

## Appendix K : Simulation of the degradation of a bird call during propagation

We used our full sound attenuation model (see Eq. 4) to simulate the degradation of a sound according to its propagation distance and its frequency content. The process has been tested on a song of the screaming Piha (*Lipaugus vociferans*) recorded with the same acquisition device and parameters at the very same place, in the Nouragues reserve (French Guiana), in November 2019 at the beginning of the afternoon. We assumed that  $a_0$  is the same as the one found experimentally and the average sound level of the song over its frequency bandwidth is 111.5 dB SPL re20 $\mu$ PA at 1 m (Nemeth, 2004). As the distance between the audio recorder and the bird was not referenced, we measured the sound level of the song, which was 48 dB. The song was therefore estimated to be recorded at a distance of around  $r_0 = 200$  m. Fig.K-1 shows the result of the simulation of the propagation of the screaming piha song from 200 m to 800 m. The higher frequencies of the song first disappear at 400 m. Only the lowest frequency part of the song is still visible at 600 m, and the song disappears below the ambient noise at 800 m.

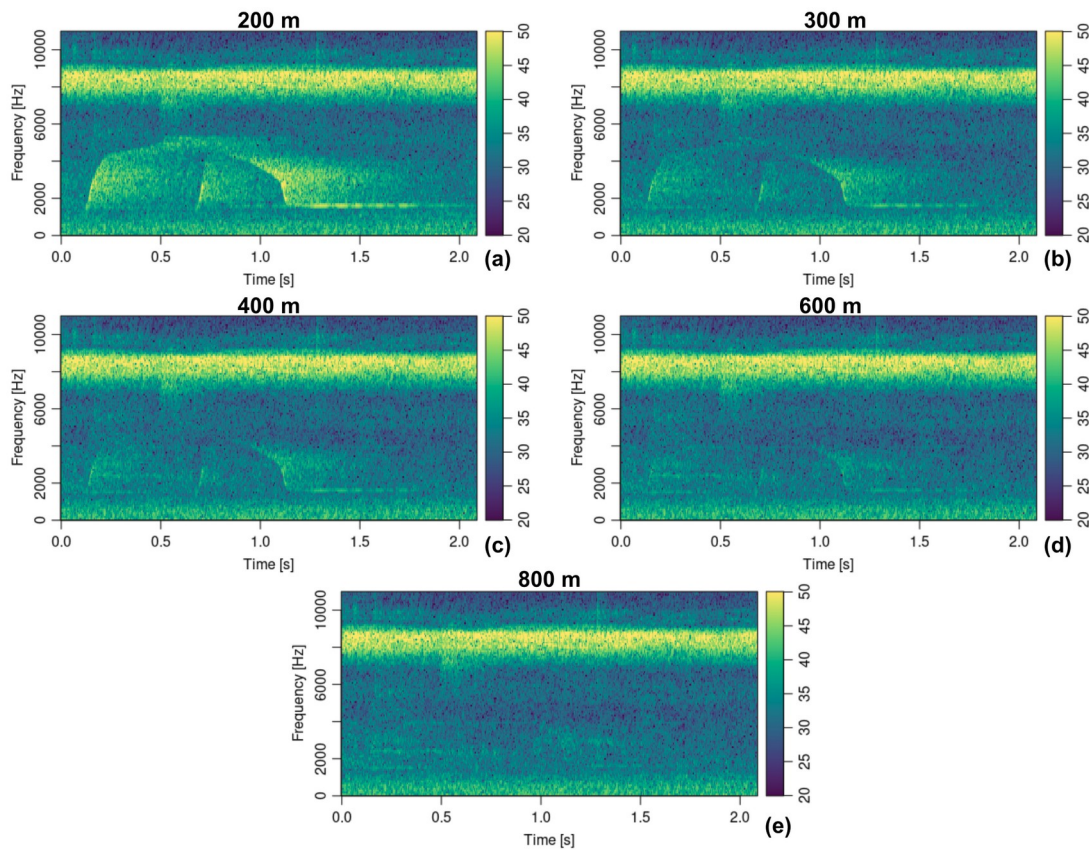


Figure K-1 : Spectrograms of the *Lipaugus vociferans* song in the Neotropical rainforest (French Guiana) at increasing distances of propagation ( (a) 200 m, (b) 300 m, (c) 400 m, (d) 600 m and (e) 800 m). Original raw audio recording (experimental data) was used to compute the spectrogram at 200 m while the other spectrograms were computed after applying attenuation law corresponding to the distance of propagation (simulated data)

We also estimated the minimum and maximum active space of the screaming piha (Fig. K-2). As for detection distance, active space was computed using the full sound attenuation model (Eq. 4) but without adjustment to the frequency response of the ARU. We found that the active space of the screaming piha ranged between 315 m for the high frequency note at 5 kHz and 666 m for the low frequency note at 1.5 kHz. We could also observe the relative role of each attenuation mechanism in the global sound attenuation. It appeared that the spreading loss was the main driver of the song attenuation followed by

habitat attenuation. More precisely, habitat attenuation corresponded to 30% of the overall attenuation that caused the extinction of the highest frequencies after 315 m of propagation.

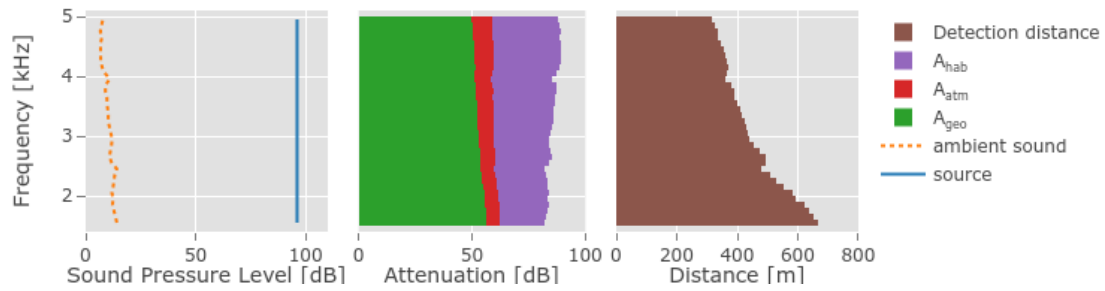


Figure K-2: Active space obtained by the model in a Neotropical rainforest (French Guiana) for the screaming piha (*Lipaugus vociferans*) which calls at 111.5 dB SPL re20 $\mu$ Pa at 1 m. The active space may depend on the ambient sound level as well as geometric or spreading loss attenuation ( $A_{geo}$ ), atmospheric absorption ( $A_{atm}$ ) and habitat or environmental attenuation ( $A_{hab}$ ). ambient sound level  $L_n$ ,  $T^\circ\text{C}$ , RH, PS and  $a_0$  values are set to the experimental values found during the French Guiana transect.

## Reference

Nemeth, E. (2004). Measuring the sound pressure level of the song of the screaming piha (*Lipaugus vociferans*): One of the loudest birds in the world? *Bioacoustics*, 14(3), 225–228. <https://doi.org/10.1080/09524622.2004.9753527>