Modelling the spatial distribution of humpback whales in the Kimberley region of Western Australia

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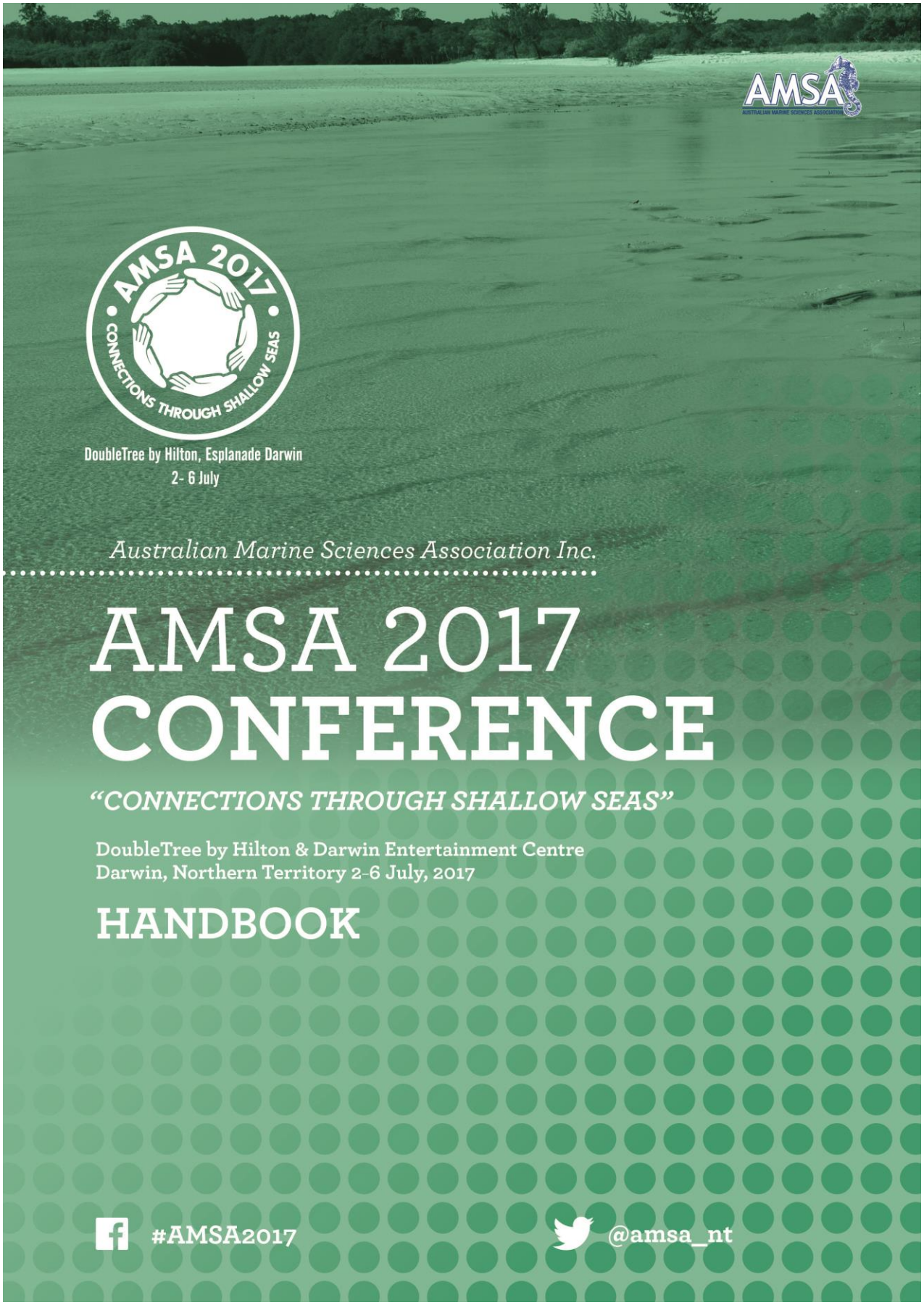
Off the west coast of Australia, humpback whales migrate annually from summer feeding grounds in Antarctica to breed and calve during winter in the nearshore waters of the Kimberley. Despite extensive aerial and shipboard surveys by industry, tourism, community groups and researchers over the last two decades there have been few attempts to use these data to quantify spatial distributions and critical habitats for the species across the Kimberley region. This information is urgently required to better inform management in an ecosystem that faces challenges of warming environments, industrial development and rapid growth of humpback whale populations. To address this need, we integrated two decades of aerial and shipboard surveys of humpback whales and linked them to environmental covariates obtained from remote sensing in order to build habitat-based models using two different modelling approaches. These included density surface modelling where distance sampling was coupled with generalised additive mixed modelling to produce density maps (individuals km^{-2}) predicted from environmental covariates. The second approach modelled the presence-only sighting data from non-systematic surveys and produced probability of occurrence maps predicted from the same environmental covariates. We also trialled very high resolution satellite imagery (30 cm resolution) to detect and count whales in the Lalang-garram/Camden Sound Marine Park and undertook a cost-benefit analysis to determine the best methods to monitor this important calving area into the future. Humpback whales could be detected in the satellite imagery and the calculated density was comparable to that estimated using traditional survey methods. Our analysis has identified and described the distribution and critical habitat requirements, particularly the core areas for calving and nursing, which were previously poorly defined.



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