



Department
for Environment
Food & Rural Affairs



Darwin Initiative Final Report

Darwin project information

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| Project Reference | 19-009 |
| Project Title | Galapagos marine invasive species: prevention, detection and management |
| Host country(ies) | Ecuador |
| Contract Holder Institution | University of Southampton |
| Partner Institution(s) | Charles Darwin Foundation (CDF), Charles Darwin Research Station, Galapagos Galapagos National Park, Ecuadorian Navy: Instituto Oceanográfico de la Armada DIRNEA Dirección Nacional de Espacios Acuáticos ABG Biosecurity and Quarantine Regulation and Control Agency for Galapagos (<i>formerly AGROCALIDAD Agencia Ecuatoriana de Aseguramiento de la Calidad del Agrio</i>) University of Dundee |
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| Project Leader Name | Dr Ken Collins |
| Project Website | www.darwinfoundation.org/en/science-research/invasive-species/marine/ www.facebook.com/darwinfoundation www.southampton.ac.uk/oes/research/projects/galapagos_marine_invasive_species_prevention_detection_and_management.page? |
| Report Author(s) and date | Dr Ken Collins with input from Inti Keith (CDF), Terry Dawson (Dundee), Stuart Banks (CI), Jenny Mallinson (Southampton) August 2015 |

Acronyms

| | |
|--------|---|
| ABG | Bio-security and Quarantine Regulation and Control Agency for Galapagos |
| CI | Conservation International |
| CDRS | Charles Darwin Research Station |
| CDF | Charles Darwin Foundation |
| DI | Darwin Initiative |
| ETP | Eastern Tropical Pacific |
| GC | Galapagos Conservancy |
| GMR | Galapagos Marine Reserve |
| INOCAR | Ecuadorian Navy's Oceanographic Institute |
| UCSU | University of Carolina State University |

1 Project Rationale

The marine ecosystems of Galapagos harbour unique biological communities and have a high incidence of endemic species (18.3%, Hickman 2009). Galapagos is a UNESCO world heritage site, renowned for its high biodiversity and extraordinary oceanographic features that provide a great variety of habitats in a unique environmental setting. Ecuador's investment in the protection and sustainable development of Galapagos has been very significant. However, due to exponential growth of tourism, maritime traffic and urban development, the sustainability of the archipelago and its unique ecosystems is at great risk. Recent assessments show that 45 marine species in Galapagos are now considered globally threatened and are included on the IUCN Red List.

Development in the archipelago is mostly oriented towards tourism, which is ship-based and growing at a rate of 14% per year. Around 240 (mostly foreign) vessels, visited Galapagos from 1997-2006. Five cargo ships from ports in mainland Ecuador supply the archipelagos ever growing population and tourists. The national and international maritime traffic acts as a potential vector for invasive species. As a result, the number of introduced terrestrial and marine species increased by an order of magnitude in the past 100 years (112 to 1321). Invasive species are considered as the second most important cause of biodiversity loss by the IUCN. While their impacts have been studied extensively in the terrestrial environment, effective quarantine protocols are now in place, few data were available for the marine realm. In fact several species with high invasive potential, such as the algae *Caulerpa racemosa* and *Asparagopsis taxiformis*, are already established. No data on their dispersion and competition with native species was available before the start of the project, but the destructive potential of invasive species in general has been demonstrated extensively in marine ecosystems worldwide.

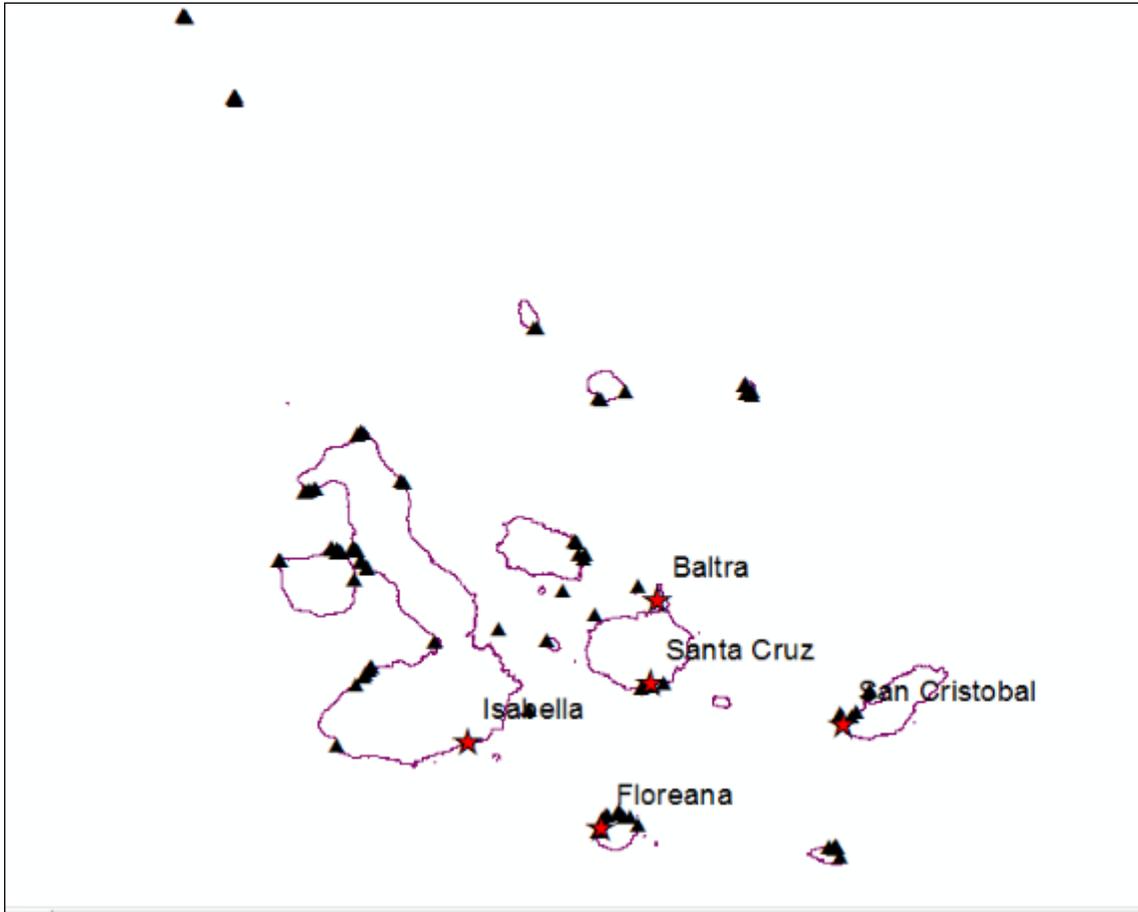


Fig.1. Galapagos ports (red stars) and marine monitoring sites (black triangles)

2 Project Achievements

2.1 Outcome

The Charles Darwin Foundation's (CDF) Charles Darwin Research Station (CDRS) has been the focus of Galapagos research for the past 50 years, training the majority of government agency staff in the region. The current CDF/CDRS director Arturo Izurieta, was originally CDF trained and until April 2015, Director of the Galapagos National Park. CDF was key to the implementation and success of this project. During the project the dire financial state of the CDRS gradually emerged (*see section 4.5*) with the very real possibility of it closing permanently in 2014 and this project terminating part way through. Closure was averted with USA Galapagos Conservancy (GC) support and the redundancy of most of the "permanent" staff. Thanks to both the assured DI support and extra funding from GC, this project has successfully concluded with a stakeholder agreed action plan (*see section 2.2.1*) plus the staff and resources in place to implement it into the future (*see section 4.5*).

2.2 Impact: achievement of positive impact on biodiversity and poverty alleviation

This project was aimed at prevention of the loss of marine biodiversity with consequent income decline, not specifically poverty alleviation or income generation (*see section 4.2*)

This project aimed to establish effective prevention, detection and quarantine measures that will significantly diminish the introduction of alien species in the marine environment. The outputs detailed below show how this has been accomplished.

Outputs

Before the inception of this project there were no marine invasives species plans or activities. This project has:

- Identified what and where potential invasive species occur in the Galapagos (*see Keith PhD, papers, reports workshop and training materials*)
- Shared this database with the Government Agencies
<http://www.darwinfoundation.org/datazone>
- Identified which species are likely to arrive and if so, could have significant impact, i.e. risk categorisation. Galapagos (*see Keith PhD, papers, reports workshop and training materials*)
- Produced training materials/courses and awareness raising materials (*see workshop and training materials*)
- Trained 560 Galapagos Natural Park, Navy and Biosecurity Agency staff as to their threat and how to identify them (*see electronic supplement workshop and training materials and attendance sheets, syllabus: MISNov2013 "Informe de salida de campo 12-16 Nov 13"*)
- Established a reporting hotline especies.invasoras@fcdarwin.org.ec
- The Ecuadorian Government agencies and CDF have incorporated marine invasives into their operating plans (*published*)
- The Ecuadorian Ministry of Environment has made CDF an administrator and beneficiary for a \$2.8m grant from its National Invasive Species Fund.
<http://www.feigalapagos.org/>
- Not funded by this project, but a significant step forward: a quarantine/inspection dock has been established in Guayaquil for all cargo shipping to Galapagos. The possibility of a similar "one stop" dock in Galapagos is being explored. (*For background see electronic supplement: MISNov2013 "Informe de salida de campo 12-16 Nov 13" and <http://www.wildaid.org/sites/default/files/resources/QuarantineChain.pdf>*)
- Produced a shipping/boat movement database (*Submitted with Y2 report, see final workshop papers and Bioinvasions 2016 submitted paper abstract*)
- Produced a future climate scenario ocean current modelling grid for the Galapagos enabling risk scenarios to be analysed. (*see report in electronic supplement*)
- Held national marine invasives workshop in Guayaquil November 2013 (*see electronic supplement*) and a final international workshop Feb 2013 (*see 2.2.1 below and <http://www.galapagos.org/blog/marine-invasives-workshop-recap/> <http://www.galapagos.org/wp-content/uploads/2015/01/Marine-Invasives-Workshop-Invitation.pdf>*)
- Run a marine invasive workshop in Edinburgh, Sept 2014 (*see MASTS workshop in electronic supplement*) which directly led to guidance for the Salinas (mainland Ecuador) to Galapagos yacht regatta Nov.2014

Table 1. The degree of completion of planned activities (3= fully, 2 = partially)

| Activity | achieved |
|--|----------|
| In depth review of scientific and specialized outreach literature to synthesize records of invasive species in the marine environment of the Galapagos in recent decades. | 3 |
| Review data of the CDF Ecological Monitoring Program of the last ten years to assess recent changes in species composition and the presence of invasive species. | 3 |
| Elaborate a marine invasive species monitoring plan and protocol for local authorities. | 3 |
| Carry out monitoring surveys in the 5 main ports of Galapagos twice a year, and in Puerto Ayora bimonthly, for higher temporal resolution, | 2 |
| Conduct yearly invasive species monitoring surveys throughout the GMR as part of the CDF Ecological Monitoring Program. | 3 |
| Determine the occurrence and spatial distribution of marine invasive species already established in Galapagos. | 3 |
| Establish a database with historical data and surveys results available to GNPS/ local government authorities. | 3 |
| Elaborate marine invasive species distribution maps in the GMR. | 3 |
| Elaborate a list of potentially invasive marine species in Galapagos after review scientific literature and technical reports about potentially invaders, including information provided by marine invasive species programs already established in the ETP region and expert workshops. | 3 |
| Elaborate a risk categorization for incoming ships, combining their provenance and recent shipping route with the identification of hotspots of transmission and propagation of invasive species in the Eastern Pacific. | 3 |
| Elaborate sensitivity maps with spatial data on distribution of invasive species combined with traffic routes and density of maritime traffic within the GMR. | 2 |
| Develop ocean circulation and invasive dispersal models for the GMR. | 3 |
| Elaborate a risk assessment report. | 2 |
| Elaborate, in close collaboration with the other institution involved, a rapid response protocol applicable in case of invasive species detection within GMR. | 3 |
| Elaborate species identification guides for marine invasive species presents in ETP region especially for naturalist guides and tour operators and train them in their use. | 3 |
| Establish a reporting hotline and procedures for invasive species detections by naturalist guides to take advantage of their knowledge and year-round presence throughout the archipelago. | 3 |
| Organize public workshops for GMR users about marine invasive species in the main 4 population centres of the Archipelago. | 3 |
| Elaborate annual outreach reports. | 3 |
| Training course in marine invasive species identification, monitoring and database analysis for the technical staff of the three institutions involved: GNP, Agrocalidad and INOCAR. | 3 |
| Organize technical participative workshops with GNP, Agrocalidad and INOCAR to inform about the progress of the project, advisement and results achieved so far. | 3 |
| Thesis projects carried out for three national students Bachelor and one national student PhD thesis on invasive species. | 2 |
| Elaborate an annual report about the progress of the project and the results achieved. | 3 |

2.2.1 Final workshop



Fig.2. Participants in the 1st Tropical Island Marine Bioinvasions Workshop, CDRS, Feb 2015

The final workshop was originally intended as a project dissemination exercise for the Ecuadorian stakeholders, however with the involvement of Prof. Jim Carlton, Williams College, USA, founding Editor-in-Chief of the international journal *Biological Invasions*. The scope of the workshop was expanded to: **1st Tropical Island Marine Bioinvasions Workshop**, 24-26 Feb 2015, Charles Darwin Research Station.

There were 53 participants, of which 40 represented Ecuadorian government agencies and NGOs: Galapagos National Park (7), ABG (7), INOCAR(4), Undersecretary of Marine and Coastal Management (2), Technical Secretariat of the Sea (2), local port Captain, Galapagos Tourism, Ecuadorian universities (3); NGOs: CDF (4), Galapagos Conservancy, Island Conservation, WWF, Instituto Nazca, Wildaid, CI (3)

+ International participants: UK (3), USA (4), NZ (2), Trinidad, Spain, Panama,

The aim of the meeting was to review both international and Galapagos marine invasive issues, then formulate research and management plans for the Galapagos. The meeting was held in Spanish and English with simultaneous translation and facilitators to summarise discussions around two themes:

- Invasions of Marine Ecosystems in Tropical Islands
- Action Plan for Marine Invasive Species in the Galapagos Marine Reserve

The key document arising from this meeting and this project was circulated in Spanish, has been commented on and now (Sept 2015) finally endorsed by all Ecuadorian participants and translated into English (see *electronic supplement: Final_Workshop_2015/ "English FINAL_Plan de Accion para Especies Invasores Marinas en la Reserva Marina de Galapagos)*

:

Action plan to minimize risks of marine invasive species introduction into the Galapagos Marine Reserve

Key questions addressed are:

How many non-native marine species are established in the Galapagos Marine Reserve (GMR)?

- Search for marine invasive species around the GMR
- Monitoring of the main ports in the GMR
- Monitoring abundance and distribution of non-native species present in the GMR
- Installation and analysis settlement plates (GMR & mainland ports, other GMR key sites)
- Training workshop on species identification and use of settlement plates
- Identification of samples taken during the workshop in Galapagos in February 2015

How could non-native species reach the GMR?

- Flow analysis and maritime routes for incoming traffic to the GMR
- Analysis of risk vessels entering the GMR as vectors of marine species
- Analysis of currents in the GMR and the Tropical Eastern Pacific
- Identify potential invasions by climate change and / or a possible "El Niño"
- Analysis of marine garbage in the GMR
- Model of dispersion of non-native species into the GMR
- Analysis of Connectivity in the Eastern Tropical Pacific
- Risk Analysis of supply ships from the mainland to the GMR

What are the most effective measures to minimize the introduction and establishment of marine species in the archipelago?

- Implement equipment cleaning regulations for scuba diving and snorkelling between visitor sites in the GMR
- Plan to prevent the introduction of non-native species to the GMR (an example: *Carijoa riisei*)
- What are the resolutions to discharge ballast water in the GMR and how they can be improved to reduce risk of introduction of marine species?
- Creating an Emergency Operations Committee for quick response in case of introduction of non-native species to the GMR
- What it is the most efficient way to make boat hulls inspections to detect non-native species?)
- Training workshops for inspection of ship hulls and sample collection
- Create inspection protocols for hulls

What is the risk that *Carijoa riisei* (recently established on the Ecuadorian mainland coast) reaches the GMR and how can we avoid it?

- Monitoring *Carijoa riisei* in the Ecuadorian coast to map the distribution of this species
- Investigate *Carijoa riisei* control mechanisms in the Ecuadorian mainland



Fig.3. Inti Keith, CDRS being interviewed by Ecuador national television during the Final workshop

2.3. SWOT analysis of the overall project

Strengths: Prior to this project Galapagos had (and still has) good terrestrial biosecurity, so the stage was set for extending this into the marine sector with this project. CDF/CDRS is respected by the Ecuadorian government agencies, because of the quality of its work, the fact that many regional government staff received training there and collaborative programmes. For the first 2 years of the project there was a large marine biology team (~12) actively working together on a wide range of projects. The team was led by Banks who had worked at CDRS since 2000 with both Collins and Dawson on previous Darwin projects plus collaborated with many other international teams notably from the USA and Australia. Banks was supported by Keith who had been working in the Galapagos since 2002.

Weaknesses: After 50 years of operation, the financial demise of CDF was not foreseen. This led to the loss of the majority of the station staff and all but Keith of the marine biology team. Banks, the instigator of this project, was expecting to be largely leading this project in-kind supported by CDF core-funding rather than directly paid from Darwin funds. The modelling by UCSU was complex and underfunded leading to its late delivery. In turn its output was expected to be taken on by the Australian CSIRO CONNIE2 team who were keen to expand their on-line interface to the Galapagos region but also experienced financial and staffing problems.

Opportunities: There is increasing interest in regional Eastern Tropical Pacific (ETP) science based on the connectivity of the marine ecosystems of the region. A regional shark tagging project showed movement of animal between Galapagos and islands off Columbia, Panama and Costa Rica. Conservation International (CI) with a regional base in Galapagos, has an ETP focus including its fisheries. An unsuccessful application for an ETP connectivity project was made to DI, unfortunately at the same time that DI priority was switched to British Overseas Territories. The spread of and threats from marine invasive species are common across the region and post this project, related collaborations are developing, largely triggered by this project's final workshop.

Threats: This project could have come to abrupt end with the threatened closure of CDRS last year which is why the UCSU sub-contract was switched from CDRS to Southampton. A long period of financial uncertainty was very unsettling to the CDF staff with wages not being paid for several months. It is notable that even those who knew they were going to be made redundant continued working enthusiastically on the project.

3 Project Partnerships

The host country project leader was the Charles Darwin Foundation (CDF) which both the UK project leader, Collins and the other UK partner, Dawson have successfully collaborated with previous DI projects:

1997-2000, 6174, Collins, Revision of the Galapagos Marine Management Plan.

2005-2007, 14-048, Dawson, Galapagos Coral Conservation: Impact Mitigation, Mapping and Monitoring.

The CDF project leader Stuart Banks (y1&2), a former postgraduate research student of Collins, was sent to Galapagos to complete the former DI project and was the CDF project leader for the latter. Banks has led the CDF marine programme 2003-14. Subsequently Banks has been working with Conservation International (CI) still based in Galapagos and very involved in regional strategic planning.

Inti Keith, an Ecuadorian MSc marine biologist, was employed throughout the project. In Feb 2013 she formally registered for a project linked PhD at the University of Dundee supervised by Dawson with Collins as an external supervisor. Keith took over as project leader for y3 supported by Pricilla Martinez, an Ecuadorian employed and trained by the original 1997-2000 DI project, now an environmental marine consultant with Instituto Nazca based on mainland Ecuador.

CDF works closely with ABG, Biosecurity Agency for Galapagos, (formerly AGROCALIDAD) in charge of quarantine measures and now has greater autonomy. A strong alliance has been forged between CDF and all governmental partners in Ecuador (INOCAR is the Ecuadorian Institute of Oceanography of the Navy, DIRNEA the national maritime authority, Navy in control of ports) in Ecuador. For this project there were regular (every 2 months) meetings as well as workshops and training events with partners.

The Ministry of Environment made (October 2014) CDF an administrator and beneficiary for its \$2.8m grant from its National Invasive Species Fund.

The CMAR Marine Corridor project for the Eastern Tropical Pacific currently involves Costa Rica, Panama, Columbia, but Ecuador's government is holding back. However within this, CDF formed a technical committee for Mallpello, Gorgona, Cocos and Galapagos.

Collins will return to Galapagos in September 2015 with 15 MSc marine biology students to undertake marine invasive species mapping with Keith and consider future collaboration with the new director of CDF.

Keith will spend Oct 2015-March 2016 with Collins and Dawson completing her PhD.

One legacy project for long term monitoring arose from the final workshop, a co-operative fouling panel study in conjunction with Dr Linda McCann, Smithsonian Environmental Research Center, Tiburon, California.

4 Contribution to Darwin Initiative Programme Outputs

“Help countries rich in biodiversity but poor in financial resources to meet their objectives under international biodiversity conventionsaddress threats to biodiversity such as invasive species”

Arguably introduction of new marine species is a method of increasing biodiversity but the danger is from those introduced species which are invasive, spreading uncontrollably, ousting natives and thus reducing biodiversity. Before the project started there was no marine biosecurity for Galapagos. A key aim of the Darwin Initiative is capacity building to conserve biodiversity. Through training and workshops this project has built an awareness of the problem, helped introduce screening measures to stop or at least slow the rate of introduction (see *section 2.2*) and produced an agreed action plan to strengthen control, monitor and react when new species arrive (see *section 2.2.1*).

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

CDF works closely with the National Park Service, operational arm of the Ministry of Environment in direct contact with the World Heritage Coordination Ministry for Ecuador. These agencies are responsible for addressing Ecuador’s obligations under the CBD/CMS and CITES treaties, including information requests and scenario development. CDF routinely responds to questions on all three treaties and is actively contributing to the ESBA (Ecologically Significant Biological Areas) dialogues set up jointly by UNESCO, IOC and OBDI.

Specific CBD Articles:

- baseline work on marine invasive species, their monitoring (CBD Art 7)
- establish a preventive program into Galapagos regional plans (CBD Art 6).
- preventing introduction of marine invasive species and controlling impacts (CBD Art 8h),
- benefit for the local sustainable livelihood (CBD Arts 8i and 8j).
- local government agency staff trained and integrated in the project (CBD Art 12)
- close collaboration with international experts (CBD Arts 16 and 18).
- outreach program to inform and encourage local community participation (CBD Art 13).
- databases updated and available for information exchange (CBD Art 17)

Ecuador (unlike the UK) is a signatory to the IMO Ballast Water Convention. It is also an active member of the Permanent Commission for the Southeast Pacific GLOBALLAST partnership. (see *electronic supplement/Final workshop2015/INOCAR presentation*). The proximity of both mainland Ecuador and Galapagos to the Panama Canal spread of marine invasive species by ballast water is of particular concern. Fortunately cargo traffic to Galapagos is largely one way, ships entering laden and leaving empty, require taking on ballast water in the Galapagos rather than dumping it there.

4.2 Project support to poverty alleviation

This project was not aimed at poverty alleviation or income generation, rather prevention of the loss of marine biodiversity and potential income decline. Galapagos is dependent on its unique biodiversity for its 200,000 tourists per year yielding direct park entry fees of £10m/y alone, of which a proportion directly benefits the local administration and population. Apart from tourism related employment, fishing supports many of the local population which again could be impacted by marine biodiversity loss.

4.2.1 Programme indicators

- Did the project lead to greater representation of local poor in management structures of biodiversity?

The Galapagos Marine Reserve Management Plan (supported by the 1997-2000 DI project) specifically established stakeholder involvement (including the local authorities and fishermen) in decision making. Marine invasives have been incorporated in the Galapagos National Park (including the marine reserve) management plans.

- Were any management plans for biodiversity developed?

An action plan to minimize risks of marine invasive species introduction into the Galapagos Marine Reserve was developed during the February 2015 workshop (see section 2.2.1)

- Were these formally accepted?

Yes

- Were they participatory in nature or were they 'top-down'? How well represented are the local poor and women, in any proposed management structures?

Yes, participatory, involving government agencies and NGOs, of which half the attendees were women.

- Were there any positive gains in HH income as a result of this project?

Not known, but increased government agency surveillance to prevent marine invasives has required an increase in staff.

- How many HH saw an increase in their HH income?

Not known

- How much did their HH income increase (e.g. x% above baseline, x% above national average)? How was this measured?

Not known

4.3 Transfer of knowledge

Did the project result in any formal qualifications?

- i. How many people achieved formal qualifications?
- ii. Were they from developing countries or developed countries?
- iii. What gender were they?

Inti Keith (Ecuadorian female) is on course to gaining her PhD on Galapagos marine invasives with the University of Dundee early 2016. One of the consequences of the financial demise of CDF and the closure the CDRS shop (*see section 4.5*) in particular, was that this had historically generated the funding to support mainland Ecuadorian university students working at CDRS, none was available for the years 2&3 of this project.

A 3 day training programme delivered to 560 Ecuadorian government agency staff, along with major workshops in Guayaquil, Nov 2013 (Ecuadorian participants) and Galapagos. The final workshop, Galapagos Feb 2015 (with international participants) has increased awareness of the issues with required control measures.

Public lectures were given in the main Galapagos population centres on Santa Cruz, San Cristobal and Isabella. Posters (Fig.4, section 6) were displayed at Galapagos ports, fishing docks and distributed to tourist guides.

4.4 Capacity building

- i. Did any staff from developing country partners see an increase in their status nationally, regionally or internationally? For example, have they been invited to participate in any national expert committees, expert panels, have they had a promotion at work?
- ii. What gender were they?

Inti Keith's (Ecuadorian female) status and profile has increased enormously (from junior scientist CDF) as a result of this project through running training programmes, national and international workshops, conferences and publications. She was specifically asked by the Galapagos National Park to lead environmental monitoring of Galapagos cargo ship groundings in both 2014 and 2015. She is the only member of the CDF marine team (12) to not be made redundant as a result of the CDRS's financial difficulties and effectively promoted to principal investigator. Her international contacts generated through organising the February 2015 workshop have resulted in co-authorship of several academic papers. She met with Lorena Tapia, Ecuador's Minister for the Environment after the workshop to discuss the FEIG (Fondo Especies Invasoras Galapagos) award to CDF from the National Invasive Species Fund. Dawson and I are determined to assist Keith gain her PhD and return to Galapagos to take a senior role with CDF continuing to work with the multiple agencies collaborating with this project.

CDF works closely with the National Park Service, operational arm of the Ministry of Environment in direct contact with the World Heritage Coordination Ministry for Ecuador. Section 4.1 describes the support for international conventions

Before the inception of this project there were no marine invasives species plans or activities. Sections 2.2 and 2.2.1 summarise the project achievements

Three day training courses have been delivered to 560 government agency staff as well as major workshops in Guayaquil and Galapagos (*see workshop and training materials in electronic supplement*). Now the Biosecurity Agency ABG are routinely inspecting the hulls of visiting cargo ships and yacht (*see final workshop presentations in the electronic supplement*) with the powers to send them clear of the Galapagos marine reserve boundaries for hull cleaning should they be heavily fouled. A quarantine dock has been established in Guayaquil for cargo ships serving the Galapagos.

4.5 Sustainability and Legacy

The Charles Darwin Research Station is accepted by the Ecuadorian authorities as giving the academic lead to Galapagos research and management strategies.

There was a danger that the Charles Darwin Research Station would close having become effectively insolvent in 2013. By y3 all the CDRS marine staff had been made redundant with the exception of Keith. This project continued through y2&3 because of assured DI funding. An emergency appeal by CDF and the Galapagos Conservancy raised \$1.5m, staving off bankruptcy. One of the contributing factors to the financial crisis was the considerable cost buying out of the existing externally run CDRS shop and construction of an impressive premises at the start of this project. This shop was anticipated to raise \$0.5m/y (equivalent to the basic CDRS running costs) from the thousands of CDRS visitors. Sadly local political pressure blocked all trading and the shop did not raise any money. In April 2015 Swen Lorenz, the German CDRS director, was replaced by Arturo Izurieta, originally CDF trained and former Galapagos National Park Director. It is expected that now with an Ecuadorian in charge of the CDRS, relationships with the local political establishment will be less fraught and the shop will start trading ensuring survival of the CDRS.

Inti Keith, CDF 2010-present and project leader y3, is on course to submit her PhD March 2016. Before joining CDF she was a Galapagos dive guide for 8 years, is well known and respected by the Galapagos community and led the majority of government agency training workshops (total 560 staff) within this project. This considerable investment in training ensured a body of knowledgeable government staff committed to the exclusion and control of marine invasives. In both 2014 and 2015 she was retained by the National Park to lead the underwater evaluation of the ecological impact caused by the grounding of cargo supply ships on San Cristobal Island. She led the organisation of the project's final workshop and as a result secured strong academic support from USA, NZ and Panama which should secure the revival of the CDRS marine programme. Once Keith has her PhD she would be likely to secure a senior position within one of the government agencies, but our hope is that she continue fundamental research as a member of CDF, supported by international experts, advising the Ecuadorian government.

Lorena Tapia, Ecuador's Minister for the Environment visited the CDRS at the end of the workshop, meeting with the then director, Swen Lorenz and Inti Kieth specifically to discuss the \$2.8m grant (FEIG-Fondo Especies Invasores Galapagos) to CDF from its National Invasive Species Fund.

Banks (CDF 2003-14) is now employed by Conservation International which has an influential position in Galapagos and the Tropical Eastern Pacific. CI is benefitting from Bank's considerable expertise and experience for regional strategic fisheries and biodiversity planning.

Jennifer Suarez, employed by CDF on the project (y1&2) is now employed by the Galapagos National Park. Macarena Parra (also employed y1& 2) is on track to start a PhD with Queens University, Belfast. Nathalia Tirado, curator of CDF marine collections moved to Quito.

Dr Luis Vinueza, formerly a student researcher with the 1997-2000 project, now University of San Francisco, Quito and Galapagos Science Centre, San Cristobal, Galapagos participated in the workshop and is continuing Galapagos marine research.

A new long term monitoring collaboration resulting from the final workshop has been a co-operative fouling panel project in conjunction with Dr Linda McCann, Smithsonian Environmental Research Center, Tiburon, California.

In August 2015 Keith represented CDF at the Coiba National Park, Panama, discussing setting up a regional group for marine invasive species.

Collins and Mallinson will return to CDF in September 2015, with 15 Southampton MSci marine biology students to work with Keith surveying marine invasive species. Keith will return to the UK, October 15 - March 2016 to complete her PhD with Dawson and Collins.

5 Lessons learned

This project had a straightforward management structure (reliant on CDF) built on years of experience and trust between the partners plus commitment from CDF. Banks (Collins' former student) helped CDF conclude the 1997-2000 DI marine reserve project, then the CDF PI for the 2005-2007 DI coral project led by Dawson, was the originator of this project and CDF PI for its first 2 years. CDF has forged good relations with all Galapagos stakeholders, government agencies and NGOs over the past decades. Galapagos had (and still has) good terrestrial biosecurity, so the stage was set for extending this into the marine sector with this project.

Beyond very clear aims and objectives, the key to the success of implementing this project has been Keith (MSc marine biologist) who had intimate local knowledge through being a Galapagos dive guide for 8 years, before joining the CDF staff 2 years prior to the start of this project and leading all its survey work and training. Her boundless energy and determination is inspirational and accounts for the respect accorded to her by Galapagos authorities, NGOs and residents.

Fortunately the redundancies enforced by CDRS's financial difficulties (see section 4.5) did not affect Keith. Martinez was employed on a short contract to fulfil the final year commitments. The USA Galapagos Conservancy additionally supplied funding (see section 6.2) for the very successful final workshop transforming it from a local (as originally planned) to an international event (see section 2.2.1).

Ocean modelling scenarios by North Carolina State University (NCSU) was envisaged to be completed by the end of Year 2. Banks specifically visited NCSU in December 2013 to discuss and clarify our requirements. Southampton took over the sub-contracting from CDF. The extreme complexity of the modelling meant that the work was not completed until October 2014. Whilst not an explicit objective, this always was intended to extend the Australian CONNIE 2 ocean particle tracking model <http://www.csiro.au/connie2/background/>, from the western Pacific to the Galapagos/Tropical Eastern Pacific. There have been delays in rolling out new features of the freely accessible Marine Connectivity interface <http://www.csiro.au/connie2/> but it will eventually provide INOCAR with a decision support tool to forecast the rate of transport of invasive species larvae. The modelling was arguably under-resourced since the adoption of the NCSU data by the CSIRO team was expected to be at no cost, but they had funding/staffing problems at the critical time (which this project did not have the capacity to solve) that are now being resolved. Banks has been the driving force behind this and although having moved from CDF to CI is still based in Galapagos and in a position to see this through to the envisaged endpoint.

We also underestimated the amount of effort required to gather shipping data from the mainland and between islands of the Galapagos. The database has required months of effort at Navy offices in the various ports transcribing the paper records to an electronic format.

One area of expertise which we lacked, was that to assess the socio-economic impact of marine invasives. Both WWF and CI personnel in Galapagos have the required skills and it had been hoped to sub-contract them using GC funding however this was absorbed by the final workshop.

5.1 Monitoring and evaluation

All the components of the project happened as anticipated, there were 2 delays: both the NCSU modelling time frame (*the required financial adjustment was agreed beforehand*) and gathering shipping data slipped by a year.

M&E system

CDF had regular meetings (every 2 months) plus training events with the government agency partners/stakeholders. The UK partners visited CDF in Feb/Mar each year of the project and discussed the formal monitoring and evaluation with CDF as well as meeting with the agencies. Given the simplicity of this project the formal monitoring and evaluation was useful in keeping the project on track. The most important mass feedback vehicles were the workshops: Guayaquil, Nov 2013 and Galapagos, Feb 2015.

Internal and external evaluation

The final workshop, Galapagos Feb 2015 (see section 2.2.1) effectively provided the most detailed internal (stakeholder) and external (international expert) evaluation of the project. The opportunity to bring in international marine invasive workers was invaluable, particularly in revising both the assessment of the range of species likely to reach the Galapagos and the transport pathways which has resulted in a new body of collaborative study with New Zealand workers to be presented at the international Bioinvasions conference, Sydney Jan 2016.

This final workshop was never intended to have been a “this is what we have found and this is what we think you should do” event. The long negotiations with stakeholders leading to the revision of the Galapagos Marine Reserve Management plan, 2000 firmly established the value of facilitators. This, plus the extensive training and workshops in the preceding 2 years had set the scene for informed discussion and the adoption of an agreed strategy for the future.

A test of the emerging response protocol was provided by a cargo ship running aground off San Cristobal early May 2014, prior to the establishment of routine surveillance by the Biosecurity Agency ABG, Keith led a survey team to inspect the vessel and two tug boats sent from the mainland, specifically for potentially invasive species. She was asked by the Galapagos National Park and ABG to remain there to assist with technical information on monitoring techniques of what to do before and after the eventual removal of the ship and its sinking in deep water outside the marine reserve. Sadly another ship grounded in early 2015.

5.2 Actions taken in response to annual report reviews

The reviewer’s feedback was not received after the first annual report and thus the second report was submitted without reaction to this, incurring considerable criticism. Once made aware of this and reacting to the review a revised 2.5 year report was submitted. The review of this revised third report acknowledged that issues had been addressed. Other issues are commented on below. This final review along with an overview of the whole project were discussed in Galapagos by the UK team (Collins, Dawson and Mallinson) with CDF (Keith and the director Swen Lorenz) and Banks (CI, ex CDF) in March 2015.

Post project fate of Darwin staff - detailed in section 4.5.

Annual summary reports – electronic supplement Reports:

- ESPECIES INVASORAS MARINAS..230713 (Abril 2012- Mar 2013)
- GC Marine Invasives Interim Report Aug 2014 (GC funding see section 6.2)
- Informe Galapagos 2013-14 pp 83-88
- Manual de monitoro submareal ecologico 2014

Workshop reports - electronic supplement:

- MISNov2013 “Informe de salida de campo 12-16 Nov 13”
- Final_Workshop_2015 “English FINAL_Plan de Accion para Especies Invasores Marinas en la Reserva Marina de Galapagos”

The electronic supplement has been reduced to only those documents of direct relevance.

6 Darwin identity

This project has used the Darwin logo on all its conference, workshop, training and publicity materials, but not exclusively as all the partners who have made in-kind contributions or Ecuadorian government agencies not funded by the project have to be acknowledged. However, there is no doubt that the Marine Invasive Species, *Especies Invasoras Marinas* project has had a clear identity throughout, with no confusion with the terrestrial biosecurity programme. Give the extensive exposure of government agencies and NGOs to workshops and training the within this project and previously through other DI projects the Darwin logo and aims are familiar, including to the Director of the Galapagos National Park and the Ecuadorian Minister for the Environment.

Fig.4. Marine invasives poster displayed at Galapagos ports and fishing docks and distributed to tourist guides.

Finance and administration

6.1 Project expenditure

The total claim in this final year is less than originally budgeted to absorb the small overspends in years 1&2. It was originally envisaged that CDF would be directly employing Xie Lian, UCSU (years 2&3) and Stuart Banks (year 3) for computer modelling with associated overheads (~30%). Instead payment to both was made direct from Southampton by no overheads were charged by Southampton for this, releasing funds for extra CDF staff costs. CDF's financial crisis led to the loss of most of its staff requiring the employment of Priscilla Martinez, external consultant to assist with the delivery of this project in the final year. No capital items were purchased and again the funds used to support the project, principally travel and subsistence which was higher than originally envisaged covering: all UK team costs travelling to and staying in Galapagos (in y1&2 the latter had been partly borne by CDF), supporting Inti Keith CDF attending the workshops in Glasgow and Edinburgh Sept 14, supporting Fadilah Ali, Trinidad attending the Galapagos workshop Feb 2015.

| Project spend (indicative) since last annual report | 2015/16 Grant (£) | 2015/16 Total actual Darwin Costs (£) | Variance % | Comments (please explain significant variances) |
|---|-------------------|---------------------------------------|------------|--|
| Staff costs | | | 26% | Increase in cost due to external consultant to CDF |
| Overhead Costs | | | -100% | Transfer to staff & travel and Subsistence |
| Travel and subsistence | | | 84% | Actual travel costs more than expected plus supported Fadilah Ali Galapagos conference attendance. |
| Operating Costs | | | -60% | Transfer to travel and subsistence |
| Capital items (see section 8) | | | -100% | Transfer to travel and subsistence |
| Others (see section 9) | | | -8% | modelling runs |
| OTAL | | | | |

| Staff employed (Name and position) | Cost (£) |
|--|----------|
| Priscilla Martinez – External Consultant to CDF replacing Stuart Banks as PI | |
| Inti Keith – Marine Ecologist CDF | |
| TOTAL | |

| Capital items – description | Capital items – cost (£) |
|-----------------------------|--------------------------|
| | |
| TOTAL | |

| Other items – description | Other items – cost (£) |
|---|------------------------|
| Local workshop costs, meetings and outreach | |
| Studentship | |
| Audit Costs | |
| Xie Lian UCSU modelling sub-contract to Southampton | |
| Stuart Banks – Head of CDF Marine Research (yr 1+2) Modelling Study Y3 UCSU | |
| TOTAL | |

6.2 Additional funds or in-kind contributions secured

| Source of funding for project lifetime | Total (£) |
|---|-----------|
| Galapagos Conservancy \$159,487 y3 fieldwork & final workshop | |
| Lindblad support for Inti Keith \$10,000 | |
| Rufford Foundation support for Inti Keith, | |
| WWF \$5000 | |
| | |
| TOTAL | |

| Source of funding for additional work after project lifetime | Total (£) |
|--|-----------|
| Rufford Foundation support for Inti Keith, | |
| University of Southampton, Dr Ken Collins | |
| | |
| | |
| The Ecuadorian Ministry of Environment has made CDF the an administrator and beneficiary for a \$2.8m grant (FEIG-Fondo Especies Invasores Galapagos) from its National Invasive Species Fund. | |
| TOTAL | |

6.3 Value for Money

Expenditure on biosecurity can be difficult to justify. When there was none on marine biosecurity, as before this project started, then “why start?” Subsequently, as now with Galapagos marine biosecurity established and developing this could be an easy target for future financial cuts. Galapagos had (and still has) good terrestrial biosecurity, so the stage was set for extending this into the marine sector with this project. This project has achieved a lot in a relatively short time through:

- (1) Identifying the potential problem species and their transmission pathways.
- (2) Training 560 government agency staff in marine invasives awareness and control. (If the whole project budget were simply divided by this number, that would represent ~£450/head for the three day course, arguably good value in UK terms alone.)
- (3) Building on the above “buy-in”, a final stakeholder workshop involving the broad spectrum of both government agency and NGO staff, using experience/expertise from around the world has produced an agreed strategy for the future.
- (4) The success of this project has undoubtedly contributed to the Ecuadorian Ministry of Environment making CDF an administrator and beneficiary from a \$2.8m grant (FEIG-Fondo Especies Invasores Galapagos) from its National Invasive Species Fund. Whilst this will be shared with terrestrial control, the marine component is assured.

£251,560 was requested from Darwin Funds compared to in-kind contribution of £180,960 in the original budget (over half being UK/CDF staff time). A further £136,000 cash contribution was secured for the project effectively increasing the DI funding by 126%.

The project is considered to have delivered good value, Only 10% of the DI funds were spent on administrative overheads, all by CDF/CDRS supporting the project staff and infrastructure. No overheads or salaries were charged Southampton and Dundee. Wages for the majority of the staff employed were £8000/y or less. Air travel was by economy class and boat charter for surveys was inexpensive compared to tourist rates

The true value for money of this project has been the political good will generated from Ecuadorian government agencies enthusiastically participating in workshops and training and exemplified by the visit of Lorena Tapia, Ecuador’s Minister for the Environment to the CDRS at the end of the final workshop.

Annex 1 Project's logframe, including indicators, means of verification and assumptions.

Note: Insert your full logframe. If your logframe was changed since your Stage 2 application and was approved by a Change Request the newest approved version should be inserted here, otherwise insert the Stage 2 logframe.

| Project summary | Measurable Indicators | Means of verification | Important Assumptions |
|---|---|--|--|
| Goal: | | | |
| Effective contribution in support of the implementation of the objectives of the Convention on Biological Diversity (CBD), the Convention on Trade in Endangered Species (CITES), and the Convention on the Conservation of Migratory Species (CMS), as well as related targets set by countries rich in biodiversity but constrained in resources. | | | |
| Outcome: Establish a baseline for marine invasive species in the Galapagos archipelago, and implement preventative, detection, control and mitigation measures within the new government biosecurity framework (Agrocalidad 2011-2015) and regional planning. | -Prevention and early detection monitoring plan accepted and implemented with collaboration of government agencies. -Increased knowledge on the presence, distribution of invasive species and their impacts upon native species and communities. -New records of invasive species in GMR restricted to early stage of appearance, long before definitive settlement happens and impact on ecosystems have started. -Government agencies (GNPS, Agrocalidad and INOCAR) have access to databases and risk assessment tools and are trained in their use. | Final workshop February 2015, presentations and agreed action plan Workshop and training materials Zoobotryon paper, McCann et al. (2015) Workshop and training materials | This will be a long term test of the action plan |
| Outputs: 1. 1. A baseline compilation of historical records and updated information on marine invasive species in GMR and their distribution, from literature research and census/monitoring in ports of entry and the whole archipelago. | 1.1 GMR invasive species historical records in depth researched. 1.2 Invasive species monitoring plan for GMR and Galapagos main ports implemented. 1.3 Invasive baseline database updated and integrated into national GNPS/ local government database under development (online). | Workshop and training materials, Keith PhD chapters and papers Workshop, training materials, publications, agency presentation from final workshop http://www.darwinfoundation.org/datazone | |
| 2. Marine invasive species risk assessment tools and rapid response protocols for their control/eradication for | 2.1 Marine invasive species risk assessment tools (incoming ships classified into risk categories depending on their providence, sensitivity maps, | Workshop, training materials and publications | |

| | | | |
|---|---|--|--|
| the GMR. | oceanographic modelling and dispersal scenarios for potential invaders) for the GMR implemented. 2.2 Rapid response protocols finished and handed over to local authorities. | Final workshop February 2015, presentations and agreed action plan | |
| 3. Community outreach program on invasive species and the threats they pose for the Galapagos marine ecosystems, including their active collaboration in the detection program | 3.1 GMR invasive species identification guides produced and distributed. 3.2 500 Naturalist guides and other GMR users informed and trained in the identification guides use through workshops. 3.3 Reporting hotline and procedures for new findings of invasive species established (mainly for guides). 3.4 Number of media dissemination (news articles, radio, TV interviews and websites). | Workshop and training materials Workshop attendance sheets examples in report supplement especies.invasoras@fcdarwin.org.ec . Workshop and training materials Press agencies, web links & copies of articles | |

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)

- 1.1 In depth review of scientific and specialized outreach literature to synthesize records of invasive species in the marine environment of the Galapagos in recent decades.
- 1.2 Review data of the CDF Ecological Monitoring Program of the last ten years to assess recent changes in species composition and the presence of invasive species.
- 1.3 Elaborate a marine invasive species monitoring plan and protocol for local authorities.
- 1.4 Carry out monitoring surveys in the 5 main ports of Galapagos twice a year, and in Puerto Ayora bimonthly, for higher temporal resolution.
- 1.5 Conduct yearly invasive species monitoring surveys throughout the GMR as part of the CDF Ecological Monitoring Program.
- 1.6 Determine the occurrence and spatial distribution of marine invasive species already established in Galapagos.
- 1.7 Establish a database with historical data and surveys results available to GNPS/ local government authorities.
- 1.8 Elaborate marine invasive species distribution maps in the GMR.

- 2.1 Elaborate a list of potentially invasive marine species in Galapagos through review of scientific literature and technical reports about potential invaders, including information provided by marine invasive species programs already established in the ETP region and expert workshops.
- 2.2 Elaborate a risk categorization for incoming ships, combining their providence and recent shipping route with identified hotspots of transmission and propagation of invasive species in the Eastern Pacific and elsewhere.
- 2.3 Elaborate sensitivity maps with spatial data on distribution of invasive species combined with traffic routes and density of maritime traffic within the GMR.
- 2.4 Develop ocean circulation and invasive dispersal models for the GMR.

2.5 Elaborate a risk assessment report.

2.6 Elaborate, in close collaboration with the other institution involved, a rapid response protocol applicable in case of invasive species detection within GMR.

3.1 Elaborate species identification guides for marine invasive species presents in ETP region especially for naturalist guides and tour operators and train them in their use.

3.4 Establish a reporting hotline and procedures for invasive species detections by naturalist guides to take advantage of their knowledge and year-round presence throughout the archipelago.

3.2 Organize public workshops for GMR users about marine invasive species in the main 4 population centres of the archipelago.

3.3 Elaborate annual outreach reports.

4.1 Training courses in marine invasive species identification, monitoring and database analysis for the technical staff of the three institutions involved: GNPS, Agrocalidad and INOCAR.

4.2 Organize of technical participative workshops with GNPS, Agrocalidad and INOCAR to inform about the progress of the project, advisement and results achieved so far.

4.3 Thesis projects carried out for three national students Bachelor and one national student PhD thesis on invasive species.

5.1 Elaborate an annual report to DI about the progress of the project and the results achieved.

Annex 2 Report of progress and achievements against final project logframe for the life of the project

Note: For projects that commenced after 2012 the terminology used for the logframe was changed to reflect DFID's terminology.

| Project summary | Measurable Indicators | Progress and Achievements in the last Financial Year 2014-15 | Actions required/planned for next period |
|---|---|--|--|
| <p>Goal/Impact:</p> <p>Minimise negative impacts of invasive species on marine biodiversity, ecosystem services and resilience of the Galapagos Marine Reserve (GMR).</p> | | <p>The final workshop reports showing controls already implemented, action plan agreed with government agencies and establishment of FEIG (-Fondo Especies Invasores Galapagos)</p> | <p>Do not fill not applicable</p> |
| <p>Purpose/Outcome</p> <p>Establish a baseline for marine invasive species in the Galapagos archipelago, and implement preventative, detection, control and mitigation measures within the new government biosecurity framework (Agrocalidad 2011-2015) and regional planning.</p> | <ul style="list-style-type: none"> • Prevention and early detection monitoring plan accepted and implemented with collaboration of government agencies. • Increased knowledge on the presence, distribution of invasive species and their impacts upon native species and communities. • New records of invasive species in GMR restricted to early stage of appearance, long before definitive settlement happens and impact on ecosystems have started. <p>Government agencies (GNPS, Agrocalidad and INOCAR) have access to databases and risk assessment tools and are trained in their use.</p> | <ul style="list-style-type: none"> • Monitoring plan and protocol finished and agreed with local authorities. • Technical reports to the government agencies involved (GNPS, Agrocalidad and INOCAR). • Baseline report updated with new invasive species records and distribution maps. • Reports of training conducted. • Scientific publications. | <p>Do not fill not applicable</p> |
| <p>Output 1. 1. A baseline compilation of historical records and updated information on marine invasive species in GMR and their distribution, from literature research and census/monitoring in ports of entry and the whole archipelago.</p> | <p>1.1 GMR invasive species historical records in depth researched.</p> <p>1.2 Invasive species monitoring plan for GMR and Galapagos main ports implemented.</p> <p>1.3 Invasive baseline database updated and integrated into national GNPS/ local government database under</p> | <ul style="list-style-type: none"> • Marine invasive species baseline database on-line. • CDF taxonomic on-line database updated. • Project monitoring reports. • Technical participatory workshops with government agencies reports. <p>National GNPS/local government on-line database (under development).</p> <p>All indicators considered appropriate</p> | |

| | | |
|--|--|--|
| | development (online). | |
| Activity 1.1 In depth review of scientific and specialized outreach literature to synthesize records of invasive species in the marine environment of the Galapagos in recent decades | | Literature review complete for each of the established and potential invasives. This is the key introductory chapter to Keith's PhD and Pacific Conservation paper |
| Activity 1.2. Review data of the CDF Ecological Monitoring Program of the last ten years to assess recent changes in species composition and the presence of invasive species. | | Has been completed and is under continuous review. Nature (2013) paper showed Galapagos as different. Functional diversity per species high but low species lack redundancy therefore disruption more significant/ sensitive., |
| Activity 1.3. Elaborate a marine invasive species monitoring plan and protocol for local authorities. | | Monitoring manual produced. Plans in place for ports and general marine reserve monitoring working with Navy and Biosecurity agencies. Action plan from final workshop |
| Activity 1.4. Carry out monitoring surveys in the 5 main ports of Galapagos twice a year, and in Puerto Ayora bimonthly, for higher temporal resolution, | | Target ports: Baltra, Puerto Ayora, San Cristobal, Floreana, Puerto Villamil. Port. Settlement plate monitoring programme started with Smithsonian Environmental Research Center, Tiburon, California. |
| Activity 1.5. Conduct yearly invasive species monitoring surveys throughout the GMR as part of the CDF Ecological Monitoring Program. | | An extensive marine reserve monitoring programme is in place (50m transects, covering fish, and benthic organisms) 102 sites have been examined through y1&2 as planned |
| Activity 1.6. Determine the occurrence and spatial distribution of marine invasive species already established in Galapagos. | | Completed to date. Continued general and specific monitoring surveys combined with reporting hotline |
| Activity 1.7. Determine the occurrence and spatial distribution of marine invasive species already established in Galapagos | | Completed as a module within the CDF database, has been shared stand alone with the Park, Navy and Biosecurity agencies. On-line web version in beta format. |
| Activity 1.8. Elaborate marine invasive species distribution maps in the GMR | | GIS layers produced from above database |
| Output 2. Marine invasive species risk assessment tools and rapid response protocols for their control/eradication for the GMR. | 2.1 Marine invasive species risk assessment tools (incoming ships classified into risk categories depending on their providence, sensitivity maps, oceanographic modelling and dispersal scenarios for potential invaders) for the GMR implemented. 2.2 Rapid response protocols finished and handed over to local authorities. | <ul style="list-style-type: none"> • Risk assessment report and tools (maps, dispersal scenarios, risk categorization for incoming ships). • Rapid response protocol document. • Counterpart (US NCSU/UK National Oceanographic Centre) with high resolution (4Km nested) Hybridised Coordinate Model (HyCom) provided for future development. All indicators considered appropriate |
| Activity 2.1. Elaborate a list of potentially invasive marine species in Galapagos after review scientific literature and technical reports about potentially invaders, including information provided by marine invasive species programs already established in the ETP region and expert workshops. | | Master sheet prepared ID sheets & posters for guides and others prepared for outreach to disseminate information and raise awareness |

| | |
|--|---|
| Activity 2.2. Elaborate a risk categorization for incoming ships, combining their providence and recent shipping route with the identification of hotspots of transmission and propagation of invasive species in the Eastern Pacific. | Data base of national and international shipping port arrivals (2012-14) compiled |
| Activity 2.3. Elaborate sensitivity maps with spatial data on distribution of invasive species combined with traffic routes and density of maritime traffic within the GMR. | These have been produced but are now being revised as a result of the final workshop and will be presented at Bioinvasions 2016 |
| Activity 2.4. Develop ocean circulation and invasive dispersal models for the GMR. | Completed by North Carolina State University using the hybridised coordinate model funded by NASA (2004-2007 produced by University of Miami, North Carolina State University and University of North Carolina, Wilmington) |
| Activity 2.5. Elaborate a risk assessment report. | Within workshop presentations. |
| Activity 2.6. Elaborate, in close collaboration with the other institution involved, a rapid response protocol applicable in case of invasive species detection within GMR. | Under constant review with active programme of meetings, strong government agency support. GNP and Biosecurity agency have included marine invasives in their operating plan. The Ministry of Environment has made CDF an administrator and beneficiary fromr a \$2.8m grant from its National Invasive Species Fund. Marine Invasives are now high priority for endowment funds set up under GEF project through FEIG (Fondo de Especies Invasories Galapagos) based in Quito. |
| <p>Output 3.</p> <p>Community outreach program on invasive species and the threats they pose for the Galapagos marine ecosystems, including their active collaboration in the detection program.</p> | <p>3.1 GMR invasive species identification guides produced and distributed.</p> <p>3.2 500 Naturalist guides and other GMR users informed and trained in the identification guides use through workshops.</p> <p>3.3 Reporting hotline and procedures for new findings of invasive species established (mainly for guides).</p> <p>3.4 Number of media dissemination (news articles, radio, TV interviews and websites).</p> <ul style="list-style-type: none"> • GMR invasive species identification guides. • Report of GMR users workshops and outreach activities conducted. • Reporting hotline files. • CDF and The Galapagos Conservation Trust websites, videos, newspaper articles, radio spots <p>All indicators considered appropriate</p> |
| Activity 3.1. Elaborate species identification guides for marine invasive species presents in ETP region especially for naturalist guides and tour operators and train them in their use. | Produced as laminated sheets. Used with marine invasives module established within Galapagos Guide training course (500 naturalist guides who lead 180,000 tourists/year) |
| Activity 3.2. Establish a reporting hotline and procedures for invasive species detections by naturalist guides to take advantage of their knowledge and year-round presence throughout the archipelago | especieas.invasoras@fcdarwin.org.ec . Established, alongside existing wildlife help/reporting and strandings hotlines. |
| Activity 3.3. Organize public workshops for GMR users about marine invasive species in the main 4 population centres of the Archipelago. | Delivered at: Santa Cruz, Puerto Ayora; Isabella, Puerto Villamil; San Cristobal, Puerto Baquerizo Moreno. |

| | | |
|---|---|---|
| Activity 3.4. Elaborate annual outreach reports. | | Stakeholder meetings every 2 months with annual summary reports |
| Output 4. Capacity building in local community: a) Key staff members of GNPS, Agrocalidad, and INOCAR trained in monitoring techniques for marine invasive species. Local students trained in scientific method and writing their thesis on marine invasive species topics. | 4.1 9-12 staff members of GNPS, Agrocalidad, and INOCAR trained in monitoring techniques, and risk assessment and integrated in the implementation stage. 4.2 Three national bachelor students, one masters, and one PhD student with finished thesis on invasive species ready to graduate and orientated towards complementary positions in new government biosecurity initiative. | <ul style="list-style-type: none"> • Training workshops reports and evaluation. • References to marine invasive species prevention, early detection and management plans in government agencies reports and programs involved. .Thesis documents or drafts. All indicators considered appropriate |
| Activity 4.1. Training course in marine invasive species identification, monitoring and database analysis for the technical staff of the three institutions involved: GNP, Agrocalidad and INOCAR. | | Numerous courses in Galapagos and Guayaquil, reaching 560 staff across Park, Navy, Biosecurity agencies |
| Activity 4.2. Organize technical participative workshops with GNP, Agrocalidad and INOCAR to inform about the progress of the project, advisement and results achieved so far. | | >2 meetings/month with each principal partner agencies (including the regular meetings, see 3.4) |
| Activity 4.3. Thesis projects carried out for three national students Bachelor and one national student PhD thesis on invasive species. | | Keith PhD progressing well Closure of CDF shop cut off funding stream for Ecuadorian students |
| Activity 5.1. Elaborate an annual report about the progress of the project and the results achieved. | | DI Years1&2 reports and this final report with electronic supplement Reports to other agencies |

Annex 3 Standard Measures

| Code | Description | Total | Nationality | Gender | Theme | Language | Comments |
|--------------------------|--|-------|---------------------------|--------------------|---------------------|----------|----------------------------|
| Training Measures | | | | | | | |
| 1a | Number of people to submit PhD thesis | 1 | Ecuadorian | female | Marine invasive spp | English | To be submitted March 2016 |
| 1b | Number of PhD qualifications obtained | 0 | | | | | |
| 2 | Number of Masters qualifications obtained | 0 | | | | | |
| 3 | Number of other qualifications obtained | 0 | | | | | |
| 4a | Number of undergraduate students receiving training | 7 | Ecuadorian | 4 female 3 male | | | y1&2 |
| 4b | Number of training weeks provided to undergraduate students | 41 | | | | | |
| 4c | Number of postgraduate students receiving training (not 1-3 above) | 0 | | | | | |
| 4d | Number of training weeks for postgraduate students | 0 | | | | | |
| 5 | Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification(e.g., not categories 1-4 above) | 3 | 2 Ecuadorian 1 Chilean | Female Female | | | Scientific diving team |
| 6a | Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above) Staff of GNPS, INOCAR/DIGMER | 560 | Ecuadorian | 50/50 | | Spanish | 3 day courses |
| 6b | Number of training weeks not leading to formal qualification | 336 | | | | | 560x3days |
| 7 | Number of types of training materials produced for use by host country(s) (describe training materials) | | | | | | |

| Research Measures | | Total | Nationality | Gender | Theme | Language | Comments |
|--------------------------|--|--------------|--------------------|---------------|--------------|-----------------|---|
| 9 | Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies) | 3 | | | | | Management plans now including marine invasives: Revised Galapagos National Park management plan, National Territorial and the Biosecurity Agency operating plan. Participatory process in final workshop |
| 10 | Number of formal documents produced to assist work related to species identification, classification and recording. | | | | | | |
| 11a | Number of papers published or accepted for publication in peer reviewed journals | 3 | | | | English | See Annex 5 |
| 11b | Number of papers published or accepted for publication elsewhere | 3 | | | | English | See Annex 5 |
| 12a | Number of computer-based databases established (containing species/generic information) and handed over to host country | 1 | | | | | Marine invasive species |
| 12b | Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country | 1 | | | | | Long term monitoring |
| 13a | Number of species reference collections established and handed over to host country(s) | 0 | | | | | |
| 13b | Number of species reference collections enhanced and handed over to host country(s) | 1 | | | | | Specimens integrated into the reference species collection of the CDRS |

| Dissemination Measures | | Total | Nationality | Gender | Theme | Language | Comments |
|-------------------------------|---|--------------|--------------------|---------------|--------------|-----------------|------------------------------|
| 14a | Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work | 19 | | | | Spanish | Galapagos & mainland Ecuador |
| 14b | Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be | 18 | | | | Spanish | Ecuador |

| | | | | | | | |
|--|--------------------------|--|--|--|--|---------|--|
| | presented/ disseminated. | | | | | English | Canada/UK/ Panama +Australia 2016 |
|--|--------------------------|--|--|--|--|---------|--|

| Physical Measures | | Total | Comments |
|-------------------|--|--------|---|
| 20 | Estimated value (£s) of physical assets handed over to host country(s) | £9,000 | + laboratory equipment supplied after end of project |
| 21 | Number of permanent educational, training, research facilities or organisation established | 0 | |
| 22 | Number of permanent field plots established | 6 | Dock settlement panel stations in Galapagos and Guayaquil |

| Financial Measures | | Total | Nationality | Gender | Theme | Language | Comments |
|--------------------|--|----------|-------------|--------|-------|----------|--|
| 23 | Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work | £136,000 | | | | | Section 7.2 + The Ecuadorian Ministry of Environment has made CDF an administrator and beneficiary from a \$2.8m grant (FEIG-Fondo Especies Invasores Galapagos) from its National Invasive Species Fund. |

Annex 4 Aichi Targets

Please note which of the Aichi targets your project has contributed to.

Please record only the **main targets** to which your project has contributed. It is recognised that most Darwin projects make a smaller contribution to many other targets in their work. You will not be evaluated more favourably if you tick multiple boxes.

| | Aichi Target | Tick if applicable to your project |
|----|--|------------------------------------|
| 1 | People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably. | |
| 2 | Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems. | |
| 3 | Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions. | |
| 4 | Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits. | |
| 5 | The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced. | |
| 6 | All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits. | |
| 7 | Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity. | |
| 8 | Pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity. | |
| 9 | Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment. | ☺ |
| 10 | The multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning. | |
| 11 | At least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes. | |
| 12 | The extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained. | |
| 13 | The genetic diversity of cultivated plants and farmed and domesticated animals and | |

| | | |
|----|---|--|
| | of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity. | |
| 14 | Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable. | |
| 15 | Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification. | |
| 16 | The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation. | |
| 17 | Each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan. | |
| 18 | The traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels. | |
| 19 | Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied. | |
| 20 | The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties. | |

Annex 5 Publications

| Type * | Detail (title, author, year) | Nationality of lead author | Nationality of institution of lead author | Gender of lead author | Publishers (name, city) | Available from (e.g. contact address, website) |
|-------------------------|---|----------------------------------|---|-----------------------------|--|---|
| Journal* | Integrating abundance and functional traits reveals new global hotspots of fish diversity. Stuart-Smith et al. (2013) Nature 501, 539-542 | Australia | Australia | male | Macmillan, New York | http://www.nature.com/nature/journal/v501/n7468/full/nature12529.html |
| Conference Proceedings* | Galapagos marine invasives: identification, prediction and control. Keith et al. (2014) | Ecuadorian | Ecuadorian | female | IMMC USA | https://www.conbio.org/images/content/conferences/IMCC2014_speed_presentation_abstracts_29May14_for_posting.pdf |
| Journal* | Evolving Marine Biosecurity in the Galapagos Islands Campbell et al. (2015) Management of Biological Invasions Volume 6, online: 23 April 2015, | NZ | NZ | female | REABIC Helsinki, Finland | http://www.reabic.net/journals/mbi/2015/Accepted/MBI_2015_Campbell_etal_correctedproof.pdf |
| Journal* | First record of the non-native bryozoan <i>Amathia</i> (= <i>Zoobotryon</i>) <i>verticillata</i> (delle Chiaje, 1822) (Ctenostomata) in the Galápagos Islands. McCann et al. (2015) BiolInvasions Records, accepted 1.9.15 | USA | USA | female | REABIC Helsinki, Finland | www.reabic.net/journals/bir/ |
| Report* | Especies Marinas Invasoras en la Reserva Marina De Galápagos: Keith et al.(2015) in Informe Galápagos 2013-2014, pp.83-88 | Ecuadorian | Ecuadorian | female | PNG, CGREG, FCD, GC. Puerto Ayora, | http://www.darwinfoundation.org/media/filer_public/11/55/1155bb44-6ae9-472c-9b7e-5e588c4d198/informegalapagos_2013- |

| | | | | | | |
|-------------|--|------------|------------|--------|-----------------------|--|
| | | | | | Galápagos, | <i>2014.pdf</i> |
| Journal* | Marine Invasive Species: Establishing pathways, their presence and potential threats in the Galapagos Marine Reserve Keith et al. (2015) submitted to Pacific Conservation Biology | Ecuadorian | Ecuadorian | female | CISRO Australia | http://www.publish.csiro.au/?nid=302 |
| Conference* | Introduced species risks of marine traffic arriving to the Galapagos Marine Reserve (GMR) Keith et al. 2016 | Ecuadorian | Ecuadorian | female | ICMB international | http://www.marinebioinvasions.info/ 9 th Int Conference on Marine BioInvasions Sydney, Jan 2016 |

Annex 6 Darwin Contacts

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| Ref No | 19-009 |
| Project Title | Galapagos marine invasive species: prevention, detection and management |
| | |
| Project Leader Details | |
| Name | Dr Ken Collins |
| Role within Darwin Project | Project leader |
| Address | Ocean and Earth Science |
| Phone | |
| Fax/Skype | |
| Email | |
| Partner 1 | |
| Name | Prof Terry Dawson |
| Organisation | University of Dundee |
| Role within Darwin Project | UK partner and lead PhD supervisor for Keith |
| Address | |
| Fax/Skype | |
| Email | |
| Partner 2 | |
| Name | Inti Keith |
| Organisation | Charles Darwin Foundation |
| Role within Darwin Project | Lead worker throughout project |
| Address | |
| Fax/Skype | |
| Email | |