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Proposed Marine Mammal Noise Exposure Criteria: Current Data Base, Limitations, and Research Needs

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This paper presents the findings of an inter-disciplinary expert panel based on comprehensive review of hearing and noise effects data for marine and land mammals. The principal motivation for the review was to assist formulation of data-based noise exposure criteria in light of rapidly evolving research advances in marine mammal hearing and underwater noise effects. Levels estimated to induce permanent hearing loss were determined for single exposure events for cetaceans (in water) and pinnipeds (in air and water) for each of 15 sound type/animal group combinations. These recommendations represent a current best estimate only and are modular, with modifiable key variables; e.g., source and exposure, to facilitate revision as data improve. In some cases, relatively explicit injury limits are proposed, e.g., 186 dB re: $1\mu Pa^2$-s (frequency-weighted sound exposure level) and 218 dB re: $1\mu Pa_{peak}$ (unweighted peak sound pressure level) for pinnipeds in water exposed to multiple sound pulses. In others, particularly for behavioural effects of multiple-pulse and non-pulse exposures, response severity and significance are quantitatively scored, but the data do not allow identification of specific broadly-applicable disturbance thresholds. These findings are a current best effort and include a discussion of limitations and recommended research needed to address data gaps.