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Preliminary Results of 2017 IWC Comparisons among Southern Hemisphere Blue Whale Catalogues off Australia, New Zealand and Sri Lanka regions

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INTERNATIONAL WHALING COMMISSION

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Abstract
Blue whales are known to occur off Australia, New Zealand and Sri Lanka 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 698 photo-identified blue whales from seven different research groups working in the Perth Canyon (west Australia), Geographe Bay (west Australia), Bonney Upwelling (southern Australia), around New Zealand, and Sri Lanka provided sixteen whales resighted between different areas. Matches have been found within Australian catalogues and within New Zealand catalogues but no matches have been found between regions. Blue whales initially sighted in the Perth Canyon, Geographe Bay and the Bonney Upwelling were subsequently resighted in any of these areas, representing a high level of connectivity between these areas and thus, strengthening the hypothesis of one distinct population of Australian whales. These results also support the hypothesis of an isolated New Zealand blue whale population from the Australian population. Further efforts are needed to compare photo-identification catalogues from these areas with other catalogues from the eastern South Pacific and Southern Ocean to better understand population structure.

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*) that summers in the Antarctic Zone, and the yet unnamed Chilean blue whale that has 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 three distinct acoustic pygmy populations found within the Indian Ocean (Samaran *et al.* 2013). New Zealand and Antarctic blue whales also represent distinct acoustic populations (McDonald *et al.* 2006).

Feeding aggregations of blue whales are known to occur off Australia (Gill 2002, Rennie *et al.* 2009); off New Zealand (Torres *et al*. 2013, Olson *et al.*2015, Barlow *et al*. in press); 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 the Perth Canyon and the 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 most similar to blue whales feeding in Australian waters (Sremba *et al.* 2015, Torres *et al*. 2017, Barlow *et al*. in press). In addition, photo-identification work also suggests whales found around the North and South Islands of New Zealand were morphologically similar to Australian blue whales but not to Antarctic blue whales (Olson *et al.* 2015).

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

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 (IWC 2017). Since 2008, the IWC Scientific Committee has supported the Southern Hemisphere Blue Whale Catalogue (SHBWC) (IWC 2009) and to date the SHBWC represents the most important collection of blue whale catalogues on southern hemisphere. Preliminary results of SHBWC comparisons among catalogues of blue whales off Australia, New Zealand and Sri Lanka are reported here.

Methods

Major catalogues from different researcher groups have been contributed to the SHBWC that now comprises more than 1,519 individual blue whales. These whales have been geographically separated into four major areas from waters off 1) Antarctica region, 2) Australia/New Zealand/Indonesia region, 3) Southern Africa/Madagascar region and 4) Gulf of California/Eastern Tropical Pacific/South America region (Galletti Vernazzani 2018).

Until 2017, the Indonesia/Australian/New Zealand regional sub-catalogue of the SHBWC included photographs of 698 individuals comprising 510 left side IDs, 493 right side IDs, and 60 photo-IDs from flukes (Table 1).

The catalogues from this region were contributed by Blue Whale Study Inc. (BWS) from the Bonney Upwelling, Western Whale Research (WWR) from Geographe Bay & Timor Leste, Centre for Whale Research (CWR) from the Perth Canyon, Flinders University from the Bonney Upwelling, Australian Antarctic Division (AAD) with individuals from the Bonney Upwelling and New Zealand (AAD, Olson *et al*. 2015), Oregon State University (OSU) from New Zealand (Torres *et al.* 2017), and Asha de Vos from Sri Lanka.

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. Left side, right side, and fluke photographs of individual blue whales were compared between each group to determine the number of individuals sighted, and resighting matches.

For this report only whales from Australia, New Zealand, and Sri Lanka are compared (n=698 IDs). Matching for the other regions of the catalogue from Antarctica, South America, ETP and Africa remains in progress.

Results

Comparisons of left sides were fully completed among photo-ID collections contributed before January 2018, from the SHBWC Australian/New Zealand/Indonesia region. Right side comparisons are underway.

Sixteen matches have been found between the different groups (Table 2). Fourteen of them corresponded to whales photographed off Australia, and two of the matches corresponded to whales photographed off New Zealand. Matches of Australian whales have been found within all three sub-areas: Geographe Bay, the Perth Canyon and the Bonney Upwelling. Matches off New Zealand have been found between the northwest coast and the northeast coast of the Southern Island. No match was found between whales off Australia and New Zealand, or between whales off Sri Lanka and Australia or New Zealand.

Two whales have been seen in three different years. One (ID 6 and 7, Table 2) has been seen five times by three different groups in the Bonney Upwelling in 2005, 2010 and 2012. The other whale (ID 14, Table 2) has been seen four times. The first sighting occurred in Geographe Bay in 2003 and the resightings occurred in the Perth Canyon in 2004 and 2009.

The longest resighting period is 12 years and corresponds to a whale that was first seen in 2003 in the Perth Canyon and then was resighted in 2015 in the Bonney Upwelling (ID 11, Table 2).

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 areas. Our results are consistent with those findings. Our results show that blue whales from the Perth Canyon can also be sighted in Geographe Bay and the Bonney Upwelling. This represents a high level of connectivity between all three areas and documents blue whale movements around Australia, strengthening the hypothesis of one distinct population. This is consistent with Attard *et al.* (2010, 2012a) who found that blue whales from the Perth Canyon, the 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.

Genetic analyses (Sremba *et al*. 2015, Barlow *et al*. in press) and morphological descriptions (Olson *et al*. 2015) have found that New Zealand blue whales are similar to those found in Australia. Torres *et al.* (2017) found eight matches of whales from New Zealand from a total of 140 individuals and found no matches between these whales and 197 individuals from Australia. Australian photos used in that analysis were also compared in this study. One of the matches reported in Torres *et al*. (2017) corresponds to one of the matches reported here (ID 16, Table 2). Olson *et al*. (2016) report an additional two matches within New Zealand. These studies demonstrate re-occurrence of individuals within New Zealand waters across multiple years.

Our analyses found no matches between Australia, New Zealand and Sri Lanka, reinforcing the hypothesis of separate populations. The mixing of blue whales between three areas in Australia reinforces the hypothesis of single population there. The resighting found in New Zealand further supports the hypothesis of some level of site fidelity to this area. The lack of matches between New Zealand and Australia represent a level of site fidelity to feeding grounds that is consistent with those reported for other populations (Galletti Vernazzani *et al.* 2012, 2017).

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 Australia and New Zealand feeding areas.

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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 SHBWC as of December 2017

GROUP	WHALE ID	LEFT	RIGHT	FLUKE	AREA
BWS	132	85	84	5	Bonney Upwelling
WWR	40	30	23	0	Geographe Bay
Asha de Vos	151	89	79	0	Sri Lanka
CWR	250	204	212	50	Perth Canyon
FLINDERS	18	15	12	0	Bonney Upwelling
OSU	46	40	36	5	New Zealand
AAD-Australia	46	35	36	0	Bonney Upwelling
AAD-NewZealand	15	12	11	0	New Zealand
TOTAL	**698**	**510**	**493**	**60**	

Table 2 - Preliminary results from comparisons among SHBWC groups from Australia, New Zealand and Sri Lanka as of December 2017

ID	Groups	Whale ID	Date and Location 1	Date and Location 2	Date and Location 3	Date and Location 4	Date and Location 5
1	CWR & BWS[1]	WA0201 – BWS0055	05 April 2005, Bonney Upwelling				
2	CWR & BWS[1,2]	WA0202 /WA0203 - BWS0056	05 April 2005, Bonney Upwelling				
3	CWR & BWS[1]	WA0118 - BWS0058	09 February 2004, Perth Canyon	06 April 2005, Bonney Upwelling			
4	CWR & BWS[1]	WA0204 - BWS0057	06 April 2005, Bonney Upwelling				
5	CWR & BWS	WA0048 – BWS131	10 February 2002 Perth Canyon	24 March 2010 Bonney Upwelling			
6-7	CWR, BWS & AAD Australia	WA0205 - BWS040 - AAD-AUS122	30 march 2005, Bonney Upwelling	06 April 2005, Bonney Upwelling	13 March 2010, Bonney Upwelling	28 March 2012, Bonney Upwelling	30 March 2012, Bonney Upwelling
8	BWS & AAD Australia	BWS109 - AAD-AUS017	13 March 2010, Bonney Upwelling	18 January 2012 Bonney Upwelling			
9	BWS & AAD Australia	BWS0151 - AAD-AUS115	20 January 2009, Bonney Upwelling	25 March, 2012, Bonney Upwelling	27 March 2012, Bonney Upwelling		
10	BWS & AAD Australia	BWS026 - AAD-AUS 024	21 February 2005, Bonney Upwelling	19 January 2012, Bonney Upwelling			
11	CWR & FLINDERS	WA0088 - FLBW016	30 March 2003, Perth Canyon	3 March 2015, Bonney Upwelling			
12	BWS & FLINDERS (3)	BWS112 - FLBW018 = FLBW017	13 March 2010, Bonney Upwelling	7 March 2015, Bonney Upwelling			
13	WWR & CWR	WA0168 – WAG0009	18 November 2000, Geographe Bay	24 April 2004, Perth Canyon			
14	WWR & CWR	WA0111 – WAG0033	31 October 2003, Geographe Bay	08 February 2004, Perth Canyon	04 April 2009, Perth Canyon	08 April 2009, Perth Canyon	
15	AAD-NewZealand & OSU	AAD-NZ032 - NZBW009	10 March 2015, -41.867, 174.426	2 February 2016, -40.805, 171.811			
16	AAD-NewZealand & OSU	AAD-NZ008 - NZBW011	31 January 2013, -41.35, 170.47	2 February 2016, -40.724, 171.797			

[1] CWR and BWS conducted surveys together in April 2005 in the Bonney Upwelling and therefore they share the same photo-IDs in their catalogues

[2] WA0202 and WA0203correspond to BWS0056 from left side and right side respectively. However, the opposite sides of these whales don't match.

[3] FLBW018 seems to correspond to FLBW017 which is consistent with a comment posted by the group on their catalogue "FLBW018 can potentially be the same whale as FLBW017 based on timing. Photograph is unclear whether it is the same whale".