SC/66b/SH/27

Comparisons among Southern Hemisphere Blue Whale Catalogue off Australia and New Zealand

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INTERNATIONAL WHALING COMMISSION

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Abstract
Blue whales are known to occur off Australia and New Zealand but little is known about their long-term movements. The Southern Hemisphere Blue Whale Catalogue is a platform to share individual photo-identification catalogues among blue whale researcher groups. Comparisons of 431 photo-identified blue whales from four different research groups working in the Perth Canyon (west Australia), Geographe Bay (west Australia), Bonney Upwelling (southern Australia) and around New Zealand, provided five whales resighted between different areas. Matches have been found within all three areas of Australia but no matches have been found with New Zealand blue whales. Blue whales sighted in Perth Canyon, Geographe Bay and Bonney Upwelling have been resighted later in any of these areas, representing a high level of connectivity between these areas and thus, making stronger the hypothesis of one distinct population for Australian whales. Small sample size from New Zealand still prevents conclusions being drawn about possible isolation from the Australian population. Further efforts are needed to compare photo-identification catalogues from these areas and also with other catalogues from the eastern South Pacific and Southern Ocean.

Introduction
Three subspecies of blue whales are currently recognized in the Southern Hemisphere: the pygmy blue whale (*Balaenoptera musculus brevicauda*) in the temperate and sub-Antarctic zone; the Antarctic blue whale (*B. m. intermedia*) which summers in the Antarctic Zone, and an unnamed subspecies, the Chilean blue whale off Chile that has recently been accepted by the Taxonomy Committee of the Society for Marine Mammalogy[1].

Pygmy blue whales (*B. m. brevicauda*) in the Indian Ocean are genetically differentiated from those found in the Pacific Ocean as well as from Antarctic blue whales (LeDuc *et al.* 2007). Moreover, vocalizations vary within pygmy blue whales (McDonald *et al.* 2006) with four distinct acoustic populations found within the Indian Ocean (Samaran *et al.* 2013).

Feeding aggregations of pygmy blue whales in the Indian Ocean are known to occur off Australia (Gill 2002, Rennie *et al.* 2009); off New Zealand (Torres *et al*. 2014; Olson *et al.*2015); off the Crozet islands (Samaran *et al.* 2010); and off Sri Lanka (de Vos *et al.* 2014).

Both Antarctic and pygmy blue whales occur off Australia but data suggest the pygmy blue whale is predominant. Acoustic data from western Australia reveal blue whale calls that are unique to the region while calls made by Antarctic blue whales are rare in comparison (McCauley *et al.* 2004; Stafford *et al.* 2004). Genetic analyses indicated that whales using Perth Canyon and Bonney Upwelling are part of the same stock (Attard *et al.* 2010), as are the whales transiting through Geographe Bay (Attard *et al.* 2012a).

Recent studies on mtDNA haplotype frequencies revealed that blue whales from the surrounding waters of New Zealand are genetically similar to blue whales feeding in Australian waters (Sremba *et al.* 2015). In addition, photo-identification work also suggests whales found around the North and South Islands of New Zealand were similar to Australian blue whales but not to Antarctic blue whales (Olson *et al.* 2015).

Photo-identification data from long-term studies as well as a coordinated, multi-site effort is required so that the population abundance, trend and distribution of pygmy blue whales can be assessed accurately (Jenner *et al.* 2008). Since 2008, the IWC Scientific Committee has supported the Southern Hemisphere Blue Whale Catalogue (SHBWC) (IWC, 2009). Major contributions from Australian researchers were

[1] https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/

received and comparisons between catalogues were scheduled for 2014-2015 (IWC, 2014). Results of SHBWC comparisons among catalogues of blue whales off Australia and New Zealand are reported here.

METHODS

The SHBWC represents the most important collection of blue whale catalogues on southern hemisphere. Major catalogues from different researcher groups have been contributed and currently the SHBWC comprises more than 1,381 individual blue whales. These whales have been geographically separated into four major areas from waters off 1) Antarctica, 2) Australia/NewZealand/Indonesia, 3) Southern Africa/Madagascar and 4) Gulf of California/Eastern Tropical Pacific/South America (Galletti Vernazzani 2016).

Until 2015, the Indonesia/Australian/New Zealand sub-catalogue of the SHBWC included photographs of 431 individuals comprising 326photo ID from left side, 324 photo ID from right side and 46 photo ID from flukes (Table 1).

The catalogues were contributed by Blue Whale Study Inc. (BWS) from Bonney Upwelling, Western Whale Research (WWR) from Geographe Bay & Timor Leste, Center for Whale Research (CWR) from the Perth Canyon and Australian Antarctic Division (AAD) with individuals from Bonney Upwelling (AAD, *unpub.*) and New Zealand (AAD, Olson *et al*. 2015).

In 2016, additional blue whale photo-identifications have been received at the SHBWC from within this geographic area and will be compared in the near future.

Blue whales are individually identifiable from the unique pattern of mottling on both sides of the body near the dorsal fin (Sears *et al.* 1990). Separate photographic collections for left sides, right sides and flukes are maintained under the SHBWC. Photographs of individual blue whales were compared between each group for left and right sides as well as for their flukes to determine the number of individuals sighted, and re-sighting matches.

According to SHBWC protocols, photographs of low quality or whales only partially photographed (whales that do not show dorsal fin as reference point) should not be included in the catalogue (SHBWC 2011). However photographs of low quality or whales only partially photographed have been found during the matching process on all the groups involved. Comparisons were conducted with all individuals in spite of their photo quality.

RESULTS

Comparisons of fluke, right side and left side have been fully completed among photo-ID collections contributed by December 2015 from the SHBWC Australian/New Zealand/Indonesia region.

Five matches have been found between the groups (Table 2). Comparisons between AAD and CWR as well as AAD and WWR provided no matches. All the other group comparisons provided at least one positive match. BWS had matches will all other groups and WWR had matches with both CWR and BWS, in spite of a small number of photo-ID submitted.

One whale was first seen at Geographe Bay, west coast of Australia on 10 February 2003 and was later sighted on 25 March 2009 at Bonney Upwelling, southern Australia. Two whales first seen at Geographe bay on 18 November 2000 and 31 October 2003 respectively were later seen at Perth Canyon, west Australia on 24 April 2004, and three times on 08 February 2004, 04 April 2009 and 08 April 2009. Another whale first seen at Bonney Upwelling on 21 February 2005 was resighted at Bonney Upwelling on 19 January 2012. Finally one whale seen at Perth Canyon on 09 February 2004 was resighted at Bonney upwelling on 06 April 2005. No matches have been found with whales from around New Zealand waters.

DISCUSSION AND CONCLUSIONS

Jenner *et al* (2008) reported one match between the Bonney Upwelling and the Perth Canyon and three matches between Geographe Bay and the Perth Canyon, showing connectivity between those regions. Our results showed that some individuals using one of the three areas have been resighted in any of the others. Therefore blue whales from Perth Canyon, Geographe Bay and Bonney Upwelling, can be resighted later in any of these areas. This may represent a high level of connectivity between all these areas and document blue whale movements around Australia, making stronger the hypothesis of one distinct population. This is consistent with Attard *et al.* (2010, 2012a) who found that blue whales from Perth Canyon, Bonney Upwelling and Geographe Bay are genetically part of the same stock. This increases the likelihood that blue whales off Australia are a small population.

While genetic analyses (Sremba *et al*. 2015) and morphological descriptions (Olson *et al*. 2015) have found that New Zealand blue whales are similar to those found in Australia, results of photo-identification analyses reported here have found no matches between these two areas. Furthermore, Torres *et al.* (2015) also found no matches between 22 blue whales off New Zealand and 174 individual Australian blue whales. The lack of matches between New Zealand and Australia may represent a level of site fidelity to feeding ground that has been shown for other populations. However the small sample size from New Zealand still prevents conclusions about a possible isolation from the Australian population.

Results presented here highlight the value of collaborative efforts to better understand spatial and temporal patterns and provides evidence of a level of site fidelity to this feeding area.

In light of the results, it is likely that further photo-identification analyses with increasing catalogue contributions could provide further matches within the region. Recent data added to the SHBWC includes additional photographs from these groups and new groups from Australia, New Zealand and Sri Lanka contributing to the SHBWC (Galletti Vernazzani 2016), therefore the possibility of finding additional matches increases.

Attard *et al.* (2012b) also provided strong genetic evidence for four migrant pygmy blue whales and six admixed individuals (*i.e.* hybrid between pygmy and Antarctic blue whales) off Antarctica. Future photo-ID comparisons between the Southern Ocean and the Indian Ocean may provide further linkages between those two regions.

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Table 1 – Summary of photographic collection of blue whale photo-identifications under the Indonesia/Australian/New Zealand sub-catalogue of the SHBWCby December 2015

GROUP	WHALE ID	LEFT	RIGHT	FLUKE	AREA
BWS	131	84	84	5	Australia - Bonney Upwelling
AAD	37	27	27	0	Australia - Bonney Upwelling
CWR	209	174	180	41	Australia - Perth Canyon
WWR	40	30	23	0	Australia - Geographe Bay / Timor Leste
AAD	14	11	10	0	New Zealand
TOTAL	**431**	**326**	**324**	**46**	

Table 2 - SHBWC results from comparisons among Australian groups' blue whale photoIDs uploaded until December 2015

Groups	WhaleID and date	WhaleID and date
BWS and WWR	BWS0171 on 25 March 2009	WAG0015 on 10 February 2003
BWS and CWR	BWS0058 on 06 April 2005	WA0118 on 09 February 2004
WWR and CWR	WAG0009 on 18 November 2000	WA0168 on 24 April 2004
	WAG0033 on 31 October 2003	WA0111 on 08 February 2004, 04 April 2009 and 08 April 2009
BWS and AAD	BWS026 on 21 February 2005	PBW_bonney_2012_024 on 19 January 2012