

Photographic mark-recapture reveals turnover of beaked whales on an active sonar range

Claridge, Diane E.^{1,2}; Dunn, Charlotte A.^{1,2}; Durban, John W.³

(1) *Bahamas Marine Mammal Research Organisation, P.O. Box AB-20714, Marsh Harbour, Abaco, Bahamas*

(2) *University of St Andrews, Scotland, UK*

(3) *NOAA Southwest Fisheries Science Centre, La Jolla, California*

dclaridge@bahamaswhales.org

Beaked whales are vulnerable to certain military sonars, but are difficult to observe at sea, presenting problems for mitigating the effects of sonar use. However, beaked whales possess individually-distinctive natural markings, enabling populations to be monitored using photo-identification techniques. We fit mark-recapture models to photo-identification data to estimate abundance and turnover of Blainville's beaked whales (*Mesoplodon densirostris*) on the Atlantic Undersea Test and Evaluation Center (AUTEK) in the Bahamas. Photo-identifications were collected during 4 years (2005-2008) on AUTEK's Weapons Range, a 1500-km² area used for fleet readiness training, involving the regular use of mid-frequency active sonars. Thirty-six distinctively-marked whales were identified from high-quality photographs, with 12 whales seen in multiple years (median = 1, maximum = 4 years). Open- and closed-population mark-recapture models were used to estimate abundance and infer turnover at different temporal scales, and estimates were rescaled to account for whales that were not sufficiently distinct for between-year matches. The closed population model estimated a high probability of annual variation in catchability ($p = 0.84$) but provided little support for individual heterogeneity ($p = 0.05$). A Bayesian approach was used to analyze and convey uncertainty, resulting in a most probable abundance estimate of 62 whales using the Weapons Range over the 4-year period (75% highest probability interval [HPI] = 55-73). An open population model with varying annual catchabilities estimated a similar overall population size of 65 whales (75% HPI = 54-88) but also allowed estimation of an average annual abundance of 46 whales (75% HPI = 43-52). These estimates are notably higher than the instantaneous abundance estimated using passive acoustic monitoring on the Weapons Range (~25 whales), and in combination they show increasing abundance with longer temporal durations. These differences imply turnover of individual whales on the range, and highlight the value of individual-based monitoring through photo-identification.