Sightings and acoustic records of cetaceans during the SORP Voyage 2014

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ABSTRACT

Here we report data on cetaceans from visual and acoustic observations. gathered by the Argentinian vessel *Tango SB-15* in Antarctic and sub-Antarctic waters during a SORP research cruise in February 2014 During 13 days of active sighting effort, the total number of hours and distance covered of on-effort observations were 153 hours and 1,331 nautical miles. Totals of 211 visual sightings and 17 acoustic detections included at least 11 identified cetacean species. Sightings included fin whales, humpback whales, sei whales, a blue whale, Antarctic minke whales, hourglass dolphins, Peale's dolphins, dusky dolphins, unidentified beaked whales, killer whales and pilot whales. Fin whales were the most frequently seen cetaceans south of 60° S, with a mean encounter rate of 0.358 $\pm$ 0.196 whales/nm in the Scotia Sea. Humpback whales were the second most encountered cetacean, and had the highest mean encounter rate 0.252 $\pm$ 0.078 whales/nm in the western Antarctic Peninsula. Beaked whales were the most detected animals by the hydrophone array. This study contributes with relevant data to increase the knowledge of the current status of whales in the Southern Ocean.

INTRODUCTION

The Southern Ocean was the main commercial whaling region from the late 19th to the 20th centuries. Over 2 million whales were taken in the Antarctic during that period (Clapham and Baker, 2009). Catches moved through different species as stocks of the original targets became depleted: humpback whales (*Megaptera novaeangliae*), blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), and minke whales (*Balaenoptera bonaerensis*) (Tønnessen and Johnsen, 1982). In 1986, the International Whaling Commission (IWC) completely banned commercial whaling and in 1994 created a whale sanctuary in the Southern Ocean, However, knowledge about the current state of the population of whales in the Southern Ocean is limited. Some estimations indicate that populations in the Antarctic are still at small fractions of the pre-exploitation levels (Branch and Butterworth, 2001a).

The Southern Ocean Research Partnership (SORP) is an integrated, collaborative consortium for cetacean research, created within the IWC. The principal aim of SORP is to get a full understanding of the post-exploitation status, health, dynamics and environmental linkages of the populations of cetaceans in the Southern Ocean, as well as the threats they face. The main focus of this program is the Antarctic blue whale, humpback whale, fin whale, Antarctic minke whale and killer whale populations.

The principal objectives of this research cruise were: 1) to assess and refine passive acoustic methods for monitoring and to gain insight into the acoustic repertoire of cetaceans; and 2) to collect photographic data for identification of whales and to collect distance sampling data for regional abundance estimate of cetacean species.

MATERIALS AND METHODS

Visual monitoring

Visual surveys of cetaceans were conducted onboard the vessel *Tango SB-15* of the Argentinian Coast Guard (Prefectura Naval Argentina). The vessel departed from the port of Ushuaia on 17 February 2014,

navigated through the waters of the Mar del Scotia/ Scotia Sea towards the Islas Orcadas del Sur/ South Orkney Islands and through the Estrecho de Gerlache/ Gerlache Strait down to the Argentine Antarctic base " *Brown*" (64º 53'S,062º 53'W) (Fig. 1). On 5 March 2014 the vessel arrived back at Ushuaia. Observations were conducted daily during daylight hours. During the surveys, two experienced observers collected the data from the bridge and the exterior wings of the bridge. The search for cetaceans was made with 7x50 reticuled Fujinon binoculars and the naked eye. Data on species, group size, GPS position, date, time, vessel speed and heading, animal bearing from the ship were recorded for each sighting. Sightings for which species identification was not possible were classified as unidentified beaked whale or unidentified rorqual. Photographs of the animals were taken with a reflex digital camera to assist in later species identification and to compare appropriate pictures with existing catalogs. Vessel speed and heading, air temperature, wind speed and direction, Beaufort sea state, weather conditions and visibility were recorded at the start of each day and updated every hour. The visual surveys were interrupted when Beaufort scale was approximately 8. 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). Ship speed varied between 4 and 10 knots.

Acoustic monitoring

Acoustic monitoring for cetaceans during line-transect surveys was conducted using a 4-element oil-filled hydrophone. The array was equipped with an omni-directional sensor (BII-7011 Type 3, Benthowave Instrument Inc., Collingwood, Ontario, Canada) that had an approximately flat (±2 dB) hydrophone sensitivity from 30 Hz to 200 kHz of –204 dB re V/µPa. The sensor was connected to a custom-built preamplifier board and bandpass filter. The preamplifiers were designed to flatten the frequency response of the ambient ocean noise, which provided greater gain at higher frequencies at which ambient noise levels are lower and sound attenuation is higher (Wiggins and Hildebrand, 2007). The calibrated system response was corrected for during analysis. Each pre-amplified element was high-pass filtered at 300 Hz to decrease flow noise at low frequencies. Three mid-frequency hydrophone channels recorded at a 192 kHz sample rate using a MOTU 896HD. One high-frequency channel recorded at a 500 kHz sample rate using an Avisoft Ultrasound-Gate USB 116. The array was towed 200m behind the vessel. An acoustic technician monitored the incoming signals from the towed array using both a real-time scrolling spectrogram in Ishmael 2.0 and headphones.

Data analysis

The mean encounter rate (number of sighted cetaceans per nautical mile surveyed) was estimated for each species after dividing the study site into two areas: western Antarctic Peninsula (including Mar de la Flota/ Bransfield and Estrecho de Gerlache/Gerlache Strait) and Mar del Scotia/Scotia Sea (between Islas Shetland del Sur/South Shetland Islands and Islas Orcadas del Sur/South Orkneys Islands). Mean encounter rates and standard deviations were calculated using each survey day as a sample. Only data obtained during searching effort was considered in the analysis.

Acoustic data collected from the towed acoustic array was analyzed for the presence of calls from all odontocete cetaceans. Mysticete calls were too low-frequency to be detected in the presence of ship noise.

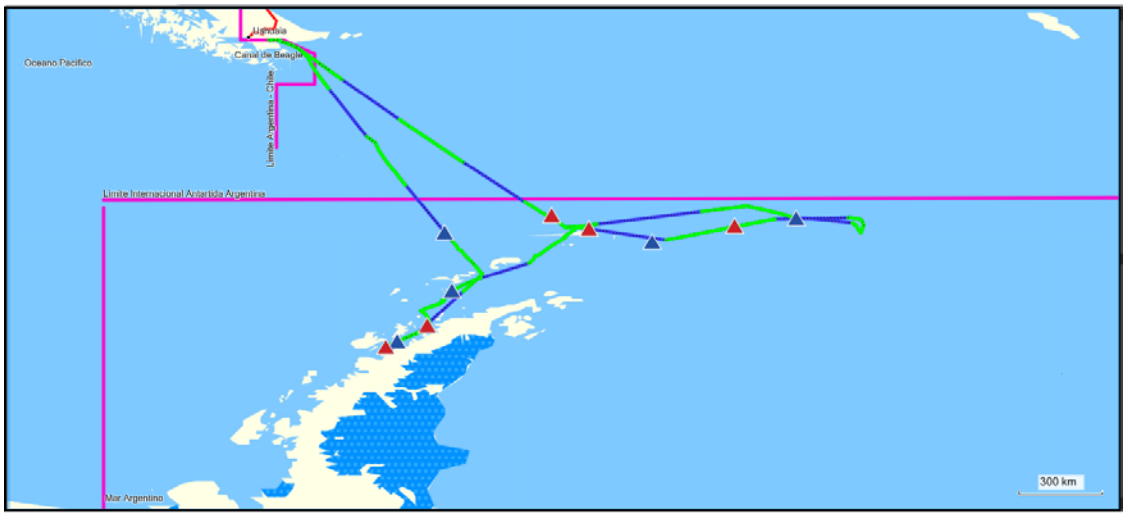

Fig.1. Map showing the track of the total navigation. Tracks of visual survey effort are shown in green. Triangles show the location of hydrophone array deployment (red) and retrieval (blue).

RESULTS AND DISCUSSION

Details of all cetacean sightings are listed in Table 1. Plots of all visual detections for each species, as well as the tracks of visual survey effort, are provided in figures 2 to 9. During 13 days of active sighting effort, the total number of hours and distance covered of on-effort observations were 153h and 1,331nm, respectively. Cetacean sightings included 6 odontocete and 5 mysticete species, encompassing a total of 211 encounters, out of which 90% were mysticetes and 10% were odontocetes. The mean encounter rate of cetaceans in the whole study area was 0.54 ± 0.58 cetaceans/nm. The geographic distribution of cetacean species encountered in the study area was not uniform.

Fin whales were the most frequently seen cetaceans south of 60°S, with a mean encounter rate of 0.358 ± 0.196 whales/nm in the Scotia Sea. Humpback whales were the second most encountered cetacean, and had the highest mean encounter rate in the western Antarctic Peninsula (Table 1). Sei whales were only observed north of Islas Shetland del Sur/South Shetland Islands and in the area between those islands and Islas Orcadas del Sur/South Orkneys Islands. Very few sightings of minke whales were recorded in the whole study area, and all except one were within the Bahía Paraíso/Paradise Bay. The occurrence of fin and sei whales in the open waters far from the pack ice agrees with previous data for these species (Reyes Reyes and Iñiguez, 2013, Sirovic *et al.* 2006). In contrast, humpback and minke whales were more concentrated in the western Antarctic Peninsula in shallower waters, near islands and close to shore.

A blue whale was seen on one occasion in the Scotia Sea near Islas Orcadas del Sur/South Orkneys Islands (Fig. 6).

Killer whales were sighted on two separate occasions near the South Shetland Islands. The first sighting occurred between King George Island and Elephant Island, and consisted of a group of Gerlache killer whales (small type B) that swam next to the ship for about 15 minutes, including an adult male, a mother with a calf, and a juvenile. The second encounter was with a group of five individuals sighted northwest of Nelson Island by the Bransfield Strait. We think they might type A killer whales, although we are not completely sure because they were pretty far from the vessel.

Hourglass dolphins were seen on only one occasion in sub-Antarctic waters of the Scotia Sea, north of 60°S. Only a group of more than 25 pilot whales was seen while crossing the Drake Passage (Fig. 3).

Dusky dolphins were the most abundant species in sub-Antarctic waters within the Beagle Channel, and on several occasions were seen in association with Peale's dolphins (Fig. 2).

A total of 17 acoustic detections were obtained from the towed array data, and included signals from beaked whales and killer whales (Figs. 8 and 9). Only one visual sighting of beaked whales was obtained during the whole cruise. However, beaked whales were the most detected animals by the hydrophone array. Beaked whales spend the majority of their time at depth, are relatively inconspicuous at the surface and have unique characteristics of their echolocation clicks that allow to easily discriminate them from other odontocetes. These are some of the reasons why passive acoustic monitoring possess advantages in comparison to traditional visual survey methods to detect beaked whales (Yack, *et al.* 2013).

No baleen whales sounds were recorded due to low-frequency masking from vessel noise.

Table 1. Total number of individuals sighted for each species, frequency of sightings, group size and encounter rates. WAP: western Antarctic Peninsula. SS: South Shetlands. ER: encounter rate.

	Scientific name	Common name	N° of individuals	Frequency of sightings	Group size		WAP_ER	SS_ER
					Range	Mean ± SD		
Mysticetes	*Balaenoptera physalus*	Fin whale	186	95	1-5	1.96 ± 1.01	0.094 ± 0.027	0.358 ± 0.196
	Balaenoptera bonaerensis	Antarctic minke whale	5	5	-------	1 ± 0	0.009 ± 0	0.009 ± 0
	Balaenoptera borealis	Sei whale	28	14	1-5	2.00 ± 1.11	--------	0.080 ± 0.011
	Megaptera novaeangliae	Humpback whale	92	49	1-4	1.86 ± 0.53	0.252 ± 0.078	0.062 ± 0.066
	Balaenoptera musculus	Blue whale	1	1	-------	--------	--------	0.01 ± 0
	Balaenoptera spp	Unidentified rorqual	45	26	1-4	1.73 ± 0.83	--------	--------
Odontocetes	*Globicephala melas*	Pilot whale	>25	1	-------	--------	--------	0.24 ± 0
	Lagenorhynchus obscurus	Husky dolphin	max 137	8	4-50	17.13 ± 15.87	--------	--------
	Lagenorhynchus Australis	Peale's dolphin	max 25	7	1-7	3.57 ± 2.23	--------	--------

	Lagenorhynchus cruciger	Hourglass dolphin	10	1	-------	--------	--------	--------
	Orcinus orca	Orca	6	2	1	3.00 ± 1.41	0.040 ± 0.005	--------
	Unidentified beaked whale	Unidentified beaked whale	1	1	-------	--------	--------	0.009 ± 0

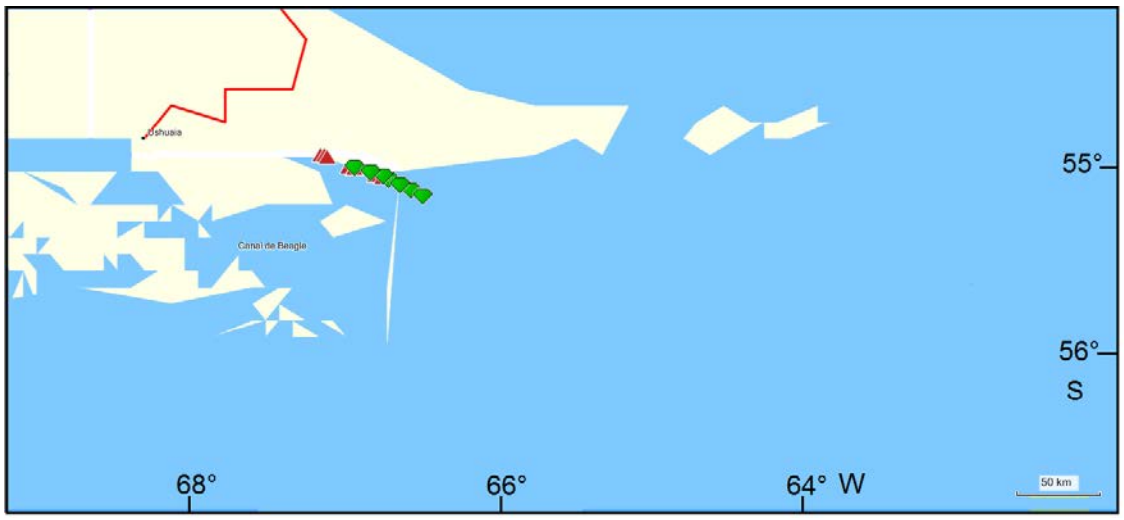

Fig. 2. Location of visual sightings of dusky dolphins (green rhombus) and Peale's dolphins (red triangles). Each symbol represents a single sighting event that may include one or many individuals.

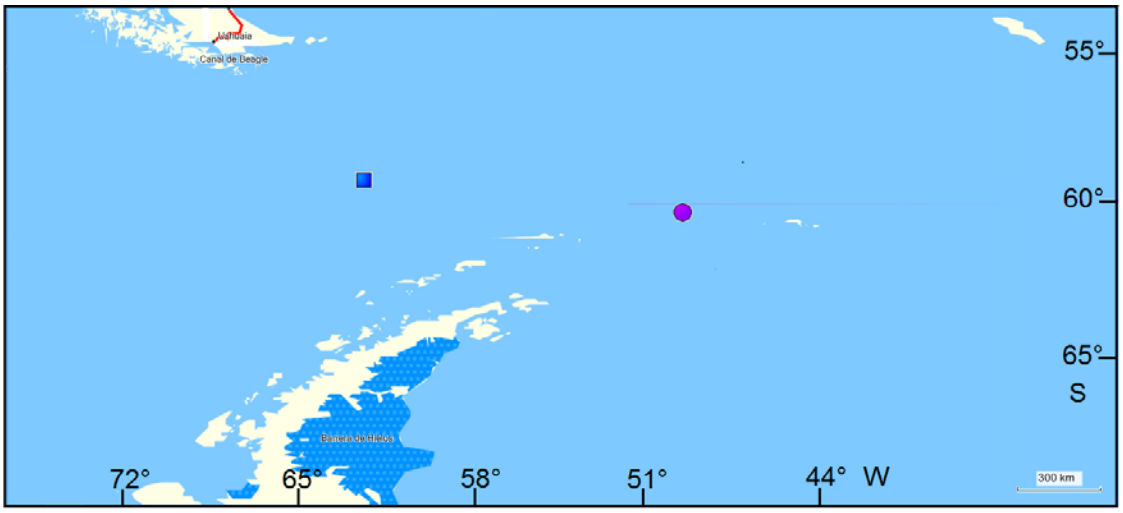

Fig. 3. Location of visual sightings of hourglass dolphins (violet circle) and pilot whales (blue square). Each symbol represents a single sighting event that may include one or many individuals.

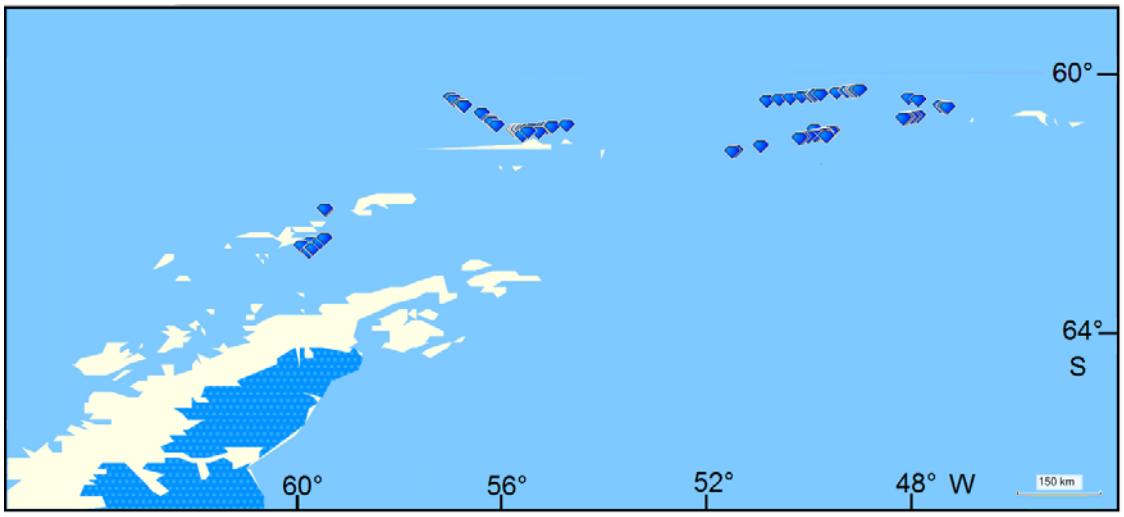

Fig. 4. Location of visual sightings of fin whales. Each symbol represents a single sighting event that may include one or many individuals.

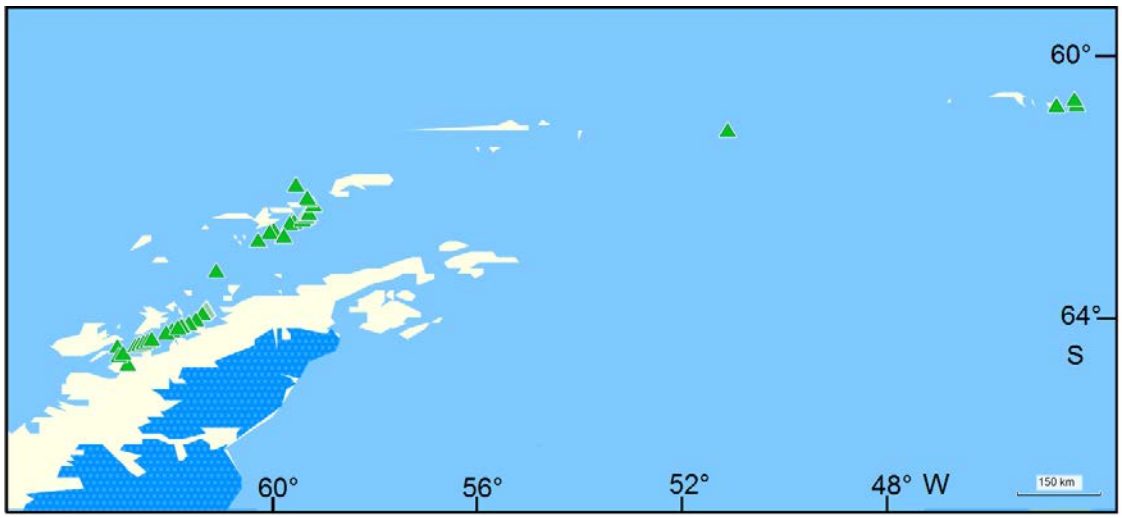

Fig. 5. Location of visual sightings of humpback whales. Each symbol represents a single sighting event that may include one or many individuals.

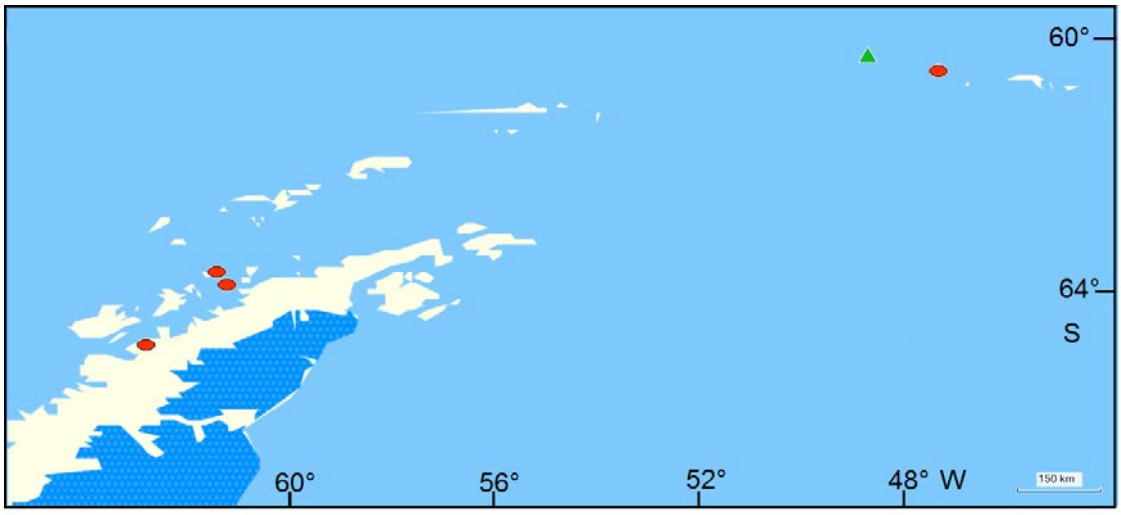

Fig. 6. Location of visual sightings of minke whales (red circles) and a blue whale (green triangle). Each symbol represents a single sighting event that may include one or many individuals.

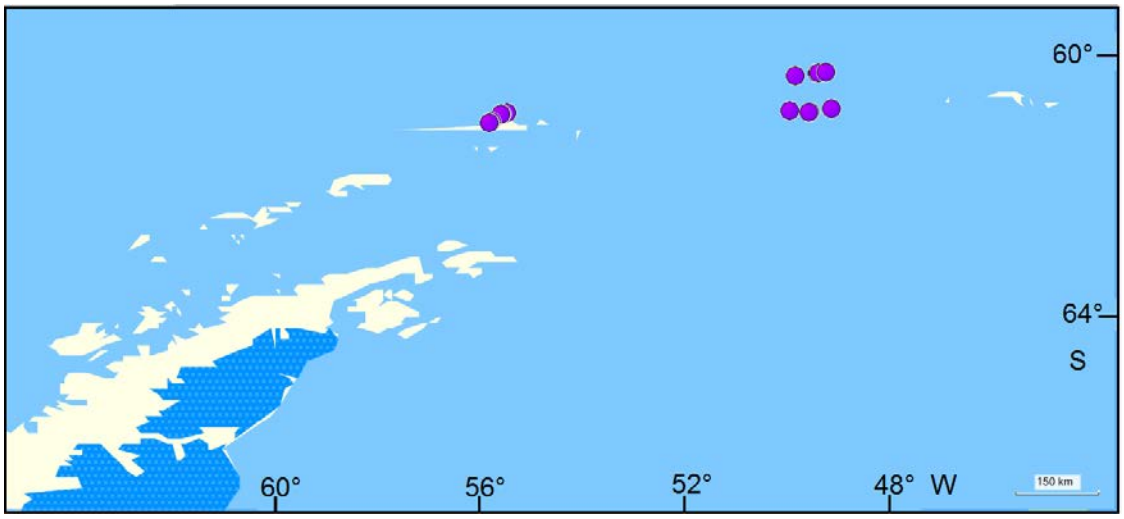

Fig. 7. Location of visual sightings of sei whales. Each symbol represents a single sighting event that may include one or many individuals.

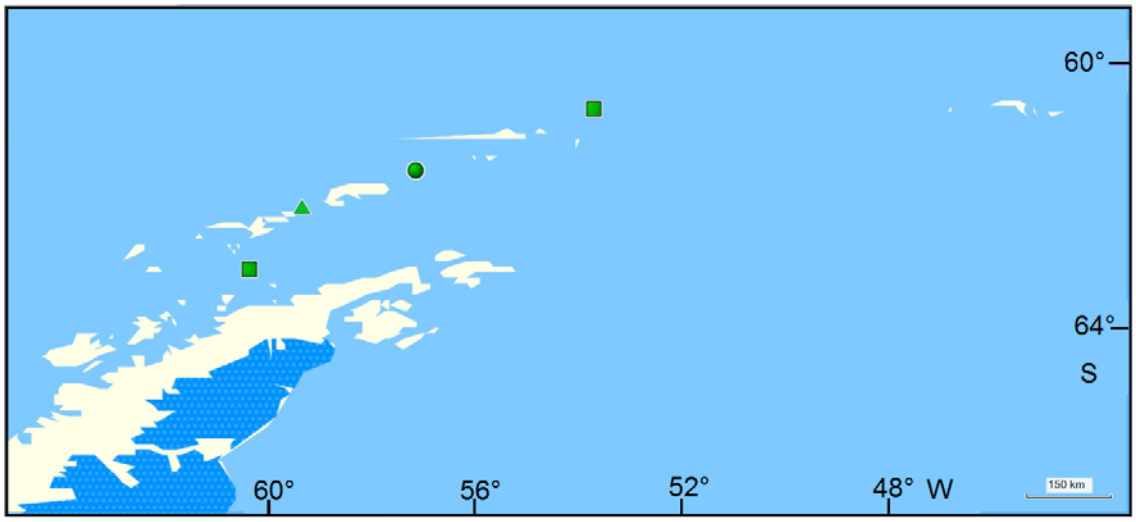

Fig. 8. Location of visual sightings (triangle) and acoustic detections (squares) of killer whales. The circle represents an acoustic detection with visual confirmation. Each symbol represents a single encounter that may include one or many individuals.

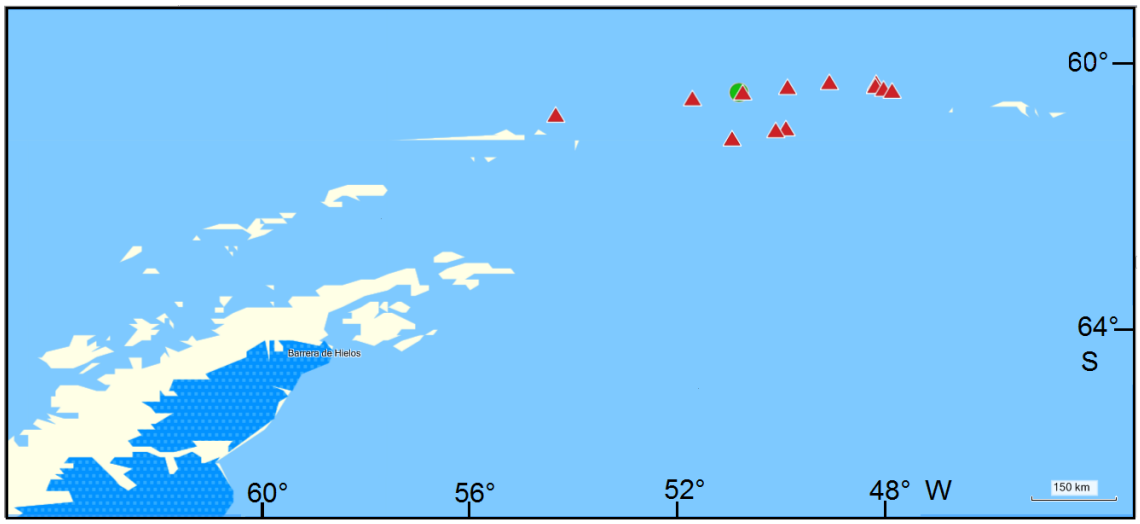

Fig. 9. Location of a visual sighting (green circle) and acoustic detections (red triangles) of beaked whales. Each symbol represents a single encounter that may include one or many individuals.

CONCLUSIONS

The present study provides new data on the distribution of cetaceans in Antarctic and sub-Antarctic waters, and intends to contribute to the efforts of the International Whaling Commission to increase the knowledge of the current status of whales in the Southern Ocean.

FUTURE WORK

Photos will be shared for comparisons with other regional photo-ID catalogues and to explore th potential exchange of individuals between different areas. Visual sightings along with data on distance will be analyzed for abundance estimations.

ACKNOWLEDGEMENTS

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