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INTERNATIONAL WHALING COMMISSION

# Assessment of Pygmy type Blue Whales in the Southern Hemisphere

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Here we review available information on pygmy-type blue whales in the Southern Hemisphere in preparation for a preliminary assessment to be conducted at SC66a. Call types, as described and labeled in McDonald *et al*. (2006), are used as a proxy for identifying populations, and (unless otherwise noted) catch records are derived from the IWC database. Goals of the preliminary assessment are to 1) provide an updated catch series split by sub-species and call type/area; 2) collate positional data from sightings, catch, acoustic sources, and satellite tags; and 3) identify important feeding areas for pygmy-type blue whales in the Southern Hemisphere.

## Chile – Peru and southern ETP -- Call Type 2

***Distribution***. – In the austral summer and fall (January through at least April), blue whales have been found off the western coast of Isla de Chiloe, in the Golfo de Corcovado, in the waters around the Chonos Archipelago and the Moraleda Channel, and in the northern Los Lagos region (Hucke-Gaete *et al*. 2004, Cabrera *et al*. 2005, Galletti-Vernazzi *et al*. 2012a). Based on photo-identification analyses, between-year movements have been detected between 1) eastern Golfo de Corcovado (March 2004) and northwestern Isla de Chiloe (April 2007), 2) the Atacama Region (December 2006, ~29°2'S, 71°33'W) and northwestern Isla de Chiloe (February 2007); and 3) northwestern Isla de Chiloe (April 2007) and the northern Los Lagos region (March 2008) (as detailed in Galletti Vernazzani *et al*. 2012a). A whale photographed during the IWC SOWER cruise on 5 January 1998, either at 39.96°S and 74.15°W or at 40°S and 74.14°W, was observed again on 13 March 2008 at 41.94°S and 74.29°W, about 220km southwest from previous location (Galletti Vernazzani and Cabrera 2011). Of five whales tagged in the fjords off southern Chile in January 2004, two travelled north as far as the Nazca Ridge (~800km from shore, ~25°S), which is known to be an area of upwelling, before their tags stopped transmitting (Hucke-Gaete & Mate 2005). Inter-seasonal movement between the Corcovado Gulf and the Galapagos region was confirmed recently by photo-ID and supported with genetics. An individual blue whale was photographed in 1 Nov 1998 at 1°18' S; 92°19' W and subsequently in February

2006 and 2008 in the Corcovado Gulf (Torres-Florez *et al*. in press). Although rare, occasional sightings of blue whales in the inlets of southern Chile have been reported between April and July (Abramson and Givens 2010; Försterra and Häusermann 2012). At least two of the whales photographed off Comau Fjord in 2010 have also been photographed off NW Chiloe Island in April (Försterra and Häusermann 2012) suggesting that the inlets are also part of the austral summer southern Chile range.

Aerial surveys between January and April of 2012 suggested that the blue whale distribution had shifted northwards during that season. In comparison to previous seasons, aerial surveys between January and April of 2012 counted fewer whales off Isla de Chiloe and a higher number of whales north of the Chacao Channel (41°45'S), including whales sighted in the South Araucania/Los Rios region where no sightings had been previously reported (Galletti Vernazzani *et al*. 2012b). These findings suggested that the distribution of blue whales shifted northwards in 2012. During this same season, blue whales were sighted feeding in February off Isla de Chanaral (~29° S). A blue whale photographed in this area on 21 December 2006 was later resighted off northwestern Isla de Chiloe in February and April of 2007, providing a link between these two (Isla de Chiloe and Isla de Chanaral) feeding areas (Galletti Vernazzani *et al*. 2012b).

***Acoustics***. – The original Type 2 call (SEP1) was recorded off Isla Guafo in May 1970 (Cummings and Thompson 1971, McDonald *et al*. 2006). More recently, SEP1and a second call type (SEP2) have been reported off Chile in the Golfo de Corcovado between February and May 2008-2011 (Buchan *et al*. 2010). Both call types have also been recorded year-round in the ETP (Stafford *et al*. 1999, Buchan *et al*. 2014), providing a link between Chilean blue whales and those in the ETP. The occurrence of songs peaked in June, and most calls of this type were recorded at ~8°S (Stafford *et al*. 1999, Buchan *et al*. 2014). .

***Exploitation***. – No Soviet catches were made in the 1960s. However, large numbers of blue whales (2,852) were taken by various land stations off Chile from 1929 and 1967 (Aguayo 1974) but none were reported landed at the station in northern Peru. Tønnessen and Johnsen (1982:202) reported plenty blue whales off Isla San Pedro, Chile, off the southeast coast of Isla Chiloe and the first catches were during the Austral fall of 1909 when the *Vesterlidae* took 32 blue whales. These were processed at the land station (Stasjonen Normandia) on the island.

***Reproductive Status***. – A large number of mother-calf pairs (11 out of 47 sightings) were reported on their austral summer feeding grounds off western Isla de Chiloe and in the Corvacado Gulf in 2003 (Hucke-Gaete *et al*. 2004). However, details on the sizes of calves were not provided and few calves have been subsequently reported from this area. From 2004 to 2010, systematic aerial surveys did not observe any calves on the same feeding area, and from marine platforms only two sightings out of 621 corresponded to mother-calf pair (Galletti Vernazzani *et al*. 2012a).

***Genetics***. – LeDuc *et al*. (2007) included samples from the 1997 SOWER cruise (n=16 collected off the coast of Chile) as well as 12 samples collected as part of a SWFSC research cruise in Peruvian and Ecuadorian waters. Additional samples (from n= 52

individuals) from Chilean waters have been collected and reported on by Torres-Florez et al. (2014a, b). Additional samples and photo-identification images (from n = 12 individuals) were collected between February and March 2015 as part of a collaborative project between by MERI, WHOI, OOC[Open Ocean Consulting, UK], and J. Durban of the SWFSC. Photogrammetric and tagging data were also collected from some of these individuals.

***Feeding***. – Feeding behaviour has been reported for blue whales in their austral summer and autumn distribution in southern Chile (Galletti Vernazzani *et al*. 2012a) as well as off Isla de Chanaral, northern Chile (Galletti Vernazzani *et al*. 2012b).

***Photo-ID catalogue***. – A photo-identification catalogue has been maintained by Centro de Conservacion Cetacea since 2004. In 2012, this catalogue included 419 individuals identified from right side with sufficient quality to perform mark-recapture analyses.

***Health Assessment***. – Raised and/or blister-like skin lesions were observed in 52 (of 68) individuals off Isla de Chiloe. In addition, at least one whale had extensive tattoo-like lesions. A high proportion of the individuals photographed off Isla de Chiloe have cookie cutter shark bite scars and *Xenobalanus* attached to the trailing edge of the dorsal fin and flukes (Brownell *et al*. 2008). Thin or "skinny whales" have been observed and photographically documented since 2005 (Galletti Vernazzani *et al*. 2008).

***Threats***. – Ship strikes are known to be a threat in this population (Brownell *et al*. 2014). Pollution from intensive salmon farming and projected renewable energy projects, as well as its associated increase in vessel traffic represents additional threats, but these are still poorly understood at this time.

***Specimens***. – Only a single specimen is known to exist in Chilean museum collections. This specimen is a skeleton of a 25m male blue whale held by the Regional Museum of Ancud. One additional specimen was collected in 2014 but it is underwater off Puerto Montt and need to be recovered.

***Future research needs***. – The following is needed: (1) continue photo-id work to improve population estimate, (2) health assessment using photo-id, and (3) assess ship strike and any other threats.

***Estimate pre-exploitation abundance***. – There is no estimate of the pre-exploitation abundance and the IWC catch database shows that 2,758 blue whales were taken between 0-44$^{o}$S from 1926 to 1967. However, the land station catches from Chile alone total 2,852 between 1929 and 1967 (Aguayo 1974) and no catches were reported from Paita station in Peru (Valdivia *et al*. 1984). Barthelmess (2010) reported that the *Olympic Challenger* killed 285 blue whales off Peru in the 1954/55 season.

***Current abundance estimate***. – Based on surveys conducted from the IWC-SOWER 1997/98 blue whale cruise off central Chile in December 1997 (Findlay *et al*., 1998), Branch *et al*. (2007c) used line-transect methods to estimate a population abundance of

452 individuals. However, the survey was designed primarily to maximize blue whale encounters and thus did not have an equal coverage probability design. Williams *et al*. (2011) reanalyzed these data using spatial modeling methods and obtained a smaller abundance estimate of 303 whales in 1997. Both estimates represent the number of whales present in the sampled area, which encompassed waters from 12 nm to 200 nm offshore and from ~18°30' S to 38° S (Findlay *et al*. 1998). This latter estimate is lower than the 363 blue whales photo-identified between 2004-2010 off Isla de Chiloe, southern Chile (Galletti Vernazzani *et al.* 2012a); most of the photo-identification effort for this catalogue has been concentrated off northwestern Isla de Chiloe, between the Chacao Channel (41°45 S) to south of Isla Metalqui (42°12 S) and within 12 nmi (Galletti Vernazzani *et al*. 2012a). Galletti Vernazzani *et al*. (2015) reported the results of nine years of photo-identification surveys of this unique population feeding in the waters of Isla de Chiloé and Isla Chañaral. Over these years, a total of 1,070 blue whales were encountered, yielding 318 and 267 unique photographs of the left and right side of the flank, respectively. Mark recapture analysis of left and right side photographs collected from Isla de Chiloé (2006-2011) using open population models suggest abundance in this region is small. POPAN model-averaged estimates of 2011 super-population abundance for the feeding ground are 711 (95% confidence intervals, CI = 574-848) and 549 (95% CI 442-656) for left and right side datasets respectively. Pradel and POPAN estimates of annual trend revealed strong variation in abundance, peaking in 2009 and suggesting fluctuating use of this feeding area over time. Inter-annual fluctuations in abundance are also seen in the dataset when a 2012 survey at Isla Chañaral is included, with larger POPAN super-population abundances estimated overall (N=1,353, SE=453 and N=1,060, SE=283 for left and right side datasets respectively). These results indicate that whales using the Isla de Chiloé feeding ground are part of a larger Chilean blue whale population feeding along the coast, with abundance estimates derived from surveys in Isla de Chiloé reflecting local abundance on this feeding ground.

***Preliminary status under IUCN***. – The pygmy blue whale subspecies is listed on the IUCN Red List as DD and none of the subpopulations have yet been assessed.

**Australia Perth Canyon and Bass Strait to Timor -- Call Type 8**

***Distribution***. – Feeding aggregations of blue whales are known to occur in the Bonney Upwelling off the coast of South Australia and Victoria (Gill 2002, Gill *et al*. 2011) as well as in the Perth Canyon off Rottnest Island in Western Australia (Rennie *et al*. 2009).

Blue whales tagged in the Perth Canyon migrated to the Banda and Molluca Seas off eastern Indonesia (Gales *et al*. 2010, Double *et al*. 2014). One of these whales retained its tag while migrating south, although no locations were transmitted during this time. However, when the tag resumed transmitting the whale was located at the approximate position of the subtropical front, south of Western Australia, where it remained for three months before the tag failed (Double *et al*. 2014). Along the south coast of Australia, PBWs are found between November and May in the Great Australian Bight eastward to the Bass Strait region (Gill 2002, Gill *et al*. 2011).

Additional records from Indonesian waters are reported in Rudolph *et al*. (1997): 1) an animal (23.5m long) stranded near Namlea, Buru Island on 22 June 1987, the skeleton of which resides in the Ambon Museum; 2) an adult and calf in the Savu Sea (8°45'S, 122°35'E) on 16 June 1990; 3) an adult and calf between Flores and Sumba Islands in the Savu Sea in June 1990; 4) a sighting of what may have been three pygmy blue whales ~8 miles southwest of Lamalera, Lembatu Island on 14 August 1991; 5) two animals southwest of Lamalera on 13 September 1993; and 6) one animal at 8° 40' S, 123° 27'E) on 30 September 1993. Blue whales are also sometimes observed around Komodo Island.

***Acoustics***. – McDonald *et al*. (2006) reported Type 8 calls from off Fremantle, Western Australia during the years 1993-2000 (McCauley et al., 2001). Type 8 calls have been recorded off Cape Leeuwin (peaks from mid-November to mid-January, and early February to late June or mid-July; Stafford *et al*. 2011, Gavrilov & McCauley 2013), to the NE (470 nmi, March – June) and SW (350 nmi, Jan – June) of Amsterdam Island (Samaran *et al*. 2013), and off Crozet Island in the sub-Antarctic portion of the southern Indian Ocean (Jan – April, Samaran *et al*. 2010). No Type 8 calls were recorded near Diego Garcia (Stafford *et al*. 2011) or the Madagascar Basin (~320 nmi south of La Reunion Island; Samaran *et al*. 2013).

***Exploitation***. – The main exploitation of this subpopulation was by Soviet pelagic operations in the 1960s along both the western and southern coasts of Australia (Mikhalev 1997). Some whales from this population may have been hunted by Japanese and Soviet pelagic operation working in the central Indian Ocean in the area around Kerguelen during the late 1950s and early 1960s. Small numbers were taken off Western Australia and taken the land station in Carnarvon.

***Reproductive Status***. – Mother-calf pair sightings have been reported off south Australia (Gill *et al*. 2011), the Perth Canyon (Gill 2004), and Geographe Bay, Western Australia (Recalde-Salas *et al*. 2014), as well as in the Savu Sea (Rudolph *et al*. 1997).

***Genetics***. – LeDuc *et al*. (2007) included samples from 28 individuals from the southern and western coasts of Australia, but samples from other areas (Madagascar, Northern Indian Ocean) were too limited to assess population structure within the Indian Ocean. Genetic analyses (mtDNA control region and 10 microsatellite loci) of these and additional samples from the two known feeding aggregations (Perth Canyon and the Bonney Upwelling) indicated that whales using these two areas are part of the same stock (Attard *et al*. 2010), as are the whales transiting through Geographe Bay, approximately 200km south of the Perth Canyon (Attard *et al*. 2012).

***Feeding***. – Gill (2002) reported PBWs feeding in the Bass Strait on krill.

***Photo-ID catalogue***. – While a catalogue exists (Jenner's, Burton, Gill *et al*.), the exact number of identified individuals is currently unknown. Also a small sub-catalogue (47 whales) exists from AAD voyages in Bonney upwelling in 2012.

***Health Assessment***. – None started but will be possible using photo-id catalogues.

***Threats***. – Oil and gas development occurs in the Timor Gap (see 8 June 2013 *The Economist*), and interest in building a gas pipeline between the Greater Sunrise field in the Timor Sea with the onshore Tasi Mane Project, Timor-Leste, exists. Ship strikes will likely increase as vessel traffic increases, especially off NW Western Australia due to PNG terminals, salt and other mining and increased traffic north to China.

***Specimens***. – Chittleborough in Ichihara (1966:82) reported that pygmy blue whales were landed at the whaling station in Carnarvon, Western Australia. An adult (pregnant female) stranded at Whale World, Albany, Western Australia in May 1973 (JLB unpublished).

***Future research needs***. – Research is ongoing on this population (photo id, acoustics and abundance). A health assessment based on the photo-id work is needed.

***Estimate pre-exploitation abundance***. – None but Soviet catches will provide a minimum size for this population because of the short period they were exploited during the 1960s.

***Current abundance estimate.*** **–** The abundance estimates based on passive acoustics and photo-identification/recapture are 1,100 and 791, respectively (McCauley and Jenner 2010; Jenner *et al*. 2008) but these estimates need to be reviewed in more detail.

***Preliminary status under IUCN***. – This subpopulation has not been assessed for the IUCN Red List, in part because the Soviet catches of PBWs have not been allocated to subpopulations (also see Zemsky and Sazhinov 1994). Also the population structure of PBWs in the Indian Ocean is poorly known.

**East South Africa, Madagascar to Kerguelen (49˚15”S, 69˚35”E) Call Type 9**

***Distribution*****.** – In the central Southern Indian Ocean, concentrations of blue whales around Crozet and Marion –mainly north of 52˚ and between 30˚ and 80˚ E – have been reported. Best *et al*. (2003) reported sightings on the Madagascar Plateau region during the 1996 SOWER blue whale cruise. Gambell (1964) reported a specimen taken by whaling operations at Durban on the east coast of South Africa, while Bannister and Grindley (1966) suggested that one animal examined by them at Durban in 1962 was a pygmy blue whale. Ichihara (1966) reported that the type specimen was collected off Marion Island (49° 59’ S, 28° 25”E). Some sightings were recorded during the IWC IDCR / SOWER database around Kerguelen in February (1992?).

Jayasankar *et al*. (2007) documents three sightings of blue whales between 15-22 February 2004: 1) one whale near Lena seamount (53°28’S, 44°59’E, 326m depth) moving south; 2) one to the southeast of Crozet Island (48°08’S, 57°14’E, 4,500m depth) moving southwest; and 3) one near Marion Dufresne Seamount (52°14’S, 52°58’E, 4,240m depth). The total lengths of the animals were estimated at 25-28m. Ten sightings

of blue whales were recorded on seismic surveys west of Madagascar between January and May 2014 (pers comm. Jean Purdon, MRI Whale Unit, University of Pretoria). Images of at least five of these individuals are available for addition to the SHBWC.

***Acoustics.*** – Call Type 9 was first recorded south of Madagascar on the December 1996 SOWER cruise (Ljungblad *et al*. 1998, McDonald *et al*. 2006). Type 9 calls have also been reported from the Madagascar Plateau between March and June (with peaks in April and May, Samaran *et al*. 2013), north of the Diego Garcia Atoll between May and June (McDonald *et al*. 2006, Stafford *et al*. 2011), off Crozet Island during summer and fall (January to June, peak in April but were absent between August and October; Samaran *et al*. 2010), and southwest of Amsterdam Island from December through May (predominantly in autumn; Samaran *et al*. 2013). Although rare, Call Type 9 has also been recorded south of 60°S, below the Kerguelen and Heard Islands (as far as 66°S; Gendamke *et al*. 2007, Gendamke & Robinson 2010).

***Exploitation.*** – Catches were made off Kerguelen in three seasons (8 in 1908/09, 4 in 1909/10, and 113 in 1928/29). The catches in the 1928/29 season by the Norwegians were small adults and they called them *Mybjønner* (Brownell 1999). Since the late 1950s all blue whales caught in this area by the Japanese expeditions were pygmy blue whales (Ichihara, 1961, 1963; Ichihara, 1966). Large Soviet catches of pygmy blue whales also occurred in this region in the 1960s.

***Reproductive Status.*** – Best et al. (2003) reports sightings of 8 calves (8.4% of the individuals sighted) in the December 1996 SOWER survey of the Madagascar Plateau.

***Genetics.*** – All samples (n=6) reported by LeDuc et al. (2007) from the southwestern Indian Ocean are from Madagascar Plateau and were collected during IDCR/SOWER cruise in December 1996. One recent sample was collected off Madagascar by Sal Cerchio.

***Photo-ID catalogue.*** – Some of the 65 animals observed during the IWC SOWER blue whale cruise in 1996 were supposedly photo-identified. Two individuals were photographed in Saldanha Bay as were some others from Madagascar seismic survey (KF).

***Health Assessment.*** – None

***Threats.*** – Not known, but ship strikes and seismic surveys are potential issues. Pygmy blue whales were observed from seismic survey vessels in 2014 (KF, unpublished data).

***Specimens.*** – *Holotype and type locality* — The type specimen is a single piece of baleen, "the longest baleen plate from the left side of a female 19.2 m long, from the Antarctic [sic] 49 59' S., 28 25"E" (Ichihara 1966:80) at the National Science Museum, Japan as NSM 9287. The specimen is registered as NSM 9287 and was collected 5

February 1962 by Tadayoshi Ichihara. Another complete skeleton was also collected by Ichihara, and it was deposited in the Tokai [University] Museum of Natural History in Shimizu, Shizuoka, Japan. This specimen was collected from a specimen taken during Japanese commercial pelagic whaling operations in the Southern Hemisphere in the 1960s.

***Future research needs*.** – Current research needs are: (1) genetics of holotype, (2) collection of additional genetic samples from this region.

***Estimate pre-exploitation abundance*.** – Ichihara and Doi (1964) used catch age-composition and CPUE data to estimate that the abundance of pygmy blue whales in the region between 0° and 80° E and north of 54°S (equivalent to the sub-Antarctic region) was 7,600 whales (based on current recommendations with respect to age estimation from ear plug laminations) in 1960/61. They further estimated that the number of whales within this area would have been reduced to 6,000 animals by the start of the 1963/64 season. Zemsky and Sazhinov (1982) projected this estimate forward in time using the 1960/61abundance estimate, catch series data, and assuming a recruitment rate of 5%. They estimated that by the close of the 1971/72 season, only 4,000 pygmy blue whales remained in this region. In total, Zemsky and Sazhinov (1982) reported 6,875 blue whales removed from this area between 1960/61 and 1971/72 [As reported in Best et al. 2003].

***Current abundance estimate***. – Best et al. (2003) estimated the abundance of these whales south of Madagascar on the Madagascar Plateau at 424 (CV=0.42) based on SOWER survey sightings in December 1996. This survey did not cover what is thought to be the full range of pygmy blue whales associated with Call Type 6 and is thus likely to have been an underestimate.

***Preliminary status under IUCN***. – No current IUCN subpopulation assessment.

**NIO-Sri Lanka, India, Maldives, et al Call Type 7**

***Distribution***. – Blue whales are distributed throughout the northwestern Indian Ocean, with the main concentrations (sightings and catches) in the Gulf of Aden, off the Indus Canyon, Maldives, Seychelles, Sri Lanka and the northern Bay of Bengal (Mikhalev 2000, Anderson et al. 2012, de Vos *et al*. 2014). There are eight stranded blue whales reported from the northern Bay of Bengal (Anderson *et al*. 2012), but these need to be have re-examined to confirm if they are blue whales.

***Acoustics***. – Type 7 calls have been reported offshore of Sri Lanka during the years 1984-2002 (Alling & Payne 1987, Alling et al. 1991, as reported in McDonald *et al*. 2006). The type 7 call has also been recorded as far south as NEAMS and SWAMS (Samaran et al. 2013). Although type 7 calls were not recorded on the hydrophone off Cape Leeuwellen, they were common and were recorded year-round on both the northern and southern Diego Garcia hydrophones (Jan 2002 – Dec 2003; Stafford et al 2011). On the DGS hydrophone, the calls peaked in winter (May – July) and again during spring through summer (Oct – Feb) with highest number of calls recorded in January 2003. At

the DGN hydrophone, type 7 calls were most often detected between March through June, and less frequently heard between July and December (Stafford et al. 2011).

A series of blue whale calls attributed to the Sri Lanka type were detected off the coast of Northern Angola (approximately 6°S, Cerchio *et al*. 2010) on 13 October 2008. Cerchio reconfirmed to us (RLB) recently that this call is a match with the Sri Lanka type call.

***Exploitation***. – In the northern Indian Ocean, Soviet pelagic operations took 1,294 blue whales were taken during the 1963/64 – 1966/67 seasons, from the Arabian Sea region (Mikhalev, 2000). Based on the distribution, length frequencies and biological data from these animals, all were assumed to be pygmy blue whales (Mikhalev, 2000; Branch et al. 2007b). Catches were concentrated in the following regions: Gulf of Aden, Seychelles, Maldives and along the SW coast of India to Sri Lanka.

***Reproductive Status***. – Frequent sightings of mothers and calves are made in March and April off southern Sri Lanka and the Maldives (Anderson et al., 2012; de Vos unpublished). Mikhalev (2000) suggested that a peak in calving occurred in April, with a possible second peak in October for whales in the waters around the Seychelles. [as reported in Anderson et al. 2012).

***Genetics***. –LeDuc et al. (2007) had only a few samples (n=2) from this population.

***Photo-ID catalogue***. – The Sri Lankan Blue Whale Project (AdV) maintains a collection of blue whales photographed in Sri Lankan water between 2008 and 2014; these are being developed into a photo-identification catalogue. The Oman Whale and Dolphin Research Group / Environmental Society of Oman also has a few images of blue whales.

**Health Assessment**. – None. Northern Indian Ocean pygmy blue whales were reported to have a lower frequency of shark bite scars when compared with southern Indian Ocean pygmy whales (Mikhalev 2000, as reported in Anderson et al. 2012). One of the four individuals sighted near the Maldives in April 1998 was reported to be very thin (Ballance et al. 2001). This population also showed no evidence of killer whale rake markings (de Vos unpublished). Some individuals in the population do possess lesions and entanglement scars.

***Threats***. – The major problem for this population is ship strikes (de Vos et al. 2013).

***Specimens***. – In 1998, one of us (RLB) examined the holotype specimen in the Calcutta Natural History Museum.

Skeletal material collected from blue whales can be found in institutions in Sindh (Karachi University – Zoology Department Museum) and Balochistan, Pakistan (Gore et al. 2012).

***Future research needs***. – The following are the major research needs: (1) population

structure in the NIO [genetic samples], (2) develop photo-id catalogue from existing photographs, (3) better stranding data on blue whales in Sri Lankan waters to relate to ship strikes, and (4) health assessment based on photo-ids.

***Estimate pre-exploitation abundance***. –None available.

***Current abundance estimate.* –** None, but populations is assumed to have been depleted due to the removal of almost 1,300 whales by the illegal Soviet pelagic whaling operations during a few seasons in the 1960s

***Preliminary status under IUCN***. – This subpopulation has not been assessed for IUCN Red List.

**South Atlantic Call Type Not Recorded** (but see below)

***Distribution***. – In the western South Atlantic, there are small numbers of pygmy blue whales recorded as *myrbjønners* from South Georgia (Mackintosh 1942, Fraser In Ichihara (1966) and the others are all Antarctic blue whales. There are no confirmed coastal records from eastern South America (Brazil, Uruguay and Argentina). [There is a possible Bovet record in IWC database.] In the eastern South Atlantic, most of the blue whale records from off the west coast of Africa (Congo, Angola and Namibia and western South Africa) are Antarctic blue whales; however, a small portion (3.9%) were estimated to by pygmy blue whales based on their length frequencies (Branch et al. 2008). Bannister and Grindley (1966) refer to a pygmy blue whale caught off Donkergat, South Africa in 1962.

Figuerido & Weir (2014) reported four photographically verified (and one probable) sightings of blue whales in deep waters (>1000m) off central Angola (11°S to 12°30'S) between late July and early August 2012. Further sightings of blue whales have been reported for seismic survey vessels operating off Namibia in 2014, at least two of which were photographed. Attempts to obtain these images are being carried out by the MRI Whale Unit for their addition to the SHBWC. Two sightings of blue whales have been recorded off Saldanha Bay in recent years and images of these individuals have been compared to the Antarctic blue whale catalogue curated by Paula Olson with no matches found.

Dalla Rosa & Secchi (1997) report a 23.1 female blue whale that stranded on 29 April 1992 in southern Brazil (33°45' S, near the border with Uruguay). Morphological, biological, and osteological data were collected, but the taxonomic identity (pygmy *vs*. Antarctic) of the specimen could not be confirmed. However, evidence indicating the whale was physically immature (vertebral ankylosis) suggests this may have been an Antarctic whale.

***Exploitation***. – No Soviet catches in the 1960s. Few were landed in Brazil land stations (three in 1948 and one in 1965) at Costinha (Williamson 1975, Ferreira and Tartari 1965, Paiva and Grangeiro 1970) and one at the Cabo Frio station in 1962 (Williamson 1975).

These Brazilian catches are assumed to be Antarctic blue whales. Tens of thousands of blue whale were taken from the waters around South Georgia between 1910 and 1940, and all these whales were Antarctic blue whales.

Branch et al. (2008) reported catches in the South Atlantic were almost exclusively taken off the west coast of Africa: Congo ($n$ = 1), Angola ($n$ = 1,918), Namibia ($n$ = 1,863), and western South Africa ($n$ = 8,059). Analysis of length frequencies of the south-western African catches, excluding unreliable data from the 1914 Hangklip station, provided an estimate that 3.9% of these blue whales were pygmy blue whales, although the sample size was small ($n$ = 56) and the 95% credibility intervals (0.6–10.7%) were broad (Branch *et al.*, 2007). Nevertheless, for the base case analysis, 3.9% of all blue whales off Congo, Angola, Namibia and western South Africa were assumed to be pygmy blue whales, the rest were assumed to be Antarctic blue whales. No whales from land stations in this region were listed as unspecified species.

***Acoustics***. – A series of blue whale calls attributed to the Sri Lanka type were detected off the coast of Northern Angola (approximately 6°S, Cerchio et al. 2010) on 13 October 2008. Three additional vocalizations that were considered to possibly represent blue whales were recorded. One of these shared some similarity with the New Zealand call type (recorded on 13 days between 29 May and 16 September 2008); the other two did not match calls reported in the literature (one recorded on 45 days between 27 May and 29 November 2008; the other recorded on 18 days between 10 June and 15 November 2008).

An additional call type that was recorded on multiple days in early to mid August off South Georgia has been attributed to pygmy blue whales based on similarity in call characteristics (Pangerc 2010).

Analyses of recordings from an autonomous acoustic recorder deployed off the west coast of Cape Town are currently underway while a second recorder is currently soaking in this region in 2015.

***Reproductive Status***. – At least one of the sightings noted in Figuero & Weir (2014) off central Angola included a cow-calf pair.

***Genetics***. –No samples from the South Atlantic were included in LeDuc et al (2007). Sremba (2011) identified 16 mtDNA haplotypes among 18 blue whale bone samples collected from old whaling station grounds in South Georgia. Ten haplotypes had not been found in contemporary blue whale samples. Of the six haplotypes that had been previously identified, five were found only among whales sampled in the Antarctic, while one haplotype identified in South Georgia was also identified in the Indian Ocean and the North Pacific. Genetic samples are available from the two recent blue whale sightings made off the west coast of South Africa (KF).

A genetic analysis by Attard et al. (2012b) identified hybrid (Australian pygmy x Antarctic) individuals in a region (65°31′S–69°51°S, 0°02′W–16°14′E inclusive) off the Princess Astrid coast.

***Photo-ID catalogue***. – None

***Health Assessment***. – None

***Threats***. – None known, but ship strikes and seismic surveys are potential issues.

***Specimens***. – *Brazil*: mandible collected 130 km south of Rio Grande (32˚07'S, 52˚05'W) in the Museo Oceanografico de Rio Grande, MORG 0003 (Paiva 1961, Pinedo *et al*. 1992); 23.12 m female stranded alive at Chui (33˚45'S, 53˚22'W) on 29 April 1992 almost complete skeleton collected MORG 0088 (Irion *et al*. 1992, Dalla Rosa & Secchi 1997). *Uruguay*: 18.30 m female stranded 1.5 km west of Puerto Platero, Rio de la Plata 9 July 1983 [skeleton in Colonia?] (Praderi 1985). *Argentina*: Type specimen of *Balaenoptera m. intermedia* Burmeister 1871. Type location is near the mouth of the Rio Luján, Buenos Aires. TL was 58 ft. black baleen. Skeleton of the type specimen is in the Bs. As. Museum but tail missing. South Africa: Material from at least two blue whales exists in the Iziko SA Museum in Cape Town.

***Future research needs***. – The following projects need to be undertaken: (1) Subspecies identification is needed for the specimens from Brazil and Uruguay, (2) do any specimens exist on the Atlantic coast of Africa for B. m. yes see above (3) collection of genetic samples [Described above].

***Estimate pre-exploitation abundance***. – None

***Current abundance estimate.*** **–** None

***Preliminary status under IUCN***. – No IUCN subpopulation assessment.

**New Zealand -- Call Type 3**

***Distribution***. – Sightings of blue whales in New Zealand waters include both eastern and western coasts of the North Island (NI) and South Island (SI), as well the South Taranaki Bight (STB), between South and North Islands (Torres 2013, Torres *et al*. 2014, Olson *et al*. in press). Combining acoustic and sighting data sources (Miller *et al*. 2014, Torres 2014, Olson *et al*. in press) blue whales have been documented almost year-round in New Zealand waters. Sightings of blue whales in the STB have been made in all months except July and the area has been documented as a foraging ground (Torres 2013, Torres *et al*. 2014). Feeding behavior has also been observed in the Hauraki Gulf and off the east and west coasts of the South Island (Olson *et al*. in press). Torres 2013 noted another cluster of sightings off the east coast of Northland between the Hauraki Gulf and the Bay of Islands (the NE portion of the North Island) and hypothesized that this area might represent a migratory route. [Add details from Soviet catches for range].

Eight blue whales were sighted off the west coast of the North Island on 27-28 March 2013 during a Heritage Expeditions cruise[1]. During the summers of 2014 and 2015, blue whales were sighted in in this same area by marine mammal observers aboard seismic operations[2]. In January 2015 eight blue whales were seen 13 nmi off Westport, along the west coast of the South Island from a Silversea's cruise ship[3].

***Acoustics***. – The Type 3 call was recorded in 1964 near Three Kings Island off the coast of the NI (Kibblewhite *et al*. 1967) and between June to December 1997 near the Great Barrier Island in the outer Hauruki Gulf (McDonald 2006, McDonald *et al*. 2006). More recently, additional Type 3 calls were recorded during late January to early February and in mid-March off both the eastern and western coasts of the SI (Miller *et al*. 2014). These recordings suggested that the range of NZ pygmies extends at least as far south as 52°S. Recently Miller (unpub. data) has documented NZ-type calls in the western Tasman Sea (southern Tasmania and Bass Strait), sub-Antarctic (Macquarie and Auckland Islands), and in the southwest Pacific (Lau Basin).

***Exploitation***. – Most of the Soviet catches were made in the 1960s around North Island and the northern half of the South Island (Mikhalev 2000).

***Reproductive Status***. –One female/calf pair was observed in STB (Torres *et al*. 2014). An additional sighting of a female/calf pair was made by R. Constantine in November 2010 in the Hauraki Gulf (reported in Olson *et al*. 2013).

***Genetics***. – No samples from New Zealand were included in the LeDuc *et al*. (2007) study. Ten biopsies were collected in STB between 25 January and 14 February 2014 but the results are yet to be reported (Torres *et al*. 2014). And the results are presented in SC/66a/SH19. Rochelle Constantine and Debbie Steele (University of Auckland) have recently completed an analysis of samples from whales stranded in New Zealand and report they were consistent with pygmy whales.[4]

***Feeding***. – In the STB these whales feed on krill *Nyctiphanes australis* (Torres *et al*. 2014).

***Photo-ID catalogue***. – At least 21 individuals were identified in the STB, with one possible resighting (Torres *et al*. 2014). This low resighting rate suggested that a relatively low proportion of the whales that use the STB were photographed.

Thirty-one blue whales were photo-identified from the coastal waters of the North and South Islands from 2004-2014 (Olson et al. in press). One photographic match was found

[1] http://heritage-expeditions.com/media/news_downloads/WPO_systematic_list_2013.pdf
[2] Dave Lundquist pers. comm. to PAO
[3] Olive Andrews pers. comm. to PAO.
[4] Rochelle Constantine pers. comm. to PAO.

between June 2011, in Cook Strait, and March 2013, off the east coast of the South Island. Fourteen of the identifications were obtained in January and March 2013 (Olson *et al*. in press). The other identifications were made from opportunistically collected images from Bott (2008, 2011, 2013, 2014), Weir (2012, 2014), Childerhouse (2004), van de Linde/B. Miller (2007), and Constantine (2010, off the NI).

New photos collected off NZ by Olive Andrews in austral summer 2015 from a cruise ship yielded five ID's and one whale was photo-identified during the recent New Zealand-Australia Antarctic Ecosystems Voyage. None of these whales matched to the 31 whales reported in Olson *et al.* in press.

Note that Nadine Bott (DOC, NZ) is coordinating an effort to compile all photo-ID's of New Zealand blue whales into a single collection. This includes the collections of photo-IDs currently held separately by Olson *et al.*, Leigh Torres, and Ingrid Visser.

***Health Assessment***. –Photos from Olson *et al*. (in press) indicated poor body condition and poor skin condition (noted as similar to Australian and Chilean whales), with scars from lesions and from cookie cutter bites. External morphology (body length and proportions, head shape) was noted as being similar to Australian (pygmy type) but not to Antarctic whales (Olson *et al*. in press).

***Threats***. – At least one ship strike has been reported off the coast of Auckland (see Torres 2013 Supplementary Table S2), and significant vessel traffic and fishing effort occur (reviewed in Torres 2013). The oil and gas industry has been present and active in the STB since 1979, and significant growth of the industry in and around this area is occurring, including frequent and extensive seismic surveys and drilling of test wells (Torres 2013, Torres *et al*. 2014).

***Specimens***. – The Te Papa National Museum in Wellington has one complete skeleton of a pygmy blue whale.

***Future research needs***. Current research needs include 1) continuation of the Torres project (including collection of additional photos and genetic samples); and 2) a better estimate of the number of Soviet catches in the 1960s.

***Estimate pre-exploitation abundance***. – None but Soviet catches would provide a minimum size because of the short period they were exploited.

***Current abundance estimate***. – No current abundance estimate is available.

***Preliminary status under IUCN***. – No IUCN subpopulation assessment has been conducted.

**Southwest Pacific – New Caledonia, Solomon Islands – New Call Type?**

*Distribution*. -- Sightings of blue whales in the southwestern Pacific are rare. Ohsumi and Shigemune (1993) reported that 21 pods (41 individuals) of blue whales were observed [near] the Solomon Islands in August 1957.However, no blue whales were observed during in the region during November and December 1993 (Shimada and Pastene 1995) or September and October 1994 (Goto et al. 1995). With the exception of a single sighting of blue whales at the equator at ~170°E, all sightings through at least 1999 occurred south of 30°S in the austral summer (Kato et al. 1995). A male blue whale, first sighted on 26 December 2001, stranded in Baie de la Somme, New Caledonia on 29 Jan 2002 (Garrigue et al. 2003; Borsa & Hoarau 2004; Borsa 2006). The whale's length was estimated at 16.5m (Borsa & Hoarau 2004), suggesting that it was a juvenile or potentially a newly weaned calf, and it was in poor body condition. Garrigue et al. (2003) classified this whale as a pygmy on the basis of the criteria listed in Kato et al. (2002). Borsa & Hoarau (2004) agreed with this classification and also found that measurements of the skull and baleen were more similar to those of pygmy (v. Antarctic) blue whales.

*Acoustics.* – In December 1999, a previously undocumented blue whale call type was recorded off the coast of eastern Papua New Guinea (Frank & Ferris 2011). This call type did not match call type 3 from New Zealand, and was most similar to (though sufficiently different from) call type 4, which has been recorded in the western and central Aleutians and the Gulf of Alaska, as well as off Hawaii and Wake Island (Watkins et al. 2000, Stafford et al. 2001, Stafford 2003). Although Stafford et al 2001 believed that some of the Wake calls were the Eastern call type, M. MacDonald (pers. comm. 5 August 2009) believes these Wake calls are exclusively the North Pacific western type.

*Exploitation*. – Illegal Soviet pelagic whaling operations are known to have occurred south of this region [NZ] during the 1960s and therefore would have further depleted this population. This would explain why blue whales were not observed around the Solomon Islands during November-December 1993 and September-October 1994 (IWC 1996).

*Reproductive status*. -- Only a single mother/calf pair has been reported.

*Genetics*. -- A partial sequence of the mitochondrial control region is archived in Genbank (AY235201.1). No exact matches for this sequence were identified; however, the sequence is similar to haplotype j from LeDuc et al. 2007 (411/414 bps matched), which has been identified in a single whale sampled in the Antarctic.

*Photo-ID catalogues*. -- None

*Health assessment*. -- None

*Threats.* – None reported, but ship strikes, bycatch and seismic surveys are potential issues.

*Specimens.* – Borsa and Hoarau (2004) reported that the calavarium of the stranded whale described above was deposited in the Musee de l'histoire maritime, Noumea (MHM).

*Future research needs*. – Collection of photos for photo-id and genetic samples from whales within this region is needed. These data then need to be compared with similar data from New Zealand waters to better understand the possible link between these two regions.

*Estimate pre-exploitation abundance*. -- None

*Current abundance estimate*. -- None

*Preliminary status under IUCN*. -- No IUCN subpopulation assessment has been undertaken.

**References**


Abramson J.Z., Gibbons J. 2010. New records of blue whales Balaenoptera musculus (Linnaeus, 1758) in winter season in the inlet waters of Chiloe continental-Chile. *Anales del Instituto de la Patagonia* 38:107-109.

Aguayo L.A. 1974. Baleen whales off continental Chile. *In*: W.E. Schevill ed.) *The whale problem: A status report*. Harvard University Press, Cambridge, MA. 209-217.

Alling, A. and Payne, R. 1987. Songs of Indian Ocean blue whales, *Balaenoptera musculus*. (Unpublished) [Available from the lead author). 11pp.

Alling, A.K., Dorsey, E.M. and Gordon, J.C.D. 1991. Blue whales *Balaenoptera musculus* off the northeast coast of Sri Lanka: Distribution, feeding and individual identification. pp.247–58. In: Leatherwood, S. and Donovan, G.P. (eds). Cetaceans and Cetacean Research in the Indian Ocean Sanctuary. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.

Anderson R.C., Branch T.A., Alagiyawadu A., Baldwin R., Marsac F. 2012. Seasonal distribution, movements and taxonomic status of blue whales (*Balaenoptera musculus*) in the northern Indian Ocean. *Journal of Cetacean Research & Management* 12:203-218.

Attard C.R.M., Beheregaray L.B., Jenner C., Gill P., Jenner M., Morrice M., Bannister J., LeDuc R., Moeller L. 2010. Genetic diversity and structure of blue whales (*Balaenoptera musculus*) in Australian feeding aggregations. *Conservation Genetics* 11:2437-2441.

Attard C.R.M., Beheregaray L.B., Burton C.L.K., Jenner K.C.S., Gill P.C., Jenner M.-N., Morrice M.G., Moller L.M. 2012a. Genetic identity of blue whales (*Balaenoptera musculus*) in Geographe Bay, Western Australia: Progress report. *Paper SC/64/SH27 presented to the IWC Scientific Committee.*

Attard C.R.M., Beheregaray L.B., Jenner K.C.S., Gill P.C., Jenner M.-N., Morrice M.G., Robertson K.M., Moeller L.M. 2012b. Hybridization of Southern Hemisphere blue whale subspecies and a sympatric area off Antarctica: impacts of whaling or climate

change? *Molecular Ecology* 21:5715-5727.

Ballance L.T., Anderson R.C., Pitman R.L., Stafford K., Shaan A., Waheed Z., and R. L. Brownell Jr. 2001. Cetacean sightings around the Republic of the Maldives, April 1998. *Journal of Cetacean Research and Management* 3(2):213-218.

Bannister, J.L. and Grindley, J.R. 1966. Notes on *Balaenophilus unisetus* and its occurrence in the Southern Hemisphere. (Copepoda, Harpacticoida). Crustaceana, 10(3):296-302.

Barthelmess K. 2010. Die Gegner der" Olympic Challenger" Wie amerikanische Geheimdienste, Norweger und Deutsche das Walfangabenteuer des Aristoteles Onassis beendeten (Rivals of the" Olympic Challenger" How secret services, Norwegian and German institutions terminated the whaling activities of Aristoteles Onassis). *Polarforschung* 79:155-176.

Best P., Rademeyer R., Burton C., Ljungblad D., Sekiguchi K., Shimada H., Thiele D., Reeb D., Butterworth D. 2003. The abundance of blue whales on the Madagascar Plateau, December 1996. *Journal of Cetacean Research and Management* 5:253-260.

Borsa P. 2006. Marine mammal strandings in the New Caledonia region, Southwest Pacific. *C. R. Biol.* 329:277-288.

Borsa P., Hoarau G. 2004. A pygmy blue whale (Cetacea: Balaenopteridae) in the inshore waters of New Caldonia. *Pacific Science* 58:579-584.

Branch T.A., Allison C., Mikhalev Y.A., Tormosov D., Brownell Jr R.L. 2008. Historical catch series for Antarctic and pygmy blue whales. *Paper SC/60/SH9 presented to the International Whaling Commission Scientific Committee*.

Branch TA, et al. 2007a. Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. Mammal Review 37:116-175.

Branch TA, et al. 2007b. Separating southern blue whale subspecies based on length frequencies of sexually mature females. Marine Mammal Science 23:803-833.

Branch T.A., Zerbini A.N., Findlay K.P. 2007c. Abundance of blue whales off Chile from the 1997/98 SOWER survey. *Paper SC/59/SH8 presented to the International Whaling Commission Scientific Committee*.

Branch TA, YA Mikhalev and H Kato. 2009. Separating pygmy and Antarctic blue whales using long-forgotten ovarian data. *Marine Mammal Science* 25:833-854.

Brownell, R. L., Jr. 1999. Japanese and Soviet exploitation of pygmy blue whales. IBI Reports 5:25-29.

Brownell Jr R.L., Carlson C.A., Galletti Vernazzani B., Cabrera E. 2008. Skin lesions on blue whales off southern Chile. *Paper SC/60/SH25 presented to the International Whaling Commission Scientific Committee*. 7 pp.

Brownell, R. L., Jr., Cabrera, E., and Galletti Varnazzani, B. 2014. Dead blue whale in Puerto Montt, Chile: Another case of ship collision mortality. Paper SC/65b/HIM8 presented to the IWC Scientific Committee Bled, Slovenia, May 2014.

Buchan S.J., Rendell L.E., Hucke-Gaete R. 2010. Preliminary recordings of blue whale (*Balaenoptera musculus*) vocalizations in the Gulf of Corcovado, northern Patagonia, Chile. *Marine Mammal Science* 26:451-459.

Buchan S. J., Hucke-Gaete R., Rendell L., Stafford K. M. 2014. A new song recorded from blue whales in the Corcovado Gulf, Southern Chile, and an acoustic link to the Eastern Tropical Pacific. Endangered Species Research 23:241-252

Burmeister 1871, G. [Del Ano 1871] Boletin del Museo Publico de Buenos Aires2: 11-20.

Cabrera E., Carlson C., Galletti Vernazzani B. 2005. Presence of blue whale (*Balaenoptera musculus*) in the northwestern coast of Chiloé Island, southern Chile. *Latin American Journal of Aquatic Mammals* 4:73-74.

Cerchio S., Collins T., Mashburn S., Clark C.W., Rosenbaum H. 2010. Acoustic evidence of blue whales and other baleen whale vocalizations off northern Angola. *Paper SC/62/SH13 presented to the International Whaling Commission Scientific Committee*.

Cummings, W. C. and Thompson, P. D. 1971. Underwater sounds from the blue whale, *Balaenoptera musculus*. *Journal Acoustic Society America* 50:1193.

Dalla Rosa L., Secchi E.R. 1997. Stranding of a blue whale (*Balaenoptera musculus*) in southern Brazil: 'True' or pygmy? *Report of the International Whaling Commission* 47:425-430.

de Vos A., Wu T., Brownell Jr R.L. 2013. Recent blue whale deaths due to ship strikes around Sri Lanka. *Paper SC/65a/HIM03 presented to the International Whaling Commission Scientific Committee.* 8 pp.

de Vos A., Pattiaratchi C.B., Harcourt R.G. 2014. Inter-annual variability in blue whale distribution off southern Sri Lanka between 2011 and 2012. *Journal of Marine Science and Engineering* 2:534-550.

Double M.C., Andrews-Goff V., Jenner K.C.S., Jenner M.-N., Laverick S.M., Branch T.A.,

Gales N.J. 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as Revealed by Satellite Telemetry. *Plos One* 9.

Ferreira M.V., Tartari S.C. 1965. Observacoes sobre a temporada baleeira de 1965 ao largo do litoral nordestino. *B. Est. Pesca* 5:28-40 [In Portuguese].

Figueiredo I., Weir C.R. 2014. Blue whales *Balaenoptera musculus* off Angola: recent sightings and evaluation of whaling data. *African Journal of Marine Science* 36:269-278.

Findlay, K., Pitman, R., Tsurui, T., Sakai, K., Ensor, P., Iwakami, H., Ljungblad, D., Shimada, H., Thiele, D., Van Waerebeek, K., Hucke- Gaete, R. and Sanino-Vattier, G.P. 1998. 1997/1998 IWC-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) blue whale cruise, Chile. Paper SC/50/Rep2 presented to the IWC Scientific Committee (unpublished). 40pp. [Available from the IWC office].

Försterra G., Häussermann V. 2012. Report on blue whales sightings (*Balaenoptera musculus* Linnaeus, 1758) in a narrow fjord during autumn-winter in southern Chile. *SPIXIANA* 35:237-245.

Frank S.D., Ferris A.N. 2011. Analysis and localization of blue whale vocalizations in the Solomon Sea using waveform amplitude data. *Journal of the Acoustical Society of America* 130:731-736.

Gales, N., Double, M.C., Robinson, S., Jenner, C., Jenner, M., King, E., Gedamke, J., Childerhouse, S. and Paton, D. 2010 Satellite tracking of Australian humpback (*Megaptera novaeangliae*) and pygmy blue whales (*Balaenoptera musculus brevicauda*). Paper SC/62/SH21 presented to the IWC Scientific Committee.

Galletti Vernazzani B., Cabrera E. 2011. Long term mark-recapture of blue whales in Chilean Waters. *Paper SC/63/SH8 presented to the IWC Scientific Committee.* 10 pp.

Galletti Vernazzani B., Carlson C.A., Cabrera E., Brownell Jr R.L. 2008. Status of blue whales off Isla de Chiloe, Chile, during 2008 field season. *Paper SC/60/SH24 presented to the IWC Scientific Committee*. 9 pp.

Galletti Vernazzani, B., Carlson, C., Cabrera, E. and Brownell Jr., R.L. 2012a. Chilean blue whales off Isla Grande de Chiloe, 2004-2010: distribution, site-fidelity and behaviour. *Journal of Cetacean Research and Management* 12(3): 353–360.

Galletti Vernazzani, B., Brownell, Jr., R.L, Cabrera, E., Carlson, C.A. and Sironi, M. 2012b. Update on 2012 blue whale field season in Chile. Paper SC/64/SH18 presented to the IWC Scientific Committee, June 2012 (unpublished). 8pp. [Available from the IWC office]

Galletti Vernazzani, B. and Olson, P. 2013. Progress on Southern Hemisphere Blue Whale Catalogue. Paper SC/65a/SH23 presented to the IWC Scientific Committee, June 2013 (unpublished). 5pp. [Available from the authors].

Galletti Vernazzani, B., Jackson, J. A., Cabrera, E., Carlson, C., Brownell, Jr., R.L. Jr. 2015. Estimates of Chilean blue whale abundance and trends by mark-recapture. Paper SC/66a/SHxx presented to the IWC Scientific Committee, May 2015 (unpublished). 16 pp. [Available from the authors].

Gambell, R.G. 1964. A pygmy blue whale at Durban. *Norsk Hvalfangst-Tidende* 53:66-68.

Garrigue C., Clua C.E., Breitenstein D. 2003. Identification of a juvenile pygmy blue whale (*Balaenoptera musculus brevicauda*) in New Caledonia, South-west Pacific. *Paper SC/55/SH4 presented to the IWC Scientific Committee*.

Gavrilov A.N., McCauley R.D. 2013. Acoustic detection and long-term monitoring of pygmy blue whales over the continental slope in southwest Australia. *Journal of the Acoustical Society of America* 134:2505-2513.

Gedamke J., Gales N., Hildebrand J., Wiggins S. 2007. Seasonal occurrence of low frequency whale vocalisations across eastern Antarctic and southern Australian waters, February 2004 to February 2007. *Paper SC/59/SH5 presented to the International Whaling Commission*.

Gedamke J., Robinson S.M. 2010. Acoustic survey for marine mammal occurrence and distribution off East Antarctica (30-80 degrees E) in January-February 2006. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 57:968-981.

Gill PC. 2002. A blue whale (*Balaenoptera musculus*) feeding ground in a southern Australia coastal upwelling zone. *Journal of Cetacean Research and Management* 4:179-184.

Gill, P. C. 2004. Ecological linkages in the Bonney Upwelling blue whale feeding area. Ph.D. thesis, School of Ecology and Environment, Deakin University, Warrnambool, Victoria 3280.

Gill P.C., Morrice M.G., Page B., Pirzl R., Levings A.H., Coyne M. 2011. Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. *Marine Ecology Progress Series* 421:243-263.

Gore M.A., Kiani M.S., Ahmad E., Hussain B., Ormond R.F., Siddiqui J., Waqas U., Culloch R. 2012. Occurrence of whales and dolphins in Pakistan with reference to fishers' knowledge and impacts. *Journal of Cetacean Research and Management* 12:235-247.

Goto, M., Nagatome, I. and Shimada, H. 1995. Cruise report of the cetacean sighting survey in

waters off the Solomon Islands in 1994. Paper SC/47/SH12 presented to the IWC Scientific Committee.

Hucke-Gaete R, LP Osman, CA Moreno, KP Findlay & DK Ljungblad. 2004. Discovery of a blue whale feeding and nursing ground in southern Chile. *Proceedings of the Royal Society of London Series B (Suppl.) Biology Letters* 271: S170–S173.

Hucke-Gaete R., Mate B. 2005. Feeding season movements and fall migration to wintering areas for Chilean blue whales. Abstract presented at the16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA, 12 – 16 December 2005.

Ichihara, T. 1961. Blue whales in the waters around Kerguelen Island. *Norsk Hvalfangst-Tidende* 50(1):1-20.

Ichihara, T. 1963. Identification of the pigmy blue whale in the Antarctic. *Norsk Hvalfangst-Tidende* 52(6):128-130.

Ichihara, T. 1966. The pygmy blue whale, *Balaenoptera musculus brevicauda*, a new subspecies from the Antarctic. Pages 79-111 *in* K. S. Norris, editor. Whales, dolphins, and porpoises. University of California Press, Berkeley and Los Angeles.

Ichihara T and Doi T. 1964. Stock assessment of pigmy blue whales in the Antarctic. Norsk Hvalfangst-tidende 6:145-167.

IWC 1996. Report of the Scientific Committee. Report of the International Whaling Commission. 46:49-236.

Jayasankar P., Krishnan A.A., Rajagopalan M., Krishnakumar P.K. 2007. A note on observations on cetaceans in the western Indian sector of the Southern Ocean (20-56 degrees S and 45-57 30'E), January to March 2004. *Journal of Cetacean Research and Management* 9:263-267.

Jenner, C., Jenner, M., Burton, C., Sturrock, V., Salgado Kent, C., Morrice, M., Attard, C., Möller, L. And Double, M. 2008. Mark recapture analysis of Pygmy Blue Whales from the Perth Canyon, Western Australia 2000-2005. Paper SC/60/SH16 presented to the IWC Scientific Committee, June 2008 (unpublished). 9pp. [Available from IWC]

Kato H., Miyashita T., Shimada H. 1995. Segregation of the two sub-species of the blue whale in the Southern Hemisphere. *Report of the International Whaling Commission* 45:273-283.

Kato H., Honno Y., Yoshida H., Kojima E., Nomura A., Okamura H. 2002. Further developments on morphological and behavioural key for sub-species discrimination of Souterm dn bleu whales, analyses from data through 1995/96 to 2001/02 SOWER cruises. *Paper SC/54/IA08 presented to the International Whaling Commission's*

*Scientific Committee.*

Kibblewhite A.C., Denham R.N., Barnes D.J. 1967. Unusual low frequency signals observed in New Zealand waters. *Journal of the Acoustical Society of America* 41:644-655.

LeDuc R.G., Dizon A.E., Goto M., Pastene L.A., Kato H., Nishiwaki S., LeDuc C., Brownell Jr. R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales and the use of assignment test to detect mixing on the feeding grounds. *Journal of Cetacean Research and Management* 9:73-80.

Ljungblad D.K., Clark C.W., Shimada H. 1998. A comparison of sounds attributed to pygmy blue whales (*Balaenoptera musculus brevicauda*) recorded south of the Madagascar Plateau and those attributed to 'True' blue whales (*Balaenoptera musculus*) recorded off Antarctica. *Report of the International Whaling Commission* 48:439-442.

Mackintosh, N. A. 1942. The southern stocks of whalebone whales. Discovery Reports 22:197-300.

McCauley R.D., Jenner C., Bannister J.L., Burton C.L.K., Cato D.H., Duncan A. 2001. Blue whale calling in the Rottnest Trench – 2000, Western Australia. Report available at http://www.curtin.edu.au.

McDonald M.A. 2006. An acoustic survey of baleen whales off Great Barrier Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 40:519-529.

McDonald M.A., Mesnick S.L., Hildebrand J.A. 2006. Biogeographic characterisation of blue whale song worldwide : using song to identify populations. *Journal of Cetacean Research and Management* 8:55-65.

Mikhalev Y.A. 1997. Additional information about the catches of Soviet whaling fleet Sovetskaya Ukraina. *Report of the International Whaling Commission* 47:147-150.

Mikhalev Y. 2000. Whaling in the Arabian Sea by the whaling fleets Slava and Sovetskaya Ukraina. *Soviet Whaling Data (1949-1979)*:141-181.

Miller B.S., Collins K., Barlow J., Calderan S., Leaper R., McDonald M., Ensor P., Olson P.A., Olavarria C., Double M.C. 2014. Blue whale vocalizations recorded around New Zealand: 1964-2013. *Journal of the Acoustical Society of America* 135:1616-1623.

Ohsumi, S. and Shigemune, H. 1993. A sightings survey of larger whales in lower latitudinal waters of the Pacific, with special reference to the blue whale. Document Blue/WP6 presented to the ad hoc Steering Group Intersessional meeting on research related to conservation of large baleen whales –blue whales- in the Southern Ocean, Tokyo October 1993, 8 pp.

Olson, P.A. Ensor, P. Olavarria, C., Bott, N., Constantine, R., Weir, J. Childerhouse, S., van der Linde, M., Schmitt, N., Miller, B.S. and Michael C. Double. *In Press.* New Zealand blue whales: residency, morphology, and feeding behavior of a little-known population. Pacific Science.

Omura, H. 1984. Measurements of body proportions of the pygmy blue whale, left by the late Dr Tadayoshi Ichihara. The Scientific Reports of the Whales Research Institute. 35:199-203.

Omura, H., T. Ichihara, and T. Kasuya. 1970. Osteology of pygmy blue whale with additional information on external and other characteristics. The Scientific Reports of the Whales Research Institute 22:1-28 + 5 plts.

Paiva M.P. 1961. Recursos basicos da pesca maritima no nordeste brasileiro. *Bol Est Biol Mar Univ Ceara* 3:1-10.

Paiva M.P., Grangeiro B.F. 1970. Investigations on the whaling seasons 1964-1967, off the northeastern coast of Brazil. *Arquivos de Ciencias do Mar* 10:111-126.

Pangerc, T. 2010. Baleen whale acoustic presence around South Georgia. Ph.D. thesis, University of East Anglia, Norwich, 241 pp.

Pinedo, M. C., Weber Rosas, F. C. and Marmontel, M. 1992. Cetaceos e pinipedes do Brasil. Manaus, UNEP/FUA, 213 p.

Praderi, R. 1985. Notas sobre un varamiento de *Balaenoptera musculus* Linnaeus, 1758. (Cetacea, Balaenopteridae) en la costa de Colonia, Uruguay. Boletin de la Sociedad Zoológica Del Uruguay, 2a. Época, 3,16–21. [In Spanish].

Recalde-Salas A., Kent C.P.S., Parsons M.J.G., Marley S.A., McCauley R.D. 2014. Non-song vocalizations of pygmy blue whales in Geographe Bay, Western Australia. *Journal of the Acoustical Society of America* 135:EL213-EL218.

Reeves R.R., South Pacific Regional Environment P., South Pacific Biodiversity Conservation P. 1999. *Marine mammals in the area served by the South Pacific Regional Environment Programme (SPREP)*. South Pacific Regional Environment Programme, [Apia, Samoa]. viii, 48 p.

Rennie S., Hanson C.E., McCauley R.D., Pattiaratchi C., Burton C., Bannister J., Jenner C., Jenner M.-N. 2009. Physical properties and processes in the Perth Canyon, Western Australia: links to water column production and seasonal pygmy blue whale abundance. *Journal of Marine Systems* 77:21-44.

Rudolph P., Smeenk C., Leatherwood S. 1997. Preliminary checklist of Cetacea in the Indonesian archipelago and adjacent waters. *Zoologische Verhandelingen Leiden* 312:3-48.

Samaran F., Adam O., Guinet C. 2010. Discovery of a mid-latitude sympatric area for two Southern Hemisphere blue whale subspecies. *Endangered Species Research* 12:157-165.

Samaran F., Stafford K.M., Branch T.A., Gedamke J., Royer J.-Y., Dziak R.P., Guinet C. 2013. Seasonal and Geographic Variation of Southern Blue Whale Subspecies in the Indian Ocean. *Plos One* 8.

Shimanda, H. and Pastene, L. 1995. Report of a sighting survey off the Solomon Islands with comments on Bryde's whale distribution. Report of the International Whaling Commission 45:413-418.

Sremba A. 2011. A whale's tale of mtDNA diversity and differentiation: The Antarctic blue whale. M.S. thesis, Oregon State University. 160 pp.

Stafford K.M. 2003. Two types of blue whale calls recorded in the Gulf of Alaska. *Marine Mammal Science* 19:682-693.

Stafford K.M., Nieukirk S.L., Fox C.G. 1999. Low-frequency whale sounds recorded on hydrophones moored in the eastern tropical Pacific. *Journal of the Acoustical Society of America* 106:3687-3698.

Stafford K.M., Nieukirk S.L., Fox C.G. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. *Journal of Cetacean Research and Management* 3:65-76.

Stafford K.M., Chapp E., Bohnenstiel D.R., Tolstoy M. 2011. Seasonal detection of three types of "pygmy" blue whale calls in the Indian Ocean. *Marine Mammal Science* 27:828-840.

Torres L.G. 2013. Evidence for an unrecognised blue whale foraging ground in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 47:235-248.

Torres L., Gill P., Hamner R., Glasgow D. 2014. Documentation of a blue whale foraging ground in the South Taranaki Bight, New Zealand. *Paper SC/65b/SH02 presented to the IWC Scientific Committee*.

Torres-Florez J.P., Hucke-Gaete R., Rosenbaum H., Figueroa C.C. 2014a. High genetic diversity in a small population: the case of Chilean blue whales. *Ecology and Evolution* 4:1398-1412.

Torres-Florez J.P., Hucke-Gaete R., LeDuc R., Lang A.R., Taylor B.L., Pimper L.E., Bedrinana-Romano L., Rosenbaum H., Figueroa C.C. 2014b. Blue whale population structure along the eastern south Pacific Ocean: Evidence of more than one population. *Molecular Ecology* 23:5998-6010.

Torres-Florez,J. P., Olson, P. A., Bedrinana-Romano, L. Rosenbaum, H. C. Ruiz, X. LeDuc, R. Hucke-Gaete, R. *In Press.* First documented migratory destination for SE Pacific blue whales, Marine Mammal Science.

Watkins W.A., Daher M.A., Reppucci G.M., George J.E., Martin D.L., DiMarzio N.A., Gannon D. 2000. Seasonality and distribution of whale calls in the North Pacific. *Oceanography* 13:62-67.

Williams, R., Hedley, S., Branch, T. A., Bravington, M., Zerbini, A. N., and Findlay, K. 2011. Chilean blue whales as a case study to illustrate methods to estimate abundance and evaluate conservation status of rare species. *Conservation. Biology* 25(3): 526–535.

Williamson, G. R. 1975. Minke whales off Brazil. The Scientific Reports of the Whales Research Institute, Tokyo 27:37-59.

Zemsky V.A., Sashinov E.G. 1982. Distribution and current abundance of pygmy blue whales. Pages 53-70 in *Marine mammals: Collected papers [Translated as SWFSC Administrative Report LJ-94-02, 17 pp.]*.