

Whales and earthquakes: adapting distance sampling for use with Ocean Bottom Seismometer data for baleen whale density surface estimation

Monitoring programs to determine marine mammal densities are costly, so using opportunistic data from instrumentation deployed for other purposes is one way to achieve cost efficiency. However, using such data often requires adjustments be made to standard analytical methods. Ocean bottom seismometers (OBSs) are prime examples of such “platforms of opportunity”: they were designed to detect earthquakes and study other geophysical processes, but can also record the low frequency calls of baleen whales, particularly blue and fin whales. Further, OBSs are increasingly being deployed in large arrays for periods of a year or more. Depending on the oceanographic properties and instrument configuration, locations of calling whales may be estimated. Therefore, distance sampling can be used to estimate the detection function for OBSs, leading to an estimate of whale density. However, a practical issue is that some OBSs may only detect whales, but not locate them. This impacts distance sampling because the distances at which whale calls can be both detected and localised by an OBS may be smaller than simply detecting calls. Here we use a case study from the south coast of Portugal to demonstrate how a distance sampling analysis was adapted to incorporate detections from non-localising OBSs to work towards a density surface of fin whales. Of the 24 OBSs deployed between September 2007 and August 2008, 12 of the instruments could not estimate distances to fin whale calls. Multiple-covariate distance sampling was used to estimate the detection function using data from the localising OBSs. Depth and month were used as covariates, enabling detection functions for the non-localising OBSs to be estimated. Next, for each non-localising OBS, the estimated probability density function was used to scale the number of fin whale detections to remove a proportion of calls that were likely detectable but not localisable. Finally, the resulting detections were combined with the data from the localising OBSs in a spatio-temporal GAM to estimate a density surface of fin whale calls, which can be converted to a fin whale density surface with an appropriate multiplier of fin whale call production rate.