Darwin Plus Main: Annual Report

To be completed with reference to the "Project Reporting Information Note"
(https://darwinplus.org.uk/resources/information-notes)

It is expected that this report will be a **maximum of 20 pages** in length, excluding annexes)

Submission Deadline: 30th April 2024

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Darwin Plus Project Information

Project reference	DPLUS149
Project title	Resolving ecosystem effects of the South Georgia winter krill fishery
Territory(ies)	South Georgia and the South Sandwich Islands
Lead Partner	British Antarctic Survey
Project partner(s)	Government of South Georgia and the South Sandwich Islands (GSGSSI) and Antarctic Research Trust (ART)
Darwin Plus grant value	£469,653.00
Start/end dates of project	1 December 2021 – 31 May 2024
Reporting period (e.g. Apr 2023-Mar 2024) and number (e.g. Annual Report 1, 2)	1 April 2023 – 31 March 2024, Annual Report 3
Project Leader name	Martin [redacted]
Project website/blog/social media	https://www.bas.ac.uk/project/winter-krill-at-south-georgia/
Report author(s) and date	Cecilia [redacted], Norman [redacted], Russell [redacted], Martin [redacted] April 2024

1. Project summary

Our project is entitled 'Resolving ecosystem effects of the South Georgia winter krill fishery', hereafter referred to as the Winter Krill Project. The main objectives of the Winter Krill Project are 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 fishery area. The motivation behind this is that the commercial krill fishery around South Georgia (SG) operates exclusively during the winter period, yet information on the stock dynamics and distribution of krill during this period are sparse. Although MPA restrictions include a 30 km no-take zone around the SG coast, there is evidence to suggest that the foraging habits of krill-dependent predators such as penguins and seals vary depending on the abundance of krill, and that this may result in overlap between them and the krill fishery, particularly during low krill years. There is also evidence of baleen whales returning to SG in large numbers during the summer and of some remaining during the winter, with the increased prey demand potentially further increasing competition for krill resources. Our project will address this gap in winter data, in turn improving management of the SG ecosystem and enabling the ecosystem-based management of the krill fishery.

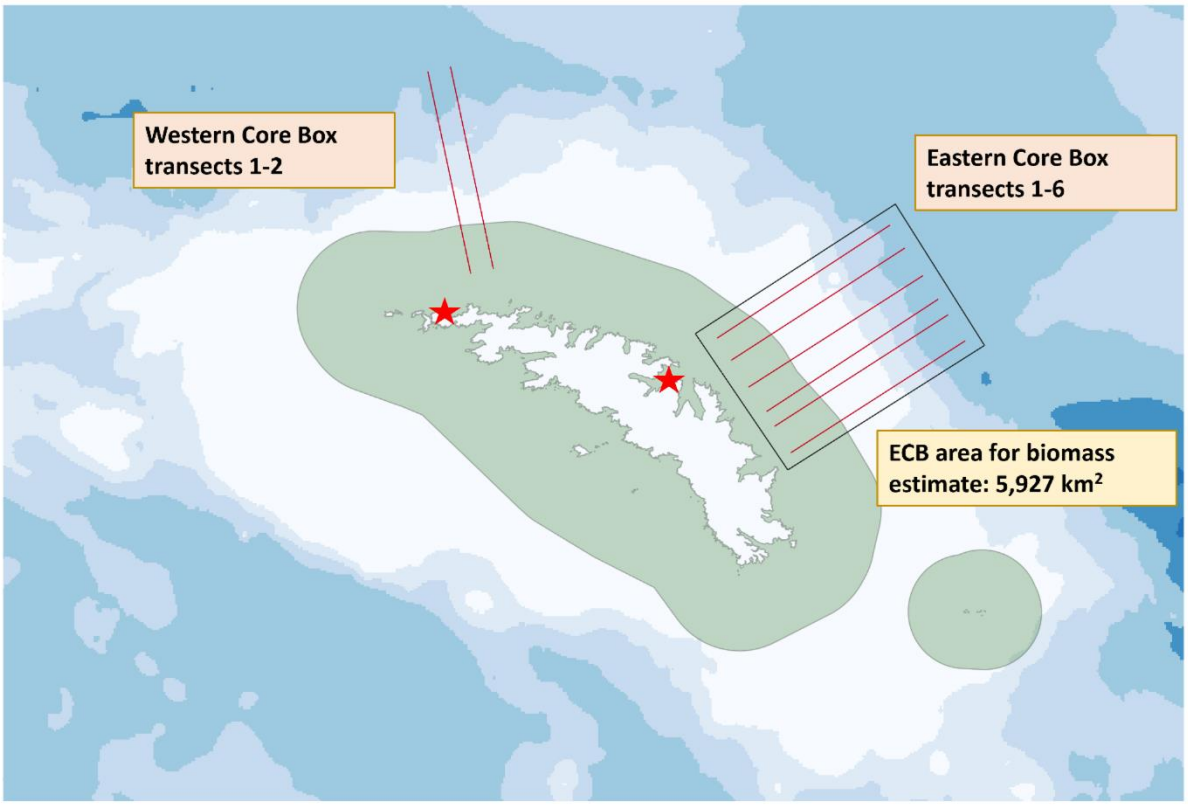

Figure 1: Map of part of the South Georgia and South Sandwich Islands Marine Protected Area (SGSSI MPA) showing the survey area with the six Eastern Core Box (ECB) and two Western Core Box (WCB) transects shown in red. The black box around the ECB shows the area of the region used to estimate krill biomass over. The red stars indicate the locations of gentoo penguin tag deployment at Bird Island (west) and Maiviken (central), respectively. The green area indicates the No Take Zone where fishing is prohibited (a 30 km distance from the SG coastline and a 12 nm (22.2 km) distance from the coastline of Clerke Rocks to the south-east).

2. Project stakeholders/partners

Formal project partners are the GSGSSI and the Antarctic Research Trust (ART). The project team includes members of these organisations and they, as well as the BAS project team members, are included in all project meetings and communications. These partnerships were developed based on the mutual interest of all partners in the project and its outcomes and the value that the partners could add to the project by being involved, and the project was developed with the involvement of both. The GSGSSI has a central role in the management of the SG ecosystem, MPA and the krill fishery; hence they have been directly involved in developing and executing the acoustic element of the project. The role of the ART is enabling the conservation of Antarctic and sub-Antarctic animals and has therefore been involved directly in the penguin monitoring aspect of the project, including providing the satellite tags.

Monthly meetings of the full project team are held (hybrid, with Zoom link for those not in Cambridge) on the first Monday of each month (or rearranged when this falls on a public holiday). Minutes are recorded and shared with all team members or made available through a team OneDrive folder which contains all documentation related to the project. In between these meetings, regular communication is maintained with team members and partners usually via email or by Zoom meeting. In addition, we have held more substantial full day project workshops for all team members, partners and key stakeholders where interim results have been presented, discussed and used to inform further work. These have taken place at BAS with an online link for those unable to join in person in December 2022 and December 2023. All partners have therefore been involved in project planning, decision-making and analytical elements.

In addition to the formal project partners, we have a range of interested stakeholders that we are maintaining communications with. This includes the Association for Responsible Krill Harvesting (ARK), AkerBiomarine, WWF, Birdlife International, Cefas, Pew Charitable Trusts, RSPB, South Georgia Heritage Trust (SGHT), South Georgia Association (SGA), Plymouth Marine Laboratory (PML), South Atlantic Environmental Research Institute (SAERI) and the UK Foreign, Commonwealth and Development Office (FCDO) and we update our list as required. We have maintained stakeholder communications via dedicated workshops, email updates, updating our website e.g. with our latest field reports; and presenting our findings to various stakeholders at a number of scientific conferences, workshops and meetings. Relevant meetings during this review period include GSGSSI MPA Review Workshop, Winter Krill Project Workshop December 2023, ICES/PICES 7th International Zooplankton Symposium 2024, SKEG 2024.

We have also developed a relationship with colleagues at the College of Staten Island (New York) who have been conducting research of a similar nature to us on the US research vessel Lawrence Gould. We were in particularly close contact during the July 2023 survey as both teams were in the SG region during this time, and have had a number of conversations discussing potential scientific collaborations, although these are likely to come to fruition beyond the scope of the current project.

3. Project progress

3.1 Progress in carrying out project Activities

The completion of activities 1.1-1.6 have been reported on in previous annuals reports.

Additional comments are that as KEP Science personnel change, they are trained in the methods in a period of handover, and following the protocols provided in the manual, and that tweaks to the manual have been made to include or clarify certain details.

Activities 2.1 -2.3: Following completion of the first year of surveys, the second year of acoustic and predator surveys were carried out in March/April, July and September 2023. In addition, a February 2023 survey was carried out which is not directly related to the project but provided additional summer context. The reason for the first survey being carried out earlier than in 2022 was due to the MV *Pharos SG*'s dry dock scheduling (during May). This was agreed as part of a change request. The locations of the surveys are shown in Figure 1 and were the same as the previous year. Reports from each of the surveys are available on our project website. Additional matched funding (not included in original proposal) was secured BAS/GSGSSI to support the participation of dedicated seabird observers experienced in JNCC methods on each of the July and September surveys. Unfortunately timescales were too short to be able to recruit someone for the March/April survey. Ryan Irvine (seabird observer for 2022 surveys) providing continuity training and data sheets for the new observers to enable consistency between years (**Activity 2.2**). Additional funding secured from the South Georgia Heritage Trust and Friends of South Georgia Island enabled the deployment of passive acoustic DIFAR sonobuoys during the September 2023 survey. The sonobuoys detect cetacean vocalisations and this has supplemented the at-sea transect work, being used to acoustically locate whales in real time, and to record their vocalisations (**Activity 2.3**). We equipped gentoo penguins *Pygoscelis papua* with Wildlife Computers SPOT 257 satellite tags (or Platform Terminal Transmitters; PTTs) provided as matched funds by the Antarctic Research Trust. Tags were mounted in the centre of the penguin's back using Tesa tape, adhesives and cable ties (Fig. 1). These were deployed at Maiviken (Y1 n=6, Y2 n=8), on the central portion of the north coast of South Georgia, and Bird Island (Y1 n=6, Y2 n=4), at its western tip, during the winters of 2022 and 2023. PTTs transmit signals to the ARGOS satellite system, so locations are obtained irrespective of where birds travelled. Around 13 fixes are obtained per day with accuracy varying from 120 m to 25 km (as indicated by a fix-specific error ellipse). We similarly equipped birds (n=9) with Pathtrack Nanofix GPS tags at Bird Island which were provided by BAS matched funding. These tags logged positions every 30 minutes with an

error ellipse of ~50 m. Their data were relayed by a radio link to one of four base stations deployed next to the main gentoo penguin roost sites on Bird Island. This link has a range of a few kilometres, so any birds that moved permanently away from Bird Island were lost from the study. Some GPS tags had inbuilt time-depth-recorders (TDRs) which will allow investigation of diving behaviour by recording time and pressure every 5 seconds. A summary of tag deployments according to site, year and device type is presented in Table 1. (**Activity 2.5**).

Activities 3.1-3.2: The acoustic data obtained during the three Y2 surveys were cleaned and processed in Echoview (version 13.0.378), and calibrated with *in situ* temperature, salinity and speed of sound derived from CTD measurements. Time-varied gain background noise was removed (De Robertis & Higginbottom 2007), and intermittent noise was removed and replaced with a 7x7 average Sv (Wang et al. 2016). A surface exclusion of 7 m was applied to account for the transducer depth (4.3 m) and non-linearity in the echo response in the 120 kHz transducer nearfield (2.7 m). Krill aggregations were identified using the SHAPES algorithm (Coetzee 2000), applied to clean 120 kHz acoustic data filtered using a 3x3 dilation (Macaulay et al. 2019). The algorithm detected swarms with a minimum length of 15 m and height of 3 m. Adjacent swarms were joined together if they were horizontally <23 m and vertically <5 m apart. This overcame an issue identified with missing pings, which in some cases resulted in swarms being incorrectly joined. The data from Y1 were reprocessed with the same 23 m join distance. This value was determined through a series of sensitivity analyses which identified this as being the minimum join distance to resolve the issue in the majority of cases. In two instances, the join distance was increased manually to account for a larger than usual number of missed pings. All files were additionally manually checked to ensure no erroneous swarms had been identified. Data pertaining to individual swarms and their associated characteristics e.g. length, depth, height, area and density were exported from Echoview for subsequent analysis. The Nautical Area Scattering Coefficient (NASC) was integrated over 1 nm x 250 m and 100 m x 250 m bins, and exported from Echoview. This was then converted into biomass by multiplying it by a coefficient calculated from the krill target strength, based on the length-frequency obtained from the plankton trawls (**Activity 3.1**). All raw data has been backed up on BAS internal systems and stored in the BAS Polar Data Centre (PDC) in a dedicated Winter Krill project directory which links to data collected on the *Pharos SG*, organised by survey. A link from here to the South Georgia Data Portal is being created so the data can be accessed via both routes (**Activity 3.2**).

Activities 3.3-3.4: The krill acoustic data from both years have been analysed in detail, with krill biomass estimates being produced and swarm metrics analysed. These analyses have been presented at a number of project meetings, at international scientific conferences (e.g., GSGSSI MPA Review Workshop 2023, SKEG 2023, ICES/PICES 7th Zooplankton Symposium 2024, SKEG 2024), and in CCAMLR Working Group papers.

The distribution of krill throughout the survey period is shown in Figure 2. Estimates of krill density (g m^{-2}) and biomass (tonnes) within the ECB area (calculated as 5927 km^2, shown in Figure 1) have also been made for each of the survey periods, based on all transect data (day and night, Table 1); as well as daytime only and night-time only transects (Figure 3 and Table 2). Note that estimates from Y1 have been updated from last year to reflect corrections made to the acoustic data processing procedure.

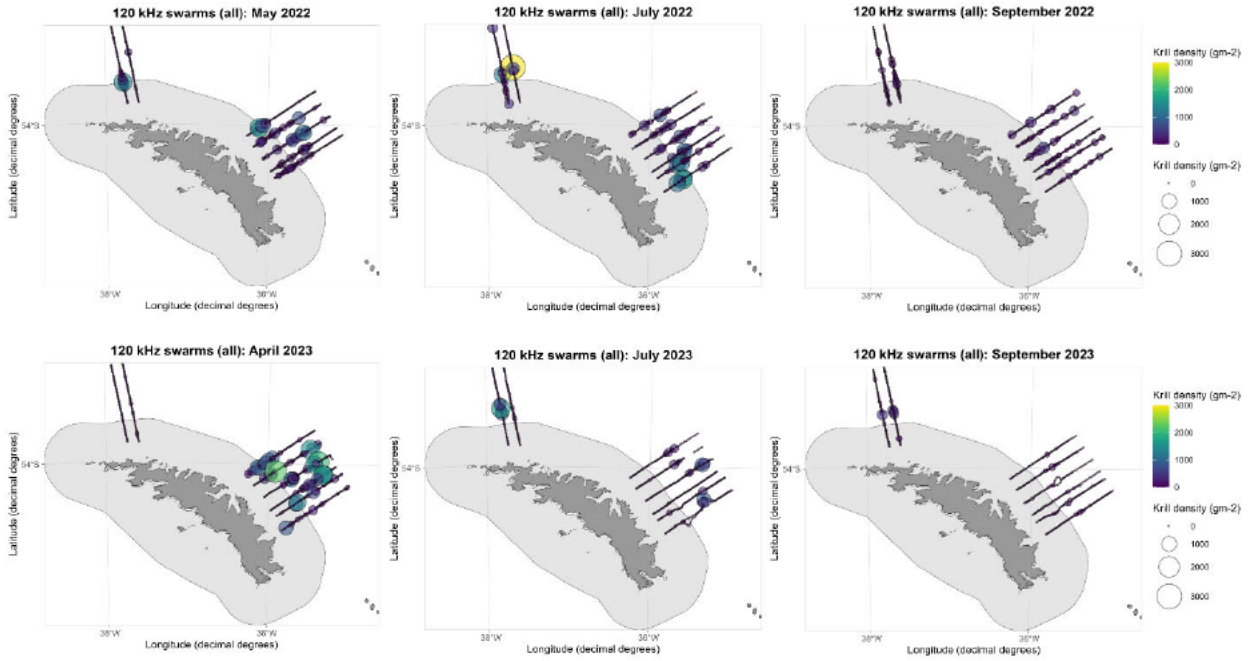

Figure 2: Maps showing the distribution of krill biomass in 2022 (top) and 2023 (bottom) as estimated using the CCAMLR swarms algorithm (g m^{-2}) and integrated over 1 nm by 250 m intervals. All plots show day and night transect data combined. May (2022) & April (2023) are shown on the left, July in the centre and September on the right.

Table 1: Estimates of krill density (g m^{-2}), biomass (tonnes) and variance for the ECB area in May, July and September 2022, and April, July and September 2023. Numbers are based on day and night transect data combined.

Survey	May 22	Jul 22	Sep 22	Apr 23	Jul 23	Sep 23
Mean density (g m^{-2})	45.3	41.5	12.8	96.9	10.7	1.5
CV	20%	31%	24%	26%	45%	29%
Biomass (tonnes)	268,571	245,816	75,676	574,249	63,389	8,641
Lower interval	162,623	95,568	39,971	277,930	7,151	3,809
Upper interval	374,520	396,064	111,381	870,568	119,626	13,472

In 2022, krill generally appeared closer to the inshore than offshore end, with greatest densities found over the shelf or at the shelf-break. Densities in the ECB were broadly similar in May and July (42-45 g m^{-2}), decreasing substantially by September (13 g m^{-2}). In the WCB, densities appeared lowest in May and highest in July, although statistical estimates were not possible due to only 2 transects being covered. This was suggestive of a westward movement of krill from the ECB region earlier in the season, towards the WCB region later in the winter. In 2023, ECB densities in April (97 g m^{-2}) were almost double those of May 2022, although the earlier survey date likely influenced this. There was no clear pattern of on vs off-self distribution. However July and September densities were substantially lower than the previous year (11 and 2 g m^{-2}, respectively) and krill was mostly encountered at the shelf break. Distribution patterns in the WCB were similar to 2022, with lowest densities in April and highest in July.

A clear diurnal influence was also apparent in both years, with biomass estimates in general higher when using night-time transect data alone (the exception being May 2022). This effect was strongest in July and September of 2022 but was still apparent in 2023 (Table 2 and Figure 3).

Table 2: Estimates of krill biomass (thousand tonnes) for the ECB area in May, July and September 2022, and April, July and September 2023 constructed using daytime or night-time transects only. Numbers are presented rounded to the nearest thousand tonnes.

	Day	Night
May 2022	294	243
Jul 2022	56	427
Sep 2022	40	113
Apr 2023	565	584
Jul 2023	42	83
Sep 2023	7	10

This suggests that the usual CCAMLR protocol to use daytime transect data to construct biomass estimates may risk underestimating krill biomass during the winter. It may also lead to alternative interpretations of how krill biomass changes over the course of the season, with the maximum biomass in 2022 being observed in May (July) depending whether we use daytime (night-time) transect data. The reasons for this diurnal variability are unclear at present and are the subject of ongoing analysis. One hypothesis is that krill are diurnally vertically migrating, perhaps with a seasonal or other environmental component that causes this to vary throughout the year, and that during daytime the krill are pressed close to the seafloor and therefore less detectable on the acoustics. The second hypothesis is that the krill are off-shelf during the day and move onto the shelf at night. Modelling work is currently underway to assess the drivers of variability in krill distribution and extrapolate this across the survey area and to relate this to predator observations and movements.

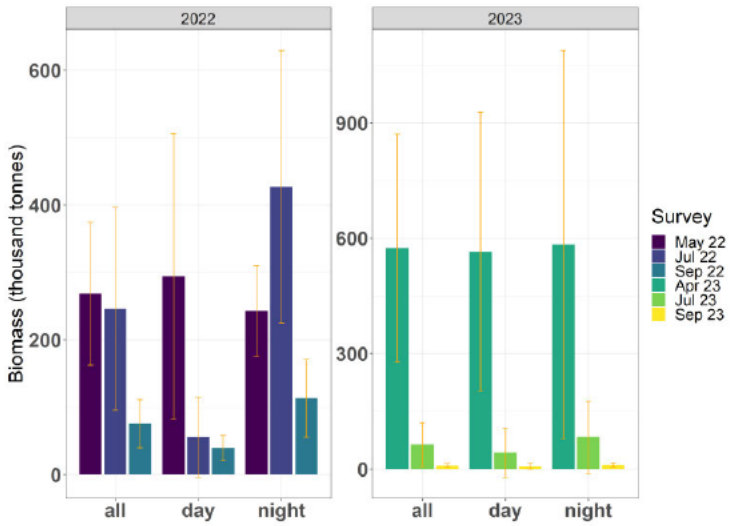

Figure 3: Box and whisker plots showing the estimated krill biomass (thousand tonnes) in 2022 (left) and 2023 (right). Plots show estimates constructed with day and night-time transect data combined (left), daytime transect estimates (middle) and night-time transect estimates (right). Note different biomass scales on the y axis between years due to higher April 2023 biomass.

Diurnal differences were also apparent in swarm depth (Figure 4). There was a significant difference in the mean depth of swarms between 2022 (71 m) and 2023 (114 m). This appeared to be driven largely by much deeper swarms during daytime in 2023, whereas the depth of night-time swarms remained consistent between years (~70 m).

Whilst there was no significant difference in depth between day and night during 2022, in July and September the night-time swarms were slightly deeper than the daytime swarms. A reversal in this pattern occurred in 2023, when daytime swarms were significantly deeper in all survey months. In both years, night-time swarms were deepest during July (the middle of winter) reinforcing the idea that there may be a seasonal component to krill vertical distribution.

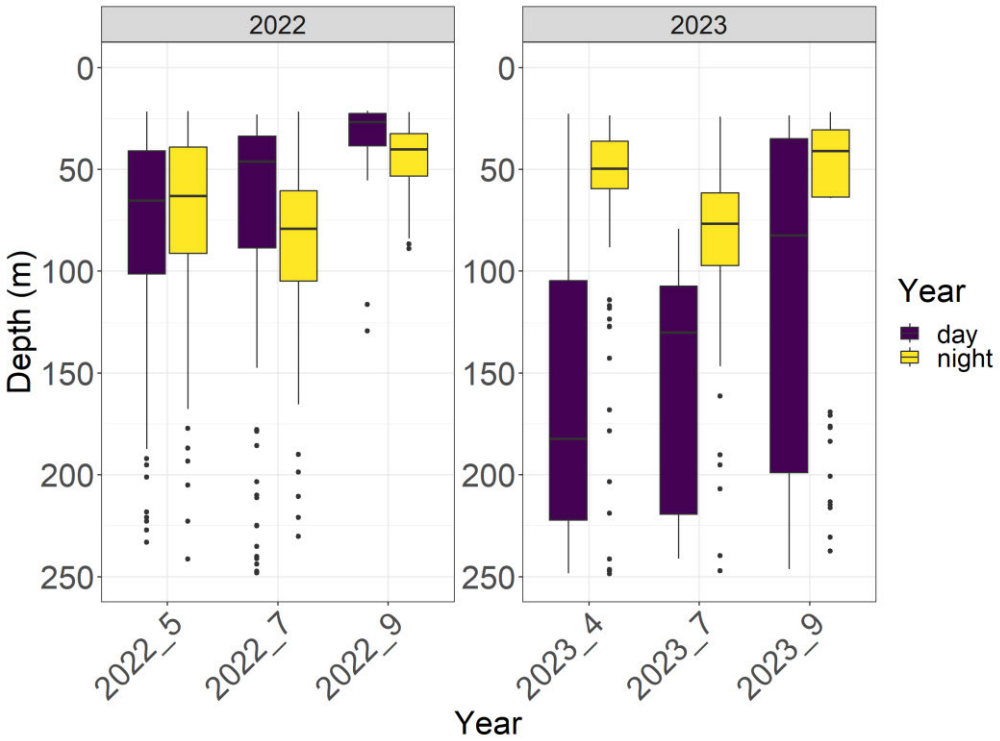

Figure 4: Box and whisker plots showing the average swarm depth in each survey for 2022 (left) and 2023 (right), split by day (blue bars) and night (yellow bars).

One hypothesis for both the deeper swarms and the lower winter (July and September) krill biomass observed during 2023 is that there was an influence of ice from the breakup of iceberg A76A. This resulted in substantial large icebergs and brash ice in the survey region, necessitating some deviations from transects, and lower in situ salinity, particularly during July and September 2023 (Figure 5). Work is currently underway to examine this hypothesis and the potential mechanism in more detail, as well as to consider patterns in other swarm characteristics and potential relationships to environmental or other drivers.

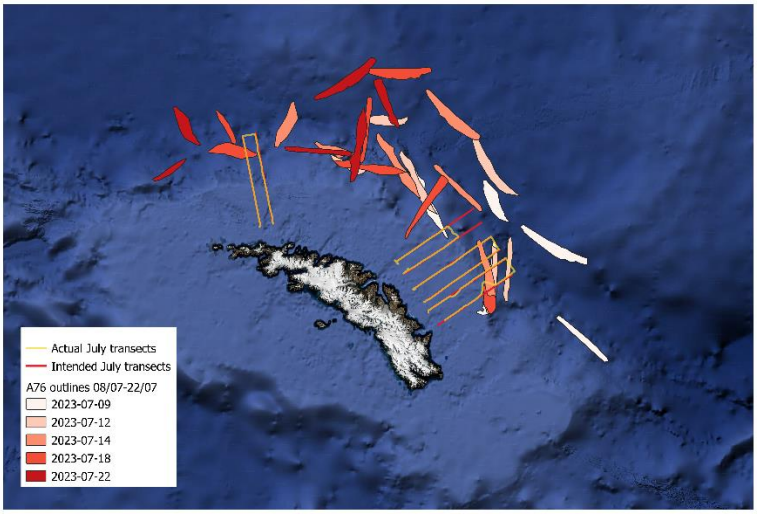

Figure 5: Positions of icebergs during the July 2023 survey coloured by date, with the positions of our transects shown in orange.

Based on the analyses of Y1 data, one paper based on the krill acoustic analyses was submitted to the CCAMLR ASAM Working Group 2023, and one based on krill and predator distributions was submitted to the CCAMLR EMM Working Group 2023. Further papers incorporating Y2 data, as summarised above, will be submitted to the 2024 meetings. These also form the basis of a number of publications that are being prepared for peer-review (**Activity 3.4**).

Activity 4.1: Data from the tracked penguins was relayed via the ARGOS systems and near real-time tracks were shown on the BAS project site whilst transmitting. The data obtained through the project is stored in the BAS PDC and a link to the PDC repository is being created from the South Georgia Data Portal.

Activity 4.2: The penguin tracking data were processed using the R package CRAWL (Johnson et al. 2008) which estimates the most likely path based on swimming speed and error ellipses of the ARGOS and GPS fixes. Tracks were sampled every hour, on the hour, so that the frequency of fixes was constant through time and across device types. Time spent ashore was taken as the proportion of time the saltwater sensors were dry in the case of PTTs or whether fixes were within a 150 m buffer of the coast in the case of GPS tags. Line plots of movements at sea and the locations of roosts were plotted on a map of South Georgia and bathymetry (from gebco.net) using a Lambert Conformal Conic projection. Grid maps of time spent at sea ('Activity') were used to examine distributions within the areas of intensive use around the release sites in greater detail. These summarised the proportion of total activity across all individuals within a grid of 2.5km diameter hexagonal cells. Overlaps with the no take zone for krill fishing (NTZ; a 30 km buffer around the South Georgia coast) and the 95% isopleth of the krill fishing grounds (derived from the kernel density net haul locations in the focal year) were calculated to infer risk of exposure to fisheries competition.

The tracked gentoo penguins mostly remained within shelf waters and showed a considerable degree of fidelity to the area local to the release location. However, with time, some birds moved along the coastline to utilise new foraging locations, travelling in a series of hops by using intermediate roost sites as steppingstones (Fig. 6). This pattern of habitat utilisation and movement has been observed previously at South Georgia (Tanton et al. 2002, Ratcliffe et al. 2021) as well as in the Falkland Islands (Clausen and Putz 2003, Baylis et al. 2021) and the South Shetland Islands (Hinke et al. 2017). There was very little overlap in the wintering distributions of the birds from Bird Island and Maiviken in either year (Fig. 6).

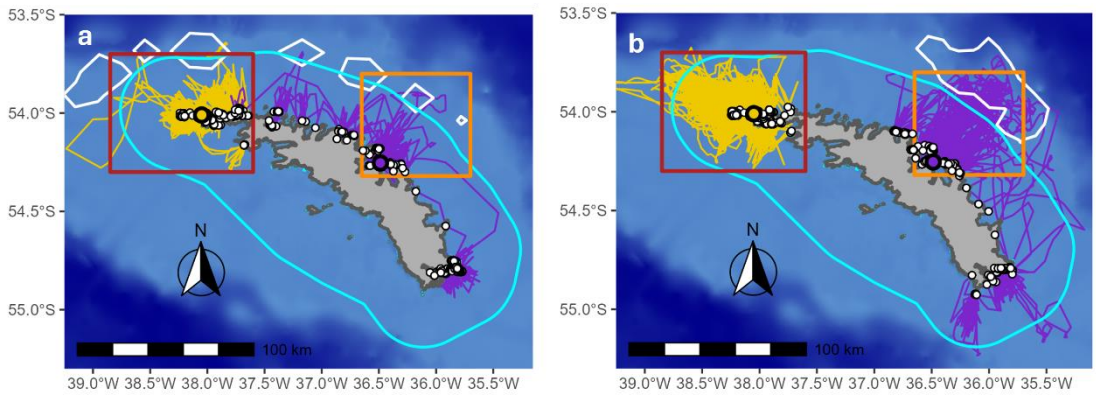

Figure 6. Movements of gentoo penguins during the winters of (a) 2022 and (b) 2023. Yellow lines are tracks from Bird Island and purple those from Maiviken. Large, coloured circles indicate release locations and white locations where at least one bird roosted ashore. The white polygon is the 95% isopleth of krill fishery catches and the cyan polygon the boundary of the 30 km no-take zone. Boxes are extents of inset maps (Figs 6 and 7).

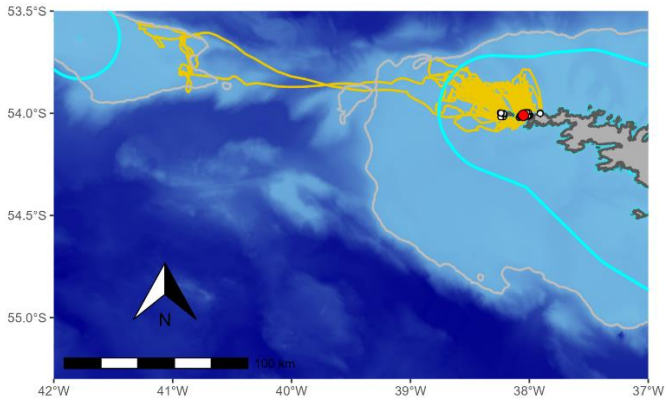

Figure 7. An extraordinary trip to the west of Bird Island by a GPS-TDR equipped gentoo penguin in 2023. This trip is cropped out of Fig 2 to allow a map scale that allows typical tracks to be seen more clearly. The yellow line is the track of the bird, cyan line the boundary of the South Georgia and Shag Rocks NTZ, red circle the deployment location, white dots roost locations and the grey line the 400m depth contour which approximates the continental shelf edge.

Penguins tracked from Bird Island showed strong fidelity to their deployment location (Figs. 6 and 7), utilising the area to the north and south of Willis Island most intensively in a pattern similar to the 2009-2010 breeding season (Ratcliffe et al. 2018). Previous satellite tracking of gentoo penguins from Bird Island in 2001 also found most birds remained in the local area, although in that study one bird did move to the SE of South Georgia (Tanton et al. 2004). Some birds in our study ranged east along Church and Right Whale Bays in both years and in 2022 one moved southeast to Elephant Cove before returning to Bird Island (Fig. 6). One GPS tagged bird in 2023 performed an extraordinarily long trip to the eastern Shag Rocks shelf, 223 km to the west of Bird Island with evidence of linear travel across waters deeper than 400 m (Fig. 7).

Birds from Maiviken used the area off Cumberland Bay most intensively in both years (Fig 6 and 8). Some birds made directed movements to the Cooper Island / Drygalski Fjord region in the SE of South Georgia, an area similar to that used by the mobile individual from Bird Island in 2001 (Tanton et al. 2004). Movements extended further to the west of Cumberland Bay in 2022 than in 2023 (Fig 6).

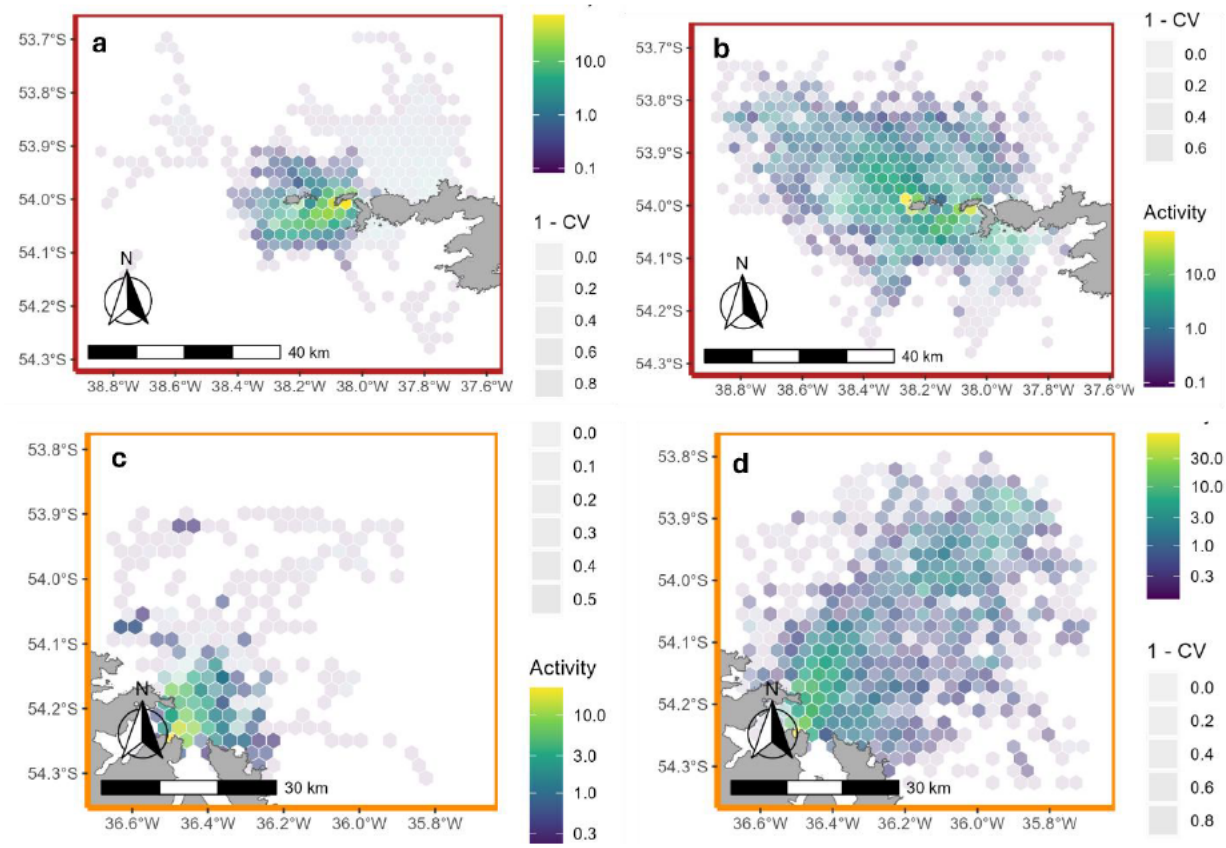

Figure 8. Density maps of gentoo penguin activity (time at sea) from Bird Island in (a) 2022 and (b) 2023 and Maiviken in (c) 2022 and (d) 2023, where colour indicates the intensity and opacity the variability in cell use across all individuals. Colour boundary matches that of the inset box in Fig. 1.

At both sites gentoo penguins moved further offshore in 2023 compared to 2022, with an associated reduction in activity occurring within the NTZ at both Bird Island and Maiviken (Table 3). The activity outside the NTZ in 2023 was 3.8 and 13.6 times higher than in 2022, at Bird Island and Maiviken respectively. The activity of birds from Maiviken occurring inside the 95% isopleth of krill fishing net hauls was 17.1 times higher in 2023 compared to 2022. In addition to birds foraging further from shore in 2023, the fished area to the NE of Cumberland Bay was larger in comparison with 2022 (when fishing was spread out along the northern shelf break; Fig. 6). Birds from Bird Island showed virtually no overlap with the fished area in either year (Table 3). The lower krill availability in 2023 is likely to have forced gentoo penguins to forage for longer and further from shore to meet their energetic requirements, which increased their risk competition with the fishery during periods when resources were limited (Ratcliffe et al. 2021). Further analyses are planned to model gentoo distribution and movements in relation to habitat availability (including krill distribution and abundance) and to investigate patterns in dive depth, trip duration and time-budgets through the winter period.

***Table 3**: Overlaps of gentoo penguin activity (time at sea) with the krill no take zone (NTZ) and krill fishing area (FA) according to release location and year.*

Location	Year	Polygon	% Overlap
Maiviken	2022	NTZ	97.92
Maiviken	2023	NTZ	71.75
Maiviken	2022	FA	1.07
Maiviken	2023	FA	18.35
Bird Island	2022	NTZ	98.57
Bird Island	2023	NTZ	94.56
Bird Island	2022	FA	0.34
Bird Island	2023	FA	0.00

Activities 4.3-4.5: All the cetacean observation and passive acoustic data obtained during the project has been backed up on BAS internal systems and archived as described above for other datasets. Final datasets will also be published with DOI upon manuscript publication.

On all surveys, seabird and marine mammal observations in accordance with standard JNCC Seabirds at Sea methods (Tasker et al., 1984) were conducted concurrently with all daytime krill-acoustic transects. On most of the surveys, seabird and marine mammal observations were conducted concurrently with all daytime transects, in accordance with standard JNCC Seabirds at Sea methods (Tasker et al., 1984). On three surveys there were additional marine mammal researchers using distance sampling methods to carry out visual surveys. There was also passive acoustic monitoring using DIFAR sonobuoys on two of the surveys (Table 4).

Table 4. Summary of cetacean observation effort on each survey

Survey	Marine mammal data collected
May-22	Single seabird observer also recording marine mammal observations
Jul-22	Single seabird observer 3 marine mammal observers Passive acoustic monitoring (sonobuoys)
Sep-22	Single seabird observer also recording marine mammal observations
Mar/Apr 2023	No seabird observer Opportunistic visual effort from other researchers
Jul-23	Single seabird observer Single marine mammal observer
Sep-23	Single seabird observer 3 marine mammal observers Passive acoustic monitoring (sonobuoys)

During the July 2022 and September 2023 surveys, a minimum of two marine mammal researchers at any one time collected visual data on cetacean and pinniped sightings. In July 2023 this was done by a single marine mammal researcher. These were separate from 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 Release 6.2 (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 3m-tall antenna was mounted above the bridge with the base at a height of 11.5m, giving a maximum effective reception range to the sonobuoys of around 10km. 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 to a depth of 140 m.

The planned survey transects comprising around 500 km of effort each survey were completed on each of the six surveys with some additional opportunistic effort, and some modifications for weather or ice (Figure 9). Areas of large icebergs throughout 2023 blocked parts of some transects. Humpback whales were the most frequently sighted species, followed by southern right and fin whales. Surface feeding southern right whales were seen at dusk on three occasions in July 2022, all at the inshore end of transects. Further details of these observations are given in Calderan et al. (2023). Further details including hours of effort and species counts can be found in the survey reports on the website, or in the paper submitted to IWC 2024 (available on request).

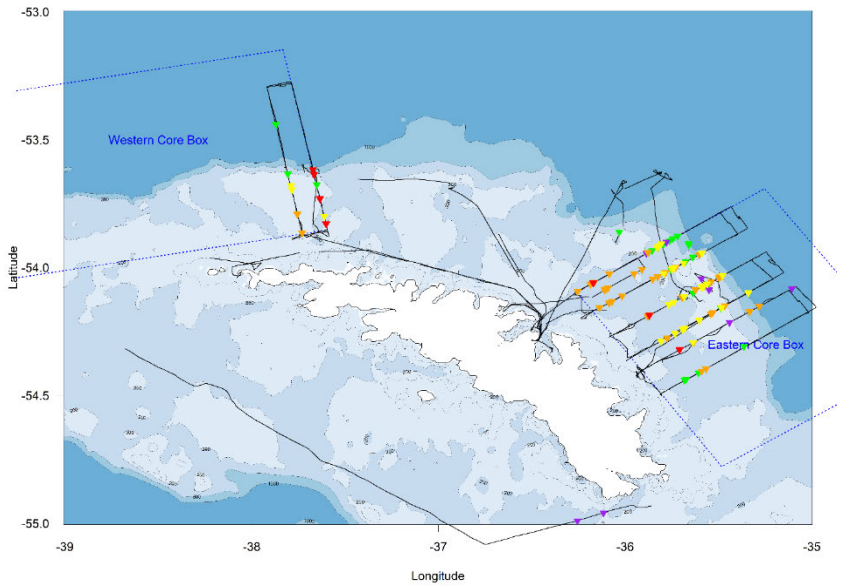

Figure 9. Transects in the Eastern and Western Core Boxes and other survey effort with marine mammal researchers (black lines). Sightings of humpback whales (May 2022 = yellow, July 2022 = orange, September 2022 = red, July 2023 = green, September 2023 = purple). Dotted lines represent full extent of original BAS ECB and WCB survey boxes.

Data suitable for Distance analyses were collected on the three surveys with dedicated marine mammal researchers. Combining July 2022, July 2023 and September 2023 surveys gave 74

positively identified humpback sightings with perpendicular distances. Truncating at a perpendicular distance of 3km removed 3 observations. This provided sufficient sample sizes to test for differences between the single observer and larger team. For the full team, there were 47 sightings and the best fit detection function based on minimum AIC was a half-normal, giving an estimated strip width (ESW) of 1345m (95% CI 1097m – 1649m). For the single observer, there were 25 sightings with the best fit detection function a half-normal with second order cosine adjustments, giving an ESW of 1267m (95% CI 719m – 2235m). These were considered sufficiently similar to pool the data giving a best fit detection function of half-normal with second order cosine adjustments (Figure 10), and an ESW of 1149m (95%CI 881m-1499m).

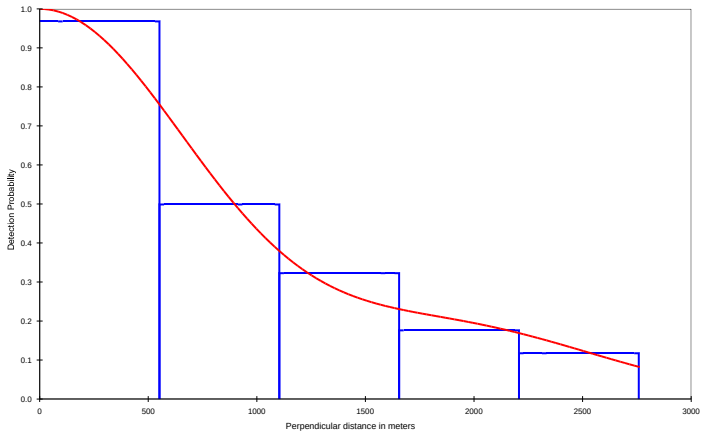

Figure 10: Perpendicular distance and fitted detection function for humpback whales (n=71), truncation at 3000m.

Given the lack of significant differences between observer teams for the larger sample of humpback whale sightings, it was assumed that the southern right whale sightings could also be pooled to obtain sufficient samples to estimate a detection function. Truncating at 1600m removed two observations leaving 38. The best fit detection function was a half-normal (Figure 11) giving an ESW of 910m (95% CI 729m-1137m).

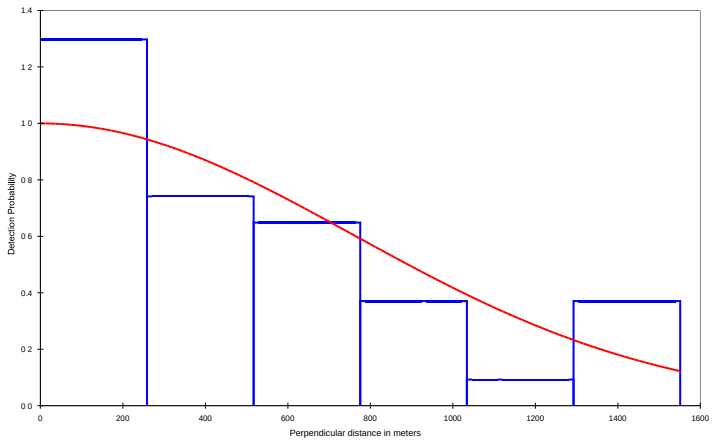

Figure 11. Perpendicular distances and fitted detection function for southern right whales (n=38), truncation at 1600m.

The aim with the sonobuoy deployments was to achieve as even broadscale coverage as possible within the constraints of the other vessel operations (Figure 12).

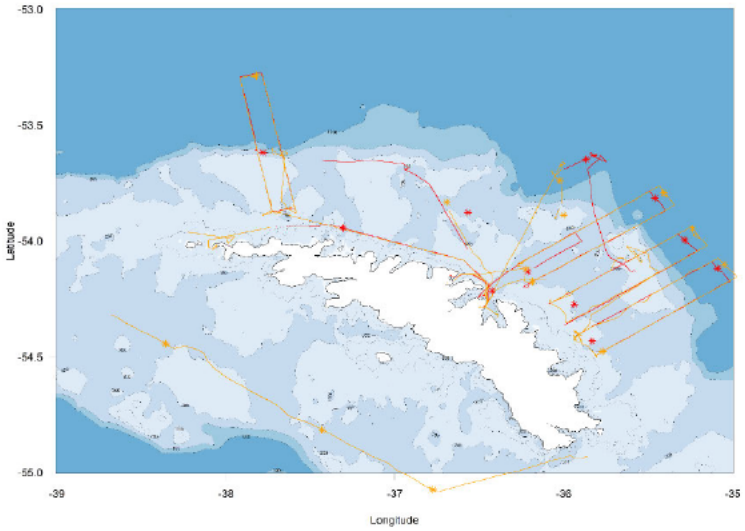

Figure 12. Locations of all sonobuoy deployments and survey tracks in July 2022 (red) and September 2023 (orange).

Thirteen sonobuoys were deployed in July 2022 resulting in 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.

Sixteen sonobuoys were deployed in September 2023 giving a total monitoring time of 33.5 hours. Calls were detected from southern right whales, Antarctic blue whales, fin whales and Antarctic minke whales. In contrast to previous surveys, no humpback whale vocalisations were detected in September 2023 despite sonobuoys being deployed relatively close to sightings of humpback whales which were likely feeding. The number of fin whale calls received (144 bearings measured) was also much lower than in July 2022.

Although unit A calls from Antarctic blue whale calls were detected on the majority of sonobuoy deployments in both 2022 and 2023, these calls were faint, and the locations of whales were likely several hundred kilometres ENE of the survey area. There was a higher number of blue whale FM calls (indicative of closer whales) in July 2022 than in September 2023. Further details are provided in the IWC paper (available on request).

A number of images suitable for photo identification were also obtained during the surveys (Table 5). 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 5. Summary of cetacean photo-ID records obtained during the surveys.

Survey	Humpback whale	Southern right whale	Fin whale	Sperm whale
May 2022	2	-	-	-
July 2022	5	5	-	-
Sep 2022	-	-	-	-
April 2023	2	-	1	-
July 2023	4	-	-	-
Sep 2023	1	-	-	1
TOTALS	14	5	1	1

First observations of southern right whales feeding on surface krill swarms were published in Calderan et al. (2023). Further work is currently underway to construct estimates of consumption

and to carry out more detailed spatial analysis and associations between whale distributions and krill occurrence, density and swarm characteristics **(Activity 4.5)**.

Activities 4.6-4.7: All the seabird and fur seal data obtained during the project have been backed up on BAS internal systems and is being archived as described above for other data (**Activity 4.6**).

To estimate abundance and distribution of predators within the survey area, seabird observations were conducted during all three 2022 surveys, and the July and September 2023 surveys, concurrently with all daytime acoustic transects, in accordance with standard JNCC Seabirds at Sea Methods (Tasker et al., 1984) and following the Winter Krill Seabird Observation protocol. Observations were also undertaken during patrol around the islands and on passage between Falklands and South Georgia. Observations were made from the bridge, with the seabird observer viewing either port or starboard side of the vessel, depending on conditions. No attempt was made to identify Diving Petrels to species level for these surveys, although the majority of close birds fitted the appearance of Common rather than South Georgia. Results from the 2022 surveys are presented in last year's report.

During July 2024, the most abundant seabird species were diving petrels (a mix of common and South Georgia diving petrels, n=2,342). Diving petrels were particularly abundant in the Western Core Box area. Next most abundant were blue petrels (n=150), Antarctic terns (n=123) and giant petrels (n=101). Antarctic terns and giant petrels were most common in the ECB area, whilst the abundance of blue petrels was fairly even across both ECB and WCB. Cape petrels and Kerguelen petrels were also seen in reasonable numbers (n=74 and n=58 respectively), with Cape petrels more abundant in the ECB and Kerguelen more common in the WCB.

During September 2024, within both Eastern and Western Core Boxes, the most abundant seabird species were blue petrels (n=655) and cape petrels (n=253). Many Antarctic fur seals were also present in the area (n=181), with many more seen on patrols. It was noticeable that there was generally a much lower number of most species compared to September 2022, with far fewer blue petrels and diving petrels especially. There was also a complete lack of black-browed albatross in either Core Box and grey-headed albatross was only recorded in the Western Core Box. There were also very low numbers of prions, with every photographed bird proving to be Fairy prion. In general, the area nearer the coast supported very small densities of birds compared to areas further offshore. Further detail on the species counts can be found in the reports published on our website.

Activity 4.8: In addition to the papers mentioned in 3.4 above, two papers presenting preliminary cetacean analyses were submitted to the International Whaling Commission (IWC) meetings, in 2023 and 2024 respectively (see also sections 4.4-4.5).

Activities 5.1-5.2: The initial stakeholder meeting was held on 24th January 2022 and on 7th December 2022 we held a project team workshop to share and discuss preliminary findings, which included primary project partners and some key stakeholders. Updates to all stakeholders have been provided regularly by email and through our website. We have also invited all stakeholders to a final project workshop that will be held at BAS with an online participation option on 14-15 May 2024.

Activity 5.3: In addition to the articles reported in our last report, articles by Cecilia Liszka & Martin Collins were published in Ocean Challenge magazine in April 2023 the Marine Biologist in July 2023.

Activity 5.4: One paper (Calderan et al, 2023, DOI https://doi.org/10.1111/mms.13025) was published in the Journal of Marine Mammal Science. At least four further papers are being developed and are likely to be submitted after the end of the project.

Activity 5.5: Our final stakeholder meeting has been arranged for 14-15 May 2024 and stakeholders have been invited.

Activities 6.1 & 6.2: We have input our findings to date to the GSGSSI 5 Yearly MPA Review process and have engaged in regular subsequent discussions with GSGSSI regarding future management recommendations. Further discussion will take place both at the final stakeholder workshop and on an ongoing basis, including via submissions to the CCAMLR process. Any revisions to the relevant plans coming as a result of our results are likely to be implemented after the end of the project.

3.2 Progress towards project Outputs

Output 1: Long-term capability for winter pelagic ecosystem assessment enabled for South Georgia

This output was largely achieved during Y1 & Y2 as described in previous annual reports. The decision to undertake pelagic ecosystem assessment throughout the whole year, with at least 4 acoustic transects approximately every other month alongside plankton tows, CTDs and opportunistic cetacean observations, is being incorporated into the new KEP Science Plan. Capacity to run the surveys continues to be maintained within KEP, GSGSSI and *Pharos SG* staff and crew.

Output 2: Winter krill acoustic and predator surveys / tracking undertaken.

All our survey work has now been completed and reports from all surveys are available on our website.

Output 3: Winter krill stock assessment in South Georgia fishery area for each of two years, including krill swarm characteristics

Estimates of krill biomass and density across the ECB (area covered by the transects) for both years have been produced. Krill swarm characteristics, including length, depth, height and density, have also been obtained for both years of surveys for both the ECB and WCB transects. Results have been presented in a wide range of fora, including CCAMLR Working Group papers, stakeholder workshops and international science conferences.

Output 4: Winter predator abundance, distribution and tracking data analysed

The distributions of cetaceans, fur seals and seabirds have been analysed based on data collected from both years of surveys. This has been submitted to the IWC in 2023 and 2024 and CCAMLR EMM 2023, with a paper to CCAMLR EMM 2024 in preparation. The movement of gentoo penguins from BI and KEP based on the PTT and GPS tracking tags have also been analysed for both years and has also been incorporated in the EMM papers described above.

Output 5: Stakeholder engagement and dissemination of results in scientific and popular literature and at international fora

Stakeholder engagement has been maintained throughout the project, including by email, website updates, meetings, workshops and conferences. Three articles for general readership have been published. A general talk was provided to the Young Marine Biologist Conference in 2023.

One paper presenting observations of southern right whale surface feeding on krill swarms in the survey area has been published in the scientific journal, Marine Mammal Science.

Two papers were submitted to CCAMLR in 2023 and two more are planned for 2024. These will also be worked up into papers for the scientific literature.

Output 6: Updates to SGSSI management plans and legislation

Initial results of the project were presented at the GSGSSI MPA Review Workshop in June 2023 and conversations have been continued as the GSGSSI response to the review is developed.

3.3 Progress towards the project Outcome

Outcome: *An understanding of the winter distribution of Antarctic krill and potential impacts of the krill fishery on dependent predators facilitates ecosystem-based management of the krill fishery.*

Having completed both years of acoustic and predator surveys, the project is already providing new understanding of the distribution of krill during the winter period throughout the area favoured by the fishery and key krill predators. We have been sharing our results with the wider krill community throughout the project so that we can better understand and interpret our results. This has been through presentations at the Scientific Committee on Antarctic Research (SCAR) Krill Expert Group (SKEG) workshops in both 2023 and 2024, and the ICES 7th Zooplankton Symposium in 2024. Having analysed both years of data some interesting patterns and responses have been identified, which is helpful both to current management and to guiding future research directions. The ongoing bi-monthly surveys that have been agreed with GSGSSI will continue to inform their understanding of krill distribution and abundance within the Marine Protected Area.

3.4 Monitoring of assumptions

Assumption 0.1: Stakeholder community engage in discussions regarding management.

Comments: Stakeholders engaged in the initial meeting and were enthusiastic about the project and it's expected outcomes.

Assumption 0.2: Acoustic fit to Pharos SG successful in Year 1

Comments: The acoustic system has been fitted to *Pharos SG* and been calibrated and tested. The fitting of the instrument was more expensive than envisaged and hence additional funds were sourced to cover the additional costs.

Assumption 0.3: GSGSSI update MPA Management Plan

Comments: Interim results of the project were presented at the GSGSSI MPA Review Workshop in June 2023. Conversations have been continued as the GSGSSI response to the review is developed and we will continue to provide input as required.

Assumption 1.1: Dry-docking is necessary for transducer fit. Vessel owners have agreed and dry-dock scheduled for Feb/March 2022; possible Covid-related uncertainty over dry-dock schedule.

Comments: The acoustic system has been fitted to *Pharos SG* and been calibrated and tested.

Assumption 1.2: GSGSSI staff are available for training.

Comments: Staff were available and training was provided.

Assumption 2.1: *Pharos SG* is available and not diverted for emergency or suffers mechanical issues.

Comments: The vessel was available for all surveys as planned during the 2022 season, but the first survey of the 2023 season was brought forward due to changes in dry dock timing for the vessel. No subsequent issues occurred during 2023.

Assumption 2.2: Weather is suitable. *Pharos SG* will seek appropriate weather windows to undertake transects.

Comments: A 3-day weather window is required for the ECB to be run successfully and a 1-2 day window is required for the WCB. In general the weather has been sufficiently favourable during all surveys allowing all activities to complete as planned.

Assumption 2.3: Birds can be captured and tags function correctly (previous work shows these assumptions are safe). Permits will be issued by GSGSSI.

Comments: Birds were able to be captured and during 2023 all tags functioned well.

Assumption 3.1 *Pharos SG* can collect high quality acoustic data. Appropriate weather windows to undertake transects (wind > 30 knots).

Comments: A 3-day weather window is required for the ECB to be run successfully and a 1-2 day window is required for the WCB. In general the weather was favourable during all surveys and acoustic data quality was sufficient. In July and September 2023 some deviations from transects were required due to large icebergs in the path of the transect. In September 2023 a large ice field necessitated slower vessel speeds at night and thus a shortening of the transects. Weather also deteriorated to some degree during the transects but all transects were still completed and data quality remained sufficient to enable analyses to be completed.

Assumption 4.1: Dependent on success of both at-sea acoustics and penguin tracking.

Comments: Penguin tracking and krill acoustics during both years were successful.

Assumption 4.2: Data quantity and quality adequate to obtain density estimates for baleen whales that can be extrapolated to the broader SG region. Multiple surveys and careful, adaptive transect design reduce this risk.

Comments: Sufficient data were obtained to be able to obtain density functions for humpback and southern right whales in both years.

Assumption 4.3: Numbers of detected cetaceans are sufficient to allow comparisons to be made. Multiple surveys maximise detection opportunities.

Comments: Sufficient data have been obtained.

Assumption 5.1: Publication in scientific journals will take time and is likely to occur after the end of the project.

Comments: This will occur following the end of the project.

Assumption 5.2: Newsletters willing to publish articles.

Comments: Newsletters have been very happy to publish articles (4 published/accepted so far).

Assumption 5.3: Stakeholders engage in meetings. Key stakeholders have provided letters of support.

Comments: Stakeholders have proven engaged in the project judging by responses to updates and participation in meetings.

Assumption 6.1: MPA review, which is due towards the end of the project, takes place.

Comments: Results were presented at a workshop to support the MPA review and we continue to feed in to the process.

4. Project support to environmental and/or climate outcomes in the UKOTs

Determining the abundance of krill during the winter and the impact of the winter krill fishery on krill-dependent predators is critical to ensuring the sustainable management of South Georgia's krill fishery and, more broadly, the Marine Protected Area. Until now, it has proved difficult to collect data on krill during winter, as suitably equipped vessels (such as the BAS ships) return north during the austral winter. The fit of the scientific echosounder system to the *Pharos SG* is critical to obtaining winter data for this project, but also enables the Government of SGSSI to undertake acoustic surveys in the future and at any time of year. This possibility is already being realised with the inception of bi-monthly acoustic and plankton surveys of at least four ECB transects throughout the year. The acoustic fit has also allowed the *Pharos SG* to carry out the summer WCB survey that would ordinarily be carried out by BAS vessels. The provision of winter data on krill is supporting both domestic management of the krill fishery and contributing to CCAMLR's management. An update on the project and results to date have been shared at a project workshop involving our OT partner, at the GSGSSI MPA review workshop, and during intervening conversations. Further engagement with the OT and other key fishery and conservation stakeholders will occur during our end of project workshop. In addition, we have engaged with the wider CCAMLR management process via contributions to relevant working groups in 2023 and are planning additional submissions for the 2024 round of meetings.

5. Gender Equality and Social Inclusion (GESI)

Please quantify the proportion of women on the Project Board[1].	50%
Please quantify the proportion of project partners that are led by women, or which have a senior leadership team consisting of at least 50% women[2].	66%

GESI Scale	Description	Put X where you think your project is on the scale
Not yet sensitive	The GESI context may have been considered but the project isn't quite meeting the requirements of a 'sensitive' approach	

[1] A Project Board has overall authority for the project, is accountable for its success or failure, and supports the senior project manager to successfully deliver the project.

[2] Partners that have formal governance role in the project, and a formal relationship with the project that may involve staff costs and/or budget management responsibilities.

Sensitive	The GESI context has been considered and project activities take this into account in their design and implementation. The project addresses basic needs and vulnerabilities of women and marginalised groups and the project will not contribute to or create further inequalities.	
Empowering	The project has all the characteristics of a 'sensitive' approach whilst also increasing equal access to assets, resources and capabilities for women and marginalised groups	X
Transformative	The project has all the characteristics of an 'empowering' approach whilst also addressing unequal power relationships and seeking institutional and societal change	

The project lead and board have considered gender equality and inclusion aspects in all relevant aspects of project design and implementation with the result that women make up half of the board and more than half of the implementation team (which includes the field team). There is no resident OT population to engage with specifically but both BAS and GSGSSI (the main two organisations involved in delivering work in the OT) will continue to ensure that recruitment of staff to continue the work will consider equality and diversity, and that the results of the work are communicated and made available to the wider community.

6. Monitoring and evaluation

Project delivery is monitored and evaluated by a Project Management Group (PMG) that is led by the Project Manager (Collins) and Marine Ecologist (Liszka) and includes all partners and the cetacean consultants (Leaper and Calderan). The PMG meets on the first Monday of each month to discuss and review the overall progress of the project activities in the context of the agreed log-frame and to agree and plan the next steps. Meetings were initially held on zoom but are now held in a hybrid format. This allows the BAS-based team to meet in person where possible, and facilitates full participation of all other partners. Information is shared between partners using email and a shared OneDrive folder, and key documents are also posted on the project web-page.

The BAS Finance Team (key contact Abby Lawrence) is responsible for financial management and works closely with the Project Leader and Marine Ecologist to ensure that spending is within budget.

Collins and Liszka also meet weekly to discuss project progress, issues and plans, and to review progress alongside the logframe.

7. Lessons learnt

The project has benefitted from excellent communication between partners, facilitated by the use of Zoom for meetings. Monthly meetings have been held between all partners, with updates provided on all aspects of the project with reference to the agreed log-frame.

Methods and protocols have been updated as necessary throughout the project in response to changing circumstances and user feedback, for example refining the acoustic calibration and operation protocols to ensure that anyone is easily able to run the acoustic surveys and ensure that the data are collected in a standardised way. Copies have been made available in hard and online format.

Careful planning and preparation has been key to the success of the fieldwork, including close communication within and between the project team to ensure correct and timely purchase of equipment; liaison with the GSGSSI and *Pharos SG* for planning the surveys and amending plans

as necessary to accommodate the dry dock timings; with wider colleagues to ensure equipment reached the OT in time; and with staff in the OT to ensure adequate training.

The cost of fitting the echosounder to the hull of the *Pharos SG* was greater than budgeted and additional funding was diverted from other BAS/GSGSSI research to cover this. Estimating the cost at the project planning phase was difficult, as it was uncertain and depended on both the vessel operator and dry-dock operator.

8. Actions taken in response to previous reviews (if applicable)

Comment 1: It would be helpful in the final report, as the evidence base increases, if the project could reference specific reports and other evidence against individual Output indicators in the text and/or Logframe accounts.

Response: We have referenced reports against activities and outputs in this report. This will also be done more fully for the final report.

Comment 2: The change to the timing of the Pharos SG going into dry dock has meant that project survey work planned for May 2023 has been brought forward to March/April. Does this have any implications for the comparison of results between survey years?

Response: This does influence the direct comparability of results between May 2022 and March/April 2023 and will require careful interpretation but this is aided with contextual data we obtained on the oceanographic conditions at the time of each survey. In addition, it provides some useful context on krill availability immediately prior to the winter season and how those dynamics change over the coming months. Overall our comparisons of krill distribution and predator/fishery interactions throughout the winter season, and the associated analyses, still remain achievable.

9. Risk Management

See Risk Register.

10. Sustainability and legacy

The project is a high priority for the OT Government as it seeks to manage its waters to the highest standards. The long-term legacy of the project is secured by a) the fit of the state-of-the-art scientific echosounder to the *Pharos SG* and that equipment can be transferred to any future GSGSSI chartered vessel, and b) that results from this project will feed directly into considerations for managing conservation and the krill fishery around SG.

Due to the interest in the results obtained by the project so far, and the value to management of continuing to evaluate krill distribution and interactions over the longer term, agreement has been reached with GSGSSI to continue to undertake bi-monthly acoustic surveys of krill along at least 4 transects in the ECB throughout the year, adding to the longer-term legacy and sustainability of the project.

To support this, detailed manuals and protocols for carrying out the acoustic surveys and calibrations have been provided to the *Pharos SG* and the marine biologists at KEP. Staff at GSGSSI and KEP as well as the crew on the *Pharos SG* have been trained in the methods and objectives of the project so that expertise is being maintained in the OT.

11. Darwin Plus identity

A project website has been established (https://www.bas.ac.uk/project/winter-krill-at-south-georgia/#about), which features the Darwin logo and highlights Darwin Plus as the funder. Darwin Plus funding and logo has been acknowledged on all presentations given about the project

and in all articles that have been published. Darwin Plus funding support will also be acknowledged in all published manuscripts.

12. Safeguarding

Has your Safeguarding Policy been updated in the past 12 months?		Yes
Have any concerns been reported in the past 12 months		Yes
Does your project have a Safeguarding focal point?	*Yes we have a safeguarding lead across BAS plus a Health and Wellbeing Manager who will work with the safeguarding lead*	
Has the focal point attended any formal training in the last 12 months?	*Yes the lead has attended a formal training session on her role and responsibilities as safeguarding lead*	
What proportion (and number) of project staff have received formal training on Safeguarding?		*30% of our total staff have been trained. They are primarily staff living and working on a research vessel. More training is planned this year.*

Has there been any lessons learnt or challenges on Safeguarding in the past 12 months? Please ensure no sensitive data is included within responses.

The most challenging part continues to be developing a clear understanding of safeguarding and who is affected. We do not employ staff working with children, however many of our staff live and work in isolated environments and under challenging conditions. These make them more vulnerable than others.

Does the project have any developments or activities planned around Safeguarding in the coming 12 months? If so please specify.

More training across all BAS personnel is planned this year.

Please describe any community sensitisation that has taken place over the past 12 months; include topics covered and number of participants.

N/A

Have there been any concerns around Health, Safety and Security of your project over the past year? If yes, please outline how this was resolved.

No

13. Project expenditure

Table 1: Project expenditure during the reporting period (1 April 2023 – 31 March 2024)

Project spend (indicative in this financial year	2023/24 D+ Grant (£)	2024/25 Total actual D+ Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs	[redacted]			Some staff members came under budget
Consultancy costs				
Overhead Costs				Ties in with the 40% of the salary
Travel and subsistence				Higher costs associated with fieldwork due to flight cancellations
Operating Costs				
Capital items				
Others (Please specify)				
TOTAL	£190,939.56	£192,345.42		

Table 2: Project mobilised or matched funding during the reporting period (1 April 2023 – 31 March 2024)

	Secured to date	Expected by end of project	Sources
Matched funding leveraged by the partners to deliver the project (£)	£240,262 as per the original project plan for staff time and provision of PTT penguin tags	[redacted]	
Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project (£)	An additional ~£15k was provided by BAS/FCDO for Y2 seabird observers £6,210 additional funding mobilised by BAS for additional GPS tags – in addition to what was in the original application/budget		

14. Other comments on progress not covered elsewhere

N/A

15. OPTIONAL: Outstanding achievements or progress of your project so far (300-400 words maximum). This section may be used for publicity purposes.

I agree for the Biodiversity Challenge Funds to edit and use the following for various promotional purposes (please leave this line in to indicate your agreement to use any material you provide here).

The Winter Krill project has successfully completed six surveys during two austral winters, obtaining the first comprehensive and concurrent set of data on the winter distribution and abundance of Antarctic krill; key cetacean and seabird species; fur seals; and the winter habitat use of gentoo penguins. Based on these data, we have been able to generate the first reliable estimates of krill biomass at South Georgia during the winter, and the distribution of krill biomass in relation to the krill fishery. We have presented these results to the scientific working groups of CCAMLR and IWC and to the international krill community through the Scientific Committee on Antarctic Research (SCAR) Krill Expert Group (SKEG), and to others interested in wider krill ecology (ICES/PICES 7th International Zooplankton Symposium). We have published a peer-reviewed paper in the Journal of Marine Mammal Science (Calderan et al, 2023) describing observations of southern right whales actively feeding in South Georgia waters during the winter period. We are also contributed directly to the Government of South Georgia and South Sandwich Islands (GSGSSI) Marine Protected Area (MPA) Review 2023/24 and will contribute to CCAMLR and GSGSSI's krill fishery management procedures.

File Type (Image / Video / Graphic)	File Name or File Location	Caption including description, country and credit	Social media accounts and websites to be tagged (leave blank if none)	Consent of subjects received (delete as necessary)
Graphic	Winterkrill_Final_A3	Infographic about the "Winter Krill" project.		Yes
Image	Antarctic petrel	Credit: Garry Taylor		Yes
Image	Blue petrel	Credit: Garry Taylor		Yes
Image	Cape petrel	Credit: Garry Taylor		Yes
Image	Wandering albatross	Credit: Garry Taylor		Yes
Image	DSC07622	Humpback whale Credit: Conor Ryan		Yes
Image	DSC00124	Killer whale: Credit: Conor Ryan		Yes
Image	DSC05526	Southern Right Whale Credit: Conor Ryan		Yes

Annex 1: Report of progress and achievements against logframe for Financial Year 2023-2024

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Impact: *Potential ecosystem impacts of the South Georgia krill-fishery are understood and mitigated through enhanced ecosystem-based fisheries management, ensuring the conservation and protection of South Georgia's iconic wildlife populations.*		Both years of surveys were successful, providing winter biomass estimates of krill, demonstrating likely differences in krill distribution between summer and winter and highlighted the use of the area by foraging baleen whales in winter.	
Outcome: An understanding of the winter distribution of Antarctic krill and potential impacts of the krill fishery on dependent predators facilitates ecosystem-based management of the krill fishery.	1. Krill Fishery Management Plan updated in Y3 (Mar 2024) to take account of distribution of fishing effort and impacts on the ecosystem. 2. Scientific papers presented to CCAMLR & IWC (2023 & 2024) on the winter distribution of krill, swarm characteristics and krill-predator distribution and food requirements during winter to directly contribute to CCAMLR management of the krill fishery. 3. Marine Protected Area provisions updated (if necessary) to take account of project results.	Both years of data collection have been achieved with three surveys completed in 2022 and 2023 and detailed reports available via the project website. Papers were submitted to IWC (May 2023 and April 2024), CCAMLR ASAM (June 2023) and EMM (July 2023) meetings and papers are in preparation for ASAM and EMM 2024.	Papers for CCAMLR 2024 need to be completed and submitted.
Output 1. Long-term capability for winter (and other times of year) pelagic ecosystem assessment enabled for South Georgia.	1. Scientific echosounder fitted to the MV *Pharos SG* in Y1 (March 2022). 2. GSGSSI Government Officer / KEP staff trained in acoustic methods, echosounder calibration and at-sea surveys by Sep 2022.	The scientific echosounder system was fitted to the *Pharos SG* (see Section 3.1), which facilitates the rest of the project and enables future acoustic surveys for krill and other organisms to be undertaken by the vessel in South Georgia waters (or elsewhere).	
Activity 1.1 Plans prepared for fit of acoustic transponders to Pharos SG.		**Complete**. Plans were prepared in good time for dry-dock. Hardware was purchased with matched funding from UK Govt. Blue Belt Programme.	
Activity 1.2 Transducers and associated electrical kit fitted to Pharos SG during dry-dock.		**Complete**. The echosounders and associated electronics were fitted to the	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
		Pharos SG during dry-dock in March in Montevideo.	
Activity 1.3 Transducers tested in SG waters prior to krill season.		**Complete.** The system has been calibrated and tested by Co-I Fielding in Falkland Island waters in early April 2022.	
Activity 1.4 GSGSSI GOs and KEP science team trained in operation of echosounders on Pharos SG.		**Complete.** GOs and KEP staff were trained on the echosounder, calibration and project activities throughout the 2022 survey period.	
Activity 1.5 GSGSSI GOs and KEP science team trained in acoustic calibration methods generally and bespoke to Pharos SG.		**Complete.** GOs and KEP staff were trained on the echosounder, calibration and project activities throughout the 2022 survey period.	
Activity 1.6 Manual developed for acoustics operation on Pharos SG		**Complete.** A manual was prepared following the first survey of 2022 and has since been updated to reflect learnings during the three surveys in 2022.	
Output 2. Winter krill acoustic and predator surveys / tracking undertaken.	1. Three surveys (minimum of four transects) conducted during each of two winter krill seasons (2022 and 2023). 2. Cetacean focussed surveys conducted in each austral winter (2022 & 2023). 3. Six gentoo penguins tracked from each of Bird Island and Maiviken during each winter season (2022 & 2023; 24 in total).	All surveys have been successfully undertaken and all tags were successfully deployed.	
Activity 2.1 Acoustic surveys conducted shortly before, during and at the end of the krill fishing season in Y1 and Y2 (austral winters 2022 & 2023).		**Complete**. Both sets of surveys have been undertaken in May, July and Sept 2022, and March/April, July and Sept 2023.	
Activity 2.2 At-sea observations of seabirds and marine mammals undertaken in association with each acoustic survey.		**Complete**. Observations were carried out on all three surveys of 2022 and on July and Sept of 2023	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
		(https://www.bas.ac.uk/project/winter-krill-at-south-georgia/).	
Activity 2.3 Cetacean surveys conducted on *Pharos SG* in association with each mid-season acoustic survey.		**Complete**. Both detailed surveys were carried out (July 2022, Sept 2023), supplemented by the deployment of SonoBuoys for acoustic detection of whales. In addition, a dedicated cetacean researcher was recruited to conduct observations on the July 2023 survey.	
Activity 2.4 Survey summary reports prepared after each survey and published on GSGSSI website.		**Complete.** Reports for all surveys have been prepared and published on the project website (https://www.bas.ac.uk/project/winter-krill-at-south-georgia/). The rest will follow as they are produced.	
Activity 2.5 Six gentoo penguins tracked from each of Bird Island and Maiviken during each winter season (2022 & 2023; 24 in total).		**Complete**. The tags (Wildlife Computers) were successfully purchased and deployed at Bird Island and Maiviken in 2022 & 2023. GPS tags were also provided by BAS to improve sampling at Bird Island.	
Output 3. Winter krill stock assessment in South Georgia fishery area for each of two years, including krill swarm characteristics.	1. Acoustic data collected, cleaned and analysed within 3 months of completion of winter surveys (by Dec 2022 & Dec 2023). 2. Estimate of krill density and swarm characteristics derived for each season (March 2023, March 2024). 3. Cetacean observations characterised in relation to krill swarms in order to identify any associations between swarm characteristics, and particular whale species (Mar 2024). 4. At-sea data on seabirds and fur seals archived (Dec 2022 & 2023) and analysed	All data has been analysed and backed up as planned. Data from both years have been analysed and preliminary analysis provided as per Section 3.1 above. Further detailed analyses are ongoing and will be developed into manuscripts.	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
	(Mar 2023 & 2024) in relation to krill abundance and fishery (Y1 & Y2).		
Activity 3.1 Acoustic data cleaned and processed using Echoview software after each year's surveys.		**Complete.** Data from both years have been cleaned and processed as described in section 3.1 above.	
Activity 3.2 Acoustic data (cleaned raw data & processed) lodged on GSGSSI Data Portal after each year's surveys.		**In progress.** Data from both years have been backed up on the BAS PDC and final data curation is underway.	Final data archiving following project completion needs to be completed.
Activity 3.3 Acoustic data analysed to estimate winter biomass and swarm characteristics from each survey, linked to environment.		**In progress.** Data from both years have been analysed as described in section 3.1 above and final checks are being completed.	Acoustic data from 2023 will be analysed for biomass and swarm characteristics and further detailed analyses of both years carried out.
Activity 3.4 Papers prepared for CCAMLR WG-EMM and WG-ASAM and for peer review publication.		**In progress.** Papers for CCAMLR 2023 were submitted and discussed. Papers are being prepared for CCAMLR 2024.	Papers for CCAMLR 2024 will be submitted and developed into scientific publications.
Output 4. Winter predator abundance, distribution and tracking data analysed.	1. Gentoo penguin data archived and analysed in relation to krill abundance, swarm characteristics, operating area of fishery and the MPA No-take Zone (Dec 2022 & Dec 2023). 2. Cetacean observation data archived (Dec 2022 & 2023) and analysed (Mar 2023 & 2024) to provide (i) spatial habitat use patterns of krill-feeding baleen whales in South Georgia in winter; (ii) concordance with areas of high krill density; (iii) overlap with krill fishery; (iv) estimate of seasonal krill consumption by whales at South Georgia in winter. 3. Cetacean observations characterised in relation to krill swarms in order to identify any associations between swarm characteristics, and particular whale species (Mar 2024).	All data has been analysed and backed up as planned. Data from both years have been analysed and preliminary analysis provided as per Section 3.1 above. Further detailed analyses are ongoing and will be developed into manuscripts.	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
	4. At-sea data on seabirds and fur seals archived (Dec 2022 & 2023) and analysed (Mar 2023 & 2024) in relation to krill abundance and fishery (Y1 & Y2).		
Activity 4.1 Data from tracked penguins relayed via the Argos satellite system; uploaded to BAS and ART websites for track visualisation and archived on the GSGSSI Data Portal		**In progress.** Data was uploaded in real time on the BAS website and has been archived in the BAS PDC.	Links between the BAS PDC and GSGSSI Data Portal to be established.
Activity 4.2 Gentoo penguin data analysed in relation to krill abundance, swarm characteristics and operating area of fishery.		**In progress.** Data from both years have been analysed as described in section 3.1 above and see tracks on project website (https://www.bas.ac.uk/project/winter-krill-at-south-georgia/#about).	Further detailed analyses are ongoing and will be developed in manuscripts.
Activity 4.3 Cetacean observation data archived on the GSGSSI Data Portal following each survey.		**In progress.** Data from both years have been archived on the BAS PDC.	Links between the BAS PDC and GSGSSI Data Portal to be established.
Activity 4.4 Cetacean distribution data analysed in relation to krill density, the krill fishery and to determine spatial patterns of use and winter krill consumption estimates.		**In progress.** Data from both years have been analysed as described in section 3.1 above.	Further detailed analyses are ongoing and will be developed in manuscripts.
Activity 4.5 Cetacean observations characterised in relation to krill swarms in order to identify any associations between swarm characteristics, and particular whale species.		**In progress.** Data from both years have been analysed as described in section 3.1 above.	Further detailed analyses are ongoing and will be developed in manuscripts.
Activity 4.6 At-sea seabird and fur seal data archived on the GSGSSI Data Portal.		**In progress.** Data from both years have been archived on the BAS PDC.	Links between the BAS PDC and GSGSSI Data Portal to be established.
Activity 4.7 Seabird / fur seal data analysed in relation to the distribution and abundance of krill and in relation to the activity of the krill fishery.		**In progress.** Data from both years have been analysed as described in section 3.1 above.	Further detailed analyses are ongoing and will be developed in manuscripts.
Activity 4.8 Papers prepared for annual meetings of CCAMLR ASAM & EMM Working Groups and IWC and prepared for peer reviewed publications.		**In progress.** Papers on krill acoustics and the overall project were submitted to CCAMLR 2023 meetings and are in prep for CCAMLR 2024. A paper on the cetacean analysis was submitted to IWC in April 2023 and 2024.	Papers in prep will be submitted for CCAMLR Working Groups in 2024 and developed into scientific publications.
Output 5. Stakeholder engagement and dissemination of results in scientific and popular literature and at international fora.	1. Minimum of three papers submitted to peer reviewed journals (open access) by March 2024 and submitted to CCAMLR / IWC Working Groups (2023 & 2024).	The initial stakeholder meeting was held in Jan 2022 and project website established. General interest articles have been published. One scientific paper has been published and more will follow at the end of the project. Papers to IWC and CCAMLR have been	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
	2. Articles published for general audience (e.g., South Georgia Association Newsletter; Penguin News, MBA Newsletter) and on BAS, ART and GSGSSI websites (min 2 per year). 3. Stakeholder meetings held at the initiation of the project to outline plans (by Dec 2021) and at the end (March 2024) to disseminate and discuss the project results. 4. Six-monthly updates circulated to stakeholders and published on BAS / GSGSSI website.	submitted and more are in preparation. A further stakeholder meeting is planned for 14-15 May.	
Activity 5.1 Stakeholder meeting at the outset of the project – likely over zoom to engage with all stakeholders and provide information about project and timelines.		**Complete.** Initial stakeholder meeting held in Jan 2022 and recording available via project website.	
Activity 5.2 Six-monthly updates circulated to stakeholders and published on BAS, GSGSSI & ART websites.		**Complete.** Updates have been sent to stakeholders regularly.	
Activity 5.3 Articles prepared for general audience is publications such as the South Georgia Association Newsletter & UK Marine Biological Association Newsletter.		**Complete.** Articles published in SGA Newsletter; Ocean Challenge magazine; an online article on RBR website; and Marine Biologist magazine (as described in section 3.1 above).	
Activity 5.4 Minimum of three papers submitted to peer review journal (by March 2024).		**In progress.** One peer reviewed paper on southern right whale feeding observations published and others in progress.	Additional papers are in preparation.
Activity 5.5 Stakeholder meeting towards the end of the project (Dec 2023) to disseminate and discuss the results.		**In progress.** Final workshop to be held May 2024.	Final workshop to be held May 2024.
Output 6. Updates to SGSSI management plans and legislation	1. Krill Fishery Management Plan revised to take account of project results and stakeholder input (Mar 2024). 2. SGSSI MPA Management Plan and Order updated (Mar 2024; if required).	Progress towards this output has been made and further engagement is ongoing.	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Activity 6.1 Krill Fishery Management Plan reviewed and revised to take account of project results and stakeholder input.		**In progress.** Fed into the GSGSSI MPA review process in June 2023 workshop and are pursuing ongoing discussions.	Further discussions ongoing.
Activity 6.2 SGSSI MPA Management Plan and MPA Order reviewed and updated (if required) to take account of project results and stakeholder input.		**In progress.** Fed into the GSGSSI MPA review process in June 2023 workshop and are pursuing ongoing discussions.	Further discussions ongoing.

Annex 2: Project's full current logframe as presented in the application form (unless changes have been agreed)

Project Summary	Measurable Indicators	Means of Verification	Important Assumptions
Impact: Potential ecosystem impacts of the South Georgia krill-fishery are understood and mitigated through enhanced ecosystem-based fisheries management, ensuring the conservation and protection of South Georgia's iconic wildlife populations. (Max 30 words)			
Outcome: An understanding of the winter distribution of Antarctic krill and potential impacts of the krill fishery on dependent predators facilitates ecosystem-based management of the krill fishery. (Max 30 words)	0.1 Krill Fishery Management Plan updated in Y3 (May 2024) to take account of distribution of fishing effort and impacts on the ecosystem.	0.1 Krill Fishery Management Plan published on the GSGSSI website.	Stakeholder community engage in discussions regarding management. Acoustic fit to Pharos SG successful in Year 1 GSGSSI update MPA Management Plan.
	0.2 Scientific papers presented to CCAMLR & IWC (2022 & 2023) on the winter distribution of krill, swarm characteristics and krill-predator distribution and food requirements during winter to directly contribute to CCAMLR management of the krill fishery.	0.2 Paper(s) submitted to CCAMLR & IWC (2022 & 2023) and to peer reviewed journals (May 2024). CCAMLR & IWC papers available on websites. Project papers cited in text of CCAMLR and IWC reports.	
	0.3 Marine Protected Area provisions updated (if necessary) to take account of project results.	0.3 MPA Order and MPA Management Plan updated and published on GSGSSI website.	

Outputs: **1.** Long-term capability for winter (and other times of year) pelagic ecosystem assessment enabled for South Georgia.	1.1 Scientific echosounder fitted to the MV *Pharos SG* in Y1 (March 2022).	1.1 Photographs taken pre- and post-fitting.	Dry-docking is necessary for transducer fit. Vessel owners have agreed and dry-dock scheduled for Feb/March 2022; possible Covid-related uncertainty over dry-dock schedule.
	1.2 GSGSSI Government Officer / KEP staff trained in acoustic methods, echosounder calibration and at-sea surveys by Sep 2022.	1.2 Training record for GSGSSI staff. Training manual written.	GSGSSI staff are available for training.
2. Winter krill acoustic and predator surveys / tracking undertaken.	2.1 Three surveys (minimum of four transects) conducted during each of two winter krill seasons (2022 and 2023).	2.1 Survey reports available on GSGSSI & BAS website and submitted to CCAMLR ASAM Working Group after each field season.	*Pharos SG* is available and not diverted for emergency or suffers mechanical issues.
	2.2 Cetacean focussed surveys conducted in each austral winter (2022 & 2023).	2.2. Survey reports submitted to GSGSSI (available on website) and IWC Scientific Committee following each field season.	Weather is suitable. *Pharos SG* will seek appropriate weather windows to undertake transects.
	2.3 Six gentoo penguins tracked from each of Bird Island and Maiviken during each winter season (2022 & 2023; 24 in total).	2.3 Argos locations updated daily on BAS website map, on ART website and archived with GSGSSI / Polar Data Centre.	Birds can be captured and tags function correctly (previous work shows these assumptions are safe). Permits will be issued by GSGSSI.
3. Winter krill stock assessment in South Georgia fishery area for each of two years, including krill swarm characteristics.	3.1 Acoustic data collected, cleaned and analysed within 3 months of completion of winter surveys (by Dec 2022 & Dec 2023).	3.1 Raw acoustic data archived on GSGSSI Data Portal.	*Pharos SG* can collect high quality acoustic data. Appropriate weather windows to undertake transects (wind > 30 knots).
	3.2 Estimate of krill density and swarm characteristics derived for each season (March 2023, March 2024).	3.2 Krill density estimates and swarm characteristics provided to CCAMLR in WG papers.	
4. Winter predator abundance, distribution and tracking data analysed.	4.1 Gentoo penguin data archived and analysed in relation to krill abundance, swarm characteristics, operating area of	4.1. Paper submitted to CCAMLR's Working Group on Ecosystem Monitoring and	Dependent on success of both at-sea acoustics and penguin tracking.

	fishery and the MPA No-take Zone (Dec 2022 & Dec 2023).	Management (WG-EMM) in Y2 & Y3 (2023 & 2024).	
	4.2 Cetacean observation data archived (Dec 2022 & 2023) and analysed (Apr 2023 & 2024) to provide (i) spatial habitat use patterns of krill-feeding baleen whales in South Georgia in winter; (ii) concordance with areas of high krill density; (iii) overlap with krill fishery; (iv) estimate of seasonal krill consumption by whales at South Georgia in winter.	4.2 Papers submitted to IWC's Scientific Committee and CCAMLR WG-EMM and available on websites (July 2023, July 2024).	Data quantity and quality adequate to obtain density estimates for baleen whales that can be extrapolated to the broader SG region. Multiple surveys and careful, adaptive transect design reduce this risk.
	4.3 Cetacean observations characterised in relation to krill swarms in order to identify any associations between swarm characteristics, and particular whale species (Apr 2024).	4.3 Papers submitted to IWC's Scientific Committee and CCAMLR WG-EMM (Y3, 2024).	Numbers of detected cetaceans are sufficient to allow comparisons to be made. Multiple surveys maximises detection opportunities.
	4.4 At-sea data on seabirds and fur seals archived (Dec 2022 & 2023) and analysed (Mar 2023 & 2024) in relation to krill abundance and fishery (Y1 & Y2).	4.4 Data archived on GSGSSI Data Portal. Paper submitted to CCAMLR's WG-EMM.	
5. Stakeholder engagement and dissemination of results in scientific and popular literature and at international fora.	5.1 Minimum of three papers submitted to peer reviewed journals (open access) by May 2024 and submitted to CCAMLR / IWC Working Groups (2023 & 2024).	5.1. Darwin Plus acknowledged as funding source, noting award number in publications.	Publication in scientific journals will take time and is likely to occur after the end of the project.
	5.2 Articles published for general audience (e.g., South Georgia Association Newsletter; Penguin News, MBA Newsletter) and on BAS, ART and GSGSSI websites (min 2 per year).	5.2 Records of all articles kept and Darwin Plus acknowledged.	Newsletters willing to publish articles.
	5.3 Stakeholder meetings held at the initiation of the project to outline plans (by Dec 2021) and at the end (April/May 2024) to disseminate and discuss the project results.	5.3 Meeting report / minutes published on GSGSSI website.	Stakeholders engage in meetings. Key stakeholders have provided letters of support.

	5.4 Six-monthly updates circulated to stakeholders and published on BAS / GSGSSI website.	5.4 Updates published on websites.	
6. Updates to SGSSI management plans and legislation.	6.1 Krill Fishery Management Plan revised to take account of project results and stakeholder input (Mar 2024).	6.1 Updated plan published on GSGSSI website.	
	6.2 SGSSI MPA Management Plan and Order updated (May 2024; if required).	6.2 Updated MPA Management Plan published on GSGSSI website and (any) changes to legislation enacted.	MPA review, which is due towards the end of the project, takes place.

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)

Output 1 Long-term capability for winter pelagic ecosystem assessment enabled for South Georgia

1.1 Plans prepared for fit of acoustic transponders to *Pharos SG*.
1.2 Transducers and associated electrical kit fitted to *Pharos SG* during dry-dock.
1.3 Transducers tested in SG waters prior to krill season.
1.4 GSGSSI GOs and KEP science team trained in operation of echosounders on *Pharos SG*.
1.5 GSGSSI GOs and KEP science team trained in acoustic calibration methods generally and bespoke to *Pharos SG*.
1.6 Manual developed for acoustics operation on *Pharos SG*.

Output 2 Winter krill acoustic and predator surveys / tracking undertaken 2.1 Pharos SG echosounders calibrated in Cumberland Bay in advance of each season

2.2 Acoustic surveys conducted shortly before, during and at the end of the krill fishing season in Y1 and Y2 (austral winters 2022 & 2023).
2.3 At-sea observations of seabirds and marine mammals undertaken in association with each acoustic survey.
2.4 Cetacean surveys conducted on *Pharos SG* in association with each mid-season acoustic survey.
2.5 Survey summary reports prepared after each survey and published on GSGSSI website.
2.6 Six gentoo penguins tracked from each of Bird Island and Maiviken during each winter (2022 & 2023) season (24 in total).

Output 3 Winter krill stock assessment in South Georgia fishery area for each of two years, including krill swarm characteristics

3.1 Acoustic data cleaned and processed using Echoview software after each year's surveys.
3.2 Acoustic data (cleaned raw data & processed) lodged on GSGSSI Data Portal after each year's surveys.
3.3 Acoustic data analysed to estimate winter biomass and swarm characteristics from each survey, linked to environment.
3.4 Papers prepared for CCAMLR WG-EMM and WG-ASAM and for peer review publication.

Output 4 Winter predator abundance, distribution and tracking data analysed

4.1 Data from tracked penguins relayed via the Argos satellite system; uploaded to BAS and ART websites for track visualisation and archived on the GSGSSI Data Portal.
4.2 Gentoo penguin data analysed in relation to krill abundance, swarm characteristics and operating area of fishery.
4.3 Cetacean observation data archived on the GSGSSI Data Portal following each survey.
4.4 Cetacean distribution data analysed in relation to krill density, the krill fishery and to determine spatial patterns of use and winter krill consumption. Estimates.
4.5 Cetacean observations characterised in relation to krill swarms in order to identify any associations between swarm characteristics, and particular whale species.
4.6 At-sea seabird and fur seal data archived on the GSGSSI Data Portal.
4.7 Seabird / fur seal data analysed in relation to the distribution and abundance of krill and in relation to the activity of the krill fishery.
4.8 Papers prepared for annual meetings of CCAMLR ASAM & EMM Working Groups and IWC and prepared for peer reviewed publications.

Output 5 Stakeholder engagement and disseminated of results in scientific and popular literature and at international fora
5.1 Stakeholder meeting at the outset of the project (Dec 2021) – likely over zoom to engage with all stakeholders and provide information about project and timelines.
5.2 Six-monthly updates circulated to stakeholders and published on BAS, GSGSSI & ART websites.
5.3 Articles prepared for general audience is publications such as the South Georgia Association Newsletter & UK Marine Biological Association Newsletter.
5.4 Minimum of three papers submitted to peer review journal (by May 2024).
5.5 Stakeholder meeting towards the end of the project (Apr/May 2024) to disseminate and discuss the results.

Output 6 Updates to SGSSI management plans and legislation
6.1 Krill Fishery Management Plan reviewed and revised to take account of project results and stakeholder input.
6.2 SGSSI MPA Management Plan and MPA Order reviewed and updated (if required) to take account of project results and stakeholder input.

Annex 3: Standard Indicators

Table 1 Project Standard Indicators

DPLUS Indicator number	Name of indicator using original wording	Name of Indicator after adjusting wording to align with DPLUS Standard Indicators	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
DPLUS-A01	GSGSSI Government Officer / KEP staff trained in acoustic methods, echosounder calibration and at-sea surveys by Sep 2022	Number of people from key national and local stakeholders completing structured and relevant training	People proportion	Stakeholder group: Local Communities, Nationals, public sector, civil society, private sector	4	6	4	10	6
DPLUS-C01	GSGSSI Government Officer / KEP staff trained in acoustic methods, echosounder calibration and at-sea surveys by Sep 2022	Number of best practice guides and knowledge products published and endorsed	Number	Product typology (methodologies)	6	6	6	6	6
DPLUS-C05	Scientific papers presented to CCAMLR & IWC on the winter distribution of krill, swarm characteristics and krill-predator distribution and food requirements during winter to directly contribute to CCAMLR management of the krill fishery	Number of projects contributing data, insights, and case studies to national Multilateral Environmental Agreements (MEAs) related reporting processes and calls for evidence	Number	Scientific papers/ papers to CCAMLR & IWC	0	1	3	4	4
DPLUS-C17	Minimum of three papers submitted to peer reviewed journals (open access) by March May 2024	Number of unique papers submitted to peer reviewed journals	Number	None	0	1	0	1	3
DPLUS-B01	Marine Protected Area provisions updated (if necessary) to take account of project results.	Number of new/improved habitat management plans available and endorsed	Number of instruments	Policy typology (Local, National Policy)	0	0	0	0	1

Table 2 Publications

Title	Type (e.g. journals, best practice manual, blog post, online videos, podcasts, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Observations of southern right whales (*Eubalaena australis*) surface feeding on krill in austral winter at South Georgia*	Journal article	Susannah V. Calderan, Tracey Dornan, Sophie Fielding, Ryan Irvine, Jennifer A. Jackson, Russell Leaper, Cecilia M. Liszka, Paula A. Olson, Martin A. Collins (2023)	Female	British	Wiley Periodicals LLC on behalf of Society for Marine Mammalogy.	https://onlinelibrary.wiley.com/doi/full/10.1111/mms.13025
WG-ASAM-2023/06: Acoustic determination of Antarctic krill biomass at South Georgia (Subarea 48.3) during winter	Paper to CCAMLR WG-ASAM	C.M. Liszka, S. Fielding, T. Dornan and M.A. Collins	Female	British	N/A	Attached as supplementary info and available from CCAMLR on request
WG-EMM-2023/22: Determining the distribution of Antarctic krill and krill-dependent predators at South Georgia (Subarea 48.3) during winter	Paper to CCAMLR WG-EMM	C. Liszka, S. Calderan, T. Dornan, S. Fielding, M. Goggins, J. Jackson, R. Leaper, P.A.Olson, N. Ratcliffe, K. Owen, R. Irvine and M.A. Collins	Female	British	N/A	Attached as supplementary info and available from CCAMLR on request
SC_69A_ASI_08: CRUISE REPORT FROM WINTER SURVEYS (MAY –	Paper to IWC Scientific Committee	Russell Leaper, Martin A Collins, Susannah Calderan, Ryan Irvine, Cecilia Liszka, Paula	Male	British	N/A	Available on request.

Title	Type (e.g. journals, best practice manual, blog post, online videos, podcasts, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
SEPTEMBER 2022) AROUND SOUTH GEORGIA (ISLAS GEORGIAS DEL SUR)		Olson and Jennifer Jackson				
WINTER CETACEAN SURVEYS (APRIL – SEPTEMBER 2022 AND 2023) AROUND SOUTH GEORGIA (ISLAS GEORGIAS DEL SUR)	Paper to IWC Scientific Committee	Russell Leaper, Martin Collins, Susannah Calderan, Cecilia Liszka, Paula Olson, Conor Ryan and Jennifer Jackson	Male	British	N/A	Available on request.

Annex 4: Onwards – supplementary material (optional but encouraged as evidence of project achievement)

This may include outputs of the project, but need not necessarily include all project documentation. For example, the abstract of a conference would be adequate, as would be a summary of a thesis rather than the full document. If we feel that reviewing the full document would be useful, we will contact you again to ask for it to be submitted.

It is important, however, that you include enough evidence of project achievement to allow reassurance that the project is continuing to work towards its objectives. Evidence can be provided in many formats (photos, copies of presentations/press releases/press cuttings, publications, minutes of meetings, questionnaires, reports etc.) and you should ensure you include some of these materials to support the Annual Report text.

If you are attaching separate documents, please list them here with an Annex reference number so that we can clearly identify the correct documents.

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	Y
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	Y
Is your report more than 10MB? If so, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	Y
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Y
If you are submitting photos for publicity purposes, do these meet the outlined requirements (see section 15)?	Y
Have you involved your partners in preparation of the report and named the main contributors	Y
Have you completed the Project Expenditure table fully?	Y
Do not include claim forms or other communications with this report.	