



## **Auditory and Behavioral Responses of Arctic Seals to Seismic Signals**

**Colleen Reichmuth**

University of California, Santa Cruz, coll@ucsc.edu

**Asila Ghaul**

University of California, Santa Cruz, asila@ucsc.edu

**Andrew Rouse**

University of California, Santa Cruz and SEA, Inc., arouse@ucsc.edu

**Jillian Sills**

University of California, Santa Cruz, jmsills@ucsc.edu

**Brandon Southall**

SEA Inc., brandon.southall@sea-inc.net

Following a series of experiments to describe the auditory capabilities of spotted and ringed seals (Sills et al., 2014, 2015), we sought to determine the effects of signal impulse noise exposure on hearing in these Arctic species. We applied behavioral methods to measure the sensitivity thresholds at 100 Hz before and immediately after voluntary exposure to impulsive noise produced by a seismic airgun. Auditory responses were determined from psychoacoustic data, and behavioral responses were scored from video recordings. Four successive exposure conditions of increasing levels were tested, with received sound exposure levels (SELs) extending from 165 to 181 dB re 1  $\mu\text{Pa}^2\cdot\text{s}$  and peak-to-peak sound pressure levels (SPLs) from 190 to 207 dB re 1  $\mu\text{Pa}$ . We found no evidence that these single seismic exposures influenced hearing, including at SELs that exceeded those previously predicted to cause temporary threshold shift (TTS). After training at low-exposure levels, relatively mild behavioral responses were observed during testing at higher exposure levels. This suggests that individuals can learn to tolerate loud, impulsive sounds but does not necessarily imply that similar sounds would not elicit stronger behavioral responses in wild seals. The absence of an observed TTS in this study confirms that current regulatory guidelines for single-impulse noise exposures are conservative for seals. Additional studies using multiple impulses and/or higher exposure levels are needed to quantify exposure conditions that do produce measurable changes in hearing sensitivity.

Sills, J. M., Southall, B. L., and Reichmuth, C. (2014). Amphibious hearing in spotted seals (*Phoca largha*): Underwater audiograms, aerial audiograms and critical ratio measurements. *Journal of Experimental Biology*, 217, 726-734.

Sills, J. M., Southall, B. L., and Reichmuth, C. (2015). Amphibious hearing in ringed seals (*Pusa hispida*): underwater audiograms, aerial audiograms and critical ratio measurements. *Journal of Experimental Biology*, 218, 2250-2259.