Darwin Plus Main: Annual Report

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

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

Submission Deadline: 30th April 2024

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

Darwin Plus Project Information

Project reference	DPLUS185
Project title	Safeguarding Antarctic Krill Stocks for Baleen Whales
Territory(ies)	British Antarctic Territory
Lead Partner	University of Southampton
Project partner(s)	British Antarctic Survey Scottish Association for Marine Science
Darwin Plus grant value	£630,031.00
Start/end dates of project	1 April 2023 – 31 March 2026
Reporting period (e.g. Apr 2023-Mar 2024) and number (e.g. Annual Report 1, 2)	1 April 2023 – 31 March 2024 Annual Report 1
Project Leader name	Ryan [redacted]
Project website/blog/social media	https://www.bas.ac.uk/project/safeguarding-antarctic-krill-stocks-for-baleen-whales/
Report author(s) and date	Ryan [redacted], Tracey [redacted], Phil [redacted], Phil [redacted], Sophie [redacted], Ari [redacted]

1. Project summary

Krill are central to Antarctic marine ecosystems but are subject to a fishery managed with insufficient spatiotemporal resolution or species representation. There is an urgent need to elucidate the spatiotemporal characteristics of interactions among krill, baleen whales and the krill fishery and to develop our capacity to forecast these interactions. This project aims to provide this information by collecting and analysing fine-scale data on krill and whale distribution, to improve krill fishery management and conserve krill-based Antarctic marine ecosystems.

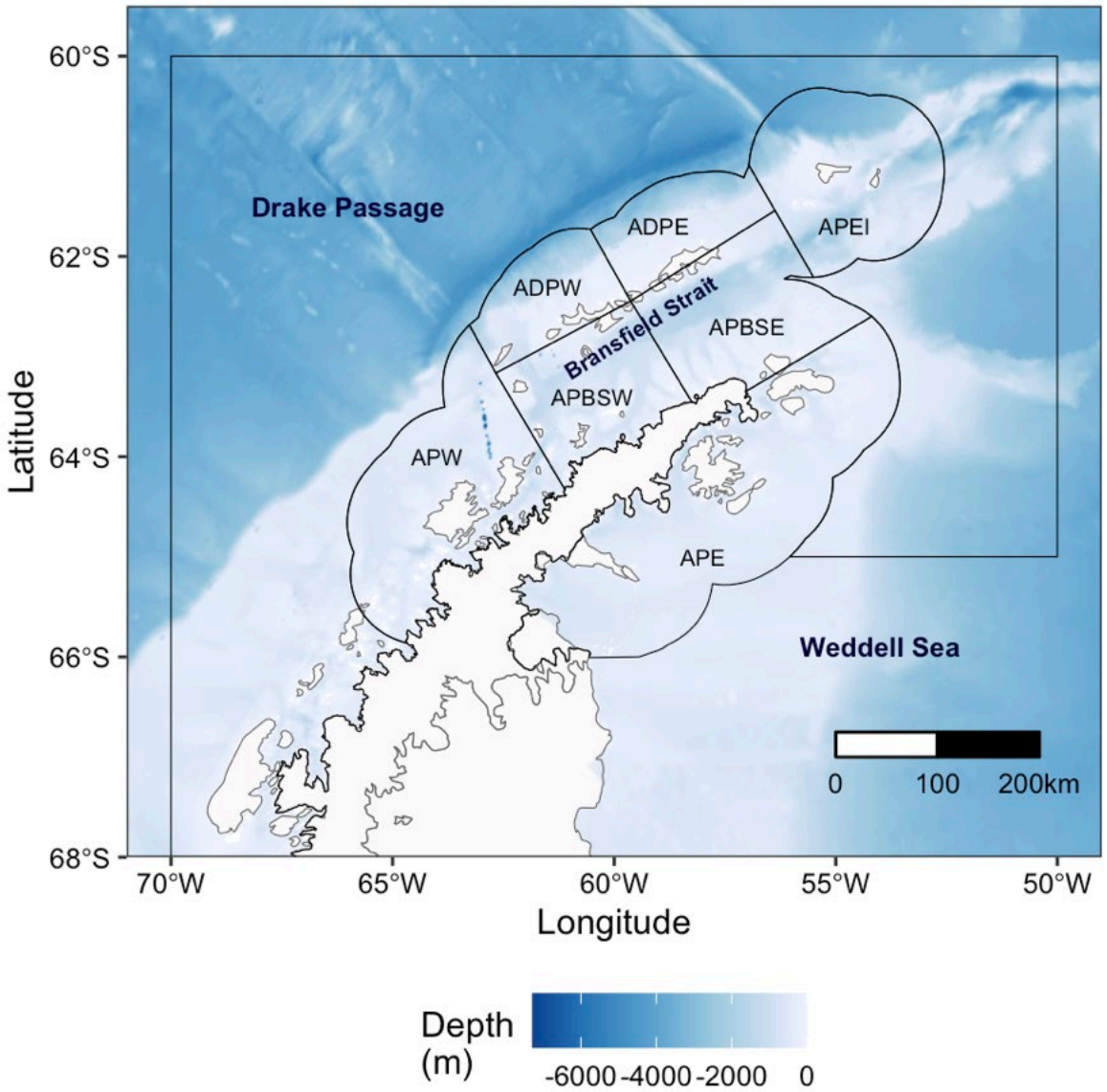

Figure 1. Map of the Western Antarctica Peninsula in the British Antarctic Territory, where the project is being conducted. Black lines indicate the CCAMLR Area 48.1, used for krill fishery management, and 'Small Scale Management Units', which have been proposed for management. These are: Antarctic Peninsula West (APW), Antarctic Peninsula East (APE), Antarctic Drake Passage West (ADPW), Antarctic Drake Passage East (ADPE), Antarctic Peninsula Elephant Islands (APEI), Antarctic Peninsula Bransfield Strait West (APBSW), Antarctic Peninsula Bransfield Strait East(APBSE).

Antarctic krill (*Euphausia superba*) are food for numerous natural consumers, including birds and marine mammals. Interactions between krill and its consumers structure Antarctic marine ecosystems [1]. However, krill are also subject to a commercial fishery operating in the British Antarctic Territory (BAT) (Figure 1) and elsewhere [2], which overlaps in time and space with foraging consumers. Competition between fisheries and consumers is thus a major concern [e.g., 3, 4], especially given i) long-term krill abundance and distribution changes, attributed to climate change, ii) predator population changes post historical overexploitation, and iii) likely expansion of the krill fishery.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) manages the fishery with an ecosystem approach, according to which fishing should not interfere with krill population growth, or krill-dependent consumers [5]. Yet catches have become concentrated in a few coastal hotspots, raising concerns about how local depletion of krill impacts its natural consumers [e.g., 3, 6]. There is currently a mismatch between the scales at which krill fisheries are managed, and that at which they operate and at which consumers forage [3]. Moreover, baleen whales - now recovering from historical overexploitation - are not

explicitly included in CCAMLR's management approach, even though they consume more than 50% of krill eaten by all air-breathing predators [7].

To conserve biodiversity and improve protection of natural environments, better understanding is urgently needed about the spatiotemporal characteristics of interactions among krill, baleen whales and the fishery, so we can develop our capacity to forecast such interactions.

This project aims to provide such information to CCAMLR to improve krill fishery management and better conserve krill-based ecosystems. This is being achieved by analysing the contemporaneous fine-scale spatiotemporal distribution of krill, baleen whales and fisheries in the BAT.

Our project has relevance to the Government of South Georgia and the South Sandwich Islands (SGSSI) and to the Member states of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The krill fishery primarily operates in the southwest Atlantic including within the BAT. Our project addresses various BAT management themes, importantly, that relate to environmental challenges and development of mitigation measures. We also address Darwin Plus themes on Biodiversity, Climate change and Environmental quality.

[1] Trathan, P. N., and Hill, S. L. (2016). "The Importance of Krill Predation in the Southern Ocean," in Biology and Ecology of Antarctic Krill, ed. V. Siegel (Cham: Springer), 321–350. doi:10.1007/978-3-319-29279-3_9.

[2] Nicol, S., Foster, J., and Kawaguchi, S. (2012). The fishery for Antarctic krill - recent developments. Fish Fish. 13, 30–40. doi:10.1111/j.1467-2979.2011.00406.x.

[3] Trathan, P. N., Warwick-Evans, V., Young, E. F., Friedlaender, A., Kim, J. H., and Kokubun, N. (2022). The ecosystem approach to management of the Antarctic krill fishery - the 'devils are in the detail' at small spatial and temporal scales. J. Mar. Syst. 225, 103598. doi:10.1016/j.jmarsys.2021.103598.

[4] Reisinger, R. R., Trathan, P. N., Johnson, C. M., Joyce, T. W., Durban, J. W., Pitman, R. L., Friedlaender, A. S. (2022) Spatiotemporal overlap of baleen whales and krill fisheries in the Antarctic Peninsula region. Front. Mar. Sci. 9, 914726. doi: https://doi.org/10.3389/fmars.2022.914726

[5] Constable, A. J., De LaMare, W. K., Agnew, D. J., Everson, I., and Miller, D. (2000). Managing fisheries to conserve the Antarctic marine ecosystem: Practical implementation of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). ICES J. Mar. Sci. 57, 778–791. doi:10.1006/jmsc.2000.0725.

[6] Santa Cruz, F., Krüger, L., and Cárdenas, C. A. (2022). Spatial and temporal catch concentrations for Antarctic krill: Implications for fishing performance and precautionary management in the Southern Ocean. Ocean Coast. Manag. 223, 106146. doi:10.1016/j.ocecoaman.2022.106146.

[7] Warwick-Evans, V., Fielding, S., Reiss, C. S., Watters, G. M., and Trathan, P. N. (2022b). Estimating the average distribution of Antarctic krill Euphausia superba at the northern Antarctic Peninsula during austral summer and winter. Polar Biol. 45, 857–871. doi:10.1007/s00300-022-03039-y.

2. Project stakeholders/partners

The project's formal partners are the University of Southampton (UoS) (lead), British Antarctic Survey (BAS), and the Scottish Association for Marine Science (SAMS). The University of California Santa Cruz (UCSC) was a formal project partner until beginning 2024, when a

change request was approved to change UCSC to an informal project partner since UCSC could not agree to the flow-through terms of the grant's funding agreement. All partners are involved in project planning, monitoring, evaluation and decision making through a) involvement of a co-investigator from each partner (Ryan Reisinger at UoS, Sophie Fielding at BAS, Phil Anderson at SAMS, Ari Friedlaender at UCSC, and Phil Trathan at BAS and UOS). These project members, as well as the project's first postdoctoral research fellow (Tracey Dornan at BAS) and PhD students involved with some aspects of the project (Natalie Nickells at BAS/UoS, Kay Ihle at SAMS, Amy Feakes at UoS, Joshua Wilson at UoS/BAS) met approximately monthly over the first year of the project, online (minutes of the meetings are not appended in the annex, but are available on request). Fieldwork included team members from UoS, BAS and SAMS.

The Government of BAT recognises the environmental challenges facing the Antarctic and seeks to develop appropriate mitigation measures. CCAMLR also enshrines similar such objectives, as it seeks to ensure that no long-term damage to the marine ecosystem arises as a consequence of harvesting.

Our project has relevance to the Government of South Georgia and the South Sandwich Islands (SGSSI) and to the Member states of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). These stakeholders will be engaged through a stakeholder meeting planned for the final year of the project, reports to CCAMLR in project years 2 and 3 (see Activities 1.3, 2.3, 3.2, 4.4 in the logframe Annex 2), and participation in CCAMLR workshops in years 2 and 3. CCAMLR has clearly identified the need for better information fine scale spatiotemporal interactions between krill predators and the krill fishery.

Our team includes scientists (Trathan) that helped CCAMLR develop the current Risk Assessment Framework, including the collation of relevant biomass estimates of krill (Fielding, Dornan), we are therefore well-placed to influence CCAMLR's management strategy.

The challenge relating to UCSC's inability to accept the funding terms--and therefore engage formally as a partner—was unexpected, but was met my starting to engage UCSC formally as a collaboration partner instead (approved through a formal change request).

3. Project progress

3.1 Progress in carrying out project Activities

The project's main activities in year 1 have related to the planning and execution of fieldwork in the Western Antarctic Peninsula in March 2024 (see appended cruise report – Annex 4), including preparation of various data collection systems.

Output 1. Whales. Spatiotemporally explicit predictions of whale foraging presence.

This output required the deployment of tracking tags on whales in the Western Antarctic Peninsula Region (Activity 1.1.). Tags and related equipment were purchased and prepared, and UCSC personnel were ready to deploy tracking tags. However, very near departure neither team member could travel (due to illness and a personal situation, respectively) and no continency could be activated in time, without incurring significant costs. Therefore, no tagging took place this year and tagging will be conducted next year. Consequently, Activities 1.1 (analyse whale tracking data and develop models which produce spatiotemporally explicit predictions of whale foraging presence within the BAT) and 1.2 (prepare data layers of these predictions for presentation to CCAMLR as Working Papers), will also now be delayed to project years 2 and 3, although some progress has been made through analysis by two undergraduate students at UoS, using existing data: "Using first passage time and time-spent modelling to compare krill search behaviour of baleen whales and krill fishing vessels in the West Antarctic Peninsula" (Amber Hutchinson) and "Predicting the spatiotemporal distribution of humpback whale (*Megaptera novaeangliae*) foraging areas around the Western Antarctic Peninsula from 2003 to 2019" (Freya Burleigh).

Output 2. Krill. Spatiotemporally explicit nearshore krill abundance information.

Two attempts were made to undertake field trials of the ImpYak autonomous vehicle in waters local to Oban, Scotland. Both attempts failed due to illness of key participants. Only a small window (March – October) existed to complete these trials in before the system needed to be shipped South. A scaled down version of the trials was completed in October 2023 prior to shipping (Activity 2.1). During further testing in the Western Antarctic Peninsula several technical problems with the ImpYak system were identified (see Annex 4), which resulted in an inability to use it during the 2024 field season. These will be addressed in field trials in Scotland in summer 2024.

However, krill surveys were conducted using a ship-mounted echosounder and standardised CCAMLR methodology, preparation of which has been the main work of Dornan over the last year, thereby progressing Activity 2.2. The data from these surveys will be used towards Activity 2.3 (produce spatially-explicit krill abundance estimates from these survey data and submit estimates to the CCAMLR Acoustic Survey and Assessment Methods Working Group).

This work is ongoing; Dornan has prepared a paper for submission to CCAMLR WG-ASAM 2024, to be held in Cambridge May 20-24, 2024.

Output 3. 3D predator-consumer interactions. Publication of 3D models of whale-krill interactions.

Activities (3.1 and 3.2) towards this output will only take place in project years 2 and 3.

Output 4. Integrated krill-consumer-fisheries interactions. Temporally explicit maps of potential interactions among krill, whales and fisheries.

Activities 4.1-4.1 will take place in project years 2 and 3, once krill, whale and fishery data are together available for analysis, although initial compilation of fishery data (Activity 4.1) and compilation of historical whale tracking data (part of Activity 4.2) have commenced. These activities will be a main task of the project's second PDRA, who will be starting 1 September 2024.

Output 5. Forecasting. Test our ability to make seasonal forecasts of krill-consumer-fisheries interactions using correlative spatial models in conjunction with oceanographic model forecasts.

Activities 5.1 and 5.2 are contingent on data from activities under outputs 1-4, and will start in year 2 of the project.

3.2 Progress towards project Outputs

Overall, project activities in year 1 have focussed on data collection (including preparation for fieldwork and testing and preparation of the ImpYak system) (see appended Cruise Report for evidence). Mostly successful data collection contributes towards each output, but the analytical activities required for all outputs mainly commence in year 2, closely tied to the appointment of a second postdoctoral researcher, starting 1 September 2024. Progress towards the outputs is still happening as planned/proposed, without major deviations from the Implementation timetable.

Output 1. Whales. Spatiotemporally explicit predictions of whale foraging presence.

Some existing data are in place, but the second field season is now critical given we could not tag in the first. Nonetheless, preliminary analyses have been conducted to make some preliminary spatiotemporal predictions of whale foraging (Hutchinson dissertation, Burleigh dissertation).

Output 2. Krill. Spatiotemporally explicit nearshore krill abundance information.

The first season of data towards this output has now been collected, which will allow us to progress towards this output in the coming year.

Output 3. 3D predator-consumer interactions. Publication of 3D models of whale-krill interactions.

This output relies on data and analyses that will go into outputs 1 and 2. Thus, work towards this output takes place mainly in the coming two project years.

Output 4. Integrated krill-consumer-fisheries interactions. Temporally explicit maps of potential interactions among krill, whales and fisheries.

We have obtained earlier krill fishery data and will in the coming year update this collation. Through Hutchinson's dissertation we have started preliminary analyses of overlap between whales and fisheries (e.g., maps of overlap)—we now need to add the krill distribution data.

Output 5. Forecasting. Test our ability to make seasonal forecasts of krill-consumer-fisheries interactions using correlative spatial models in conjunction with oceanographic model forecasts.

Work towards this output will take place mainly in years 2 and 3, led by the second postdoctoral researcher, who will be starting on 1 September 2024.

3.3 Progress towards the project Outcome

Our stated outcome is to provide to CCAMLR Working Papers, data and information to help ensure krill fishery management occurs at ecologically relevant spatial and temporal scales. For Indicator 0.3 (By March 2026, the project has demonstrated, through two field seasons and peer-reviewed publication of results, a new method for low-cost, near-shore acoustic surveys in areas where research vessels currently do not operate), we have conducted in-situ testing of the low-cost nearshore survey system, which revealed technical issues to be solved for the second field season in 2025, before we can achieve this indicator. Regarding indicators 0.1 and 0.2, we have started collected the data to be used in the analyses and reports that are the major driver for CCAMLR to (Indicator 0.1) review the small-scale management units used to set krill catch limits in the BAT and (Indicator 0.2) consider sensitive time periods for krill-dependent predators, especially baleen whales, within each fishing season, and manage catches temporally within such seasons rather than only annually, as is the baseline at present. We are confident that the indicators are adequate to measure the intended outcome. We are progressing as expected towards the outcome.

3.4 Monitoring of assumptions

Assumption 0.1: CCAMLR reviews the information provided by this project and considers it as part of a future revision and designation of small-scale management units and adoption of krill fishery catch limits.

This assumption still holds. Working papers submitted to CCAMLR must be considered and discussed. The issue of spatiotemporal scale and overlap with predators in relation to krill fishery management is high on its agenda.

Assumption 1.1: Tags are able to be deployed on fin whales.

This assumption should still hold, although we were not able to deploy tags on fin whales this year due to an unexpected, last-minute problem with two team members. For next field season,

we will prepare two independent tagging teams to avoid the same situation. Weather conditions remain a risk, though, since we require good weather for tagging.

Assumption 2.1: Krill is able to be surveyed using yacht-mounted echosounders or the ImpYak system.

This assumption holds. We were able to survey krill using a yacht-mounted echosounder. We had some technical problems with the ImpYak during in-situ trials this field season, but we are working to resolve the issues for the second field season. Then, we can use both methods for krill surveys in the next field season.

Assumption 3.1: CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey mapping can be undertaken.

CATS tagging is only planned for next field season, but based on our observations during this field season, this assumption still holds.

Assumption 4.1: CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey mapping can be undertaken using yacht-mounted echosounders or the ImpYak system.

As for Assumption 3.1. We observed aggregations of fin whales during our first field season.

Assumption 4.2: Fishery data is made available.

This assumption should hold. We have previously successfully requested fishery data.

Assumption 5.1: CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey mapping can be undertaken.

As for Assumptions 3.1 and 4.1

Assumption 5.2: Interactions can be forecast based on their correlations with oceanographic covariates for which forecasts exist.

This assumption should still hold. Work in other marine fisheries indicates that this should work.

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

Among the British Antarctic Territory's stated objectives is to "protect the Territory's environment, on the basis of thorough science and research (British Antarctic Territory Strategy 2019-2029). In support of this objective, the BAT states it will "2.4 support efforts to protect and study the marine environment around BAT. 2.5 encourage activity, funded by the UK Government or through philanthropic means, which increases understanding of BAT's environment and assists in its protection." The BAT falls within the jurisdiction of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), "and UK scientists have worked closely through CCAMLR to ensure that the BAT marine environment is managed under CCAMLR measures to the highest international standards, with effectively regulated marine activities underpinned by robust science" (https://www.britishantarcticterritory.org.uk/research/environmental-protection/). Our outcome to provide information to CCAMLR to improve krill fishery management thereby supports BAT strategy. As detailed in other sections of the report, the first project year focusses on data collection through fieldwork (and preparation therefor) in support of the outcome, while analysis and communication will take place in years 2 and 3.

5. Gender Equality and Social Inclusion (GESI)

Please quantify the proportion of women on the Project Board[1].	20%
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].	33%

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	

The University of Southampton, British Antarctic Survey and Scottish Association of Marine Science are committed to equality, diversity and inclusion with all three institutes awarded either bronze or silver Athena Swan awards.

The project team includes senior and junior female scientists (Fielding and Dornan). University of Southampton policies ensured that equal opportunities were promoted during recruitment for the PDRA position in project year 2. A female scientist has been appointed. In the 2024 fieldwork campaign, half (3/6) of the science team were women. We promote gender equality in our project culture and operation through: promoting a positive working environment (especially fieldwork), enabling personal and professional development; and, in future, inspiring females to pursue STEM subjects through public engagement.

6. Monitoring and evaluation

Monitoring and evaluation is conducted by reading CCAMLR meeting reports and by project members attending CCAMLR meetings and CCAMLR working group meetings. Monitoring and evaluation work is shared by UoS and BAS. The activities and processes of CCAMLR are well recorded/documented, making close monitoring and evaluation of progress towards the outcome feasible. Our project contributions to CCAMLR meetings are similarly recorded in meetings, allowing us to demonstrate links between the project activities, and outcomes.

[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.

7. Lessons learnt

The project partner-composition broadly worked well, however that UCSC could not agree to the funding terms, due to IP ownership issues, was unexpected. To other projects we would recommend that example grant funding agreements are inspected by all partners before submitting proposals. Budget management has been challenging because fieldwork, in the austral autumn, takes place near the end of the financial year. This is unavoidable in this case as it is the most appropriate time of year for us to collect data. Our project uses a small flexible platform (the 28 m long Hans Hansson), which allows us to direct where and when to collect data, and to be more responsive to ecological and weather conditions, but does come with high logistical overheads related to contract negotiations, transport, T&S for field personnel, etc. We still think this is preferable to working with a platform (e.g., Sir David Attenborough) run by a national operator (e.g., British Antarctic Survey), mainly because it is difficult to secure science time on these national vessels, but we recommend that projects operating in the same geographic area carry out a careful cost-benefit analysis. We would also recommend a higher budget for conducting fieldwork—our current budget tightly constrains how long we can conduct fieldwork. A positive element of our project is that it aims to feed into a well-established organisation and process for sustainable environmental management—CCAMLR. This does require a detailed understanding of CCAMLR's workings, however, and in that regard our inclusion of team members with long experience with CCAMLR (Trathan, Fielding) is critical. To mitigate the risk of not being able to tag whales next field season if tagging team members are not able to travel, we will try to distribute tagging equipment between two teams (UoS and UCSC).

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

Not applicable.

9. Risk Management

It was not anticipated that UCSC would not be able to accept the flow-through terms of the funding agreement, and therefore could not be an official 'partner'. We submitted an approved change request to engage UCSC as a 'non-partner collaborator'. An unanticipated risk of not being able to secure a fieldwork platform was introduced when the search for an appropriate, available platform was drawn out (and even further drawn out due to a lengthy and complex procurement and contracting process at UoS. Both are in place for the upcoming field season, and we are already securing the same platform for next field season.

10. Sustainability and legacy

Minimal effort has been made to promote the work in the first year (although, see two press releases and one newspaper story); promotion is planned for years 2 and 3 when data are being analysed and we have preliminary results to share. Nonetheless, Reisinger presented the project at a Southern Ocean baleen whales-krill interaction workshop in Oxford in October 2023, organised by team member Trathan and funded by the Great Blue Ocean coalition (comprising The Pew Trusts, the Blue Marine Foundation, the Zoological Society of London, Greenpeace UK, the Marine Conservation Society and the Royal Society for the Protection of Birds). Reisinger is a member of the ARK Expert Panel that provides advice to the Association of Responsible Krill harvesting companies, and uses this forum to disseminate information from this project. The post-project benefits are still valid.

11. Darwin Plus identity

The project has been promoted through two press releases (one by UoS, one by BAS) and these both state that the project is funded by the UK Government through Darwin Plus. The press releases were promoted by BAS and UoS social media. The project was covered by The

Daily Echo (Southampton). Tweets by the 'Ocean Predator Lab (OPEL)' at the University of Southampton, tag the Biodiversity Challenge Funds X account. The project's page on the BAS website states that the project is funded by the UK Government through Darwin Plus.

12. Safeguarding

Has your Safeguarding Policy been updated in the past 12 months?		No
Have any concerns been reported 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?	NA	
What proportion (and number) of project staff have received formal training on Safeguarding?		Past: 0% [0] Planned: 0% [0]
Has there been any lessons learnt or challenges on Safeguarding in the past 12 months? Please ensure no sensitive data is included within responses. Not applicable.		
Does the project have any developments or activities planned around Safeguarding in the coming 12 months? If so please specify. No.		
Please describe any community sensitisation that has taken place over the past 12 months; include topics covered and number of participants. Not applicable.		
Have there been any concerns around Health, Safety and Security of your project over the past year? If yes, please outline how this was resolved. None.		

13. Project expenditure

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

Project spend (indicative) in this financial year	2023/24 D+ Grant (£)	2024/25 Total actual D+ Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs	[redacted]			DRAFT
Consultancy costs				NA
Overhead Costs				DRAFT
Travel and subsistence				DRAFT
Operating Costs				DRAFT
Capital items				DRAFT
Others (Please specify)				DRAFT
TOTAL	**211,653.0**	**211,653.0**	**0**	**DRAFT**

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

	Secured to date	Expected by end of project	Sources
Matched funding leveraged by the partners to deliver the project (£)	University of California Santa Cruz i) Vessel berths x 16 and small boat time for fieldwork through their agreement with Antarctic tour operators: [redacted] in-kind value. ii) Use of CATS (Customised Animal Tracking Solutions) tags for fine-scale three-dimensional tracking of whales in foraging aggregations: total equipment value [redacted], indicative value of use not estimated. iii) Friedlaender staff cost @5% FTE: [redacted] in-kind value. Use of equipment is already agreed from	--	University of California Santa Cruz, British Antarctic Survey

	the British Antarctic Survey, including: i) Use of Simrad EK80 echosounder system (yacht) for prey mapping: total equipment value [redacted], indicative value of use not estimated. ii) Use of Simrad autonomous echosounder fitted to ImpYak: total equipment value [redacted], indicative value of use not estimated. TOTAL value of support [redacted].		
Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project (£)	--	--	--

14. Other comments on progress not covered elsewhere

Note changes and risks around UC Santa Cruz not being able to accept grant terms.

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

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

Antarctic krill are one of the most abundant animals on earth and are a major food source for many predators, including fish, penguins, seals and baleen whales. Antarctic krill also send carbon to the deep ocean through the sinking of their faeces and by moulting their exoskeletons. The small crustaceans are the focus of a commercial fishery and are being caught at an increasing rate to be processed into feed for fish farms (e.g. salmon) and oils for nutritional supplements.

At the same time, populations of baleen whales, a major consumer of krill, are in recovery. Fin whales - the second largest baleen whale after the blue whale, had been hunted to near extinction. Now they are growing in number, returning to historic feeding grounds, and finding themselves in competition with fishing vessels.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is the international body which sets limits on how much Antarctic krill can be caught, where and when. These catch limits are measured in thousands of tonnes across vast swathes of ocean, but krill are particularly concentrated in smaller shelf areas close to land which are frequented by both predators and fishing vessels.

To address this mismatch in scales, CCAMLR plans to implement finer scale management procedures. To inform this, the researchers from the University of Southampton, the British Antarctic Survey, the University of California Santa Cruz, and the Scottish Association for Marine Science are collecting data to better understand the distribution of foraging fin whales, Antarctic krill and fishing vessels.

Funded by the UK Government through Darwin Plus, the team conducted an expedition to the Antarctic Peninsula in March 2024 to survey Antarctic krill and the baleen whales that feed upon them. The expedition will provide data to assess whether the current fishery management framework is sufficient to safeguard krill stocks, which underpin the unique Southern Ocean ecosystem.

“The risk is that fishing becomes concentrated in krill-rich predator feeding spots and then depletes them, leaving nothing behind for the marine animals that rely on them to survive,” says Dr Ryan Reisinger from the University of Southampton, who led the expedition.

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File Type (Image / Video / Graphic)	File Name or File Location	Caption including description, country and credit	Social media accounts and websites to be tagged (leave blank if none)	Consent of subjects received (delete as necessary)
Image	RRR4749	Southampton PhD student	https://twitter.com/OPELresearch https://twitter.com/bas_news	Yes

		Amy Feakes prepares a hydrophone – an underwater sound recorder – that she will leave at Elephant Island for a week to record fin whale calls. Photo: Ryan Reisinger	https://twitter.com/SAMSoceannews	
Image	RRR4944	A fin whale surfaces in front of an iceberg in King George Bay, South Shetland Islands, Antarctica. Photo: Ryan Reisinger	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	NA
Image	RRR5582	The research team approaches the research vessel-Hans Hansson-after a day out on the small boat, following fin whales. Photo: Ryan Reisinger.	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	NA
Image	RRR5852	The research vessel Hans Hansson trialling the ship-mounted echosounder in King George Bay, King George Island. Photo: Ryan Reisinger.	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	
Image	RRR7736	Southampton PhD students Josh Wilson (left) and Amy Feakes (right) conduct	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	Yes

		marine mammal observations aboard the Hans Hansson along the Western Antarctic Peninsula. Photo: Ryan Reisinger.		
Image	RRR7932	Antarctic krill caught during net tows to understand the sizes of individual krill that make up the krill swarms observed using an echosounder aboard the boat. Photo: Ryan Reisinger.	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	NA
Image	RRR8175	A pair of fin whales surfaces at Elephant Island, Antarctica. Photo: Ryan Reisinger.	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	NA
Image	RRR8263	A fin whale surfaces near Elephant Island, Antarctica. Photo: Ryan Reisinger.	https://twitter.com/OPELresearch https://twitter.com/bas_news https://twitter.com/SAMSoceannews	NA

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

Project summary	Progress and Achievements April 2023 - March 2024	Actions required/planned for next period
Impact The krill fishery is managed sustainably by CCAMLR in the BAT to safeguard Antarctic krill-based ecosystems, especially including baleen whales, and especially in autumn when relevant ecological data are sparse.	None yet. Progress towards the impact relies on outcomes indicated below. Overall, project activities in year 1 have focussed on data collection (including preparation for fieldwork and testing and preparation of the ImpYak system) (see appended Cruise Report for evidence). Mostly successful data collection contributes towards each output, but the analytical activities required for all outputs mainly commence in year 2, closely tied to the appointment of a second postdoctoral researcher, starting 1 September 2024.	
Outcome Provision to CCAMLR of Working Papers, data and information to help ensure krill fishery management occurs at ecologically relevant spatial and temporal scales.		
Outcome indicator 0.1 By end 2027, CCAMLR has reviewed the small-scale management units used to set krill catch limits in the BAT.	We have not yet produced working papers for CCAMLR, which will be submitted to CCAMLR, or peer-reviewed journal papers. These outputs are expected to generate Outcomes 1 and 2. Project year 1 has focussed on data collection and collation, and preparation therefor, including development and testing of the ImpYak system.	Data analysis of whale tracking, krill abundance and fishery data. Preparation of CCAMLR working papers and peer-reviewed journal papers.
Outcome indicator 0.2 By end of 2027, CCAMLR has taken into account sensitive time periods for krill-dependent predators, especially baleen whales, within each fishing season, and catches are managed temporally within such seasons rather than only annually, as at present.	We have not yet produced working papers for CCAMLR, which will be submitted to CCAMLR, or peer-reviewed journal papers. These outputs are expected to generate Outcomes 1 and 2. Project year 1 has focussed on data collection and collation, and preparation therefor, including development and testing of the ImpYak system.	Data analysis of whale tracking, krill abundance and fishery data. Preparation of CCAMLR working papers and peer-reviewed journal papers.
Outcome indicator 0.3 By March 2026, the project has demonstrated, through two field seasons and peer-reviewed publication of results, a	Development and field testing (in Scotland) of the ImpYak system took place during project year 1, culminating in the ImpYak system being tested in-situ in the Western Antarctic Peninsula, where several critical issues (see cruise report and section 3.1).	Resolve technical issues with ImpYak system for second field season.

new method for low-cost, near-shore acoustic surveys in areas where research vessels currently do not operate.		
Output 1 **Whales.** Spatiotemporally explicit predictions of whale foraging presence.		
Output indicator 1.1 1.1 Data layers of spatiotemporally explicit predictions of humpback, minke and fin whale foraging presence within the BAT (CCAMLR Subarea 48.1) are produced for each month in the CCAMLR fishing season, and presented as information papers to CCAMLR and the IWC (International Whaling Commission) by end of 2025.	Some existing data are in place, but the second field season is now critical given we could not tag in the first. Nonetheless, preliminary analyses have been conducted to make some preliminary spatiotemporal predictions of whale foraging (Hutchinson dissertation, Burleigh dissertation).	Deployment of whale tags in second field season. Analysis of tagging data. Produce monthly predictions of humpback, minke and fin whale presence. Prepare information papers for CCAMLR and IWC.
Output 2 **Krill.** Spatiotemporally explicit nearshore krill abundance information.		
Output indicator 2.1. Novel acoustic survey data, to calculate krill abundance, are collected nearshore in the Western Antarctic Peninsula during two fieldwork periods in the project: January-April 2023 and January-April 2024.	While we could not collect acoustic data with the ImpYak system this field season, we did conduct acoustic surveys using a ship-mounted echosounder, following standard CCAMLR protocols, to collect novel acoustic data during March 2024.	Analyse acoustic data. Resolve technical issues with ImpYak system for second field season. Collect acoustic data with both ImpYak and ship-mounted echosounder during the second (2025) field season.
Output indicator 2.2.	While we could not collect acoustic data with the ImpYak system this field season, we did conduct acoustic surveys using a ship-mounted echosounder, following standard CCAMLR protocols. Analysis of	Analysis of acoustic data to estimate krill abundance.

Novel spatially-explicit krill abundance estimates are produced for nearshore regions in the Western Antarctic Peninsula, by the end of 2024.	these data, to estimate krill abundance, will be conducted this project year.	
Output 3. **3D predator-consumer interactions.** Publication of 3D models of whale-krill interactions.		
Output indicator 3.1 By March 2026, information on 3D spatiotemporal characteristics of the interactions between krill and baleen whale predators on their foraging grounds in the BAT will be published as a peer-reviewed paper and reported to CCAMLR.	This output relies on data and analyses that will go into outputs 1 and 2. Thus, work towards this output takes place mainly in the coming two project years.	Analyse whale tracking data and krill abundance data to characterise spatiotemporal interactions between krill and predators on foraging grounds in the BAT. Write up the results from these analyses and submit 1) for peer-reviewed publication and 2) as a Working Paper for CCAMLR.
Output 4 **Integrated krill-consumer-fisheries interactions.** Temporally explicit maps of potential interactions among krill, whales and fisheries.		
Output indicator 4.1 A key unknown for predator-krill-fishery interactions, is whether fishing vessels compete with predators and reduce the available food resource within an area. By March 2026, we will have measured this for the first time, helping confirm the impacts of krill fishing are not simply spatial overlap, but also functional overlap, demonstrated through analyses published as peer-reviewed papers and reports.	We have obtained earlier krill fishery data and will in the coming year update this collation. Through Hutchinson's dissertation we have started preliminary analyses of overlap between whales and fisheries (e.g., maps of overlap)—we now need to add the krill distribution data.	Continue collating krill fishery data. Analysis of functional overlap between whales, krill and the fishery.

Output indicator 4.2 By March 2026, produce data layers for spatiotemporally explicit maps of potential interactions among krill, whales and fisheries within the BAT.	Through Hutchinson's dissertation we have started preliminary analyses of overlap between whales and fisheries (e.g., maps of overlap).	Update preliminary work and produce predictions for all three whale species being considered – humpback, minke and fin whales.
Output indicator 4.3 By March 2026, present data layers on spatiotemporal interactions as information papers to CCAMLR.	This output relies on data and analyses from other outputs and activity related to it takes place in years 2 and 3.	Prepare results as a working paper to be submitted to CCAMLR.
Output 5 **Forecasting.** Test our ability to make seasonal forecasts of krill-consumer-fisheries interactions using correlative spatial models in conjunction with oceanographic model forecasts.		
Output indicator 5.1 By March 2026, development of habitat models for humpback, fin and minke whales, the output of which will allow us to determine, at monthly timescales during the krill fishing season, where interactions with fishing vessels will be most predictable and most intense. Such identified areas should be subject to detailed scrutiny, potentially for designation by CCAMLR as areas requiring enhanced management (e.g. temporal closures within the fishing season or reduced fishery impacts) compared with current management practices.	Work towards this output will take place mainly in years 2 and 3, led by the second postdoctoral researcher, starting 1 September 2024. Humpback and minke whale habitat models have undergone preliminary development (e.g., Burleigh dissertation).	Postdoctoral researchers starts 1 September 2024. Analysis of humpback, minke and fin whale data and development of habitat models.
Output indictor 5.2 By March 2026, create a Shiny prediction application that produces seasonal forecasts at a monthly resolution of potential interactions for CCAMLR Statistical Subarea 48.1 in the BAT.	Work towards this output will take place mainly in years 2 and 3, led by the second postdoctoral researcher, starting 1 September 2024.	Start analysing data and building the analysis pipeline for the Shiny prediction app.

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: The krill fishery is managed sustainably by CCAMLR in the BAT to safeguard Antarctic krill-based ecosystems, especially including baleen whales, and especially in autumn when relevant ecological data are sparse.			
Outcome: Provision to CCAMLR of Working Papers, data and information to help ensure krill fishery management occurs at ecologically relevant spatial and temporal scales.	0.1 By end 2027, CCAMLR has reviewed the small-scale management units used to set krill catch limits in the BAT. 0.2 By end of 2027, CCAMLR has taken into account sensitive time periods for krill-dependent predators, especially baleen whales, within each fishing season, and catches are managed temporally within such seasons rather than only annually, as at present. 0.3 By March 2026, the project has demonstrated, through two field seasons and peer-reviewed publication of results, a new method for low-cost, near-shore acoustic surveys in areas where research vessels currently do not operate.	0.1 CCAMLR has reviewed the limits set for small-scale units, evidenced through CCAMLR meeting reports. 0.2 CCAMLR has reviewed the catch limits set for different time periods within each fishing season, evidenced through CCAMLR meeting reports. 0.3 Our CCAMLR working papers are recorded as submissions in meeting reports, with discussions also included in the reports. Our peer-reviewed journal papers will also demonstrate our autonomous vehicle acoustic surveying capability, and will be openly available for download from journal websites. 0.4 Verification will be available in the reports of the CCAMLR Scientific Committee and its Working Groups, (especially WG-Ecosystem Monitoring and Management, WG-Acoustic Survey Analysis Methods).	CCAMLR reviews the information provided by this project and considers it as part of a future revision and designation of small scale management units and adoption of krill fishery catch limits.

Project summary	SMART Indicators	Means of verification	Important Assumptions
Output 1. Whales. Spatiotemporally explicit predictions of whale foraging presence.	1.1 Data layers of spatiotemporally explicit predictions of humpback, minke and fin whale foraging presence within the BAT (CCAMLR Subarea 48.1) are produced for each month in the CCAMLR fishing season, and presented as information papers to CCAMLR and the IWC (International Whaling Commission) by end of 2025.	1.1 Data layers are published to a publicly-accessible data repository. 1.2 Working Papers are recorded in the reports of the CCAMLR Scientific Committee and its Working Groups and in the report of the International Whaling Commission Scientific Committee.	Tags are able to be deployed on fin whales.
2. Krill. Spatiotemporally explicit nearshore krill abundance information.	2.1 Novel acoustic survey data, to calculate krill abundance, are collected nearshore in the Western Antarctic Peninsula during two fieldwork periods in the project: January-April 2023 and January-April 2024. 2.2 Novel spatially-explicit krill abundance estimates are produced for nearshore regions in the Western Antarctic Peninsula, by the end of 2024.	2.1 Our spatially-explicit krill abundance estimates have been produced and have been communicated via Working Papers to the CCAMLR Acoustic Survey and Assessment Methods Working Group, and noted in reports from Working Group meetings.	Krill is able to be surveyed using yacht-mounted echosounders or the ImpYak system.
3. 3D predator-consumer interactions. Publication of 3D models of whale-krill interactions.	3.1 By March 2026, information on 3D spatiotemporal characteristics of the interactions between krill and baleen whale predators on their foraging grounds in the BAT will be published as a peer-reviewed paper and reported to CCAMLR.	3.1 Publication of data layers and peer-reviewed manuscript, which can be obtained from the journal website. 3.2 Working Paper submitted to CCAMLR, noted in meeting reports. 3.3 Copies of these papers provided as means of verification.	CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey mapping can be undertaken.
4. Integrated krill-consumer-fisheries interactions.	4.1 A key unknown for predator-krill-fishery interactions, is whether fishing vessels compete with	4.1 Publication of data layers and peer-reviewed manuscript, which	4.1 CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey

Project summary	SMART Indicators	Means of verification	Important Assumptions
Temporally explicit maps of potential interactions among krill, whales and fisheries.	predators and reduce the available food resource within an area. By March 2026, we will have measured this for the first time, helping confirm the impacts of krill fishing are not simply spatial overlap, but also functional overlap, demonstrated through analyses published as peer-reviewed papers and reports. 4.2 By March 2026, produce data layers for spatiotemporally explicit maps of potential interactions among krill, whales and fisheries within the BAT. 4.3 By March 2026, present data layers on spatiotemporal interactions as information papers to CCAMLR.	can be obtained from the journal website. 4.2 Working Paper submitted to CCAMLR, noted in meeting reports. 4.3 Copies of these papers provided as means of verification.	mapping can be undertaken using yacht-mounted echosounders or the ImpYak system. 4.2 Fishery data is made available.
5. Forecasting. Test our ability to make seasonal forecasts of krill-consumer-fisheries interactions using correlative spatial models in conjunction with oceanographic model forecasts.	5.1 By March 2026, development of habitat models for humpback, fin and minke whales, the output of which will allow us to determine, at monthly timescales during the krill fishing season, where interactions with fishing vessels will be most predictable and most intense. Such identified areas should be subject to detailed scrutiny, potentially for designation by CCAMLR as areas requiring enhanced management (e.g. temporal closures within the fishing season or reduced fishery impacts) compared with current management practices.	5.1 Shiny prediction application produced and accessible online. 5.2 Publication of peer-reviewed manuscript, which can be obtained from the journal website. 5.3 Working Paper submitted to CCAMLR, noted in meeting reports. 5.4 Copies of these papers provided as means of verification.	5.1 CATS tags are able to be deployed in foraging aggregations of whales, and simultaneous prey mapping can be undertaken. 5.2 Interactions can be forecast based on their correlations with oceanographic covariates for which forecasts exist.

Project summary	SMART Indicators	Means of verification	Important Assumptions
	5.2 By March 2026, create a Shiny prediction application that produces seasonal forecasts at a monthly resolution of potential interactions for CCAMLR Statistical Subarea 48.1 in the BAT.		

Activities

1.1 Deployment of tracking tags on whales in the Western Antarctic Peninsula region.
1.2 Analyse whale tracking data and develop models which produce spatiotemporally explicit predictions of whale foraging presence within the BAT.
1.3 Prepare data layers of these predictions for presentation to CCAMLR as Working Papers.

2.1 Final trials of ImpYak survey system and training field personnel on system.
2.2 Conduct acoustic surveys of krill abundance nearshore at the Western Antarctic Peninsula during two fieldwork periods in the project.
2.3 Produce spatially-explicit krill abundance estimates from these survey data and submit estimates to the CCAMLR Acoustic Survey and Assessment Methods Working Group.

3.1 Analyse whale tracking data and krill abundance data to characterise spatiotemporal interactions between krill and predators on foraging grounds in the BAT.
3.2 Write up the results from these analyses and submit 1) for peer-reviewed publication and 2) as a Working Paper for CCAMLR.

4.1 Collate krill fishery data, obtained from CCAMLR, for the Western Antarctic Peninsula region.
4.2 Analyse whale tracking data, krill abundance data, and krill fishery data together to characterise function overlap among krill, their predators and the fishery.
4.3 Produce data layers for spatiotemporally explicit maps of potential interactions among krill, whales and fisheries.
4.4 Write up the results from these analyses and submit 1) for peer-reviewed publication and 2) as a Working Paper for CCAMLR.

5.1 Develop habitat models for different baleen whale species to determine where interactions with fishing vessels will be most predictable and most intense.
5.2 Create a Shiny prediction application that produces seasonal forecasts of interactions for CCAMLR Statistical Subarea 48.1 in the BAT.

Annex 3: Standard Indicators

Table 1 Project Standard Indicators

DPLUS Indicator number	Name of indicator	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
DPLUS-A03 (Core)	Number of local/national organisations with improved capability and capacity as a result of project.	Number of organisations	--	0				1
DPLUS-A07	Number of government institutions/departments with enhanced awareness and understanding of biodiversity and associated local community issues	Government institution	--	0				1
DPLUS-B02 (Core)	Number of new/improved species management plans available and endorsed.	Number	--	0				1
D-PLUS-B11	Area identified as important for biodiversity.	Area (km2)	--	0				65,800
DPLUS-D01 (Core)	Hectares of habitat under sustainable management practices.	Area (km2)	--	0				658,000
DPLUS-C03 (Core)	New assessments of habitat conservation action needs published.	Number	--	0				1
DPLUS-C05 (Core)	Number of projects contributing data, insights, and case studies to national Multilateral Environmental Agreements (MEAs) related reporting processes and calls for evidence.	Number	--	0				1
DPLUS-C06	Number of downloads of new peer reviewed publications.	Number	Downloads per year	0				200
DPLUS-C07	Number of projects contributing evidence to biodiversity conservation or associated community benefits to policy/regulation/standards consultations.	Number	International	0				1
DPLUS-C15	Number of media related activities	Number	Web	3				10
DPLUS-C17	Number of unique papers submitted to peer reviewed journals16.	Number	--	0				5
DPLUS-C18	Number of papers published in peer reviewed journals	Number	--	0				5
DPLUS-C19	Number of other publications produced	Number	Dissertations	2				4

DPLUS Indicator number	Name of indicator	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
DPLUS-C19	Number of other publications produced	Number	Working papers	0				4
DPLUS-D01 (Core)	Hectares of habitat under sustainable management practices.	Area (km2)	--	0				658,000

Table 2 Publications

Title	Type (e.g. journals, best practice manual, blog post, online videos, podcasts, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Krill for whales – Fine scale acoustic krill surveys in Area 48.1	Paper submitted to the CCAMLR Working Group on Acoustic Survey and Analysis Methods (WG-ASAM)	Tracey Dornan, Natalie Nickells, Ryan Reisinger, Sophie Fielding, 2024	Female	UK	British Antarctic Survey, Cambridge	Not available online, contact tarna70@bas.ac.uk
Safeguarding Antarctic krill stocks for baleen whales 2024 cruise report	Cruise report	Tracey Dornan, Amy Feakes, Kay Ilhe, Natalie Nickells, Joshua Wilson, Ryan Reisinger, 2024	Female	UK	University of Southampton, Southampton	Not available online, contact r.r.reisinger@southampton.ac.uk
Using first passage time and time-spent modelling to compare krill search behaviour of baleen whales and krill fishing vessels in the West Antarctic Peninsula.	BSc dissertation	Amber Hutchinson, 2023	Female	UK	University of Southampton, Southampton	Not available online, contact r.r.reisinger@southampton.ac.uk
Predicting the spatiotemporal distribution of humpback whale (Megaptera novaeangliae) foraging areas around the Western Antarctic	MSci dissertation	Freya Burleigh, 2024	Female	UK	University of Southampton, Southampton	Not available online, contact r.r.reisinger@southampton.ac.uk

Title	Type (e.g. journals, best practice manual, blog post, online videos, podcasts, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Peninsula from 2003 to 2019						

Annex 4: Cruise report

Appended: Cruise report “Safeguarding Antarctic krill stocks for baleen whales 2024 cruise report” by Dornan et al. NOT FOR PUBLICE RELEASE.

Annex 5: Summary of dissertations

Abstract of "Using first passage time and time-spent modelling to compare krill search behaviour of baleen whales and krill fishing vessels in the West Antarctic Peninsula” by Amber Hutchinson. BSc dissertation, 2023, University of Southampton.

The Antarctic krill species Euphausia superba, constitutes one of the few fisheries with room to sustainably expand, and expanding it is. However current management regulations, executed by the Commission for the Conservation of Antarctic Marine Living Resources, are in need of revision to effectively uphold its promise to maintain an ecosystem-based approach. This requires the consideration of dependent krill consumers; the largest of which, the baleen whales, are currently over-looked from a conservation perspective. Currently, Small-Scale Management Units have been assigned to sub-divide area 48.1 with the ambition to set specific catch limits according to the ecosystem conservation requirements of each unit. This study aims to supplement recent literature with evidence for spatiotemporal overlap between fishing vessels and the baleen whales Megaptera novaeangliae (humpback whale) and Balaenoptera acuturostrata (minke whale) in area 48.1 of the Western Antarctic Peninsula between 2012 and 2018. Through the use of First-passage time to deduce prey search scales, and time-spent modelling to narrow down track locations of area-restricted search behaviour, the distribution of the three study groups is compared by SSMU and by month of the fishing/feeding season. Whilst no overlap was detected between minke whales and fishing vessels, several significant zones of overlap were found between humpbacks and the vessels spanning 4 out of the 7 SSMU’s and 6 out of the 7 months. The p-values generated from a two-way ANOVA test dictated that months had no significant effect on the degree of overlap, whereas spatial scales (specifically which SSMU) had a statistically significant effect on overlap. From the results of this study, we would advise that the APBSW and APW SSMU’s should be prioritised when implementing regulations that sustain krill populations in the interest of baleen whales.

Abstract of “Predicting the spatiotemporal distribution of humpback whale (*Megaptera novaeangliae)* foraging areas around the Western Antarctic Peninsula from 2003 to 2019” by Freya Burleigh. MSci dissertation, 2024, University of Southampton.

Top marine predators, such as the humpback whale (*Megaptera novaeangliae*), are essential to ecosystem functioning through top-down control on prey populations, nutrient cycling, and carbon sequestration. However, climate change and other anthropogenic activities are altering the distribution of humpback whales in our oceans. For effective management strategies to be implemented, more information on the spatiotemporal distribution on humpback whales and their responses to changes in environmental conditions is essential, particularly in key feeding areas such as the Western Antarctic Peninsula (WAP). This study predicted the spatiotemporal distribution of humpback whale foraging areas from 2003-2019 in the WAP region and analysed the extent to which 15 environmental covariates are the main predictors of habitat selection. Using existing humpback whale tracking data, random forests – a machine learning algorithm – were used to fit monthly habitat selection models. Yearly predictions on the habitat selection of humpback whales were generated for the months January-March. Overall, model performance was high, with AUC scores between 0.72 and 0.83. The main environmental factors that determined habitat selection were chlorophyll-a concentration, distance from the continental slope, and sea surface height. Habitat selection was predicted to be highest in the coastal waters off the northwest WAP, with probabilities of habitat selection greater than 0.6. There was little interannual variation in humpback whale foraging areas, however for January and March there was a decline in the spatial extent of high probability of habitat selection. Notably, monthly variation was observed, likely due to the different models being used for each month. This study has highlighted the importance of predictive modelling to decipher the

spatiotemporal distribution of top marine predators, particularly in areas where tracking data is limited.

Annex 6: Links to press releases and media coverage

University of Southampton press release: https://www.southampton.ac.uk/news/2024/03/researchers-in-antarctica-to-help-safeguard-krill.page

British Antarctic Survey press release: https://www.bas.ac.uk/media-post/antarctic-expedition-to-study-krill-stocks/

Coverage in The Daily Echo: https://www.dailyecho.co.uk/news/24208131.university-southampton-investigates-antarctic-krill-sustainability/

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?	Yes
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	Yes
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.	No
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
If you are submitting photos for publicity purposes, do these meet the outlined requirements (see section 15)?	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.	