http://www.darwin.gov.uk

ECTF

Edinburgh Centre for Tropical Forests
John Muir Building, Kings Buildings,
University of Edinburgh,
Mayfield Rd,
Edinburgh EH9 3JK, UK

stefanie.halfmann@ed.ac.uk
Tel: +44 (0)131 650 7862
Fax: +44 (0)131 650 7863

Darwin Initiative Annual Report

1. Darwin Project Information

Project Ref. Number	*162/12/018*
Project Title	*Climate Change and Conservation of Galapagos Bird Species*
Country	*Ecuador*
UK Contractor	*Wildlife Conservation Research Unit (WildCRU), Oxford University*
Partner Organisation(s)	*Galapagos National Park Service (GNPS) and the Charles Darwin Foundation (CDF)*
Darwin Grant Value	*£120,000*
Start/End dates	*April 2003 / March 2006 (final report 30th June 2006)*
Reporting period and report number	*1 April 2004-31 March 2005* *Report Number 2*
Project website	*http://www.wildcru.org/research/es/galapagosbirds.htm*
Author(s), date	*Professor David Macdonald & Hernán Vargas, 30 April 2005*

2. Project Background

This project is conducted in the Galapagos Islands, Ecuador. The Archipelago is well known for its unique endemic biodiversity. The majority of the land, and of the marine areas, are protected in the Galapagos National Park (GNP) and Galapagos Marine Reserve (GMR), respectively. The project aims to mitigate existing and future

negative impacts on three endangered bird species - the Galapagos penguin, Flightless cormorant and Mangrove finch - and associated biodiversity.

3. Project Purpose and Outputs

3.1. Purpose

- To increase local expertise in scientific research, ecological monitoring and sustainable management in the Galapagos Islands.
- To understand the underlying mechanisms associated with natural and anthropogenic impacts on the conservation of threatened endemic bird species, and the associated biodiversity, in the rich upwelling ecosystems of the Galapagos.

3.2. Outputs

- At least 8 Ecuadorian students trained in research methodologies and conservation biology, and 8 park rangers trained in wildlife management and monitoring techniques.
- Management plans and manuals for long term monitoring and conservation of the three endangered bird species with reference to climate change, fisheries and alien predators.
- Practical recommendations and multilayered maps for the zoning, and use, of the GMR.

4. Progress

4.1. Brief history of the project to the beginning of this reporting period.

The project began formally on 1st April 2003. Project planning and purchase of key equipment took place between April and July 2003, and fieldwork began in August that year. To facilitate assessment of the impact of climate variability on bird demography, the schedule includes two intensive field seasons each year - one during the hot rainy season (February-April), and the other during the coldest months (August-October). Two field seasons were conducted in 2003-2004, when the UK-Ecuador DI team, together with collaborators from Germany and the USA, executed various components of the project. Data have also been collected each month by Ecuadorian university students and park rangers.

4.2. Progress over the last year against the agreed baseline timetable for the period and the logical framework (complete Annexe 1).

See results in Annex 1. According to the project implementation timetable for April 2004-March 2005, we agreed to conduct surveys of penguins, cormorants and mangrove finches, train students and park rangers, carry out a workshop, complete a manual for surveying mangrove finches and rats, and publicise the project. With the exception of the manual, which is at its preliminary stage, we have completed all other activities. After careful consideration we have decided that the rat monitoring aspect of the manual will need to be more comprehensive than first we thought (and it will also need to include rats outside mangrove finch areas). We are in the process of recruiting an Ecuadorian specialist to help put the manual together.

4.3. Project's achievements during the last year.

4.3.1. Monitoring sea temperature and precipitation

Sea temperature: Data from 20 fixed temperature loggers were downloaded in February 2005. These devices have been recording continuous data, at 10m and 20m depths, every half hour since their deployment in September 2003.

Precipitation: Data from logging rain gauges at Caleta Iguana and Playa Tortuga Negra were downloaded in March 2005.

Analysis: Preliminary analysis suggests that sea temperatures were generally low during 2004-2005, and likely to be associated with successful breeding and post-fledging survival of penguins and cormorants. Conversely, scant precipitation on land in the same period was most likely insufficient for successful nesting by Mangrove finches – no more than 4 active finch nests were found in each of 2004 and 2005.

Final year: Environmental variables (sea temperature and precipitation) will be correlated with bird demography data (egg productivity, chick survival, movements and dispersal). Fixed temperature loggers and rain gauges will continue to collect data, which will be downloaded every six months.

4.3.2. Demography of penguins and cormorants

To facilitate monitoring bird variables, we originally proposed using microchips (PIT-tags) to mark one third of the penguin and cormorant populations over three years. We have achieved this; to date we have marked 683 penguins and 989 cormorants.

Birds are monitored every month at the selected sites - data gathered include distribution, total population numbers, egg and chick productivity, survival, movements and dispersion. In September 2004, we conducted a complete 10-day census of penguin and cormorant populations over their entire geographical range.

Analysis: All data have been entered into our database, this constituting a basis from which to tackle all the other project objectives.

Final year: The data will be further evaluated. As sufficient numbers of adult birds have been marked, we will preferentially mark chicks and juveniles in the final year.

4.3.3. Research on the foraging behaviour of the Flightless cormorant and the Galapagos penguin

During the 2004-2005 field seasons, we deployed the GPS-TDlog on 26 cormorants, and the PreciTD-Log on 34 different cormorants. We also deployed the GPS-TDlog device on 10 penguins. Between August 2003 and March 2005, we have sampled a total of 90 cormorants and 20 penguins.

Analysis: Cormorant GPS data are at an advanced stage of analysis, and shape files have been created for each bird using ArcView. 50% of the data on cormorant diving behaviour have also been analysed. Analysis of penguin data has not yet begun.

Final year: Antje Steinfurth and Rory Wilson will collaborate in completion of penguin and cormorant analyses respectively. We believe that we have already collected sufficient cormorant data. Penguins are more difficult to sample as they nest in caves, and nests may be inaccessible for retrieving the devices to download data. We will attempt to sample at least 10 more penguins during the final year.

4.3.4. Annual penguin and cormorant census

Between 26 August and 4 September 2004, we used our own standard methodology to complete penguin and cormorant censuses along parts of the Archipelago coast where the species are known to occur. As well as monitoring and relocating PIT-tagged penguins and cormorants, to evaluate their between-site movements, the annual census allows us to collect data on cormorant nesting success and juvenile survival for both species.

We counted a total of 858 penguins, 11% more than the 770 recorded in 2003-2004. The greatest Galapagos penguin population ever recorded was in 1971 with 1,931 penguins; our 2004 count was less than half this number. Since 1998, when the last strong Nino occurred, penguin numbers have recovered well on Isabela, but not on Fernandina. In 2004 about 14% of the population consisted of juvenile birds, which is consistent with the long-term average since 1998.

A total of 1,411 Flightless cormorants were counted in 2004, the second-highest number ever recorded during a survey, and approximately double the number counted in the first survey (1977). It is also a slight decrease from the 1,456

cormorants recorded in 2003. Cormorant numbers on southwestern Isabela have increased steadily. About 6% of the cormorants recorded in 2004 were juvenile birds, fewer than the 12% recorded in 2003.

Analysis: A technical report including results from the 2004 penguin and cormorant census was submitted to the National Park (Wiedenfeld & Vargas 2004) [Appendix 1: Attached]. Data collected between 1970 and 2004 were analysed for the Briefing book (CBSG-IUCN/SSC 2004) [Appendix 2. sent by post] used in the PHVA workshop, and also for the recently published paper in *Ibis*: Population size and trends of the Galapagos Penguin (Vargas et al. 2005) [Appendix 3. attached]

The annual penguin and cormorant census provides key GPS data on locations and bird distribution for the production of maps that will be incorporated into the "Manual for monitoring penguins and cormorants".

Many features of the surveys have been standardised. However, some have not, e.g. the amount of time spent surveying, and the time of day each section of coast is surveyed. Because these factors could affect the comparability of surveys, they will be standardised in future according to the "Instruction Manual for monitoring penguins and cormorants", being put together for this purpose (Vargas In preparation). [Appendix 4: Sent by post]

Final year: Records of PIT-tagged birds, egg and chick productivity, population numbers and distribution (based on GPS location) gathered during annual censuses will contribute to several chapters of the Ph.D. thesis. The next penguin and cormorant census will take place in September 2005. As in previous years, it is expected that Sea World will fund this. The "Manual for monitoring penguins and cormorants" will be completed, revalidated in the September 2005 census, and published in April 2006.

4.3.5. Health status, diseases and parasites

In 2005 we completed collection of the samples necessary for studying the prevalence of diseases and parasites in penguins and cormorants. This work is conducted in partnership with the Saint Louis Zoo and the University of Missouri, Saint Louis. Blood, faeces and conjunctival-choanal-cloacal swabs were each taken from 412 penguins and 603 cormorants on four separate occasions (August 2003, and March 2004, August 2004 and February 2005).

Analysis: Comprehensive blood work has never previously been conducted on the Flightless cormorant or Galapagos penguin. Blood samples from 70 cormorants (taken in 2003), and 132 penguins (taken in 2003 and 2004) have been tested to identify normal haematology baseline values (complete blood counts and biochemistry analysis). Blood smear evaluations and molecular tests (for haemoparasites) were also conducted. Serological tests were conducted for 13 different viruses (including West Nile virus), and one bacterium (*Chlamydophila psittaci*). The birds appeared to be healthy. However, some cormorants were seropositive for adenovirus type 1, while some cormorants and penguins were seropositive for *C. psittaci*. This means that antibodies for these disease agents were detected, but not that the birds were actively infected. Blood was also evaluated microscopically for the presence of haemoparasites - microfilarids were found in both bird species. Molecular tests (Polymerase Chain Reaction (PCR)) also revealed the presence of haemoparasites, but further work will be necessary to differentiate between *Plasmodium* and *Haemoproteus*. As result of this collaborative effort, one paper has been submitted on the baseline blood work and disease surveillance of the Flightless cormorant (Travis et al. Submitted) and a similar manuscript on penguins is currently being finished for submission (Travis et al. In preparation). A separate manuscript is being prepared on microfilarid parasites in both bird species.

Final year. All samples will be analysed by December 2005. The same blood samples, which were collected for investigating diseases, will be used to study the genetic structure of cormorants, and the genetic diversity and sex ratio of penguins.

Since all the sampled birds are marked with PIT-tags, we are hoping to continue our collaboration, with Saint Louis Zoo and the University of Missouri, on heath status monitoring of both species – we are in discussions with them over this.

4.3.6. Effect of El Niño on sex ratio

This component aims to determine whether El Niño causes sex-biased mortality among adult penguins. We hypothesised that male survival would exceed that of females during an El Niño event, when the availability of food is greatly reduced.

Analysis: To date, 182 penguin blood samples, taken in August 2003 and March 2004, have been sexed using PCR techniques at the University of Missouri. Of these, 111 (61%) were males and 71 (39%) females. This ratio of 111:71 is significantly skewed towards males at the Archipelago level ($X^2 = 8.79$, df = 1, P = 0.003). However, the sex ratio per island was biased towards males only on Fernandina where, of 33 penguins captured, 76% were males and 24% females ($X^2 = 8.76$, df = 1, P = 0.003). The bias was only marginally significant on Isabela ($X^2 = 4.17$, df = 1, P = 0.041).

Final year: All remaining penguin blood samples will be sexed. This information will also be used to investigate the extent of sexual dimorphism in penguins. First, a multivariate method (discriminant analysis) will be used on the sexed individuals to assess the extent to which sex can be predicted by a series of measures (e.g. 3-D beak measurements, body weight) routinely made on penguins during our surveys. Our results can potentially be used to extrapolate back to data gathered from 418 penguins between 1996 and 2001, and from that to make estimates of the past sex ratio during the strong El Niño of 1997-98.

4.3.7. Monitoring the effect of the introduced Black rats (*Rattus rattus*) on the Galapagos penguin and the Mangrove finch

As part of the matched funding provided by the GNPS, GNPS personnel carried out rat trapping (using live tomahawk traps) for ten days in October 2004. Trapping took place at selected sites considered to be important for the Galapagos penguin, the Mangrove finch, and endemic rats, *Nezorysomys narboroughi,* which are not thought to disadvantage native birds, and which are usually out competed by the introduced Black rats. We began monitoring Black rats at Caleta Iguana in 2004 after identifying Caleta Iguana as the most important nesting site for the Galapagos penguin on the Archipelago. The GNPS has agreed to include Caleta Iguana as one of their regular sites for monitoring the effects of introduced rats on penguins in the coming years. Rat trapping was also conducted at Playa Tortuga Negra and Caleta Black, the two main strongholds of the Mangrove finch.

The good news is that, during October 2004, we detected no Black rats on Fernandina, suggesting that this invasive species has not yet arrived on this pristine island, where significant numbers of penguins and endemic rats occur. On the other hand, Black rats were detected at Caleta Iguana, Mariela Mediana and Bartolome, locations that are important for penguins (Table1). Rats were also found at Playa Tortuga Negra, where the main Mangrove finch population survives. No rats were detected on Mariela Grande, Mariela Pequeña, and Lougie where Brodifacaum poisoning had previously taken place. The fact that these islands remain free of the introduced rats can be considered a major success. The relatively small number of Black rats detected at most of the sites during 2004 may reflect the impact of the drought that occurred over the previous two years (2003-2004). The number of endemic rats trapped on Fernandina suggests that they may be less dependent on rain than are Black rats (Table 1)

Analysis: A rodent monitoring manual for the Galapagos is currently being outlined and prepared. A database has been designed to manage the data on monitoring endemic and introduced rodents. The GNPS has agreed to incorporate rodent monitoring into its annual operation. Two 10-day trips are to be made each year; one in the rainy season (late February-early March) and one in the dry season (late September- early October).

Final year: The rodent monitoring manual will be completed and published.

Table 1. Results of rodent trapping in the Galapagos, 20th-30th October 2004.

Island	Location	Traps/night	Rat species	Individuals
Isabela	Caleta Iguana[P]	60	*Rattus rattus*	3
Marielas	Mariela Mediana[P]	20	*Ratus rattus*	3
Marielas	Mariela Grande[P]	36	No rat	0
Marielas	Mariela pequeña[P]	5	No rat	0
Fernandina	Punta Mangle[P,ER]	60	*Nezorysomys narboroughi*	22
Fernandina	Copiano[P,ER]	60	*Nezorysomys narboroughi*	9
Fernandina	Espinosa[P,ER]	60	*Nezorysomys narboroughi*	14
Isabela	P.Tortuga Negra[MF]	119	*Rattus rattus*	2
Isabela	Caleta Black[MF]	61	No rat	0
Santiago	Albany [ER]	19	No rat	0
Santiago	Mao[ER]	15	No rat	0
Bartolome	Bartolome[P]	60	*Ratus rattus*	12
Baindridge	Bainbridge[ER]	90	*Rattus rattus*	5

Site important for:

[P] = Penguin

[MF] = Mangrove Finch

[ER] = Endemic rat

4.3.8. Fisheries

The CDRS and the GNPS continued to collect data on sea cumber fisheries as part of the matched funding they provide. Meetings with fishermen were conducted in the framework of the participatory management process and were aimed at resolving current conflicts, especially regarding long line and sport fishing. Fishermen continue to exert pressure on the central government to be allowed to carry out unregulated sport fishing and long lining activities in the Galapagos Marine Reserve. Long line fishing is known to be one of the most destructive fishing methods, and is responsible for considerable “by-catch” of non-target species, such as albatrosses, in other parts of the world. If these fishing activities are permitted in the Galapagos, they may have negative consequences for the persistence of penguins and cormorants and other biodiversity. A trial conducted in Galapagos waters confirmed that these techniques are destructive and the prospect of such fishing being allowed in the GMR is a great concern. The GNPS is taking steps to sanction fishing boats that break the Special Law for Galápagos. Patrols of the Marine Reserve are to be maintained with the support of the Ecuadorian Navy.

Present status: It is difficult for the GNPS to monitor the entire coast of the Galapagos Archipelago, because they have limited personnel and funding. Consequently, it is not uncommon to find illegal fisherman campsites - several were discovered last year, and as recently as January 2005, often in sea cucumber areas. These camps are also often found in critical breeding locations for the Mangrove finch, cormorants and penguins. The presence of campsites increases the risk of introducing exotic species, e.g. rats and fire ants, into these important and vulnerable habitats. From January 2005, patrolling and vigilance activities will be stepped up,

with the introduction of a new long-distance patrol boat. This boat will also carry out oceanographic studies, which may benefit the birds, and it will act as a support boat for the other patrol boats owned by the GNPS. The GNPS has offered to collaborate, by using this boat to provide DI personnel with transport to western Isabela, where the selected penguin and cormorant colonies are located.

The CDRS, the GNPS and the Participatory Management Board (PMB) have agreed to conduct pilot studies to evaluate the feasibility and impacts of allowing sport and long line fishing in the Galapagos, as well as fishing for a different sea cucumber species. These studies should be completed before June 2005. Meanwhile, the Inter-institutional Management Authority (IMA) has enacted a 2-year moratorium on sea cucumber fishing (2005 and 2006).

Final year: GIS layers will be created from our data on fisheries, bird distribution, nesting sites, and foraging ranges, to facilitate measurement of the degree of overlap between fisheries and areas vital for the survival of penguins and cormorants.

4.3.9.Training

Five park rangers and 1 high school student have been trained in ecological monitoring techniques. Four undergraduates and 1 Ph. D. student have been trained in research methodologies, ecological surveying, monitoring, basic GIS, experimental design, and modelling. For more specific details of the nature of training received by each type of student, please see: “Response to Annual report review”, 30 October 2003, submitted to the Darwin Initiative with the previous 6-monthly report.

One of the undergraduate students, recruited in March 2005, will conduct her Tesis de Licenciatura on the movements, breeding dispersal and reproductive success of cormorants.

Final year: We expect to recruit at least two more Ecuadorian students to work as volunteers. Park rangers will continue to participate in the activities described above. The student is to submit her Tesis de Licenciatura by January 2006.

4.3.10. Multilayered GIS database

The GIS technician working at the CDF has been compiling, organising and making shape files from the different types of GPS data. Data include: foraging data from GPS devices deployed on cormorants and penguins, and location data relating to birds being marked and recaptured, different bird densities, rat-trap stations, mangrove finch censuses, fishing boats and fishing sites.

Bathymetric maps of the Archipelago, including the coastline, are being geo-referenced and used as base maps on which to overlay the data layers.

Final year: Multilayered database will be completed.

4.3.11. Significant difficulties encountered during the year

The most significant difficulty encountered has been the instability at the National Park Service. Four successive GNPS directors were appointed during March 2004 and April 2005 and the GNPS suffered cuts in budget and personnel. This posed difficulties for implementing monitoring activities due to the reduced capacity of boat transportation and of park staff to assist the DI team. The DI- team currently lacks an outboard motor and a zodiac dinghy needed to census and monitor selected colonies of penguins and cormorants in the western Galapagos. This transportation was provided until two months ago by the GNPS.

Another difficulty experienced by the project has been the lack of highly trained personnel in the host country to implement the various technical components of the project (e.g elaboration of manuals, direction of GIS outputs, planning and administration of budget and expenses, among others). This has placed a heavy

workload on Hernan Vargas, our Ph.D. student, who also has responsibility for data analysis, completion of his thesis and production of reports and publications.

4.3.12.Timetable (work plan) for the next reporting period.

Period/month	Year	Activity
April 2005- March 2006	2005 2006	Monthly monitoring of bird variables at selected colonies/sites
June 2005- April 2006	2005 2006	Data analysis, writing of thesis and preparation of manuscripts for publication
June 2005- March 2006	2005 2006	Preparation of GIS data and GIS layers for multi-layered database
July 2005	2005	Completion of PHVA report and manuscript
September	2005	Implementation of penguin and cormorant census
September	2005	Monitoring of rats at penguin and Mangrove finch sites
October	2005	Submission of six month DI report
November	2005	Submission of technical reports to the GNPS and CDF
December	2005	Draft Ph.D. thesis prepared
January-March	2006	Review of thesis by thesis panel and revision by student
April 2006	2006	Final submission of Ph.D. Thesis
April-May 2006		Completion and publication of manuals and management plans. Completion of multi-layered database.
June 2006	2006	Submission of two manuscripts to peer-reviewed journals
June 30	2006	Submission of final report to the Darwin Initiative

This timetable is in good agreement with the timetable in our original proposal. The only significant difference is in the timing of submission of the Ph. D. thesis - originally planned for October 2005, but now rescheduled to April 2006. This delay is likely because it is intended that the data chapters will appear in the thesis as a compilation of advanced-stage manuscripts nearly ready for submission to peer-reviewed journals.

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

We made a comprehensive response (Macdonald & Vargas 2004) to the review which was submitted to the Darwin Initiative in October last year. In our response, we provided detailed answers to each of the questions raised by the reviewers.

We have continued to analyse the various data sets in order to provide scientific answers necessary to determine the appropriate management of the species. One key criterion is knowledge of the species' population size, as species are clearly more likely to become extinct when their populations become smaller than the minimum viable size. This is the theme of papers published recently in Ibis (Vargas et

al. 2005), and Oryx (Dvorak et al. 2004), which draw attention to critical population sizes for the Galapagos penguin and Mangrove finch, respectively.

We have made efforts to link climate change with the population dynamics of penguins. We correlated sea surface temperature between1965-2003 to penguin numbers between 1970 and 2003. The analysis revealed a strong link between the ENSO (El Niño Southern Oscillation) cycle and penguin population changes. The population shows positive growth during cold La Niña periods and negative growth during El Niño episodes. The manuscript was completed and submitted to Oecologia in January 2005 (Vargas et al. Submitted).[Appendix 4, attached]

We committed to teaching the university students ecological modelling. The students were introduced to the software VORTEX (Lacy 1993; Miller & Lacy 2003) and learned the basics of modelling during the PHVA workshop in February 2005. Our Ph.D. student and other participants of the PHVA workshop modelled the effects of El Niño under different scenarios of intensity and frequency of strong and weak El Niño events. A draft of this manuscript (Vargas et al. In preparation) [Appendix 6, attached] is in preparation, and this will be submitted to a peer-reviewed journal in the coming months. The modelling results indicate that, under the present El Niño conditions, the Galapagos penguin population has a 30% probability of extinction in the next 100 years. If strong Niño events were to become twice as frequent, then the probability of extinction would increase to in excess of 90%.

Our partner organisations in the Galapagos (CDF and GNPS) have continued to work with the fishing cooperatives and other stakeholders as members of the Participatory Management Board (MPB). Despite the political instability of the GNPS and the pressure from fishermen to be allowed to fish everywhere in the GMR, we have made progress with collecting valuable fishing data. This was possible through a combined effort between the CDF, GNPS, fishing cooperatives and the tourist sector. These data will be used: 1) to assess the impact of opening the sea cucumber fisheries legally this year; and 2) as an input to the multi-layered database.

Students are participating in all phases of the project including ecological surveying, monitoring, basic GIS, experimental design, and modelling. One of the undergraduate students will use data collected during the DI project for her Tesis de Licenciatura at the Universidad Católica del Ecuador.

Copies of technical reports and publications have been submitted to the GNP. Main documents submitted are listed in this report. The project web page is now completed (*http://www.wildcru.org/research/es/galapagosbirds.htm).*

We have given serious thought to progressing from data collection to data analysis, modelling, publishing and the production of management recommendations to the GNPS.

In summary, for the third year we propose the following timetable:

May-December 2005: Data analysis of various data sets and writing of Ph.D. thesis. First draft of thesis will be submitted to thesis panel in December 2005.

January-April 2006: Thesis panel will review thesis, and Ph.D. thesis will be completed. Publication of manuals and management plans with recommendations for the GNPS. Completion of undergraduate Tesis de Licenciatura.

May-July 2006: Final report to the Darwin Initiative. Preparation of three manuscripts and submission to peer reviewed journals.

6. Partnerships

The Galapagos National Park Service (The GNPS)

During 2003-2004, the GNPS suffered from the political instability in Ecuador. Several GNPS directors were appointed and lasted only a couple of months. These unexpected changes required timely action by the DI project coordinator in order to continue progressing the planned work. Park rangers continue to be trained and,

operating from the Base Bolivar in northwestern Isabela, they participated in the monitoring of penguins and cormorants. However, factors beyond our control, such as a reduction in the number of park rangers (more than 100 employees were fired this year), and delay in the delivery of funds from the central government, reduced the capacity of the National Park for patrolling the GMR. As a consequence, fishermen fished illegally in the reserve and established illegal campsites in several areas (see fisheries section).

The Charles Darwin Foundation

In February 2005, Dr. Graham Watkins was appointed as the new executive director of the CDF. He has committed himself to fully supporting our work over the rest of the DI project.

The Darwin project has catalysed a series of positive collaborations with other organisations specialising in various subjects. This will strengthen our project outputs. The main collaborating institutions are:

Ecuadorian Universities

Ecuadorian Universities continue to provide undergraduate students to participate in the Darwin project for 2-6 month periods. To date, we have recruited students from six Ecuadorian universities: Universidad de San Francisco, Universidad Católica, Universidad Central, Universidad de Guayaquil, Universidad Politécnica del Litoral and Universidad de Loja.

The Saint Louis Zoo and University of Missouri, Saint Louis

Main lines of collaboration

1. Avian diseases and health status of penguins and cormorants
2. Sex ratio of the Galapagos penguin
3. Genetic structure of Flightless cormorants
4. Past and present genetic diversity of the Galapagos penguin

Collaboration lines 1 and 2 have been carried out since August 2003 under the leadership of Prof. Patricia Parker. Collaboration lines 3 and 4 were initiated this year with collection of the samples necessary to determine the genetic structure of cormorants and the genetic diversity of the Galapagos penguin. Lines 3 and 4 constitute the thesis of two Masters students at the University of Missouri, with completion scheduled for the end of 2005.

University of Swansea and University of Kiel

The Darwin Project established this collaboration to study the foraging behaviour of penguins and cormorants. Dr. Rory Wilson (University of Swansea), his Ph.D. student Antje Steinfurth (University of Kiel) and other members of Dr. Wilson's team have been involved in data collection and analysis of the data gathered using GPS-TD and Preci-TD loggers. Antje Steinfurth, will be involved in the analysis of data on penguin foraging behaviour, and Dr. Wilson will focus on the analysis of foraging behaviour among cormorants.

Durell Wildlife Conservation Trust

As a joint effort between the DI team and the CDF, the Durrell Wildlife Conservation Trust (DWCT) was invited to collaborate in research and monitoring activities aimed at recovering populations of the critically endangered Mangrove finch. Between the 25th of February and 5th March 2005, ornithologist Glynn Young of the DWCT joined Hernan Vargas on a trip to assess the current status of the finch. We are now putting together a proposal to continue the ecological monitoring and research needed to maintain a viable population of this threatened species. Therefore, the project will also investigate the feasibility of breeding the Mangrove finch in captivity. This will be a five-year project and the DWCT is also interested in seeking funding for this, especially after the Darwin Initiative project comes to an end early next year.

7. Impact and Sustainability

Despite political instability, the GNPS and the CDF should be commended for their efforts to promote the work of this DI project. Evidence that the interest of the GNPS authorities is increasing includes: 1) incorporation of rat monitoring into the GNPS operation for 2004 and inclusion of Caleta Iguana as a regular site for monitoring the effect of rats on penguins; 2) allocation of more funding to finance transportation costs; and 3) allowing park rangers to participate in the project for greater lengths of time. These actions indicate that the GNPS acknowledges the importance of our work and is willing to commit strongly to the long-term conservation of the three endangered species and associated biodiversity via consolidation of the DI project.

8. Post-Project Follow up Activities

See section on partnerships. Although, the project is financed for one more year, the DI team has already initiated talks with the DWCT regarding further research on the Mangrove finch. The Saint Louis Zoo and the University of Missouri are willing to continue with research on genetics, parasites and diseases. We are encouraging Sea World to double the amount of funding that they provide so that two 10-day censuses can be carried out each year. The Worldwide Fund for Nature (WWF) is also interested in allocating some funding towards continued monitoring of penguins, cormorants and mangrove finches.

9. Outputs, Outcomes and Dissemination

Details of project outputs, outcomes and dissemination are provided in Table 1. The project has successfully achieved the outputs originally listed for 2004-2005 in the project implementation timetable. The main difference is that although we have completed advanced drafts of the manuals for monitoring penguins and cormorants and a preliminary draft of the manual for monitoring rodents, these are not yet complete. We believe that the data analysis, which will be done for the Ph.D thesis, will provide complementary inputs for inclusion in manuals and management plans, therefore, these outputs are to be revised and published towards the end of the project. On the other hand, we achieved additional (originally unplanned) outputs: 1) progress in data analysis as described earlier for the various components; 2) preparation of manuscripts; and 3) publications in peer-reviewed scientific journals. This year we were also very successful in continuing “old” and building “new” partnerships with international collaborators.

Table 1. Project Outputs (According to Standard Output Measures)

Code No.	Quantity	Description
15D	3	Press release in Ecuador (target audience: general public)
4A	4	Undergraduate Ecuadorian students trained in research methodologies
4C	1	Ph.D. student from Oxford University trained in scientific modelling methodologies
6A	5	Park rangers and high-school students trained in ecological monitoring techniques
19C	2	Local radio interview in the Galapagos, Ecuador
19C	1	Local radio interview in Quito, Ecuador
14B	2	Preliminary findings presented in conference
10	1	Manual for surveying penguins and cormorants (advanced draft)

10	1	Manual for monitoring rodents (preliminary draft)
14A	1	PHVA workshop for the Galapagos
11B	1	Briefing book produced for PHVA participants
11B	2	Submission of manuscripts to peer-reviewed journal
11B	2	Papers published in peer-reviewed journal

The outcomes of the project were disseminated at local (Galapagos), national and international levels. The focus of the dissemination has been in Ecuador, where awareness is critical if we are to ensure support for this essential conservation work. One large recent activity involving and empowering local stakeholders was the successful PHVA workshop.

PHVA workshop

As a result of the significant threats facing the Galapagos penguin, it was recognised that a meeting was needed to discuss the conservation status of this species. Emphasis was placed on analysis of the viability of the population and its habitat, and the development of management recommendations. Between 8th-11th February 2005, the Population and Habitat Viability Analysis (PHVA) workshop for the Galapagos penguin was held in Puerta Ayora, Santa Cruz Island, Galapagos, Ecuador. This workshop took place because the Darwin Initiative team alerted the relevant community about the need for it. The Darwin Initiative funded the workshop and complementary funding was provided by Sea World, the St. Louis Zoo, and Brookfield Zoo, which also financed the participation of scientific experts from seven countries. The workshop was organised and coordinated by the Darwin Initiative team, the Conservation Breeding Specialist Group of the IUCN - The World Conservation Union's Species Survival Commission (CBSG), GNP and the CDF.

The results of the workshop indicate that the Galapagos penguin is threatened by a variety of factors. The increasing frequency and intensity of El Niño events have increased the risk of extinction in the next 100 years to more than 35%. Mosquitoes, which are vectors of diseases such as West Nile Virus and avian malaria (potentially lethal to the penguins and other birds), have recently been introduced to the Galapagos. Increasing human activity, e.g. tourism, illegal fishing, and oil spills, together with introduced predators, e.g. cats - particularly in penguin nesting and feeding areas - is affecting important aspects of the biological cycle of the species. In addition, the dangerous monofilament nets used by coastal fisheries could soon be common in areas inhabited by penguins.

The workshop participants wrote and signed a declaration on the conservation of the Galapagos. This was submitted to the Minister of Environment of Ecuador and local authorities (Lacy et al. 2005) [Appendix 5: attached]. The declaration urgently recommends:

1. The rapid implementation of regulations to prevent oil spills;

2. Declaration of the Galapagos Marine Reserve as an especially sensitive zone by the Marine International Organisation (OMI);

3. Establishment of regulations prohibiting the use of monofilament nets, especially in penguin feeding and breeding areas;

4. Formulation of measures to prevent the introduction of new diseases to the Galapagos, including prohibition of all international direct flights to the islands and fumigation of all national flights;

5. Participation and inter-institutional cooperation in the ecological and health monitoring programs of the penguins; and

6. Efficient control and inspection of the feeding and reproduction areas of the penguin to ensure that the fishing regulations are strictly adhered to.

Analysis: The PHVA technical report is to be completed by June 2005.

Final year: Recommendations of the PHVA will be incorporated into the management plan for the conservation of the Galapagos penguin.

Table 2: Publications

Dvorak, M., H. Vargas, S. Tebbich, and B. Fessl. 2004. On the verge of extinction: A survey of the mangrove finch (Cactospiza heliobates) and its habitat on the Galápagos Islands. Oryx 38:171-179

Vargas, H., C. Lougheed, and H. Snell. 2005. Population size and trends of the Galapagos Penguin Spheniscus mendiculus. Ibis 147:367-374. . Available at http://www.blackwell-synergy.com/links/doi/10.1111/j.1474-919x.2005.00412.x/abs

The project outcomes have been disseminated in the host country though local (Galapagos) and national radio, newspapers and television. The DI team worked in close collaboration with the GNPS press office, which was responsible for editing press releases and video clips of the project activities. CDs and paper copies of these outputs are available from WildCRU, Oxford, upon request.

10. Project Expenditure

Table 3: Project expenditure during the reporting period (Defra financial year 01 April 2004 to 31 March 2005)

Item	Budget	Expenditure	Balance

11. Monitoring, Evaluation and Lessons

The project was monitored and evaluated this year according to the following indicators of achievement:

- Number of field plots (colonies or locations) established for long term ecological monitoring (taking into account financial considerations, availability of manpower and commitment of host partners).
- Number of birds marked for long-term monitoring.
- Frequency of visits to the study area to monitor birds.
- Support of local partners (CDF, GNPS and Universities) via provision of park rangers, volunteers, logistical and administrative support.
- Number of students and park rangers trained.
- Number of temperature loggers and rain gauges deployed, and successful downloading of the data after six months.
- Number of birds on which GPS and Preci-TD devices were deployed.
- Percentage of data entered into databases, and extent of analysis.
- Number of manuscripts written and published

We believe that the success of a project depends on good planning and the commitment of all host country and international partners involved. We have achieved both of these elements, and this has allowed us to carry out a very successful second year.

12. OPTIONAL: Outstanding achievements of your project during the reporting period (300-400 words maximum)

■ **I agree for ECTF and the Darwin Secretariat to publish the content of this section**

One of our most outstanding achievements this year has been the collection of large volumes of data through the application of logger technology, deployed both at sea and directly on birds.

The sea temperature data recorded by the 20 temperature loggers, deployed at 10 and 20 m depths, will help us to understand local changes in oceanographic conditions in relation to global climate change. High sea temperatures (relating to El Niño) ultimately mean that less food is available for penguins and cormorants, no reproduction will occur, and a proportion of their populations will die. On the other

hand, low temperatures (relating to La Niña) signify that food is plentiful and that the birds have sufficient resources for successful breeding and survival.

The loggers applied directly to birds are providing data that until now have not been available. The devices are making measurements in two dimensions: horizontally and vertically. The GPS units (deployed on birds) track their movements when they are away from their colonies, while Preci-TD loggers take readings of temperature and diving depths. Bird foraging data (GPS fixes and diving depths) will be overlaid onto geographical layers of fishing data. Bird data gathered using the loggers should allow us to determine whether the current “no take fishing zones” in the GMR are large enough to guarantee full protection of penguin and cormorant feeding areas.

13. Overall assessment of the project

The project has gathered abundant data over the last two years. The different types of data are at various stages of analysis. Training of students and park rangers has been successful. GIS work has been initiated. Dissemination of outputs has mainly been conducted at the local and national levels, where it is most urgently required.

Despite these achievements and submission of reports to the GNP, ultimate decisions (based on science conducted during the first two years of the DI project) have been hampered by frequent changes in the directorship of the GNPS. This resulted in a decline in the control and vigilance of the GMR and hindered consensus among the different stakeholders in the Galapagos. The special law of the Galapagos and other environmental legislation was only partially enforced during this time.

Annexe 1 Report of progress and achievements against Logical Framework for Financial Year: 2004/2005

Project summary	Measurable Indicators	Progress and Achievements April 2004-Mar 2005	Actions required/planned for next period
Goal*:* To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve • The conservation of biological diversity, • The sustainable use of its components, and • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources			
Purpose To increase local expertise for scientific research, ecological monitoring and sustainable management in the Galapagos Islands. To understand the mechanisms of natural and anthropogenic factors on the conservation of threatened endemic bird species and associated biodiversity in rich upwelling ecosystems of the Galapagos Islands.	**Original purpose level indicators** Increased understanding of the role of natural and anthropogenic factors affecting threatened species. Increased ability to predict population changes of threatened species and make timely management actions to mitigate impacts. Effective management of the GMR in western Galapagos**.**	**Impacts and achievements resulting from the project (report against purpose indicators)** Continuous meteorological (temperature and precipitation) and ornithological data (bird numbers, egg and chick productivity) gathered throughout year. Data on fishing, diseases and sex ratio gathered during August 2004 and March 2005. Initiation of data analyses for Ph.D. thesis. Preparation of 3 manuscripts for publication; 2 scientific papers published. One briefing book published in collaboration with CBSG. Implementation of multi-layered GIS database begun.	**Lessons learned resulting from the project & highlight key actions planning for next period** 1) Novel technology has facilitated collection of large volumes of climatic and ornithological data 2) Participation of Ecuadorian students in all phases of the work has enabled continuous data collection 3) The CDF and the GNPS have provided strong continuous support for the project, despite political instability in Ecuador and frequent changes in GNPS directorship. Key Actions for the final year will include completion of data analyses, Ph.D. thesis, GIS database and production of manuals and management plans for consideration by the GNPS and other local and

		All data collection, analyses and GIS database described above are contributing to this end target	national authorities and stakeholders.
Outputs			
Original outputs	**Original output level indicators**	**Completed activities and outcomes that contribute toward outputs and indicators**	**Lessons learned resulting from the project & highlight key actions planning for next period**
UK and host country partner organisations develop a unique partnership for participating in the planning process and implementing project outputs.	Minimum of: 8 Ecuadorian park rangers trained in ecological monitoring techniques, 6 under-graduate students trained in research methodologies including 1 in GIS, and 1 Galapagos-born student to pursue higher education leading to Ph.D. in conservation biology.	This year: 4 park rangers (and 1 high school student) were trained in ecological monitoring techniques, 4 undergraduates and 1 PhD student were trained in research methodologies, ecological surveying, basic GIS, experimental design, and modelling. See above In addition, in March 2005, one local student began her Tesis de Licenciatura (Bachelor's thesis) under the umbrella of the Darwin Project. She will be a "Becaria" (Darwin Scholar) until December 2005.	1) Ecuadorian University students represent valuable project resources, as they gather continuous data throughout the year. Participation of local high school students should be encouraged. 2) Local Ph.D. student played a key role during this year of political instability in the islands. The project continued to be implemented, even under these adverse conditions. Key Actions for the final year will include: Training of 2 university students in basic GIS and data analysis. Training of 4 more park rangers and 2 more high school students in ecological surveying techniques.
Management plans, manuals technical reports and papers published and distributed	Number of manuals, management plans, workshops, reports, papers, Ph.D. thesis, conferences, and presentations on local radio and	Technical reports submitted to GNPS, and to CDF. PHVA for the Galapagos penguin	1) The GNPS realise the need for good science for planning and carrying out effective management. 2) The PHVA workshop outputs and

	television.	completed. Preliminary findings were presented at 2 conferences Project activities publicised through local radio in Ecuador and websites in host country and the UK. The GNPS and CDF press offices have committed themselves to the continued dissemination of information on project activities via the media in the next period.	the penguin declaration submitted to the Minister of the Environment drew attention to the urgent need to protect the GMR and the penguin, a species that faces a 35% of risk of extinction in the next 100 years. Key actions for the final year will include: Completion of Ph.D. thesis. Publication of two manuals for monitoring birds and rodents and two management plans. Publication of 3 peer-reviewed papers. Dissemination of project outputs via local and national radio and TV.
Multilayered GIS database that describes distribution, densities, and foraging ranges of bird species with physical parameters and fishing areas of the GMR.	Number of birds sampled to assess distribution, densities and foraging ranges. Numbers of monitoring devices deployed to measure temperature and precipitation.	Climatic data downloaded from two rain gauges and 20 temperature loggers in February 2005. Penguin and cormorant censuses conducted to record distributional GPS point data. 31 cormorants and 10 penguins sampled to determine foraging ranges and diving behaviour. Majority of bird data converted into shape files and added to GIS database.	1) Data management is time consuming. To set up a multilayered GIS database, good management of data is required from initial data collection in the field, through entry of data into well designed data bases, and ultimately transfer to GIS layers. Key actions for the final year include gathering remainder of data and adding several GIS layers regarding physical parameters (temperature and precipitation) and fisheries (sea cucumbers).

Note: Please do NOT expand rows to include activities since their completion and outcomes should be reported under the column on progress and achievements at output and purpose levels.

References

CBSG-IUCN/SSC 2004. Population and Habitat Viability Analysis for the Galapagos Penguin (Spheniscus mendiculus): Briefing Book. CBSG, Apple Valley, MN, USA.

*Dvorak, M., H. Vargas, S. Tebbich, and B. Fessl. 2004. On the verge of extinction: A survey of the mangrove finch (Cactospiza heliobates) and its habitat on the Galápagos Islands. Oryx **38**:171-179.*

Lacy, R., P. Guerrero, and H. Vargas. 2005. Declaración sobre la conservación del Pingüino de Galápagos. Page 2. CBSG-SPNG- Darwin Initiative, Puerto Ayora, Galápagos, Ecuador.

*Lacy, R. C. 1993. VORTEX: A computer simulation model for Population Viability Analysis. Wildlife Research **20**:45-65.*

Macdonald, D., and H. Vargas. 2004. Response to annual report review. Pages 1-12. Wildlife Conservation Research Unit, University of Oxford, Oxford.

*Miller, P. S., and R. C. Lacy. 2003. VORTEX: A computer simulation model for population viability analysis. Wildlife Research **20**:45-65.*

Travis, E. K., F. H. Vargas, J. Merkel, N. Gottdenker, G. Jiménez Uzcátegui, E. Miller, and P. G. Parker. In preparation. Hematology, serum chemistry, and disease surveillance of the Galapagos Penguin (Spheniscus mendiculus) in the Galápagos Islands, Ecuador.

Travis, E. K., H. Vargas, J. Merkel, N. Gottdenker, E. Miller, and P. G. Parker. Submitted. Hematology, plasma chemistry, and serology of the Flightless Cormorant (Phalacrocorax harrisi) in the Galápagos Islands, Ecuador. Journal of Wildlife Diseases.

Vargas, F. H., P. Jonhson, R. C. Lacy, R. Crawford, A. Steinfurth, and D. W. Macdonald. In preparation. Modelling the effect of El Niño on the endangered Galapagos Penguin.

Vargas, H. In preparation. Manual Instructivo para el censo de pinguinos y cormoranes. Pages 1-30. Parque Nacional Galapagos - Fundacion Charles Darwin, Puerto Ayora.

Vargas, H., S. Harrison, S. Rea, and D. W. Macdonald. Submitted. Biological effects of El Niño on the Galapagos penguin. Oecologia.

*Vargas, H., C. Lougheed, and H. Snell. 2005. Population size and trends of the Galapagos Penguin Spheniscus mendiculus. Ibis **147**:367-374.*

Wiedenfeld, D., and H. Vargas. 2004. Penguin and Cormorant survey 2004 Report to the Charles Darwin Research Station and the Galapagos National Park Service. Pages 1-27. Charles Darwin Research Station, Puerto Ayora.

APPENDICES ATTACHED TO THIS REPORT

Appendix 1. *Wiedenfeld, D., and H. Vargas. 2004. Penguin and Cormorant survey 2004 Report to the Charles Darwin Research Station and the Galapagos National Park Service. Pages 1-27. Charles Darwin Research Station, Puerto Ayora.*

Appendix 3. *Vargas, H., C. Lougheed, and H. Snell. 2005. Population size and trends of the Galapagos Penguin Spheniscus mendiculus. Ibis **147**:367-374.*

Appendix 4. *Vargas, H. In prep. Manual Instructivo para el censo de pinguinos y cormoranes. Pages 1-30. Parque Nacional Galápagos - Fundación Charles Darwin, Puerto Ayora.*

Appendix 5. *Lacy, R., P. Guerrero, and H. Vargas. 2005. Declaración sobre la conservación del Pingüino de Galápagos. Page 2. CBSG-SPNG- Darwin Initiative, Puerto Ayora, Galápagos, Ecuador.*

Appendix 6. *Vargas, F. H., P. Jonhson, R. C. Lacy, R. Crawford, A. Steinfurth, and D. W. Macdonald. In prep. Modelling the effect of El Niño on the endangered Galapagos Penguin.*

APPENDICES SENT BY POST

Appendix 2. *CBSG-IUCN/SSC 2004. Population and Habitat Viability Analysis for the Galapagos Penguin (Spheniscus mendiculus): Briefing Book. CBSG, Apple Valley, MN, USA*