Movement of a humpback whale between breeding stocks A and C3 and a new distance record

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Abstract
We report on the movement of an individual humpback whale from Brazil to Madagascar. This constitutes a displacement between non-adjacent breeding stocks (A and C3) that are separated by a continent, an ocean basin, 88.5 degrees of longitude and a minimum swimming distance of >9,800km. This is 4,000km longer than any previously reported movement between breeding areas in humpback whales, and constitutes a new mammalian distance record, slightly longer than the longest migration yet observed between seasonal habitats. Although studies of gene flow have suggested that long-distance movement from east to west predominates in this region, this animal was photographed in the more westerly location first. The individual is female, contravening the prevailing belief that males more commonly travel longer distances between breeding habitats. This finding highlights the value of opportunistic data collection from whale watch vessels, and the importance of comparing identified individuals between areas without preconceptions about probable destinations. It provides further evidence that longitudinal movement may be an important feature of humpback whale habitat use in the Southern Hemisphere.

Introduction

Movement of individual animals determines population structure and so informs effective conservation and management. However, knowledge of the movements of Southern Hemisphere humpbacks remains fragmentary. The extensive history of hunting and severe depletion of humpbacks throughout the Southern Hemisphere (Clapham & Baker 2002) and the apparent inconsistencies in the patterns of recovery make this of considerable conservation concern.

There are few barriers to movement at sea, so individuals are capable of virtually unrestricted long-distance movement. Humpback whales are long-distance seasonal migrants between high-latitude feeding areas and low-latitude breeding and calving habitat, with several documented instances of migration >8,000km (Stone et al. 1990, Stevick et al. 1999, Rasmussen et al. 2007, Robbins et al. 2008). Although there is no strict correspondence between feeding and breeding grounds, the current model suggests that individuals migrate between seasonal habitats at approximately similar longitudes leading to largely north-south migration. However, this is based primarily on work in the northern hemisphere where movement is to some extent constrained by the adjacent continents, and even there substantial longitudinal movement in migration has been documented (Darling et al. 1996, Stevick et al. 1999). Although instances of movement between two breeding sites that are separated by ~6,000km has been reported (Darling & Cerchio 1993, Salden et al. 1999), long-distance movement of individuals between discrete low-latitude breeding grounds over long

distances is rarely reported (Calambokidis et al. 2001), leading to low rates of gene flow and relatively distinct breeding stocks between and frequently within ocean basins (Olavarría et al. 2007).

We report on a the movement of an individual humpback whale between non-adjacent breeding stocks (A and C3) that are separated by a continent, an ocean basin, ~100 degrees of longitude and a minimum swimming distance of nearly 10,000km.

Methods

The Antarctic Humpback Whale Catalogue (AHWC) is an international collaborative project investigating movement patterns of humpback whales in the Southern Ocean and corresponding lower latitude waters (Allen et al. in press). Whales were identified by photographs of the individually distinctive markings on the ventral fluke surface using standard procedures (Katona et al. 1979) as modified for use with digital images (Allen et al. in press). Data from the AHWC are used to investigate movement between concentrations of humpback whales in the Southern Hemisphere (Stone et al. 1990, Stevick et al. 2004, Rock et al. 2006, Stevick et al. 2006, Rasmussen et al. 2007). The collection contains records of 888 whales identified from breeding stock A in the western South Atlantic Ocean off Brazil, collected by Instituto Baleia Jubarte during systematic research cruises along the Abrolhos Bank, the main concentration in the Brazilian coast (Engel 1996, Martins et al. 2001) and 226 from breeding stock C in the Western Indian Ocean (Allen et al. 2010). New sightings were compared to all 3,665 identified individuals in the collection regardless of the time or area of any prior sighting, so pre-conceptions about probable movement patterns do not influence the results.

Results and Discussion

AHWC#1363 was first identified on Abrolhos Bank, Brazil (17°49.25'S 38°43.41'W) on August 7, 1999. It was one of a pair that was observed for about an hour by staff from the Instituto Baleia Jubarte. Both whales in the group were identified as female by genetic markers from skin biopsy samples. Neither of the two was photographed again in the Abrolhos Bank. The whale subsequently was photographed just over two years later on September 21, 2001 from a commercial whale watch tour vessel. It was one of a trio of whales seen in the channel between Ile Sainte Marie/Nosy Boraha and the east coast of Madagascar (approx 16°50’S, 49°50’E).

The minimum travel distance between these locations is >9,800 km, making this about 4000km longer than any previously reported movement between breeding grounds. The difference between the two locations spans 88.5 degrees of longitude. It is the longest documented displacement by a mammal, about 400km longer than the longest seasonal migration that has been reported (Robbins et al. 2008).

Between these two sightings are breeding stocks off the west coast of Africa (breeding stock B1 & B2), the east coast of Africa (breeding stock C1), and around Mayotte & the Comores (breeding stock C2). This is unprecedented, as previously all documented long-distance movement at low latitudes has involved individuals moving between adjacent breeding grounds (Chittleborough 1959, Darling & Cerchio 1993, Salden et al. 1999, Pomilla & Rosenbaum 2005).

Evidence for isolation of breeding stocks in the South Atlantic and Indian Oceans is weaker than in many other areas that have been studied. Evidence from both vocalizations (Darling & Sousa-Lima 2005) and genetics (Rosenbaum et al. 2009) has suggested that there is some degree of movement or interaction between whales breeding along the western and eastern margins of the south Atlantic, while genetics shows movement directly through genetic identification (Pomilla & Rosenbaum 2005) and indirectly through levels of divergence (Rosenbaum et al. 2009) between whales from west Africa and Madagascar. However, movement between Brazil and Madagascar has been considered so unlikely that no estimates of movement rates from genetics have been attempted (Rosenbaum et al. 2009).

Genetics suggests that the predominant directionality of movement between these feeding areas is from east to west (Rosenbaum et al. 2009), as was found in the only previously documented individual movement between the Indian Ocean and the Atlantic Ocean (Pomilla & Rosenbaum 2005). However, this individual was sighted first in the western site.

It is somewhat unexpected to find exceptionally long-distance displacement between breeding groups by a female. The breeding system of many mammals results in more common occurrence of movement to new breeding areas by males, and more breeding-area fidelity among females (Greenwood 1980), and it is widely perceived that young 'roving male' cetaceans are the more likely to travel long distances. Previously documented movement between humpback whale breeding grounds were made by males (Darling & Cerchio 1993, Salden et al. 1999, Pomilla & Rosenbaum 2005), while males are over-represented in individuals moving between habitat units within breeding areas (Cerchio et al. 1998). Using genetic signals, males in the Indian and South Atlantic Oceans had higher evidence of movement between breeding groups (Rosenbaum et al. 2009), and the only other whale to have been identified in both of these oceans was a young male (Pomilla & Rosenbaum 2005).

This finding highlights the value of large, collaborative catalogues like the AHWC. It also illustrates the importance of opportunistic data collection from whale watch vessels, as this whale was not represented in a number of other collections of photographs that were examined from breeding stock C. It demonstrates the remarkable distances over which animals can be re-sighted, and thus the importance of comparing identified individuals between areas without preconceptions about probable destinations.

Results from Discovery tags (Brown 1957) and natural markings (Robbins et al. 2008) have also shown substantial east-west migratory movement between breeding and feeding areas in the Southern Hemisphere. This could suggest that longitudinal movement is a more important feature of humpback whale habitat use in the Southern Hemisphere than has previously been recognized.

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