Darwin Plus: 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.

Submit to: BCF-Reports@niras.com including your project ref in the subject line.

Darwin Plus Project Information

Project reference	DPLUS144
Project title	Protecting South Georgia's terrestrial communities from climate change-invasion synergies
Territory(ies)	South Georgia and the South Sandwich Islands; the Falkland Islands
Lead Organisation	Durham University
Project partner(s)	Royal Botanic Gardens, Kew; British Antarctic Survey; South Atlantic Environmental Research Institute
Darwin Plus Grant value	£323700
Start/end date of project	01.07.2021/30.06.2024
Project Leader name	Wayne [redacted]
Project website/Twitter/blog etc.	@SG_bio_invasion http://www.conservationecology.org/sg_content.html
Report author(s) and date	Wayne [redacted], Rosemary [redacted] 27.07.2024

1 Project Summary

South Georgia is an isolated, mountainous sub-Antarctic island in the Southern Atlantic Ocean, some 1300 km SE of the Falkland Islands (Figure 1a). Tourist, fishing, research and supply ships connect the Falkland Islands to South Georgia and represent the main risk of invasive non-native species introductions to the island. The climate is warming relatively rapidly on South Georgia, and sea-terminating glaciers on the north side of the island have been receding quickly in recent decades (Figure 1b). Thus, large areas of bare ground have been, and will continue to become, available for colonisation by both native and non-native plants and invertebrates.

South Georgia's unique terrestrial ecosystems are therefore vulnerable to invasion by non-native plants and invertebrates that will benefit from climate change. Our project was designed to generate information immediately applicable to conservation management in a warming climate by 1) recording colonisation of recently deglaciated areas by non-native species, 2) identifying 'winning' and 'losing' native and non-native plants under simulated warming, 3) mapping invasive carabid beetle and native invertebrate distribution and abundance, and 4) identifying high-risk potential future invaders from the Falkland Islands.

This project built on the successful DPLUS080 project which sought to monitor vegetation changes on South Georgia after the eradication of rodents and reindeer, to assess the efficacy

of the non-native plant eradication programme on the island, and to understand ongoing risk of invasion from seed dispersal and soil seedbanks of eradicated and established non-native plants. Together the two projects provide a comprehensive picture of the current invasion risks posed by the established non-native plants on the island. Project DPLUS144 extends that picture to include invertebrates, and to future risks posed by both non-native species already on the island and by those that have a high likelihood of arrival.

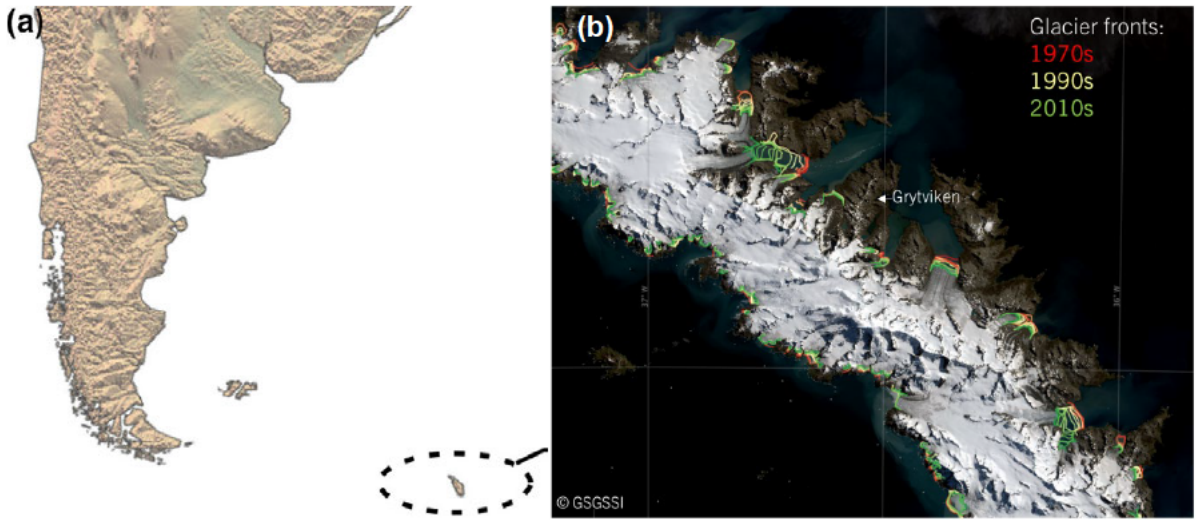

Figure 1. a) Location of South Georgia in relation to South America and the Falkland Islands (from Tichit et al. (2023)). b) Central section of South Georgia Island, showing glaciers, ice-caps, and glacier fronts of tidewater glaciers in the 1970s, 1990s and 2010s. Adapted from the South Georgia Geographic Information System (https://sggis.gov.gs//).

2 Project Partnerships

The project was designed with project partners Royal Botanic Gardens Kew (RBG Kew, Dr Rosemary Newton), the South Atlantic Environmental Research Institute (SAERI, CEO Dr Paul Brickle) and the British Antarctic Survey (BAS, Prof. Peter Convey). The project design included the hiring of Dr Pierre Tichit as a postdoctoral research assistant (PDRA), and all project partners participated in the recruitment process that led to P Tichit's employment on the project (Job advert design, shortlisting, interview design and final recruitment decision: see Annex 5.1, 5.2). P Brickle and SAERI assisted in recruiting field assistants Ryan Irvine and Simon Browning for the first and second field seasons, respectively (see Annex 5.3-5.4 for job adverts). P Brickle also assisted in the organising logistics for fieldwork and obtaining of supplies in the Falkland Islands. All project partners were involved in our six-monthly monitoring and evaluation meetings, which were chaired by Dr Colin Clubbe (RBG Kew: see minutes in Annex 5.5-5.10). We also had multiple additional meetings intermittently when required, for project activity planning, both online and in person.

The main stakeholder of the project is the Government of South Georgia and the South Sandwich Islands (GSGSSI), and we discussed the project during early development with GSGSSI members, namely Jennifer Black (Environment Officer) Ross James (Former Visitor Management and Biosecurity Officer), and Sue Gregory (Senior Marine and Fisheries Manager; Darwin Project Coordinator). Fieldwork planning involved discussion with and advice from J Black (in preparing Regulated Activity Permit -RAP- applications, Annex 5.11-5.12), and with Steve Brown (Former Logistics and Operations Manager). Organising both the first and the second field seasons was challenging, due to the Pharos ship being in dry dock in early 2022, and reduced sailing frequency as a result of the fuel and energy crisis in 2023. Communications with GSGSSI staff were crucial to overcoming these challenges and making the fieldwork campaigns a success. GSGSSI members S Gregory and Mark Belchier attended the project's final workshop on 10 May 2024, held at the British Antarctic Survey in Cambridge, and all project partners and C Clubbe attended (attendance list- Annex 5.13). This workshop doubled as our last M & E Steering Committee Meeting.

The project partners had a very successful collaboration, building on the experience of working together in previous projects (e.g. DPLUS080). The strength of the collaboration and

working relationships with GSGSSI have resulted in the development of a new Darwin PLUS application, initiated during the 10 May workshop.

3 Project Achievements

3.1 Outputs

Output 1.

The project officially started on the 1st of July 2021. One of the first activities was to advertise the PDRA position, shortlist applications, and then interview and select a candidate for the role. We shortlisted four applicants for interview, out of 27 applications received. Before the shortlisting and interview process, the Project Lead underwent unconscious bias training, which was a pre-requisite stipulated by Human Resources at Durham University. The job advert text and interview questions used are shown in Annex 5.1/5.2. The application deadline was extended to September 2021, and the shortlist interviews were on 24 September 2021. Dr. Pierre Tichit was chosen for the position, which he accepted. Due to delays in the UK Visa process, P. Tichit did not arrive in Durham until mid-December 2021. Adjustments were made to the budget via a change request, to ensure a fixed contract of 24 months for P Tichit was honoured.

Another activity in 2021 and early 2022 for the whole project, was to draft and complete a Collaboration Agreement among the project partners (Durham, BAS, RBG Kew, SAERI). The Collaboration Agreement was seen, revised and approved by all parties on 19 January 2022 (Annex 5.14). P Brickle at SAERI organised the hiring of Ryan Irvine as the field assistant for the first field season.

Planning for the first field season started before P Tichit started, with discussions among project partners and GSGSSI members (See Meeting minutes for July 2021 and Jan 2022, Annex 5.5/5.6). Planning continued in earnest in January 2022, to conduct field work specifically focused on Output 1 ("Presence of plant and invertebrate species (including non-natives) in areas of glacial retreat and vegetation fronts established"). Before then, P Tichit undertook an outdoor 'wilderness' first aid course at High Peak First Aid Centre in Derbyshire. Due to the Pharos ship being in dry-dock for repairs, the planned field season was delayed, with travel by P Tichit to the Falklands at the start of March (Annex 5.7), and a voyage arranged through GSGSSI to South Georgia on the HMS Forth, departing Stanley on 14 March 2022. Prior to leaving, the project team developed and designed the methods plan for fieldwork, which informed the application for the approved RAP (Annex 5.11). In brief, P Tichit and R Irvine aimed to survey up to three tidewater glacier sites, and up to three upland deglaciation sites (Fig. 2), using transects set at different times since deglaciation which were estimated using the GSGSSI GIS information (Fig. 1b, https://sggis.gov.gs//). At each transect, presence of all vascular plant species, and where possible, bryophytes and lichens, was recorded in area quadrats (5m x 5m), and cover was measured at intervals along the transect line (30m) using a 10-pin point quadrat. Pitfall traps at the ends and centre of the transect line, soil cores at those points, and hand searches along the line were used to capture information about the presence of invertebrate species.

Due to difficult weather conditions, not all sites were visited on this field season: the three tidewater glacier sites (1-3 in Fig. 2) were surveyed. However, P Tichit did manage to collect seeds from 14 plant species for use in Output 2 (Table 1).

P Tichit returned in May 2022 to Durham and spent the summer processing the invertebrate samples and collected data, which enabled him to present preliminary results at several conferences in 2022: (Annex 5.15). While P Tichit had already achieved the goal of surveying at least three deglaciation sites (meeting Output Indicators 1.1-1.4), we planned to add three upland/inland sites in the second field season, which would allow us to assess colonisation of deglaciated areas further from the coast, and from existing vegetation patches (sites 4-6 in Fig. 2). Thus, with the six sites surveyed, we were able to assess a) which species were more (or less) likely to be present with increasing time since deglaciation, and which species were increasing (or decreasing) with increasing time since deglaciation. The full results can be found in a peer-reviewed publication from the project (Tichit et al. 2024). In summary, across all

surveyed tidewater glaciers, non-native mouse-ear chickweed (*Cerastium fontanum*) and annual meadow grass (*Poa annua*) were among the top-10 most frequently encountered plant species (Figure 3a), along with dandelion (*Taraxacum officinale*) at inland glaciers (Fig. 3b). We found that while non-native *Cerastium fontanum* and annual *Poa annua* were persistent over time, *Cerastium* showed a decline in abundance (Table 1). In contrast, multiple native forb and grass species were more likely to be present with greater time since deglaciation, and the grasses *Festuca contracta* and *Phleum alpinum* increased in abundance (Table 1) as did the mosses *Polytrichum* sp. and *Syntrichia* sp. (see Tichit et al. 2024). For upland deglaciation, the pattern was different, with both *Poa annua* and *Cerastium fontanum* more likely to occur, and with increasing abundance with greater time since deglaciation (Table 1).

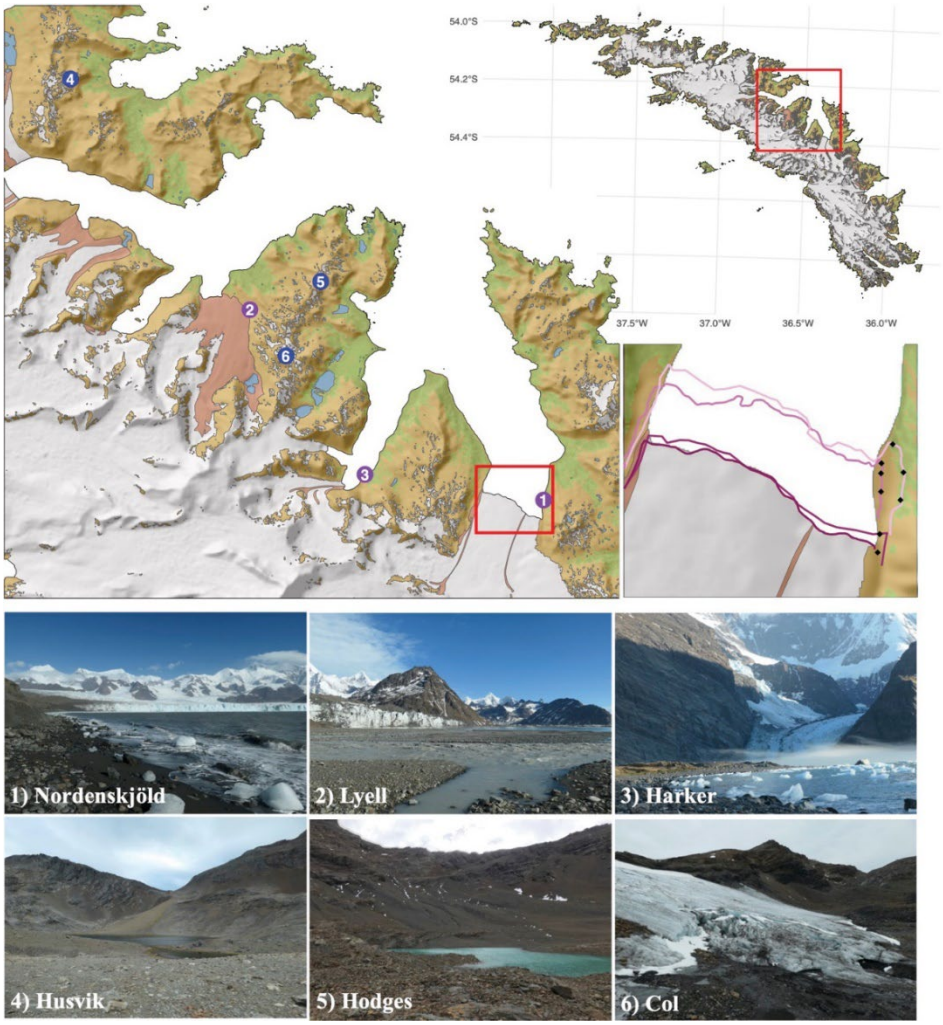

Figure 2. Tidewater (1-3) and upland (4-6) deglaciation sites where plant and invertebrate community compositions were measured using transects at points on chronosequences with differing times since deglaciation. The inset figure shows transect points on a chronosequence by Nordenskjöld glacier (From Tichit et al., 2024).

For the invertebrates, we detected the invasive carabid *Merizodus soledadinus*, and the collembolan *Hypogastrura viatica*, as two of the top-10 most frequently occurring invertebrates at tidewater glacier sites. Unfortunately, invertebrate samples were very low in number among pitfall traps at upland/inland glacier sites, so we only analysed data for invertebrate presence at tidewater glaciers. Both the non-native invertebrates mentioned, were just as likely to occur at point with greater time since deglaciation as they were at point where deglaciation was more recent (Figure 5 c in Tichit et al., 2024).

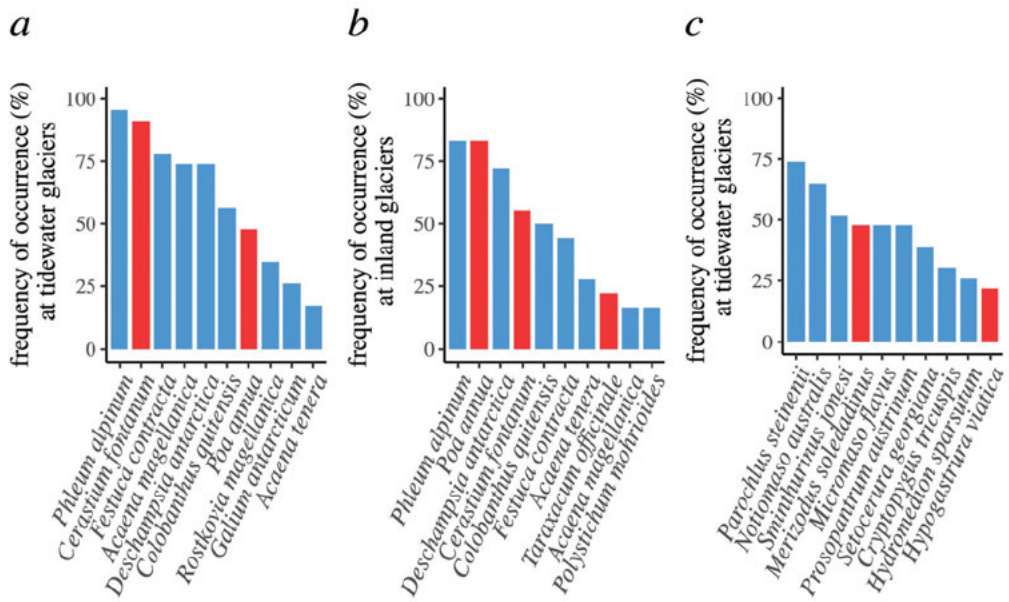

Figure 3. The top-10 most frequently occurring (a) plant species at tidewater glacier sites, b) upland/inland glacier sites, and c) invertebrate species at tidewater glacier sites. From Tichit et al. (2024). Blue= native species, red= non-native species.

Table 1. The 14 species with seeds collected from populations on South Georgia, intended for use in the climate warming experiment (Output 2), and status of the species in relation to time since deglaciation (Output 1): More / less likely to be present or persistent with increasing time, and increasing, decreasing or no change in abundance with time. Hyphen indicates species was absent or too infrequent to allow analysis. Based on Tichit et al. (2024). Significant changes with time highlighted in yellow.

Species (growth form)	Status	Tidewater Glaciers		Upland Glaciers	
		Presence	Abundance	Presence	Abundance
Agrostis capillaris (grass)	Non-native	-	-	-	-
Cerastium fontanum (forb)	Non-native	Persistent	Decreasing	More likely	Increasing
Deschampsia parvula (grass)	Non-native	-	-	-	-
Poa annua (grass)	Non-native	Persistent	No change	More likely	Increasing
Poa pratensis (grass)	Non-native	-	-	-	-
Taraxacum officinale (forb)	Non-native	-	-	Persistent	-
Trisetum spicatum (grass)	Non-native	-	-	-	-
Acaena magellanica (forb)	Native	More likely	-	Persistent	-
Acaena tenera (forb)	Native	More likely	-	More likely	-
Deschampsia antarctica (grass)	Native	Persistent	No change	Persistent	No change
Festuca contracta (grass)	Native	More likely	Increasing	More likely	Increasing
Phleum alpinum (grass)	Native	More likely	Increasing	More likely	(Increasing)
Poa flabellata (grass)	Native	-	-	-	-
Rostkovia magellanica (rush)	Native	More likely	-	-	-

Output 2.

The original goal was to collect seeds and conduct the climate warming experiment for 6 native and 8 non-native plant species (Indicator 2.1); we almost made this target in seed collection, with 7 non-native and 7 native plant species collected (Table 1), which still gave us 14 species in total. Seeds from *Lobelia pratiana* and *Cardamine glacialis* (non-native) could not be collected, because of successful eradication (pers. comm. with South Georgia Non-native Plant Management Team) and prohibited access to plants (See RAP in Annex 5.11), respectively.

During Summer 2022, we planned and executed a climate warming experiment, to assess which of the native and non-native plant species would be winners and losers under a warming climate. We used Weiss Gallenkamp 'Fitotron' plant growth chambers for this, at Durham University (Fig. 4).

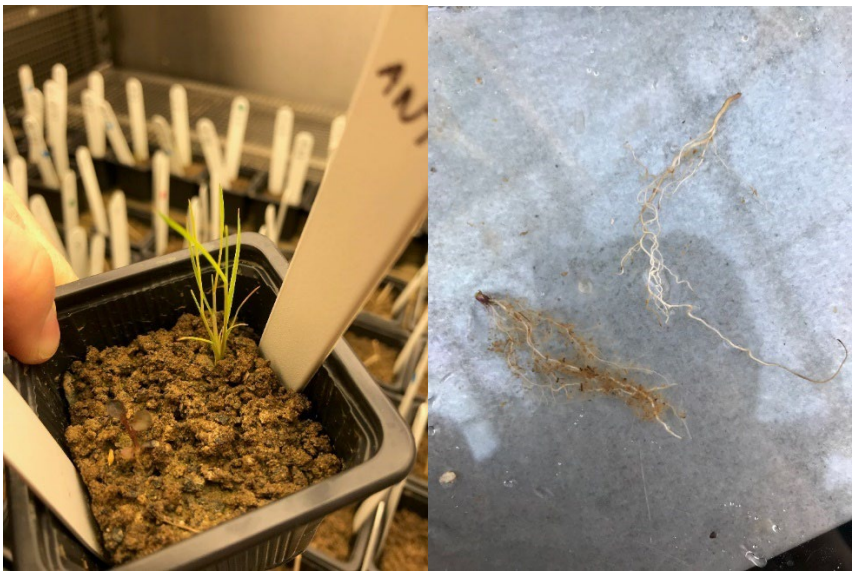

Figure 4. Left: Photograph of plants growing pairwise (1 non-native, one native) in pots within one of two plant growth chambers, with simulated air temperatures (1 m aboveground) reflecting either recent (1910-2010) or future (2061-2080) temperatures on South Georgia. Right: roots of a plant pair after harvest at the end of the experiment.

The growth chamber temperature and light settings were set to change over a 24-hour cycle, to simulate growing conditions in the Austral summer (January). The maximum and minimum temperature for the recent climate chamber were 6.9 and 3.6 °C, respectively. To simulate warming, we calculated the average predicted air temperature in the warmest month for 2061-2080, in the 30-second grid cell containing King Edward Point, from 21 global circulation model projections. The average increase was calculated as ~+1.5 C, so we added this to the 24-hour cycle for the mid-century climate treatment. This gave a maximum and minimum temperature in the future of 8.4 and 5.1 °C, respectively. The plants were grown for approximately 78 days, with some variation due to early replacement of plants that died.

The experiment was successful in that we obtained some pilot evidence that native species may actually do better under the warmer climate than the three non-native plants that survived and grew in sufficient numbers: the grasses *Poa annua*, and to some extent *Poa pratensis*, grew less well relative to native competitors under the warmer climate (Fig. 5a). In contrast, from the native plant perspective, only *Festuca contracta* showed some evidence of growing less well than non-native competitors (but sample size was very low), while the grasses *Phleum alpinum* and *Deschampsia antarctica* grew better than non-native neighbours and especially under the warmer climate. However, due to problems with germination, we were unable to complete the experiment for all 14 plant species we targeted (only 3 non-native and 6 native species survived in sufficient numbers for analysis). In addition, there were problems with the growth chambers, and a break-down meant the experiment needed to end earlier than planned. As a follow-up, a new experiment with new growth chambers will be conducted at the University of Liverpool in Summer/Autumn 2024, using a more realistic 24-hr temperature cycle obtained from TOM-ST data loggers, that P Tichit placed out in the field in the second field season (see Output 3). Therefore, we have partially met Outcome Indicator 0.2 and Output Indicators 2.2 and 2.4.

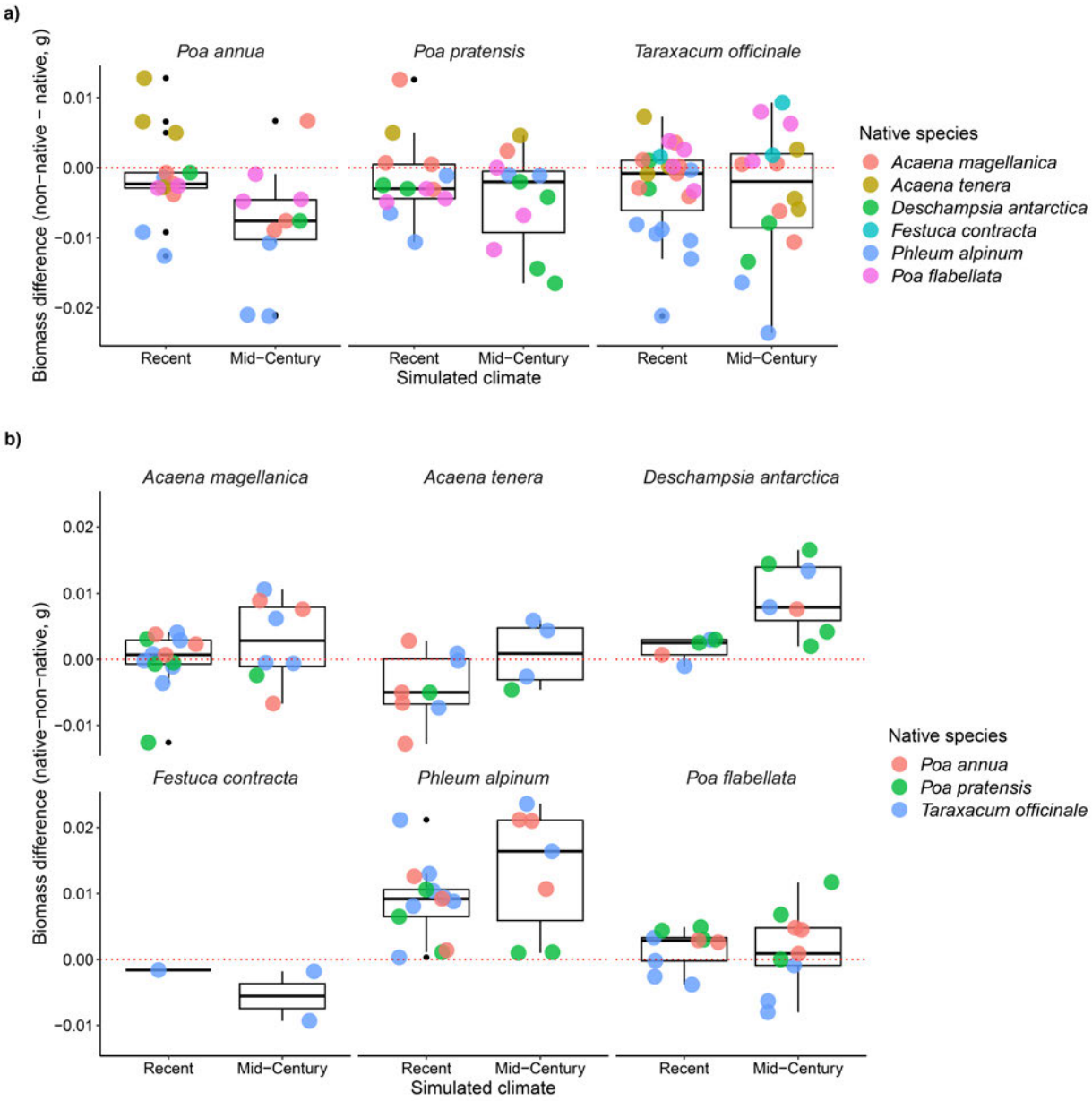

Figure 5. a) Boxplots showing the difference in biomass between one of three target invasive plant species, and the native competitors under recent and mid-century (2061-2070) simulated climates. Different coloured points represent individual plants facing competition from one plant of a native species (shown by the key). Values >0 mean the non-native species grows more than the native, values <0 mean the native grows more. b) Boxplots showing difference in biomass between one of six target native plant species and one of the three non-native plants (different point colours) as a competitor. Values >0 mean the native species grows more than the non-native, values <0 mean the non-native grows more.

Output 3.

In September (29-30) 2022, R Newton and P Convey visited Durham (Annex 5.16), for a project update and planning meeting. P Convey assisted P Tichit in the identification of some of the invertebrate samples brought back to the UK from the first field season, and we discussed the preliminary results, progress on Output 2, and planning for the second field season of Output 3. P Brickle and SAERI assisted in recruiting Simon Browning as field assistant (Advert: Annex 5.4).

Apart from surveying the three upland/inland sites of deglaciation (Output 1), the main goal of the second field season was to better understand the current distribution of the two invasive carabid beetles (*Merizodus soledadinus*; *Trechisibus antarcticus*), in relation to habitat type, elevation and other native invertebrate species. The protocol for the survey is provided in Annex 5.17 and in the RAP (Annex 5.12), but what follows is a brief summary. Sites were either points along 2-km elevational transects, from 0 to 360 m asl., or points located in representative areas of vegetated habitat at lower elevations. The sites on elevational transect were located every 100 m on the transect, with 3 pitfall traps set per site. The same number of traps were set at each

site in lower elevation vegetation. In addition, 10 stones were turned at each site, and presence/absence of macroinvertebrates was recorded. Pitfall trap samples were collected, sorted and identified at KEP and back in the UK. In total, 447 pitfall trap samples were collected, and 1450 stones turned over, at 161 sites. This includes 36 stones in an opportunistic survey at Salisbury Plain, to the west of the Busen region. No beetles were observed under Salisbury Plain stones.

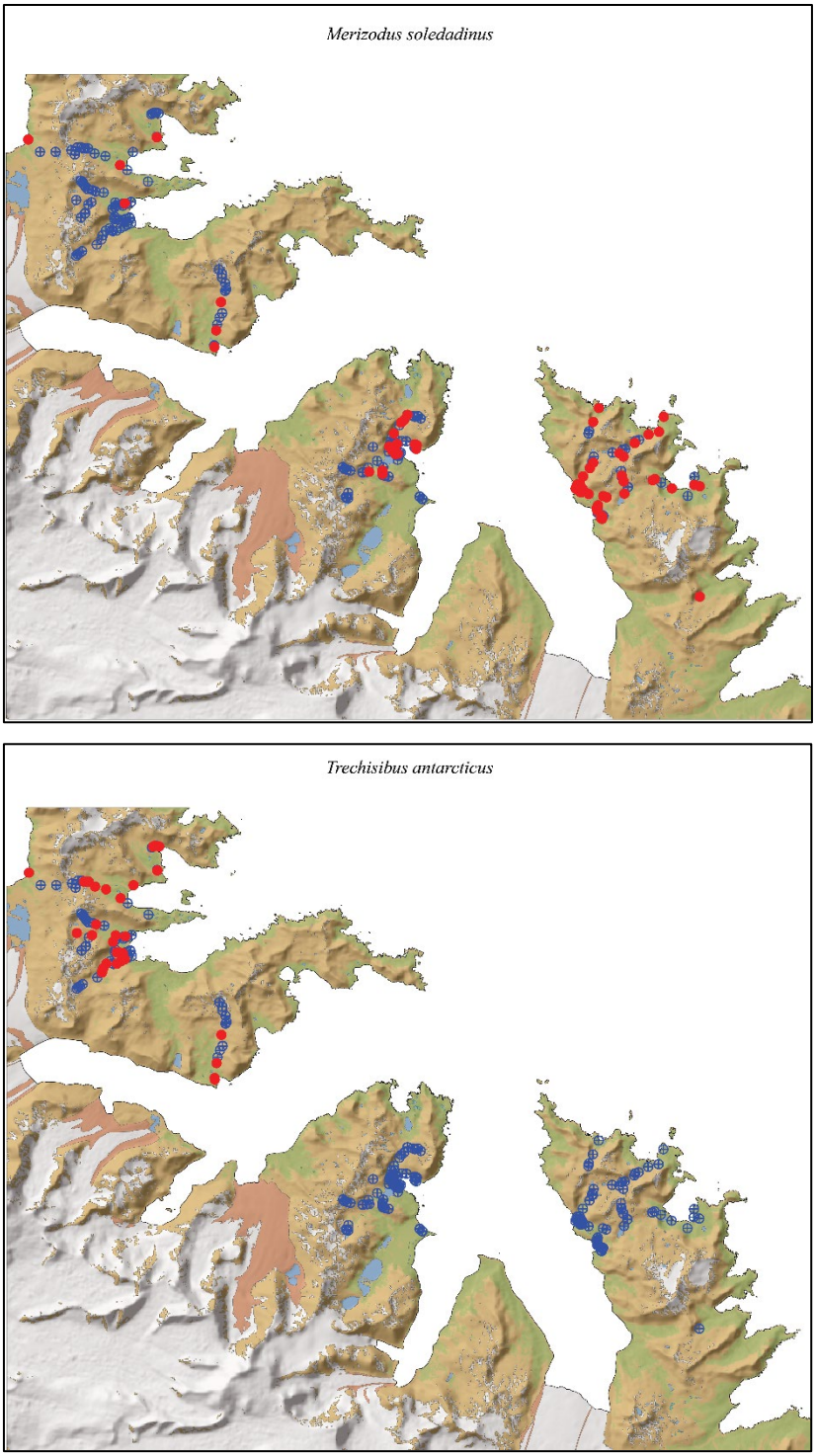

Figure 6. Sites surveyed in the 2nd field season (2023) with hand searches and pitfall traps (blue points), and presence (red points) of the carabid beetles *Merizodus soledadinus* (top) and *Trechisibus antarcticus* (bottom). Peninsula regions from left (west) to right (east): Busen, Thatcher, Barff.

For the three main survey peninsulas (Busen, Thatcher and Barff, west to east), the distributions of detected *Merizodus* and *Trechisibus* showed distinct patterns. *Merizodus* was mostly detected on Thatcher and Barff peninsulas, while *Trechisibus* was restricted to the Busen region where *Merizodus* was largely absent (Fig. 6). In addition, both species were found inland and upslope: up to 325 m asl for *Merizodus*, and up to 316 m asl for *Trechisibus*. For habitat types, proportional

presence (number of sites detected out of the total number of sites for the habitat type) was highest in Tussock (Tussac) habitat followed by *Poa annua* grassland for *Merizodus* (Fig. 7a), while for *Trechisibus* Bog and mire and then Tussac habitat had the highest proportion of sites with the species detected (Fig. 7b). The activities of the second field season and our preliminary results fully satisfy Output indicators 3.1- 3.3, and partially satisfy 3.4-3.5: ongoing analyses of our data-set will satisfy the last two indicators, once we have analysed the relationship between the beetles' presence and native invertebrate species, while also accounting for habitat and elevation. We aim to prepare a publication reporting the full results by the end of 2024.

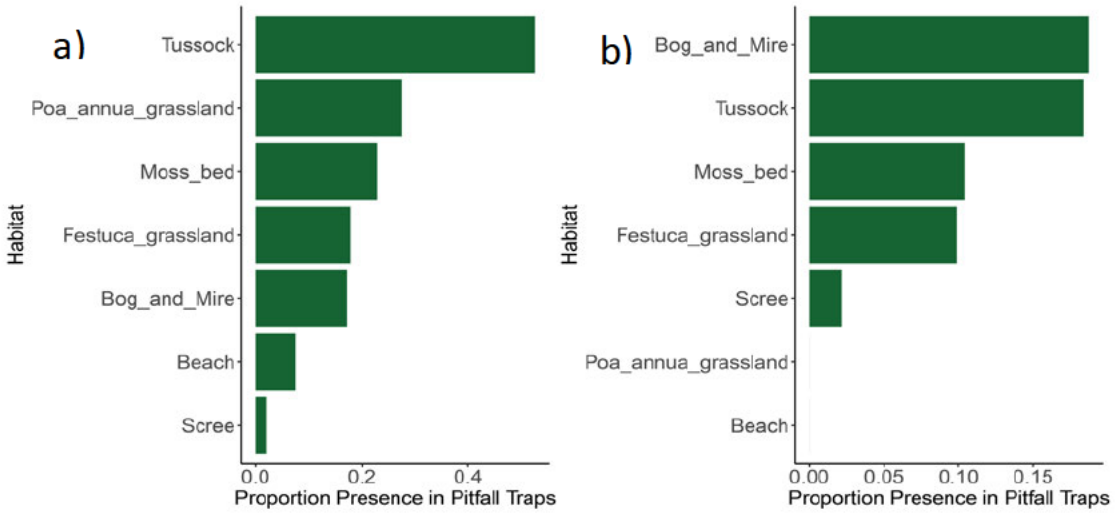

Fig. 7. Proportion of sites per habitat type where a) *Merizodus soledadinus* and b) *Trechisibus antarcticus* were present in pitfall trap samples.

In addition to fulfilling Output 3, P Tichit set up 7 TOMST (TMS-4) temperature and humidity data-loggers in locations around King Edward Point (KEP), which recorded temperatures over a 24-hour cycle at 6 cm belowground, 2 cm and 15 cm aboveground. The 12 cm aboveground temperatures will be used to simulate a more realistic 24-hr cycle of temperatures experienced at the plant level under a current climate that given by weather stations (Fig. 8), for the follow-up climate-warming experiment in Liverpool (Output 2). The data loggers belong to W Dawson, purchased for a separate PhD research project.

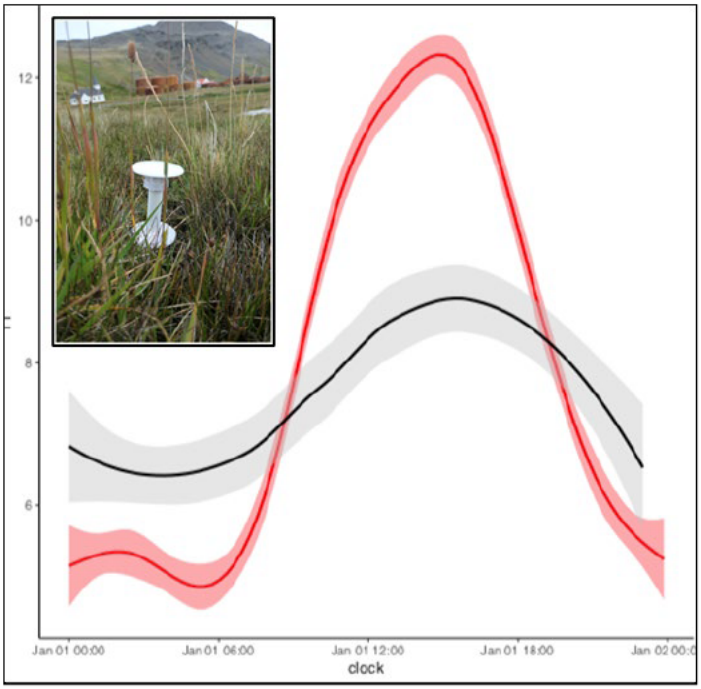

Figure 8. Inset: One of the TOMST (TMS-4) data-loggers placed in the field in South Georgia, to capture the temperature regime experienced by plants at the plant level. Plot: average temperature (°C) and 95% confidence envelope, over a 24-hour cycle captured ~15 cm aboveground with a TOMST data logger (red) and 1 m aboveground at KEP weather station (black).

Output 4.

In February 2023, P Convey met with W Dawson during a visit to Durham for other business, and they put together a preliminary list of invertebrate species and sources that would form the 'longlist' on invertebrates not yet present on South Georgia, but with a high likelihood of arrival. Species considered were those that are known to occur within the neighbourhood region, and with ship transport connections to South Georgia. The whole horizon scan process is summarized in Fig. 9. The information on ships visiting South Georgia from the

GSGSSI 2021-2022 report on visitors was used, and identified the Falklands as the top origin region, followed by Antarctica, Argentina and Chile. In addition to these regions, we also considered New Zealand, W Cape of South Africa and other sub-Antarctic islands to build longlists of invertebrate and plant species with a higher chance of arriving to the island.

For the plant longlist, the Global Naturalized Alien Flora database, and a database on introduced and invasive species of Antarctica and sub-Antarctic islands was used. All invertebrate species in the longlist (329) were considered to have a high chance of arrival by default along pathways relevant to South Georgia (Fig. 9). For plants, known association with these pathways was obtained from a previously published dataset, and from the CABI Invasive Species Compendium. This yielded 149 plant species with evidence of being introduced on SG-relevant pathways. For the 149 plant and 329 invertebrate species we downloaded species occurrence records worldwide from the Global Information Facility (GBIF), and we filtered out invalid occurrences (uncertainty of location greater than 1000 m; incorrect coordinates; not field observation or collection). This resulted in 96 invertebrate and 136 plant species having 50 or more observations that could be used for estimating overlap of between South Georgia's climate and that of the species' occurrences worldwide. The overlap value was estimated as a geometric mean of individual climatic variable overlaps, calculated using a distribution-free dynamic range box method. The climatic variables were obtained from the CHELSA dataset. We used average minimum temperature of the coldest month, mean annual precipitation, and precipitation seasonality for the years 1981-2010, obtained at a 30-second grid-cell scale. Projected values for these variables were obtained using 5 different global circulation models (GCMs), for a future climate for 2041-2060 (2055), based on a 'regional rivalries' shared socioeconomic pathway scenario of radiative forcing. Table 2 shows the top-10 plant species with current South Georgia climate overlap that is at least in the range of values for native and already established non-native species (>0.013; Annex 5.18), and the projected change in suitability according to the 5 GCMs. Note that there is uncertainty around future climate suitability, with increases or declines depending on the GCM used. Four of the top-10 species have predicted increases in future climate overlaps with SG for the majority of GCMs (Table 2). Annex 5.19 shows the full list of 43 shortlisted plant species. Annex 5.20 shows the list of 96 invertebrate species: climate overlap analyses for these species are still to be completed.

We opted for a simpler approach to assessing current and future overlap than using species distribution models as originally described, based on known species occurrences worldwide that provides a single score. We did this instead of using complex species distribution models, because discussions with colleagues conducting research currently at the University of Vienna (T Vorstenbosch) confirmed that South Georgia's climate does not have a clear analogue in the rest of the world, and only a few bioclimatic variables (the ones we chose) for South Georgia had reasonable overlap with elsewhere.

Overall, we have largely met the Output indicators 4.1 and 4.2 by producing a shortlist of 40 higher-risk plant species accounting of likelihood of arrival and key introduction pathways, though we still need to subject the preliminary shortlist of 92 invertebrate species to climate overlap analyses. These analyses will be completed in 2024, and results will be compared with modelling results obtained by T Vorstenbosch (University of Vienna). To assess robustness of the two approaches. First, we met Output 4.1 in two ways. First, we had our end-of-project workshop on 10 May 2024 at British Antarctic Survey in Cambridge, attended by GSGSSI members, BAS, SAERI, Kew, Natural History Museum (NHM), and the Helmholtz Institute for Marine Biology. A member of the Falkland Islands Government was invited, but was unable to attend (see Annex 5.13 for attendance list). Second, W Dawson gave a presentation summarising the project outputs and finding to the GSGSSI Stakeholder Event in Cambridge on 9 July 2024. This event was attended by multiple stakeholders, including GSGSSI, FIG BAS, South Georgia Heritage Trust, CEFAS, IAATO, NHM, and Birdlife International.

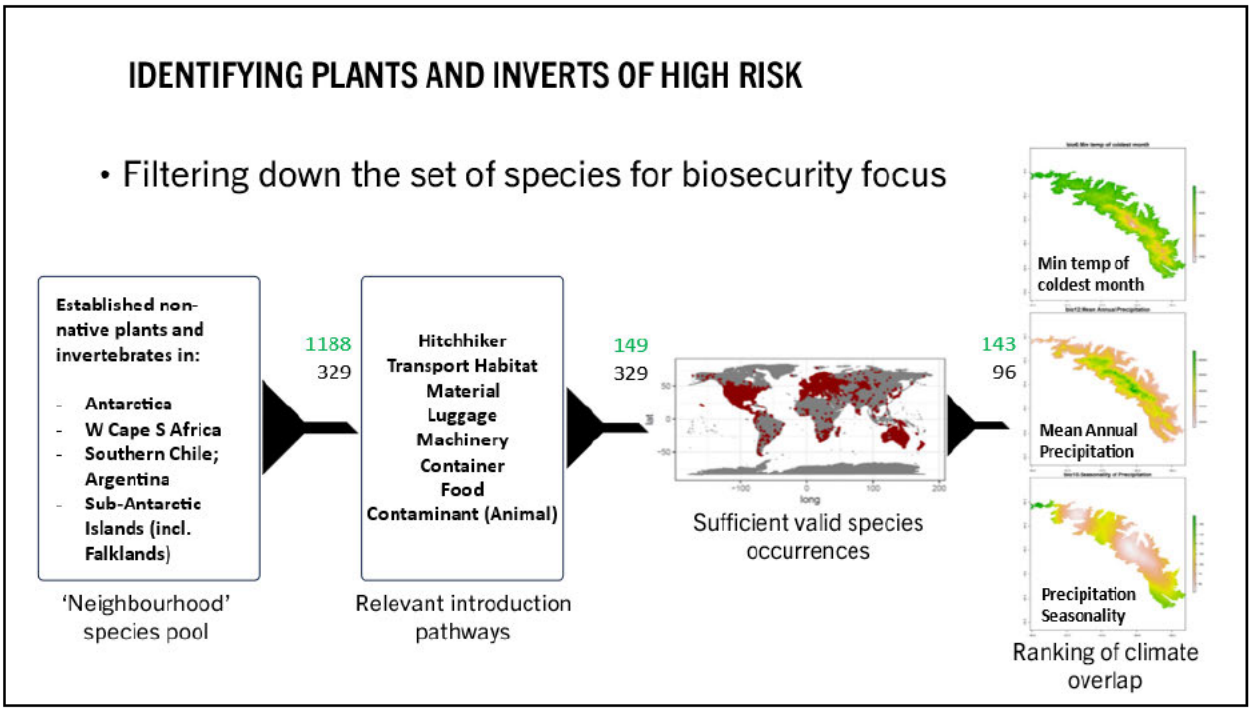

Figure 9. Summary of the horizon-scanning procedure. A neighbourhood pool of species occurring in regions with direct or indirect transport connections to South Georgia was created from multiple data sources. A subset of these species known to be introduced on South Georgia-relevant pathways was created, and the subset of these with sufficient valid species occurrences elsewhere was subject to climate overlap analysis, used three climatic variables that capture South Georgia's current climate. Numbers in green= number of plant species at each stage of the process; numbers in black= number of invertebrate species.

Table 2. The top-10 plant species in the neighbourhood with known relevant introduction pathways for South Georgia, and with current climate overlap (1981-2010) within the range of native and already-established plant species. Change in climate suitability under future climate (2041-2060) for South Georgia is also indicated (red for increase, blue for decrease) for each of 5 Global Circulation Model projections (values to 2 d.p.). All 43 shortlisted plant species are in Annex 5.19. Global Circulation Models: 1= GFDL-ESM4, 2= IPSL-CM6A-LR , 3= MPI-ESM1-2-HR , 4= MR-I-ESM2-0 , 5= UKESM1-0-LL.

Species (growth form)	Current overlap	Future Overlap (2041-2060)				
		1	2	3	4	5
Prunella vulgaris (forb)	0.12	0.15	0.14	0.1	0.13	0.09
Reynoutria japonica (forb)	0.11	0.12	0.1	0.11	0.11	0.1
Fragaria vesca (forb)	0.09	0.09	0.07	0.08	0.07	0.06
Bellis perennis (forb)	0.08	0.1	0.09	0.07	0.09	0.07
Poa nemoralis (forb)	0.08	0.08	0.06	0.07	0.07	0.06
Plantago major (forb)	0.07	0.08	0.07	0.06	0.07	0.06
Rumex obtusifolius (forb)	0.07	0.08	0.07	0.07	0.08	0.06
Galeopsis tetrahit (forb)	0.06	0.06	0.05	0.06	0.05	0.04
Plantago lanceolata (forb)	0.06	0.07	0.07	0.05	0.07	0.05
Hypochaeris radicata (forb)	0.06	0.07	0.07	0.06	0.07	0.06

Output 5.

We set up a webpage, but also set up a Twitter/X profile for communications. We decided against webinars as the main means of achieving this output (means of verification 5.2), and instead diversified our means of information sharing and awareness-raising.

The Twitter/X profile has 134 followers and 794 likes to date, while a repost reporting the discovery of a non-native ladybird beetle by the project team (see 14. 'Outstanding Achievements') received > 4000 views.

In addition to the Twitter/X account, we have presented our findings at multiple UK and international conferences (ECCB Czechia, 2022, SCAR 2022, NeoBiota Estonia 2022, BES Belfast 2023; see Annex 5.15). W Dawson presented the project findings at invited seminars in 2023 and 2024 (Durham University, and University of Stirling, UK; University of Tübingen, Germany), and has an accepted talk abstract to present the project at NeoBiota 2024 in Lisbon (Annex 5.15).

P Tichit also gave a talk about the project to a research-focused audience at King Edward Point in the 2023 field season (Fig. 10), and P Tichit and S Browning gave a talk to tourists on the National Geographic Explorer cruise ship (Fig. 10). A full list of outreach and awareness-raising presentations, interviews and articles is provided in Annex 5.15. Instead of a poster at South Georgia to raise awareness (Indicator and means of verification 5.3), we decided on a more active and engaging activity, and so P Tichit designed and piloted a Citizen Science project with the Polar Collective. The project was titled 'Beetles versus Stones', and the idea was for tourists (under supervision of operator guides) to turn over stones and record the presence of a set of invertebrates, including native or non-native species, on a field score card. The project was intended to supplement detection of the non-native invertebrate species (carabid beetles in particular), especially in areas the field team could not reach. Three surveys were obtained this way from participants at St Andrews Bay, but we were unable to roll out the project fully due to concern over the spread of avian influenza. We came to an agreement with IAATO, Polar Collective and GSGSSI to pause the project until further notice. The leaflet advertising Polar Collective project and the trial itself achieve our Output indicators 5.3 and 5.4 (see Annex 5.21 and 5.22) Finally, we've raised awareness about the non-native species on South Georgia through two open-access publications (see Annex 3, Table 2). The first study, reporting on the first record of the 11-spot ladybird beetle, has had 687 full text views. The second study, reporting on output one, has had 817 unique views so far, and has been picked up by 10 online news outlets.

Figure 10. Left. Pierre Tichit giving a talk with Simon Browning about the project to other researchers and staff at King Edward Point, South Georgia, (23.02.2023). Right. Simon Browning giving a talk with Pierre about the project to tourists on the cruise ship National Geographic Explorer, off the coast of South Georgia (02.03.2023).

3.2 Outcome

Our stated intended Outcome was: "South Georgia's evidence-based management of invasive species will be improved by identifying which non-native species pose the greatest risk to SG (pre- and post-introduction) in a future climate". W Dawson commented on a draft of the latest version of the South Georgia Non-native Management Strategy (Annex 5.23), which was informed by the findings of this project and of DPLUS080. It is premature for further improvements to non-native species management to be effected on the basis of this project, but we have made solid progress on our Outcome indicators:

- We met Outcome 0.1 on time, by surveying three tidewater glacier sites in 2022, then three more inland glacier sites in 2023, and by analysing and publishing the results of the

full dataset. The open-access publication for Output 1 (Annex 3, Table 2) forms the means of verification 0.1 in place of a summary report as indicated in the logframe (Annex 2).

- We have identified that some native plant species may win out over non-natives under climate change, satisfying Outcome 0.2 of the project (see Fig. 5). The follow-up climate warming experiment in Liverpool will help to confirm this preliminary result and will widen the set of species assessed. At this point Outcome Indicator 0.2 will be fully met.

- We have shown the carabid beetles are more widespread and found further upslope than previously thought, and we have also shown that the species may be particularly prevalent in Tussac grass vegetation (see Figs. 6 and 7). Thus, we have largely met Outcome Indicator 0.3. Further analysis of the native invertebrate community data in 2024 will mean that we will soon fully meet this indicator.

- Across Outputs 1, 2 and 3, we have one open-access publication for Output 1, and the data are available as supplementary material on the article webpage (meeting Means of Verification 0.3 for Output 1). Preliminary analysis of the pilot Durham warming experiment has been presented to GSGSSI members (Annex 5.24; Fig. 5), as have summary findings on Carabid beetle distributions (Annex 5.24; Fig. 6 and 7). We have sought advice from the UK Polar Data Centre, on how to deposit the datasets of species locations and environmental data from South Georgia. To fully meet MoV 0.3 for Output 2 and Output 3, datasets will be made available with the resulting publications.

- Finally, we have been able to identify higher-risk plant species under current and future climates and provide the list of top 43 species in Annex 5.19. The preliminary shortlist of invertebrate species is also provided in Annex 5.20. Thus, we have partly met Outcome indicator 0.4.

Our findings so far and their ramifications for ongoing management have been presented at least twice so far to members of the GSGSSI (see Annex 5.24 and 5.25 presentation slides for means of verification 0.5, also partly serving as MoV 0.2). To summarise, we advised that:

i) Non-native plants present on SG are unlikely to dominate developing communities, but they will nonetheless spread and colonise rapidly as glaciers recede further and will persist as a component of succeeding vegetation.

ii) *Merizodus* has a wider distribution than *Trechisibus* beetles, which may reflect past introduction history on different peninsulas or chance dispersal from one peninsula to another. There may be a need for further internal biosecurity precautions to prevent spread to new peninsulas.

iii) Further checks will be needed for invertebrate hitchhikers on boats, given the discovery of 11-spot ladybird beetles by the team on SG.

iv) Temperate forbs may pose a greater invasion risk in current and future climates, but there is some uncertainty around the change in climate suitability, with declines predicted in multiple cases (see Table 2). Many of the species listed can be spread through luggage and/or transport of habitat material (Annex 5.19): biosecurity that targets these pathways should be maintained.

Thus, we consider Outcome Indicator 0.5 to have been met.

3.3 Monitoring of assumptions

Our discussions in M & E meetings every six months regularly involved discussion about the risks and assumptions to completing the project activities. In the first year of the project the Team still had concerns about Covid: P Tichit had to remain in a quarantine hotel in Durham when first arriving in December 2021, and again when first arriving in the Falkland Islands for the Output 1 field season in March 2022: we had accounted for this possibility by adding funds in stage 2 of the application process to cover quarantine accommodation. However, we were right to assume

that the Covid pandemic would subside in time for the start of fieldwork (Assumptions 0.1/1.1) and for in-person meetings to take place (assumption 1.4). To minimise jeopardising P Tichit's first field season, we avoided in-person Team meetings before the scheduled field season in the first half of 2022 (M&E Meeting minutes 12.01.2022, Annex 5.6).

We also assumed that weather conditions would allow fieldwork to be completed in 2022 (Assumptions 0.2/1.2) and in 2023 (Assumptions 0.1/3.02). While weather conditions were at times difficult in the first field season, the planned survey and data collection for both field seasons were completed successfully (M&E Meeting minutes 21.06.2022, Annex 5.7). Plants in the field and invertebrates in the lab were identifiable: the invertebrates required some extra work, and expert knowledge of P Convey for some taxa. In a few cases, it was deemed satisfactory to identify invertebrates to genus level (assumptions 0.4/1.3/3.3 were largely valid).

Checks on seeds were planned and executed in summer 2022 (M&E Meeting minutes 21.06.2022) to check assumptions 0.3/2.1 (Seeds are viable and germinate in sufficient quantity to allow climate experiment and germination trials to proceed). The results of these tests and the progress on the Output plant growth experiment were discussed in the M & E meeting at the start of 2023 (M&E Meeting minutes 05.01.2023, Annex 5.8). While most species did germinate successfully, we discussed the problems encountered, including successful germination of *Cerastium fontanum* but its failure to grow. We reduced the germination trial element of Output 1 to reduce seed wastage and conserve seeds for a planned repeat experiment at Liverpool. We also assumed that growth chambers at Durham would function well (2.2). However, this proved not to be the case in the end. A malfunction during the experiment, and again in December, meant that reliability of the data may be questionable (discussed in M&E meeting minutes 01.05.2023; Annex 5.9). A follow-up study would be necessary for publication and is planned.

For Output 4 to be delivered, the evidence base from Outputs 1-3 was not really required in the end, making Assumption 4.1 irrelevant. This, in part, reflects the shift in approach toward a more data-driven, quantitative method of horizon scanning. We had planned to travel to FI for a final workshop in 2024 (weather and Covid permitting: Assumption 4.2); however, we realised that in terms of carbon footprint and cost, it would be better to have the final workshop in the UK at BAS, Cambridge. P Brickle flew from FI to attend the meeting (discussed in M&E Meeting 17.01.2024: minutes in Annex 5.10). This meeting was held on 10 May 2024 (Annex 5.13 for attendance list).

4 Contribution to Darwin Plus Programme Objectives

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

The project's key achievements so far are the delivery of i) baseline information on species that will colonise deglaciated areas, and ii) a much better understanding of where invasive carabid beetles are located, and their potential for further spread. The project has yet to deliver against indicator DPLUS-A03 (Annex 3), as it will take time for the project evidence base to follow through to any changes in capability to manage non-native invasive species on South Georgia. Influence of decision-making is yet to be demonstrated given the project did not specifically set out to change decision making, but the greater awareness of invertebrate introductions as a biosecurity risk has been embedded by the project's first record of 11-spot ladybird on the island. This awareness includes the SG Non-native Plant Management Team, members of which have since recorded the species again. Hopefully, this will lead to a better understanding of the species distribution and establishment status on the island, which will inform decisions regarding management or control.

We have delivered two peer-reviewed knowledge publications (DPLUS-C01; Annex 3, Table 2) on non-native species found in deglaciated areas. We have also generated sufficient knowledge on non-native plant distributions and responses to climate warming/deglaciation that can contribute to future iterations of the GSGSSI Non-native Plant Management Strategy (DPLUS-B02). We are not aware of GSGSSI plans to develop management strategies for non-native invertebrates specifically, but we have generated potentially useful baseline information on carabid beetle distributions and the 11-spot ladybird. For DPLUS-D03, we have generated lists of plant and invertebrate species in the neighbourhood that pose a higher risk of invasion to South Georgia (Annexes 5.19/5.20) which are available for use by GSGSSI in updating

biosecurity targets and policy as they see fit, which will contribute to the government's Protect, Sustain, Inspire Stewardship Framework. Finally, we have almost reached 800 likes on our Twitter/X profile, and we currently have 134 followers (Annex 3, Table 1). However, the awareness-raising of our project will be sustained longer term through engagement with and promotion of the studies published and still to be published, from the project.

4.2 Gender Equality and Social Inclusion (GESI)

Please quantify the proportion of women on the Project Board[1].	1 out of 5
Please quantify the proportion of project partners that are led by women, or which have a senior leadership team consisting of at least 50% women[2].	2 out of 4 (the Vice-Chancellor of Durham University; the Director of the British Antarctic Survey).

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.	X
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	
Transformative	The project has all the characteristics of an 'empowering' approach whilst also addressing unequal power relationships and seeking institutional and societal change	

GESI did not exist in its current form on the application we submitted, with a single question (#17) on just gender in the application. However, interview panel members for the postdoc position on the project did have unconscious bias training before the interviews, and one member of the interview panel was a woman. Among the 4 shortlisted applicants we interviewed, two were women and this exceeded the gender balance of initial applications. Thus, gender equality was considered and was achieved in the PDRA recruitment process.

The project was very much focused on South Georgia, which has no permanent human population. Therefore, there was little to no prospect of ensuring equitable participation and engagement during the project activities.

5 Monitoring and evaluation

The largest change to the project was in Output 5: using a Twitter account instead of a regularly updated webpage (though we have a web-page too), and monitoring awareness-raising that way,

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

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

and then also not running Webinars. We quickly realised this would take up too much time, and there was a significant risk that engagement would be low. Whilst we did not update these details in our logframe, we have reported on it previously, and we have arguably achieved more outreach and awareness raised with a broader audience through the multiple approaches we took instead (see Output 5 in 3.1 above; Annex 5.15).

A smaller change to the project involved Output 4: rather than conducting a classical 'horizon scanning' exercise, with invited expert opinion, we opted for a more data-driven, quantitative approach to assessing the climate suitability of South Georgia in the future, to develop a list of higher risk species that occur in the neighbourhood. This approach had the advantage of saving time and avoiding risks of a lack of engagement, and as discussed above (Section 3.1, Output 4) there is uncertainty around the ability of species distribution models to accurately predict climate suitability for sub-Antarctic islands using worldwide occurrence data. Thus, the simpler, coarser approach we took was appropriate, and has already resulted in a working shortlist of plant and a longer list of neighbourhood invertebrate species of high biosecurity risk to focus on. These modifications did not represent changes in the Outcome and Outputs of the project, but rather the means by which we achieved them. As a result, the indicators and means of verification differed to some degree in the end.

For our M & E, we met every six months, with Dr Colin Clubbe (RBG Kew) acting as meeting chair. The time interval between meetings worked very well, as did having a semi-independent and external person chairing the meeting (providing critical appraisal and advice where needed). The delivery of meeting minutes was largely the responsibility of the Lead Organization staff. Meeting minutes are provided in Annex 5.5-5.10.

6 Lessons learnt

Overall, the project team worked well together, and the designed field campaigns were a definite success. Success did require some flexibility in timing due to operational limitations, especially in 2022 when the Pharos ship was in dry-dock at the start of the year. This resulted in a later start for the field season. However, being offered passage to SG on the HMS Forth meant the field season still went ahead as planned, and despite difficult weather conditions at times, the field season still resulted in meeting Output Indicators 1.2 and 1.3.

Seedling growth post-germination can be unpredictable, as can the reliability of climate growth chambers. We knew that chamber malfunction was a risk, but nonetheless, the experiment of Output 2 has yielded informative preliminary data which we can verify in a follow-up experiment. Further trialling of different germination approaches may have revealed a more optimal approach to producing seedlings for the experiment and can be employed in preparation for future experiments.

In the interests of delivering value for money, the PDRA position was kept to 2 years. With hindsight, the benefit of having the PDRA position for 2.5 years instead would probably have outweighed the costs. Analysis of the Output 3 data-set may have been completed before the end of the project if the PDRA position had been 6 months longer. However, it is doubtful that the study would have been published or submitted for publication by the end of the project. Having the PDRA position for an extra 6 months would also have provided an opportunity for more project management support at the close of the project.

7 Actions taken in response to Annual Report reviews

Responses to DPLUS144 AR2 reviewwer comments:

"Can you clarify the sentence at the start of the last paragraph on page 3 – "to allow monitoring of sites that we were unable to visit due to logistical constraints"

Apologies for lack of clarity: the point made here: there are limits on areas that scientific researchers can reach and visit safely using boats travelling from King Edward Point. Tourist operators, however, do land with tour groups in areas beyond these limits, and our idea was to trial the citizen science project to extend our sampling reach.

"Under Output 3, can you clarify the difference between 'locations' and 'sites' – Indicators 3.1 and 3.6 talk about 10 sites, but your narrative update mentions hundreds of 'locations'. Can you also highlight how scientifically effective the citizen science project has been at replacing the more methodologically robust surveys."

Because of avian influenza, we were not able to roll out the citizen science project, so we cannot judge its effectiveness. For Output 3, 'site' and 'location' are synonymous. In this report, however, we have kept to describing a 'site' in Output 3 as where 10 stones were turned and where 3 pitfall traps were set. See Annex 5.26 for GPS points of sites.

"Consider what it is you want to achieve under Output 5. Your MoVs suggest a generic approach which could refined to be more targeted towards your key audience (see Section 7 below) – consider adapting those MoV for the target audience accordingly. Is the project's key audience for this increase in awareness really 'twitter and inaturalist' users? Or should MoVs be developed to understand the increase in awareness of government staff and possibly Antarctic tour operators."

Apologies for the oversight on our part: we had not appreciated that we could change the MoVs in our existing logframe. With hindsight, we should have changed these. However, we believe we have been able to target both a general online audience and three specific in-person targets within Output 5's activities (scientists and students at conferences and seminars; tourists on cruises to SG; stakeholder groups of SG). See section 3.1, 'Output 5' and Section 3.2.

8 Sustainability and Legacy

The data-sets we have produced will endure, especially on species distributions and occurrence records on South Georgia, because they are available as supplementary material with the publications, and will eventually be made available through the UK Polar Data Centre. The knowledge embedded in the open access publications we have published so far will endure, and as the Project Lead seeks further funding for biosecurity work in the South Atlantic involving GSGSSI and other project partners, there is strong potential for further collaboration and implementation of the knowledge gained in DPLUS144. While we cannot say that the project has had a direct impact on SGSSI policy to date, we presented project outputs, what we've learned, and management implications at the GSGSSI Stakeholder Event (Annex 5.24).

The PDRA on the project has since started a new postdoctoral position at the Swedish University of Agricultural Sciences, and will have taken the skills and experience gained on this project with him in his continuing career.

As already mentioned, the publications from the project are open-access, and the data are available as supplementary material. Formal depositing of data into the UK Polar Data Centre will occur once we have received information from curators on the format and metadata required, and once Output 3 is published.

9 Darwin Plus Identity

The Darwin PLUS Twitter/X account handle @Darwin_Defra was included in the bio of the project's account profile. This handle, which was active at the time, was included in multiple posts during the project; however, the project team notes that this Darwin account no longer exists, having been superceded by @UKBCFs. Darwin was also included on Twitter/x posts using #DarwinPlus.The Darwin Plus logo was used in all oral and poster presentations of the project outputs (see Annex 5.15). The project was presented as an independent project and not within a larger programme. In addition, Defra Darwin PLUS is included in the acknowledgements/funding statements of the two publications resulting for the project:

- Tichit et al. (2023). Ecology & Evolution: "We thank Simon Browning, Sally Poncet and Ken Passfield for their help and advice during sample collection and Jennifer Black for helpful and constructive comments on an earlier draft. We are grateful to an anonymous referee and the associate editor for their helpful comments. Field work on South Georgia was made possible through the logistic support of SAERI, BAS and GSGSSI. **This work**

was funded by the Darwin PLUS scheme [DPLUS144] from the UK Department for Environment, Food and Rural Affairs."

- Tichit et al. (2023). NeoBiota: **"This study was funded by the Darwin PLUS scheme [DPLUS144] from the UK Department for Environment, Food and Rural Affairs."**

10 Risk Management

The only potential unforeseen risk that played out was the Project Lead's move to a different organisation (University of Liverpool). This move was discussed in advance with the project team soon after the move was confirmed (July 2023). However, the team agreed the move would have little impact on the delivery of the project, because W Dawson was moving in January 2024, 7 months before the project end. W Dawson discussed the move with E Young at NIRAS, and was advised that a point of contact at Durham needed to be maintained for admin and finance purposes. This was achieved, and the project has continued to run to its completion with no impact from the move.

11 Safeguarding

Has your Safeguarding Policy been updated in the past 12 months?	No
Have any concerns been investigated in the past 12 months	No
Does your project have a Safeguarding focal point?	No
Has the focal point attended any formal training in the last 12 months?	No
What proportion (and number) of project staff have received formal training on Safeguarding?	Past: % [1] Planned: 0- end of project
Has there been any lessons learnt or challenges on Safeguarding in the past 12 months? Please ensure no sensitive data is included within responses. **None**	
Please describe any community sensitisation that has taken place over the lifetime of the project; include topics covered and number of participants. None	
Have there been any concerns around Health, Safety and Security of your staff over the lifetime of the project? If yes, please outline how this was resolved. No	

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)	2024/25 Grant (£)	2024/25 Total actual Darwin Plus Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs	[redacted]		1	Durham's sta costs include conference registration and other costs for subsistence for staff P Tichit	[redacted]			Staff costs higher than estimated

Project spend (indicative since last Annual Report	2023/24 Grant (£)	2023/24 Total actual Darwin Plus Costs (£)	Variance %	Comments (please explain significant variances)	2024/25 Grant (£)	2024/25 Total actual Darwin Plus Costs (£)	Variance %	Comments (please explain significant variances)
Consultancy costs	[redacted]				[redacted]			
Overhead Costs	2			Durham's overhead costs calculated on expenditure c [redacted]				Overheads costs lower than estimated
Travel and subsistence								
Operating Costs								
Capital items								
Others				PDRA Travel to Kew for meeting: [redacted] Durham Freight charges and consumables [redacted] Lab Consumables [redacted]				Costs of the final project workshop were lower than anticipated due to some participants requiring less accommodation and travel than anticipated
TOTAL	85320	83752.93	**-1.8**		**15037**	**13013.42**	**-13**	**See comment for 'others'**

Staff employed (Name and position)	Cost (£)
RJ Newton (Seed Scientist, RBG Kew) 2024/2025	[redacted]
P Brickle (CEO, SAERI) 2024/2025	
P Convey (Researcher, BAS) 2024/2025	
TOTAL	**5911**

Consultancy – description and breakdown of costs	Other items – cost (£)
TOTAL	0

Capital items – description	Capital items – cost (£)
TOTAL	0

Other items – description	Other items – cost (£)
Other Costs: Workshop- travel and accommodation 2024/25 Other Costs: Workshop- catering 2024/2025 Other Costs: (ring-fenced Audit Costs, final cost tbc) 2024/2025 Other Costs: Open access publication charge + VAT: NeoBiota 2024/2025	[redacted]
TOTAL	4626.72

12.2 Additional funds or in-kind contributions secured

Matched funding leveraged by the partners to deliver the project	Total (£)
Project Lead time at University of Durham (2.5 years) + unclaimed overheads (Across whole project)	[redacted]
RBG Kew unclaimed overheads (Across whole project)	
BAS unclaimed overheads (Across whole project)	
TOTAL (Across whole project)	**174230**

Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project	Total (£)
Project Lead time at University of Liverpool (20 days) Jan-Jun 24	[redacted]
£480-worth of TOMST loggers used and deployed to collect microclimate data	
TOTAL	**6367**

12.3 Value for Money

The most expensive single element of the project budget was hiring a PDRA on a 2-year fixed term contract (staff costs and associated overheads amounting to 45% of the total funds requested). This spend was excellent value for money, because the field, experiment and lab work demands of Outputs 1-3 required someone working on the related activities full-time. The project would simply not have been deliverable in its current form without the PDRA, who not only assisted greatly in project planning and management, but also in monitoring and evaluation (regularly writing up minutes of meetings, for example). With this spend, the project has already produced two publications and four data-sets for Outputs 1-4. Value for money was further enhanced by the Project Lead's time on the project being entirely in-kind, bringing in organisational skill and expert knowledge in the field of biological invasions and data analysis. Finally, fieldwork on remote South Georgia is expensive due to travel costs and the long periods of accommodation time required on the island between Pharos rotations. Nonetheless, we have managed to largely deliver our stated project outputs with two field seasons that yielded high-quality publishable datasets, and we still have an underspend at the end of the project.

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.

I agree for the Biodiversity Challenge Funds Secretariat to publish the content of this section

An unexpected project outcome was making the first record of a non-native species on the island of South Georgia. The 11-spot ladybird beetle was observed in between field survey sites purely

by chance by P Tichit and S Browning. P Tichit collected the group of individuals, found on the edge of Stromness Bay in the Busen Region, prepared them in ethanol, and confirmed their sex and species identity back in Durham. P Tichit discovered a fairly balanced ratio of females to males, strongly suggesting the species can reproduce and may be establishing or is already established. The project team prepared this discovery for publication as an article in the open-access journal *Ecology & Evolution*. Our discovery would not have been possible without conducting surveys for this Darwin-funded project, and it highlights the ongoing introduction risk to South Georgia.

File Type	**File Name or File Location**	**Caption, country and credit**	**Online accounts to be tagged**	**Consent of subjects received**
Image (.png)	11_spot_ladybird	An adult male 11-spot ladybird beetle. Scale-bar= 1mm (Credit. P Tichit)	@SG_bio_invasion	NA

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

Project summary	Progress and achievements
Impact South Georgia's dynamic terrestrial communities are protected from invasion by non-native plants and invertebrates	As a longer-term impact resulting from the project, progress on achieving the impact in this 3-year project is limited. However, we have i) demonstrated that some invasive plants decline over time and are unlikely to threaten developing native plant communities, ii) identified a set of plant species that pose an invasion risk to SG with a warming climate that biosecurity can target, and iii) raised awareness of invasion risks posed by invertebrates through the discovery of ladybird beetles on the island, and a polar collective citizen science pilot project.
Outcome South Georgia's evidence-based management of invasive species will be improved by identifying which non-native species pose the greatest risk to SG (pre- and post-introduction) in a future climate	We have contributed to the drafting of GSGSSI's updated Non-native Plant Management Strategy (Annex 5.23); key project results and recommendations have been presented to GSGSSI and stakeholders in presentations (Annex 5.24 and 5.25)
Outcome indicator 0.1 Species in early successional communities identified in at least 3 sites by October 2022	Six sites of deglaciation were surveyed, and results were published in Tichit et al. 2024 (Annex 3, Table 2). Two of the 10 most frequently observed species were non-native, for both plants and invertebrates.
Outcome indicator 0.2 'Winning' and 'Losing' plants under future climate identified, among at least 14 species (8 invasive and 6 native) by July 2023	Several native plants may win out over non-native *Poa annua* and *Cerastium montanum* with increasing temperatures (Figure 5 in report); to be verified with follow-up experiment.
Outcome indicator 0.3 Associations between vegetation type and occurrence of invertebrates established by October 2023	Field surveys completed using stone hand searches and pitfall traps along an elevational gradient and in different vegetation types. Carabid beetles are found >300 m elevation and far away from shores (Fig. 6 and 7 of report).
Outcome indicator 0.4 Top 10 plant and invertebrate species present on FI that pose a high invasion risk to SG under future climate identified by March 2024	Top 43 plant species identified (Annex 5.19), preliminary shortlist of 96 species identified; climate overlap analysis of species to be completed (Annex 5.20)
Outcome indicator 0.5 Final workshop on evidence base for future management and biosecurity by June 2024	Workshop completed, presentation at GSGSSI Stakeholder Event given (Annex 5.24, 5.25)
Output 1 Presence of plant and invertebrate species (including non-natives) in areas of glacial retreat and vegetation fronts established.	
Output indicator 1.1 At least 3 sites suitable for survey located and selected using SAERI World View vegetation data by December 2021	Six sites of deglaciation were selected, using GSGSSI and GIS information (RAPs, Annex 5.11-5.12)

Output indicator 1.2 At least 3 sites surveyed for plant species present and % cover estimated March 2022	Six sites were surveyed, data were analysed and published (Annex 3, Table 2)
Output indicator 1.3 Pitfall traps and soil cores taken, invertebrate species identified for at least 3 sites by March 2022	Six sites were surveyed, data were analysed and published (Annex 3, Table 2)
Output indicator 1.4 By December 2022: Colonisation of communities by native versus non-native species (richness and abundance) compared and analysed; diversity and composition of communities among sites analysed	Six sites were surveyed, data were analysed and published (Annex 3, Table 2)
Output 2. Winners' and 'losers' of competition between non-native plant species and native plant communities under climate change (ex-situ experiment) identified	
Output indicator 2.1. By October 2021: 8 invasive and at least 6 native plant species selected for experiment and germination trials; seeds obtained from MSB Kew	7 non-native and 7 native species were finally selected (Table 1 in report); seeds were collected from SG plants instead during the first field season. These 14 species were the ones with seed available on the plants that we could access (See RAP, Annex 5.11)
Output indicator 2.2. Climate experiment conducted; plant growth rate and biomass measured for 14 species by July 2022	Experiment was conducted, but only 9 species (3 non-native and 6 native) survived the experiment period in sufficient numbers for analysis of biomass (See Fig. 5 in report): Follow-up experiment planned for 2024
Output indicator 2.3. Germination trials of at least 6 native species conducted; % germination data obtained by April 2023	Germination trials paused for follow-up experiment (to save on existing seed stocks) in 2024
Output indicator 2.4. Performance of at least 6 native and 8 invasive plant species under future climate compared to current climate by December 2022	Biomass difference between non-native and native plants in pairs calculated for 3 non-native and 6 native species; current and future climate compared (Fig. 5). Natives may do better than non-natives in warmer climate.
Output indicator 2.5. Germination success under future climate change established for at least 6 native species by July 2023	Germination trials paused for follow-up experiment (to save on existing seed stocks) in 2024
Output 3. Distribution of invasive carabid beetles, native herbivorous beetles and association with each other and vegetation types established	
Output indicator 3.1. At least 10 sites for surveys across vegetation types identified by December 2022	A total of 160 sites were surveyed with pitfall traps and hand searches (GPS points, Annex 5.27)

Output indicator 3.2. Hand-search surveys conducted, presence and abundance of beetle species recorded at each site by March 2023	A total of 160 sites were surveyed with pitfall traps and hand searches (GPS points, Annex 5.27); see Fig. 6 in report.
Output indicator 3.3. Pitfall traps and soil samples taken at each site; invertebrates identified to species level by March 2023	A total of 160 sites were surveyed with pitfall traps and hand searches (GPS points, Annex 5.27); see Fig. 6 in report.
Output indicator 3.4. Distribution of invasive carabids updated and relationship to native beetles and vegetation described by July 2023	Distributions of *Merizodus soledadinus* and *Trechisibus antarcticus* among surveyed sites shown in Fig. 6; relationship with vegetation type summarized in Fig. 7. Full analysis of carabid occurrence data in relation to native species and vegetation types/elevation is in progress.
Output indicator 3.5. Effects of vegetation type and invasive carabid presence on invertebrate community composition identified by October 2023	Full analysis of carabid occurrence data in relation to native species and vegetation types/elevation is in progress.
Output 4. Non-native terrestrial species from FI that pose greatest invasion risk to SG under a future climate identified	
Output indicator 4.1. At least 50 plant and invertebrate species present on FI screened for climate suitability on SG under year 2060 climate scenarios by July 2023	143 out of 1188 initial plant species have been screened for climate suitability; 43 species shortlisted (Figure 9 in report; Annex 5.19 for 43 shortlist species). Preliminary list of 329 invertebrates filtered to 96 species (Annex 5.20): climate overlap analysis to complete.
Output indicator 4.2. Horizon scanning exercise conducted with project partners and beneficiaries, future climate invaders prioritised from 4.1 according to invasion risk (product of severity of impact and likelihood of arrival and establishment). Top 10 high-risk species identified by March 2024	Top 10 higher risk plant species identified (Table 2 in report; Annex 5.19). Horizon scanning was done differently, used data on pathways in addition to climate overlap. Top 10 invert species to be identified.
Output indicator 4.3. By June 2024: Information from all 4 outputs synthesised in a final workshop attended by at least 10 beneficiary participants based in Stanley FI/remotely, hosted by SAERI; priorities for FI-GSGSSI discussed	Workshop delivered at BAS Cambridge on 10.05.2024. Attendance list in Annex 5.13 with 14 attendants (13 signed)
Output 5. Increased awareness of invasive species and climate change impacts on SG	
Output indicator 5.1. Project information provided to a global audience via a webpage created by September 2021	We created a webpage, but also a Twitter profile: @SG_bio_invasion http://www.conservationecology.org/sg_content.html
Output indicator 5.2. Project findings presented to interested audience in webinars held in Dec 2021, Dec 2022, Dec 2023 and July 2024	Instead of webinars, we presented our projects' findings at multiple conferences, seminars, and on a SG cruise ship (Fig. 10; Annex 5.15)

Output indicator 5.3. Awareness raised of invasive species on SG among tourists visiting via a poster, by February 2023	In addition to the SG cruise ship talk (Fig. 10), a Polar Collective Citizen Science Project was designed and trialled with SG tourists (leaflet in Annex 5.21, Data sheet in Annex 5.22)
Output indicator 5.4. Awareness raised among Antarctic tourists via a digital information leaflet by December 2023	Due to avian influenza, GSGSSI, IAATO and the project team agreed not to roll out the 'Beetle vs Stones' project. All materials are available for a future rollout, when feasible

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: South Georgia's dynamic terrestrial communities are protected from invasion by non-native plants and invertebrates			
Outcome: South Georgia's evidence-based management of invasive species will be improved by identifying which non-native species pose the greatest risk to SG (pre- and post-introduction) in a future climate	0.1 Species in early successional communities identified in at least 3 sites by October 2022 0.2 'Winning' and 'Losing' plants under future climate identified, among at least 14 species (8 invasive and 6 native) by July 2023 0.3 Associations between vegetation type and occurrence of invertebrates established by October 2023 0.4 Top 10 plant and invertebrate species present on FI that pose a high invasion risk to SG under future climate identified by March 2024 0.5 Final workshop on evidence base for future management and biosecurity by June 2024	0.1 Summary report published on GSGSSI website 0.2 Datasets from outputs 1-3 compiled, analysed and shared with FI government and GSGSSI and publicly available 0.3 Articles from outputs 1-3 submitted as peer-reviewed publications 0.4 List of high-risk plant and invertebrate species under climate change resulting from horizon-scanning exercise 0.5 Workshop report and proceedings	0.1 Covid pandemic subsides, allowing field work to proceed 0.2 Weather conditions allow boat access to SG and access to field sites for surveys 0.3 Seeds are viable and germinate in sufficient quantity to allow climate experiment and germination trials to proceed 0.4 Species samples from the field are identifiable
Output 1 Presence of plant and invertebrate species (including non-natives) in areas of glacial retreat and vegetation fronts established	1.1 At least 3 sites suitable for survey located and selected using SAERI World View vegetation data by December 2021 1.2 At least 3 sites surveyed for plant species present and % cover estimated March 2022	1.1 Datasets compiled on plant and invertebrate species composition in surveyed areas 1.2 Datasets analysed	1.1 Covid pandemic subsides by field season in year 1, permitting fieldwork 1.2 Weather conditions permit safe completion of surveys, and access to field sites

	1.3 Pitfall traps and soil cores taken, invertebrate species identified for at least 3 sites by March 2022 1.4 By December 2022: Colonisation of communities by native versus non-native species (richness and abundance) compared and analysed; diversity and composition of communities among sites analysed	1.3 Summary report of field season and preliminary findings published on GSGSSI website and ResearchGate 1.4 Submitted plant and invertebrate community analyses for peer-reviewed publication, including data deposited at UK Polar Data Centre/SAERI	1.3 Plant and invertebrate species are identifiable 1.4 Covid restrictions lifted to allow UK-based partner meeting at BAS (Cambridge)
Output 2 'Winners' and 'losers' of competition between non-native plant species and native plant communities under climate change (ex-situ experiment) identified	2.1 By October 2021: 8 invasive and at least 6 native plant species selected for experiment and germination trials; seeds obtained from MSB Kew 2.2 Climate experiment conducted; plant growth rate and biomass measured for 14 species by July 2022 2.3 Germination trials of at least 6 native species conducted; % germination data obtained by April 2023 2.4 Performance of at least 6 native and 8 invasive plant species under future climate compared to current climate by December 2022 2.5 Germination success under future climate change established for at least 6 native species by July 2023	2.1 Dataset compiled of plant growth rate and biomass under each climate condition 2.2 Dataset compiled of native germination % under each temperature regime and deposited in Kew MSB Database 2.3 Datasets analysed 2.4 Summary report of experiments and preliminary findings published on GSGSSI website and ResearchGate 2.5 Submitted climate experiment analyses for peer-reviewed publication	2.1 Seeds from SG and MSB collections are viable and germinate in sufficient numbers 2.2 Growth chambers at Durham continue to function well at required climate settings
Output 3 Distribution of invasive carabid beetles, native herbivorous beetles and association with each other and vegetation types established	3.1 At least 10 sites for surveys across vegetation types identified by December 2022 3.2 Hand-search surveys conducted, presence and abundance of beetle species recorded at each site by March 2023	3.1 Dataset and maps produced, describing current distribution of surveyed beetle species in relation to vegetation types 3.2 Database compiled of invertebrate communities 3.3 Datasets analysed	3.1 Covid pandemic subsides by field season in year 2, permitting fieldwork 3.2 Weather conditions permit safe completion of surveys, and access to field sites 3.3 Invertebrate species are identifiable

	3.3 Pitfall traps and soil samples taken at each site; invertebrates identified to species level by March 2023 3.4 Distribution of invasive carabids updated and relationship to native beetles and vegetation described by July 2023 3.5 Effects of vegetation type and invasive carabid presence on invertebrate community composition identified by October 2023	3.4 Summary report of field season and preliminary findings published on GSGSSI website and Researchgate 3.5 Submitted analyses assessing relationship between invasive and native vertebrate distributions, and associations with vegetation type as peer-reviewed publication, and data deposited at UK Polar Data Centre/SAERI	
Output 4 Non-native terrestrial species from FI that pose greatest invasion risk to SG under a future climate identified	4.1 At least 50 plant and invertebrate species present on FI screened for climate suitability on SG under year 2060 climate scenarios by July 2023 4.2 Horizon scanning exercise conducted with project partners and beneficiaries, future climate invaders prioritised from 4.1 according to invasion risk (product of severity of impact and likelihood of arrival and establishment). Top 10 high-risk species identified by March 2024 4.3 By June 2024: Information from all 4 outputs synthesised in a final workshop attended by at least 10 beneficiary participants based in Stanley FI/remotely, hosted by SAERI; priorities for FI-GSGSSI discussed	4.1 Priority list produced of 10 plant and invertebrate species from FI that pose the highest invasion risk to GSGSSI under future climate 4.2 Report of Horizon-Scanning exercise and priority list published on SGSSI and FI governments websites and ResearchGate 4.3 Final workshop report and priority list of actions for biosecurity and management of invasive species to 2060 published on SGSSI and FI governments websites and ResearchGate 4.4 Submitted analyses of Horizon-scanning exercise for peer-reviewed publication, and data deposited at UK Polar Data Centre/SAERI	4.1 Evidence base will be successfully obtained from outputs 1-3 4.2 Travel to FI for final workshop will be possible in 2024 (Covid and weather permitting)
Output 5 Increased awareness of invasive species and climate change impacts on SG	5.1 Project information provided to a global audience via a webpage created by September 2021 5.2 Project findings presented to interested audience in webinars held in	5.1 Webpage launched and data on page visits and origins collected 5.2 Webpage and webinars advertised on Twitter; number of 'likes', 'retweets' and webinar registrations recorded	5.1 Work in outputs 1-4 is delivered on time for webinar content 5.2 Webinars are sufficiently advertised to attract a wide audience

	Dec 2021, Dec 2022, Dec 2023 and July 2024 5.3 Awareness raised of invasive species on SG among tourists visiting via a poster, by February 2023 5.4 Awareness raised among Antarctic tourists via a digital information leaflet by December 2023	5.3 Poster created and displayed describing invasive plants and invertebrates of SG in Grytviken museum, with QR codes linked to project webpage and digital poster copy 5.4 Digital leaflet disseminated to cruise operators via IAATO. Number of tour operators and tourists reached estimated and recorded. Leaflet linked to project webpage	5.3 Tourists will view posters and leaflets, and want to search for more information

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

Output 1

1.1 Project Management Group Meeting [PMGM] 1 (online)

1.2 Recruit PDRA and Field Assistant

1.3 Draw up Memorandum of Collaboration between Project Partners

1.4 Select at least 5 sites suitable for plant and invertebrate communities in areas of glacier retreat and vegetation fronts

1.5 UK-based project partners meet at BAS (Cambridge) for fieldwork planning; PDRA to obtain plant and invertebrate ID information

1.6 Produce fieldwork protocols for first field season, including details of survey sites

1.7 Apply for SG fieldwork permits

1.8 Organise logistics for first field season (PDRA travel to FI, onward transport to SG, SG accommodation, purchase and transport of field kit, on-island boat transport)

1.9 Project meeting in Stanley, FI prior to first field season (WD, PC and RN to join online, for PMGM 2)

1.10 PDRA/Field Assistant first field season on SG: Plant and invertebrate communities surveyed, collection of unidentifiable plant samples, collections of seeds for experiments where possible

1.11 PDRA and plant samples return to UK: plant samples stored for molecular analysis at Kew

1.12 Plant DNA extracted and sequenced to verify species ID of unidentified samples (Kew)

1.13 Plant and invertebrate community data compilation and analysis after PDRA return to UK

1.14 Project Management Group Meeting 3 (online)

1.15 Write up and submit plant and invertebrate community manuscript for peer-reviewed publication

Output 2

2.1 Select native and invasive plant species for climate experiment and germination trials

2.2 Durham and Kew-based project partners meet online, to draw up experiment/trial plans; obtain seeds from Kew if required

2.3 Order materials required for experiment/germination trials

2.4 Identify current and future (year 2060) climate and light regimes for realistic experimental treatments and germination trial conditions

2.5 Durham and Kew: Apply any germination pre-treatments to seeds prior to sowing, as required, and sow
2.6 Durham: Set up and conduct climate experiment
2.7 Durham: Terminate experiment, harvest biomass, weigh and collate data
2.8 Kew: Conduct germination trials in incubators at current and future climates
2.9 Kew: Terminate germination trials, collate data and publish in Kew's seed information database
2.10 Durham: Data compilation and analysis from climate experiment
2.11 Write up and submit manuscript for Durham climate experiment and germination trials for peer-reviewed publication
2.12 Write up and publish year report online, combining key results and progress for Outputs 1 and 2
2.13 Project Management Group Meeting 4 (online)
2.14 Analyse and write up results of seed germination trials
Output 3
3.1 Identify at least 10 sites for invertebrate survey work on SG, across vegetation types
3.2 UK-based project partners meet at Durham, plan surveys for 2nd SG fieldwork season, and produce fieldwork protocols
3.3 Reapply/update permits for fieldwork on SG as necessary
3.4 Purchase materials required for survey fieldwork
3.5 Organise transport and accommodation logistics for 2nd fieldwork season
3.6 PDRA travels to FI, and then on to SG for 2nd fieldwork season: survey 10 sites for invasive and native invertebrate species presence and abundance
3.7 Compilation and analysis of invertebrate survey data
3.8 Write up and publish year report on field season and results online
3.9 Project Management Group Meeting 5 (online)
3.10 Write up and submit manuscript of analyses assessing relationship between invasive and native vertebrate distributions for peer-reviewed publication
Output 4
4.1 Plan remote horizon-scanning exercise details and invite beneficiaries representatives as well as project partner organisations to participate. Exercise will be done virtually, using Zoom and Slack platforms
4.2 Identify at least 50 species of plants and invertebrate present on FI but not yet on SG (distinguish whether native or non-native to FI)
4.3 Model species distributions and project resulting models onto SG to quantify and rank climate suitability under year 2060 climate for best, medium and worst-case socioeconomic pathway scenarios
4.4 Disseminate list of species screened for climate suitability to participants for opinion on the invasion risk of each species focusing on entry, establishment, spread and impact risk
4.5 Gather participant opinions and categorise species according to perceived risk across participants. Present categorised list to stakeholders and elicit feedback
4.6 Adjust risk-categorised list of species based on (dis-)agreements until a consensus list is reached, and top-10 high-risk species under a future climate are identified
4.7 Plan final workshop in Stanley, FI: invite attendees from FI-based beneficiaries, organise travel and accommodation, secure venue and organise materials
4.8 Project Management Group Meeting 6 (online)
4.9 Prepare delivery of workshop

4.10 Write up final year project report, including outcome of horizon-scanning exercise

4.11 Hold project final workshop in FI: present findings; discuss horizon-scanning exercise outcome; discuss how project findings can best inform GSGSSI management strategy

4.12 Project Management Group Meeting 7 (online)

4.13 Submit analyses of horizon-scanning exercise for peer-reviewed publication

Output 5

5.1 Create and launch project webpage, promote on Twitter and partner websites

5.2 Advertise 1st project webinar on Twitter/through Scientific Committee on Antarctic Research and its Integrated Science for the Sub-Antarctic sub-group (SCAR/ISSA), IAATO, SGHT; collect registration

5.3 Hold 1st project webinar, embed recording on project webpage, promote on Twitter

5.4 Write blog about first field season on project web-page, promote on Twitter

5.5 Advertise 2nd project webinar on Twitter/through SCAR/ISSA, IAATO, SGHT; collect registration

5.6 Hold 2nd project webinar, embed recording on project webpage, promote on Twitter

5.7 Write blog about Output 2 experiments on project web-page, promote on Twitter

5.8 Advertise 3rd project webinar on Twitter/through SCAR/ISSA, IAATO, SGHT; collect registration

5.9 Hold 3rd project webinar, embed recording on project webpage, promote on Twitter

5.10 Write blog about second field season on project web-page, promote on Twitter

5.11 Advertise 4th project webinar on Twitter/through SCAR/ISSA, IAATO, SGHT; collect registration

5.12 Create and display hard-copy poster at Grytviken Museum, SG; make digital version available on webpage

5.13 Create and disseminate digital leaflet to tour operators via IAATO

5.14 Hold 4th project webinar, embed recording on project webpage, promote on Twitter5.15 Write blog about Output 4 and final project workshop on project web-page, promote on Twitter

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-A03	Final workshop on evidence base for future management and biosecurity by June 2024	Number of South Georgia /Falkland Island organisations with improved capability and capacity as a result of project	Number	None	0	0	0	0	2 minimum (Governments of Falkland Islands and South Georgia and South Sandwich Islands)
DPLUS-C01	Species in early successional communities identified in at least 3 sites by October 2022	Number of knowledge products published that catalogue communities in deglaciating sites	Number	None	0	0	1	2	Minimum of 2 (report; publication)
DPLUS-B02	'Winning' and 'Losing' plants under future climate identified, among at least 14 species (8 invasive and 6 native) by July 2023	Number of habitat management plans identified that can be improved with new knowledge	Number	None	0	0	1	1	Minimum of 1
DPLUS-B02	Associations between vegetation type and occurrence of invertebrates established by October 2023	Number of invasive species management plans identified that can be improved with new knowledge	Number	None	0	0	0	1	Minimum of 2 (invasive carabid beetles; invasive non-native plants)
DPLUS-D03	Top 10 plant and invertebrate species present on FI that pose a high invasion risk to SG under future climate identified by March 2024	Number of policies with biodiversity provisions that can be amended with new invasion risk information	Number of instruments	Policy typology (Local, National Policy); Typology of biodiversity provisions	0	0	0	1	Minimum of 1: Biosecurity policy for South Georgia
DPLUS-C17	Increased awareness of invasive species and climate change impacts on SG	Social Media presence (Twitter)	Cumulative number of: Followers Likes	Year Followers Likes	0	Followers: 135 Likes:329	Followers: 134 Likes:465	Followers: 134 Likes:794	At least 500 followers; At least 1000 likes

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)
Introduced species infiltrate early stages of succession after glacial retreat on sub-Antarctic South Georgia	Journal	Tichit P, Brickle P, Newton RJ, Convey P, Dawson W.	Male	French	PenSoft,	https://doi.org/10.3897/neobiota.92.117226
First record of the introduced ladybird beetle, *Coccinella undecimpunctata* Linnaeus (1758), on South Georgia (sub-Antarctic)	Journal	Tichit P, Roy HE, Convey P, Brickle P, Newton RJ, Dawson W.	Male	French	J Wiley & Sons,	https://doi.org/10.1002/ece3.10513

Annex 5 Supplementary material (optional but encouraged as evidence of project achievement)

5.1 PDRA Job Advert

5.2 Interview Template Sheet

5.3 Field Assistant Job Advert 1

5.4 Field Assistant Job Advert 2

5.5 M&E Steering Committee Meeting Minutes Jul 2021

5.6 M&E Steering Committee Meeting Minutes Jan 2022

5.7 M&E Steering Committee Meeting Minutes Jun 2022

5.8 M&E Steering Committee Meeting Minutes Jan 2023

5.9 M&E Steering Committee Meeting Minutes May 2023

5.10 M&E Steering Committee Meeting Minutes Jan 2024

5.11 Fieldwork Research Activity Permit 2022

5.12 Fieldwork Research Activity Permit 2023

5.13 Final Project Workshop attendance list (10 May 2024)

5.14 Project Collaboration Agreement

5.15 List of presentations, interviews and videos raising awareness about the project (includes posters and talk abstracts)

5.16 Screenshot of Twitter/X post with photo of P Convey, W Dawson and P Tichit in Durham

5.17 Protocol for Output 3 invertebrate surveys

5.18 Climate overlap between South Georgia and other worldwide occurrences of plant species native to or already established on South Georgia, using 1981-2010 climatologies from CHELSA and occurrence records from the Global Biodiversity Information Facility

5.19 Climate overlap between South Georgia and other worldwide occurrences of 43 plant species in the neighbourhood of South Georgia. Overlaps calculated using 1981-2010 and SSP340 climatologies for 2041-2070, from CHELSA and occurrence records from the Global Biodiversity Information Facility. Pathways also shown.

5.20 Preliminary list of 96 invertebrate taxa in the neighbourhood of South Georgia (with >50 records, at top. Remaining species have insufficient records to be considered).

5.21 Polar Collective ‘Beetles vs Stones’ citizen science project leaflet

5.22 Polar Collective ‘Beetles vs Stones’ citizen science project field data sheet

5.23 Updated Non-native Plant Management Strategy, GSGSSI

5.24 Pdf of powerpoint slides from GSGSSI Stakeholder Event presentation

5.25 Pdf of powerpoint slides from end-of-project workshop

5.26 Spreadsheet of GPS points for sites surveyed in Field Season 2 (Transects for pitfall traps; glacial sites).

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	x
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 discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line. All supporting material should be submitted in a way that can be accessed and downloaded as one complete package.	x
If you are submitting photos for publicity purposes, **do these meet the outlined requirements (see section 14)?**	Yes
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.	Yes
Have you involved your partners in preparation of the report and named the main contributors	Yes
Have you completed the Project Expenditure table fully?	Yes
Do not include claim forms or other communications with this report.	