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ABSTRACT

During the RV Polarstern PS 89 (ANT-XXX/2) expedition from Cape Town to Atka Bay and back, 20 sightings of 26 individual blue whales (*Balaenoptera musculus*) were recorded in Antarctic waters west of the Greenwich Meridian between 16-20 January 2015. These observations suggest a more westerly extension of a reported hot spot between the Greenwich Meridian and 20°E.

KEYWORDS: ANTARCTIC, BLUE WHALE, SHIP-BASED SURVEY, OPPORTUNISTIC DATA

INTRODUCTION

Three subspecies of blue whale (*Balaenoptera musculus*) are recognized; the Northern blue whale (*B.m.musculus*) inhabits the Northern hemisphere, while the Antarctic blue whale (*B.m.intermedia*) and the pygmy blue whale (*B.m.brevicauda*) occur in the Southern Hemisphere (Rice, 1998). Both subspecies differ acoustically (Ljungblad et al., 1998) and show slight differences in morphology (Attard et al., 2012; Branch et al., 2007a, Omura et al., 1970). The Pygmy blue whale is distributed in lower latitudes and occurs mainly in the southern Indian Ocean and the south-western Pacific Ocean (Rice, 1998). Antarctic blue whales are known to have a circumpolar distribution in Antarctic waters during austral summer and early autumn (e.g., Branch et al., 2007b). Contrasting with traditional migration hypotheses, the year-round presence of Antarctic blue whales in Antarctic waters south of 55°S was revealed by acoustic detections off the western Antarctic Peninsula (Sirovic et al., 2009), in the southern Indian Ocean (Samaran et al., 2010, 2013) and in eastern Antarctica (Gedamke et al., 2007; Sirovic et al., 2009). To estimate population sizes of Antarctic blue whales annual sighting surveys compiling three circumpolar cruises were conducted under the auspices of the IWC's International Decade of Cetacean Research (IDCR) and Southern Ocean Whale Ecosystem Research (SOWER) programmes in 1978/79-1983/84, 1985/86-1991/92 and 1991/92-2003/04 (Branch et al., 2007b; Branch & Butterworth, 2001). Despite the enormous effort of these surveys, information on the abundance and distribution of blue whales in Antarctic waters remains scarce due to the species reduced density caused by commercial whaling as well as the area's remoteness. In this paper we document a series of sightings of blue whales in the Antarctic waters west of the Greenwich meridian made on board the multidisciplinary

expedition by the German research vessel Polarstern (PS 89 ANT-XXX/2) following Cape Town-Atka Bay-Cape Town in December 2014-February 2015.

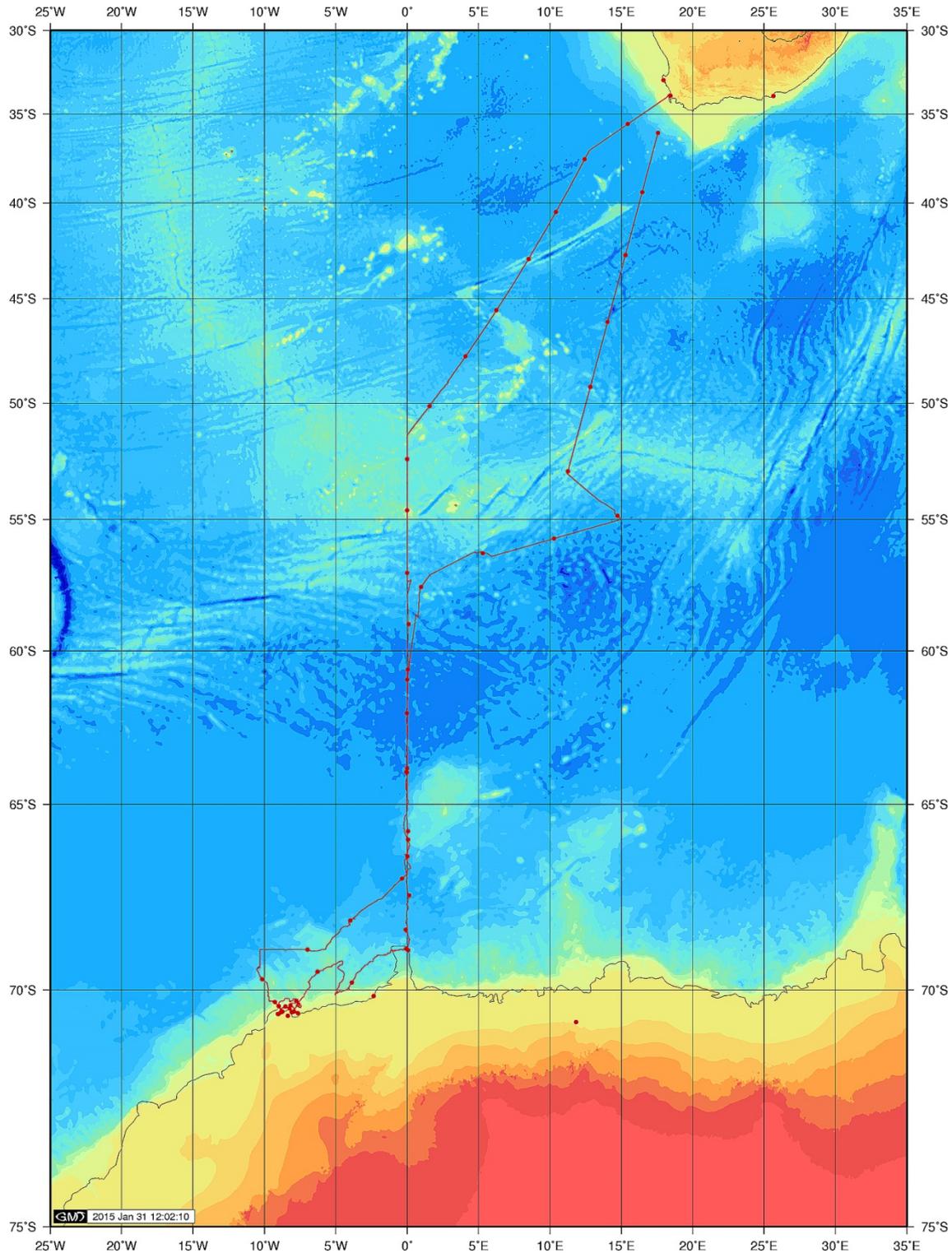


Figure 1. Cruise track from RV Polarstern during PS 89 (ANT-XXX/2) expedition Cape Town-Atka Bay-Cape Town, 2 December 2014 – 1 February 2015. Dots represent sampling stations, moorings and deployment sites for oceanographic research.

METHODS

During PS 89 (ANT-XXX/2) expedition on board RV Polarstern from Cape Town to Atka Bay, located off the Ekström ice shelf in the Weddell Sea, and back (2 Dec 2014-1 Feb 2015, Fig 1), marine mammals were recorded by three different teams from different platforms, as well as opportunistically, adding up to 5 different sources for collected marine mammal sightings: 1) dedicated marine mammal survey using line transect distance sampling from the crow's nest, 2) dedicated marine mammal survey using line transect distance sampling from a helicopter, 3) dedicated top predator (birds and marine mammals) strip transect survey from the monkey deck, 4) non-dedicated observations from the bridge, and 5) non-dedicated opportunistic observations.

Platforms 1-3 use standardized methods during survey effort. Platform 1-2 use line-transect distance sampling. The track from the crow's nest 29.5 meters above sea level was linked to the ship course, whereas the helicopter survey design was created ad hoc depending on weather and ice conditions. On both platforms two independent observers searched for and collected data on marine mammals along the track line using the naked eye. In the crow's nest binoculars were used to aid identification. Sighting details such as date, time, species, number and behaviour were recorded. If possible pictures were taken to document observations of scarce species and help with species ID. Coordinates were directly recorded by means of a handheld GPS connected to a computer running the sightings recording software VOR (Hiby & Lovell, 1998). Additional information (cue, distance perpendicular to the transect line, sighting conditions, environmental data) was recorded by a third person acting as data recorder.

Line-transect surveys of top predators were made from open observation posts installed on the monkey deck. Standard strip band transect methods are used, with snapshot methodology for birds in flight, and additional distance sampling line-transect methods for marine mammals. One observer searched for and collected data on seabirds and marine mammals along the track line using the naked eye. Binoculars were used to aid identification. Sighting details such as date, time, species, number and behaviour, and environmental data were recorded. If possible pictures were taken to document observations of scarce species and help with species ID. Coordinates were directly recorded by means of a handheld GPS. The surveyed bandwidth was 300 m, that is 150 m to both sides. Marine mammals outside the surveyed bandwidth were recorded as well. The angle and distance from the ship were measured additionally to calculate the perpendicular distance to the transect line.

From the non-dedicated platforms 4 and 5 opportunistic observations were made. Observers searched for animals with the naked eye or with binoculars. Date, time, species, number and behaviour were recorded. If possible pictures were taken to document observations of scarce species. Coordinates were either directly recorded or derived from the observation time. Additional information on sighting and other environmental conditions was collected on an ad-hoc basis. The number of observers for the non-dedicated platforms 4 and 5 varied between one and five; observations from the bridge were primarily collected by the bridge officers. Other cruise participants and observers that were off effort from their dedicated surveys made all non-dedicated observations on platform 5.

Observation effort varied per day and is impossible to quantify for the non-dedicated observations. Especially the effort from the bridge is non-homogenous, since officers are primarily tasked with other duties and collect sighting data in addition to other tasks. During the time period 16-20 January dedicated survey effort amounted to a total of 7.9 hrs from the crow's nest and 51.5 hrs from the monkey deck (table 1). Helicopter-based surveys were not

conducted. All surveys from the crow's nest were conducted simultaneously with the observations from the monkey deck.

Table 1. Observation effort per platform, 16-20 January 2015. No helicopter surveys (2) were conducted. Effort from the bridge (4) and from non-dedicated opportunistic observations (5) cannot be quantified.

<i>Date</i>	<i>Effort (hrs)</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
<i>16-1-2015</i>	3.2	-	11.8	NA	NA
<i>17-1-2015</i>	1.7	-	12.3	NA	NA
<i>18-1-2015</i>	-	-	6.2	NA	NA
<i>19-1-2015</i>	-	-	11.3	NA	NA
<i>20-1-2015</i>	2.7	-	9.8	NA	NA
<i>Total</i>	7.9	-	51.5	NA	NA

Sightings were validated and checked for double counts by the authors. Only sightings that were documented with pictures or that were based on a combination of several distinctive characteristics (e.g. surfacing pattern, colouration, shape and size of dorsal fin) were qualified as certain blue whale. Other sightings were qualified as uncertain blue whale or no blue whale. Double counts were excluded by comparing times, and other collected sighting data (e.g. group size, distance to the ship, swim direction). Communication between the observers shortly after sightings were made filtered out most double counts. In case of doubt only one sighting was entered in the database.

Weather and sighting conditions ranged from very poor to excellent, with strong winds and heavy snowfall on 17-18 January 2015. Those days observations were carried out under very poor sighting conditions. The weather and ice conditions made some alterations to the proposed ship track necessary and did not permit helicopter surveys.

RESULTS AND DISCUSSION

From 16-20 January 2015, 20 unique sightings of 26 blue whales were made (table 2, fig 2). Despite survey effort no blue whales were seen outside this period. The majority of the sightings was made during non-dedicated opportunistic observations ($n = 14$). No calves were observed. Most sightings were of single animals, but some groups of two individuals were recorded. The average group size was 1.3 animals. Sightings were unevenly distributed with two 'concentrations'; north of the ice edge around 69°S (16 Jan 2015, 12 individuals and along the north-western slope of the Lichtner Seamount (18 Jan 2015, 7 individuals). It should be noted, however, that the sighting conditions on 17-18 January were poor.

Though information on the subspecies-level of the sighted individuals could not be ascertained in the field we assume all animals were Antarctic blue whales. This is supported by an observed geographic variation of the subspecies with Antarctic blue whales mainly occurring in high-latitude waters south of 55°S during summer (Kato et al., 1995). In contrast, pygmy blue whales were rarely sighted south of 55°S (Kato et al., 1995), therefore, it seems reasonable to assume that most of the blue whale sightings in high-latitude water represent Antarctic blue whales. Further evidence is provided by studies reporting acoustic presence of Antarctic blue whales all around Antarctica during austral summer (Gedamke et al., 2007, 2010; Ljungblad et al., 1998; Rankin et al., 2005; Sirovic et al., 2004, 2009).

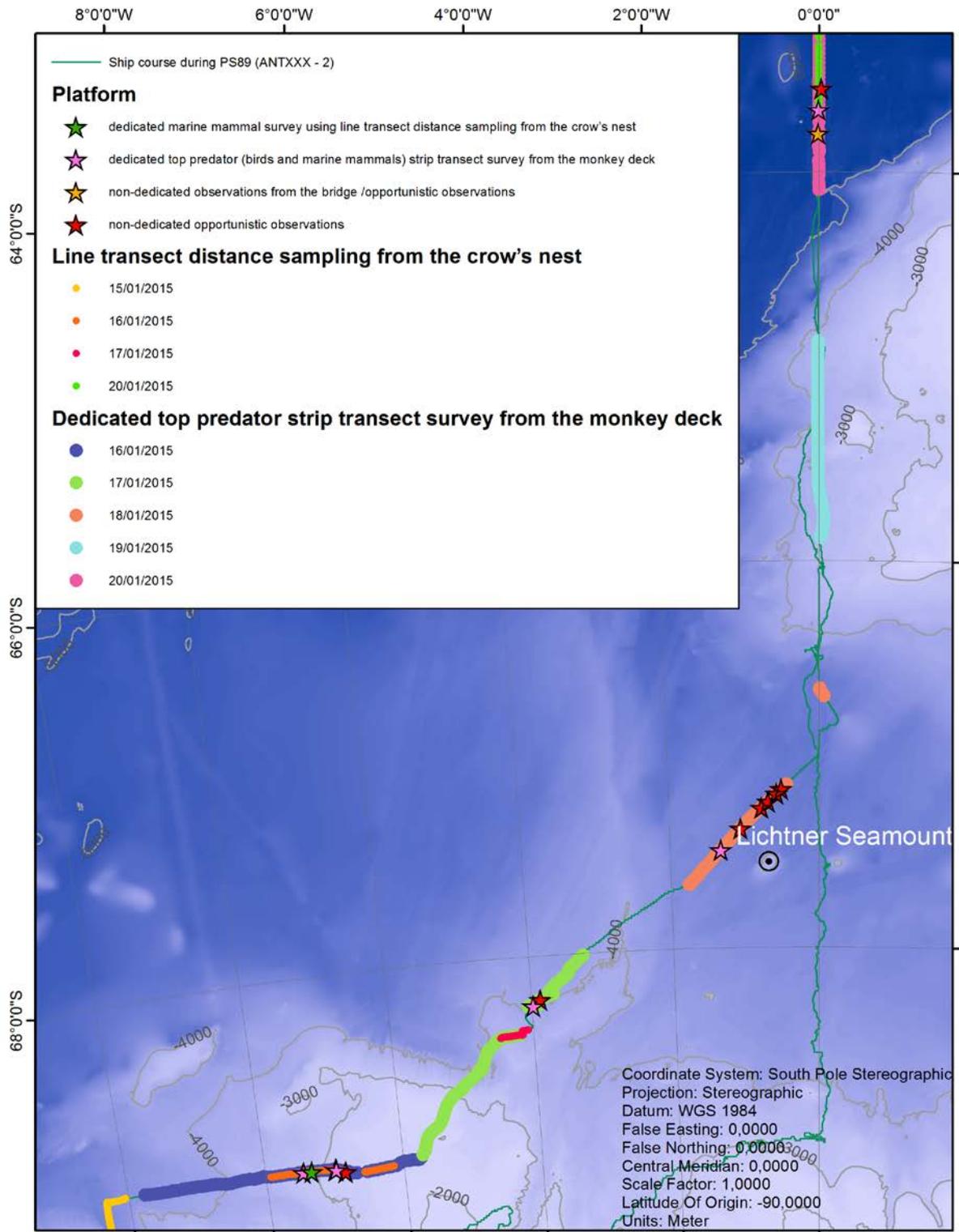


Figure 2. Blue whale sightings in Antarctica west of the Greenwich meridian, during the PS89 (ANT XXX-2) expedition, 16-20 January 2015.

Table 2. Blue whale sightings in Antarctica west of the Greenwich meridian, 16-20 January 2015. Platform numbers refer to 1) dedicated marine mammal survey using line transect distance sampling from the crow's nest, 2) dedicated marine mammal survey using line transect distance sampling from a helicopter, 3) dedicated top predator (birds and marine mammals) strip transect survey from the Monkey Island, 4) non-dedicated observations from the bridge, and 5) non-dedicated opportunistic observations.

<i>Date</i>	<i>Time</i>	<i>Number</i>	<i>Lon (W)</i>	<i>Lat (S)</i>	<i>Platform</i>
16-1-2015	5:40	1	7.449	69.0016	3
16-1-2015	5:57	1	7.33249	69.0031	1
16-1-2015	6:53	2	6.98731	69.0062	5
16-1-2015	6:57	1	6.98731	69.0062	5
16-1-2015	7:32	1	6.98731	69.0062	5
16-1-2015	9:00	2	6.98731	69.0062	5
16-1-2015	14:40	2	6.9767	69.0074	3
16-1-2015	16:26	2	6.8453	69.023	5
16-1-2015	17:17	1	6.8453	69.023	5
17-1-2015	14:30	1	3.9793	68.2567	3
17-1-2015	15:32	1	3.8758	68.2251	5
18-1-2015	8:00	1	1.3147	67.4888	3
18-1-2015	9:05	1	1.0473	67.3798	5
18-1-2015	10:19	1	0.7638	67.273	5
18-1-2015	10:40	1	0.6760	67.2417	5
18-1-2015	11:08	2	0.5602	67.2004	5
18-1-2015	11:24	1	0.4965	67.1778	5
20-1-2015	15:03	2	0.0050	63.8	4 & 5
20-1-2015	16:30	1	0.0001	63.6795	3
20-1-2015	17:16	1	0.0288	63.5708	5

Worldwide exploitation depleted the population(s) of blue whales, with Antarctic blue whales being the preferred target of commercial whaling (Branch et al., 2004). The pre-whaling population of estimated 239,000 individuals has been decimated to a minimum in 1973 (Branch et al., 2004). After implementation of protection measures, commercial whaling on blue whales was banned in the 1960's. Reported population estimates of Antarctic blue whales are based on three circumpolar surveys carried out under the auspices of the IWC's International Decade of Cetacean Research (IDCR) and Southern Ocean Whale Ecosystem Research (SOWER) programmes in 1978/79-1983/84, 1985/86-1991/92 and 1991/92-2003/04 (Branch et al, 2007b; Branch & Butterworth, 2001). These surveys were conducted south of 60°S till the ice edge and yielded population estimates of 453 (CV = 0.40), 559 (CV = 0.47) and 2,280 (CV = 0.36), respectively (Branch, 2007). Based on data from these surveys, the rate of Antarctic blue whale population increase was estimated to be 8.2% per year (95% CI 1.6-14.8%) (Branch 2007) and the minimum abundance of Antarctic blue whales to be as low as 395 (CI 235-804) in the early 1970's, less than 2% of the pre-exploitation level (Branch, 2008). At present, Antarctic blue whales are listed as 'critically endangered' by the International Union for Conservation of Nature (Reilly et al., 2013). Circumpolar SOWER surveys were not continued after the 2003/04 season and no new abundance estimates are available. The stated numbers nowadays are at least ten years out of date. For generating a new circumpolar abundance estimate of Antarctic Blue whales, today

the Antarctic Blue whale project, an international collaboration led by the Australian Antarctic Division, employs mark-recapture techniques rather than conventional sighting surveys. Over a number of seasons genetic as well as photo-ID sampling will collect data on individual blue whales around Antarctica, to ultimately contribute to a new abundance estimate. For this purpose, high encounter rates of blue whales are of utmost importance to increase the sampling size. Information on areas of high blue whale densities are thus of great interest to the project.

Highest encounter rates of blue whales (0.17-0.52 sighting/1000 km) were found close to the sea ice edge in the area between 20°W-50°E during the IWC IDCR/SOWER surveys (Branch et al., 2007b). Recently, a survey was conducted in the area 0- 20°E along zigzag transect lines from the ice edge to 67°S, within the period 13-23 January 2014 (Findlay et al., 2014). During 82 hours of dedicated survey effort covering almost 1000 nm (ca 1800 km), 14 observations of 20 blue whales were recorded, corresponding to an encounter rate of almost 0.78 sighting/1000 km. Findlay et al. (2014) concluded that the relatively high number of Antarctic blue whale individuals sighted supports previous findings by the IDCR/SOWER cruises reporting the waters from 0-to 20°E off the Queen Maud Land coast as a hotspot area for Antarctic blue whales.

Our results are well in line with the hotspot areas identified from historical whaling records, SOWER and IDCR surveys, more recent surveys and acoustic detections, but they suggest a more westerly extension of the reported hot spot between the Greenwich Meridian and 20°E (Findlay et al., 2014).

In addition to the six sightings during dedicated survey effort fourteen sightings were made during opportunistic observations. Since information on the abundance and distribution of blue whales in Antarctic waters remains scarce, opportunistically collected data can be an important additional source of information, preferably made available to the Southern Ocean Research Partnership (SORP) and the Antarctic Blue Whale Project. Photos that qualify for photo-ID purposes and have geographical information can be added to the Antarctic Blue Whale catalogue and the collection of identified individuals. Thus contributing to the ultimate goal of a new circumpolar abundance estimate. In this regard, opportunistically collected data are of the same value as data from dedicated surveys – every blue whale sighting and especially every identified individual counts.

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