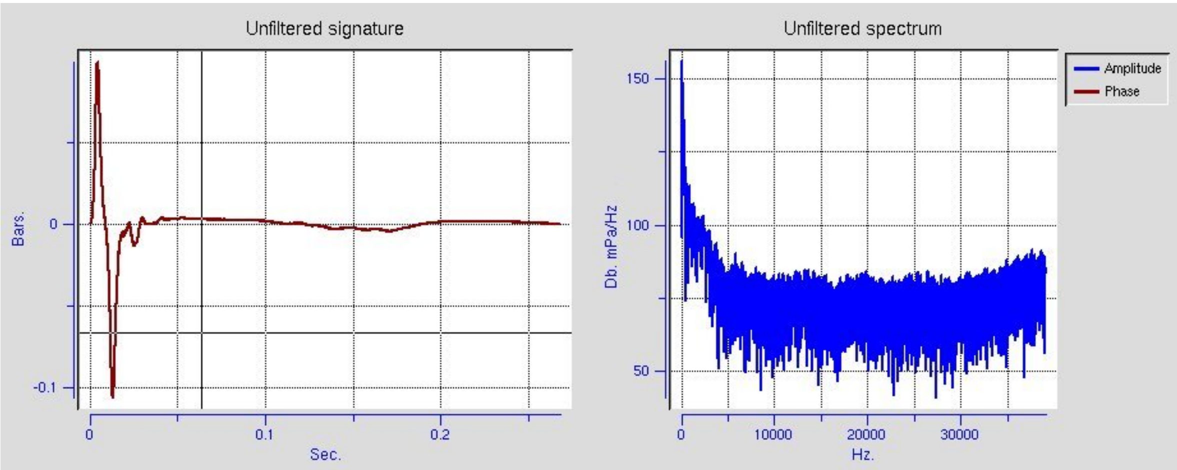

Figure 1: A recorded broad-band signature taken approximately 740m underneath a seismic survey vessel discharging an array of around 3590 cu.in. comprising 31 guns, (data released courtesy of IFRC). Note that the pressure here is measured in bars and the spectra in dB relative to 1µPa.

2METHODOLOGY

The ASCII format signature files needed to be converted into sound files which could be played on any normal digital playback software. After a search on the web, no easily portable conversion software was found so it was decided to write a completely portable method of converting files of ASCII numbers as appear in the field recordings into .wav files suitable for such playback. This software has itself been released for general use in parallel with this paper under the Gnu Public Licence. The software can be found at [2].

2.1EXACTLY AS A HUMAN WOULD HEAR

To playback signatures as a human would hear them, the raw recordings are directly converted to a wav file at the appropriate sample rate. For this a value of 78000 samples per second was chosen which is very close to the actual recording value. This .wav file has the name *EARS_shot_human_30kHz.wav*. This is clearly audible as a quiet thump when played back.

An example of the depth transponder signature taken from the same field recording is shown as Figure 2. As can be seen, this has a central ping frequency of 18 kHz and so is effectively inaudible to a human ear.

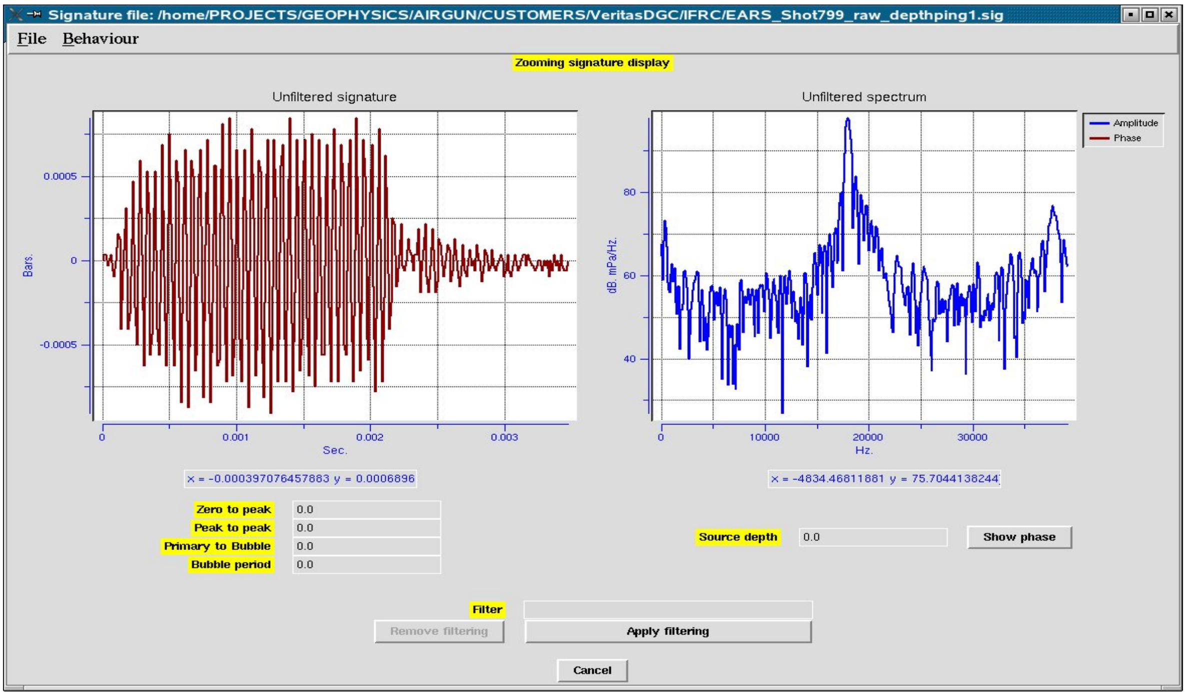

Figure 2: A recorded depth transponder ping taken approximately 740m underneath a seismic survey vessel, (data released courtesy of IFRC). The ping duration is approximately 2 msec with a central frequency of 18kHz. At 18kHz, this ping is around 20dB higher than an airgun array at the same frequency and is very close to the peak sensitivity frequency for odontoceti as can be seen in Figure 3.

2.2AS AN ODONTOCETI WOULD HEAR, SCALED FOR HUMAN HEARING

First note that the .wav files referenced in this section are available for download at [3].

To attempt to simulate how both airgun array and depth transponder ping might sound to an odontoceti, two steps must be taken:-

1. The recorded airgun signature, the depth transponder signature and the sea background noise must all be filtered with a digital filter which is the approximate inverse of the natural audiogram sensitivity of odontoceti as shown in Figure 3. This was approximately simulated with a high-pass filter with a 10kHz low cut and a low slope of 20 dB/octave.
2. The frequency range from the recorded range of up to around 30kHz, must be filtered down to the easily audible human part of the audio spectrum. In this case a maximum of 5kHz was chosen. For calibration purposes, the effects of the compression alone can be heard simply by comparing *EARS_shot_human_30kHz.wav* with the compressed form *EARS_shot_human_5kHz.wav*.

The three recorded components of airgun signature, depth transponder pulse and sea background noise were combined into a synthetic trace by filtering each to invert the audiogram response in Figure 3 and placing an airgun signature every 6 seconds and a depth transponder pulse every 1 second for easy contrast against a continuous sea background noise level. (Note that the depth transponder was actually sounding every 6 seconds on the IFRC recording as the water was quite deep). The relative amplitudes of airgun array signature, depth transponder pulse and sea background noise have been matched with the continuous IFRC recording.

The resulting signature as might be heard by an odontoceti but compressed into the 5kHz frequency band is *EARS_combined_odonto_5kHz.wav* which has both shot and depth transponder ping scaled appropriately to give their relative levels.

Two things become quickly apparent. First, the low cut filtering effect of the odontoceti audiogram changes the thump of the airgun as heard by a human on *EARS_shot_human_5kHz.wav* into a noise similar to a wave breaking on a beach. Second, the durations of the airgun signature and the depth transponder pulse are very different with the depth transponder pulse some 50 times shorter than the airgun signature, and comparable with the echo-location click duration of an odontoceti. The airgun signature has a very different sound indeed. From a purely subjective point of view, it is hard to imagine the airgun signature causing any kind of echo-location confusion to such highly evolved species, although it is easy to imagine it provoking curiosity.

Although inferring any kind of behavioural response by extrapolating from human response is highly problematic, this may at least give some insights as to how these two very different sounds could affect odontoceti.

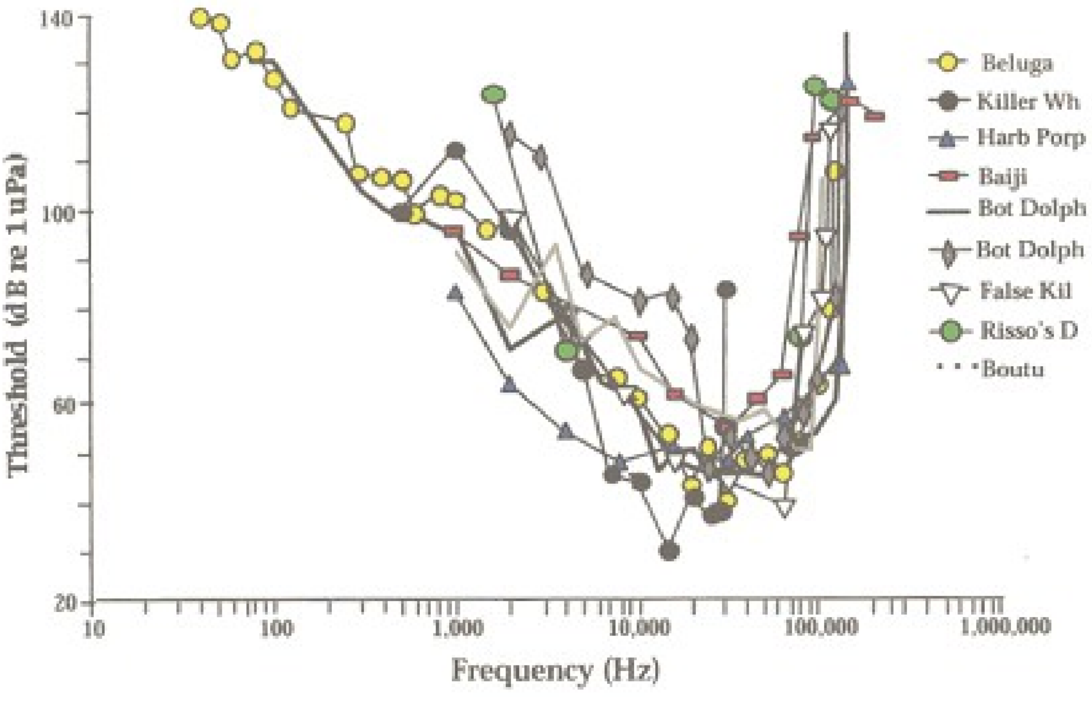

Figure 3: Audiogram data assembled from sources such as [4] for various species.

3CONCLUSIONS

These recordings have been produced to try and answer questions about the possible comparative effects on odontoceti, of airgun array signatures and depth transponder pulses introduced into the marine environment. In the case of odontoceti, the recordings suggest that the nature of the depth transponder pulse may be more invasive than the airgun array signature itself as heard by the odontoceti.

A natural way of extending this would be to compare pulses for different kinds of transponder, for example, those used for searching for shoals of fish.

4REFERENCES

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[5] L. Hatton, ‘Commentary on two airgun videos’, http://www.leshatton.org/two_airgun_videos.html, (2007)