Darwin Plus Main & Strategic: Final 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: no later than 3 months after agreed end date.

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Darwin Plus Project Information

Scheme (Main or Strategic)	Main
Project reference	DPLUS 186
Project title	Evidence-based conservation of key biodiversity in the South Sandwich Islands
Territory(ies)	South Georgia and South Sandwich Islands
Lead Organisation	British Antarctic Survey (BAS)
Project partner(s)	Oxford Brookes (OBU) and Edinburgh Universities, Antarctic Research Trust (ART), Government of South Georgia and South Sandwich Islands (GSGSSI)
Darwin Plus Grant value	£440,264
Start/end date of project	1 Apr 2023 – 31 Mar 2024
Project Leader name	Norman Ratcliffe
Project website/Twitter/blog etc.	Zavodovski Expedition - British Antarctic Survey - Project
Report author(s) and date	Norman Ratcliffe, Claudia Colesie, Pete Convey, Tom Hart, Laure Cugniere, Gemma Clucas, Pete Fretwell, Nicole Richter, John Dickens, Nathan Fenney, Michael Walters, Klemens Putz, Mark Belchier, Sue Gregory and Jen Black.

1 Project Summary

The South Sandwich Islands (SSI) are among the most data deficient places in the UK OTs, owing to their remote location in rough seas (Fig. 1) and their hazardous landing sites. Zavodovski Island, the most northerly in the archipelago, hosted the largest penguin colony in the world and vegetation communities exceptional to the region according to previous surveys over a decade ago. An eruption occurred in March 2016 which covered a third of the island in ash, which raised concern over its impacts upon biodiversity. The foraging areas of penguins around the island were unknown, yet are of clear importance for marine spatial planning and krill fishery management. This project aimed to address these knowledge gaps for one of the region's biodiversity hotspots to inform ongoing development of the management plans for the South Georgia South Sandwich Island Marine Protected Area (SGSSI MPA) and the South Sandwich Islands Terrestrial Protected Area (SSI TPA).

A key component of the project was a successful, if challenging, expedition to one of the last remaining geographic frontiers on the planet. During this, a team of researchers collected unique data and samples to fill the identified knowledge gaps. Drone and satellite surveys

revealed that between 2011 and 2024, chinstrap penguin numbers have declined by two thirds while macaroni penguin numbers have increased by two and a half times. Patterns of change are consistent with a regime shift; a warming event which has favoured the subantarctic macaroni penguin over the maritime Antarctic chinstrap penguin, as opposed to a catastrophic mortality event associated with the eruption. Further investigation is required to discover the location and season in which these impacts are occurring.

Satellite tracking of penguins show how the extension of No Take Zones (NTZs) within the SGSSI MPA, following successive 5-yearly reviews, have afforded greater protection to penguin foraging areas. These findings influenced decision-making during consultations relating to the third SGSSI MPA review and have helped to support marine spatial planning in the territory.

Geolocator tracking has revealed chinstrap penguins migrate east to winter to the south of Africa; an area subject to rapid warming. Studies of chinstrap declines across other areas of the Scotia Sea implicate reduced overwinter survival as a driver, warranting further investigation of oceanographic changes in the wintering grounds.

Terrestrial surveys identified a large moss bank with associated plant and invertebrate communities in the north of the island which has developed since a previous survey in the 1990s. A vegetated fumarole was also located. These sites, along with the penguin, seal and giant petrel colonies mapped by the survey, will be notified as interest features in the next revision of the SSI TPA management plan. This will identify environmentally sensitive areas that need to be avoided by future visitors to the island.

The study has allowed us to ground-truth satellite images by comparing these with higher accuracy drone images and surveys on foot. We found that the areas of penguin colonies could be clearly delimited from both optical and radar remote sensing. The development of radar remote sensing is particularly useful for future monitoring, given that cloud often obscures most of the island which limits the availability of optical imagery. These developments will enable design of ongoing remote monitoring of the island which reduces the requirement to make expensive and hazardous visits to this sensitive island in the future.

2 Project Partnerships

The project comprised three funded partner organisations (BAS, OBU, Edinburgh University) and two in-kind partners (ART and GSGSSI). Roles and responsibilities were clearly defined at the outset. Norman Ratcliffe (BAS) has led the project, coordinating logistics, expenditure and the work across the partner organisations. He has also led on the penguin tracking data analysis with support from Klemens Putz (ART). Co-Is Claudia Colesie (Edinburgh) and Pete Convey (BAS) have led on the terrestrial biodiversity module of the project (vegetation and invertebrates). Colesie led the terrestrial fieldwork with support from Ian Hey (BAS). Tom Hart (OBU) has led on analysis of penguin numbers in drone images using Artificial Intelligence methods with support from his Research Project Coordinator, Laure Cugniere. Peter Fretwell has led on GIS analysis of satellite and drone imagery for penguins and terrestrial features, with input from Ratcliffe and Nathan Fenney (BAS). Fenney coordinated the RAF survey with support from Liz Mackley (BAS), who also conducted the survey work.

The number of in-kind partners has grown as the project has evolved. Nicole Richter at RWTH Aachen University, Germany, joined the team to help with management of the risks of working on an active volcano, conduct research on the volcano and develop outputs relating to the monitoring of penguins using satellite radar imagery. Gemma Clucas at Cornell University, USA, also joined the team to provided expertise in estimating diet of penguins by analysis of prey DNA in their droppings. She and John Dickens (BAS) undertook the penguin fieldwork (tagging, faecal sampling, drone surveys). Jen Black, Sue Gregory and Mark Belchier provided input from GSGSSI, including issuing of permits and application of findings to policy and management.

The project also involved several third parties: the RAF at Mount Pleasant who supported the crewed aerial surveys of the island and Pelagic Expeditions who provided the charter yacht and crew needed to access the island. A film crew, Talesmith, were also affiliated with the project

and contributed to the costs of the yacht charter, but withdrew their participation in the expedition due to concerns over avian influenza.

This was a complex, multidisciplinary project that involved fieldwork on an extremely remote and potentially hazardous field site, so good communication and meticulous planning were essential. Considerations included gathering information from previous expeditions, chartering the yacht, purchase and shipping of the science and field equipment, management of risk, environmental and animal ethics permitting, coordination / MoUs among partners, and budgeting. GSGSSI were central in discussions, particularly those relating to environmental permits for work on the Special Protected Area and management of emerging risks relating to Highly Pathogenic Avian Influenza (HPAI).

The coordination of the work plan has been effective and the team members have worked well together. Coordination was achieved through a series of Zoom meetings with all members, or among specific sub-groups to help streamline discussions. Meetings were held on a demand-based, rather than regular, schedule. At the kick-off meeting on 24 April 2023, partners discussed the project's aims and logistics in detail and agreed sub-groups going forward: Logistics, Terrestrial, Penguins and Filming. These sub-groups then met to advance their work areas and reported back to all of the whole team on 07 Jun 2023. An in person meeting between the PI and all the expedition team members was held at Girton College on 13 Sep 2023, where the team also received wilderness first aid training from the BAS Medical Unit. Progress with planning was reported to the whole team on 11 Oct 2023.

A full project meeting to share outcomes of the expedition and agree content of the first Annual Report was held on 19 March 2024. All partners contributed to the production of the report and approved the final submitted version. The project team has since focussed on analysis of data and samples and the PI has coordinated efforts through email and 1:1 discussions. This has included in-person meetings with Mark Belchier from GSGSSI on 11 Nov 2024 and 20 May 2025 to discuss the application of findings to protected area management. Ratcliffe visited OBU on 2 Oct 2025 where Hart demonstrated application of the AI tool for counting penguins. A full project catch-up meeting was held on Zoom on 15 Oct 2025 to discuss co-production of the second half-year report. A workshop was held in Cambridge on 24-25 Mar 2025 which was attended in person by 10 project members and an 11th by Zoom (Clucas, whose in person attendance was prevented by the power outage at London Heathrow). The team co-produced outputs relating to survey and monitoring work on the island using the various sources of information derived from satellites, drones and crewed aircraft.

The final project meeting was held on 25 June 2025 on Zoom. Project members met to review the contents of this report, agreed plans for subsequent completion of scientific outputs, discussed management implications of the findings and considered future collaborations to improve research and monitoring in the territory. All project members contributed sections to this report, commented on drafts and approved the submitted version.

The project has led to enhanced networking, training of staff and collaborations that will extend beyond the lifespan of the project that will further advance conservation work in the territory.

3 Project Achievements

3.1 Outputs

Output 1. Accurate ground-truthing data collected that allows continued five-yearly monitoring of penguins and terrestrial biodiversity from remote sensing data at low cost/effort/risk by project partners.

Indicator 1.1 Expedition logistics planned and completed end of Y1Q3. This activity was completed successfully. Planning included agreeing the yacht charter to access the island and support from the RAF for aerial surveys, obtaining environmental, animal welfare and drone flying permits for the fieldwork, producing a thorough risk assessment, procuring and shipping equipment, booking travel and accommodation and managing finances. A major change from the proposal was that the timing of the expedition had to be changed from January to December owing to the yacht being booked by another project for the January period after the grant was awarded, which created both benefits and drawbacks depending

on activities (see Section 3.3). All tasks were completed in time for the expedition beginning on 27 November 2023 (see Annex 5, Fig 2 for images of the operations). The expedition was challenging owing to storms and last-minute staff changes. Storms meant that landing on the island was delayed until 10 Dec 2023. A camp was pitched in the location used previously in Jan 2023, but the tents were damaged by storms on the first night, forcing relocation to a sheltered but cramped gully the following day. Bad weather meant science was only possible for four days, before the approach of yet another storm forced the team to evacuate on the 16 Dec to avoid being stranded. The yacht spent 18-22 Dec at the BAS King Edward Point station (KEP), South Georgia, to clean equipment and sort samples. Field equipment was donated to the station's stores to support future expedition work in the territory. The yacht then took a circuitous route back to Stanley to avoid more storms, arriving on 28th Dec when the team demobilised. A full expedition report was included in the Annex of the First Year Report.

Indicator 1.2 Cloud-free, stable images of all ice-free areas of Zavodovski for at least one day from satellite/RAF flyovers obtained in Y1Q4 and analysed by end of Y2Q1. Maxar and Airbus satellites were tasked with acquiring high resolution (30 cm) optical imagery between 1 Dec 2023 and 31 Jan 2024, Y1. A useable image with cloud only over the summit and the west coast was obtained on 07 Dec 2023. No further useful images had been obtained by 31 January so tasking was extended to the end of March. Marginal quality images were obtained on 27 February 2024 and 23 March 2024, where the north and east coast were visible through gaps in the cloud. A lower resolution image from Airbus SPOT satellites (1.5m) was obtained on 1 January 2024 and we also used Darwin funds to obtain two other similar images from the archive (2016 and 2020; another from 2011 was also acquired by BAS previously and was made available for use *gratis*).

Further tasking in Y2 produced an excellent image of most of the coastal plain of Zavodovski on 12 Jan 2025 (Annex 5, Fig 2a) which has been the focus of further analysis. We used remaining funds to acquire archive satellite images of other poorly surveyed sites in the eastern Scotia Arc which will help to put the counts on Zavodovski into context (Visokoi, Candlemas, Saunders and Thule in the South Sandwich Islands, plus West Coronation Island in the South Orkney Islands).

Our partner at RWTH Aachen University tasked Synthetic Aperture Radar (SAR) satellite images at a rate of one image every 4-7 days during 2023/24 and 2024/25 and is developing a novel method of identifying the extent of penguin colonies using their unique texture. The method can deliver imagery at night and through cloud which offers obvious advantages over optical satellite imagery.

The RAF made two flights (12 and 20 Dec 2023) over Zavodovski with the A400M (Annex 5, Fig 2e, 3b), operating out of Mount Pleasant on the Falklands. Operational constraints prevented any doors opening during flight and so all photography was through the cockpit windows, which affected the quality of images. Image stabilisation in the camera lens reduced blur from vibration. On both flights, low cloud or haze obscured upslope colonies, but some excellent images were obtained of the coastal sub-colonies where individual penguins could clearly be discerned and counted.

Indicator 1.3. Ground and drone surveys achieved for at least 50% of penguin colonies and 10% of vegetated fumaroles on island in Y1Q4. Penguin colonies were surveyed using a Mavic 3 Enterprise multirotor drone operating at 70-100m above ground level (Annex 5, Fig. 4). This was programmed to follow the topography using a 3D elevation model to ensure constant ground sampling distance across the survey. The timing of the survey was ideal at the peak of incubation (i.e. few pairs were still to lay eggs and few had failed) and during a period when off-duty birds were scarce in the colony. Drone surveys of penguin colonies were hampered by strong winds and low cloud. Reasonable conditions occurred on the 14 Dec and, thanks to the efforts of the team, all of the penguin colonies at the north, east and south sectors of the island were surveyed (>90% of total extent and numbers). Attempts were made to survey the small western colonies on 15 Dec, but winds were too strong to allow this. We used satellite imagery from 2025 and the RAF aerial survey to fill this small gap in coverage. Surveys of terrestrial biodiversity were conducted across the plain and lower slopes of the island on foot and using drones. Only one accessible geothermal site was found, which was surveyed and sampled. Significant terrestrial biodiversity was also found in non-geothermal habitats (see below).

Indicator 1.4. Open access publication of two papers describing (i) status of terrestrial flora/fauna and (ii) seabirds on the island, (including ground-truth correction factors) by Y2Q4. We are behind schedule and no papers on the findings relating to predators have yet been published. However, as evidenced from the following account, we have made good progress with analysis and interpretation of the data which is an important step towards publication and application of findings. The findings are publishable and write up of these data for submission to scientific journals is underway (submissions expected by October 2025). Publications have resulted from the terrestrial study and more are being drafted (see Annex 3, Table 2).

(i) *Terrestrial flora/fauna*. Field surveys revealed unexpectedly high levels of terrestrial biodiversity, with several notable discoveries. A particularly striking finding was a large patch of the moss *Bryum argenteum*—estimated at 100 m²—just south of Reek Point. (Annex 5, Fig 5a) which was not present during the previous terrestrial survey in the 1990s. This moss patch constitutes a well-developed biological soil crust (Annex 5. Fig 5b) which is indicative of a mature and healthy terrestrial community. The site was surveyed with a drone to map its extent. Lichens were also observed on approximately 40% of rocks between 100–300 m elevation. These were diverse in their appearance, but DNA analysis showed that all belonged to a single species, *Myriospora signyensis*, previously known only from South Georgia. Additional biodiversity observations included the likely presence of *Ixodes uriae* ticks—parasites of Chinstrap penguins—and small earthworms under rocks near penguin colonies. A small geothermal site (~1–2 m²) was found in the north of the island with soil temperatures of ~60°C at 10 cm depth was also recorded (Annex 5, Fig. 5c) supporting growth of *Campylopus pyriformis*, a moss associated with geothermal habitats. Soil samples were collected and shared with the Thermophile Research Unit at the University of Waikato for microbial analysis, though progress has been delayed due to the passing of a key collaborator.

(ii) *Predator numbers*. The drone surveys of penguins were analysed by digitising colony boundaries manually to estimate area of occupation and running a classifier that discriminated penguins from their background. This also identified chinstrap and macaroni penguins to species, based on coloration, size, shape and spacing (Annex 5, Fig. 6 & 7). The count unit was apparently occupied nests, so penguins standing close together at the same nest were counted as a single unit. Validation was performed within 5x5m quadrats sampled from the imagery, which were counted manually and then compared with the classifier count in the same image. The two count types showed excellent agreement (Annex 5, Fig 8) which shows the classifier performs well in counting and identifying penguins. It was therefore used to count penguins across the whole island, apart from areas where they occupied broken rocky areas. Here, the classifier failed to discriminate between penguins and dark rocks, fissures or shadows and so these areas were counted manually. We excluded penguins outside of our manually digitised colony boundaries (e.g. those roosting on beaches) to avoid these being counted as breeding pairs.

We also attempted to use an AI computer vision approach (CountGD algorithm to count penguins in the drone imagery). When calibrated against manual counts, we experienced similar problems to the classifier when separating penguins from their background in rocky, fissured areas. This resulted in an overestimate of the intercept and underestimate of the slope in the regression model of manual vs. automated. By this point, the classifier was producing robust outputs so further analyses focussed on using the classifier approach.

The western upland colonies that were not captured in the drone survey had their area estimated from the 2025 satellite image, which was multiplied by the average density in upland western colonies (calculated from drone images). Counts of Stink Point in the far west, which supported a large colony in 2011, were obtained from the RAF imagery. Numbers had fallen to just 130 pairs in 2024, all at the foot of the cliff, while the large flat area at the top of the cliff had been completely abandoned.

We estimate the number of chinstrap and macaroni penguin pairs in 2024 at 194,350 and 220,730, respectively, which compares to 600,000 and 90,000 in 2011. Chinstrap numbers have therefore declined by two thirds in 13 years (-3.76% pa) and the extent of their colonies have contracted over the same period (Annex 5, Fig. 8). The observation is alarming given the global importance of the site. Our findings contradict the widely held belief that the chinstrap's stronghold in the South Sandwich Islands has been isolated the long-term declines witnessed

across the rest of the species' range. The -3.7% pa decline we observed on Zavodovski is very similar to the -3.6% pa in the South Orkneys and -3.5% pa in the South Shetlands/ Antarctic Peninsula. Over three generations (28.2 years) the global decline of the species at an average rate of -3.6% would be ~35%, which is just above the IUCN status of Vulnerable and suggests the listing of chinstrap penguin ought to be increased from Least Concern to Near Threatened. Zavodovski has now slipped in the rankings to second largest penguin colony in the world (Cape Adare, Ross Sea, now claims that title, having hosted 504,332 pairs of Adelie penguins in 2018). Macaroni penguins have increased by two and a half times (+2.93% pa) on Zavodovski and now outnumber chinstraps, which represents a marked shift in predator community composition. Satellite images from 2016, 2022 and 2025 indicate a consistent decline in the total area occupied by penguins: 99.5 ha in 2011, 51.4 ha in 2016 and 29.9 ha in 2015. Colony contraction and fragmentation was particularly severe on the southern plateau, where cloud-free satellite imagery was also available for 2020 (Annex 5, Fig 9).

Antarctic fur seal rookery boundaries were digitised from the drone images and the number of breeding cows and pups within these were counted. Bulls were more widely distributed and were counted across the whole coastal plain. The counts of 1,154 cows, 1,265 pups and 545 bulls have been contributed to a global review of Antarctic fur seal populations being led by Jaume Forcada at BAS. A count of the three southern giant petrel colonies on the island totalled 178 pairs, compared to 64 in 2011, which has been submitted to the Agreement on the Conservation of Albatrosses and Petrels (ACAP) database.

Indicator 1.5. Plans, funding streams and data analysis pipelines for five-yearly surveys agreed by project partners by Y2Q4. As part of the 2023 Zavodovski field expedition, we pioneered a novel application of high-resolution dual-polarimetric synthetic aperture radar (SAR) data to detect and map penguin colony activity. Using time-series coherence analyses from TerraSAR-X and PAZ satellites, we were able to identify spatial patterns of ground disturbance associated with nesting penguins. This discovery was made possible only through the unique combination of satellite tasking, expert knowledge from both volcanology and biology, and *in situ* validation during the Zavodovski expedition — without which this method would not have been developed.

The SAR-derived maps will be compared to a kernel density model based on our 2023 ground survey data in forthcoming analyses. While this comparative assessment is ongoing, initial results strongly suggest that SAR coherence can serve as a powerful, independent proxy for identifying and monitoring penguin colonies irrespective of cloud cover or daylight. This approach not only opens new possibilities for large-scale, long-term wildlife monitoring in remote regions but also lays the foundation for a new interdisciplinary field at the intersection of remote sensing and ecological research. Richter has an agreement with the supplier, DLR, to continue to receive SAR imagery from Zavodovski at 11-day intervals. We are also investigating application to other sites across the Scotia Arc and Antarctic Peninsula which will be ground-truthed with BAS high-resolution aerial photography.

In line with the original proposal, BAS will seek funds to task Maxar and Airbus satellites in Dec-Feb 2030 to obtain further optical satellite images. If cloud cover allows these will enable further analysis of changes in colony area on the island to corroborate trends observed in SAR imagery. These optical images will also be used to assess the status of the moss patch. Analysis of hyperspectral images from the 2023 Airbus satellite image during our project reveals that the moss has a distinct signature from the green algae which is widespread on the plain, allowing its extent to be monitored by remote sensing in the future (Annex 5, Fig. 10).

Output 2: Seasonal movements of penguins described. Important areas and vulnerability to overlap with areas and seasons open to krill fisheries revealed.

Indicator 2.1. Equipping penguins with GPS, PTT and GLS, recovery of GPS and GLS. We equipped 12 chinstrap and 8 macaroni penguins with PTTs during the incubation stage on 13 and 14 Dec (Annex 5, Fig 11). Deployments were divided equally between the northern and southern colonies on the island. The earlier timing of the expedition to that originally planned was advantageous by allowing long incubation trips to be tracked. One tag fitted to a chinstrap stopped transmitting after a few weeks, but the remainder continued throughout the breeding and pre-moult periods until they were moulted off on land in March.

Only four GLS (and one leg band with no GLS) were recovered from chinstraps (out of 20 deployed) and none from macaroni penguins (out of 15) despite daily searches of the deployment site during the expedition. This was due to the visit occurring during incubation when only half the birds were present and long nest attendance shifts make it difficult to recover tags without disturbing lone birds and exposing their eggs to skua predation.

No birds were equipped with archival GPS loggers, since the expedition visited the island during incubation rather than chick rearing as first proposed. Incubation shifts are 10-14 days in duration so any GPS deployed would not have been available for recovery before the team left the island.

Indicator 2.2. Open access paper published describing penguin tracks from all seasons, including identification of marine KBAs and assessment of spatiotemporal overlap with areas open to krill fishing by Jan 2025:

(i) *PTT tracking*. The penguin PTT tracking data were processed to allow for their observation errors and sample locations at hourly intervals to provide a measure of time spent. Tracks were split into trips using a 2 km coastal buffer. Overlaps with the SGSSI MPA polygon and the boundaries of the no take zones (NTZs), which have expanded through time, were expressed as proportion of time spent within the focal polygon. Tracks were divided into long and short trips by a 4-day threshold. Short trips mostly occurred during chick-rearing and long trips during incubation and pre-moult. Failed breeders also tended to conduct few long trips rather than multiple short ones. These findings suggest that short trips are for chick provisioning and long ones for self-maintenance.

The species showed clear differences in distributions during both short and long trips (Annex 5, Figs 12 & 13). Macaroni penguin trips tended to move to the north and east of the colony toward the warmer waters near or beyond the Southern Antarctic Counter Current Front (SACCF), whereas chinstraps preferred to remain south of the SACC Boundary (SACCB), which is in keeping the species' expected habitat preferences (macaroni are a subantarctic and chinstraps a maritime Antarctic species). The overlaps in the 95% and 50% isopleth (i.e. polygons within which the given species spent the given proportion of their at-sea time) were low during long trips. Specifically, Bhattacharyya's Affinity (BA) values (an index where zero is no overlap and one is complete overlap) were 0.238 for the peripheral utilisation distributions (95% isopleth) and 0.037 for the core (50% isopleth). For short trips these values were higher at 0.494 and 0.168, respectively, but can still be considered low given the duration of the trips constrains them to remain close to their shared colony site. This is indicative of strong niche partitioning among the two species based on differences in habitat preference.

The proportion of at-sea time that each species spent in the South Georgia MPA, the North South Sandwich Island Key Biodiversity Area and the combined No Take Zones and Pelagic Exclusion Zones (NT/PEZs, in which krill fishing is prohibited) are shown in Annex 5, Table 1. The data show that the KBA and the NT/PEZs are particularly effective in recognising or protecting important penguin foraging areas during short trips. Both species move outside these features more often during long trips. While chinstraps remain within the MPA, macaroni penguins spend 30% of the time during long trips outside it in CCAMLR Subarea 48.4. The data show a clear improvement in the proportion of time at sea protected from krill fishing by NT/PEZs as extensions to the areas are added on successive 5-yearly MPA reviews (Annex 5, Table 1). However, in practice, krill fishing has not occurred in the South Sandwich Islands region for over 20 years, owing to the industries' choice (remote location, lack of shelter, unpredictable catches) and wider regulation of the MPA (closed seasons, catch trans-shipment rules and, since 2023, GSGSSI ceasing to issue krill fishing licenses for 48.4). Competition with fisheries is therefore not a serious current threat to penguins breeding in the South Sandwich Islands.

(ii) GLS tracking. The GLS data were analysed using geolocation, which estimates the positions of birds at sunrise and sunset of each day from local time of midday (longitude) and daylength (latitude). Step lengths were constrained by swim speed and latitude by a sea surface temperature mask. These measures prevent movements over unrealistic distances or into waters of a temperature inconsistent with those recorded by the GLS tag. All four chinstraps showed similar migration paths (Annex 5, Fig 14). In March, after moult, they moved south within the MPA but remained north of the 60 Degree South NTZ. In April and May there

was a directed migration east that took birds south of Bouvet Island before they reached the wintering grounds over the South Indian Ridge Fracture Zone which lies to the south of Africa. This is an area subject to rapid climate change and southward shifts in the location of frontal boundaries. They resided here until the end of Aug then migrated back west to the north of the outbound leg, which was now unavailable as it was covered in winter sea ice. The return to the colony in late Oct and early Nov was direct and rapid. Birds spent only 14% of their time in the MPA during winter, with the majority of time in CCAMLR Subarea 48.6, which is open to krill fishing, although none actually occurs.

Indicator 2.3. Advice to SGSSI MPA review and CCAMLR formulated and presented at 2024 MPA workshop and summer 2025 WG-EMM meeting.

See reporting under Outcome 0.1 and 0.2.

Output 3. Breeding season penguin diets quantified: proportion of Antarctic krill in diet reveals risk of dietary competition with krill fishery.

Indicator 3.1. 100 fresh scats collected and frozen from both chinstrap and macaroni penguins in Jan 2024 then archived in the BAS Biostore by June 2024. This proved challenging as the visit was during mid-incubation, when both species were fasting through long incubation shifts lasting 10-14 days. Birds on nests produce faeces with no prey remains and low numbers of birds were returning from foraging trips to relieve their partners. Had the expedition been in January, as first planned, obtaining droppings rich in prey DNA from chicks would have been straightforward. With perseverance, the team were able to collect 50 droppings from each species, from both the northern and southern colonies.

Indicator 3.2. DNA analysis of prey composition in 100 samples, including discrimination of Antarctic krill in Euphausiid component, by Jan 2025. Faecal samples were transferred to the Cornell Lab of Ornithology for DNA metabarcoding analysis. DNA has been extracted from most samples, but only the fish component of the diet has been analysed to date. Only three chinstrap samples and nine macaroni samples successfully amplified fish DNA. This low success rate likely stems from the birds' incubation status at the time of collection, as they had potentially been fasting for several days while tending their eggs. Previous studies have reported similarly low success rates when attempting to amplify prey DNA from incubating birds. The particularly low success rate in chinstrap penguins, compared to macaronis, may also reflect the former's greater dietary specialisation on krill. From the three chinstrap penguin samples that amplified fish DNA, we identified two bathypelagic fish species: *Notolepis coatsi* and *Gymnoscopelus nicholsi*. The nine macaroni penguin samples contained *Notolepis coatsi*, *Notothenia coriiceps*, and additional myctophid and notothenioid DNA that could not be identified to species-level due to insufficient reference sequences. The next phase of analysis will involve amplifying the 18S gene using universal eukaryotic primers to examine total dietary breadth, and the 16S gene using krill-specific primers to identify krill species, which will take 2-3 months to complete. However, we expect similar low recovery rates to that seen in the fish marker so sample sizes are likely to be small.

Indicator 3.3. Section on diets included in paper from Output 2.4 by Jan 2025. Given the low prey recovery rates and changes to the plans for the content of papers we now aim to combine data from Zavodovski with faecal sampling from previous years at Saunders and Thule Islands, where we collected from chinstrap, Adelie and gentoo penguins. This will allow an assessment of penguin diet composition across the South Sandwich Islands. We aim to submit this by Dec 2025.

Indicator 3.4. *Advice to SGSSI MPA review and CCAMLR on potential for dietary overlap with krill fishery formulated and presented at 2024 MPA workshop and summer 2025 WG-EMM meeting*. The information from the diet paper will be summarised for inclusion in the paper to EMM in 2026. The findings of the paper will be presented at the next SGSSI MPA meeting alongside the tracking information to inform further policy relating to krill fisheries management.

3.2 Outcome

Development and implementation of appropriate Protected Area Management Plans in the South Sandwich Islands, resulting in reduced potential for fisheries competition and risk assessments in relation to volcanic eruptions.

The project has largely achieved its intended Outcome and has delivered a sound evidence base for ongoing management of the island and its surrounding waters. It has delivered accurate baseline surveys that have uncovered an alarming decline in chinstrap penguin numbers and development of regionally significant terrestrial habitats. We have also tracked penguin foraging trips that have informed extensions to NTZs and use of KBAs and CCAMLR Subareas.

Indicator 0.1. By Mar 2025 management recommendations from the penguin tracking work submitted to GSGSSI MPA review. Ratcliffe presented a talk on the project at the MPA Science Symposium in Cambridge on 13/06/2023. This was prior to the expedition but served as a placeholder for the project's findings in future meetings. Hart attended the Spatial Management Workshop in Cambridge on 07/02/2024 where he presented the PTT tracking data. These findings were influential in designating two new NTZs (North Scotia Ridge and SSI Trench Extension), which have produced a marked increase in the proportion of penguin at-sea distribution encompassed by closed areas (Annex 5, Table 1).

Indicator 0.2. By Mar 2025 paper on penguin tracking/diet work submitted for discussion at summer CCAMLR WG-EMM meeting to inform krill management in Area 48.4. The results will be of interest to CCAMLR as they show the proportion of time penguins spend in different Subareas throughout their annual cycle. The results relating to the use of the MPA cannot be presented at WG-EMM owing to the disputed sovereignty of South Georgia. We failed to complete a paper for WG-EMM before the June 2025 deadline. The UK CCAMLR delegation have agreed to table the published paper for discussion at the June 2026 WG-EMM meeting.

Indicator 0.3. By 2025 data are submitted to the Terrestrial Protected Areas Advisory Group. We have produced an accurate baseline survey of abundance and distribution of globally or regionally important populations of marine predators and of terrestrial biodiversity. These will provide basis for monitoring change in relation to various stressors in the future (e.g. climate change, volcanic eruptions, fisheries, avian influenza). We will also produce an accurate map showing the distribution of environmentally sensitive features on the island. Highly sensitive features are the moss patch (vulnerable to damage from trampling), the fumarole (vulnerable to introduction of human-borne microbes) and the giant petrel colonies (sensitive to disturbance which can cause temporary abandonment of nests which exposes eggs to predation). These sites will be strictly off-limits to expedition pax unless access is authorised by a Restricted Activity Permit from GSGSSI and appropriate mitigation measures are followed.

Indicator 0.4. By Y2Q4 findings and recommendations are submitted to Ant-ICON programme of SCAR. Colesie's PhD student, Charlotte Walshaw, who is an Ant-Icon Sc-ATS fellow, will join the SCAR delegation to the Antarctic Treaty Consultative Meeting (ATCM) in Milan, Italy (23 June – 3 July 2025). As part of that, she is also attending the Ant-ICON workshop following the ATCM that will take place in Paris, France (7 – 9 July). On both occasions, she will speak about the relevance of the protection of terrestrial vegetation in the Antarctic realm, specifically focused on vegetation and including examples from the Zavodovski expedition.

Volcano risk assessment: The project has also documented an alarming decline in the numbers of chinstrap penguins on Zavodovski Island and provides ancillary information that narrows the diagnosis of its causes. Analysis of the satellite images from 2016, 2020 and 2025 show a consistent decline of the total area occupied by penguins through time. This pattern of change argues against the decline being caused by a mass mortality event from the March 2016 eruption of Mount Curry as a large decline had already occurred between 2011 and Jan 2016, prior to the eruption occurring. Declines have also continued at a similar rate since 2016, rather than stabilising or recovering as would be expected after an isolated mortality event. Finally, we would also expect that macaroni penguins would have been equally impacted by a volcanic eruption, but their numbers have actually increased.

An alternative explanation is that competition from macaroni penguins could be driving down chinstrap numbers, but this also seems unlikely. The area occupied by nesting penguins has shrunk overall and the drone imagery shows extensive areas of abandoned nest sites around the chinstrap colonies, indicating nesting habitat is not limiting. The tracking data show different marine distributions and habitat use by the two species (see Output 2), and such spatial niche partitioning will reduce competition for food. Competition with krill fisheries is also unlikely to be the cause of decline in chinstraps given no take zones have increased protection for penguins

in the region (Output 2) during the period of decline and moreover no actual krill fishing has occurred in CCAMLR Subarea 48.4) for over 20 years.

The most plausible explanation for the observed patterns is that a climate-change induced regime shift (a warming event that alters community structure) has occurred that has been detrimental to the maritime Antarctic chinstrap penguin but has favoured the sub-Antarctic macaroni penguin. Further analysis of marine climate change in the eastern Scotia Arc during the breeding season and in the wintering areas are being developed. We aim to publish these ground-breaking results in a high impact journal (Nature Climate Change or Global Change Biology). Final data sets and imagery will be published on the NERC Polar Data Centre at the same time to satisfy journal open data policies and so they are available to the wider science and conservation community.

3.3 Monitoring of assumptions

Assumption 1: Suitable charter vessel and skipper is available. Agreement reached in principle but cannot be booked until funding available.

Comments: The charter vessel had been booked for January for the GSGSSI albatross survey by the time funding became available. We therefore booked it for late Nov to the end of Dec following approval of a Change Request. This change resulted in some plus and minus points:

+ The expedition coincided with the incubation stage rather than chick rearing. Surveys are more accurate during this period (fewer losses of nests have occurred, few off-duty birds present)
+ The collection of incubation stage foraging trips was possible (longer than chick-stage ones)
- Weather conditions were extremely stormy during Dec (see Assumption 3) but were calm in Jan.
- Long incubation shifts made recovery of GLS difficult (see Assumption 7)
- GPS deployments were not possible (see Assumption 7).
- Finding fresh faeces with a high DNA load was difficult (see Assumption 8).

Assumption 2: Cloud free images may be difficult to obtain given the inclement weather on Zavodovski, but by tasking the satellite there is a high chance of success.

Comments: In Jan 2025 we obtained an excellent high-resolution image of the island with the coastal plain clear from cloud cover (Fig 3a). Images obtained in 2024 were of marginal quality due to cloud and haze or lower resolution. Analysis has focussed on the 2025 image.

*Assumption 3***:** RAF mission is flown successfully, given uncertainties in scheduling, weather and aircraft maintenance. Image stabilisation implemented as part of this project will improve the quality of images taken from RAF flights.

Comments: Despite stormy weather two missions were flown over the island. Low cloud meant that upslope colonies could not be photographed but good quality images were obtained from coastal ones. The image stabilisation in the camera body and lens eliminated vibration but image quality was affected in some cases by having to shoot through the cockpit windows: doors-open operations were not allowed. The images have proven valuable for confirming the demise of the colony at Stink Point which was not visited on foot or photographed with drones.

*Assumption 4***:** Landing on Zavodovski was previously challenging owing to lack of landing points and high swells. However, a relatively safe natural harbour for Zodiacs in the NW of the island has been discovered and used with success in recent expeditions, which reduces the risk of being unable to land. Our proposed survey duration is intentionally much longer than previous scientific expeditions to allow for lost days to poor weather or swell.

Comments: Weather conditions during the expedition were appalling, with successive storms sweeping across the Scotia Sea, which may have been due to a strong El Nino event in 2023/24. This necessitated sheltering at South Georgia and detouring South to Thule Island on the inbound journey which took 13 days compared to the expected 7 days. Landing at the south of the island was finally made on 10 Dec (the north landing was deemed unsuitable by the skipper). The team left on 16 Dec to avoid another inbound storm, as otherwise the resulting swell would have stranded them ashore. The return journey to Stanley was also slowed by storms that necessitated extended sheltering at South Georgia and a circuitous route back to Stanley. Of the 5-week expedition only 4 days were available for science, and we consider ourselves fortunate to have achieved that.

Assumption 5: Zavodovski is an active volcano, so in the unlikely event of an eruption, landing or close approach by vessels will be dangerous and prohibited by GSGSSI. Postponement to the following year is possible, subject to agreement from Darwin Plus, as we are not employing contract staff.

Comments: The volcano was monitored from satellite imagery prior to the expedition which showed no increase in the ash cloud. Upon arrival, the volcanologist assessed the state of the volcano and found no significant changes in activity since the previous visit in Jan 2024. Work therefore commenced as planned.

Assumption 6: Drone flying is dependent on relatively favourable weather, but the BAS Skyranger military-grade drone is able to fly in worse conditions than standard DJI models, which provides greater confidence of obtaining data.

Comments: We chose not to use the Skyranger as is it an old model and its camera is of lower quality than modern aircraft. We instead selected an eBeeX as the primary survey aircraft: a fixed wing model that can achieve more rapid coverage of large areas than multi-rotors. Unfortunately, the pilot on the expedition qualified to use it was taken ill in South Georgia and was medivaced back to the UK. We therefore resorted to Mavic 3 Enterprise multirotor aircraft and, thanks to a weather break and efforts of the field team, we obtained coverage of over 90% of penguin colonies on the island.

Assumption 7: GPS and GLS tags are archival and birds need to be recaptured to obtain their data. We have assumed a 90% recapture rate for GPS and 70% for GLS, which is reasonable based on previous experience.

Comments: The change in timing of the expedition (see Assumption 1) meant that the work was conducted in the penguin incubation rather than chick rearing stage. During incubation, one partner remains alone at the nest for 10-14 days compared to chick rearing when birds perform repeated 1-2 day long trips. GPS deployments were therefore not appropriate: most birds would not have simply sat on the nest throughout and those that did leave would not have returned before the expedition members had departed the island. We therefore relied on PTTs for tracking breeding stage and pre-moult trips and purchased three additional tags to increase sampling following approval of a Change Request. GLS recoveries were low due to being timed to the incubation period. Half of the birds equipped were at sea throughout the expedition and female macaroni penguins are prone to leave the nest when incubating alone which can expose eggs to skua predation so the team were reluctant to disturb them.

Assumption 8: 100 fresh scats containing high DNA loads are available for both species. During January, chicks have hatched and they will produce copious amounts of suitable material.

Comments: Incubation shifts are 10-13 days long during which birds fasting and so produce faecal material that contains little prey DNA. This made finding suitable scats for diet studies more difficult. With perseverance, the penguin team were able to find 50 scats from each species but the recovery rate of DNA from these was low.

4 Contribution to Darwin Plus Programme Objectives

The project has made significant contributions to multiple Darwin Plus Programme Objectives.

Biodiversity: The survey of the penguin colonies has provided the most accurate census of numbers of chinstrap and macaroni penguins at this globally important colony to date and discovered a concerning decline in chinstrap numbers since 2011. This will have implications for global population estimates and the 1% threshold for IBA/KBA recognition. The IUCN status of chinstrap penguins may need to be revised from Least Concern to Near Threatened. Surveys of terrestrial biodiversity found unique interest features that were not detected on previous visits. The moss bank and communities associated with the fumarole are particularly important and sensitive habitats, that warrant specific recognition and protection in the SSI Terrestrial Action Plan. We will produce detailed maps to allow future expeditions to avoid these sensitive areas.

Environmental quality: The penguin tracking data provide the first insights into the use of the SGSSI MPA by penguins from Zavodovski. Our tracking data supported decision-making relating to the latest extensions of No Take Zones around Zavodovski which have reduced the proportion of time penguins spend foraging in areas open to pelagic fisheries. We demonstrate a consistent increase in protection for penguin foraging through time following successive MPA reviews and confirm the effectiveness of the KBA in encompassing important areas used during chick-rearing. These findings provide evidence to inform ongoing debates between GSGSSI and conservation NGOs concerning marine spatial planning and fisheries management in Subarea 48.4.

Climate change: We show a fascinating, if concerning, regime shift in the penguin community on the island, where the maritime Antarctic chinstrap penguin have been replaced by the sub-Antarctic macaroni. This is likely to be due to a climate change effect creating winners and losers, where conditions become less suitable for cold-adapted species and more so for warm-adapted ones. We found that chinstraps migrate away from the SGSSI MPA during winter to an area south of Africa which is known to be experiencing rapid warming. We will conduct further work to identify the likely effects of climate change upon Zavodovski's penguin populations and to identify the seasons and locations in which this may be operating.

Capability and capacity building: Our ground-truthing work has allowed development of novel methods of monitoring penguin colonies using satellite radar which will facilitate estimation of trends on Zavodovski and other areas of the UKOTs and BAT. This frees researchers from the difficulties of visiting remote sites or using optical satellite imagery, which depends on clear skies and daylight. This promises to overcome significant uncertainties in the status of penguins across the Scotia Arc in particular, given counts from many large but remote sites are several decades out of date. The classifier we developed to count penguins will also have wider applications for aerial survey work, allowing estimation of numbers of penguin in drone or crewed aerial survey imagery without labour intensive manual counts or the implementation challenges of AI methods. These advancements will support improved assessment of the conservation status of species and sites and help to develop evidence-based ecosystem management of krill fishing.

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

The projects outputs have strategic value both within SGSSI and more broadly across the UKOTs and BAT.

The novel method of surveying penguins developed by Co-I Richter, which has been ground-truthed using data from this project, has enormous potential for monitoring penguin colonies in remote locations that experience frequent cloud cover, where censuses on the ground or from optical satellite images are difficult. This has potential to provide much-needed updates on status and trends of Antarctic penguins and to assess their responses to climate change. We are seeking funding to test the method more widely across BAT using the aerial surveys by the BAS Twin Otters equipped with high-resolution cameras, combined with simultaneous tasking of the Terra SAR satellites by Aachen University.

The project has detected a marked decline in chinstrap penguins at Zavodovski, which held approximately a third of their global population in 2011. Our findings contradict the previous

belief that the South Sandwich populations of chinstrap penguins were isolated from the declines observed across the remainder of their Scotia Sea range. This has implications for the species IUCN threat status and will alter the 1% threshold for recognition of IBAs and KBAs. These findings will afford greater strategic priority for further research and monitoring of the species to better understand and manage these trends.

The extensions to the No Take Zones in the SGMPA will remain in place for the long-term and will reduce the potential for spatial overlap between foraging penguins and krill fisheries. We have provided quantitative evidence that informs a long-standing debate between GSGSSI and conservation NGOs relating to legislation of krill fishing in Subarea 48.4.

4.2 Gender Equality and Social Inclusion (GESI)

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	
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	

We have increased the proportion of women involved in the project since it was proposed. The six-person expedition included three women. They contributed valuable scientific skills and knowledge in the fields of ornithology, terrestrial biodiversity and volcanology/satellite imagery. Privacy issues in the camp were discussed sensitively to reach arrangements all participants were comfortable with. We have included new woman members of the Project Board since the proposal was funded; Nicole Richter who brings expertise in volcanology and remote sensing and Gemma Clucas who brings expertise in analysis of predator diets from prey DNA in faeces. Claudia Colesie from Edinburgh and Jen Black/Sue Gregory from GSGSSI continue to provide valuable inputs on terrestrial biodiversity and management applications of the findings.

5 Monitoring and evaluation

Monitoring and Evaluation: This was conducted throughout the year, assessing progress toward outputs, assumptions, emerging risks (using the Risk Register) and expenditure. The project has made five Change Requests in its lifetime to agree changes in the expedition timing and pax, the reallocation of budgets across years and cost headings and to agree participation of a film crew in the expedition. The emergence of bird flu in South Georgia created an additional risk that was not anticipated when the proposal was written and necessitated extended discussions about operating practices and PPE on the expedition if HPAI were found to be present upon arrival at the island (thankfully, no signs were apparent). Last minute pax changes to the expedition occurred: the film team pulled out three days prior to sailing over concerns relating to bird flu, and two of the science staff returned home to the UK for health reasons. We were able to replace one staff member to undertake the RAF flights, but the filming component was lost and the expedition lost a science team member with unique drone

piloting skills. Despite the significant challenges the expedition encountered due to these setbacks, bad weather and timing changes (see Assumptions) we achieved most of the fieldwork objectives, which is a testimony to careful planning, responsive problem solving and the resilience of the team. The project's Indicators relating to the fieldwork element of the project have been fulfilled. The write up and publication of the findings is behind schedule but the evidence presented in this report show that analysis and interpretation of the data are at an advanced stage. The application of the results to management and development of the projects legacy are progressing well.

6 Lessons learnt

Planning the expedition took far longer than anticipated owing to the multi-disciplinary nature of the expedition (multiple topics, personnel and organisations), the hazardous nature of the study site (volcanic, exposed to storms, remote) and the special protected status of the island. Additional complications were inclusion of a film team and emergence of HPAI on South Georgia. Future projects should budget 4 months of PI time to adequately plan a similar expedition.

The expedition delivered its objectives despite numerous setbacks (weather, staff changes). The five weeks allowed was just sufficient to complete the round trip and even this was thanks to an additional contribution to the yacht charter costs from the Talesmith film team. Future expeditions would be wise to allow 6-7 weeks to ensure more than a few days ashore, while having provision to extend work to other islands in the archipelago if good weather allows objectives to be completed early.

The team worked well together but there was a lack of clear leadership as the PI was unable to participate in the expedition owing to care responsibilities that arose after the grant was awarded. Responsibilities for logistics, safety and science were delegated among team members but there was no single authority figure to make final decisions, coordinate efforts or provide accountability. This is an important consideration for future trips to improve project management. Having two pilots for the e-Bee X drone would have provided redundancy in key skills that would have allowed it's use, although the use of the Mavic 3 drone did provide good coverage it its absence.

The work on the island has added to the understanding of the hazards and practicalities of camping on, travelling across and working at this challenging field site. Expedition reports have been submitted to the BAS archive which will help with planning future trips to Zavodovski.

The write up of the findings is behind schedule as the project is run by established staff with multiple commitments. With hindsight a 2.5-year project with more time allocation to investigators might would have been more appropriate. Alternatively, a dedicated, full time postdoctoral research assistant would have helped deliver publications on time. Either option would have made what was already an expensive project more costly, while finding a single PDRA with all the skills required would have been difficult. Nonetheless, the Outputs and Outcomes will be delivered as the investigators are committed to publishing the results of the project using institutional time, which represents ongoing in-kind support to the project.

7 Actions taken in response to Annual Report reviews

The first-year reviewer showed a sound understanding of the project's objectives and an appreciation of the difficulties we had faced, and overcome, during the planning and execution of the fieldwork. The evaluation was Good, both in terms of progress toward objectives and presentation of the report. The reviewer was concerned that the roles and responsibilities of the project's partners were not fully explained, particularly in the case of new partners with whom we engaged after the proposal stage (Co-Is Richter and Clucas). To address this comment, we have provided a more detailed overview in Section 2 of this report. The reviewer also queried whether a return visit would be made to attempt to retrieve further GLS tags to better describe winter distributions of chinstraps and to obtain any data for macaronis. We have recently learned of an expedition to the SSI led by Cornell University in 2026 which aims to investigate

occurrence of HPAI on the islands. This may provide an opportunity to recovery more GLS tags and we have reached out to the PI to investigate opportunities to recover further tags, as well as collect further faecal samples and drone imagery.

8 Risk Management

The Darwin Risk Register was used to monitor risks and plan contingencies. The main emerging risk was Highly Pathogenic Avian Influenza which was found on South Georgia in October 2023 before the expedition began. Presence of the virus on the SSI would only be recognised upon our expedition's arrival. If present in penguins this would have prevented any bird handling and possibly landing on the island altogether. The project leaders discussed contingencies in detail with members of GSGSSI, BAS and the Animal and Plant Heath Agency (APHA), including acceptable working practices and PPE. Thankfully there was no sign of the virus on the island and so work could proceed as planned. Management of other risks relating to fieldwork is outlined in the Assumptions section. During the final year, which has been entirely desk-based, no unforeseen risks have arisen; the project has run smoothly thanks to good coordination (see Section 2), although progress with publications is somewhat behind schedule. We have plans to complete the work beyond the project's lifetime using further in-kind staff contributions.

9 Scalability and Durability

The monitoring of penguins on Zavodovski Island will continue thanks to an ongoing collaboration between the partners, using SAR (available weekly through an agreement between Terra SAR and Aachen University) and optical Maxar or Airbus imagery (tasked at 5 yearly intervals). The finding that chinstrap numbers at this globally important colony are declining provides greater impetus to continue monitoring and more leverage to secure funding. We will also commit to analysis of satellite images, secured during this project, from other islands in the South Sandwich and South Orkney archipelagos to place the declines in a wider geographic context and revise the global IUCN threat category of chinstrap penguins.

The extensions to the No Take Zones around Zavodovski, whose justification was assisted by data from this project, will remain in place in the long-term. These will reduce the potential for penguin-fishery overlap and help demonstrate a commitment to progressive marine spatial planning by GSGSSI. The detailed mapping of terrestrial biodiversity on Zavodovski has allowed mapping of environmentally sensitive areas that need to be avoided during future research or media visits to the island.

The project staff will continue to work on the project's scientific outputs and to secure policy and management impact over the coming 12 months, using core institutional funds. The results are novel and high-impact which provides motivation to the partners to complete and publish the work.

The camping equipment used on the expedition was donated to the King Edward Point station for use in deep field camps on SGSSI. The thermal imaging scope and camera/lens are being used at Bird Island, South Georgia to observe nocturnal petrel activity. The camera and lens will be used for photo-ID of individual whales and leopard seals at KEP and Bird Island which assists with studies of their population ecology.

Data from the project, once published, will be made open access on the NERC Polar Data Centre so other researchers and managers can develop further science and policy outputs.

10 Darwin Plus Identity

A project web page is posted on the BAS website. This includes the Darwin Plus logo and states the project is funded by them. The page includes text describing the project, a number of pictures and an infographic depicting elements of the expedition, plus an interactive map of the penguin tracks.

The Vinson of Antarctica (the charter yacht we used for input) has a landing page that features the Darwin Plus logo. This leads to an engaging series of blogs (accessible at the bottom left of successive pages) written by team members and illustrated with photos and videos.

A two-page article was published in the Falkland Island's "*Penguin News*" paper on 26th Jan describing the expedition. This acknowledges Darwin Plus funding in the opening paragraph.

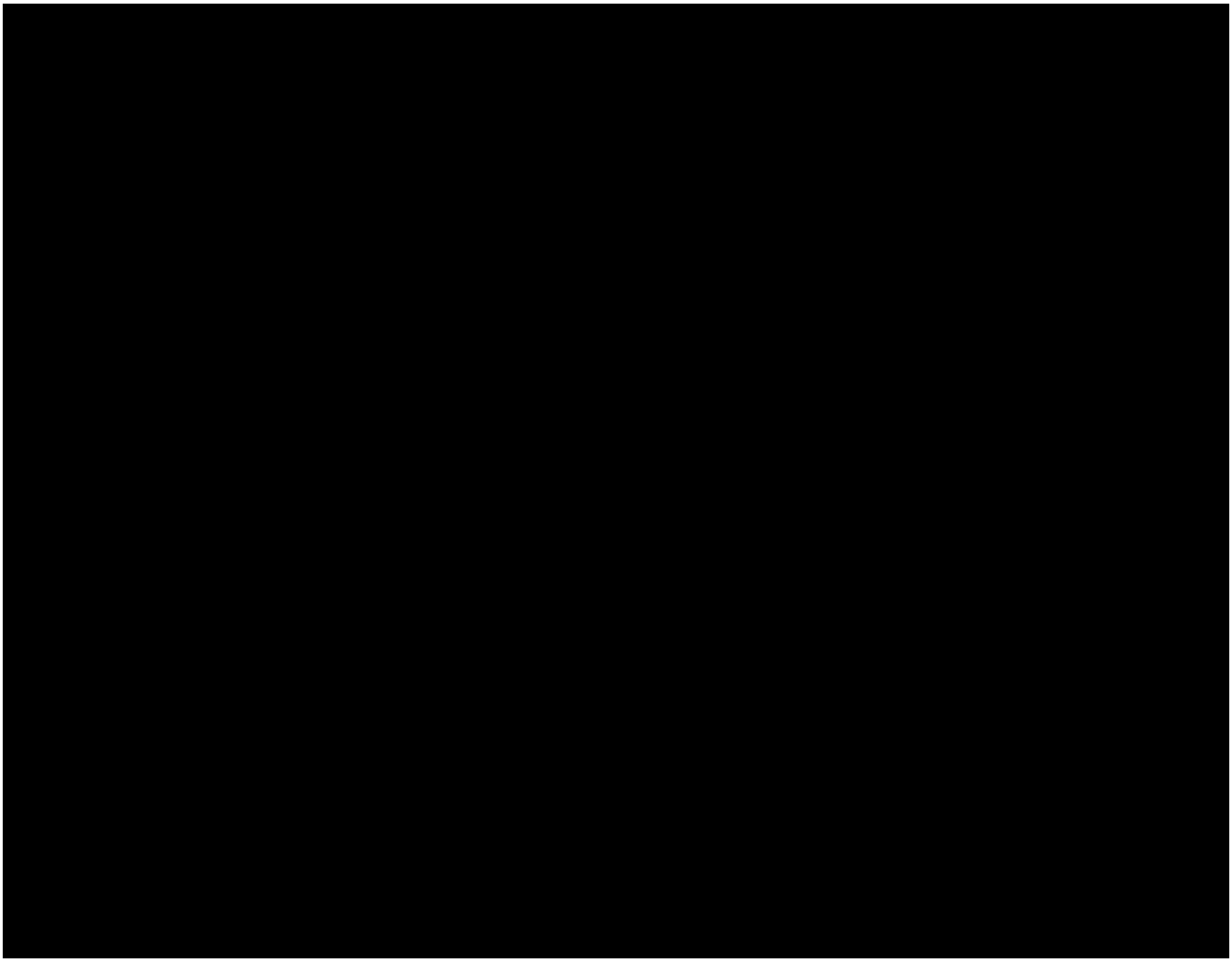
Social media: An Instagram reel, X tweet and Facebook post released for Penguin Awareness Day promoted the expedition to a wide public audience. Instragram: 17K views and 847 likes, X 12.9K views and 1000 engagements, Facebook 1.7K views. These had tags to the Darwin funder.

We contributed penguin PTT tracks to the Argonautica project; an interactive web page that makes data available to school children to help them learn about the marine environment.

Norman Ratcliffe presented a short talk at the GSGSSI MPA meeting in Cambridge on 13 June 2023 to outline the scope of the project. Gemma Clucas presented at talk entitled "Using drones, faecal DNA, and satellite trackers to gather baseline data from the world's largest and under-studied penguin colony" at the Pacific Seabird Group annual meeting, 20th - 24th February 2024, Seattle. Norman Ratcliffe presented talks at the Seabird Group Meeting in Coimbra, Portugal, on 2-5 Sep 2024 and the Pacific Seabird Group conference in San Jose, Costa Rica, on 6-8 Jan 2025. These acknowledged Darwin Plus as the project funder.

Darwin Plus and the full project code and name appear in the Acknowledgements of the two published papers that have emerged from the project to date (Annex 3, Table 2). The findings relating to the decline of the world's largest penguin colony and the apparently climate-change-induced change in species composition is likely to be highly newsworthy and based on previous experience we expect a huge uptake of the story by traditional and social media. We will ensure Darwin Plus are involved in press releases up to the embargo release date and receive accreditation for funding.

11 Safeguarding



[redacted]

12 Finance and administration

12.1 Project expenditure

Project spend (indicative since last Annual Report	2023/24 Grant (£)	2023/24 Total actual Darwin Plus Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs	[redacted]			
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items				
Others				
TOTAL	£91,651.75	£90,085.96		

Staff employed (Name and position)	Cost (£)
Norman Ratcliffe, BAS	[redacted]
Peter Fretwell, BAS	
Peter Convey, BAS	
Tom Hart, OBU	
Claudia Colesie, Edinburgh University	

TOTAL	[redacted]

Consultancy – description and breakdown of costs	Other items – cost (£)
None	
TOTAL	

Capital items – description	Capital items – cost (£)
None	
TOTAL	

Other items – description	Other items – cost (£)
Lab Analysis of scat DNA Satellite Images OBU Collaborator Costs Edinburgh University Collaborator Costs (posted as a credit due to the rectification of a prior period overbill)	[redacted]
TOTAL	

12.2 Additional funds or in-kind contributions secured

Matched funding leveraged by the partners to deliver the project	Total (£)

Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project	Total (£)
TOTAL	

12.3 Value for Money

Expenditure in the final year has been modest and mostly spent on staff time and overheads at standard institutional rates. Further time is required to complete publications and secure impact on the Outputs and Outcomes of the project which the investigators will commit to with in-kind contributions. The lab analysis of the diet from DNA metabarcoding only included charges for consumables; the staff time and use of facilities were in kind. Satellite images were bought at standard commercial rates; we used the funds effectively to obtain tasked images from Zavodovski and cheaper archived images from several other large penguin colonies in the eastern Scotia Sea to enable updating of regional totals. We underspent on travel and subsistence as demand from the partners to attend conferences was lower than anticipated. Ratcliffe attended two conferences and selected the most economical travel and accommodation options in line with UK government policy. Matched funding of staff time and overheads across the partners in Y2 do not appear as transacrions on the project ledger and so are not presented in the table above, but total an estimated [redacted]

13 Other comments on progress not covered elsewhere

None

14 OPTIONAL: Outstanding achievements of your project (300-400 words maximum). This section may be used for publicity purposes.

We have several outstanding achievements and those relating to the change in the penguin community at this, the largest penguin colony in the world, are likely to be particularly newsworthy and generate huge media interest. We therefore prefer to keep publicity of these findings quiet until the paper is published, as early sharing of the findings could compromise publication and media impact. We will keep Darwin Plus informed of progress to publication and commit to engage fully with the Programme over media releases during the embargo period.

Annex 1 Report of progress and achievements against logframe for the life of the project

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Impact Effective conservation of South Sandwich Islands penguins and terrestrial biodiversity is underpinned by scientific evidence and implemented through marine and terrestrial management plans, produced by GSGSSI with stakeholder input		Completion of the fieldwork element of the project produced the data needed to secure the projects impact. Further analytical, write up and policy engagement is required through Y2 to achieve the desired impact.	
Outcome Development and implementation of appropriate Protected Area Management Plans in the South Sandwich Islands, resulting in reduced potential for fisheries competition and risk assessments in relation to volcanic eruptions.	0.1 By Y2Q2 preliminary management recommendations from the penguin tracking and diet studies submitted to GSGSSI MPA review. 0.2 By Y2Q4 paper on penguin tracking/diet work submitted for discussion at CCAMLR WG-EMM meeting to inform krill management in Area 48.4. 0.3 By Y2Q4 paper on terrestrial biodiversity submitted to Terrestrial Protected Areas Advisory Group 0.4 By Y2Q4 findings and recommendations are submitted to Ant-ICON programme of SCAR	Data collected and placeholder for findings made at SGSSI MPA workshop in June 2023. Data collected ready for analysis and write up Data and samples collected ready for analysis and write up Recommendations to be developed from above paper	Year 2 will focus on analysis of data, write up of results. We will achieve policy impact by contributing information relevant to the revision of the SGSSI MPA management plan and production of the SSI Terrestrial Protected Area action plan.

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Output 1. Accurate ground-truthing data collected that allows continued five-yearly monitoring of penguins and terrestrial biodiversity from remote sensing data at low cost/effort/risk by project partners.	1.1 Expedition logistics planned and completed end of Y1Q3 1.2 Cloud-free, stable images of all ice-free areas of Zavodovski for at least one day from satellite/RAF flyovers obtained in Y1Q4 and analysed by end of Y2Q1. 1.3 Ground and drone surveys achieved for at least 50% of penguin colonies and 10% of vegetated fumaroles on island in Y1Q4. 1.4 Open access publication of two papers describing (i) status of terrestrial flora/fauna and (ii) seabirds on the island, (including ground-truth correction factors) by Y2Q4. 1.5 Plans, funding streams and data analysis pipelines for five-yearly surveys agreed by project partners by Y2Q4.	Expedition logistics planned and expedition completed High resolution image obtained from Jan 2025 which is ideal for further analysis. Radar images acquired which can "see" through cloud and provide information on ground texture. Two RAF flyovers made and imagery obtained. Drone surveys of >90% of penguin colonies. The only fumarole found on the island was surveyed, along with and extensive, previously undocumented, moss bank. Data and samples obtained and analysis and interpretation well underway. Write up of results for scientific journals by Oct 2025. Planning for further satellite survey work into the future and across wider areas of the eastern Scotia Sea is underway.	
Activity 1.1 Logistic preparations for expedition (Output 1): Yacht charter, environmental and ethics permits, travel and subsistence, risk assessments, insurance, procurement of equipment.		Completed	No further action.
Activity 1.2 Ground-based survey work (Output 1): drone surveys and DGPS referenced ground surveys of both penguin colonies and terrestrial communities.		Completed	No further action

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Activity 1.3 Remote sensing from satellite/A400M (Output 1): Tasking of satellites and A400M mission. Aerial photography using stabilised medium format camera from A400M.		RAF missions completed. Satellite tasking completed	No further action
Data management and analysis (all Outputs): Coding and curation of data on PDC/TOW. Data analysis, modelling and mapping.		Samples consigned to UK on BAS ship. Data securely archived on BAS server.	Publish final datasets on NERC Polar Data Centre
Policy impact (all Outputs): Production of advice to decision makers and presentation at appropriate fora for discussion by stakeholders.		Influence on MPA review supported revision of NTZ boundaries	Secure impact with CCAMLR at 2026 WG-EMM, SSI Terrestrial Protected Area Advisory Group, June/July 2025 SCAR/Ant-ICON meeting/workshop
Output 2. Seasonal movements of penguins described. Important areas and vulnerability to overlap with areas and seasons open to krill fisheries revealed	1.1 Collection of penguin foraging tracks: (i) GPS during chick rearing for at least 20 chinstrap and 10 macaroni penguins over 3 weeks in Jan2024. (ii) PTTs during chick rearing and pre-moult for at least 10 chinstrap and 5 macaroni penguins over 4 months Jan-Mar 2024 (iii) GLS tracks during winter for at least 20 chinstrap and 10 macaroni penguin over ~6 months from May 2023-Nov 2023 with recapture in Y1Q4.	Change in timing of expedition from chick-rearing to incubation meant GPS tags could not be used: equipped birds would not have been available for recapture as foraging trips would have been completed after the team left the island. PTTs deployed on 12 chinstraps and 8 macaroni in Dec 2023. One chinstrap tag failed in Dec but the remainder transmitted until moulted off in March 2024. 4 GLS out of 20 recovered from chinstraps and none out of 15 from macaroni. Timing of visit would have reduced recovery rate (half of birds absent throughout and concerns over animal ethics when removing lone birds from nests and exposing eggs to predation).	
	2.2 Open access paper published describing penguin tracks from all seasons, including identification of marine KBAs and assessment of		

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
	spatiotemporal overlap with areas open to krill fishing by Y2Q4. 2.3 Advice to SGSSI MPA review and CCAMLR formulated and presented at MPA workshop (probably early in Y2Q1) and WG-EMM meeting (Y2Q3). .	Data obtained and analysed and write up will occur by Oct 2025 Advice already provisioned to MPA review. Paper to CCAMLR WG-EMM in 2026.	
Tracking of penguin foraging tracks (Output 2): Equipping penguins with GPS, PTT and GLS, recovery of GPS and GLS.		Completed	No further action required
Data management and analysis (all Outputs): Coding and curation of data on PDC/TOW. Data analysis, modelling and mapping.		Analysis of tracking data completed	Write up of paper by Oct 2025.
Policy impact (all Outputs): Production of advice to decision makers and presentation at appropriate fora for discussion by stakeholders.		Presentation at SGSSI MPA review workshop	Secure impact upon Terrestrial Protected Area and WG-EMM
Output 3. Breeding season penguin diets quantified: proportion of Antarctic krill in diet reveals risk of dietary competition with krill fishery	3.1 100 fresh scats collected and frozen from both chinstrap and macaroni penguins in Y1Q4 and returned to BAS Biostore by Y2Q1. 3.2 DNA analysis of prey composition in 100 samples, including discrimination of Antarctic krill in Euphausiid component, by Y2Q2. 3.3 Section on diets included in paper from Output 2.4 by Y2Q4. 3.4. Advice to SGSSI MPA review and CCAMLR on potential for	50 collected from both chinstrap and macaroni penguin. Change of timing made droppings harder to find: most birds fasting on long incubation stints and producing no material. Sample sufficient to achieve aims. Samples transferred direct to Cornell University rather than via BAS biostore. Samples have been received at Cornell University lab. Analysis complete but recovery of DNA poor owing to timing of visit during incubation. Samples may not be worthy of publication owing to small samples and bias	

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
	dietary overlap with krill fishery formulated and presented at 2024 MPA workshop and summer 2025 WG-EMM meeting	Advice to be developed and implemented as results emerge.	
Collection and processing of penguin scats (Output 3): collecting scats from penguins in the field. Analysis of diet composition in the lab using DNA fingerprinting.		Sample collection completed. Analysis of diet has been difficult due to low DNA recovery from droppings.	Finalising lab results. Data analysis and publication, if samples sufficient.
Data management and analysis (all Outputs): Coding and curation of data on PDC/TOW. Data analysis, modelling and mapping.		None	Data analysis, visualisation, write up.
Policy impact (all Outputs): Production of advice to decision makers and presentation at appropriate fora for discussion by stakeholders.		None	Secure impact with SGSSI MPA and WG-EMM

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

Project summary	SMART Indicators	Means of verification	Important Assumptions
Impact: Effective conservation of South Sandwich Islands penguins and terrestrial biodiversity is underpinned by scientific evidence and implemented through marine and terrestrial management plans, produced by GSGSSI with stakeholder input .			
Outcome: 0. Development and implementation of appropriate Protected Area Management Plans in the South Sandwich Islands, resulting in reduced potential for fisheries competition and risk assessments in relation to volcanic eruptions.	0.1 By Y2Q2 preliminary management recommendations from the penguin tracking and diet studies submitted to GSGSSI MPA review. 0.2 By Y2Q4 paper on penguin tracking/diet work submitted for discussion at CCAMLR WG-EMM meeting to inform krill management in Area 48.4. 0.3 By Y2Q4 paper on terrestrial biodiversity submitted to Terrestrial Protected Areas Advisory Group 0.4 By Y2Q4 findings and recommendations are submitted to Ant-ICON programme of SCAR	0.1 Attendance at, and proceedings of, stakeholder consultation workshop. Updated Action Plan published online citing evidence from project. 0.2 Publication of paper online and presentation at WG-EMM meeting. 0.3 Email confirming receipt of findings and invitation to present evidence at future consultation workshop 0.4 Email confirming acceptance of paper and invitation to present evidence at next meeting	The outcome assumes that the ground-truthing and penguin tracking work is successful (see below for risks).
Output 1 1. Accurate ground-truthing data collected that allows continued five-yearly monitoring of penguins and terrestrial biodiversity from remote sensing data at low cost/effort/risk by project partners.	1.1 Expedition logistics planned and completed end of Y1Q3 1.2 Cloud-free, stable images of all ice-free areas of Zavodovski for at least one day from satellite/RAF flyovers obtained in Y1Q4 and analysed by end of Y2Q1.	1.1 Yacht charter and travel booking paperwork received, email confirmation of equipment being received at BAS Stanley Office, with photographs. Electronic copies of environmental and animal welfare permits. Approved risk assessments received.	Suitable charter vessel and skipper is available. Agreement reached in principle but cannot be booked until funding available. Cloud free images may be difficult to obtain given the inclement weather on Zavodovski, but by

Project summary	SMART Indicators	Means of verification	Important Assumptions
	1.3 Ground and drone surveys achieved for at least 50% of penguin colonies and 10% of vegetated fumaroles on island in Y1Q4. 1.4 Open access publication of two papers describing (i) status of terrestrial flora/fauna and (ii) seabirds on the island, (including ground-truth correction factors) by Y2Q4. 1.5 Plans, funding streams and data analysis pipelines for five-yearly surveys agreed by project partners by Y2Q4.	1.2 Images obtained and archived with the Polar Data Centre 1.3 Data sets and aerial images collected and archived with the Polar Data Centre 1.4 Publication of papers open access online 1.5. Census estimates updated and reported to GSGSSI regularly from Jan 2025 onward to inform site condition monitoring and Terrestrial Action Plan development.	tasking the satellite there is a high chance of success. RAF mission is flown successfully, given uncertainties in scheduling, weather and aircraft maintenance. Image stabilisation implemented as part of this project will improve quality of images taken from RAF flights. Landing on Zavodovski was previously challenging owing to lack of landing points and high swells. However, a relatively safe natural harbour for Zodiacs in the NW of the island has been discovered and used with success in recent expeditions, which reduces the risk of being unable to land. Our proposed survey duration is intentionally much longer than previous scientific expeditions to allow for lost days to poor weather or swell Zavodovski is an active volcano, so in the unlikely event of an eruption, landing or close approach by vessels will be dangerous and prohibited by GSGSSI. Postponement to the following year is possible, subject to agreement from Darwin Plus, as

Project summary	SMART Indicators	Means of verification	Important Assumptions
			we are not employing contract staff. Drone flying is dependent on relatively favourable weather, but the BAS Skyranger military-grade drone is able to fly in worse conditions than standard DJI models, which provides greater confidence of obtaining data.
Output 2 Seasonal movements of penguins described. Important areas and vulnerability to overlap with areas and seasons open to krill fisheries	2.1 Collection of penguin foraging tracks: (i) GPS during chick rearing for at least 20 chinstrap and 10 macaroni penguins over 3 weeks in Jan2024. (ii) PTTs during chick rearing and pre-moult for at least 10 chinstrap and 5 macaroni penguins over 4 months Jan-Mar 2024 (iii) GLS tracks during winter for at least 20 chinstrap and 10 macaroni penguin over ~6 months from May 2023-Nov 2023 with recapture in Y1Q4. 2.2 Open access paper published describing penguin tracks from all seasons, including identification of marine KBAs and assessment of spatiotemporal overlap with areas open to krill fishing by Y2Q4. 2.3 Advice to SGSSI MPA review and CCAMLR formulated and presented at MPA workshop	2.1 All data sets collected and archived with Polar Data Centre and BirdLife Tracking Ocean Wanders database. 2.2 Publication of paper online. Inclusion of revised/new KBAs in BirdLife gazetteer. 2.3 Presentation of work at SGSSI MPA review workshop and CCAMLR WG-EMM meeting. Revision of MPA closed area/season restrictions as appropriate given evidence.	Penguin tracking requires landings: risk and mitigation are as for Output 1. GPS and GLS tags are archival and birds need to be recaptured to obtain their data. We have assumed a 90% recapture rate for GPS and 70% for GLS, which is reasonable based on previous experience

Project summary	SMART Indicators	Means of verification	Important Assumptions
	(probably early in Y2Q1) and WG-EMM meeting (Y2Q3).		
Output 3 3. Breeding season penguin diets quantified: proportion of Antarctic krill in diet reveals risk of dietary competition with krill fishery	3.1 100 fresh scats collected and frozen from both chinstrap and macaroni penguins in Y1Q4 and returned to BAS Biostore by Y2Q1. 3.2 DNA analysis of prey composition in 100 samples, including discrimination of Antarctic krill in Euphausiid component, by Y2Q2. 3.3 Section on diets included in paper from Output 2.4 by Y2Q4. 3.4. Advice to SGSSI MPA review and CCAMLR on potential for dietary overlap with krill fishery formulated and presented at 2024 MPA workshop and summer 2025 WG-EMM meeting.	3.1 Samples collected and catalogued in BAS Biostore. 3.2 DNA analysis completed bycontractors and data archived with Polar Data Centre. 3.3 Acceptance email from journal editor. 3.4 Presentation of work at SGSSI MPA review workshop and CCAMLR WG-EMM meeting.	Penguin scat collection requires landings: risk and mitigation are as for Output 1. 100 fresh scats containing high DNA loads are available for both species. During January, chicks have hatched and they will produce copious amounts of suitable material
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) Logistic preparations for expedition (Output 1): Yacht charter, environmental and ethics permits, travel and subsistence, risk assessments, insurance, procurement of equipment. Ground-based survey work (Output 1): drone surveys and DGPS referenced ground surveys of both penguin colonies and terrestrial communities. Remote sensing from satellite/A400M (Output 1): Tasking of satellites and A400M mission. Aerial photography using stabilised medium format camera from A400M. Tracking of penguin foraging tracks (Output 2): Equipping penguins with GPS, PTT and GLS, recovery of GPS and GLS. Collection and processing of penguin scats (Output 3): collecting scats from penguins in the field. Analysis of diet composition in the lab using DNA fingerprinting. Data management and analysis (all Outputs): Coding and curation of data on PDC/TOW. Data analysis, modelling and mapping.			

Project summary	SMART Indicators	Means of verification	Important Assumptions
Write up and reporting (all Outputs): Annual reports to Darwin Plus, writing of scientific papers. Policy impact (all Outputs): Production of advice to decision makers and presentation at appropriate fora for discussion by stakeholders. Monitoring and Evaluation (all Outputs): Assessment of safeguarding, risks, finances, progress against key objectives.			

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-B01	Number of new/improved habitat management plans available and endorsed[6].	Creation/revision of SGSSI MPA management plan and SSI TPA	Number	Marine / Terrestrial	0			1 Marine	2
DPLUS-A03	Number of local/national organisations with improved capability and capacity as a result of project.	Number of local/national organisations with improved capability and capacity as a result of project.	Number of organisations	International/ National Governmental/ NGO	5			5	5
DPLUS-C01	Number of new conservation or species stock assessments published[11]	Publication of penguin population estimates and trends, terrestrial biodiversity baseline survey	Number	Taxa (birds, terrestrial biodiversity	0	2		2	2
DPLUS-C05	Number of projects contributing data, insights, and case studies to national Multilateral Environmental Agreements (MEAs) related reporting processes and calls for evidence.	Contribution of evidence to CCAMLR relating to SGSSI MPA management and policy and SCAR ANTIcon relating to terrestrial biodiversity conservation	Number	CCAMLR/SCAR, ACAP.	0	3		3	3
DPLUS-D03	Number of policies with biodiversity provisions that have been enacted or amended[21].	Implementation management/policy prescriptions from revised/new action plans for MPA and TPA	Number	Terrestrial/Marine	0	2		2	2

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-C08	Areas of importance for biodiversity identified	Areas of importance for biodiversity identified (penguin foraging areas, terrestrial features)	Area	Terrestrial/Marine	0	4		0	2 terrestrial: moss bank, fumarole 2 NTZs covering predator foraging areas
DPLUS-C12	Social Media presence	Social Media presence	Number of posts	Platform	1 each on FB, X, Instagram			3	20; when published the chinstrap trend will go viral
DPLUS-C15	Number of Media related activities	Number of Media related activities	Number	Internet/Print/ Radio/Television, and sub-national/national/international	3 web pages, 1 local newspa per article	3 web pages, 1 local newspa per article		3 web pages, 1 newspa per article	10; when published the chinstrap trend will create a media storm
DPLUS-C16	Number of records added to accessible databases	Number of records added to accessible databases (NERC Polar Data Centre, Birdlife Tracking Ocean Wanderers, ACAP)	Number	Biodiversity (Species occurrence, Utilisation)	0			2	5
DPLUS-C18	Number of papers published in peer reviewed journals.	Number of papers published in peer reviewed journals.	Number	Annual downloads, Journal.	.0	2		2	5

Table 2 Publications

Title	Type (e.g. journals, manual, 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)
A satellite-derived baseline of photosynthetic life across Antarctica	Journal	Walshaw, C. V., Gray, A., Fretwell, P. T., Convey, P., Davey, M. P., Johnson, J. S., & Colesie, C. (2024). Nature Geoscience, 17(8), 755-762.	Female		Nature Portfolio	https://www.nature.com/articles/s41561-024-01492-4
Is Antarctica Greening?	Journal	Colesie, Claudia, Andrew Møller Gray, Charlotte V. Walshaw, Stef Bokhorst, Jeffrey T. Kerby, Shridhar Jawak, Leopoldo G. Sancho, and Peter Convey. Global Change Biology 31, no. 6 (2025): e70294.	Female		Wiley	https://onlinelibrary.wiley.com/doi/10.1111/gcb.70294

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, scheme type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	✓
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	✓
Is your report more than 10MB? If so, please consider the best way to submit. One zipped file, or a download option, is recommended. We can work with most online options and will be in touch if we have a problem accessing material. If unsure, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	x
If you are submitting photos for publicity purposes, **do these meet the outlined requirements (see section 14)?**	x
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.	✓
Have you provided an updated risk register? If you have an existing risk register you should provide an updated version alongside your report. If your project was funded prior to this being a requirement, you are encouraged to develop a risk register.	✓
Have you involved your partners in preparation of the report and named the main contributors	✓
Have you completed the Project Expenditure table fully?	✓
Do not include claim forms or other communications with this report.	