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TITLE: A Risk Function for Behavioral Disruption of Blainville's Beaked Whales (*Mesoplodon densirostris*) from Mid-Frequency Active Sonar

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ABSTRACT:

There is increasing concern about the potential effects of noise pollution on marine life in the world's oceans. For marine mammals, anthropogenic sounds may cause behavioral disruption, and this can be quantified using a risk function that relates sound exposure to a measured behavioral response. Beaked whales are a taxon of deep diving whales that may be particularly susceptible to naval sonar as the species has been associated with sonar-related mass stranding events. Here we derive the first empirical risk function for Blainville's beaked whales (*Mesoplodon densirostris*) by combining in situ data from passive acoustic monitoring of animal vocalizations and navy sonar operations with precise ship tracks and sound field modeling. The hydrophone array at the Atlantic Undersea Test and Evaluation Center, Bahamas, was used to locate vocalizing groups of Blainville's beaked whales and identify sonar transmissions before, during, and after Mid-Frequency Active (MFA) sonar operations. Sonar transmission times and source levels were combined with ship tracks using a sound propagation model to estimate the received level (RL) at each hydrophone. A generalized additive model was fitted to data to model the presence or absence of the start of foraging dives in 30-minute periods as a function of the corresponding sonar RL at the hydrophone closest to the center of each group. This model was then used to construct a risk function that can be used to estimate the probability of a behavioral change (cessation of foraging) the individual members of a Blainville's beaked whale population might experience as a function of sonar RL. The function predicts a 0.5 probability of disturbance at a RL of 150 dBrms re μ Pa (CI: 144 to 155) This is 15dB lower than the level used historically by the US Navy in their risk assessments but 10 dB higher than the current 140 dB step-function.

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