Listening for Signals in Seismic Noise: A Case Study of Masking in Arctic Seals

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When considering the effects of noise on hearing in marine mammals, the common practice is to apply standard audiometric data to predict how a noise source will influence an individual or species. In the case of auditory masking, critical ratio data, obtained in the laboratory with trained animals and tonal signals within flat-spectrum, continuous noise maskers, are often used for this purpose. Critical ratios can be combined with measured, average 0ne-third octave band noise levels to predict the amplitude of a target signal required for detection above a particular noise background. However, the extent to which this method is appropriate may vary based on the features of the noise source in question. Temporally varying noise, such as that generated by seismic surveys, presents a particular challenge. To address this issue, we trained captive spotted and ringed seals to detect 100-Hz narrowband sweeps embedded within a background of seismic noise recorded 1 and 30 km from an operational airgun array. The results of this complex masking experiment indicate that a one-third octave band plus a critical ratio model is sufficient to predict the extent of masking only in some cases. When one-third octave band noise levels vary significantly in time, it becomes necessary to consider signal-to-noise ratios within time windows shorter than the duration of the target signal. This study addresses the important issue of masking outside of the laboratory and provides much needed information about when it is appropriate to use average noise levels and critical ratio data to predict masking in real environments. Our results can inform best management practices for evaluating the effects of noise on Arctic seals and other marine mammals.