Darwin Plus:
Overseas Territories Environment and Climate Fund
Annual Report

Important note *To be completed with reference to the Reporting Guidance Notes for Project Leaders:*

it is expected that this report will be about 10 pages in length, excluding annexes

Submission Deadline: 30th April 2019

Darwin Plus Project Information

Project reference	DPLUS072
Project title	Developing the risk assessment framework for the Antarctic krill fishery
Territory(ies)	British Antarctic Territory
Lead organisation	British Antarctic Survey
Partner institutions	
Grant value	£132,599.00
Start/end date of project	1 September 2018 – 31 August 2020
Reporting period (e.g., Apr 2018-Mar 2019) and number (e.g., AR 1,2)	1 September 2018 – 30 April 2019
Project leader name	Philip N Trathan
Project website/blog/Twitter	
Report author(s) and date	Victoria Warwick-Evans and Philip N Trathan, May 2019

1. Project overview

The Southern Ocean provides critical breeding and foraging habitats for numerous marine predators, many of which rely on Antarctic krill (*Euphausia superba*) as their main prey source. An ongoing priority for the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is to set catch limits in a way that minimises the risk to dependent predator populations, whilst also accounting for the needs of the fishery. Currently, concentration of catches occurs at spatial scales smaller than CCAMLR Small Scale Management Units (SSMUs). It is therefore fundamental to determine how catch limits can be spatially and temporally apportioned, both within and between SSMUs, to avoid negative impacts on populations of krill-eating dependent predators. The Scientific Committee has advised the Commission that the programme of work is urgent, as previous work has shown that risks to the ecosystem associated with the fishery are increasing, particularly in Subarea 48.1. CCAMLR has endorsed the use of a risk assessment framework, which integrates spatial data relating to krill stocks, predator foraging, and fisheries, in order to compute the relative spatial and temporal risks associated with proposals to subdivide the regional catch limits. However, CCAMLR has noted potential limitations to the approach. Thus, the aim of this project is to initiate work to address some of these limitations and to advise CCAMLR on methods to subdivide krill catch limits within the Scotia Sea, especially the Antarctic Peninsula, in order to minimise the risk to krill-dependent predators, and whilst maintaining robustly managed, sustainable fisheries. This will be achieved via the implementation of the risk assessment framework, which will integrate existing spatial data relating to krill stocks, predator foraging and krill fisheries into data-layers at spatial and temporal scales relevant to ecosystem dynamics.

2. Project stakeholders/partners

The stakeholders for this work are the CCAMLR Member States that are actively engaged in developing a new management system for Antarctic krill. Other stakeholders include eNGOs that value the natural status of the Antarctic ecosystem, as well as fishing companies that harvest krill. We have been active in engaging key stakeholders throughout the project so far;

i. In September 2018, Dr Philip Trathan co-chaired a meeting with Dr George Watters from the United States, engaging key stakeholders from the science community, the Pew Charitable Trusts, WWF (both eNGOs), the Association of Responsible Krill Harvesting Companies (ARK), and fisheries scientists in order to try to harmonise approaches to fisheries management for the krill fishery. Approximately 30 people attended the meeting, including a few by Skype. Funding for the meeting came from Pew and WWF, greatly extending our stakeholder engagement and influence. The meeting led to commitments from Pew, WWF and ARK to fund a second meeting in June 2019, which Dr Trathan and Dr Watters will also chair. We will report on this meeting in our next report; at present approximately 40 people will be in attendance.

ii. We have engaged with the CCAMLR community during the Scientific Committee and Commission meetings held in October 2018. We submitted one paper to the Scientific Committee that arose from the September workshop, and one paper on krill management. We plan to submit a number of working papers to the CCAMLR Working Group on Ecosystem Monitoring and Management that will be held during June 2019. These papers all result from this project and will be discussed with stakeholders during this formal CCAMLR meeting.

iii. We have also engaged with different parts of Civil Society, as well as with the Pew Charitable Trusts, WWF and BirdLife International. Following this engagement, BirdLife have developed papers for submission to WG-EMM that have developed from our interactions. We will report on this work in our next report.

We plan to continue to liase with all stakeholders to aid the development of a new management system for krill, working with eNGOs and fishing nations alike.

3. Project Progress

3.1 Progress in carrying out project Activities

1.1 Use habitat models to investigate variability in the spatial distribution of the krill fishery in relation to bathymetry, sea ice cover, proximity to the shelf break and fine-scale water movement, over both historical (1981/82 to 2016/17) and recent timescales (2009/10 to 2016/17).

In order to complete this activity we obtained detailed information from CCAMLR about the catch and effort data from the krill fishery since the 1979/1980 fishing season. We have analysed all of these data, spanning nearly four decades, exploring preferred fishing locations and levels of inter-annual variation. The variability in the data was such that it proved difficult to create statistical models that generalise the behaviour of the fishery; for example, a major shift in behaviour happened in recent years, with the fishery now preferentially operating in areas different to those used in preceding decades. Using the empirical data has allowed us to identify changes in krill fishing "hotspots" in recent years, as the fishery has become more concentrated at smaller spatial scales in new areas within the Bransfield Strait. These areas are now preferred, potentially because they are now more open as a result of reduced sea-ice extent and concentration, given warming in the region. We have not developed habitat models *per se*, but have gained a much more thorough understanding of the desirability of areas used by the krill fishery through empirical analyses, which was the original objective of this activity.

1.2 Write up the model for submission to WG-EMM-19.

We have discussed the desirability, behaviours and patterns of the krill fishery, and how it has changed in recent years in our paper submitted to WG-EMM 2019.

Activity 2.1 To investigate proxies for the oceanographic flux and movement (import and export) of krill by utilising a fine-scale ocean model to estimate relative water movement rates at spatial scales relevant to predator consumption and fisheries usage.

In collaboration with oceanographic modeller, Dr Emma Young from the British Antarctic Survey, we have gained a more thorough understanding of the patterns of ocean circulation within this region. Models simulating the distribution of particles (representing 'krill') as they travel via complex oceanographic currents within the Bransfield Strait has enabled us to understand the movement patterns of krill as they travel through those parts of Subarea 48.1 used by the fishery. Transport pathways in the Bransfield Strait mean that patches of 'krill' move, and that having been the target at one site, may subsequently be the target of the fishery elsewhere. Some 'krill' remain close to the Peninsula, probably because the complex flows in and around the canyons retain particles.

These simulations highlight the vulnerability of 'krill' to exploitation at different times and in different locations. Using the mean flow field in the model highlights the fundamental physical properties of the ecosystem. However, additional complexity from krill behaviour will be important, but necessitates major assumptions about daily and seasonal behaviour patterns.

Activity 2.2. To write up results for submission to WG-EMM 2020.

We have submitted a working paper to WG-EMM 2019 with the results of such fine scale models that project the movement of krill along ocean current transport pathways.

Activity 3.1 To Integrate habitat preference models previously developed for Pygoscelis penguins (DPLUS009, DPLUS054) and humpback whales, with krill consumption estimates in order to generate spatially and temporally explicit resource demand estimates for key predator groups, including penguins, whales and flying seabirds, at relevant spatial and temporal scales in accordance with predator behaviour.

Using tracking data from chinstrap, gentoo and Adélie penguins we have developed habitat models describing their distribution during the breeding season. The models had high predictive power when predicting into new colonies where no tracking data exist, therefore by incorporating estimates of population sizes published on the Mapping Application for Penguin Populations and Projected Dynamics data portal (MAPPPD), we were able to predict the distribution of all three species of *Pygoscelis* penguin across the area of Subarea 48.1 used by the krill fishery. Combining these estimates of abundance and distribution, with estimates of energetic requirements during the breeding season, extracted from the literature, we have been able to calculate spatially explicit estimates of the consumption of krill by *Pygoscelis* penguins in this region of Antarctica. Such estimates have never been calculated before, yet are vital if we are to understand more about how the fisheries may impact krill-dependent predators.

We have been in collaboration with Dr Ari Friedlaender from the University of California Santa Cruz, who is a leading expert in the tracking of humpback whales in Antarctica, and who has provided tracking data for our work. Humpback wales were tracked in the Gerlache and Bransfield Straits, which are key foraging areas for this species. Tagged whales travelled throughout this region, mainly remaining close to shore, and overlapping with areas utilised by the krill fishery. We were able to create habitat models which identified the preferred habitats where these whales were feeding and travelling, and we were able to use this information to predict which locations in Subarea 48.1 provide important habitats for humpback whales. By combining these spatial estimates with population and consumption estimates from the literature we were also able to create the first spatially explicit krill consumption estimates for humpback whales.

The abundance estimates for humpback whales throughout the Antarctic Peninsula region are based on cetacean surveys conducted in 2000. However, it is widely accepted that humpback whales are now recovering after historical overexploitation and that population growth is estimated at approximately 3.4% per year, though this may be an underestimate. Thus, in order to validate our models created using tracking data, we were keen to acquire more up-to-date information about humpback whales in this region. Consequently, we have secured a collaboration with the Brazilian Antarctic Programme, who have been conducting cetacean sightings in this region over the past decade. As a result, they have provided us with 2 years of sightings data for cetaceans in Subarea 48.1. In order to analyse these data, we have also established a further collaboration with Dr Nat Kelly at the Australian Antarctic Division, who is a world-leading expert on the analysis of cetacean sightings data. Thus, we managed to secure additional co-funding from BAS in order for Dr Victoria Warwick-Evans to travel to Hobart to learn the necessary skills. Dr Warwick-Evans spent two weeks working closely with Dr Kelly, learning the intricacies of this type of analysis. As a result, we now have a detailed model of the abundance and distribution of humpback whales within Subarea 48.1 from which we have calculated further spatially explicit krill consumption estimates for humpback whales in this region. Interestingly, the result of models using the tracking data and the sightings data are reasonably consistent, providing validation for these approaches.

Activity 3.2 Write up the results for submission to WG-EMM-19.

These data layers have been written up to form two papers for submission to WG-EMM 2019.

3.2 Progress towards project Outputs

Output 1: Identify areas which are desirable to the krill fishery

We have successfully completed this outcome. Our measureable indicators included the analysis of historical catch data from which we can identify desirable areas for krill fisheries and submission of a Working Paper to WG-EMM 2019, both of which we have achieved.

Output 2: Produce a spatially and temporally scaled krill model which takes account of flux and movement of krill.

We have successfully initiated this outcome. Our measurable indicators included the analysis of oceanographic flow fields in an existing oceanographic model to determine preferred movement pathways and retention areas, and the submission of this to WG-EMM 2020. We have simulated krill movement pathways using a fine-scale oceanographic model, and have submitted this to WG-EMM 2019. We will continue this work over the coming year.

Output 3: Spatially and temporally explicit consumption estimates for key predator groups.

We have made significant progress with this outcome. Our measurable indicators included the production of maps highlighting the key areas for predator consumption, and the submission of these to WG-EMM 2019. We have successfully achieved this for the three species of penguins which breed in this region of Antarctica, and for humpback whales. We are yet to create models for some of the other krill-dependent predators in this region such as pack-ice seals and flying seabirds, but believe that we will be able to achieve this within the timeframe expected.

Output 4 and 5: Maps and tables of results describing the levels of risk to krill dependent predators under scenarios where management occurs at a variety of spatial and temporal scales. Peer-reviewed papers submitted for publication.

We are unable to complete these outputs until all of the data layers have come together, yet we believe that we will achieve these outcomes in the coming year. We have already written the code, in statistical software R, which will implement the risk assessment once we have completed all of the data layers. Additionally, we have developed code to produce high quality maps of the data layers and results. The working papers submitted to WG-EMM 2019 will provide an outline for the peer-reviewed papers, so we expect to publish these in a timely manner once the analyses are completed.

3.3 Progress towards the project Outcome

Outcome: A spatially and temporally scaled risk assessment to aid CCAMLR in managing a sustainable krill fishery by advising on the distribution of catch limits, taking into account the risks to predators and the desirability of areas for the krill fishery.

We are making significant progress towards the project outcome. This project has already significantly changed the dialogue within CCAMLR, and as such is achieving much of what it set out to do. Recent and upcoming meetings will continue to focus on determining the ways in which we can harmonize the approaches to manage krill fisheries; the risk assessment framework is a key tool for consideration.

Through discussions to date with international collaborators, we understand that the majority of CCAMLR Members continue to support the risk assessment approach. Once the risk assessment is complete we will have provided a better understanding not only of the best way to spread the catch to minimise the risk to krill dependent predators, but also the spatial and temporal scales at which the fishery should be managed. Both of which are vital to progressing the management framework. In addition, the spatially explicit krill consumption estimates clearly identify that near-shore coastal areas are important foraging hotspots for numerous krill dependent predators. By engaging with stakeholders such as ARK, Pew and WWF, we have helped to facilitate the voluntary closure of nearshore areas, important to krill predators during the breeding season. ARK announced these measures to CCAMLR at the Scientific Committee meeting in 2018.

3.4 Monitoring of assumptions

Risks and assumptions

Output: That ongoing discussions within CCAMLR continue along the lines anticipated with regard to the krill risk assessment and MPAs. We will revise our plans after each Commission meeting (held each October) in order to account for potential changes in direction.

As this project has developed, it has become clear that the majority of Member States support the risk assessment approach to management. Thus, we continue to feel confident that this is no longer a risk.

1. *That krill fisheries target particular features, and are not random in their distribution.*

It has become increasingly clear that krill fisheries target particular hotspots, identified by specific characteristics, and that their distribution is most certainly not random.

2. That it is possible to identify krill flux using an oceanographic model.

The complex oceanographic model traces the movement pathways of water at a fine scale around the Antarctic Peninsula and Bransfield Strait. Substantial literature describing the movement of krill, highlight that although krill are capable of independent locomotion, their large-scale movement is related to transport via ocean currents. Thus, we can be confident that the large scale flux of krill can be described by the transport pathways identified in the oceanographic model.

3. That we are able to obtain distribution data from flying seabirds.

The focus on the project to-date has been on the dominant krill-dependent predators in the region such as penguins and baleen whales. We have yet to focus on the less abundant species such as flying seabirds. However, we are confident that even if we are unable to gain empirical tracking data from flying seabirds in the region, we will be able to create robust models using data from the literature. For example, Birdlife International has created a list of Important Bird Areas in Antarctica which highlights the important colonies in our region of interest. Additionally, energetically based models exist which can provide information about the krill dietary requirements for these species. Thus, we believe that we will be able to estimate the krill consumption of flying seabirds in the region.

4. That the previous outputs are completed successfully.

We have made significant progress to date in developing data layers to be input into the risk assessment, including spatially explicit krill estimates for the dominant predator species. Thus we are confident that we will be able to implement the risk assessment for this region.

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

This project is making an important contribution to CCAMLR by providing advice about how to spread the catch of the fishery in order to minimise risks to krill dependent predators. Progress to date has stimulated discussions at the Scientific Committee and Commission meetings and will no doubt form a significant part of WG-EMM 2019 next month. The risk assessment and its data layers are at the top of the agenda for the upcoming WG-EMM 2019 meetings. Furthermore, the Pew/WWF/ARK Workshop to harmonise the approach to krill fisheries management, formed following discussions around the objectives of this project will further engage key stakeholders. Finally, as a result of the models that we created at the start of this project, ARK have voluntarily closed important predator foraging grounds to fishing during the period of the breeding season where the predators are most constrained, and during which the krill consumption is at a maximum. These voluntary closures provide a precautionary approach to ensure the protection of krill-dependent predators in Subarea 48.1.

4. Monitoring and evaluation

Monitoring and evaluation of our work remains key to the success of this project. International peer review of our ideas, concepts and outputs occurs as we introduced our work to CCAMLR. The format of CCAMLR meetings means that this peer-review is very thorough and in depth. This review has enabled us to have confidence in our work, including in the take-up of the ideas such as the introduction of voluntary buffer zones around important krill-dependent predators.

The major lesson learned from our project, is that early and close engagement with stakeholders is vital. Within CCAMLR, science is a key tool for ensuring influence. Policy objectives have to be delivered through robust scientific evidence.

Continued development of scientific ideas to influence stakeholders remains vital. We will continue to base our objectives on evidence from robust analyses. We recommend that others endeavour to engage with first class scientists as part of their DarwinPlus projects.

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

Not Applicable

6. Other comments on progress not covered elsewhere

We have not encountered any serious difficulties to date that we could not overcome. Some of our analyses were seriously delayed through collaborators not finding the time to send us data when requested, however we overcame this by prioritising different aspects until data became available. In the end, no time was lost.

7. Sustainability and legacy

The only application of the risk assessment framework for Subarea 48.1 is via this project. The majority of krill fishing in recent years has occurred in Subarea 48.1, and this area also supports a large biomass of krill-dependent predators. Yet CCAMLR remains unsure about how to spread the catch in this area to minimise the risk to krill-dependent predators, and at what spatial scale management should be considered. We have highlighted in the previous sections the impact that we are having, in terms of redirecting the discussions within CCAMLR, whilst moving towards harmonizing management approaches for the krill fishery. Once our risk assessment is complete, we will be able to advise CCAMLR about the most appropriate spatial and temporal scales at which management should be directed. Importantly, however, we highlight that CCAMLR Members each have different policy objectives, and sometime, even robust scientific evidence does not always lead to anticipated outcomes. That said, robust science does make successful outcomes more likely.

8. Darwin identity

We have included acknowledgement to Darwin Plus in all our manuscripts submitted to WG-EMM 2019 and will also include acknowledgements when the papers are submitted for peer-review. In addition both Dr Trathan and Dr Warwick-Evans have given a number of invited talks and seminars where the Darwin Plus logo was prominently displayed. This includes a high-profile talk given by Dr Trathan in China during October 2018.

End Note: This report is a little late as the Project Leader was visiting collaborators in California when the report was due. The visit proved highly profitable in terms of moving forward with the project.

Project Expenditure

Table 1: Project expenditure <u>during the reporting period</u> (1 April 2018 – 31 March 2019)

Project spend (indicative) in this financial year	**2018/19 D+ Grant (£)**	**2018/19 Total actual D+ Costs (£)**	**Variance %**	**Comments (please explain significant variances)**
Staff costs				
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items				
Others (Please specify)				
TOTAL				

Annex 1: Report of progress and achievements against Logical Framework for Financial Year 2018-2019 – if appropriate

Project summary	Measurable Indicators	Progress and Achievements April 2018 - March 2019	Actions required/planned for next period
Impact To ensure that the Antarctic krill fishery is managed sustainably, by helping ensure that the fishery has minimal impacts on both stock and on key krill dependent predators, yet remains economically attractive.		Our work contributed towards Voluntary Buffer Zones agreed by the krill fishery, through ARK.	
Outcome A spatially and temporally scaled risk assessment to aid CCAMLR in managing a sustainable krill fishery by advising on the distribution of catch limits, taking into account the risks to predators and the desirability of areas for the krill fishery.	Positive engagement at the CCAMLR Working Group meetings, and subsequent adoption of the results or methodolgy within CCAMLR's management of the krill fishery, or in Domain 1 Planning for Marine Protected Areas.	Our first opportunity to report on the outcomes will be after the next WG-EMM 2019 meeting in June. We will therefore report on this during our next project report. See text above.	Engagement at Pew/WWF/ARK Workshop. Engagement during CCAMLR WG-EMM 2019. Engagement at CCAMLR Scientific Committee and Commission.
Output 1. See Log Frame below (Annex 2) for all Outputs.	See Log Frame below (Annex 2).	Our first opportunity to report on the outcomes will be after the next WG-EMM 2019 meeting in June. We will therefore report on this during our next project report. See text above.	
Activity 1.1 See Log Frame below for all Activities.		Our first opportunity to report on the outcomes will be after the next WG-EMM 2019 meeting in June. We will therefore report on this during our next project report. See text above.	See Annex 2 below. We will continue with the development of data layers for inclusion in the risk assessment. We will continue to liaise with key stakeholders.

Annex 2: Project's full current logframe as presented in the application form (unless changes have been agreed) - <u>if appropriate</u>

N.B. if your application's logframe is presented in a different format in your application, please transpose into the below template. Please feel free to contact Darwin-Projects@ltsi.co.uk if you have any questions regarding this.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Impact; to ensure that the Antarctic krill fishery is managed sustainably, by helping ensure that the fishery has minimal impacts on both stock and on key krill dependent predators, yet remains economically attractive.			
Outcome: A spatially and temporally scaled risk assessment to aid CCAMLR in managing a sustainable krill fishery by advising on the distribution of catch limits, taking into account the risks to predators and the desirability of areas for the krill fishery.	Positive engagement at the CCAMLR Working Group meetings, and subsequent adoption of the results or methodolgy within CCAMLR's management of the krill fishery, or in Domain 1 Planning for Marine Protected Areas.	That CCAMLR Conservation Measure 51-07 (the current spatial distribution of krill catch within Area 48) is continued, but in a revised format, taking into account results from the risk assessment, including accounting for dependent predators at appropriate spatial and temporal scales.	That ongoing discussions within CCAMLR continue along the lines anticipated with regard to the krill risk assessment and MPAs. We will revise our plans after each Commission meeting (held each October) in order to account for potential changes in direction.
Output 1: Identify areas which are desirable to the krill fishery	1.1 Analysis of historical catch data from which we can identify desirable areas for krill fisheries by the end of 2018. 1.2 Submission of a Working Paper to the CCAMLR Working Group on Ecosystem Monitoring and Management in June 2019.	1.1 Classification of of near shore habitats, shelf edge habitats and off shore habitats to determine preferred areas and whether these change over time. 1.2 Report text from CCAMLR Scientific Committee in 2019.	That krill fisheries target particular features, and are not random in their distribution.
Output 2: Produce a spatially and temporally scaled krill model which takes account of flux and movement of krill.	2.1 Analysis of oceanographic flow fields in an existing oceanographic model to determine preferred movement pathways and retention areas.	2.1 Analyses of the impacts of tides on foraging and on transport pathways. 2.2 Report text from CCAMLR Scientific Committee in 2020.	That it is possible to identify krill flux using an oceanographic model.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
	2.2 Submission of a Working Paper to the CCAMLR Working Group on Ecosystem Monitoring and Management in June 2020.		
Output 3: Spatially and temporally explicit consumption estimates for key predator groups.	3.1 Production of maps highlighting the key areas for predator consumption by June 2019. 3.2 Submission of a Working Paper to the CCAMLR Working Group on Ecosystem Monitoring and Management in June 2019.	3.1 Identification of areas used by multiple predator species, particular focus on cetaceans and penguins as the taxa with most available data. 3.2 Report text from CCAMLR Scientific Committee in 2019.	That we are able to obtain distribution data from flying seabirds. We are already in possession of distribution data for the other species, and are almost certainly able to obtain seabird data from the literature if collaborators are unable to share their data.
Output 4: Maps and tables of results describing the levels of risk to krill dependent predators under scenarios where management occurs at a variety of spatial and temporal scales.	4.1 A report containing the final results will be sumitted as a Working Paper to the CCAMLR Working Group on Ecosystem Monitoring and Management in June 2020.	4.1 Report text from CCAMLR Scientific Committee in 2020.	That the previous outputs are completed successfully.
Output 5: Peer-reviewed papers submitted for publication.	5.1 Individual papers will be submitted for publication by the end of the project.	5.1 Papers in scientific journals.	Normal submission and editorial control by journal editors.
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) **Activities**: 1.1 Use habitat models to investigate variability in the spatial distribution of the krill fishery in relation to bathymetry, sea ice cover, proximity to the shelf b			

Project summary	Measurable Indicators	Means of verification	Important Assumptions
historical (1981/82 to 2016/17) and recent timescales (2009/10 to 2016/17). 1.2 Write up the model for submission to WG-EMM-19. 2.1 Investigate proxies for the oceanographic flux and movement (import and export) of krill by utilising a fine-scale ocean model to estimate relative water movem predator consumption and fisheries usage. 2.2 Write up results for submission to WG-EMM-20. 3.1 Integrate habitat preference models previously developed for *Pygoscelis* penguins (DPLUS009, DPLUS054) and humpback whales, with krill consumption esti temporally explicit resource demand estimates for key predator groups, including penguins, whales and flying seabirds, at relevant spatial and temporal scales in a 3.2 Write up the results for submission to WG-EMM-19. 4.1 Integrate existing and novel data-layers and apply the risk assessment framework to identify the areas of increased risk to predator populations or krill. We will variety of spatial scales which we will identify based on bathymetry, predator distribution, current flow, and distance from the shelf-edge, and at temporal scales ac movement constraints. This will allow us to identify the relative risks when the framework is applied at various spatial and temporal scales, and enable the identifica apportion the catch limit. We will focus initially on Subarea 48.1 as this is where the fisheries is most constrained by catch limits and where it operates in close prox dependent predators, especially penguins. We will present the methodologies utilised in the production of the data layers allowing for the addition of new informatio present a series of maps and tables which detail the data layers to be included in the risk assessment and the risk indices and catch-limit proportions under differe 5.1 All of the outputs will be written up for submission to peer reviewed journals.			

Annex 3 Onwards – supplementary material (optional but encouraged as evidence of project achievement)

Checklist for submission

	Check
Is the report less than 10MB? If so, please email to Darwin-Projects@ltsi.co.uk putting the project number in the Subject line.	Y
Is your report more than 10MB? If so, please discuss with Darwin-Projects@ltsi.co.uk about the best way to deliver the report, putting the project number in the Subject line.	N
Have you included means of verification? You need not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Y
Do you have hard copies of material you want to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number. However, we would expect that most material will now be electronic.	N
Have you involved your partners in preparation of the report and named the main contributors	N/A
Have you completed the Project Expenditure table fully?	Y
Do not include claim forms or other communications with this report.	