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VANESA REYES REYES^{1,2*}, MARTA HEVIA^{1,2}, MILTON MARCONDES³, ALEX MARINO¹, JENNIFER S. TRICKEY⁴, FERNANDO TRUJILLO⁵, AND MIGUEL IÑÍGUEZ¹

1) *Fundación Cethus, Monteverde 3695 (B1636AEM), Olivos, Prov. Buenos Aires, Argentina*

2) *Whale and Dolphin Conservation, Brookfield House, 38 St Paul Street, Chippenham Wiltshire SN15 1LJ, UK*

3) *Instituto Baleia Jubarte - Brazil*

4) *Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla, California 92093-0205, USA*

5) *Fundación Omacha – Colombia*

*Contact e-mail address: vanesa.reyes@cethus.org

ABSTRACT

Visual surveys of cetaceans were conducted across sub-Antarctic waters of the Atlantic Ocean and Antarctic waters during austral summers from 2013 through 2016. A total of 80 sei whales were observed, split into 32 groups, of which 37.5% were in Scotia Sea, 31.3% in the southern part of the Drake Passage, 28.1% in the entrance to the Beagle Channel (BC), and 3.1% in Mar de la Flota/Bransfield Strait. Mean ER was 0.03 ± 0.13 whales/nm and did not differ significantly among areas. Sei whales were seen in a broad range of depths from about 40 to 5000m. Most sightings reported in this study occurred along 60°- 61°S in the IWC Management Area I and II. Sei whales were also observed in two consecutive years, 2015 and 2016, in a very restricted area at the entrance of the BC, where calves were observed in two opportunities. Given the very scarce information on the distribution of this species this paper should prove useful to increase knowledge on the current status of this species in the southern hemisphere.

KEYWORDS: SURVEY – VESSEL; SCOTIA SEA; WESTERN ANTARCTIC PENINSULA; BEAGLE CHANNEL; SEI WHALE; DISTRIBUTION

INTRODUCTION

Like most balaenopterids, sei whales (*Balaenoptera borealis*) are found in all oceans and migrate long distances north-south from high latitude summer feeding grounds to lower latitude winter areas. However, unlike most other balaenopterids, sei whales tend to be restricted to more temperate waters (Rice, 1998). Currently, two subspecies of sei whales are recognized, with the southern hemisphere subspecies, known as *B. b. schlegelii* (Flower, 1865), found between the subtropical convergence and the Antarctic convergence during the austral summer (Rice, 1998). From the end of XIX century and during the XX century, Southern Ocean (SO) large whales, including sei whales were prime whaling targets, leading to a decimation of their populations (Tønnessen and Johnsen, 1982). Comparison of estimates of population size in 1961/62 and 1973/74 revealed that the population of sei whales in IWC Antarctic Area II (which encompasses the area from 0° to 60°W south of 40°S) had declined to 58% of their 1961/62 levels of abundance (Chapman, 1974). Historic and current information on the distribution and abundance of sei whales in the South West Atlantic and Southern Ocean is scarce, and the extent to which this species has recovered since it gained full protection in 1979 is still uncertain (Thomas *et al.*, 2016; Leaper *et al.*, 2008; Reeves *et al.*, 2003). The aim of this paper is to report new data on the austral summer occurrence of sei whales in sub-Antarctic waters of the South West Atlantic Ocean and Antarctic waters off the north Antarctic Peninsula.

MATERIALS AND METHODS

Study site and data collection

Visual surveys of cetaceans were conducted across sub-Antarctic and Antarctic waters during austral summers from 2013 through 2016. The first survey was conducted on board the CONICET's research vessel *R/V Puerto Deseado* from the Islas Shetland del Sur/South Shetland Islands (SSI), along waters of the Scotia Sea (SS), around Islas Orcadas del Sur/South Orkney Islands (SOI) and the Drake Passage northwest to Ushuaia (54°48.52'S, 68°18.17'W) from mid-February to mid-March 2013. The second cruise onboard the Argentinean Coast Guard (PNA) vessel *GC-28 Prefecto Derbes*, and the fourth and fifth cruises onboard the PNA vessel *SB-15 Tango*, departed from Ushuaia sailing southward to the western Antarctic Peninsula and covered the Mar de la Flota/Bransfield Strait (BS) and Estrecho de Gerlache/Gerlache Strait (GS), southward to the Argentinean Antarctic base "Brown" (64°53'S, 62°53'W), and back to Ushuaia, from mid-January to

mid-February 2014, late January to mid-February 2015, and 2016, respectively. The third voyage, onboard the PNA vessel *SB-15 Tango*, covered this same area plus the SS eastward to SOI from mid-February to early March 2014. Additionally, a sixth survey onboard the PNA vessel *GC-24 Mantilla* covered waters of the Beagle Channel (BC) and Cape Horn during late February 2016.

Observations of cetaceans from the bridge and starboard sides of the vessel, ~ 7-12m above sea levels depending on the vessel, were conducted when the ship was underway during daylight hours using 7x50 reticuled Fujinon binoculars and the unaided eye. Data were collected by up to three experienced observers on species identity, group size, GPS position, vessel speed and heading, and number of reticles and animal bearing from the ship for all sightings. When more than one observer were on-duty, each observer covered one side of the vessel's trackline forward of the beam (90° quadrant). Sightings for which species identification was not possible were classified to the best taxonomic level identifiable. Photographs of the animals were taken with reflex digital cameras to assist in later species identification. Vessel speed and heading, wind speed and direction, Beaufort sea state, weather conditions and visibility were recorded at the start of each day and then updated every hour. The visual surveys were interrupted when the Beaufort scale was six or higher, in case of low visibility (e.g., due to fog, precipitation), vessel speed reduced to three knots or lower or whenever other vessel duties so required. A *passing mode* method was used during surveys, in which the vessel continued to travel along the established transect line after a group of marine mammals was seen (Dawson, 2008).

Data analysis

To study the distribution of sei whales, only the geographic areas where the species was sighted were taken into account. The following areas were considered: 1) BC; 2) SDP, as the southern portion of the Drake Passage south of 60°S and to the west of Elephant Island and SSI; 3) SS, as the area bounded on the north by the South Atlantic Ocean, on the west by the Drake Passage, and further east of the SOI up to the 31°W meridian (Fig. 1). On-effort transects surveyed during a day were divided into equal segments of 10nm whenever possible to reduce intra-variability. For each area, encounter rate (ER) (number of sighted individuals per nautical mile surveyed) of sei whales was calculated. Only data obtained during search effort was considered in the analysis. Kruskal Wallis was used to test for significant differences in ER and group

sizes among areas ($p < 0.05$). The Pearson coefficient was calculated to test the correlation between group size and depth.

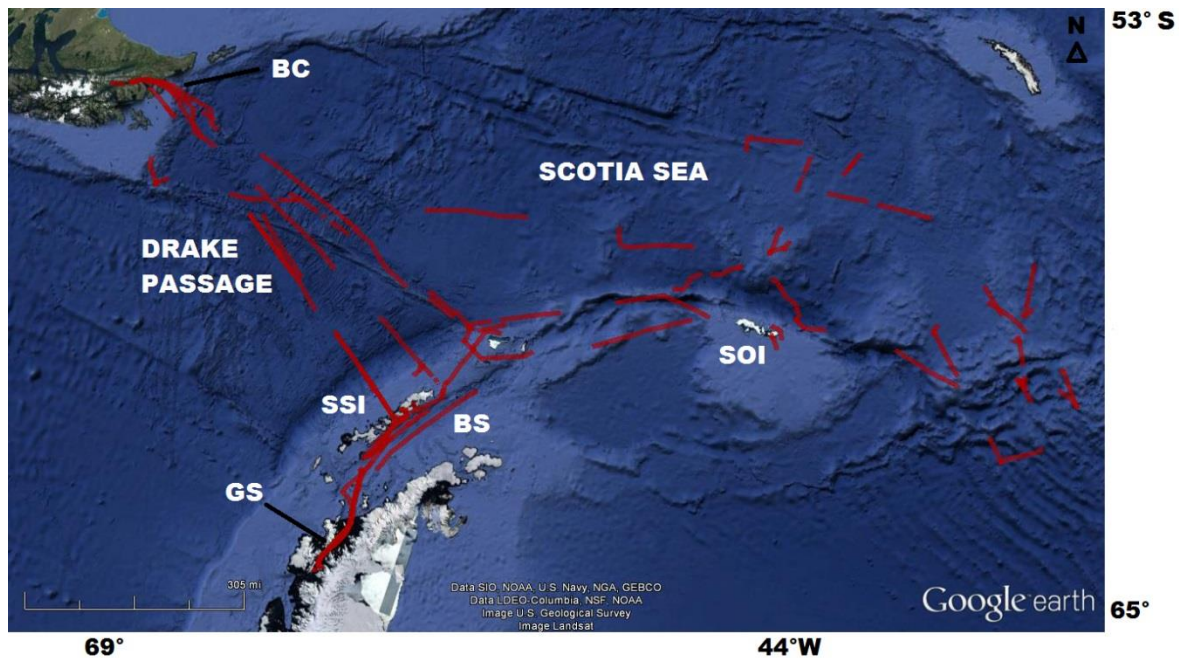


Figure 1. Total on-effort tracks of the six visual surveys conducted during austral summers from 2013-2016. BC: Beagle Channel; SSI: Islas Shetland del Sur/South Shetland Islands; GS: Estrecho de Gerlache/Gerlache Strait; BS: Mar de la Flota/Bransfield Strait; SOI: Islas Orcadas del Sur/South Orkney Islands.

RESULTS

Between the six voyages conducted in austral summers from 2013 through 2016, a total of 71 days of suitable weather conditions resulted in 5,278.7nm of survey effort. Out of 778 encounters of cetaceans, 4% corresponds to sei whales. A total of 80 sei whales were observed, split into 32 groups, of which 37.5% were in SS, 31.3% in SDP near Elephant Island and northwest Isla 25 de Mayo/King George Island (KGI), 28.1% in the entrance to the BC, and 3.1% in BS (Table 1, Fig. 2). Encounter rates ($H=0.06$, $p=0.85$) and group size ($H=4.88$, $p=0.07$) did not differ significantly among BC, SDP, and SS. Mean ER was 0.03 ± 0.13 whales/nm and median and mode group size was two individuals, ranging from 1 to 11 individuals. On only one occasion a group of 2 whales was seen in BS east of the north end of KGI ($62^{\circ}16.401'S$, $57^{\circ}2.677'W$), which represented the southernmost sighting during the present study. The largest aggregation of sei whales was observed in SS northeast SOI ($59^{\circ}43.552'S$, $44^{\circ}47.118'W$) on 10 March 2013, and consisted of a mixed

group of 11 sei whales, two humpback whales, and four fin whales. Sei whales were seen in a broad range of depths from about 40 to 5000m. No significant correlations were found between ER (Pearson coefficient=-0.09, $p=0.12$) or group size (Pearson coefficient=0.06, $p=0.73$) and depth. Groups with calves were seen only on two occasions, both in BC: one group was composed of five adults and two calves, and the other group consisted of two adults and a calf. During these surveys, no sei whales were observed in the GS.

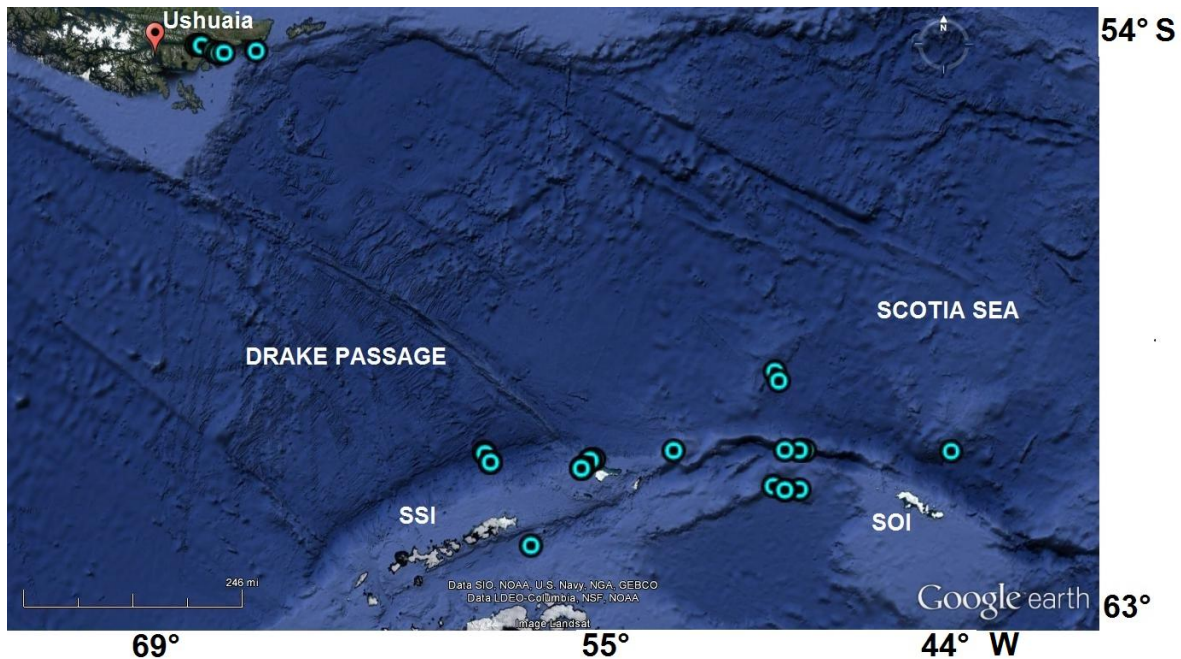


Figure 2. Locations of sei whales sightings.

DISCUSSION

Despite the increasing number of studies conducted near the Antarctic Peninsula, recordings of sei whales have been scarce. This is consistent with previous evidence that this species spends the summer months feeding in sub-polar high latitudes but does not enter higher latitudes as much as other balaenopterid whales (Horwood's 2002, Budylenko 1977, Gambell 1968). Branch and Butterworth (2001) reported relatively few sightings of sei whales south of 60° S in the IWC Management Area V, where catch data show that nearly 17,000 animals were taken between 1914 and 1977 (Leaper *et al.*, 2008). However, there is evidence of some degree of isolation of sei whales within the six IWC Management Areas (Horwood, 1987). Most sightings reported in this study occurred along 60°- 61°S in the IWC Management Area I and II. Only one group of two

animals was observed south of 62°S. No calves were observed in SS or near the Antarctic Peninsula, which is consistent with previous studies showing that only large individuals are found south of the Antarctic convergence (Lockyer, 1977). Our estimated ER of 0.02 whales/nm for the SS is consistent with estimations made by Orgeira *et al.* (2015) for the austral summer months between 2010 - 2014. The Scotia Sea receives nutrients from the Antarctic Circumpolar Current and features both high rates of primary productivity and high densities of krill in spring and summer (El-Sayed and Weber, 1982; Priddle *et al.* 1988; Hewitt *et al.* 2004; Holm-Hansen *et al.*, 2004). The SS region around Islas Georgias del Sur/South Georgia Islands (SGI) is one of the main feeding grounds for baleen whales, and before whaling it was considered to be one of the most whale-dense habitats on the planet (Harmer, 1931). Sei whales were captured from SGI mainly in March, with a few in February and April, from 1913 to 1931 (Harmer, 1931; Matthews, 1938). From 1963–1965, Gambell (1968) reported that peak catches occurred during January, with lower numbers in February and March; however, sei whales have been regularly seen during autumn months in that area (Leatherwood & Reeves, 1983). Islas Malvinas/Falkland Islands has also been reported as a feeding ground for sei whales (Iñíguez *et al.*, 2010; White *et al.*, 2002). The numbers of sei whales recorded in that area increase in November and remain high until April (White *et al.*, 2002). As the foraging season progresses from late spring through summer, relatively more whales are observed south of 40°S and abundance between 50°S and 60°S increases consistently until March (Horwood, 1987). There is evidence from marking data from whaling operations in the past that some sei whales may return to the same region of the feeding grounds year after year, but dispersal movements also occurred in other sei whales (Brown, 1977). Hart (2006) reported that sei whales were mainly found around Isla Malvinas/Falkland Islands and at SGI. However in the 1917/18 season, they were found in the Gerlache Strait when the temperature rose abnormally in February and March to 2°C. It could be hypothesized that during southward migration to feeding grounds, most of the animals stay near SGI and/or Islas Malvinas/Falkland Islands, while some adults continue further south towards the proximities of the SOI and the Antarctic Peninsula.

According to previous historic records from whaling activities, sei whales may have occurred regularly off the Argentinean coast in the past (Hart, 2002; Schwarz, 1934). There have been also some recent reports of visual sightings and strandings of this species along the Patagonian coast of Argentina (Leonardi *et al.*, 2011; Iñíguez *et al.*, 2010; Goodall *et al.*, 2007; Capozzo and Junín, 1991; Lichter and Hooper, 1983; Leatherwood

and Reeves, 1983; Hevia *pers obs*, 2016 and 2014). This study reports the presence of nine groups of sei whales observed in two consecutive years, 2015 and 2016, in the same season, and in a very restricted area at the entrance of the BC. Some of these sightings were in the presence of many seabirds around the whales, which could be indicative of the presence of fish schools. There have been some sporadic sightings of this species in the BC; however, sei whale occurrence within this area has not been extensively reported in the scientific literature. Goodall *et al.* (2007) reported that killer whales prey on dwarf minke whales (*Balaenoptera acutorostrata*) and sei whales in the BC. The presence of calves in this area seems to contradict previous studies that state that only the larger and older animals migrate far south below 50°S, with small whales only appearing in latitudes lower than 45°S (Gambell, 1968; Lockyer, 1974).

The occurrence of sei whales has been described as unpredictable, given many records of the species in some areas followed by its disappearance for many years (Best and Lockyer, 2002; Tonnesen and Johnsen, 1982). Their habitat use is unknown within this area, although the fact that there were several sightings of sei whales in the same region within a period of very few days, and also that calves were seen in this area, suggests that the waters at the entrance to the BC could have an ecological relevance for the species. Whether or not this is a recent development remains unknown, and would require further studies.

Although encounter rates of sei whales reported in this study are low, given the limited information on the distribution of this species and its seemingly erratic and highly unpredictable occurrence, this paper should prove useful for contribution to the efforts of the International Whaling Commission to increase knowledge on the current status of this species in the southern hemisphere.

Table 1. Sightings of sei whales during the present study.

No.	Date	Group size	Depth (m)	Latitude	Longitude	Area
1	21/02/2013	3	538	60° 36.445' S	53° 04.450' W	SS
2	10/03/2013	11	3255	59° 43.552' S	44° 47.118' W	SS
3	11/03/2013	2	3459	59° 19.440' S	50° 22.644' W	SS
4	11/03/2013	3	3092	59° 11.941' S	50° 32.770' W	SS
5	20/02/2014	3	2588	60° 18.340' S	49° 46.211' W	SS
6	20/02/2014	2	1476	60° 15.836' S	49° 20.625' W	SS
7	20/02/2014	2	1477	60° 15.671' S	49° 18.792' W	SS
8	20/02/2014	2	1590	60° 14.861' S	49° 10.376' W	SS
9	23/02/2014	1	1095	60° 49.843' S	49° 03.733' W	SS
10	23/02/2014	2	2482	60° 51.747' S	49° 52.820' W	SS
11	23/02/2014	5	2622	60° 52.818' S	49° 28.756' W	SS
12	23/02/2014	1	2670	60° 53.149' S	49° 30.337' W	SS
13	24/02/2014	2	200	60° 53.728' S	55° 24.855' W	SDP
14	24/02/2014	2	117	60° 54.741' S	55° 30.805' W	SDP
15	24/02/2014	3	106	60° 55.191' S	55° 31.779' W	SDP
16	24/02/2014	1	121	61° 01.945' S	55° 43.176' W	SDP
17	24/02/2014	1	126	61° 03.119' S	55° 45.247' W	SDP
18	24/02/2014	1	117	61° 03.275' S	55° 45.539' W	SDP
19	28/01/2015	6	44	55° 02.277' S	66° 41.080' W	BC
20	28/01/2016	1	4949	60° 57.302' S	58° 44.376' W	SDP
21	28/01/2016	3	5085	60° 58.789' S	58° 42.295' W	SDP
22	28/01/2016	1	4579	61° 05.874' S	58° 31.488' W	SDP
23	28/01/2016	1	4579	61° 05.874' S	58° 31.488' W	SDP
24	02/02/2016	2	1524	62° 16.401' S	57° 02.677' W	BS
25	06/02/2016	3	62	54° 55.770' S	67° 03.710' W	BC
26	06/02/2016	2	62	54° 55.660' S	67° 04.590' W	BC
27	06/02/2016	2	40	54° 55.611' S	67° 09.677' W	BC
28	08/02/2016	2	61	55° 04.556' S	66° 35.498' W	BC
29	08/02/2016	2	61	55° 04.656' S	65° 31.857' W	BC
30	08/02/2016	3	84	55° 04.690' S	66° 31.201' W	BC
31	08/02/2016	4	65	55° 04.776' S	66° 23.758' W	BC
32	19/02/2016	1	30	54° 56.427' S	67° 00.347' W	BC

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