Darwin Initiative/Darwin Plus Projects
Half Year Report
(due 31st October 2020)

Project reference	DPLUS092
Project title	Seabird sentinels: mapping potential bycatch risk using bird-borne radar
Country(ies)/territory(ies)	Falkland Islands (FI) and South Georgia and The South Sandwich Islands (SGSSI)
Lead organisation	British Antarctic Survey (BAS)
Partner(s)	BirdLife International
Project leader	Richard Phillips
Report date and number (e.g. HYR3)	*HYR2 – 31/10/2020*
Project website/blog/social media	*https://www.bas.ac.uk/project/bycatch-risk-of-wandering-albatrosses-using-radar-detection/* *http://www.birdlife.org/worldwide/news/seabird-sentinels-will-help-mitigate-bycatch* https://community.rspb.org.uk/getinvolved/b/albatross-stories/posts/ana-carneiro---real-time-albatross-conservation-part-1 https://community.rspb.org.uk/getinvolved/b/albatross-stories/posts/ana-carneiro---real-time-albatross-conservation-part-2 https://www.bas.ac.uk/blogpost/wandering-albatross-tracking-at-bird-island/ https://www.birdlife.org/worldwide/news/tracking-ocean-wanderers

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

Output 1 Understand fine-scale attendance patterns of wandering albatrosses of different age, sex and breeding status to legal and illegal fishing vessels.

Activity 1.1. Organise fieldwork logistics

Fieldwork took place from December 2019 until August 2020. Retrospective review forms were completed and sent to the relevant animal welfare ethics and permit authority. Due to failure of devices on juveniles last season, the manufacturer provided new instruments which have been programmed and are planned for deployments in December 2020. To maximise data collection, a second round of deployments will be carried out from December 2020 until April 2021. This will not delay project results, but is to increase sample size for analysis. All applications for this work, i.e., for animal welfare and ethical review, EIA and the govt. permit have been approved.

Activity 1.2 Collect and compile fisheries and tracking data (i.e. radar, 3-D acceleration, GPS location, and immersion data).

The tracking of adult and pre-breeding wandering albatrosses with GPS-radar and immersion loggers took place in December 2019-August 2020. The BAS field assistants collected data for adults during brood-guard in March/April 2020, and during post-guard chick-rearing in July/August 2020, completing data collection from all life-history stages (Figure 1).

We have made substantial progress in our collaboration with Global Fishing Watch (GFW) with regards to accessing satellite Automatic Identification System (AIS) data from vessels. In September 2020, after the completion of wandering albatross post-guard chick-rearing deployments, GFW provided detailed position data for all individual vessels operating close to locations of tracked birds (i.e. whether or not there was a radar detection). The GFW data include: unique vessel identifier, date, time, latitude, longitude, type of vessel, nationality, and a field indicating if the AIS position was scored as fishing using a neural network analysis. All vessel tracks within 5km and 10 minutes were spatially and temporally matched to the respective bird location (Figure 1). Satellite AIS data will help identify vessels with which the birds are interacting and the proportion with AIS in operation, determine the distance at which birds respond to fishing vessels - legal and illegal, unreported and unregulated (IUU), and the proportion of time spent behind vessels (and therefore at risk of bycatch).

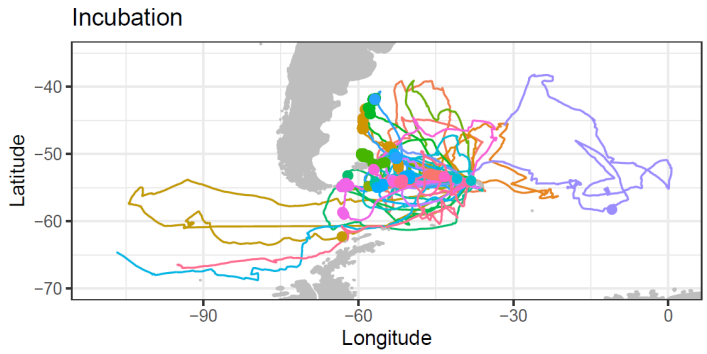
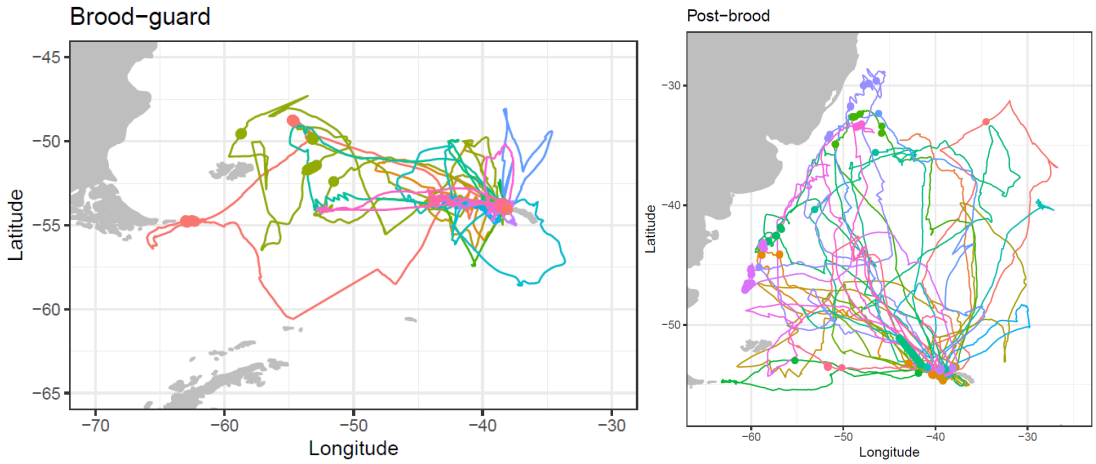


Figure 1: Foraging trips of incubating, brood-guard and post-guard chick-rearing wandering albatrosses from Bird Island, South Georgia. Larger dots represent radar detections.



Overall, devices were deployed on 134 wandering albatrosses of different ages and sex (breeders in incubation: 34; in brood-guard: 27; in post-guard: 27; immatures: 29; sabbaticals: 15). A second round of device deployments is planned for the coming field season to increase sample sizes and maximize use of project resources.

Activity 1.3 Data analysis to determine the distance at which wandering albatrosses respond to vessels (i.e. change direction, flight height etc. based on acceleration data), and proportion of time spent behind each vessel.

All positive radar detections were matched with GFW data on AIS vessel locations. Twenty-four of the 34 birds tracked on foraging trips during incubation had contact with vessel radar (18 were fishing), three in brood-guard (2 were fishing), 19 in post-guard (12 were fishing), six immatures (2 were fishing) and six sabbatical birds (one was fishing). Several radar detections were not associated with vessel AIS, suggesting possible IUU fishing. This analysis is ongoing.

Activity 1.4 Assess whether a signature is detectable in GPS, acceleration and immersion data that indicates scavenging behind vessels vs feeding on natural prey. If so, quantify time spent following vessels from other GPS and immersion datasets (from current and previous seasons).

We developed scripts involving Hidden Markov Models (HMMs) using the R package *momentuHMM*. HMMs allow the inclusion of many data streams to classify behaviour. GPS data were filtered and linearly interpolated to 10-min. sampling intervals, and positions assigned to daylight or darkness. Activity data were summarised as number of landings and proportion of time spent wet in the 10-min of track preceding each GPS location. Take-off is energetically costly for albatrosses; therefore landing events can provide a good indication of foraging effort. Behavioural classification was based on four input variables: instantaneous travel speed and turning angles, number of landings, and proportion of time spent wet. We compared the fit of models with 3-5 putative latent behavioural states, and tried different distributions and data formats to include immersion data in models. Radar data were used to validate foraging behind vessels. A series of summary statistics (speed, duration, cumulative distance, straightness, proportion of locations with positive radars, etc.) were calculated for each behavioural bout (i.e. transition of behaviours assigned by the HMMs). GFW data were also used to identify vessels, if fishing or not, and type. GFW data helped to narrow down radar detections to fishing or not fishing, as radar loggers indicate contact only (see Figure 2). Random forest algorithms were used to check whether the proportion of radar contacts per bout could be explained by any combination of variables, but could explain only 3.4% of the variation, suggesting that there is insufficient signal in the data to distinguish between bouts with and without radar contacts, and therefore to distinguish natural foraging from following vessels. We are now writing a manuscript on these results. This will show how to model immersion data in HMMs, and will highlight the importance of having multiple data streams to investigate seabird-fisheries interactions. Our results show that location data, even when combined with data from other sensors, are not enough to distinguish foraging behind vessels.

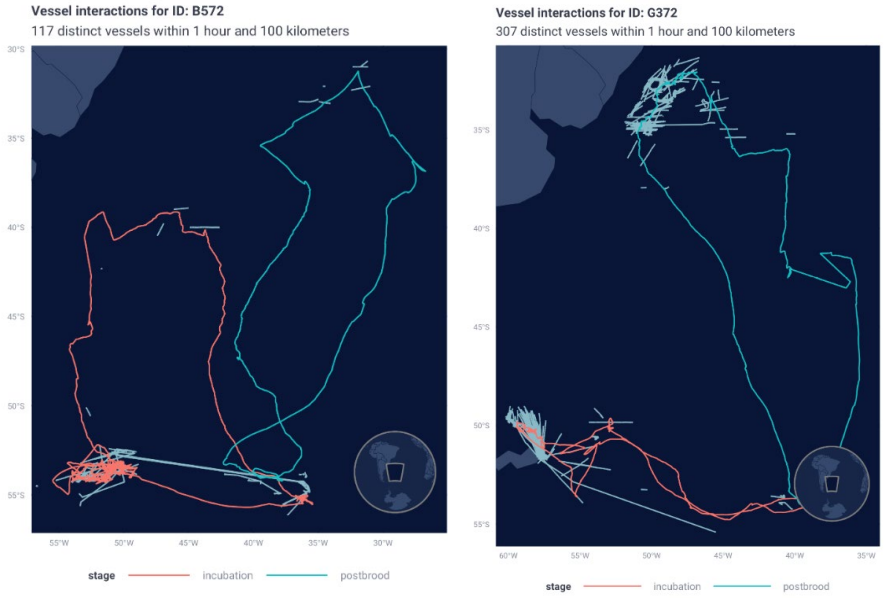


Figure 2: Individual foraging trips and vessel interactions of two selected wandering albatrosses tracked from Bird Island, South Georgia.

Output 2 Model habitat preferences of wandering albatrosses of different age, sex and breeding status.

Activity 2.1 Extract oceanographic data at appropriate spatial and temporal scales.

We have identified the most biologically relevant oceanographic variables for wandering albatrosses but we have not yet downloaded the data. Codes to extract information from raster images at appropriate spatial and temporal scales are written; see details under activity 2.2.

Activity 2.2 Build and evaluate habitat models.

To identify habitat preferences of tracked wandering albatrosses, we will build habitat models using the foraging locations identified in the most conservative, three behavioural state (i.e. foraging, resting and travelling) HMMs (see activity 1.4). All codes to build habitat models (including models and model validation) are being developed in R. We have also created codes

to manipulate the rasters of oceanographic data, but have still to download the entire set of oceanographic variables. This activity is due to finish in the next year quarter.

Activity 2.3 Generate predictive maps of distribution of wandering albatrosses of different age, sex and breeding status.

Progress to date: this activity is not due to start until the next year quarter.

Output 3 Identification of the areas, periods and fleets from which bycatch risk is greatest for wandering albatrosses of different age, sex and breeding status.

Progress to date: activities under this output are not due to start until the next year quarter.

Output 4 Dissemination and application.

Progress to date: most of the activities under this output are not due to start until January 2021, except for activity 4.5b. We have already started working on the activity *4.4 Prepare manuscripts for publication in peer-reviewed journals* showing the results of the activity *1.4*.

Activity 4.5b Make results available via websites for public dissemination.

Progress to date: We have set up multiple communication channels to publicise the project (see "Project website/blog/social media etc." above). We have also worked with a designer to create an infographic explaining how radar loggers work (Figure 5).

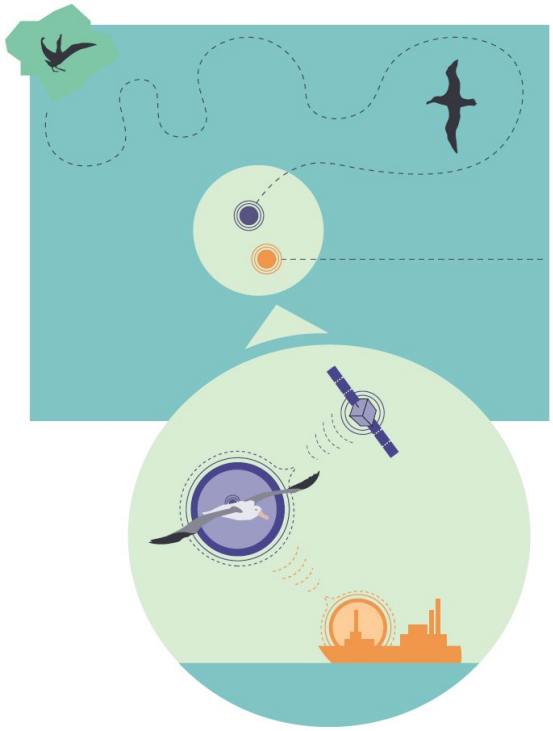


Figure 3: The logger is attached to back feathers of an albatross to record the location of the bird during their foraging trips and also to scan their surroundings to detect the presence of a vessel radar. Information can be transmitted instantaneously through the Argos system, or downloaded when the logger is retrieved.

2a. Give details of any notable problems or unexpected developments/lessons learnt that the project has encountered over the last 6 months (for Covid-19 specific delays/problems, please use 2b). Explain what impact these could have on the project and whether the changes will affect the budget and timetable of project activities.

We contacted fisheries representatives in Brazil, Argentina, Chile, Uruguay, South Georgia and the Falkland Islands to access their national Vessel Monitoring System (VMS) data. There has been some progress but these data are mostly 'commercial in confidence' and we are still discussing access in most cases. We previously identified access to these data as a potential risk, and in order to overcome the impact on our project, suggested an alternative. This is the partnership we have made with GFW to access vessel locations and details (from AIS) that can be linked in time and space to our bird tracking data. The lack of VMS data will have no impact on the project, especially as the tracked birds overlapped mainly with vessels in the high seas where VMS data are not available (and GFW are therefore the major source of data).

2b. Please outline any specific issues which your project has encountered as a result of Covid-19. Where you have adapted your project activities in response to the pandemic, please briefly outline how you have done so here. Explain what residual impact there may be on your project and whether the changes will affect the budget and timetable of project activities.
Our analyses are computationally intensive and require a high-performance computer. The original plan was to use an extra desktop computer in the BirdLife International office for some model runs, and the team also has limited access to resources on the University of Cambridge high performance computing cluster. However, the current policy of BirdLife International of working from home due to the COVID-19 pandemic has reduced access to these facilities. In response to this challenge, we sent a Change Request to buy a new high performance laptop for the lead analyst. The request was approved and we expect no further impact on the project. This has not affect the timetable of project activities. Preliminary results were going to be presented in the World Seabird Conference 2020, for which we budgeted T&S and conference fees. Due to Covid-19, the conference has been postponed to October 2021, and we will soon request these costs be transferred to the next financial year.

2c. 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 (laptop purchase only)
Formal change request submitted:	Yes
Received confirmation of change acceptance	Yes

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. Please DO NOT send these in the same email as your report.**

4. Are there any other issues you wish to raise relating to the project or to Darwin's management, monitoring, or financial procedures?
No

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.

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 DO NOT send these in the same email.

Please send your **completed report by email** to 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: 25-001 Darwin Half Year Report**