COASTAL MIGRATORY CONNECTIONS OF HUMPBACK WHALES, *MEGAPTERA NOVAEANGLIAE* BOROWSKI, 1781, IN SOUTHERN CHILE.

CONEXIONES COSTERAS MIGRATORIAS DE BALLENAS JOROBADAS *MEGAPTERA NOVAEANGLIAE* BOROWSKI, 1781, EN EL SUR DE CHILE.

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ABSTRACT

There is not published information on a comparative analysis about interchange of individual humpback whales between coastal areas of aggregation of the species along southern Chilean coast. Here we present a comparison of individually photo-identified humpback whales obtained off northwestern Chiloé Island, in Patagonian and Fuegian fjords and in the Strait of Magellan near Carlos III Island , to discover movements and interchange of individuals. Comparison of photographs resulted in conclusive matches of four individuals within the four study locations: two whales from Canal Wide (49°55'S, 74°30'W), one whale from Canal Cockburn (54°18'S, 72°15'W) and a mother-calf pair off northwestern Chiloé Island matched whales found near Carlos III. The minimum linear distance between these summering locations are approximately 80 km from Canal Cockburn to Carlos III, 540 km from Carlos III to Canal Wide, and 1300 km from Carlos III to northwestern Chiloé Island. The trip from Chiloé Island to Strait of Magellan during 38 days in the same summer season represented a minimum mean speed of transit of 34 km/day. This study provides the first evidence of direct connection of individual humpback whales along the coast of southern Chile.

Key words: humpback whales, Chile, cetaceans

RESUMEN

A lo largo de la costa del sur de Chile existen varias áreas de agregación de ballenas jorobadas durante el verano austral, pero no hay información publicada que analice el intercambio de ballenas entre ellas. En este trabajo se presenta una comparación de ballenas jorobadas identificadas individualmente

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por fotografías obtenidas en el noroeste de la isla de Chiloé, en los fiordos Patagónicos y Fueguinos y cerca de la isla Carlos III en el estrecho de Magallanes, con el fin de descubrir el movimiento e intercambio entre estas áreas. La comparación resultó en el hallazgo de cuatro ballenas comunes entre el estrecho de Magallanes y los demás sectores: dos ballenas del canal Wide (49°55'S, 74°30'W), una del canal Cockburn (54°18'S, 72°15'W) y una madre con su cría del noroeste de la isla de Chiloé también se encontraron en los alrededores de la isla Carlos III. La distancia lineal mínima entre estas localidades de verano es aproximadamente 80 km desde el canal Cockburn a Carlos III, 540 km desde Carlos III al canal Wide, y 1300 km desde Carlos III al noroeste de la isla de Chiloé. El viaje desde el noroeste de la isla de Chiloé hacia el estrecho de Magallanes en 38 días durante el mismo verano representa una velocidad mínima promedio de tránsito de 34 km/día. Este estudio proporciona la primera evidencia de una conexión directa de individuos de ballena jorobada a lo largo de la costa del sur de Chile.

Palabras clave: ballenas jorobadas, Chile, cetáceos.

INTRODUCTION

Humpback whales, *Megaptera novaeangliae* (Borowski, 1781), inhabit all major ocean basins and undertake long-distance seasonal migration between productive high-latitude areas where whales feed in the summer and fall, and low-latitude tropical waters where mating and calving occur during winter and spring (Mackintosh 1965, Clapham & Mead 1999). Photographic identification of individual humpback whales, among others methods, has confirmed migratory destinations and connections all over the world (Stone *et al.* 1990, Darling & Cerchio 1993, Darling *et al.* 1996, Stevick *et al.* 1998, Stevick *et al.* 2003).

In the eastern South Pacific, breeding grounds of humpback whales are grouped into stock G, which includes whales breeding during the austral winter along the coasts from northern Perú to Panamá and Costa Rica (Florez-González *et al.* 1998, Acevedo *et al.* 2007, Rasmussen *et al.* 2007). The main summer feeding ground for the southeastern Pacific humpback whale stock extends along the western coast of the Antarctic Peninsula (Omura 1953, Mackintosh 1942, Stone *et al.* 1990, Stevick *et al.* 2004), south to the Antarctic Convergence. A secondary and recently discovered feeding ground is found in the cold inshore waters of western South America, in the southern Patagonian fjords and the Strait of Magellan (SM) (Gibbons *et al.* 1998, Gibbons *et al.* 2003) with the most significant concentrations around Carlos III Island from summer to autumn (Gibbons *et al.* 2003, Gibbons *et al.*2004).

Based upon photographic identification effort and sighting records, another three areas of summer aggregation of humpback whales in feeding behavior have been reported: one in central Chile, around Chañaral Island and Choros/Damas (Capella *et al.* 1999, Moraga *et al.* 2008[1]) and two others in southern Chile, in the northwestern Chiloé Island (Galletti Vernazzani *et al.* 2006[2], 2008[3]) and the Golfo Corcovado (Hucke-Gaete *et al.* 2006[4]). However, to date there is not published information on a comparative updated analysis about interchange of individuals between these areas.

Here we present results on comparisons from a collection of photo-identification catalogues of individual humpback whale curated by different organizations and obtained off northwestern Chiloé Island (Centro Conservación Cetacea), in Patagonian

[1] Moraga, R., J. Capella, M.J. Pérez, Y. Vilina & J. Gibbons. 2008. Diversidad de mamíferos marinos en las reservas marinas islas Choros-Damas e isla Chañaral, Chile: 20 años de registros. Resúmenes XIII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur – 7° Congreso SOLAMAC, 13-17 Octubre, Montevideo, Uruguay.

[2] Galletti Vernazzani, B., C. Carlson, E. Cabrera and R.L. Brownell Jr. 2006. Blue, sei and humpback whale sightings during 2006 field season in northwestern Isla de Chiloe, Chile. Paper SC/58/SH17 presented to the International Whaling Commission Scientific Committee, St. Kitts and Nevis, May 2006 (unpublished). 6pp.

[3] Galletti Vernazzani, B., C. A. Carlson, E. Cabrera, J. Capella & R.L. Brownell, Jr. 2008. Recent humpback whale sightings off Isla de Chiloe, 2006-2008. Paper SC/60/SH26 presented to the Scientific Committee of the International Whaling Commission, June 2008, Santiago, Chile.

[4] Hucke-Gaete, R., J. P. Torres-Flórez, F. A. Viddi, S. Cuellar, Y. Montecinos & J. Ruiz 2006. A new humpback whale (*Megaptera novaeangliae*) feeding ground in northern Patagonia, Chile: extending summer foraging ranges. Report SC/58/SH10 to the Scientific Committee of the International Whaling Commission. St Kitts and Nevis. 16 – 20 June.

and Fuegian fjords and in the Strait of Magellan (Whalesound Ltda./Fundación Yubarta), with the aim to discover possible movements and interchange of individuals along the Chilean coast.

MATERIALS AND METHODS

Study locations, effort and data collection

Four main summering aggregations of humpback whales in southern Chile were analyzed along the Chilean coast:

a) The central sector of the Strait of Magellan around Carlos III Island (53°37'S, 72°21'W), including Whale Sound, Tortuoso Passage, and Jerónimo and Barbara Channels. The study area covers approximately 1,150 km^2 of marine channels, waters up to 600 m in depth, strong current flows and an average surface water temperature ranging between 6°C and 8°C. Photographic data of individual whales were obtained from dedicated field work conducted on small vessels from 1999 to 2008 undertaken during 350 vessel-days between January and April-May of each year.

b) The Patagonian fjords along inner waters from south of the Penas Gulf (47°40'S) to the northwestern of the Strait of Magellan (52°40'S).The area include the main channels that connect this area with the Pacific Ocean (Messier, Wide, Trinidad, Sarmiento and Concepción) and secondary channels and fjords. This zone is characterized by cold waters with low salinity due to the high rainfall, fresh water influx from rivers and glacial melting. Photographic data of individual whales were obtained in 13 cruise surveys carried out monthly on medium size vessels between February 1997 to May 1998, during 77 days of navigation.

c) The Fuegian fjords located to the south of the Strait of Magellan, between Paso Shag (Bárbara Channel) (53°43'S) and the east of Navarino Island (55°10'S). These are similar to the Patagonian fjords in environmental heterogeneity and varied geography, although glacial influence from the Darwin mountains is less important than from the Southern Ice Fields. Photographic data of individual whales were obtained during six marine trips made in December 1999, April, August, October and November 2000 and February 2001, for a total of 63 days. These surveys were made using vessels 14-16m in length along a predetermined 490 km track

d) The open waters off northwestern Chiloé Island between 41°45'S and 42°05'S and within 22 km off the coastline. Photographic data of individual whales were collected during 46 days of marine surveys on board artisan fishing vessel conducted between February and April, 2006 to 2008. The area covers approximately 1,000 km^2 with water depth up to 150 m and in-situ sea surface temperature ranging from 13°C to 21°C during the study period.

Identification and matching

Humpback whales were individually identified from photographs of the unique patterns of ventral fluke pigmentation and the natural markings and permanent scars on the associated dorsal fins (Katona & Whitehead 1981). Matches of humpback whales were found by comparing the collection of individuals identified among different areas. The total individuals catalogued includes 102 adult humpback whales in the Strait of Magellan (Capella and Gibbons unpublished catalog), 2 individuals in Patagonian fjords (Capella and Gibbons unpublished catalog), 1 individual in Fuegian fjords (Capella and Gibbons unpublished catalog) and 23 individuals in northwestern Chiloé Island (CCC unpublished catalog). The sex of whales was identified from skin biopsies obtained in Carlos III Island by amplification via the PCR and subsequent *Taq* I digestion of a homologous region of the X and Y chromosomes (details of the method is described in Sabaj *et al*. 2004[5] and Capella *et al*. in press).

RESULTS

Comparison of photographs resulted in conclusive matches of four individuals within four of the five study locations as is shown in the accompanying photographs (Fig. 1). One adult whale (EMa-015 from the Strait of Magellan) was documented in Wide Channel (49°55'S, 74°30'W) on 9 February 1997 and near Carlos III on 22 February and 29 April 1999. One of two adult whales (EMa-004) was identified in Canal Wide (49°57'S, 74°27'W)

[5] Sabaj, V., Y. Vilina, S. Guerrero, J. Capella, J. Gibbons & C. Valladares 2004. Genetic structure of the recently discovered feeding ground of Humpback whales at Straits of Magellan, Chile. Paper SC/56/SH19 submitted to the Scientific Committee of the International Whaling Commission, Sorrento, June 2004. 9pp.

on 1 March 1997 and near Carlos III several times on 1999, 2000, 2002 to 2005, 2007 and 2008. One adult whale (EMa-025) was photographed on 25 February 2001 in Canal Cockburn (54°18'S, 72°15'W) and near Carlos III Island on 11 February 2001, 13 March 2007 and 27 April 2008. Finally, a mother-calf pair (EMa-058) was photo-identified off northwestern Chiloé Island on 8 February 2008 and near Carlos III on 18 and 23 March 2008. The mother was also sighted in Strait of Magellan several days on February 2005, January 2006, February and March 2007 but never had been observed with a calf before 2008.

The minimum lineal distance between these summering locations ranges from as short as 80 km for Canal Cockburn to Carlos III, 540 km approximately for the Carlos III to Wide Channel, and as long as 1300 km approximately for Carlos III to northwestern Chiloé Island. The trip from Chiloé to SM during 38 days in the same summer season represented a minimum mean speed of transit of 34 km/day.

DISCUSSIONS AND CONCLUSIONS

Comparison of individually identified humpback whales presented in this note covers a significant area of the main known range of aggregation or presence of the species in their summering ground along Chile: northwestern Chiloé Island, Patagonian and Fuegian fjords and the Strait of Magellan. Although there is limited data on photo identification in areas north and south of Strait of Magellan, this study provides the first evidence of exchange of humpback whales along the coast of southern Chile. The evidence of exchange between northern Patagonian fjords and the Strait of Magellan in different years, the direct connection of a mother and calf between northwestern Chiloé Island and Strait of Magellan in summer 2008, and the re-sighting of one adult between Strait of Magellan and Fuegian fjords in summer 2001 is a valuable information to understand migratory connections of humpback whales.

Available information indicates that humpback whales can stay until five months in the Strait of Magellan (Gibbons *et al.* 2003, Acevedo 2006[6], Capella *et al.* in press[7]) while in the area off Chiloé Island it is known that one whale was resident for a minimum of 20 days (Galletti Vernazzani *et al.*, 2008). No data on residency exist until date for northern Patagonian and Fuegian fjords. In addition, the Strait of Magellan has been documented as a summer feeding ground for humpback whales (Gibbons *et al.* 2003, Acevedo 2006), while in the other three areas, feeding activities have also been recorded (pers. obs of the authors).

Although our data suggest a migratory connection for humpback whales, there are not recent sightings from Patagonian and Fuegian fjords to strengthen connection hypothesis. Additional data will be needed to resolve if humpback whales only travel through the fjords or if they stay there during summer as occurs near Carlos III Island waters (Gibbons *et al.* 2003, Acevedo *et al.* 2006). Further studies in southern Chile, particularly oriented to photoidentification, are essential to better understand migratory movements of humpback whales and propose a suitably migratory coastal route along southern Chile in a feeding ground that may extend from 54°S to at least 41°S.

An alternative migratory connection for Chiloé's Island humpback whales is the western Antarctic Peninsula. Photographs of flukes and dorsal fins from eight individual humpback whales identified between 2004 to 2007 off northwestern Chiloé Island were provided by CCC to the Antarctic Humpback Whale Catalogue (AHWC, curated by Allied Whale, College of the Atlantic, Maine, USA). No matches have been found between individuals off northwestern Chiloé Island (n=8) and the 3023 individuals catalogued in the AHWC from areas including the Antarctic Peninsula (n=891), Antartic areas II to VI (n=380), Gabon (n=78), Ghana (n=1), South Africa (n=1), St. Helena (n=2), Brazil (n=830), Peru (n=2), Chile (n=76), Ecuador/Colombia/Costa Rica (n=479), American Samoa (n=44), Tahiti (n=1), New Zealand (n=1), E. Australia (n=7) and Western Australia (n=308) (Allen et al. 2007[8]).

[6] Acevedo, J.A. 2006. Distribución, filopatría, residencia e identidad poblacional de las ballenas jorobadas, *Megaptera novaeangliae*, que se alimentan en las aguas del Estrecho de Magallanes, Chile. Tesis de Maestría, Facultad de Ciencias, Universidad de Magallanes, Punta Arenas, Chile. 119 pp.

[7] Capella, J., J. Gibbons, L. Flórez-González, M. Llano, C. Valladares, V. Sabaj & Y. Vilina En prensa. Migratory round-trip of individually identified humpback whales of the Strait of Magellan: clues on transit times and phylopatry to destinations. *Revista Chilena de Historia Natural* xxxx.

[8] Allen, J.M., Carlson, C., Holm, B. and Stevick, P. 2007. Interim report: IWC Research Contract 16, Antarctic Humpback Whale Catalogue. Paper SC/59/SH17 presented to the International Whaling Commission Scientific Committee, Alaska, USA, May 2007 (unpublished). 7pp.

Comparisons between northwestern Chiloé Island and the Antarctic Peninsula further strengthen the genetic and phenotypic evidence that suggest there is not migratory connection between Strait of Magellan and Western Antarctic Peninsula (Sabaj *et al*. 2004, Acevedo *et al.* 2007). It appears that humpback whales found near shore in southern Chile have separated migratory destinations.

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