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Modelling the movements and habitat use patterns of humpback whales from Oceania to Antarctica

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Advancements in global positioning technology are enabling us to study the movements of aquatic animals that traverse thousands of kilometres across open oceans and habit the remote Southern Ocean (SO). The large-scale migration paths between tropical breeding and Antarctic feeding grounds, and the fine-scale movements within the feeding grounds of the Oceania humpback whale (*Megaptera novaeangliae*) population have remained poorly understood. We deployed 25 satellite tags on Oceania humpback whales at the Kermadec Islands, New Zealand, in 2015 to determine the connectivity between breeding and feeding grounds. Nineteen whales were tracked for an average of 100 days (range=5-254) across the Pacific Ocean to their feeding grounds, straight-line distances of up to 7,000km. We applied a hierarchical state-space model to identify behavioural states in the satellite tag data: transit, or 'area restricted search' (ARS). State-space modelled tracks showed a sharp change in whales' behaviour at 60°S, representing their arrival at feeding grounds; the whales completed this migration in an average of 51 days (range=35-67). All fully tracked mother-calf pairs (n=4) migrated to the Ross Sea, while 70% of adults without calves (n=7) migrated further east to the Amundsen and Bellingshausen Seas, suggesting that feeding ground destinations may be linked to life history stage. Species distribution models and remotely sensed data are now used to correlate the animals' space use with environmental parameters to characterise the areas where ARS behaviour was identified. Satellite tagging was found to be an informative method for studying these 'hard to reach' animals. Proper understanding of how these whales use the SO marine environment for different life functions is vital for the future management and conservation of this population. Additionally, whales may play a role in the SO iron recycling, therefore the recovery and movements of whale stocks may be a critical environmental indicator in Antarctic waters.