Darwin Initiative 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: 30 April**

Darwin Project Information

Project Reference	DPLUS002
Project Title	An Autonomous Seabird Monitoring Network for the Southern Ocean
Host Country/ies	British Antarctic Territory, South Georgia and the South Sandwich Islands, Falkland Islands.
Contract Holder Institution	University of Oxford
Partner institutions	Zoological Society of London
Darwin Grant Value	£137,715 (Year1)
Start/end dates of project	1/4/13 – 31/3/14 (Year1)
Reporting period	April 2013 – March 2014, Annual Report 1
Project Leader name	Dr Tom Hart
Project website	www.penguinlifelines.org
Report author(s) and date	Tom Hart, 14/05/2014

1. Project Rationale

The Scotia Arc region has experienced dramatic increases in air and sea temperature and significant decreases in the extent, concentration, and duration of winter sea-ice over the past half-century (Meredith & King 2005, Stammerjohn et al. 2008). These warming and sea-ice trends also correlate with decreases in biological productivity and the biomass of Antarctic krill (*Euphausia superba*). In addition, an expanding fishery harvests as much as 202,346 tons of krill annually from the Antarctic Peninsula region (CCAMLR 2010) and there has been a three-fold increase in tourist visitation since 2002. The number of seabird breeding sites monitored under the Antarctic Treaty System has declined and become patchy. Whereas a scientific base or camp was necessary to collect data on seabirds, it is now possible using remote cameras. We proposed a network of Seabird Autonomous Monitoring Stations, to fill in these data gaps and assess the impacts of recent changes in climate and krill.

These problems were identified by literature review, consultation with OT governments, the FCO and through the Government of South Georgia and the South Sandwich Islands MPA consultation meeting.

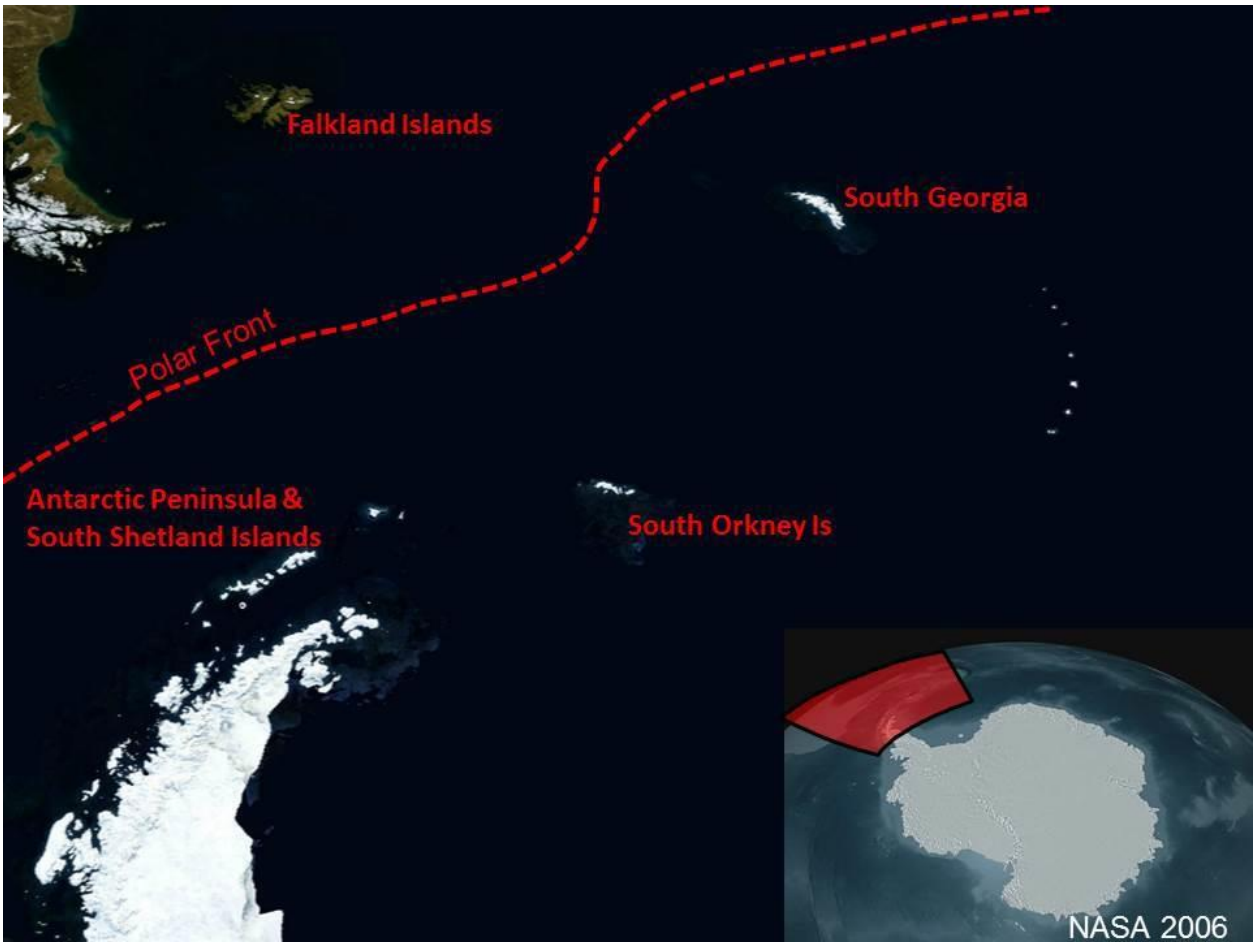

Figure 1: *Areas of the Scotia Arc are characterised by being remote and logistically challenging. Data for managing the region comes from fisheries reporting, remotely sensed data on temperature, weather and climate change, and biological monitoring and measurements from very few sites near research stations.*

This project seeks to address the level of monitoring all around the Scotia Arc, which includes three UK OT's; the British Antarctic Territory, South Georgia and the South Sandwich Islands and the Falkland Islands. It should also develop tools that are immediately applicable to other OTs, such as Tristan da Cunha, St Helena and the Chagos Archipelago. The results are of interest to scientists and conservation planners in the governments of each of these territories, and also to the Convention on Migratory Species, The Antarctic Treaty and the Convention on the Conservation of Antarctic Marine Living Resources.

2. Project Partnerships

All stakeholders have been consulted and provided feedback this year, but due to the bulk of deployments happening in the 2014/15 fieldwork season, we will be engaging with stakeholders much more this year in the lead up to this year's fieldwork to ensure appropriate delivery of outputs relevant to local as well as international policy and also to ensure the sustainability of this project post-Darwin Plus funding. We have met with most of the project stakeholders at the International Penguin Conference in Bristol, September 2013 and at the World Seabird Conference in Oxford, April 2014. We have also been negotiating with local partner and potential new partners described below.

Falkland Islands Government/ Falklands Conservation

Conservationists and policy makers on the Falkland Islands have identified Southern Rockhopper penguins as a priority for investigation and conservation following a workshop in April 2011. We have been working with Falklands Conservation to deploy one camera on a Gentoo penguin colony and six cameras on rockhopper penguins. In October 2014, we will be placing ten more cameras and will be meeting with both Falklands Conservation and the Falklands Government Environmental Planning department to ensure that this is fed into policy, delivers against their own goals and is sustainable.

Government of South Georgia and South Sandwich Islands

GSGSSI have been consulted throughout the development of this project, and PI Hart was involved in the Marine Protected Areas consultation meeting in April 2012, which highlighted the gaps in monitoring in areas around South Georgia and the South Sandwich Islands away from the Bird Island and King Edward Point research stations. GSGSSI have donated and are maintaining two monitoring stations at Maivikken on South Georgia and we are working with the predator scientist there to aid placement and data interpretation.

The Government of South Georgia and the South Sandwich Islands have approached us to deploy more cameras and audio monitoring equipment in support of their monitoring of seabird recovery post rat and reindeer eradication. We have secured a yacht charter for 2014/15 and 2015/16 for one month around South Georgia to ensure that we can deploy and service or recover large numbers of these (see new project partners below). We will soon be in a position to feed back some of the results from this project to them.

Foreign and Commonwealth Office Overseas Territories Polar Regions Department

Discussions with the Foreign and Commonwealth Office have been productive as to the placement of cameras and the possibility of integrating data derived from the camera network with CCAMLR fisheries data and the selection of candidate MPAs.

New partners

We have several new partners related to the main objectives of this project and the proposed sustainability and expansion to other regions beyond the Southern Ocean and UKOTs and after the conclusion of the Darwin Plus project. In addition to those named below, we are in discussions with Birdlife International, the Yellow-Eyed Penguin Trust and SANCCOB as to how to expand this type of monitoring worldwide.

Zooniverse

The Zooniverse team have been instrumental in redesigning the citizen science annotation tool. The shift of hosting means that we have been slower to release this than planned, but the citizen science element is now far easier to scale up beyond penguins and the Southern Ocean, as well as providing access to orders of magnitude more volunteers. The toolkit has been designed to scale up, so that any colonial seabird images could be placed within the database and annotation tool.

Cheeseman's Ecological Safaris and Golden Fleece Expeditions ltd.

We have a two-year deal with these partners to carry out month-long expeditions to South Georgia, which will be paid for by 8-10 tourists. This partnership has already resulted in a spin-out albatross survey by GSGSSI and Island Surveys. If successful, this will almost entirely eliminate the costs of fieldwork on South Georgia into the future and allow much more monitoring in this OT.

Tristan da Cunha

We have helped the Conservation Department of Tristan da Cunha to get a penguin monitoring project started. We have donated six reconditioned cameras from Antarctica to them to determine whether photo monitoring is useful and can be analysed in the same framework as our own monitoring.

3. Project Progress

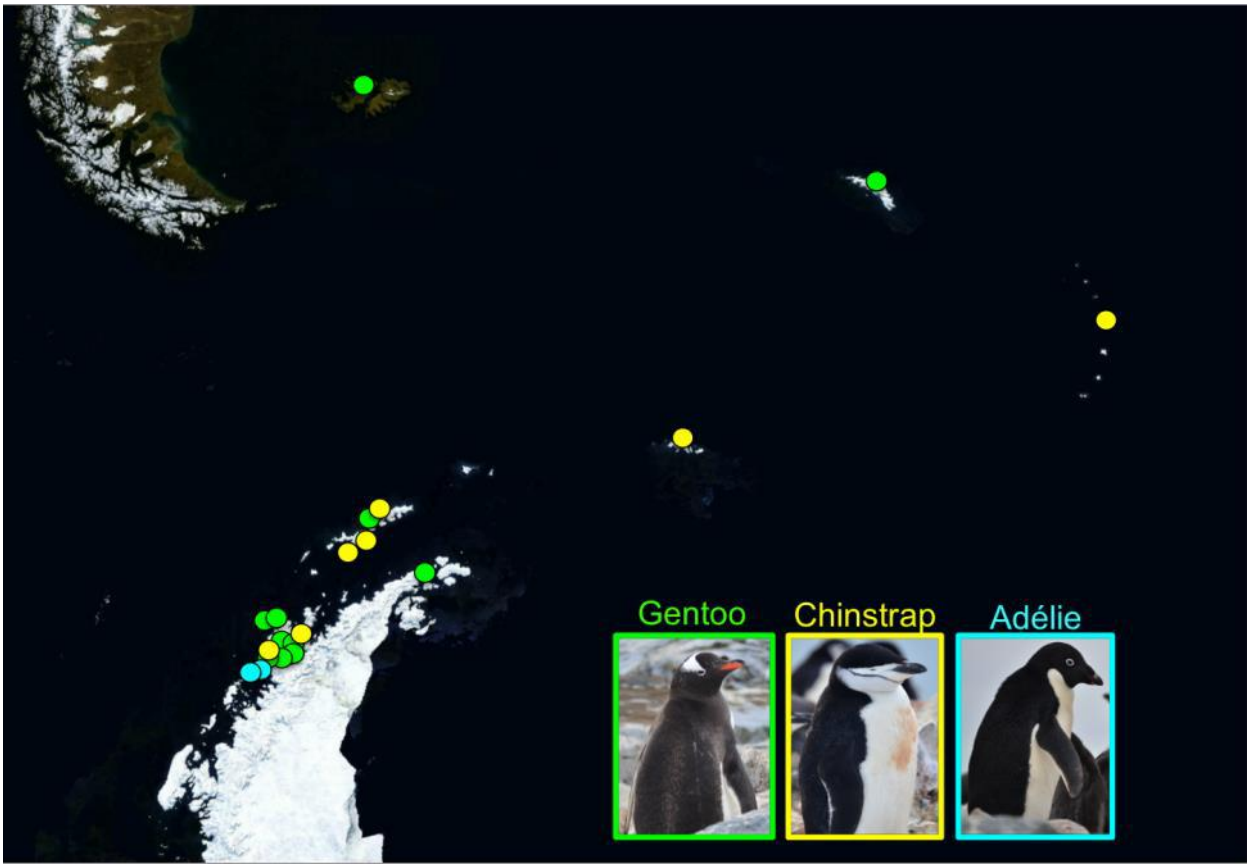

Figure 2: *Visual summary of the locations of cameras as of April 2014 by species.*

3.1 Progress in carrying out project activities

Work is progressing well towards the individual goals and output for this project, which has three goals and measures of success:

1: Design and deploy a network of SAMS sites around the Scotia Arc.

Seabird Autonomous Monitoring System is the name we have given to a modular concept for monitoring, collecting data on the ground that would otherwise require a biologist to be present. This comprises a power supply, a camera and/or audio recorder and an optional satellite or radio link to recover data. This year we have made substantial progress towards a more versatile system that we could put into mass production and we have deployed 10 sites and serviced 40. This is less than we anticipated for the first year, but many of the cameras shipped to the Falklands were help up in the US, preventing us from more deployments. In the upcoming year, we have a dedicated yacht for a month around South Georgia, we have strengthened links with Falklands Conservation to deploy on the Falklands, and we have more time on the South Sandwich Islands and the Antarctic Peninsula. We have also been awarded a grant to visit the Danger Islands in 2015/16. One notable achievement in the 2014/15 season was the placement of two cameras on the South Sandwich Islands; this is the first monitoring of breeding ever to take place in this archipelago.

Figure 3: *Gemma Clucas (left) and Tom Hart (right) deploy a new camera on Danco island, Antarctic Peninsula.*

The design of the network is complete, but is being refined in light of Bayesian decision making tools for environmental management which have been developed by Heather Lynch of Stony Brook University. The power analysis of available monitoring sites is complete, but is being refined for publication. The design of a SAMS network is complete, but is being redesigned in light of which sites are accessible in 2014/15.

In summary, we have designed the system, purchased the components and are behind in deploying them, but on track to complete this in the 2014/15 season.

Figure 4: *Deploying the first satellite linked camera on the Yalour Islands, Antarctic Peninsula. A) shows the camera setup with power solution. B) Close up of the camera and node. C) View of camera with the view of the penguin colony.*

Figure 5: *Images returned from the satellite linked camera on the Yalour Islands between January 20th and April 30th.*

2. Build an online database capable of storing and annotating data from 100 SAMS for this project and 200 SAMS from other projects.

This had two benchmark objectives; testing the current trial version with multiple user images and users, and to redesign the beta version and go live on www.penguinlifelines.org.

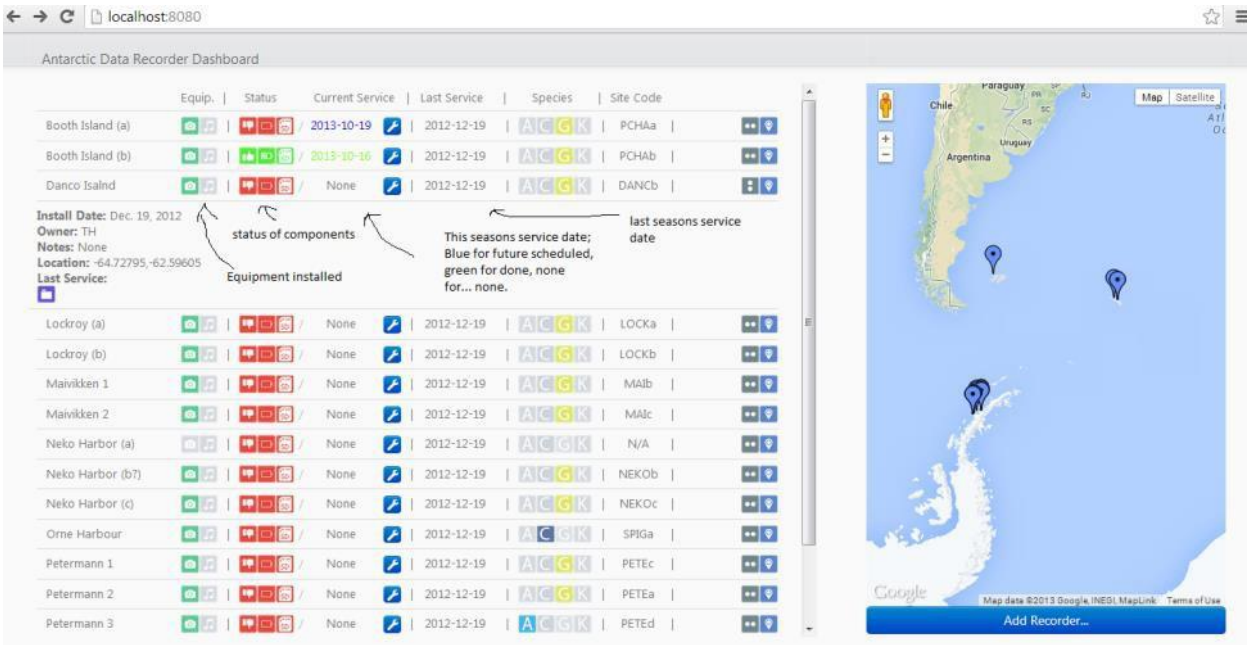

Figure 6: *Screenshot of the back end database camera management tool. Currently this is unlinked to the annotated data from images, but we plan to link both, as well as present visual summaries and timelapse video to engage the public and a data summary for policy makers.*

The current version has been trialled, refined and is now being hosted via the Zooniverse crowd sourcing platform. The trial database has been used successfully and is being transferred to the new server. The database currently holds data from 32 sites, with much redundant capacity to allow the expansion required within this project and for additional users assuming we persuade other seabird conservationists to adopt this as a monitoring tool.

We have a beta test nearly completed with annotations by 200 users. The site will go live on www.zooniverse.org/penguins and www.penguinwatch.org by the end of June, which will give 900,000 registered Zooniverse users. We will also be conducting a PR campaign, encouraging members of the public to assist, which we anticipate will bring many more users to the data set.

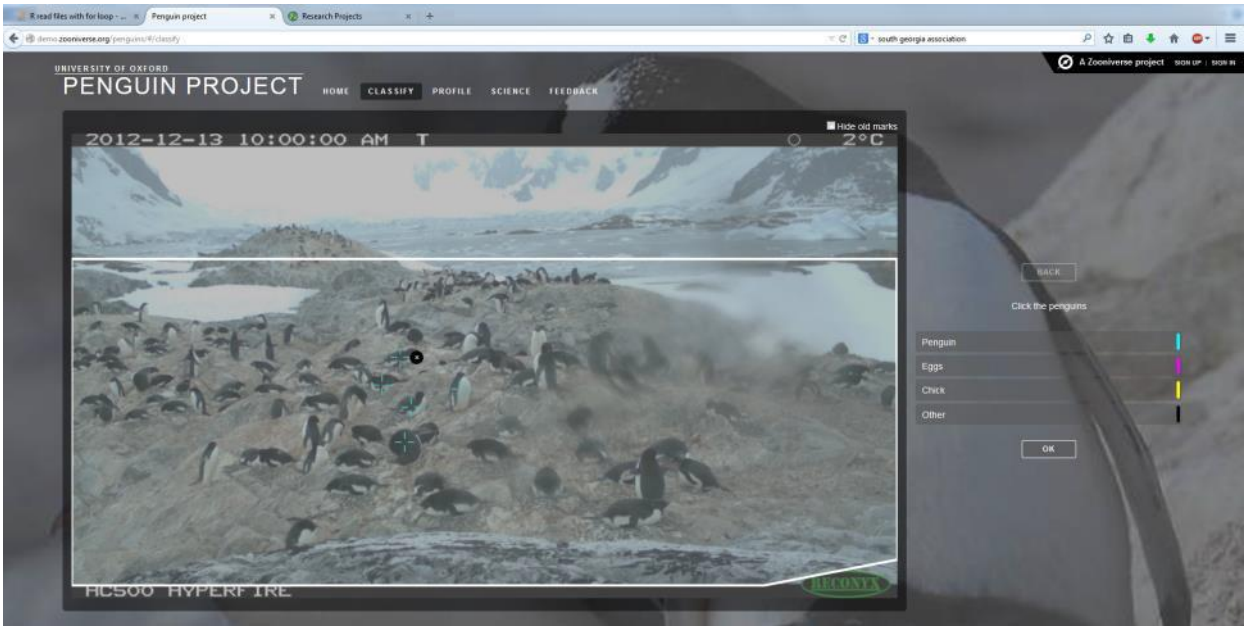

Figure 7: *Screen shot of the beta test version of the citizen science annotation tool, available to see at http://demo.zooniverse.org/penguins/#/classify. According to estimates provided by the Zooniverse team, we expect 250,000 penguin images to be annotated within two weeks of launch.*

Within this test, we are including different species, camera angles and types of problem, so that we can assess the strengths and weaknesses of this toolkit, improve our monitoring for next year and report to both Darwin, partners and potential users on how to set up a camera monitoring programme.

Output 3: Extract breeding parameters from image data and conduct a network analysis

This output had three parts, which are not yet complete:

1. Generate count data and clustering statistics from the data on the image database.
2. Pass to Dr Rezek for network analysis to determine network structure.
3. Compare the network derived from breeding phenology with estimates of population genetic structure and current management areas to determine areas of conflict.

Some count data have been obtained by pilot studies, but with the transfer of the annotation/counting tool, we are waiting for the whole data set to be annotated by Zooniverse volunteers. Count data for annual colony counts have been passed to Dr Rezek to derive a network analysis, but this is behind in the implementation.

3.2 Progress towards project outputs

Output	Likelihood of achievement by project end	Monitoring	Output indicators
Increase in the number of colonies monitored for breeding parameters.	Extremely likely; the likelihood is that we will more than double the number of monitored colonies across the Scotia Arc.	The number of cameras and the success in extracting meaningful data.	Images fully annotated by automated or citizen science means. A publication demonstrating the technique and open access of monitoring data from the cameras. This output indicator seems robust as the project proceeds.
An online database allowing analysis and interpretation.	Likely; the database is highly likely to be ready. The envisioned tools might not be ready to run online, but will be available offline through R or Matlab scripts, which will be open source.	A database that can be accessed by new users to create new projects.	Letters of support from users. Trials of the tools developed for penguins on a range of sites, species and also other seabirds.
Crowdsourcing	Extremely likely, this should be live by June 2014.	We need to assess that the data from crowd sourcing is reducible and comparable to that obtained by a scientist annotating the same images.	User data and a published paper.
Seeding similar projects	Extremely likely to achieve this in the time of this project. We have now helped projects in South Africa and New Zealand to start their own monitoring. We have also been reconditioning old Antarctic cameras and setting up a project in Tristan da Cunha.	Images from other projects placed in the data base and being annotated by crowdsourcing.	Publications and reports stemming from other projects.

3.3 Progress towards the project Purpose/Outcome

A network of Marine Protected Areas in the Southern Ocean has been called for by both the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the Antarctic Treaty Consultative Meeting (ATCM). However, data gaps remain as to how to prioritise areas and

where to place such MPAs. The purpose of this project is to fill the data gap in the Southern Ocean through automated recording stations and automated or large-scale data recovery and feed into policy. Secondarily, we aim to have a system that can rapidly be reapplied to many other fields of wildlife monitoring.

3.4 Goal/ Impact: achievement of positive impact on biodiversity and poverty alleviation

In order to measure changes in biodiversity, we must first measure changes in wildlife populations present. In the Polar Regions, comparative studies are limited in hard-to-reach areas and are often restricted to sites located at or near scientific bases. Our initial goals included Rockhopper monitoring on the Falklands, understand krill consumption by Antarctic penguins, monitor the effects of tourism on penguin populations, and improving public understanding of these species through the use of citizen science. By working towards these goals, we are able to better understand penguin population dynamics and therefore the biodiversity of the region, as penguins represent a large proportion of biomass in Antarctica and serve as sentinels to the ecosystem using a "top down" approach to measuring large-scale changes.

In particular, we were able to complete the above-mentioned goals using the camera-monitoring network and images produced by the cameras. In the Falklands, our cameras proved successful throughout the field season and have provided valuable information on the phenology and winter behaviour of the species. As analysis continues, we continue to inform Falklands Conservation of our results, which helps them to better understand the species and the islands' ecosystem. Using the Zooniverse citizen-science page, we will be asking users to annotate images with tourists and tourism vessels present, in addition to annotating penguin individuals. Coupled with public information on tourism activity from IAATO, we plan to use the data to determine the effects of direct human disturbance on the phenology and survival rate of all *Pygoscelis* penguins across the peninsula. This study will allow us to better understand the impact of increasing tourism on local biodiversity and predict how future increases in human activity will disturb wildlife in time. By studying the provisioning rates of Adélie penguins on Petermann Island, we are able to estimate krill consumption, time at sea foraging, and its effects on both adult and chick survival. We hope that by accomplishing this objective, we are able to better comprehend the influence of krill fisheries on penguin populations and therefore the greater Antarctic ecosystem. Lastly, along with our Zooniverse collaborators, we have successfully completed the beta version of our citizen science website, which brings us a step closer to launching the full alpha version of the website and therefore engaging the public in our research while also informing users of the importance of monitoring biodiversity in the Antarctic.

4. Project support to the Conventions (CBD, CMS and/or CITES)

Agreements such as the Agreement on Albatrosses and Petrels (ACAP) show the urgent need for monitoring of avian predators in Overseas Territories. The CBD and CMS have not been ratified for the Falkland Islands, South Georgia and British Antarctic Territories, but these territories have management plans expressing similar intentions to protect and conserve biodiversity and range. Estimates of population size and the timing of breeding are derived from very few sites near to scientific bases, resulting in very poor statistical power to detect change. Low cost, easily-calibrated techniques are needed that could be scaled up across other overseas territories.

We are now in a position to offer support to offer over-wintering data and the influence on arrival dates and reproductive success in the summer. Until now, no over-wintering data has meant that predator input into the fisheries catch limits is based entirely on the previous summer's activity and a few monitored sites.

Secondly, we will be providing monitoring support to GSGSSI to on the CBD as they seek to monitor and promote recovery post rat and reindeer removal.

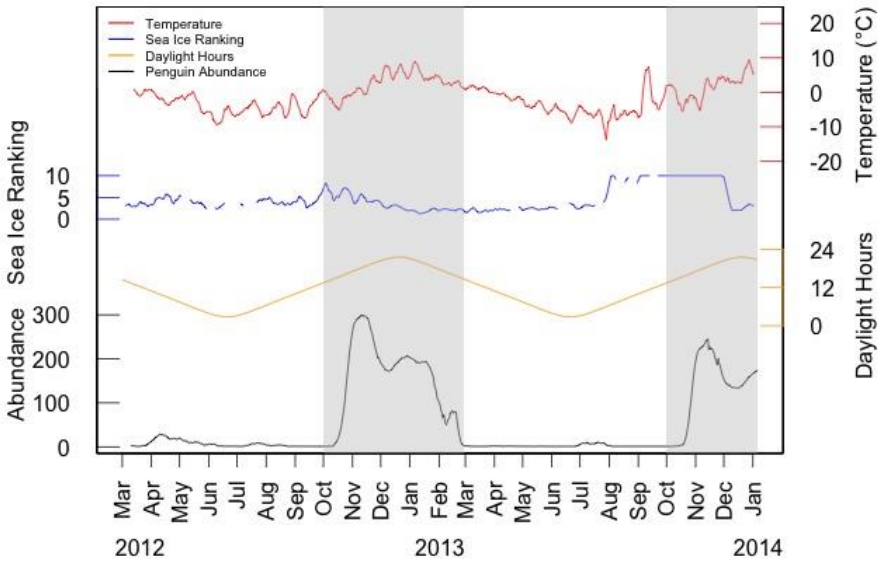

Figure 8: Year-long data extracted by annotation and citizen science in the beta test, showing moving average trends in penguin abundance, regional daylight hours, sea ice rankings, and temperature over time. Grey rectangles indicate the breeding season. We are now working on automated prediction of summer arrival date and breeding to aid in fisheries management.

5. Project support to poverty alleviation

This project is not directly related to poverty alleviation, but we do hope that the development of very cheap tools to monitor wildlife will allow local conservationists to engage a wider community and also to aid fundraising, for example in places like Tristan da Cunha, where direct visitation or ecotourism is extremely limited by ship access, but online presence and donations could funnel money into conservation projects.

6. Monitoring, evaluation and lessons

Monitoring and evaluation has been relatively easy against the objectives; the deployment of the network is easily quantifiable and the tools are relatively simple to assess whether they work or not. However, the scale images collected has already over-reached the planned crowd-sourcing through our own website. However, as we have partnered with Zooniverse, we are confident we can deliver data extraction from all of the cameras, for ourselves and partners. Additionally, work is progressing well on the automation. For detailed comments, see appendix 1.

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

Not relevant, as this is the first annual report.

8. Other comments on progress not covered elsewhere

The biggest delay, which was not anticipated was the late delivery of cameras to the Falkland Islands. Buying cameras in bulk allowed us to gain a substantial discount and therefore an additional number of cameras. However, cameras surface shipped to the Falkland Islands were delayed. This, coupled with a heavy sea ice year resulting in a change of itinerary, resulted in the majority of cameras we expected to deploy in year 1 not arriving in the Falklands until late in the season. These cameras are now in storage at Falklands Conservation, removing this risk from next year's fieldwork.

9. Sustainability

Two efforts have been made to expand this work, enhance capacity and to ensure long-term funding. Firstly, at the International Penguin Conference, additional partners were sought and a number of new collaborators have agreed to place cameras on penguins within and outside the Southern Ocean. At the International Seabird Conference in Oxford, a number of people expressed interest in applying this to other colonial seabirds, so support for long-term large scale participation is growing.

The Zooniverse crowdsourcing project is due to go live in June and we are including five species of penguin and two species of flying seabird (puffin and kittiwake). We have also built in the capacity for volunteers to identify other categories that can change between project, such as human disturbance. We anticipate working with additional partners to help them deploy cameras in the near future.

Quark Expeditions this year raised and donated nearly £40,000. We hope that annual donations close to this will be sufficient to sustain the project at the end of Darwin Plus funding. This is intended to be long-term monitoring and as such there is no exit strategy, but the development of the satellite linked camera with solar power means that we should be able to leave cameras for much longer between servicing.

10. Darwin Identity

The project is publicised on the Penguin Lifelines website (www.penguinlifelines.org) with the Darwin Plus logo, and in all talks, which this year were approximately 20 public talks to approximately 4,000 people and three talks within conferences to approximately 700 people within the conservation community.

The Darwin logo and name will be widely used in the media in relation to the citizen science tool when it is launched in June. Currently it is anticipated that most of the 900,000 users will see the logo and project description.

The Darwin logo is used explicitly in relation to the camera network and citizen science, thereby identifying it as a separate project. Within the host countries, identity varies. Within the Falklands and South Georgia, the identity is very clear. Within the British Antarctic Territory, the audience is primarily comprised of international travellers on tour ships, so far more explanation is required.

11. Project Expenditure

Table 1 project expenditure during the reporting period (1 April 2013 – 31 March 2014)

Project spend since last annual report	2013/14 Grant (£)	2013/14 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)				**37.42**
Consultancy costs				
Overhead Costs				**0.13**
Travel and subsistence				**-486.42**
Operating Costs				**449.05**
Capital items (see below)				
Others (see below)				
TOTAL	**137,715**	137,714.82		**0.18**

Highlight any agreed changes to the budget and explain any variation in expenditure where this is +/- 10% of the budget. Have these changes been discussed with and approved by Darwin?

Annex 1: Report of progress and achievements against Logical Framework for Financial Year 2013-2014

Project summary	Measurable Indicators	Progress and Achievements April 2013 - March 2014	Actions required/planned for next period
Goal/Impact This project will massively increase the number of monitored penguin populations around the Southern Ocean, by deploying autonomous camera units that can record the timing and duration of breeding. This will help to identify threats (for example, by differentiating between the influence of climate change and fisheries on penguin breeding success around the Scotia Arc). This project will also provide a template and tools for similar monitoring projects elsewhere through the provision of an online database and analysis tool.			
Output 1. Design and deploy a network of SAMS sites around the Scotia Arc.			
Activity 1.1: Complete the power analysis of available monitoring sites and couple these with the Lynch et al 2012 sites of high leverage for estimates of krill consumption. Design the network of SAMS sites in relation to these high value colonies for monitoring.	A report to the FCO and to the Antarctic Treaty showing the placement of cameras and images obtained, analysed for the phenological parameters of breeding required. A manuscript showing power analysis of currently monitored sites versus species and region.	Nearly complete, a report has been submitted to the FCO and a manuscript is in preparation that will show the needs for monitoring and trends of penguins in the Scotia Arc.	Submission of this manuscript for publication and a report based on this manuscript to the Antarctic Treaty Consultative Meeting, the South Georgia Government and the Falkland Islands Environmental Planning Department.
Activity 1.2: Order the cameras and components to the Falkland Islands for assembly.	Successful deployment of the network.	Behind; only 15 new cameras were placed in 2013/14. This was due to a change of route due to a big sea ice year and late arrival of cameras shipped from the US to the Falkland Islands.	A higher rate of deployment; this has been addressed with an additional yacht charter, cameras ready in the Falklands and more ship time in the South Sandwich Islands and the Antarctic Peninsula.
Activity 1.3: Beta test a satellite-linked camera for deployment in remote, unvisited areas.	A series of images received onto the Irridium (satellite network) server and placed into the	Complete	Further deployment of satellite cameras.

Activity 1.4: Deploy the camera trap in the 2013/14 season using Quark vessels and existing fieldwork plans.	Increase the number of cameras placed.	See 1.2	
Output 2. Build an online database capable of storing and annotating data from 100 SAMS for this project and 200 SAMS from other projects			
Activity 2.1: Test current trial version with multiple user images and users.	Complete; 20 users annotating images from the 2012/13 field season.	Complete, testing of the annotator with additional users was completed and successful. However, the number of images collected in 2013/14 greatly exceeded the rate at which volunteers within our site could annotate images. We therefore approached Zooniverse for a partnership due to the large number of volunteers they have on projects.	None
Activity 2.2: Redesign beta version and go live on www.penguinlifelines.org	A sizable proportion of the online images annotated by volunteers (crowdsourcing) to allow validation of automatic analysis and to generate data from images. A useful benchmark would be over 1000 users capable of annotating at least 20,000 images per year.	Images from pilot data and the current network now number 150,000, with an increase of 25 sites expected next year and a doubling of the rate of collection. We therefore anticipate the collection of 250,000 images from this network per year from now on and an additional 50,000 images from collaborators, which we would like to In light of this, the performance indicator is inappropriate. We would therefore like to scale this up to all of the data annotated per year.	Validation of crowdsourced data, publication of the phenological indicator.
Output 3. Extract breeding parameters from image data and conduct a network analysis.			

Activity 3.1: Generate count data and clustering statistics from the data on the image database.		Incomplete, we have been working with zooniverse on how to process the data such that the output from crowdsourcing will be compatible with our summary indicators and with machine learning tools.	Finish count data interpretation and publish report..
Activity 3.2: Pass to Dr Rezek for network analysis to determine network structure.	A paper and/or an online tool to determine clustering from count data.	Incomplete, waiting for additional count data from zooniverse.	Complete network analysis.
Activity 3.3: Compare the network derived from breeding phenology with estimates of population genetic structure and current management areas to determine areas of conflict.	A methodological paper.	Incomplete, waiting for genetic structure analysis to be completed.	Complete and publish report.

Annex 3 Standard Measures

Please expand and complete Table 1: new projects should complete the Y1 column and also indicate the number planned during the project lifetime. Continuing project should cut and past the information from previous years and add in data for the most recent reporting period. Quantify project standard measures over the last year using the coding and format from the Darwin Initiative Standard Measures (see website for details: http://darwin.defra.gov.uk/resources/) and give a brief description. Please list and report on relevant Code Nos. only. The level of detail required is specified in the Standard Measures Guidance notes under 'definitions' column. Please devise and add any measures that are not captured in the current list. Please note that these measures may not be a substitute for output level objectively verifiable indicators in the project logframe.

Table 1 Project Standard Output Measures

Code No.	Description	Year 1 Total	Year 2 Total	Year 3 Total	Year 4 Total	Total to date	Number planned for reporting period	Total planned during the project
8	Number of weeks spent by UK project staff on project work in the host country	18						
14A	Number of conferences/seminars/ workshops to be **organised** to present/disseminate findings.	1						
14B	Number of conferences/seminars/ workshops **attended** at which findings from Darwin project work will be presented/ disseminated.	2						

In Table 2, provide full details of all publications and material produced over the last year that can be publicly accessed, e.g. title, name of publisher, contact details, cost. Mark (*) all publications and other material that you have included with this report.

Table 2 Publications

Type (eg journals, manual, CDs)	Detail (title, author, year)	Publishers (name, city)	Available from (eg contact address, website)	Cost £

Annex 4 Onwards – supplementary material (optional but encouraged as evidence of project achievement)

2013 Penguin Conference, Bristol UK
ORAL PRESENTATION ABSTRACT

Seabird Autonomous Monitoring Systems (SAMS) and large-scale monitoring of penguins around the Southern Ocean

Tom Hart[1], Ben Collen[2], Colin Southwell[3], Andrew Zissermann[1], Heather Lynch[4]

1. University of Oxford;
2. Zoological Society of London;
3. Australian Antarctic Division;
4. Stony Brook University.

The biology of the Southern Ocean is changing and we need a step-change in the amount of biological data collected to understand the relative threats of climate change, fisheries, human disturbance and disease to animals in the region. While remote and logistically hard to work in, much of the Southern Ocean is visited regularly by tourist and scientific vessels. Opportunistic visits have been used to great effect to monitor large numbers of sites in the Antarctic Site Inventory. Counts, coupled with autonomous data recorders can monitor an area far greater than before and for measuring parameters that have hitherto only been recorded at a few sites, and largely next to scientific bases. Autonomous recording stations have the potential to revolutionise data collection as they are able to collect many of the parameters of breeding that usually require long-term researcher presence in the field. We present a network approach to monitoring colonies around the Southern Ocean, demonstrating (1) a power analysis of the most important sites for data collection, (2) a trial of 32 time-lapse cameras and SAMS around the Scotia arc and (3) an automated analysis of the visual data collected. We present results as to the signature of the different breeding parameters in images and over-winter and (4) How to automate analysis of the data collected to integrate it into a monitoring network that can feed into monitoring and management of the Southern Ocean.

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.	
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.	
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.	
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.	
Have you involved your partners in preparation of the report and named the main contributors	
Have you completed the Project Expenditure table fully?	
Do not include claim forms or other communications with this report.	