Climate Change and Conservation of Galápagos Bird Species

Final Report

30 June 2006

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Darwin Initiative Final Report

1. Darwin Project Information

Project Ref. Number	162/12/0118
Project Title	Climate Change and Conservation of Galápagos Bird Species
Country	Ecuador
UK Contractor	Wildlife Conservation Research Unit (WildCRU), Oxford University
Partner Organisation(s)	Galápagos National Park Service (GNPS) and the Charles Darwin Foundation (CDF)
Darwin Grant Value	£120,000
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Reporting period and report number	1 April 2003-June 2006 Final report
Project website	http://www.wildcru.org/research/es/galapagosbirds.htm
Author(s), date	Professor David Macdonald & Hernán Vargas, 30 June 2006

2. Project Background/Rationale

This project was conducted in the Galápagos Islands, Ecuador. The Archipelago is well known for its unique endemic biodiversity and the majority of the land and marine areas are protected by the Galápagos National Park (GNP) and Galápagos Marine Reserve (GMR). We undertook the field components of the project in the western coast of the Galápagos Islands, in particular around Fernandina Island and the western coast of Isabela. This area includes more than 95% of the populations of the Mangrove finch, the Galápagos penguin and the Flightless cormorant. However, this is also where most of the fishing activity occurs. The University students, park rangers and staff from the Charles Darwin Foundation (CDF) were based on Santa Cruz Island. The DPhil student spent 50% of his time in the Galápagos and the other 50% at the Wildlife Conservation Research Unit (WildCRU), University of Oxford, UK. WildCRU also provided technical and administrative support for the project, as well as expertise in statistics and in publishing results.

The three bird species have small populations (< 2000 individuals), restricted ranges and are listed by the IUCN-Birdlife as endangered (Galápagos penguin and Flightless cormorant) or critically endangered (Mangrove finch). In both 1983 and 1998 the penguin and cormorant populations crashed by more than 50%. The wet and famine conditions of El Niño events were suspected as being the underlying cause although the mechanisms were unknown. Conversely, preliminary data suggested that the Mangrove finch might suffer population crashes during the dry and cool conditions of La Niña events. In this context, there was concern that rapid climate change or extreme climatic events may cause drastic population changes, increasing the risk of

extinction of the populations. Theory predicts that small and fluctuating populations are more likely to become extinct.

In addition, there was concern about the increasing direct and indirect anthropogenic impacts on the bird species and their ecosystems. Western Galápagos provides most of the fish stocks currently being exploited from the Archipelago. Conflicts often arise due to the different interests of the conservation and fishing sectors. However, resolution is difficult as the information needed for the zoning of the GMR, or scientifically-based management plans, is not available. In this context, this project aimed to provide the scientific information required for management and increase local expertise. It was intended that this would instigate a series of actions that would safeguard the long-term conservation of these three endemic and endangered bird species, with associated biodiversity, and help reduce conflicts among users of the GMR.

The requirement for this project was identified by both the CDF and the GNPS, and included in: the Galápagos National Park Service (GNPS) Management Plans (1984, 1996); the GMR Management plan (1998) and the CDF Biodiversity Vision (1999). Furthermore, some activities (e.g population surveys) have been included in the annual Operative plans of both institutions since 1980.

3. Project Summary

Purpose

The main purpose of this project was the conservation of three Galápagos bird species (the Galápagos penguin, Flightless cormorant and Mangrove finch) and associated biodiversity in western Galápagos. Crucially this would involve strengthening local capacities for scientific research, practical conservation and decision making for sustainable management.

Objectives

- To strengthen local capacities for practical conservation, ecological monitoring and scientific research.
- To measure and understand the effects of climate and anthropogenic factors on the population dynamics of three threatened bird species.
- To clarify and highlight effects of climate change on biodiversity.
- To determine the impacts of predation by black rats and design appropriate strategies for rat control.
- To propose and implement solutions for the zoning of the GMR.
- To influence fishing policy for the better integration of biodiversity and harvest requirements.
- To seek practical solutions to the conflict between the conservation and fisheries sectors.

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, theses 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.

The project related particularly to the following CBD articles:

7. Identification and monitoring. Baseline monitoring of the three species was conducted monthly at selected sites and annually at the Archipelago scale (See Appendix 1 of DPhil. thesis).

8. In situ conservation. The project focused on conserving the species in situ, although, due to the critical status of the Mangrove finch we also proposed that consideration should be given to the establishment of a captive (ex situ) breeding programme. The DPhil student acted as a technical adviser for the writing of this proposal which is currently financed by the Darwin Initiative and managed by the Durrell Wildlife Conservation Trust (DWCT) in partnership with the CDF and the GNPS.

12. Research and training. 15 park rangers, 13 university students and 2 high school students were trained in various tasks related to ecological monitoring and conservation of endangered species.

14. Impact assessment and minimising adverse impacts. This project investigated the impact of climate, particularly of El Niño southern Oscillation events (El Niño and la Niña) and the direct (mortality of penguins in fishing nets) and indirect (predation of black rats and cats on penguins and Mangrove Finches,) impacts of human activities.

18 (technical and scientific cooperation). The work has also direct relevance to the Convention on Biological Diversity's (CBD) marine and coastal biodiversity programme, and CBD's cross-cutting issues that relate to indicators, public education, awareness and alien species.

No modifications were made to the original objectives or operational plan and the project was very successful in meeting its purpose, objectives and outputs (See Logframe, Appendix V). Due to the management decisions on fishing sites, fishing quotas, conservation measures being taken at higher levels [The Participatory Management Board (PMB) and the Inter-institutional Management Authority (IMA)], and instability in the directorship of the GNPS, the objective of reducing influencing fishing policy for the better integration of bird conservation needs and fishing-harvest needs could only be partially achieved. During the lifetime of the project, there were 10 interim directors of the GNPS. It was only in March 2006 when this position was officially filled. This high turnover in the GNPS directorship meant that the DI project leaders needed to spend more efforts coordinating and implementing activities. To date, as consequence of this instability, and despite fishing moratorium for 2005 and 2006, illegal fishing, particularly of sea cucumbers, is recurrent (See more details in HYR2, October 2004).

4. Scientific, Training, and Technical Assessment

All research objectives were achieved and represent one of the major project successes. The main project results are included in: one DPhil. thesis (sent by post); two MSc. theses; 5 publications in peer-reviewed Journals; three submitted manuscripts (with further manuscripts in preparation), and technical reports submitted to the National Park. See appendix III for a list of publications.

The project was successful in training Ecuadorian students and park rangers. One Galápagos-born student completed his Doctorate in Oxford. He is the first student from the Islands to earn a DPhil.. Undergraduate students (de Licenciatura, equivalent to MSc. at UK level) were recruited from six Ecuadorian universities (Table 1). Students were selected on the following criteria: grade point average; physical condition to work in remote locations and difficult field conditions, and place of birth. University students born in the Galápagos Islands were preferred as it was deemed more likely that they would return to work in the Galápagos. This was highly desirable in

order to enhance local capacities for science and management. The park rangers selected to support this project were those already assigned to work in either the monitoring or the vigilance programmes of the GMR in western Galápagos. Two high school students and two other Galápagos residents, with particular interest in local conservation were also given an opportunity to participate in the project. Postgraduate students worked as trainers of trainees and contributed with their expertise in different fields.

Trainees were assigned tasks according to their level of formal education. Tasks ranged from: field assistance and data collection (park rangers and high school students); to ecological monitoring, thesis-report writing and basic Geographical Information Systems (GIS) analysis using ArcView (MSc students); to project design, planning, administration and publication in peer-reviewed journals (DPhil. student). See “Response to Annual Report Review” submitted to the Darwin Initiative in October 2003 for further details on the nature and assessment of training. The performance of students was assessed by both senior personal of the CDF, Darwin Project and professors from the respective universities. The quality of the results in thesis work and technical reports were key factors used to measure success.

Table 1. Trained students and number of months that participated in the project. Postgraduate students worked as trainers of undergraduates and other staff. Several undergraduate students affiliated to, and already employed by, the CDF, are not included in the totals of trained staff in other tables or appendices presented in this report as their participation was financed by the match funding from the CDF.

Name	Education level	Affiliation	Months	Place of Birth
Hernan Vargas	Postgraduate	University of Oxford	36	Galapagos
Carolina Larrea	Undergraduate	Universidad Catolica-Quito	18	Galapagos
Carlos Carrión	Undergraduate	Universidad Catolica-Quito	9	Galapagos
Paolo Piedrahita	Undergraduate	Universidad Catolica-Quito	8	Mainland Ecuador
Carlos Vinueza	Undergraduate	Universidad de Guayaquil	10	Mainland Ecuador
Marjorie Riofrío	Undergraduate	Universidad de Guayaquil	12	Galapagos
Carlos Fonseca	Undergraduate	Universidad- ESPE- Quito	6	Mainland Ecuador
Janeth Delgado	Undergraduate	Universidad- ESPE-Quito	4	Mainland Ecuador
Diogenes Aguirre	Undergraduate	Universidad Central-Quito	3	Galapagos
Xavier Arturo Lopez	Undergraduate	Universidad Central-Quito	3	Mainland Ecuador
Susana Cardenas	Undergraduate	Universidad San Francisco-Quito	9	Mainland Ecuador
Robert Baulfour	Undergraduate	Universidad San Francisco-Quito	3	Galapagos
Juan Carlos Valarezo	Undergraduate	Universidad de Loja	6	Mainland Ecuador
Victor Carrion	Postgraduate	GNPS	2	Galapagos
Christian Sevilla	Postgraduate	GNPS	3	Galapagos
Carlos Gaona	Park ranger	GNPS	3	Mainland Ecuador
Freddy Azuero	Park ranger	GNPS	3	Mainland Ecuador
Fidelino Gaona	Park ranger	GNPS	3	Mainland Ecuador
Roberto Jiménez	Park ranger	GNPS	3	Galapagos
Hector Serrano	Park ranger	GNPS	3	Galapagos
Franklin Gil	Park ranger	GNPS	3	Galapagos
Agustin Masaquiza	Park ranger	GNPS	14	Mainland Ecuador
Segundino Masaquiza	Park ranger	GNPS	6	Mainland Ecuador
Andy Torrez	Park ranger	GNPS	4	Galapagos
Marlon San Miguel	Park ranger	GNPS	2	Galapagos
Favian Oviedo	Park ranger	GNPS	6	Mainland Ecuador
Marco Hoyos	Park ranger	GNPS	4	Mainland Ecuador
Pablo Guerrero	Park ranger	GNPS	4	Mainland Ecuador
Gustavo Jimenez	Postgraduate	FCD	2	Mainland Ecuador
Stuart Banks	Postgraduate	FCD	2	UK
Antje Steinfurth	Postgraduate	FCD-University of Kiel	24	Germany
Julio Delgado	Undergraduate	FCD	2	Mainland Ecuador
Margarita Brandt	Undergraduate	FCD	2	Mainland Ecuador
Angel Chiriboga	Undergraduate	FCD	2	Mainland Ecuador
Mariana Vera	Undergraduate	FCD	2	Mainland Ecuador
David Jimenez	Undergraduate	FCD	2	Mainland Ecuador
Washington Llerena	Undergraduate	FCD	24	Mainland Ecuador
Jose Barcia	Undergraduate	FCD	7	Galapagos
Livington Castillo	High school	Galapagos resident	6	Mainland Ecuador
Segundo Gaona	High school	Galapagos resident	2	Mainland Ecuador
Joshimar Yépez	High school	Colegio Casares	1	Galapagos
Boris Noboa	High school	Colegio Casares	1	Galapagos

5. Project Impacts

Our research has demonstrated that strong El Niño events profoundly affect bird numbers, illustrating an important large-scale ecological process affecting animal numbers. This has doubtless occurred since time immemorial. Interestingly, however, placing these findings in the context of a 6,000 yr lake sediment record of El Niño reveals that the weather patterns of the region are increasingly disturbed by more frequent and severe El Niño events. The current global warming trends may be increasing the frequencies and severities of El Niño events, exerting unprecedented climate pressures on the persistence of species. Furthermore, there are increasing pressures derived from human activities (e.g. illegal fishing) and exotic species (e.g. predation of feral cats on penguins) which may put the endemic species at high risk of extinction. Our research also indicates that the combination of climate effects and anthropogenic activities can be more acute for species with poor dispersal abilities, limited foraging ranges and restricted distributions.

Through our project, collaborations have been set up between regional (Galápagos) and international organizations. These relationships will lead to enhanced understanding of the factors influencing bird population changes, of potential solutions to save species from extinction and consolidate conservation efforts in the region. The underlying assumption is the penguin, cormorant and finch act as umbrella species. Through protecting these bird species we will also be saving the associated biodiversity of western Galápagos. An example of the effectiveness of this project, and these collaborations, is that the GNPS has launched a campaign to control cats on Southern Isabela. The GNPS has also committed to conduct regular monitoring of rodents on the sites where monitoring took place during the Darwin project. In addition, the CDF, with support of the Darwin Initiative via the DWCT are implementing a project for the conservation of the Mangrove finch.

Unanticipated results from our work have also highlighted new areas requiring research. One finding from our research was that the foraging ranges of penguins and cormorants were surprisingly smaller than expected. Data showed that both species foraged within less than one km from shore where birds feed in shallow waters, usually < 30 m depth. This is an interesting and worrisome finding because this area very likely coincides with where fishermen extract sea cucumbers, lobsters and mullets. The next step will be to quantify the degree of overlap between bird foraging ranges and human fishing ranges and propose new schemes for the zoning of the GMR.

This project has helped Ecuador to meet its obligation under the Biodiversity Convention by: (1) identifying the three endangered species as needing urgent conservation action; (2) identifying factors (extreme climate, illegal fishing, small foraging ranges, small population sizes, lack of resistance to novel diseases) predicted to have adverse effects on the bird species; (3) setting up a long-term monitoring program and establishing collaborations for scientific research and the sustainable use of the components of biological diversity; (4) training local people for ecological monitoring, and scientific research, and (5) by disseminating the results of the project to local, national and international audiences. All project partners are committed to carrying out actions in the future, and incorporating the project outcomes into management plans and policy.

Hernan Vargas gained valuable experience participating in all phases of the project. One of the main authors of this project, he is at present completing his doctoral programme at Oxford. He is also working as a technical adviser of the DWCT for the Mangrove finch project. This month, he was awarded a $20,000 from Seaworld to continue working on population surveys and the demography of the Galápagos penguin and Flightless cormorant during 2006 and 2007. He keeps on working as a CDF collaborating scientist.

The following people were also trained to varying levels, as part of the project:

- Carlos Carrion has worked for the CDF since April 2006, and is responsible for the monitoring of rodents in the Galápagos.

- Washington Llerena, works at the CDF as a GIS technician.

- Carolina Larrea and Marjorie Riofrio are analyzing data sets and their theses are expected to be submitted in September 2006.

- Diognes Aguirre is at the CDF completing his MSc. thesis on the ecology of Lava gulls.

- All the trained park rangers are still working for the GNPS

- Susana Cardenas is working at the CDF as a PA for the Director of Science.

Other students have returned to the mainland or are pursuing further studies.

The WildCRU of the University of Oxford has strong links with the CDF and the GNPS. WildCRU will continue to be involved in projects carried out in the Galápagos Islands. Nationally, the Darwin Project has fostered collaborations between universities, local high schools, tour operators and conservation sectors (CDF and GNPS).

The local community has greatly benefited from the new trained staff as, being residents with new qualifications; they can carry out long term conservation action on the Islands. An indication of the high training standard is the quality of thesis produced and the number of trainees now employed by the CDF and GNPS who are directly involved in conservation. The tourist sector has also benefited from the research by the provision of novel information used for interpretation and has enhanced visitor satisfaction.

6. Project Outputs

Most of the intended outputs were achieved and only a few were not achieved. We believe that the outputs which were not achieved are relatively minor compare to the additional outputs which were not included in the table of outputs of original proposal.

Outputs partially completed.

Manual for surveying Mangrove finch and rats. A rat monitoring component is now included in the "Manual de Monitoreo de ratas" which includes protocols for surveying and controlling rats (with anticoagulant poison) in various locations of the Archipelago. However, the component on surveying finches has not been completed and this task has been passed on to the new Mangrove finch project conducted by the DWCT.

Bird species management plans, in Spanish. Although we have not put together these management plans for the three species, now have the scientific data to produce science-based management plans. We consider that the Population Viability Analysis (PVA) report contains guidelines and important recommendations for the management of the Galápagos penguin. We also assume that these same recommendations are valid for the Flightless cormorant because both species are flightless and share the same habitat, foraging areas and distribution.

Additional outputs

Table 2. Additional outputs achieved and not included in original proposal

Output	**Originally Committed**	**Additional**
MSc Theses	0	2 theses: one on rats and one on cormorants
PVA report	0	1 Comprehensive PVA report in Spanish
Peer- reviewed papers	0	5
Submitted manuscripts	2	3 manuscripts are currently submitted
Manuscripts in preparation	0	4
High School students	0	2 students participated in project
Park ranges trained	8	Total of 15 park ranges trained
Undergraduates trained	8	Total of 13 trained
GIS technician trained	1	Total of 2 trained
Trained Postgraduates	1	Total of 5, who all worked as trainers
International collaborations	0	4 new international collaborations established
Flamingo study	0	Analyzed data on the effect of climate on flamingos
Manual for rats	0	1 Manual for monitoring rodents

The target audience were primarily the inhabitants of the Galápagos Islands where the conservation message needs to be assimilated, and secondly, the mainland of Ecuador where major conservation policy takes place. After project completion, the dissemination of the project will continue to be carried out by the well-established press offices of the CDF and the GNPS. This will be financed by international benefactors supporting the CDF or by the Government of Ecuador via the GNPS.

7. Project Expenditure

Table 3. Grant expenditure per year according to budgetary lines of original application

		Expenditure (British Pounds)				
	Budget	2003-04	2004-05	2005-06	Total expenses	Balance

No changes to the original budget were made. The expenditure includes the 10% of the final's year grant which was advanced by the University. "Other costs" were subsidized by additional funds raised as complementary funding.

8. Project Operation and Partnerships

Our original project plan included the GNPS, the CDF, local Universities and fishing cooperatives as local partners. All partners were active, contributing significantly in project planning and implementation, with the exception of the fishing cooperatives. These never became directly involved in the project due to political instability and conflicts with the conservation sector. The two most active partners were the CDF and the GNPS. The CDF is the official adviser to Ecuadorian Government on conservation in the Galápagos. The GNPS is the wildlife and resource management authority for the protected areas in the Galápagos Islands. The plans were adjusted in response to local consultation but no significant modifications were necessary. Additionally, we developed partnership with one of the local high school and several tour operators which provided volunteers and transportation from Santa Cruz to western Galápagos.

During the project lifetime, members of this project team participated in two workshops organized by the other Darwin project "Building capacity and determining disease threats to endemic Galápagos fauna", that was being implemented simultaneously in the Galápagos. We discussed strategies aimed at preventing the arrival and spread of diseases that could potential affect endemic species. Although one petition was made directly to the Minister of Environment (see copy in PVA report), most of the consultation with the host country biodiversity strategy office was done through the GNPS which is part of the Ministry of the Environment of Ecuador.

We also developed the following collaborations throughout the running of this project:

Saint Louis Zoo/ University of Missouri. This collaboration was initiated in 2003 to study the effects of avian parasites, diseases, genetic sexing, genetic structure, and genetic diversity of penguins and cormorants. A team of people, led by Professor Patricia Parker, participated in various phases and components of the project: Erika Travis, Jane Merkel, Caroline Duffy, Eric Miller, Nicole Gottdenker, Catherine Zoo, Ben Nims and Ben Murray.

University of Kiel Germany and Swansea University, UK. We developed collaborations with Antje Steinfurth of the University of Kiel and Professor Rory Wilson from Swansea University to study the foraging behaviour of penguins and cormorants using novel technologies.

Durrell Wildlife Conservation Trust (DWCT). Conservation of the Mangrove finch. Collaborators: Glyn Yound, John Fa, Quentin Bloxam.

University of Cincinnati. Genetic structure, hybridization and genetic variation of the Mangrove finch. Collaborator: Kenneth Petren.

Conservation Breeding Specialist Group (CBSG). Population Viability Analysis. Collaborators: Onnie Byers, Robert Lacy and Yolanda Matamoros. We are discussing about a similar collaboration for the conduction of a PVA workshop for the Mangrove finch in 2008.

We anticipate continued liaison and collaboration with these organizations.

The GNPS is one of the main authorities responsible for the utilization and conservation of biodiversity in the Galápagos. It is envisaged that the GNPS, with the scientific advice from the CDF, will influence the decision making process within the PMB and the IMA for the incorporation of the project recommendations into conservation action. The private sector, namely the fishing cooperatives, need to be engaged and be part of the solution for sustainable management. More education is needed at the community level to facilitate dialogue and support for conservation.

9. Monitoring and Evaluation, Lesson learning

Throughout its progression the project was monitored and evaluated according to the following strategy of indicators of achievement:

1. 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).
2. Frequency of visits to the study area to monitor birds.
3. Number of birds marked and recaptured for long-term monitoring.
4. Support of local partners (CDF, GNPS and Universities) via provision of park rangers, volunteers, graduate students, logistical and administrative support.
5. Number of students and park rangers trained.
6. Number of temperature loggers and rain gauges deployed, and successful downloading of the data after six months.
7. Number of birds on which GPS and Preci-TD devices were deployed.
8. Percentage of data entered into databases, and extent of analysis.
9. Number of manuscripts written and published.
10. Number of DPhil and MSc. theses produced.
11. Number of trained staff working at the CDF and GNPS.
12. Number of international collaborations established.

The results of the evaluation of the project, using these indicators, are demonstrated in the DPhil and MSc. theses, reports, publications and enhanced local capacity for conservation supported by international collaborations.

The project was designed within the framework of the ecological monitoring programme of the CDF and GNPS and had the following elements as part of a strategic plan (see Table 4 for a list of all data types collected).

1. Keep collecting baseline data which was already being collected before the start of the DI project (e.g bird population surveys, meteorological data).

2. Expand the coverage of data collection to other locations, particularly in western Galápagos (e.g. deployment of sea temperature loggers and logging rain gauges in western Galápagos).

3. Collect new data on several bird variables (foraging ranges, breeding success, movements, parasite, diseases).

4. Use of novel technologies for research in collaboration with UK and German scientists.

5. Correlate climate variables with bird demographic factors using old and new data sets.

6. Model the effect of climate and anthropogenic impacts on bird variables.

7. Submit research results to peer-reviewed process.

8. Train local staff and foster international collaborations for expertise not available in Ecuador.

Table 4. Baseline information collected during 2003-2005 (or analyzed when old data sets were

available). Methodologies and results of the analysis of these data sets can be reviewed in Dphil Thesis (posted in the mail).

Data	**Measurements taken**
Climate	• Sea surface temperature • Lagoon surface temperature • Lagoon water level • Rainfall
Birds	• Abundance • Survival (and mortality) • Breeding success • Sex ratio • Movements • Dispersal • Foraging behaviour • Avian parasites • Avian diseases
Direct anthropogenic impacts	• Bird mortality in fishing nets
Indirect anthropogenic impacts	• Black rat (*Rattus rattus*) abundance in areas inhabited by penguins and mangrove finches • Presence/absence of black rats on islands previously thought free of this species (through trapping) • Sea cucumber harvest areas utilised by fishermen in western Galápagos (collected by the CDF-GNPS as part of the match funding provided to this project).

In February 2004, the project steering committee carried out an evaluation of the project up to that date. The conclusion of this evaluation was included in Hernan Vargas's DPhil. upgrade report. The quality of MSc. theses are being evaluated by University professors. External evaluation of scientific findings was conducted by referees and editors of peer-reviewed scientific journals. Complementary to this, the project was monitored and evaluated by independent reviewers contracted by the Darwin Initiative.

One if the main problems encountered was the previously mentioned instability in the directorship of the GNPS. As consequence of this instability, illegal fishing activities are causing the death of penguins in fishing nets. To overcome this problem, we have modelled in the population viability analysis (PVA) the consequences of different mortality rates for adults and juvenile birds. This report was submitted to the GNPS.

Key lessons to be drawn from the experience of this project

Lesson 1. Project objectives can be met by developing partnerships in both the financial and scientific grounds.

Lesson 2. The success of a project, or its components, may be hampered by the political stability or lack of financial resources of the host nation where project is implemented. For instance, the project has made available abundant scientific data which has not been translated into conservation actions due to the weaknesses and instability in institutional directorships.

Additionally, local institutions have, at present, insufficient funds to employ the new trained staff made available by this project.

Lesson 3. The implementation of the project was greatly assisted by the fact that the GNP and CDF had actually identified the need of this study and supported the project throughout.

Lesson 4. Conservation education and training "on the job", in the manner described in this project, was incredibly beneficial for all involved. This should be included in all conservation projects.

Lesson 5. We would certainly encourage building national and international partnerships which can contribute in different fields of expertise.

10. Actions taken in response to annual report reviews (if applicable)

Issues were only raised in response to the first annual report, and they were responded to and addressed. (See Response to Annual Report review submitted to the Darwin Initiative 30 October 2003). We were delighted to know that "no issues" were raised to the second annual report and that reviewers were pleased with the project's accomplishments by the end of the second year.

11. Darwin Identity

In order to publicise the Darwin Initiative the Darwin Logo was featured in project outputs (see PVA report), on field equipment and on information advertising the project (see website http://www.wildcru.org/research/darwininitiative.htm). The Darwin Initiative has been acknowledged in seminars, newsletters, theses, reports and peer-reviewed publications.

The Darwin Initiative is well recognized in the Galápagos Islands because of its past support for other important projects. We sought to further this positive recognition throughout this project. During the life of this project, the Darwin Initiative was linked to the main project outcomes that were disseminated by radio, television, local and national newspapers. Staff and students involved in this project made every effort to ensure that the Ecuadorian people were aware of the aims and objectives of the Darwin Initiative. It was seen as important to advertise its role in facilitating conservation action in countries rich in biodiversity, but poor in economic resources, in order to implement the convention of biodiversity (CBD).

The varied aspects of this project, as scientific research, a conservation tool and a training programme, meant that this project was able to both fulfil part of a larger conservation programme as well as maintain its own identity. Firstly, the project was identified as a need by the Ministry of Environment of Ecuador, and is framed, from general to specific, within the Galápagos Regional Plan, the GNP management plan, the GMR Plan and the CDF mission and Biodiversity Vision. In this context, the project formed part of the "ecological monitoring programme" carried out jointly by the CDF and the GNPS. Secondly, this project showed a clear identity for its holistic nature integrating training of local people with rigorous research for the conservation of endangered species. This was ultimately aimed at the conservation of the biodiversity of western Galápagos in the light of changing climate and anthropogenic impacts.

12. Leverage

Throughout the duration of the project additional financial assistance was gained from a number of sources. In 2003 and 2006, SeaWorld contributed £24 000 to census penguins and cormorants at the Archipelago scale. The Swiss Friends of Galápagos made available £12 000 and the Galápagos Conservation Trust £6 000 to complement funding for field equipment and subsistence of University students. Swarovski & Co. donated an extra £15 000 to support the student stipend of DPhil. Student. The Saint Luis Zoo-University of Missouri invested £12 000 in boat transportation to study parasites and diseases and covered expenses of laboratory work and salaries for the disease component of the project. The Durrell Wildlife Conservation Trust (DWCT) contributed with £6 000 to conduct surveys of the Mangrove finch on Isabela and Fernandina in March 2005. As part of a collaborative effort to study the foraging behaviour of the Galápagos penguin the German Academic Exchange Service contributed with £20 000 to cover expenses of a German PhD. student and field equipment. The Conservation Breeding Specialist Group (CBSG) contributed £10,000 for the population viability analysis (PVA) workshop. In all using the Darwin Initiative award to attract additional funding we were able to raise £105 000.

The UK project staff were integral in providing technical support for the writing of proposals and technical reports for benefactors listed above. We have made our data available to the DWCT and will continue to work as technical advisers for this new Darwin Initiative project for the conservation of the Mangrove finch throughout its implementation over the next three years. We are also planning to submit to the Darwin Initiative a follow-up proposal building on our current findings.

13. Sustainability and Legacy

One of the most enduring results will be the conservation work of the staff trained throughout this project. The trained staff remaining in the area will certainly have a lasting positive impact in the conservation of biodiversity of the Galápagos. The organisational partnerships are also well established and are very likely to keep in touch. Moreover, the scientific results and management recommendations of the project will ultimately be incorporated into management plans of the GMR and GNP as well as the “Regional Plan for the Galápagos Islands”. This will therefore, contribute to the sustainability and legacy of our work.

As an indication of the utility and potential longevity of the projects work, part of the project conclusions have already been applied. One immediate application was the control of feral cats on southern Isabela after the DI found evidence of predation of cats on adult penguins. At present (June 2006), about 50% of the results have been published and the remaining are in the form of manuscripts in preparation of in analysis. Although, publications and theses have already included management recommendations, not all of them have been applied by the GNPS. However, it is envisage that the GNPS, will gradually incorporate, the main conclusions/ recommendations into management actions.

The legacy could be improved by securing the stability of the directorship of the GNPS), and the finances of the CDF and GNPS so that the trained Ecuadorian students can be hired permanently. This would enable them to contribute with their acquired expertise to the science, ecological monitoring and wildlife management.

We have sought funding from the Darwin Initiative to continue the work with the Mangrove finch, the species in most imminent danger of extinction. Hernan Vargas collaborated as a technical adviser to put together a proposal to be financed by the Darwin Initiative over the next three years. The DWCT is the UK institution responsible for the new project. The Darwin

Initiative team thought that the DWCT is an appropriate organization to implement this project because of its expertise in captive breeding. If the population is less than 100 birds as indicated by our project findings, it may be necessary to initiate a captive breeding programme.

The Darwin Initiative team has also encouraged the Swiss Friends of Galápagos to fundraise and provide match funding for the new Mangrove finch project. The Darwin Initiative team made contacts with Ken Petren, Universisty of Cincinnaty to study the genetic variability of the Mangrove finch and Patricia Parker, University of Missouri, to continue the work (initiated in 2003) on parasites and diseases. Both of these universities will provide support "in kind" covering the expenses to do the laboratory analysis of samples.

We have also strengthened our collaboration with the Seaworld Conservation Fund. This month Seaworld approved a US$20,000 grant to continue the surveys of Penguins and Cormorants during 2006 and 2007.

14. Value for money

Comparing the results obtained to the financial resources invested, we rate this project as very economical. We support this conclusion by the following evidence: (1) Most of the work was conducted by Ecuadorian students and park ranges, saving substantial sums of funding because we did not need to hire full time researchers, technicians and communicators; (2) The CDF and the GNPS provided boat transportation to carry out the monthly monitoring in western Galápagos saving substantial funding (a 6-12 passenger boat usually charges $1000 per day); (3) When boats needed to be hired to cover vast areas of the archipelago, we merged various collaborative groups in the same boat (e.g divers, penguin catchers and veterinarians) and diverse activities were conducted simultaneously; (4) British airways provided some free tickets up to Bogota-Colombia, and thus we only purchased the part of the ticket between Bogota and Ecuador, and (5) the GNPS and CDF provided in-kind support. Over the three years that the project was operational, we raised match funds to support the Darwin Initiative funding and activities, thus greatly enhancing the original investment.

15. Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

Please complete the table below to show the extent of project contribution to the different measures for biodiversity conservation defined in the CBD Articles. This will enable us to tie Darwin projects more directly into CBD areas and to see if the underlying objective of the Darwin Initiative has been met. We have focused on CBD Articles that are most relevant to biodiversity conservation initiatives by small projects in developing countries. However, certain Articles have been omitted where they apply across the board. Where there is overlap between measures described by two different Articles, allocate the % to the most appropriate one.

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	**Project %**	**Article Description**
6. General Measures for Conservation & Sustainable Use	10	Develop national strategies that integrate conservation and sustainable use.
7. Identification and Monitoring	20	Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities that have adverse effects; maintain and organise relevant data.
8. In-situ Conservation	20	Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources.
9. Ex-situ Conservation		Adopt ex-situ measures to conserve and research components of biological diversity, preferably in country of origin; facilitate recovery of threatened species; regulate and manage collection of biological resources.
10. Sustainable Use of Components of Biological Diversity	5	Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.
11. Incentive Measures		Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.

12. Research and Training	30	Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations).
13. Public Education and Awareness	10	Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.
14. Impact Assessment and Minimizing Adverse Impacts		Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; exchange information on impacts beyond State boundaries and work to reduce hazards; promote emergency responses to hazards; examine mechanisms for re-dress of international damage.
15. Access to Genetic Resources	2	Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits.
16. Access to and Transfer of Technology	3	Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.
17. Exchange of Information		Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge
19. Bio-safety Protocol		Countries shall take legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities and to ensure all practicable measures to promote and advance priority access on a fair and equitable basis, especially where they provide the genetic resources for such research.
Total %	**100%**	**Check % = total 100**

16. Appendix II Outputs

Please quantify and briefly describe all project outputs using the coding and format of the Darwin Initiative Standard Output Measures.

Code	Total to date (reduce box)	Detail (←expand box)
Training Outputs		
1a	Number of people to submit DPhil. thesis	
1b	Number of DPhil. qualifications obtained	1 DPhil.. First Galápagos born person to have obtained a DPhil.. Thesis is attached.
2	Number of Masters qualifications obtained	2 Theses are to be completed in September 2006
3	Number of other qualifications obtained	2 GIS technician
4a	Number of undergraduate students receiving training	13
4b	Number of training weeks provided to undergraduate students	Training was on the job
4c	Number of postgraduate students receiving training (not 1-3 above)	4
4d	Number of training weeks for postgraduate students	
5	Number of people receiving other forms of **long-term** (>1yr) training not leading to formal qualification(i.e not categories 1-4 above)	
6a	Number of people receiving other forms of **short-term** education/training (i.e not categories 1-5 above)	
6b	Number of training weeks not leading to formal qualification	2 high school students 15 park rangers
7	Number of types of training materials produced for use by host country(s)	2

Research Outputs		
8	Number of weeks spent by UK project staff on project work in host country(s)	72 week spent by DPhil. student
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (s)	3 PVA report Manual for monitoring rats Manual for monitoring the penguins and cormorants
10	Number of formal documents produced to assist work related to species identification, classification and recording.	1 DPhil. thesis 2 MSc theses 13 Technical reports handed to the GNPS 1 Petition handed to the Minister of Environment
11a	Number of papers published or accepted for publication in peer reviewed journals	5 published 3 submitted

11b	Number of papers published or accepted for publication elsewhere	2 published (WildCRU Review 2005)
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	Rodent data base Mark-recapture bird data base Multilayered GIS data base
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country	
13a	Number of species reference collections established and handed over to host country(s)	
13b	Number of species reference collections enhanced and handed over to host country(s)	

Dissemination Outputs		
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	2
14b	Number of conferences/seminars/ workshops **attended** at which findings from Darwin project work will be presented/ disseminated.	9
15a	Number of national press releases or publicity articles in host country(s)	6
15b	Number of local press releases or publicity articles in host country(s)	4
15c	Number of national press releases or publicity articles in UK	3
15d	Number of local press releases or publicity articles in UK	2
16a	Number of issues of newsletters produced in the host country(s)	3
16b	Estimated circulation of each newsletter in the host country(s)	
16c	Estimated circulation of each newsletter in the UK	
17a	Number of dissemination networks established	2
17b	Number of dissemination networks enhanced or extended	
18a	Number of national TV programmes/features in host country(s)	3
18b	Number of national TV programme/features in the UK	
18c	Number of local TV programme/features in host country	3
18d	Number of local TV programme features in the UK	
19a	Number of national radio interviews/features in host country(s)	
19b	Number of national radio interviews/features in the UK	
19c	Number of local radio interviews/features in host country (s)	4
19d	Number of local radio interviews/features in the UK	

Physical Outputs		
20	Estimated value (£s) of physical assets handed over to host country(s)	£ 5000
21	Number of permanent educational/training/research facilities or organisation established	
22	Number of permanent field plots established	35
23	Value of additional resources raised for project	£ 105 000

17. Appendix III: Publications

Provide full details of all publications and material that can be publicly accessed, e.g. title, name of publisher, contact details, cost. Details will be recorded on the Darwin Monitoring Website Publications Database that is currently being compiled.
Mark (*) all publications and other material that you have included with this report

Type * (e.g. journals, manual, CDs)	**Detail** ***(title, author, year)***	**Publishers** ***(name, city)***	**Available from** (e.g. contact address, website)	**Cost £**
Peer-Reviewed publication*	Vargas, F. H., S. Harrison, S. Rea, and D. W. Macdonald. 2006. Biological effects of El Niño on the Galápagos penguin.	Biological Conservation 127:107-114.	http://www.wildcru.org/aboutus/people/vargas.htm	
Peer-Reviewed publication*	Travis, EK, F. H Vargas, J Merkel, N Gottdenker, R.E Miller, P.G Parker. 2006. Hematology, plasma chemistry, and disease serology of the Flightless Cormorant (*Phalacrocorax harrisi*) in the Galápagos Islands, Ecuado	Journal of Wildlife Diseases: **42 (1)**: 133-141	ttp://www.wildcru.org/aboutus/people/vargas.htm	
Peer-Reviewed publication*	Vargas, H., C. Lougheed, and H. Snell. 2005. Population size and trends of the Galápagos Penguin *Spheniscus mendiculus*.	Ibis 147:367-374	ttp://www.wildcru.org/aboutus/people/vargas.htm	
Peer-Reviewed publication*	Boersma, P. D., H. **Vargas**, and G. Merlen. 2005. Living laboratory in peril (Science Editorial).	Science 308:925.	ttp://www.wildcru.org/aboutus/people/vargas.htm	

Peer-Reviewed publication*	Dvorak, M., H. Vargas, B. Fessl and S. Tebbich. 2004. On the verge of extinction: a survey of the mangrove finch *Cactospiza heliobates* and its habitat on the Galápagos Islands.	Oryx 38: 1-10	tp://www.wildcru.org/aboutus/people/vargas.htm	
Workshop publication and CD*	Matamoros, Y., F. H. Vargas, O. Byers, R. C. Lacy, and E. K. Travis, Montoya, G (Eds). 2006. Taller de análisis de Viabilidad de la Población y el Hábitat del Pingüino de Galápagos *Spheniscus mendiculus*	IUCN-SSC, CDF, GNPS, CBSG	CBSG Apple Balley, MN. USA	Free
DPhil. Thesis*	Vargas, F. H. 2006. The ecology of small populations of birds in a changing climate	University of Oxford	University of Oxford (Bodleian Library)	Free
MSc Thesis	Larrea C. 2006. Movimiento, dispersión y éxito reproductivo del cormorán no volador *Phalacrocorax harrisi*, en las islas Galápagos	Pontificia Universidad Católica del Ecuador	Pontificia Universidad Católica del Ecuador, Quito, Ecuador	
MSc Thesis	Riofrío, M. 2006. Estudios sobre la rata negra, *rattus rattus* en Galápagos: biología y opciones para el control estratégico	Universidad de Guayaquil	Universidad de Guayaquil, Guayaquil, Ecuador	
Manual	Vargas, F. H. 2006. Manual de monitoreo de roedores en las Islas Galápagos	FCD-GNPS	FCD, Isla Santa Cruz, Galápagos	Free
Manual	Vargas, F. H. 2006. Manual instructivo para el censo de pinguinos y cormoranes en las Islas Galápagos	FCD-GNPS	FCD, Isla Santa Cruz, Galápagos	Free

18. Appendix IV: Darwin Contacts

To assist us with future evaluation work and feedback on your report, please provide contact details below.

Project Title	Climate Change and Conservation of Galápagos Bird Species
Ref. No.	***162/12/0118***
UK Leader Details	
Name	Prof. D. W Macdonald
Role within Darwin Project	Project Leader
Address	WildCRU, Tubney House, Tubney, Oxon OX13 5QL, UK
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	Dr. Phil Riordan
Role within Darwin Project	GIS expert UK
Address	WildCRU, Tubney House, Tubney, Oxon OX13 5QL, UK
Phone	
Fax	
Email	
Partner 1	
Name	Hernán Vargas
Organisation	Charles Darwin Foundation
Role within Darwin Project	Main project partner in host country (Ecuador) DPhil. Student
Address	Charles Darwin Foundation, Sta. Cruz, Galápagos, Ecuador
Fax	
Email	
Partner 2 (if relevant)	
Name	Fabián Oviedo
Organisation	Galápagos National Park Service
Role within Darwin Project	Project dissemination
Address	GNPS Sta. Cruz, Galápagos, Ecuador
Fax	
Email	

19. Appendix V: Project Summary: Logical framework

Project summary	Measurable Indicators	Progress and Achievements	Important assumptions
Goal: To draw on expertise relevant to biodiversity from within the United Kingdom and 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	**Original purpose level indicators**	**Impacts and achievements resulting from the project (report against purpose indicators)**	**Lessons learned resulting from the project**
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.	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.	Climate (temperature and rainfall) and ornithological data (abundance, survival, movements, breeding success, dispersal, sex ratio, and avian parasites) gathered throughout year. Data on anthropogenic impacts gathered at regular intervals (e.g. during fishing seasons) Climate data and anthropogenic data were correlated with bird data and modelled providing estimates of relative impacts.	Novel technology facilitates collection of large volumes of climatic and ornithological data Participation of Ecuadorian students in all phases conservation work has greatly facilitated data collection. CDF and GNPS employed trained staff after completion of project The CDF and GNPS provide strong support for the project. This, despite political instability in Ecuador and frequent changes in directorships
		The presence and changes in	The CDF supports research and the

		abundance of black rats was monitored every year at 13 field plots following standardized experimental protocols to determine their impact on penguins and mangrove finches. Feral cats were controlled at Caleta Iguana, Isabela Island, the most important nesting site for the Galápagos penguin identified during study period.	GNPS incorporates results into management plans. International collaborations provide important expertise, in terms of scientific output, complementary funding and laboratory facilities usually not available in countries which are poor in economic resources.
OUTPUTS:			
Original outputs	**Original output level indicators**	**Completed activities and outcomes that contribute toward outputs and indicators**	**Lessons learned resulting from the project**
UK and host country partner organisations develop a unique partnership for participating in the planning process and implementing project outputs.	8 Ecuadorian park rangers trained in ecological monitoring techniques, 6 undergraduate 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.	15 park rangers (and 2 high school student) were trained in ecological monitoring techniques, 15 undergraduate students were trained in research methodologies including 2 in GIS, and 1 Galapagos-born student to pursued higher education leading to a DPhil in conservation biology In early 2005, two students began Tesis de Licenciatura (Msc. equivalent) under the umbrella of the Darwin Project. They are expected to submit their thesis by Sept. 2006.	Ecuadorian University students represent valuable project resources, as they gather continuous data throughout the year. Participation of local high school students should be encouraged. Local DPhil. student played a key role during periods of political instability in the islands. The project continued to be implemented, even under these adverse conditions.
Original outputs	**Original output level indicators**	**Completed activities and outcomes**	**Lessons learned resulting from the**

		that contribute toward outputs and indicators	**project**
Management plans, manuals, technical reports and papers published and distributed.	Number of manuals, management plans, workshops, reports, papers, DPhil. thesis, conferences, and presentations on local radio and television.	13 Technical reports submitted to GNPS and to CDF. Population and Habitat Viability Analysis (PHVA) workshop report for the Galápagos penguin published. Findings were presented at 9 conferences DPhil. thesis completed. 3 manuscripts submitted, 5 papers published in peer-reviewed journals. One briefing book published in collaboration with CBSG. 2 Manuals for monitoring birds and rodents. Project activities were publicised through local radio, local and national newspapers, newsletters and websites in Ecuador and the UK.	The GNPS realise the need for good science for planning and carrying out effective management. The PHVA workshop outputs and 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. 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

Original outputs	Original output level indicators	Completed activities and outcomes that contribute toward outputs and indicators	Lessons learned resulting from the project
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 rainfall.	We marked with Pit tags a total of 715 penguins and 1344 cormorants. We gathered 263 records of recaptured penguins and 5455 records of recaptured cormorants. Climatic data from 2 logging rain gauges and 20 fixed temperature loggers were downloaded every six months. Penguin and cormorant were surveyed monthly to record data on population dynamics 32 penguins 95 cormorants were deployed with novel devices to study foraging ranges and diving behaviour. Majority of bird data has been converted into shape files and added to GIS multilayered database at the CDF. Multi-layered GIS database identified important areas for bird conservation.	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. Main partners cooperate and carry out long term study on demography of marked population of birds. Extent of overlap between bird foraging ranges and human fishing areas needs to be quantified.