

## Darwin Initiative Main/Post/D+ Project Half Year Report (due 31<sup>st</sup> October 2017)

<b>Project reference</b>	DPLUS054
<b>Project title</b>	Managing Antarctic krill fisheries: identifying candidate marine areas for protection
<b>Country(ies)/territory(ies)</b>	BAT, SGSSI
<b>Lead organisation</b>	BAS
<b>Partner(s)</b>	BirdLife International, ERA
<b>Project leader</b>	<i>Philip Trathan, Head of Conservation Biology</i>
<b>Report date and number (e.g., HYR3)</b>	17HYR2
<b>Project website/blog/social media etc.</b>	

### 1. Outline progress over the last 6 months (April – Sept) against the agreed baseline timetable for the project (if your project has started less than 6 months ago, please report on the period since start up to end September).

#### Habitat Modelling during the breeding season and overlap with the krill fishery

Significant progress has been made during the most recent six months of the project. Dr Warwick-Evans has developed habitat models that integrate chinstrap penguin tracking data from colonies studied at the South Orkney Islands, including the use of remote sensing data and geometric covariates, in order to generate model predictors that estimate the spatial distribution of breeding penguins across the archipelago. The statistical models that proved to be the most suitable were General Additive Models; cross validation carried out by using the models to predict the distribution of penguins foraging from one site, and validating the predictions using tracking data collected from other sites across the South Orkney Islands, showed that the models have high predictive performance, and predict both penguin presences and penguin absences efficiently. By combining predictions from the preferred habitat models with data from the Southern Ocean krill fishery we showed that core chinstrap penguin foraging areas overlap with highly used fishing areas, particularly to the north west of the South Orkney Island archipelago, where chinstrap penguin biomass is greatest.

In further work, the models were extrapolated to chinstrap penguins breeding at the South Shetland Islands and northern Antarctic Peninsula. This work entailed close liaison with scientists from 6 Member States of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), so that tracking data not collected by UK scientists could be used. Cross validation of the model outputs using empirical data from tracked colonies indicated that the models performed well when extrapolated to other locations. However, models created using data collected from local colonies were marginally better than those extrapolated between locations. These analyses have also demonstrated that important foraging areas for chinstrap penguins breeding on the South Shetland Islands overlap with areas used intensively by the krill fishery.

Outputs from the habitat models predicting the distribution of chinstrap penguins across the South Orkney Islands, South Shetland Islands, and Antarctic Peninsula, indicate that management of the krill fishery should occur at time scales of approximately 30 days and spatial scales of 10 – 100 km, coinciding with penguin foraging preferences during incubation, brood and crèche.

### Habitat modelling during the pre-moult phase

Dr Warwick-Evans has started processing the tracking data for chinstrap and Adélie penguins for the pre-moult phase of the life cycle. Remote sensing data is currently being sourced, and model development will commence shortly.

### Krill Flux

Dr Trathan and Dr Young have integrated outputs from these habitat models with outputs from a high resolution ocean current model in order to investigate the links between krill movement and retention (krill flux) and predator foraging areas. Chinstrap penguins forage over shallow shelf waters where krill replenishment is likely to be reduced, whilst heading towards faster flowing waters where krill replenishment may be greater. These results are important because they demonstrate that penguins utilise areas where krill replenishment rates may be reduced, which means that harvesting by the fishery could lead to local depletion, potentially impacting upon chinstrap penguins (and other predators that use near-shore habitats over shallow bathymetry with slow moving water).

### Krill consumption

Dr Trathan and Dr Waluda in association with colleagues from Australia have developed krill consumption models for the populations of penguins breeding in the areas used most intensively by the krill fishery.

### Marine IBAs

Dr Warwick-Evans, Dr Trathan and Dr Dias (Birdlife International) have established novel methodologies to integrate habitat models into the approaches to delineate marine Important Bird and Biodiversity Areas (IBA) for penguins, and have identified marine IBAs around the South Orkney Islands.

### Engagement with stakeholders and policy development

Dr Trathan and Dr Warwick-Evans attended the CCAMLR Working Group on Ecosystem Monitoring and Management (WG-EMM) which was held during July this year in Buenos Aires, Argentina. At the meeting they presented all of the scientific work detailed above. WG-EMM recognised that the work on habitat models could help parameterise a risk assessment for the krill fishery and may help prioritise areas for such research. Indeed, WG-EMM discussed the general utility of the results from the habitat models with respect to the identification of wide-spread coastal areas as potential habitat for chinstrap penguins during the breeding season. In particular, WG-EMM noted that the distribution of the chinstrap penguin population will affect predation pressure within the potential foraging habitat. WG-EMM agreed that a better understanding of interactions between predators, prey and the fishery in these coastal areas is desirable. WG-EMM noted that an experimental framework could be developed within coastal zones to help study how krill movement and predation interact in the absence of fishing. Such experimental approaches could help to resolve the relative roles of predation and flux on krill distributions and improve the assessment of potential fisheries impacts on krill predators (CCAMLR WG-EMM-17 Report, Hobart – this will be publically available on line in the near future – contact Dr Trathan for prior details).

Following the WG-EMM meeting in Buenos Aires, Dr Warwick-Evans and Dr Trathan convened a one day meeting with Dr Jefferson Hinke (USA), Dr Mercedes Santos (Argentina) and Dr Andrew Lowther (Norway) to discuss improvements to the chinstrap penguin habitat models and how best to take forward the work. Arising from this meeting new data were identified that will enhance the models for the South Shetland Islands. Additional work was also identified that will help improve understanding about managing the krill fishery.

Dr Trathan subsequently submitted a paper to the CCAMLR Scientific Committee about developing an experimental framework related to fisheries within coastal zones to help study how krill movement and predation interact in the presence and absence of fishing. This was well received and the Scientific Committee welcomed the work which proposed that WG-EMM evaluate the potential for developing an experimental framework which could then be implemented within coastal zones to help study how krill movement and predation interact in the presence and absence of fishing. It noted that such an approach had the potential to help inform management strategies for krill, facilitating understanding of krill retention and

replenishment (krill flux). It noted that the approach had the potential to help increase understanding of functional overlap, as well as spatial overlap between krill predators and the fishery. As a result, Dr Trathan and Dr Watters (USA) have now been approached to develop appropriate terms of reference, through collaboration with interested scientists from CCAMLR Members, and to convene a workshop on krill management. Possible dates and a venue will be notified in due course. Outputs from the workshop will be presented to WG-EMM in 2019. (SC-CAMLR-XXXVI Report, Hobart – this will be publically available on line in the near future – contact Dr Trathan for prior details).

During 2018 WG-EMM will be held in Cambridge, UK, and organisation is underway by the UK CCAMLR Delegation, led by Dr Trathan and Dr Warwick-Evans. At this meeting we will provide further evidence to assist CCAMLR with working towards policy change, and advocate Conservation Measures for designating appropriate protection within the CCAMLR Convention Area, including with BAT, in relation to the krill fishery.

Papers submitted to CCAMLR WG-EMM and Scientific Committee

WG-EMM-17/30 Oceanography of the South Georgia and South Orkney Islands regions using high-resolution models. E. Young, E.J. Murphy and P.N. Trathan.

WG-EMM-17/32 A bioenergetics model assessment of the prey consumption of Adélie penguins in Subarea 48.1 and 48.2. C.M. Waluda, L. Emmerson, C. Southwell and P.N. Trathan.

WG-EMM-17/33 Using preferred habitat models for chinstrap penguins (*Pygoscelis antarctica*) to help improve krill fisheries management during the penguin breeding season. V. Warwick-Evans, N. Ratcliffe, H.L. Clewlow, L. Ireland, A. Lowther, F. Manco and P.N. Trathan.

WG-EMM-17/34 Characterising the preferred at-sea habitats used by chinstrap penguins and the fishery for Antarctic krill: slow-flowing, nearshore waters over shallow bathymetry. P.N. Trathan, V. Warwick-Evans, J. Hinke, E.F. Young, A.P.B. Carneiro, M.P. Dias, K. Kovacs, O.R. Godø and M. Santos.

WG-EMM-17/35 Identification of marine Important Bird and Biodiversity Areas for penguins in South Shetland and South Orkney Islands: a comparison of two different approaches. M.P. Dias, A.P.B. Carneiro, V. Warwick-Evans, C. Harris, K. Lorenz and P. Trathan.

SC-CAMLR-XXXVI/09 Developing an experimental approach to help resolve the relative roles of predation and flux on krill distribution and improve the assessment of potential fisheries impacts on predators. Delegation of the United Kingdom.

All of these papers are attached to the report as Annexes, but should not be distributed without prior permission. The papers are now in revision and a suite of papers will shortly be submitted to high impact peer-reviewed scientific journals.

**2a. Give details of any notable problems or unexpected developments/lessons learnt that the project has encountered over the last 6 months. Explain what impact these could have on the project and whether the changes will affect the budget and timetable of project activities.**

No significant problems or unexpected delays have been experienced.

**2b. Have any of these issues been discussed with LTS International and if so, have changes been made to the original agreement?**

Discussed with LTS:	Yes/No	<i>Not applicable</i>
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Formal change request submitted:	Yes/No	<i>Not applicable</i>
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Received confirmation of change acceptance	Yes/No	<i>Not applicable</i>
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**3a. Do you currently expect to have any significant (e.g., more than £5,000) underspend in your budget for this year?**

Yes  No  Estimated underspend: £

**3b. If yes, then you need to consider your project budget needs carefully.** Please remember that any funds agreed for this financial year are only available to the project in this financial year.

If you anticipate a significant underspend because of justifiable changes within the project, please submit a rebudget Change Request as soon as possible. There is no guarantee that Defra will agree a rebudget so please ensure you have enough time to make appropriate changes if necessary.

**4. Are there any other issues you wish to raise relating to the project or to Darwin's management, monitoring, or financial procedures?**

Last year, we asked LTS whether we could carry forward funds for a small workshop to discuss project development. This request was granted. This year, we used the funds to meet with CCAMLR scientists in Buenos Aires. The amount of money needed for this meeting was less than originally budgeted because all the scientists were already present at WG-EMM and only needed to stay an additional day at the end of the meeting.

**If you were asked to provide a response to this year's annual report review with your next half year report, please attach your response to this document. Additionally, if you were funded under R23 and asked to provide further information by your first half year report, please attach your response as a separate document.**

**Please note: Any planned modifications to your project schedule/workplan can be discussed in this report but **should also** be raised with LTS International through a Change Request.**

Please send your **completed report by email** to Eilidh Young at [Darwin-Projects@ltsi.co.uk](mailto:Darwin-Projects@ltsi.co.uk) . The report should be between 2-3 pages maximum. **Please state your project reference number in the header of your email message e.g. Subject: 22-035 Darwin Half Year Report**