

# First record of inter-oceanic movement of a humpback whale between Atlantic and Pacific breeding grounds off South America

PETER T. STEVICK\*, JUDITH M. ALLEN\*, MARCIA H. ENGEL<sup>+</sup>, FERNANDO FELIX<sup>†</sup>, BEN HAASE<sup>†</sup> AND MARIANA C. NEVES<sup>+</sup>

*\*College of the Atlantic, 105 Eden St., Bar Harbor, ME 04609 USA; +Instituto Baleia Jubarte, Rua Barão do Rio Branco, 26, Caravelas, BA, Brasil 45.900-000; †Museo de Ballenas, Avenida Gral Enriquez Gallo, entre calles 47 y 50, Salinas, Ecuador.*

[pstevick@coa.edu](mailto:pstevick@coa.edu)

## ABSTRACT

No movement has previously been observed between humpback whales from Breeding Stock A on the Atlantic coast of South America and Breeding Stock G on the Pacific coast, nor have whales from these regions been seen to overlap in common feeding areas. A whale first observed in the waters off Ecuador in 1996 was subsequently identified off Brazil in 1998. It was a female, travelling with a calf when first sighted. This constitutes the first record of a humpback whale in both the Atlantic and Pacific breeding grounds off South America, and one of a small number of inter-oceanic movements documented to date. It is also the first record of an inter-ocean movement by a whale that is known to be a reproductively active female. This finding highlights the importance of international collaboration in whale research in the Southern Hemisphere and of conducting analyses without reference to pre-conceptions about probable movement patterns.

## KEYWORDS:

## INTRODUCTION

The International Whaling Commission recognizes seven discrete breeding stocks of humpback whales in the South Hemisphere based on their wintering distribution (IWC, 1998). Breeding Stocks A and G occur along the east and west coasts of South America, respectively (figure 1). Animals from Breeding Stock A are found along the coast of Brazil, primarily in the vicinity of Abrolhos Bank (Martins et al., 2001). Breeding Stock G includes animals wintering from 6°S off northern Peru to 12°N off Costa Rica (Flórez-González et al., 2007; Pacheco et al., 2009). Individual movement has been documented between Ecuador and Colombia, Colombia and Panama, Ecuador and Peru, Colombia and Peru, and Ecuador and Costa Rica, indicating that interchange of individuals among these areas occurs regularly (Flórez-González et al., 1998; Castro et al., 2008; Félix et al., 2009).

The discreteness of stocks A and G has been suggested by investigation of movement patterns of naturally marked animals (Garrigue et al., 2002; Stevick et al., 2004) and by genetic analyses (Caballero et al., 2001; Olavarría et al., 2007; Cypriano-Souza et al., 2010). Stock A is considered a strongly structured population, with the majority of whales showing fidelity to breeding grounds off Brazil (Rosenbaum et al. 2009). Animals from Breeding Stock G have been documented in summer from feeding areas located on the west side of the Antarctic Peninsula as far east as the South Orkney Islands and also in the South of Chile (e.g. Stone et al., 1990; Stevick et al., 2004; Acevedo et al., 2007, Dalla Rosa et al., 2008). Animals from Breeding Group A have been identified in feeding areas off South Georgia and the South Sandwich Islands (Stevick et al., 2006; Zerbini et al. 2006; Engel et al. 2008; Engel and Martin, 2009). To date there has been no overlap observed in these feeding areas, further suggesting stock segregation.

However, some uncertainties persist regarding population structure and migration in the region. Genetic studies, natural markings, Discovery tags and acoustics have shown exchange of individuals between a number of southern breeding stocks (Chittleborough 1959; Noad et al., 2000; Garrigue et al., 2002; Darling and Souza-Lima, 2005; Pomilla and Rosenbaum, 2005; Rosenbaum et al., 2009; Stevick et al., 2010). It is possible that, even at quite low levels, this movement of individuals between breeding grounds contributes to the current high level of mtDNA diversity in these humpback populations (Engel et al., 2008). The AE clade, until recently known only from Breeding Group G has recently also been reported off Brazil (Engel et al., 2008). In a recent genetic study it was found that whales belonging to Breeding Stock G share several haplotypes with Southeast Indian Ocean and Southwest Indian/Southeast Atlantic populations, including two haplotypes first recorded in Breeding Stock A (Félix et al., in press). Further, there is genetic and acoustic evidence of movement between the eastern and western South Atlantic stocks A & B (Darling and Souza-Lima, 2005; Rosenbaum et al., 2009) and an individual from Breeding Stock A was documented travelling to Madagascar (Stevick et al., 2010).

## **METHODS**

Whales were identified by photographs of the individually distinctive markings on the ventral fluke surface using standard procedures (Katona et al., 1979; Allen et al., in press). Studies of Breeding Stock G have been conducted off mainland Ecuador since 1991 using whale watching boats as research platforms (Félix and Haase, 2001, Félix et al. in press). Photographs are contained in the catalogue curated at Museo de Ballenas of Salinas, Ecuador. Studies of Breeding Stock A have been conducted during systematic research cruises along the Abrolhos Bank, the main concentration in the Brazilian coast (Engel, 1996, Martins et al., 2001)

The Antarctic Humpback Whale Catalogue (AHWC) is an international collaborative project investigating movements of humpback whales in the Southern Ocean and corresponding lower-latitude waters (Allen et al., in press). More than 300 collaborating researchers and individuals have contributed to this project. The AHWC contains records of 4,268 individual whales identified by fluke photograph (SC/63/SH5). Geographic coverage includes all of the breeding and feeding stocks in the Southern Hemisphere. New sightings were compared to all previously 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.

The AHWC contains records of 815 whales from Breeding Stock G. Of these 586 were taken off Ecuador and are contained in the Museo de Ballenas catalogue. There are 1931 whales identified from Breeding Stock A in the AHWC. Virtually all were collected by Instituto Baleia Jubarte.

## **RESULTS AND DISCUSSION**

An individual humpback whale (AHWC#0664, Museo de Ballenas N°109, IBJ#611-98, figure 2) was first recorded off Puerto Cayo, Ecuador at 01°18'45"S, 80°49'34"W, on September 8, 1996. It was a female accompanied by a calf. The pair was followed for 50 minutes. The individual was subsequently photographed on October 14, 1998 on Abrolhos Bank at 17°55'S 38°57'W. It was travelling in a pair.

This constitutes the first record of a humpback whale in both the Atlantic and Pacific breeding grounds off South America, and one of a very few inter-oceanic movements documented to date. These locations are separated by more than 40° of longitude and a minimum travel distance of around 12,000km. Though there is evidence for considerable isolation between these breeding stocks (Engel et al. 2008; Cypriano-Souza et al. 2010), this finding supports the genetic data suggesting that a low level of recent interbreeding has occurred (Félix et al., in press). In recent years several inter-breeding-stock movements have been documented (Garrigue et al., 2002; Pomilla and Rosenbaum, 2005; Stevick et al., 2010; SC/63/SH11) suggesting that this may be a rare but regular occurrence in the Southern Hemisphere.

Evolutionary theory tends to argue that young mammals and males are more likely to travel long distances than are females and adults (Greenwood 1980; Johnson and Gaines 1990; Lawson et al., 2007). Additionally, mtDNA studies found a higher female structure in Breeding Stock A, supporting the assumption of greater female philopatry and male dispersal in the study area (Rosenbaum et al. 2009). However, this whale moved to a different and distant breeding ground after it was reproductively mature, as evidenced by the presence of a calf during the first sighting. A female also travelled from Brazil to Madagascar, though the age and reproductive status of that animal are not known (Stevick et al., 2010). Thus, the extreme long-distance travellers among humpback whales are not restricted to young males.

Such large-scale movement can only be detected by collaborative projects that bring together longitudinal studies from different regions. As such, this finding highlights the importance of continued and expanded collaboration in research.

## **ACKNOWLEDGEMENTS**

Thanks to the many who assisted with collection and processing of photographs. Instituto Baleia Jubarte is sponsored by Petróleo Brasileiro S.A. (PETROBRAS). The Whale and Dolphin Conservation Society WDSC provided support for the work in Ecuador. This study would not be possible without the hard work and dedication of the researchers and photographers who collaborate to make the AHWC possible, and the staff and students who spend countless hours comparing photographs, especially L. Crowe who identified this re-sighting and C. Carlson for her long-standing support. We are indebted to the IWC and to private donors for financial support for the AHWC.

## REFERENCES

- Acevedo, J., Rasmussen, K., Félix, F., Castro, C., Llano, M., Secchi, E., Saborío, M.T. Aguayo-Lobo, A., Haase, B., Scheidat, M., Dalla-Rosa, L., Olavaria, C., Forestell, P., Acuña, P., Kaufman, G., and Pastene, L. 2007. Migratory destinations of the humpback whales from Magellan Strait feeding ground, Chile. *Mar. Mamm. Sci.* 23(2):453-463.
- Allen, J., Carlson, C.A. and Stevick, P.T. in press. The Antarctic Humpback Whale Catalogue: Description and Summary. *J. Cetacean Res. Manage.*
- Caballero, S., Hamilton, H., Jaramillo, H., Capella, J., Flórez-González, L., Olavaria, C., Rosebaum, H. C., Guhl, F. and Baker, C. S. 2001. Genetic characterization of the Colombian Pacific coast humpback whale population using RAPD and mitochondrial DNA sequences. *Mem. Queensld Mus.* 47(2):459-464.
- Castro, C., Acevedo, J., Allen, J.M., Dalla Rosa, L., Flórez-González, L., Aguayo-Lobo, A., Rasmussen, K., Llano, M., Garita, F., Forestell, P., Secchi, E., García-Godos, I., Ferina, D., Kaufman, G., Scheidat, M. and Pasterne, L. 2008. Migratory movements of humpback whales (*Megaptera novaeangliae*) between Machalilla National Park, Ecuador and Southeast Pacific. Document SC/60/SH23, submitted to the Scientific Committee of the International Whaling Commission, Santiago, Chile, 1-13 June 2008. 6p.
- Chittleborough RG. 1959. Intermingling of two populations of humpback whales. *Norsk Hvalfangst-tidende* 48:510-521.
- Cypriano-Souza, A.L., Fernandez, G.P., Lima-Rosa, C.A.V., Engel, M.H., Bonatto, S.L. 2010. Microsatellite Genetic Characterization of the Humpback Whale (*Megaptera novaeangliae*) Breeding Ground off Brazil (Breeding Stock A). *J. Heredity* 101(2):189-200. Doi:10.1093/jhered/esp097
- Dalla Rosa, L., Felix, F., Stevick, P.T., Secchi, E.R., Allen, J.M., Chater, K. 2008. Interchange of humpback whales between the South Orkney Islands (Weddell Sea) and the northwestern coasts of South American and the Antarctic Peninsula, confirmed by photo-identification. Paper SC/60/SH42 presented to the IWC Scientific Committee, June 2008, Santiago, Chile.
- Darling, J.D. & Sousa-Lima, R.S. 2005. Songs indicate interaction between humpback whale (*Megaptera novaeangliae*) populations in the western and eastern South Atlantic Ocean. *Mar. Mamm. Sci.* 21(3):557-566.
- Engel, M. H. 1996. Comportamento reprodutivo da baleia jubarte (*Megaptera novaeangliae*) em Abrolhos. *Etologia* 14:275-284.
- Engel, M.H., Fagundes, N.J.R., Rosenbaum, H.C., Leslie, M.S., Ott, P. H., Schmitt, R., Secchi, E., Dalla-Rosa, L., Bonatto S.L. 2008. Mitochondrial DNA diversity of the Southwestern Atlantic humpback whale (*Megaptera novaeangliae*) breeding area off Brazil, and the potential connections to Antarctic feeding areas. *Conservation Genetics* 9:1253-1268.
- Engel, M.H. and Martin, A.R. 2009. Feeding grounds of the western South Atlantic humpback whale population. *Mar. Mamm. Sci.* 25:964-969.
- Félix, F., Caballero, S., and Olavarría, C. (In press). Genetic diversity and population structure of humpback whales (*Megaptera novaeangliae*) from Ecuador based on mitochondrial DNA analyses. *J. Cetacean Res. Manage.*
- Félix, F. & B. Haase. 2001. The humpback whale off the coast of Ecuador, population parameters and behavior. *Revista de Biología Marina y Oceanografía*, Vol. 36(1):61-74.
- Félix, F., Rasmussen, K., Garita, F., Haase, B. and Simonis, A. 2009. Movements of humpback whales between Ecuador and Central America, wintering area of the Breeding Stock G. Paper SC/61/SH18 presented to the 61 Scientific Committee of the International Whaling Commission. Madeira, Portugal, June 2009.
- Flórez-González, L., I.C. Ávila, J.C. Capella, P. Falk, F. Félix, J. Gibbons, H.M. Guzmán, B. Haase, J.C. Herrera, V. Peña, L. Santillán, I.C. Tobón & K. Van Waerebeek. 2007. Estrategia para la Conservación de la Ballena Jorobada del Pacífico Sudeste. Lineamientos para un plan de acción regional e iniciativas nacionales. Fundación Yubarta. Cali, Colombia. 106 p.
- Flórez-González, L., Capella, J., Haase, B., Bravo, G. A. Félix, F. and Gerrodette, T. 1998. Changes in winter destinations and the northernmost record of southeastern Pacific humpback whales. *Mar. Mamm. Sci.* 14(1):189-196.
- Garrigue, C., Aguayo, A., Amante-Helweg, V.L.U., Baker, C.S., Caballero, S., Clapham, P., Constantine, R., Denkinger, J., Donoghue, M., Flórez-González, L., Greaves, J., Hauser, N., Olavarría, C., Pairoa, C. Peckham, H. and Poole, M. 2002. Movements of humpback whales in Oceania, South Pacific. *J. Cetacean Res. Manage.* 4:255-260.
- Greenwood, P. J. 1980. Mating systems, philopatry and dispersal in birds and mammals. *Animal Behaviour* 28:1140-1162.
- IWC 1998. Report of the Scientific Committee. *Rep. int. Whal. Commn* 48:53-118.
- Johnson, M. L. and Gaines, M. S. 1990. Evolution of dispersal: theoretical models and empirical tests using birds and mammals. *Annual Review of Ecology and Systematics* 21:449-480.
- Katona, S. K., Baxter, B., Brazier, O., Kraus, S., Perkins, J., and Whitehead, H. 1979. Identification of humpback whales by fluke photographs. Pages 33-44 in H. E. Winn and B. L. Olla, editors. *The Behavior of Marine Animals. Volume 3. Cetacea.* Plenum Press, New York.
- Martins, C.C.A., Morete, M.E., Engel, M.H., Freitas, A.C., Secchi, E.R., Kinas, P.G. 2001. Aspects of habitat use patterns of humpback whales in the Abrolhos Bank, Brazil, breeding ground. *Mem. Queensld Mus.* 47:563-570.
- Noad, M.J., Cato, D.H., Bryden, M.M., Jenner, M-N., Jenner, K.C.S. 2000. Cultural revolution in whale songs. *Nature, London* 408:537.
- Olavarría, C., Baker, C.S., Garrigue, C., Poole, M., Hauser, N., Caballero, S., Flórez-González, L., Brasseur, M., Bannister, J., Capella, J., Clapham, P., Dodemont, R., Donoghue, M., Jenner, C., Jenner, M. N., Moro, D., Oremus, M., Paton, D., Rosenbaum, H. and Russell, K. 2007. Population structure of South Pacific humpback and the origin of the eastern Polynesian breeding grounds. *Mar. Ecol. Prog. Ser.* 330:257-268.

Pacheco, A.S., Silva, S., and Alcorta, B. 2009. Winter distribution and group composition of humpback whales (*Megaptera novaeangliae*) off northern Peru. *Lat. Am. J. Aquat. Mamm.* 7(1-2):33-38.

Pomilla, C. and Rosenbaum, H. 2005. Against the current: an inter-oceanic whale migration event. *Biology Lett.* 1:476-479.

Rosenbaum, H. C., Pomilla, C., Mendez, M., Leslie, M.S., Best, P.B., Findlay, K.P., Minton, G., Ersts, P.J., Collins, T., Engel, M.H., Bonatto, S.L., Kotze, D.P.G.H., Meyer, M., Barendse, J., Thornton, M., Razafindrakoto, Y., Ngouesso, S., Vely, M. and Kiszka, J. 2009. Population structure of humpback whales from their breeding grounds in the South Atlantic and Indian Oceans. *PLoS ONE* 4:e7318. doi:7310.1371/journal.pone.0007318.

Stevick, P., Aguayo, A., Allen, J., Avila, I.C., Capella, J., Castro, C., Chater, K., Engel, M. H., Félix, F., Flórez-González, L., Freitas, A., Haase, B., Llano, M., Lodi, L., Muñoz, E., Olavarría, C., Secchi, E., Scheidat, M. and Siciliano, S. 2004. A note on the migrations of individually identified humpback whales between the Antarctic Peninsula and South America. *J. Cetacean Res. Manage.* 6(2):109-113.

Stevick, P.T., Neves, M.C., Johansen, F., Engel, M.H., Allen, J., Marcondes, M.C. and Carlson, C. 2010. A quarter of a world away: female humpback whale moves 10,000 km between breeding areas. *Biology Lett.* Doi:10.1098/rsbl.2010.07.0717.

Stevick, P.T., Pacheco de Godoy, L., McOsker, M., Engel, M.H. and Allen, J. 2006. A note on the movement of a humpback whale from Abrolhos Bank, Brazil to South Georgia. *J. Cetacean Res. Manage.* 8: 297-300.

Stone, G., Flórez-González, L. and Katona, S. 1990. Whale migration record. *Nature, London* 346:705.

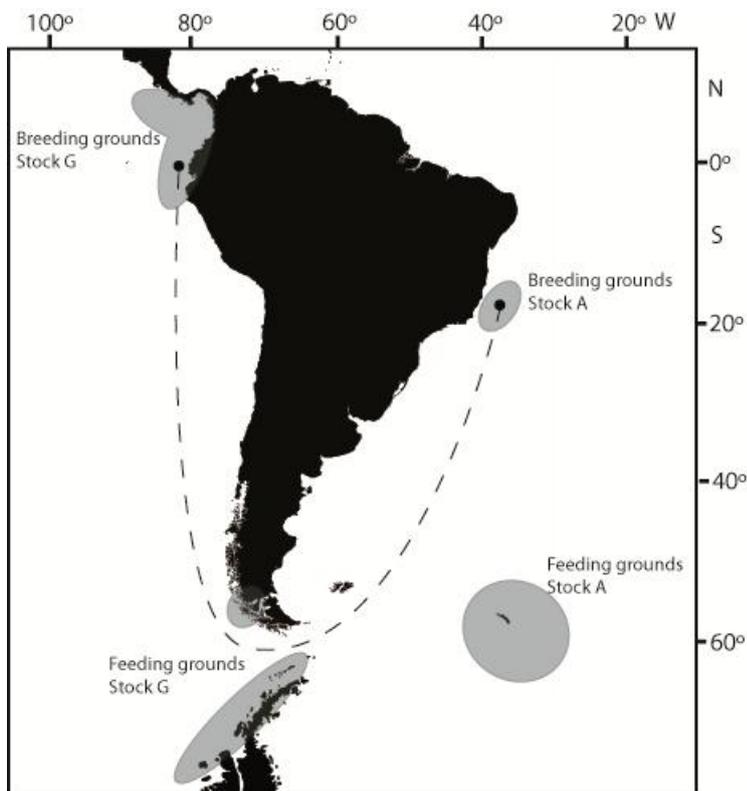


Figure 1: Distribution of Breeding Groups A and G and documented feeding destinations. Dashed line connects sighting locations for AHWC#0064.



AHWC #0664

Figure 2. AHWC#0664 photographed on Abrolhos Bank, Brazil (top – IBJ photo) and off Salinas, Ecuador (bottom – Museo de Ballenas photo).