SC/69A/ASI/08

Sub-committees/working group name: ASI

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INTERNATIONAL WHALING COMMISSION

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CRUISE REPORT FROM WINTER SURVEYS (MAY – SEPTEMBER 2022) AROUND SOUTH GEORGIA (ISLAS GEORGIAS DEL SUR)

Russell Leaper[1], Martin A Collins[2], Susannah Calderan[3], Ryan Irvine[4], Cecilia Liszka[2], Paula Olson[5] and Jennifer Jackson[2]

1 International Fund for Animal Welfare, London, SE1 8NL, UK. russell@rcleaper.com
2 British Antarctic Survey High Cross, Madingley Road, Cambridge CB3 0ET, UK
3 Scottish Association for Marine Science (SAMS), Argyll PA37 1QA, UK
4 Churchtown House, Boskennal Lane, St Buryan, Cornwall, TR19 6DB
5 5580 La Jolla Blvd La Jolla, CA 92037 USA

Abstract

A visual and acoustic survey of baleen whales in South Georgia (Islas Georgias del Sur, SG/GS) waters was carried out in July 2022, as well as combined surveys of marine mammals and seabirds in May, July and September 2022, as part of a two-year project investigating the abundance and density of krill and krill-feeding predators at SG/GS in winter. Humpback whales (*Megaptera novaeangliae*) were the most frequently seen species in all periods, with the pattern of sightings suggesting possible westerly movement of this species distribution along the north SG/GS shelf over the winter period. Fin whales (*Balaenoptera physalus*) were also sighted in all surveys, with the highest sighting rates in May. Southern right whales (*Eubalaena australis*) were encountered in May and July. Blue (*B. musculus intermedia*), sperm (*Physeter macrocephalus*) and killer whales (*Orcinus orca*) were occasionally encountered. Acoustic surveys using DIFAR sonobuoys in July identified many humpback whale vocalisations, and located these mostly in shelf waters. Southern right whales rarely vocalised, and detections of fin and blue whales suggested that both had a more offshore distribution (i.e. outside of shelf waters) in July. Analyses of this work are ongoing in order to relate observed distributions to krill occurrence and density, with a second year of surveys taking place in 2023.

Introduction

South Georgia (Islas Georgias del Sur, SG/GS) was a major centre of whaling in the early 20th century. Whilst whale populations are now showing signs of recovery from over-exploitation (Baines et al., 2021; Calderan et al., 2020), there are concerns that the krill fishery could impact on food availability and, perhaps, prevent a return to pre-exploitation population levels. At SG/GS the krill fishery operates exclusively in the winter months, but data on krill and krill-dependent predators during winter is limited. Whilst many land-breeding predators are less constrained during winter, some (e.g. fur seals and gentoo penguins) continue to forage around SG/GS and there is evidence that some baleen whales remain around SG/GS during winter (Moore et al., 1999). The "Winter Krill" project, has been established to obtain information on i) the distribution and abundance of *Euphausia superba* (Antarctic krill) during the winter; and ii) overlap between the distribution of krill-dependent predators and krill in the SG/GS fishery area.

Methods

Three surveys were conducted in the shelf waters and further offshore of the north coast SG/GS in 2022 in May, July and September. On all surveys, seabird and marine mammal observations were conducted in accordance with standard JNCC Seabirds at Sea methods (Tasker et al., 1984) concurrently with all daytime krill-acoustic transects. On the July survey there was an additional team of three marine mammal researchers using distance sampling methods to carry out visual surveys and passive acoustic monitoring using DIFAR sonobuoys.

Data were collected from the *MV Pharos SG* along transects based on those surveyed historically as part of the British Antarctic Survey's Eastern Core Box (ECB) and annual Western Core Box (WCB) surveys (Brierley et al., 1997; Fielding et al., 2014). Systematic survey effort was also conducted between transects and when the vessel was on passage. Each transect was approximately 35 nautical miles long extending from the coast to beyond the shelf break (Fig 3). Transects were undertaken at around 8-10 knots with two transects completed each day.

Active acoustic data were collected to investigate krill density and swarm characteristics using a Simrad EK80 split-beam echosounder, with 38 and 120 kHz transducers. Plankton trawls and CTD deployments were also undertaken.

During the July survey, a minimum of two marine mammal researchers at any one time collected visual data on cetacean and pinniped sightings. These were in addition to the single observer collecting seabird and marine mammal data using JNCC methods. Watches were carried out from the bridge with observers searching 180° forward of the ship from a deck height of 9.3 m (average eye height of 10.9 m). Acceptable survey conditions were considered to be Moderate or Good visibility and sea state 6 or less. Distances to marine mammals were measured using 7 x 50 binoculars (Fujinon 7x50 FMTRC-SX) equipped with reticles or estimated by eye when this was not possible. Reticle values were converted to an angular measure from the horizon to mammals and then to the distance from the ship. Radial angles from the ship to mammals were measured using angle boards mounted on the bridge. All sighting data, including distance, angle, species, group size and behaviour, were entered directly into a laptop using the program Logger (Gillespie et al. 2011). Logger also automatically recorded the time and location of the vessel. Environmental data related to sighting conditions (wind speed and direction, sea state, visibility and precipitation) were also entered into Logger. Apparent wind speed and direction were read directly from the ship's instruments. The sighting data were collected in 'passing' mode, without the ship turning to approach whales. Where possible, whales were identified to species-level. Where there was some uncertainty, a 'like' species category was used. If the sighting could not be identified to species or like-species level, an appropriate unidentified ('unid') category was used. Photo-identification images of individual whales were collected opportunistically as the ship progressed along the survey transects. Program Distance (Thomas et al., 2010) was used to estimate effective strip half widths for species where there were sufficient numbers of sightings.

DIFAR sonobuoys (Ultra Electronics HIDAR units) were used to acoustically locate whales in real time, and to record their vocalisations. DIFAR sonobuoys contain an omnidirectional acoustic pressure sensor and two orthogonal acoustic vector sensors that are directional in the horizontal plane. Sonobuoy signals were received by VHF radio onboard the research vessel, digitised, recorded, processed using specialist modules in PAMGuard passive acoustic monitoring software (www.pamguard.org). The DIFAR bearings to whale calls were also resolved and classified to species and call-type using PAMGuard and plotted on an interactive map in real time. Continuous recordings were made at a sample rate of 48,000 samples per second, and data from all buoys were monitored visually and aurally by an on-duty acoustician for the full duration of each deployment. VHF signals were received using a Procom CXL 2-3LW/s omnidirectional antenna tuned to the 137-150MHz frequency band giving a gain of 3dB. The 3 m-tall antenna was mounted above the bridge with the base at a height of 11.5 m, giving a maximum effective reception range to the sonobuoys of around 10 km. Sonobuoys were deployed in winds of up to 35 knots. In higher wind speeds, background noise levels were considered too high for effective monitoring. Sonobuoy hydrophones were deployed at a depth of 140 m.

Results

The planned survey transects of around 500 km of effort were completed on each of the three surveys with some additional opportunistic effort. Effort and cetacean sightings by the JNCC marine mammal and seabird observer are given in Table 1.

Table 1. Survey effort and cetacean observations by JNCC marine mammal and seabird observer. Sighting rates are individuals.km^{-1}.

Survey	May			July			September		
Effort in good visibility with wind force <6	650 km			483 km			510 km		
	Number of sightings	Number of individuals	Sighting rate	Number of sightings	Number of individuals	Sighting rate	Number of sightings	Number of individuals	Sighting rate
Blue whale	1	1	0.002	0	0	0.000	0	0	0.000
Fin whale	23	45	0.069	5	6	0.012	2	6	0.012
Humpback whale	22	45	0.069	35	63	0.130	7	14	0.027
Killer whale	0	0	0.000	2	3	0.006	0	0	0.000
Large cetacean spp	26	52	0.080	21	22	0.046	4	6	0.012
Southern right whale	7	18	0.028	9	9	0.019	0	0	0.000
Sperm whale	0	0	0.000	0	0	0.000	2	2	0.004

During the July survey a total of 70.7 hours of visual effort were achieved by the cetacean research team in moderate or good visibility (both on transect and on passage in SG/GS waters; Table 2). Of this, 27.1 hours were on transect in sea state 6 or less (Table 2). The numbers of sightings are given in Table 3. There were sufficient sightings with distances and angles to groups of humpback whales (n=40) and southern right whales (n=25, including 'like' right whale category) to generate an overall detection function for each species (Figures 1 and 2). Estimated strip half width for humpback whales was 1713 m (95% CI 1407 m – 2086 m) and 987 m (95% CI 722 m – 1349 m) for southern right whales.

Table 2. Cetacean researcher team effort during July survey. Visual effort (hours) during transect and on passage in SG/GS waters.

Sea state	1	2	3	4	5	6	7
Effort on visual transect in moderate or good visibility	1.6	5.9	6.3	4.7	3.3	5.5	0.0
Effort on passage in moderate or good visibility (may be used for strip width estimation)	0.0	6.5	5.1	4.5	4.5	21.3	1.6

Table 3. Summary of cetacean sightings from cetacean researcher team during July survey.

Species	Number of sightings	Number of individuals	Mean group size
Humpback whale	41	83	2.0
Like humpback whale	6	6	1.0
Southern right whale	20	31	1.6
Like southern right whale	5	5	1.0

Fin whale	10	20	2.0
Like fin whale	4	15	3.8
Sperm whale	2	2	1.0
Killer whale	8	16	2.0
Blue/fin whale	1	2	2.0
Unid large baleen	33	45	1.4
Like sei whale	1	2	2.0
Unid large whale	7	8	1.1
Unidentified whale	2	4	2.0

A number of images suitable for photo identification were obtained during the survey (Table 4). All humpback whale flukes were submitted to Happywhale (www.happywhale.com) for comparison with other photo-ID databases, and southern right whale images will be compared to the SG/GS photo-identification catalogue for this species.

Table 4. Summary of cetacean photo-ID records obtained during the survey.

Date	Sighting number	Species	Number of individuals identified	Subject
11/07/2022	011	Southern right whale	1	Left jaw, flukes
12/07/2022	153	Humpback	1	Flukes
12/07/2022	161	Southern right whale	1	Head, left & right jaw
13/07/2022	194	Humpback	1	Flukes
14/07/2022	223	Humpback	1	Flukes
14/07/2022	240	Humpback	1	Flukes
15/07/2022	258	Humpback	1	Flukes
15/07/2022	263	Southern right whale	1	Right jaw
16/07/2022	280	Southern right whale	2	Left jaw

Thirteen sonobuoys were deployed between 07/07/2022 and 26/07/2022, including a test-buoy which was not used to collect whale data (Table 5). This comprised 32.7 hours of acoustic monitoring. Antarctic blue whales, southern right whales, sperm whales, humpback and fin whales were all detected on sonobuoys, but the majority of calls were from fin and humpback whales. Bearings to 2800 humpback whale calls and 904 fin whale calls were measured.

The seasonal patterns of humpback whale sightings are shown in Figure 3. Humpback whales were mainly seen on the SG/GS shelf (Figure 4), with sonobuoy bearings also indicating an on-shelf distribution in July. Southern right whales were also primarily seen on the shelf but were rarely detected by sonobuoys. There was some evidence of a westerly shift in distribution of southern right whales between May and July, but there were no sightings in September (Figure 5). Surface feeding southern right whales were seen at dusk on three occasions, all at the inshore end of transects. Further details of these observations are given in Calderan et al. (in press). Fin whales were seen over deeper waters in July (Figure 7), with sonobuoy detections largely confirming an off-shelf distribution. However, during the May survey, fin whales were seen in shallower water closer to the coast (Figure 6).

Although unit A calls from Antarctic blue whale calls were detected on the majority of sonobuoy deployments, these calls were faint, and the locations of whales were likely several hundred kilometres ENE of the survey area. Bearings to FM calls from blue whales that would have been from closer individuals are shown in Figure 8.

Table 5. Summary of sonobuoy deployments and detected whales.

Date	Time (UTC)	Latitude	Longitude	Duration (hours)	Right whale	Humpback whale	Blue whale 26Hz	Blue whale FM call	Fin whale	Sperm whale
07/07/2022	11:32	-53.338	-42.785	n/a (test)						
07/07/2022	20:37	-53.665	-39.835	0.46		Definite	Definite	Probable		
11/07/2022	18:48	-54.133	-36.212	2.80		Definite				
12/07/2022	13:56	-53.814	-35.461	1.26		Definite	Possible	Possible	Possible	
13/07/2022	06:34	-54.274	-35.938	4.48		Definite	Definite		Definite	
13/07/2022	13:56	-53.996	-35.283	1.27		Definite	Definite		Definite	
14/07/2022	06:35	-54.432	-35.832	4.43		Definite	Definite		Definite	
14/07/2022	13:56	-54.118	-35.090	1.20		Definite	Definite		Definite	
15/07/2022	06:23	-54.216	-36.424	5.90	Definite	Definite	Definite		Definite	
16/07/2022	07:23	-53.618	-37.781	3.86		Definite	Definite	Definite	Definite	Definite
17/07/2022	10:33	-53.648	-35.869	3.03		Definite	Definite	Definite	Definite	
18/07/2022	00:04	-53.877	-36.566	2.99	Definite	Definite	Definite	Definite	Definite	
26/07/2022	16:49	-53.944	-37.306	1.04		Definite	Probable		Definite	

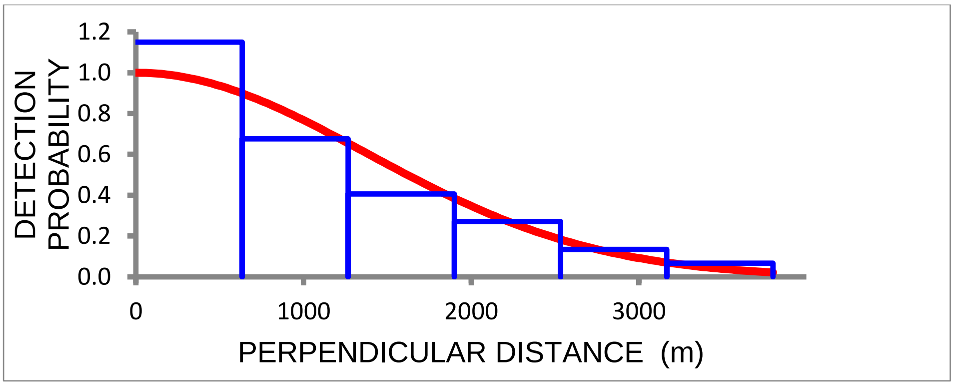

Figure 1. Perpendicular distances to humpback whale sightings (n=40). Fit shows half-normal key selected by Program Distance on the basis of AIC.

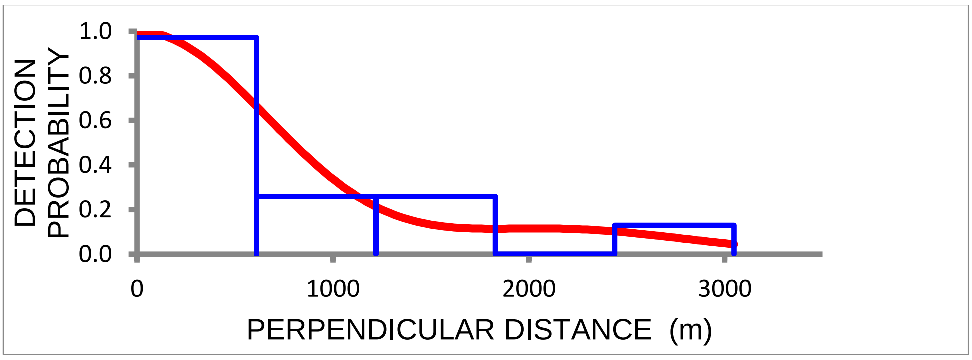

Figure 2. Perpendicular distances to southern right whale sightings (n=25). Fit shows half-normal key with second order cosine adjustments.

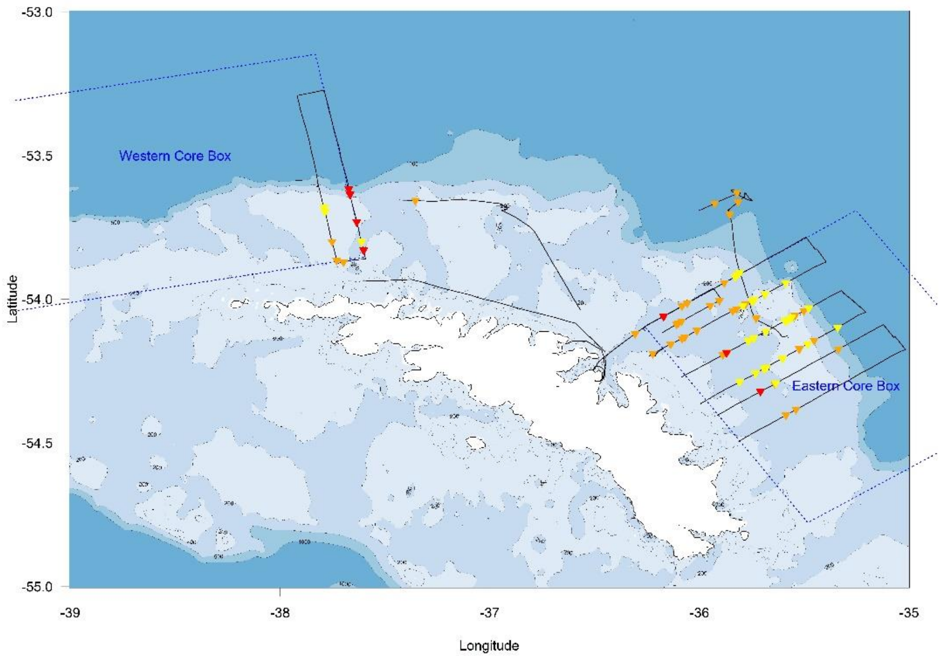

Figure 3. Visual sightings of humpback whales during May (yellow triangles), July (orange triangles) and September (red triangles) surveys.

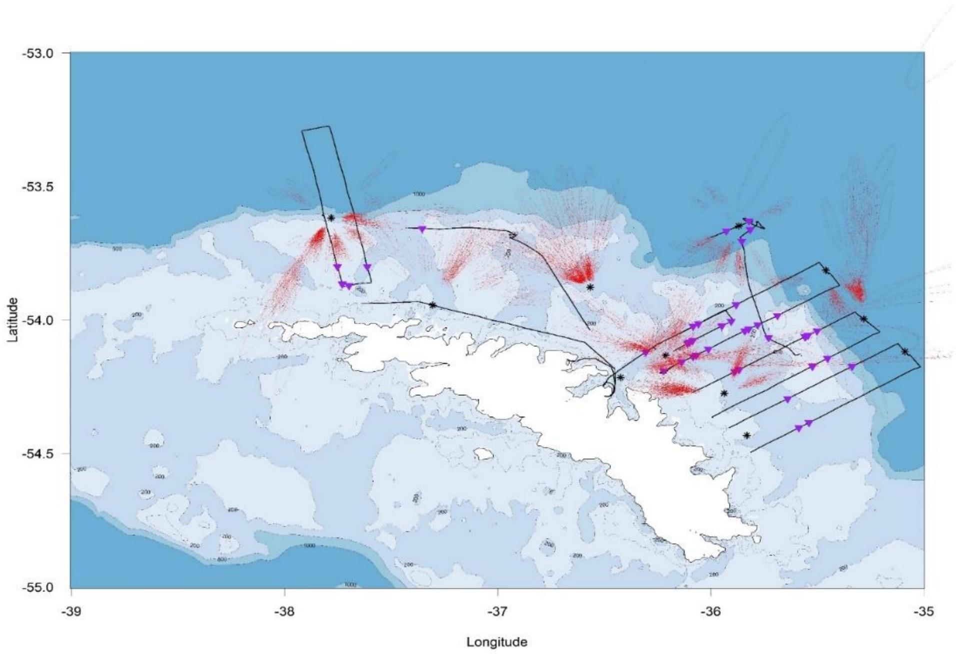

Figure 4. Visual survey effort (black lines) and sonobuoy deployments (black asterisks) in July. Purple triangles indicate humpback whale sightings. Red ellipses indicate potential location of vocalising whales from each detected call based on simple assumptions about detection range and bearing accuracy.

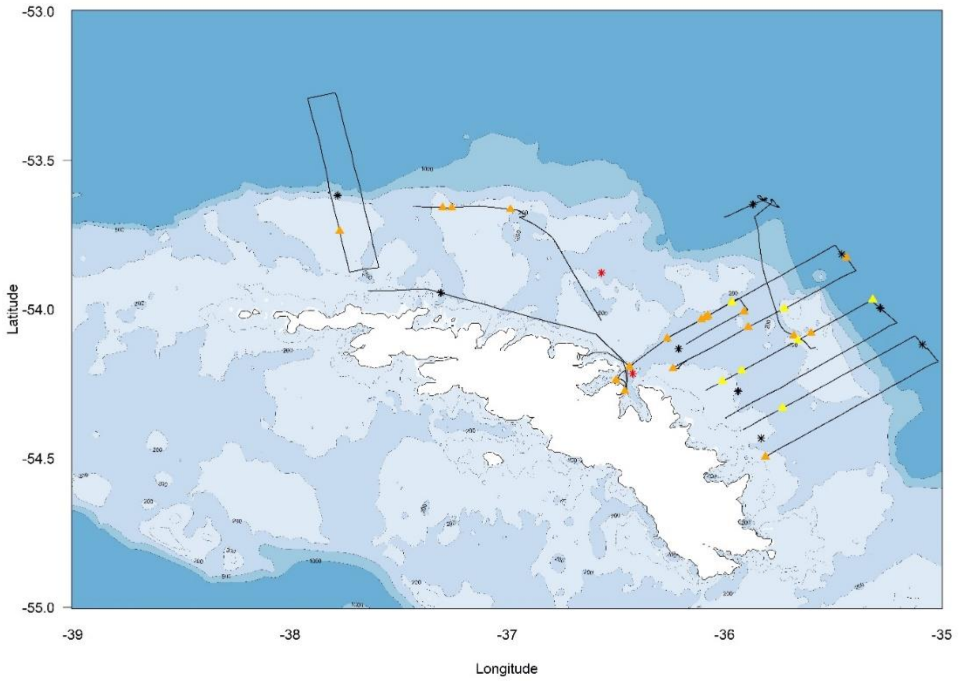

Figure 5. Visual survey effort (black lines) and sonobuoy deployments (black asterisks) in July. Yellow triangles indicate southern right whale sightings in May, orange in July. Right whales were detected on two sonobuoys in July with very few calls (sonobuoys where right whales were detected are shown in red).

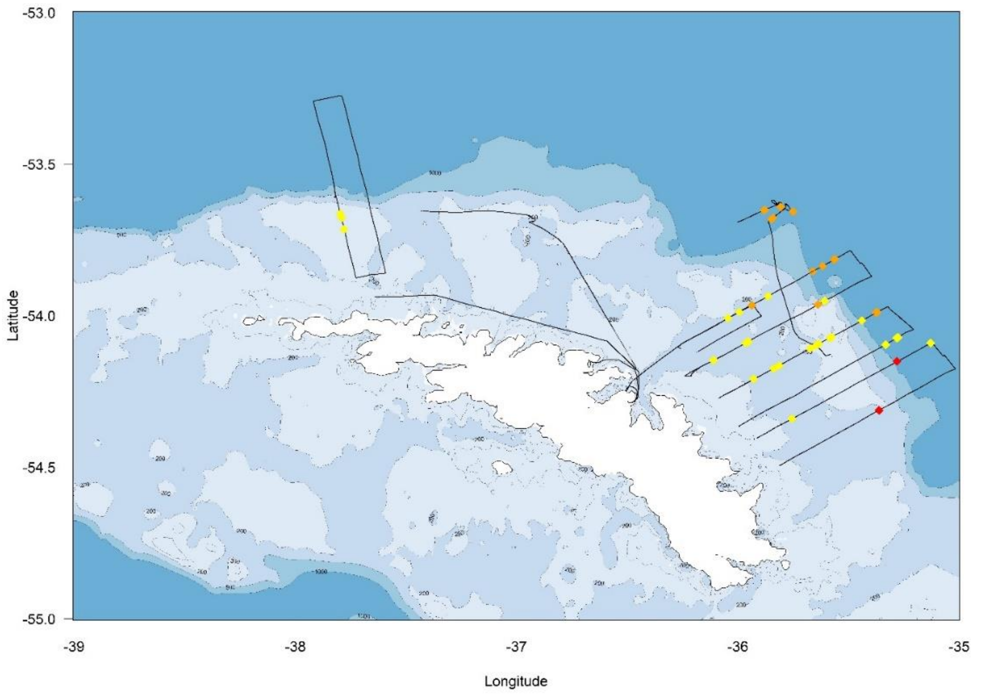

Figure 6. Visual sightings of fin whales during May (yellow triangles), July (orange triangles) and September (red triangles) surveys.

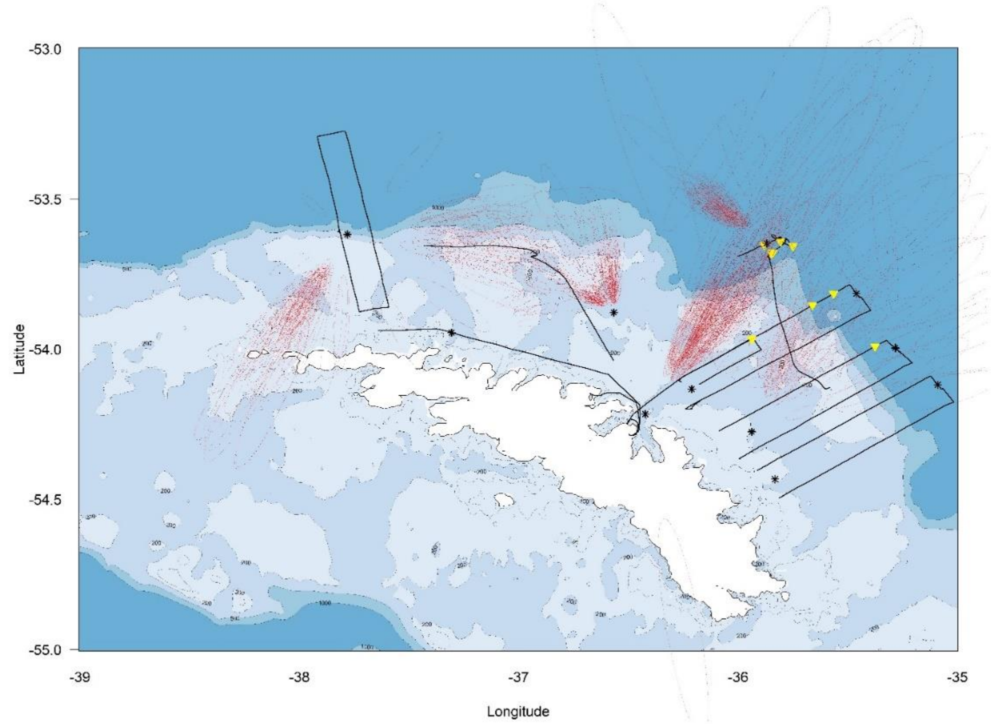

Figure 7. Visual survey effort (black lines) and sonobuoy deployments (black asterisks) in July. Yellow triangles indicate fin whale sightings. Red ellipses indicate potential location of vocalising whales from each detected call based on simple assumptions about detection range and bearing accuracy.

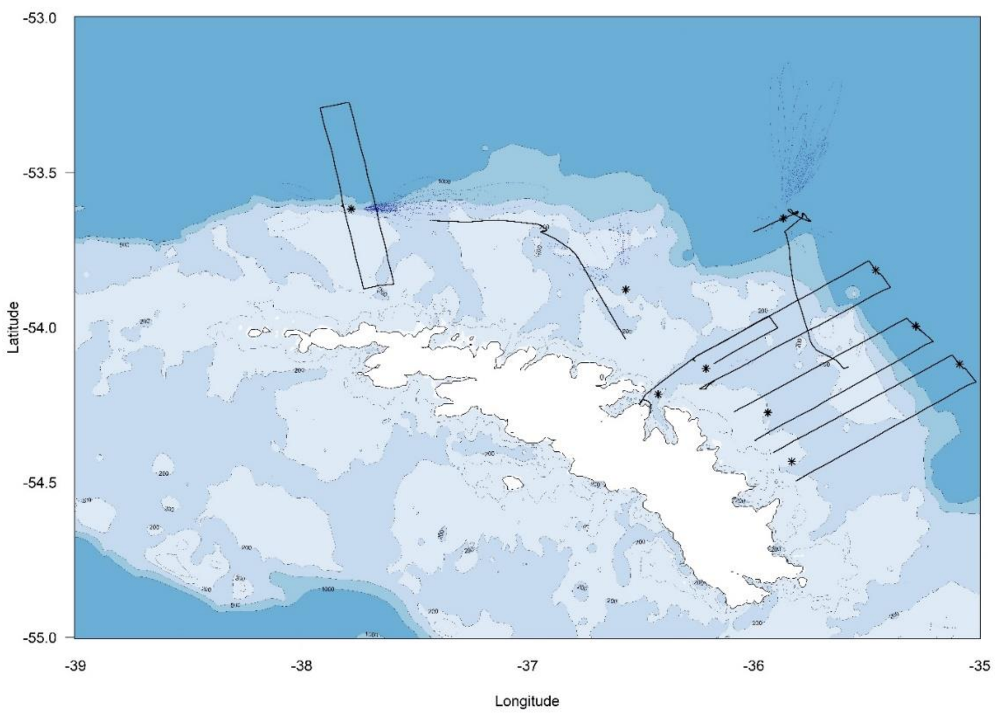

Figure 8. Visual survey effort (black lines) and sonobuoy deployments (black asterisks) in July. There were no blue whale sightings but blue ellipses indicate potential locations of detected blue whale FM calls.

Discussion

The data collected should allow estimates of absolute abundance of humpback and southern right whales in the area surveyed in July and relative abundance of all species in May and September. The passive acoustic monitoring in July, with bearings to vocalisations, allowed for some assessment of distribution over a larger area than covered by the survey transects. These data will enable an assessment of whether the limited area covered by the surveys included the main areas of distribution for the species detected, which is expected to change over the course of the season. For humpback whales the acoustic bearings indicated that the survey transects did cover a high proportion of the distribution whereas for fin and blue whales the acoustic bearings indicated whales distributed further offshore than the survey area. Humpback whales showed a tendency for the distribution to move westwards through the season which is consistent with the observed distribution of krill and the operation locations of the krill fishery during 2022.

The surveys will be repeated in 2023 with the whale researcher team and passive acoustic monitoring conducted during the September survey. Following these surveys, the analysis will use a spatial modelling approach to combine cetacean data from all the surveys with data on krill from the active acoustics, bathymetry and oceanographic co-variates. This will be used to examine abundance and distribution of whales through the austral winter season in relation to the fishery for Antarctic krill.

Acknowledgements

We thank the captain and crew of the *MV Pharos SG* for their enthusiastic support of the ship-based survey work, and the British Antarctic Survey team at the King Edward Point research station, in particular Kate Owen and Meghan Goggins, for their hard work and dedication in enabling the collection of these data. This work was supported with funding from the Darwin Plus grant DPLUS149, South Georgia Heritage Trust and Friends of South Georgia Island.

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