DETR Darwin Initiative Final Report

Revision of the Galapagos Marine Management Plan

DoE Project Ref No: 162/6/174

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1. Basic Project Details

1.1. Project Title: Revision of the Galapagos Marine Management Plan
1.2. Contractor: University of Southampton
1.3. Host country collaborating institute(s): Charles Darwin Research Station, Galapagos
1.4. Grant Round: 3
1.5. Grant Value: £125,272

2. Project Expenditure

2.1. Total grant expenditure :£125,272
2.2. Breakdown of expenditure

	1997/98	1998/99	1999/2000	Total
Office				
Postage,telphone				
Travel,subsistence				
Printing				
Conferences, seminars				
Capital item: GIS computers				
Other: GIS training & software				
Other: Boat charter				
Other: Administration				
Salaries				
Total	42300	41222	41750	**125272**

3. Explain any variations in expenditure +/- 10%
None

3. Project Background/Rationale

3.1. Why was the project needed?

3.1.1. Introduction
The coastal and marine parts of the Galápagos Islands ecosystem harbour an array of distinctive habitats, processes and endemic species. The close relationship between terrestrial and marine environments is evident when one considers such prominent Galápagos endemics as the world's only sea-going lizard (Marine Iguana), the Galápagos Penguin, Flightless Cormorant, Waved Albatross, Swallow-tail Gull, Lava Gull, Fur Seal and Sea Lion. Galápagos's strictly marine flora and fauna are also unique, located as they are at a point where cold currents from the south-east meet warm currents from the north-east, whilst east-moving deep ocean currents up well along the western side of the platform (Wooster and Hedgpeth, 1966; Houvenhagel, 1984; Chavez and Brusca, 1991). The ecological complexity of this extraordinary marine life is still only poorly understood but endemism is high (see Table 1) and the islands are noted for their spectacular creatures: sharks, whale sharks, cetaceans and manta rays amongst them, as well as constant and abundant commercially valuable pelagic fish such as bill fishes and tuna. To date ca. 3000 species of marine plants and animals have been described for the Galápagos. This figure is constantly increasing since

1990 due to new taxonomic and biodiversity inventories are conducted. Recent explorations of deep-sea communities, specially invertebrates and fishes, are yielding new addition to science and to Galápagos marine biodiversity. Being less isolated, in ecological terms, marine ecosystems tend to have low levels of endemism, so the proportion for Galápagos, about 21%, is remarkably high. In terms of species richness, the Galápagos marine ecosystem is in the intermediate-to-high range, in comparison with other insular systems (Hawaii, Marquesas, etc.), and its biological communities are less well studied than those archipelagos.

3.1.2. Pressures on the Galápagos Ecosystem

The Galápagos marine and coastal wildlife is vulnerable to inappropriate fishing and to other consequences of human presence and use in the islands. In Galápagos the population growth rate has been over 5% per year, fueled by immigration of mainlanders seeking economic opportunities in tourism and fishing (McFarland and Cifuentes, 1995). The El Niño phenomenon, in full force in 1997/8, compounds the stress on vulnerable coastal and marine species, because it alters dramatically the functioning of ecosystems in the Pacific Ocean. The last big Niño in 82/83, caused populations of many species to crash (Robinson and Del Pino, 1985; Robinson, 1987). Some bounced back whilst others, notably corals and the very rare Galápagos penguin, have never recovered their pre-82 levels. In contrast, recent findings and more detailed monitoring of El Niño 1997/98, have shown that positive effects are also occurring. Massive recruitment of macroalgae, invertebrates and some fishes have been recorded as consequence of the prolonged warm event (El Niño), that has led to a longer reproductive season for true tropical species. Consequently, the overall effects and its negative and positive consequences of El Niño phenomenon on marine biodiversity is being revised in the light of new data (Bustamante *et al*., unpubl. data).

Tourism is by far the largest economic activity in the Galápagos Islands. Almost all tour activities are concentrated in the coastal-marine areas and their immediate hinterland. The majority of the tourism involves cruises of several days, up to two weeks, around the Islands' designated visitor sites, with land visits, boat rides and snorkeling at most of them. Dive tourism is a fast-expanding element of the tourism business, attracted above all by the wealth of big marine animals, especially sharks.

The fishermen of Galápagos practice artisanal fishing with lines and nets, as well as diving for lobster. In addition, industrial fishing boats come from mainland Ecuador and abroad to fish for tuna. In recent years the total fishing pressure, of all kinds, has increased rapidly, with large numbers of medium-sized mainland long-liners visiting the Islands as well as many people migrating to Galápagos to make a living from fishing. In addition, the 1990's saw a sudden "gold rush" fishery for sea cucumbers to supply the Asian market, a trade which brought in its wake environmental damage, resource depletion, indebtedness of local people and social havoc. That fisheries continues, though illegal and much reduced, and now another lucrative market, for shark fins, is depleting those ecologically important top predators and key attractions of the dive tourism business. It is clear to everyone in Galápagos, including the local fishermen, that returns are diminishing and that effective management of the marine area is needed (Bustamante, 1997).

3.2. How was it related to conservation priorities in the host country?

3.2.1. Management of the Galápagos marine reserve
Against the background described above, the Charles Darwin Research Station (CDRS) and the Galápagos National Park Service (GNPS) initiated in May '97 a process of conflict resolution and participatory planning for the marine reserve. The process has brought together the Park and the principal stakeholders i.e. tourism sector, local fishing cooperatives, conservationists and the scientists of the CDRS and other collaborative research institutions (e.g., Universities of Southampton, Heriot-Watt, Houston, Washington and Lee). Work on a consensus-based management plan is progressing, with an agreed plan expected to be ready by late-98. But the great achievement to date has been that, by joining forces, the Park and stakeholder groups were able to get their principal points of consensus incorporated into the Special Law for Galápagos almost in their entirety (Heylings, 1998). The law, approved in March '98:

- Establishes the Marine Reserve as a legally recognized new category of protected area.
- Creates an Inter-institutional Management Authority, comprising both government departments and stakeholder groups, as the highest decision-making body.
- Charges the GNPS with the management of the Reserve.
- Establishes a Participatory Management Group or Junta, as a mechanism for stakeholders and the Park to collaborate on joint planning and management for the Reserve.
- Specifies that the fisheries use of the Reserve shall be exclusively for local artisanal fishermen (to take effect as soon as the new management plan is approved).
- Sets the boundaries of the Reserve at 40 nautical miles from the base line, which is the line joining the outermost points of land of the Archipelago. This includes almost all of the ecologically important "bajos" or shallow sea-mounts, nutrient-rich areas, and provides a large area for protection of wide-ranging species, such as marine mammals, seabirds and sharks.
- Allocates 5% of tourist entry fees for marine reserve management and a further 5% to the Navy to enhance patrolling and enforcement.

This new legal and institutional framework gives an historic opportunity to conserve one of the world's largest (over 140,000 km^2) and most important marine reserves. There is a long way to go before management of the coastal and marine ecosystems can be fully effective, with all partners able to play their respective parts. However, a promising start has been made and one major consequence is that there is now a channel, and a strong demand, for scientific data on fisheries and the coastal ecosystem, in order to inform the decisions of the participatory management group. The shortage of data on marine biodiversity and resources has been particularly notable during the process, currently underway, of defining the provisional zonation of the marine reserve. There are simply not the data available to identify priority areas for biodiversity, specify key areas for reproduction of target resources such as lobster, or assess the direct and indirect impacts of fishing on marine and coastal ecosystems and their wildlife

3.3. How was the project intended to assist the host country to meet its obligations under the Biodiversity Convention?
Without implementation of a marine management plan there would have been accelerating loss of biodiversity from an internationally recognised 'hot spot'. Fisheries, tourism and increasing population are all exerting pressures on the system.

3.4. Was there a clear 'end-user' for the project in the host country?
Ecuadorian government,
National Park Service - Galapagos National Park Service
Galapagos Participatory Management Group:
- Galapagos National Park Service
- Charles Darwin Research Station
- Local government authorities
- Navy
- Fisheries representatives
- Tourist industry representatives

4. Project Objectives

4.1. What were the objectives of the project

(a) To evaluate the conservation significance of the zoning scheme proposed in the 1992 management Plan for the Galapagos Marine Resources Reserve (GMRR) in terms of biodiversity, biological representativeness, replication and geographical variation in the marine communities of the Galapagos Islands.

(b) To identify and define the biodiversity and ecological value of distinctive geographical regions (eco-regions) or specific community types and establish sound guidelines for the priority of conservation.

(c) To promote long-term conservation of Galapagos marine biodiversity and raise awareness of how it underpins terrestrial biodiversity: by providing Ecuadorian conservation authorities (such as the Presidential Environmental Advisory Commission and the Galapagos National Parks Service) with the technical baseline data needed for the conservation and management of the Galapagos Marine Reserve.

4.2. Were the objectives of the project revised?
No

4.3. Have the objectives (or revised objectives) been achieved?
Yes:

(a) Field surveys round the Galapagos archipelago, described below, to determine the bio-diversity (see Fig.1 and publications list).

(b) Analysis of survey data to determine regional variation (see publications list).

(c) Participation by Charles Darwin Research Station staff in all meetings of the Galapagos National Park Service/Galapagos Participatory Management Group to negotiate the marine management plan with stakeholders (see Galapagos Marine Management Plan).

4.4. If relevant, what objectives have not been achieved, or only partially achieved, and why?
None

5. Project Outputs

5.1. What output targets, if any, were specified for the project?
The specific output targets specified for each year of the project are listed in 5.2.

5.2. Have these been achieved?
The specific output targets specified for each year of the project are underlined and in what way they were achieved is described below:

1987-1999
8 - 3 UK workers in Ecuador for 3 weeks
Dr Ken Collins and Jenny Mallinson (University of Southampton) and Dr Simon Jennings (University of East Anglia) working in Galapagos 10Feb-6 Mar.98 undertaking extensive diving survey of marine biodiversity, 30 sites covering all major islands of Galapagos archipelago.
6a/b - 2 Ecuadorians trained for 7 weeks in surveying and GIS
November 97, Hernan Vargas and Priscilla Martinez from Charles Darwin Research Station (CDRS), Galapagos trained for 4 weeks at the University of Southampton, GeoData Unit in GIS. Feb-March 98, 2 assistants from CDRS worked alongside UK team for 3 weeks.
7 - GIS database material produced
A basic Galapagos GIS database has been produced using SPANS (Tydeck Corporation, Canada) during the UK training course, November 1997. This has define the basic maps and bathymetry and historic survey data added. The system has been installed on a project funded PC at the CDRS and is in constant use.
10 - Fieldwork report delivered
A fieldwork report describing the activity during the Feb-March field survey has been produced. A scientific paper describing aspects the work has been accepted by J.Fish Biol. a peer reviewed scientific journal. A report of the work was given at a conference 15th April in Brussels.
15a - 2 National press releases issued in Ecuador
15b - 3 local press releases issued in Ecuador
Information about the project has been included in weekly news briefings by the CDRS which are distributed locally and nationally, fulfilling the above targets. See also International broadcast items from UK below.
15c - 1 National press release in the UK
15d - 1 local press release in the UK
2 national press releases have been issued Nov.97 and Mar. 98. A World Service radio interview on this project was broadcast as a result of the DI press release in May 97. The Nov. press release resulted in World Service radio interview, in Spanish, which was accepted by all the Spanish speaking nations. An interview was recorded for the Student Radio Network March 98. Items on the work have appeared in The local paper (Southampton Echo), THES, and New Scientist

1998-1999
6a/b - 3 Ecuadorians trained for 8-10 weeks in surveying and GIS database
6 man weeks training by UK postgraduate worker Stephanie Watkins in GIS (July 98)
9 man weeks working with UK team during fieldwork (Jan/Feb 99)
15 man weeks Ecuadorian assistant working with CDRS team on project
7 - GIS database material updated
A basic Galapagos GIS database has been produced using SPANS (Tydeck Corporation,

Canada) during the UK training course, November 1997. This has define the basic maps and bathymetry and historic survey data added. The system has been installed on a project funded PC at the CDRS and is in constant use.

10 - Fieldwork report delivered

A fieldwork report describing the activity during the Feb-March field survey has been produced published in Galapagos News No.7 produced by the Galapagos Conservation Trust.

9 &12a - Biodiversity management plan drafted

A draft Galapagos Marine management plan has been produced in March 99 for the participatory management group (see 14b below).

11b - At least one scientific paper submitted for publication

A paper presented at the Science for Conservation Symposium in Brussels 15 April 1998 has been accepted for publication in Bulletin d'Institut Royal des Sciences Naturelles de Belgique.

14b - Dissemination of results

Ecuadorian conference used for disseminating Darwin project results

Regular workshops and meetings of the participatory management group of the Galapagos marine reserve have been held enabling the results of the work to be described to the members including the National Park Service, local government, tourism representatives, local fishing community, Ports authorities

15a - 2 National press releases issued in Ecuador

15b - 3 local press releases issued in Ecuador

Information about the project has been included in weekly news briefings by the CDRS which are distributed locally and nationally, fulfilling the above targets. (98-99)

15c - 1 National press release in the UK

15d - 1 local press release in the UK

These has been fulfilled by publication of reports of the work in:

Galapagos Conservation Trust, Galapagos News No.7 Winter 98/99
University of Southampton, New Report Summer 98
Southampton Oceanography Centre, In Depth Summer 98
Sea Technology, June 98
New Scientist, 25 April 98

which are circulated to the press nationally and internationally.

6a/b - 4 Ecuadorians trained in surveying and GIS

3 weeks (Feb/March 00) with UK team and 5 weeks at CDRS (Jul/Aug 99) (99-00)

7 - GIS material updated

GIS updated with latest management zones agreed in Galapagos (March 00)

10- Fieldwork reports submitted

Fieldwork reports submitted to CDRS library (March 00)

9&12a - Galapagos marine management plan final draft completed

completed March 00

11b - Paper submitted for publication

Pacific Ocean Remote Sensing Committee

14b - Dissemination of results

Ecuadorian conference used to disseminate project results Guyaquil May 2000

15a&b, 18a, 19a, 19c- Broadcast and press, Ecuador

Monthly CDRS press releases, plus ready for broadcast radio and television items in Ecuador described progress with marine management project.

19b - UK broadcast

2 UK national radio presentations made during course of project.

15c&d - UK press
University of Southampton SOC annual report featured project and Galapagos Conservation Trust UK newsletter feature marine project work

5.3. If relevant, what outputs were not achieved, or only partially achieved, and why?
None

5.4. Were any additional outputs achieved?
(i) Visit by Stephanie Watkins to Galapagos to run GIS training, 2 weeks, July 98
(ii) Fieldwork by Dr Lin Baldock, UK marine biologist, Jan/Feb 99 and Feb/Mar 2000
(iii)Donation of spectrophotometer and accessories (for determining chlorophyll levels in water and intertidal vegetation) to CDRS and training in its use, Jan99
(iv) Paper published in Journal of Fish Biology (Jennings et al., 1998, 1999)
(v) Conference paper presented to International Marine Reserves Workshop, Murcia, Spain, March 99, (Collins et al , in press)
(vi) Contribution of material to Galapagos Crustacea Guide (Hickman and Zimmerman, 2000)
(vii) Production of a draft diver's identification guide to marine organisms (Mallinson et al 2000), leading to a further volume in the Galapagos Marine Life Series (Hickman et al., in prep)
(viii) Detailed hydroid collection, museum specimens lodged at CDRS and Royal Ontario Museum, Canada. (Calder et al, in prep).
(ix) 6 University of Southampton MSc and BSc research projects based on this project (listed in publications section)

6. Project Operation/Management
6.1. Research projects
Papers published, submitted, or planned are listed in section 12 have been subjected to standard scientific peer review.

6.1.1. Research introduction
A benthic marine survey programme was initiated by CDRS in 1995 to routinely examine the biota of some 27 sites around the archipelago. This has compiled taxonomic inventories for fishes, macroalgae and invertebrates, providing more than 30MB of quantitative data. Eight projects have been specifically evaluating the human impact (fishing, tourism) on biodiversity, whilst other projects are undertaking basic and applied biological research.

The timing of this Darwin Initiative project was particularly opportune since there was a critical need for marine biodiversity data to support demands for protection of specific areas within the Reserve. Whilst the previous zonation was complex, the new zonation is simple and flexible and thus responsive to new pressures. Overall there is a hope that the marine protection areas will represent the different biogeographic zones within the archipelago. They will complement existing land sites, e.g. important bird colonies will have seaward protection.

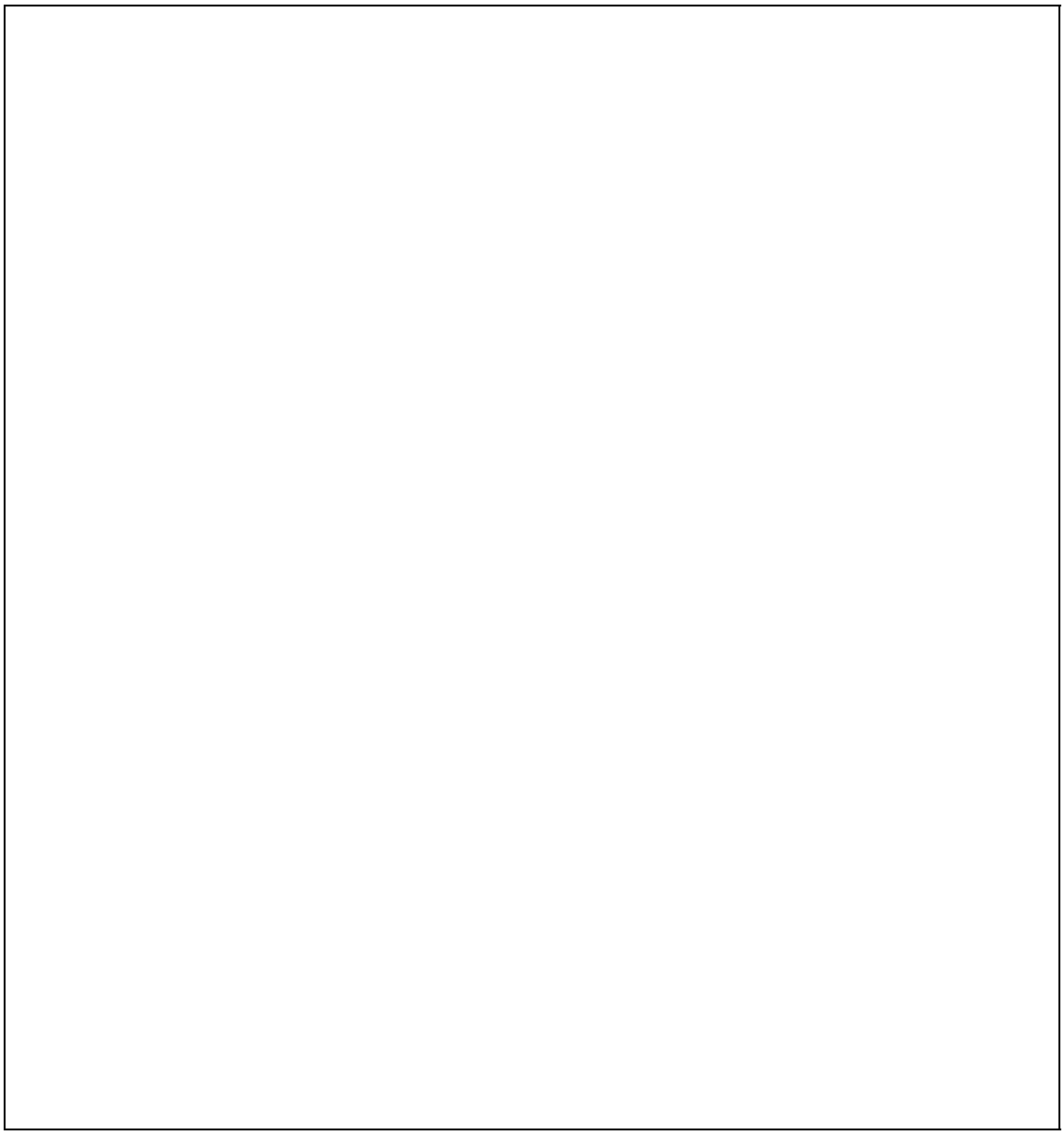
6.1.2. Diving survey
Since the early works of Houvenhagel and Houvenhagel (1974), Wellington (1975;1984), and Glynn and Wellington (1983), the benthic communities of Galápagos marine environment have been poorly described. Despite the fact that two qualitative (invertebrates

and macroalgae) and quantitative (fishes) benthic surveys have been conducted since then (Galápagos Marine Survey, 1994, 1997), the patterns of abundance, distribution and dynamics of marine biodiversity are still unclear. Diving surveys are logistically difficult and expensive. This current study is continuing the routine CDRS monitoring programme as well as undertaking a series of surveys are attempting to fill gaps in existing taxonomic and ecological knowledge. Quantitative data is being gathered to identify areas of high conservation value. Additionally this enables a description of the impacts of the current anthropic (exploitation) and natural (El Nino) events on the marine communities. Furthermore, each year since 1995, periodic surveys for specimen collection and identification have been conducted as part of collaborative work for producing a series of three field guides for Galapago's invertebrate identification -"The Marine Life of Galápagos". This series include guides for Echinoderms (Hickman, 1998), Mollusks (Hickman and Finet, unpubl. manuscript), and Crustaceans (Hickman and Wickstens, unpubl. manuscript). The role of CDRS in this project is providing scientific guidance and logistic support, and in return all specimens collected and identified are being deposited in the CDRS museum. As direct results so far, more than 30 new records for Galápagos and several new species for science have been reported.

Fig.1 shows the locations of sites examined during cruises aboard the station's vessel Beagle, February 1998- March 2000. Diving survey sites were chosen to be rocky slopes, the most widely distributed habitat type. A 50m transect was laid at each site at depths of between 10 and 15m. A point-intercept-quadrat (1.0 x 0.5m) was used to determine the abundance and coverage of organisms at 5m intervals along the transect. The number of larger, usually mobile, organisms (such as urchins, sea cucumbers and star fish) were counted within a 1m corridor either side of the 50m transect line. Fish species and abundance were estimated within a 2m wide and 3m high corridor in both directions along the transect line. A complementary fish survey was made using a point-count-census (Jennings, 1994) to estimate abundance and species richness comparable to previous work (Galápagos Marine Survey, 1994; 1997). Any other species (macroalgae, macro-invertebrates and fishes) in the area were noted. Finally an estimate of the extent of bleaching of coral communities was made.

Hydroids represent one taxonomic group that has been poorly described from the Galapagos. A detailed hydroid collection was made suppling museum specimens to CDRS and the Royal Ontario Museum, Canada. A paper reviewing Galapagos hydroids is in preparation (Calder et al, in prep). There was also a lack of readily useable identification material for many Galapagos macro flora and fauna. A draft diver's identification guide to marine organisms was produced (Mallinson et al 2000) which is leading to a further volume in the Galapagos Marine Life Series (Hickman et al., in prep). Contributions of photographs and observations were made to the Galapagos Crustacea Guide (Hickman and Zimmerman, 2000).

Fig.1 Locations of sites examined during cruises aboard the CDRS vessel Beagle, February 1998- March 2000.



6.1.3. Fisheries observations

Commercial fisheries have had a significant effect on certain species (Bustamante, 1997). The earliest fishery was for the Grouper (Bacalao, *Mycteroperca olfax*). This has been heavily exploited with a reduction in catch per unit effort. Survey results show this species to be only occasionally present. In the 1980s the lobster population was over exploited to the extent that the entire fishery was closed for 2 years. Only 3 lobsters were seen during this survey of 25 sites. Following the collapse of the lobster fishery there was an explosion in the sea cucumber (pepino, *Sticopus fuscus*) fishery for the Asian market (Cahmi, 1995). These occur in rocky areas and are collected by diving. Again very few specimens were observed during the survey with densities of 1 (or less) per $100m^2$ where formerly there have been typically more than 100 (Richmond and Martínez, 1993). At the same time as the dramatic rise in exploitation of the sea cucumbers, sharks were also targeted principally for their fins, again for the Asian market. No sharks were seen during this survey, but this may be partly due to the warmer waters caused by the current El Niño event.

6.1.4. El Niño effects

The Galápagos is experiencing elevated water temperatures (4-6 °C) due to a periodic change in water circulation known as El Niño. This happens on a 2-15 year cycle, the last event of this magnitude occurred in 1982/3.

The most well known marine effect is the mortality of corals due to a combination of higher temperatures and high light intensity. This is seen as bleaching, first the symbiotic algae leave the corals and the colony loses colour becoming white, (bleached) then within a few weeks the coral animals die leaving a bare white coral skeleton. As in El Niño 1982/83, the 1997/98 one produced increased mortality of marine iguana (*Amblyrhynchus cristatus*), sea lions (*Zalophus californianus wollebacki*, up to 48% in Central Galápagos), and sea birds (CDRS, unpubl. data).

In the benthic community, there has been a mass mortality of barnacles, at most sites studied only empty shells, coupled with massive bleaching of crustose coralline macroalgae were observed. The recovery of these two last group of species has been fast, however (Bustamante et. al, unpubl. data).

Studies of the fish community showed that new colonizations and even hybridization occurred during El Niño events (McCoscker, 1987; Wellington, 1975). Also, the reproduction of those fish species which favour warmer waters had been particularly successful during the El Nino period. In particular, new recruits of the wrasse *Thalassoma lucasanum* were very abundant and mean densities were in excess of 5 m^2 at some sites. In addition, a number of species such as the trumpetfish *Aulostomus chinensis* and cornetfish *Fistularia commersoni*, which were formerly uncommon in the southern area of the archipelago are now relatively abundant and widespread being recorded at 17 and 20 of the 24 sites surveyed respectively. A number of species which favour cooler water and which were observed in a 1991 study of fishes in the islands were not observed at any site during the course of this survey. It is assumed that these species, such as the dusky chub *Girella freminvillei* had retreated to deeper cooler waters during the El Niño event (S. Jennings, pers. com.).

6.1.5. Galápagos Geographical Information System

Geographical Information Systems (GIS) can be described as a technique that is used for the storage, integration, manipulation, analysis, modelling and presentation of data. It provides a means of assembling computer based maps and databases in a rapidly accessible and understandable form. Furthermore a wide variety of data (physical, biological, socio-economic) can be inter-related thus assisting in making management decisions. Such systems have wide application in environmental management and the establishment of a Galápagos GIS was a high priority. In 1997 two CDRS scientists received training in the SPANS GIS (Tydac Research Inc, Ottawa, Canada), beginning work on a Galápagos marine GIS importing maps, bathymetry and biological data into the system. Existing biological survey data and the results of fisheries surveys will be imported. Another GIS initiative supported by WWF has trained CDRS and GNPS staff in the use of CAMRIS.

The confluence of several ocean currents at the Galápagos produces distinct ecological zones within the archipelago. Satellite remote sensing images can provide a clear way of visualizing

these regions and studying their extent and seasonal and longer term (El Niño) variation. At Southampton two sources of data are being used to produce data for the Galápagos GIS:
- Sea surface temperatures (AVHRR) at 1km resolution, from 1994 onwards.
- Ocean colour measurements (SeaWIFS) at 4km resolution, from summer 1997 onwards, which enable the identification of high chlorophyll (productivity) regions.

The bringing together of information on species distributions and densities, physical environmental data and human impacts into a readily accessible and comprehensive form is an essential step for informed management decisions. It is essential that the scientific community makes its findings available to the (possibly non-scientific) members of the Participatory Management Group (Junta) in an understandable form in order to explain the need for protection of key species and areas.

6.2. Training projects

(i) Individual intensive GIS training in UK at the University of Southampton GeoData Institute for two senior Ecuadorian CDRS personnel for 1 month.

(ii) Follow up GIS training at CDRS by University of Southampton personnel for marine section Ecuadorian staff and volunteers.

(iii) Training of CDRS Ecuadorian research assistants in quantitative biological survey techniques working alongside UK team and CDRS senior staff during all fieldwork phases. Several of those involved have now taken over running successor fieldwork monitoring programmes.

(iv) Training at CDRS in use of spectrophotometer to determine chlorophyll levels in water and intertidal vegetation, for Ecuadorian research assistant.

6.3. Did any issues or difficulties arise in running and managing this project?
No major difficulties. Civil unrest and overthrow of the Ecuadorian government in January 2000 led to a minor postponement of collaborative fieldwork.

7. Project Impact

7.1. To what extent has the project assisted the host country to meet its obligations under the Biodiversity Convention, or to what extent is it likely to do so in the future?
Without implementation of a marine management plan there would have been accelerating loss of biodiversity from an internationally recognised ‘hot spot’. Fisheries, tourism and increasing population are all exerting pressures on the system. With uncontrolled fishing it was probable that 3 species of lobster and one sea cucumber species would have been eradicated from the Galapagos.

7.1.1. The way in which research findings have been used to address biodiversity objectives. What actions have been taken, or are expected to be taken, as a result of the project? How will these contribute towards the conservation of biodiversity in the host country concerned?

The biodiversity and ecological value of distinctive geographical regions (eco-regions) or

specific community types have been quantitatively surveyed and determined providing a baseline for future monitoring to evaluate the success of the marine management strategy.

7.1.2. The extent to which training provision has improved the capacity of the host country to conserve biodiversity in the future, and the extent to which the training has addressed real skill needs. Information should be provided on what each student/trainee is now doing (or what they expect to be doing in the longer term), and the extent to which their skills are being used in a positive way to promote biodiversity conservation in the host country.

Under the leadership of Howard Snell, CDRS zoologist, GIS has become a cornerstone of environmental and biological information management at CDRS. Hernan Vargas, the CDRS ornithologist and native of Galapagos, trained as part of this programme continues to apply GIS in his research and monitoring. The GIS system has proved to be invaluable in tracking and monitoring the effects of a major oilspill in the Galapagos January 2001.

Training of CDRS Ecuadorian research assistants in quantitative biological survey techniques working alongside UK team and CDRS senior staff during all fieldwork phases.

Lius Vinuzeza
Camillo Martinez
Veronica Torral
Jymmy Penaherrera
Juan Carlos Ricaurte

Veronica Torral and Camillo Martinez have taken over running successor fieldwork monitoring programmes

Lius Vinuzeza is currently studying for an MSc in marine conservation management at University of Wales, Bangor in order to enhance his future career in Ecuador/Galapagos Priscilla Martinez has spent 20 years working in Galapagos is now studying for a PhD in Austrailia to raise her professional status and hopefully will be the first Ecuadorian to take over the marine section of CDRS.

Dr Rodrigo Bustamate, the head of marine conservation at CDRS during this DI project, left shortly after its finish to take up a permanent post with CSIRO, Australia. However he was awarded a 3 year US Pew Foundation Fellowship which will enable him to continue his biodiversity work in Galapagos for 2 months each year as well as fund fieldwork and the salary of an Ecuadorian assistant at CDRS.

7.1.3. The wider impacts of the project in terms of the level of collaboration achieved between UK and host country institutions, and the prospects for greater joint working/information exchange in the future. To what extent has good collaboration been achieved?

Stuart Banks, who undertook his University of Southampton MSc Oceanography project on the Galapagos with Dr Collins, worked as a volunteer at CDRS during summer 2000 organising and quality controlling all the Galapagos marine biodiversity data. This was a very necessary activity and has made future use and publication of the information possible. He returned at the request of CDRS in January 2001 to contribute his computing skills. The US NASA/NOAA plan to imminently establish a satellite receiving station on Galapagos to monitor the Galapagos marine environment. Stuart plans to assist with this installation, run it for the first year during which time he will train an Ecuadorian to take over from him.

Dr Peter Statham, University of Southampton has been working with Ecuadorian Fisheries Department (INP) and Harbor Branch Oceanographic Institution (HBOI), Florida to develop a fisheries study of the Galapagos region. Dr Collins, co-ordinator of this DI project visited HBOI in March 2000 to develop the fisheries further with the support of CDRS.

Dr Collins has maintained contact with Dr Graham Edgar, the successor head of the marine section, CDRS through his former student, Stuart Banks and plans to visit later this year.

8. Sustainabililty

8.1. Did the host country institute(s) contribute resources to this project (these may have been provided in-kind, for example staff, materials etc)?

The main contribution by CDRS the host institute to this DI project has been in-kind as the salary of Dr Rodrigo Bustamante and his assistants.

8.2. If so, what is the monetary value of the resources committed to the project by the host country institute(s)?
Salaries - £50,000

8.3. To what extent was Darwin funding a catalyst for attracting resources (including in-kind contributions) from other sources? Please provide details on the other sources from which resources were secured for this project.
The formulation of marine management plan was a massive undertaking. Of particular importance was stakeholder participation/conflict resolution initiated and guided by Pipa Heyerling, CDRS. Without the local agreement and active participation of the Galapagos community any management plan would fail. This aspect has been supported by:

USAID
WWF
GEF
The Packard Foundation
Fundación Charles Darwin para las Islas Galápagos
Deutcher Entwicklungsdienst
The Dennis Curry CharitableTrust

Percentage of time spent on this project

Name	Institution	Position	97/98	98/99	99/00
Dr Ken Collins	Univ.	Senior Research Fellow	25	25	25
Jenny Mallinson	Southampton	Technician	10	10	10
Dr Simon Jennings	Univ.	Senior Research Fellow	10		
Dr Lin Baldock	Southampton	Consultant marine biologist		10	10
Stephanie Watkins	Univ. East Anglia	Postgraduate		25	
Stuart Banks	GEOS/Fugro	Postgraduate			25
Dr Rodrigo Bustamante	Univ. Southampton	Head Marine Conservation Ornithologist (MSc)	50 10	50	50
Hernan Vargas	Univ.	Marine biologist (MSc)	25	25	25

Priscilla Martinez	Southampton	Marine biologist (MSc)	10	10	
Fernando Rivera	CDRS, Galapagos	Assistant		50	50
Lius Vinuzeza	CDRS, Galapagos	Assistant		50	50
Camillo Martinez	CDRS, Galapagos	Marine biologist (MSc)			100
Veronica Torral	CDRS, Galapagos	Technician	10		
Jymmy Penaherrera	CDRS, Galapagos	Technician		10	10
Juan Carlos Ricaurte	CDRS, Galapagos				
	CDRS, Galapagos				
	CDRS, Galapagos				
	CDRS, Galapagos				

The DI project funded a fraction of this time:

The balance of time:

Dr Collins	34% - other research project funding
Dr Baldock	20% - personal contribution
Stephanie Watkins	10% - personal contribution
Stuart Banks	10% - personal contribution
CDRS personnel	balance from CDF core funds

8.4. What is the monetary value of resources generated for the project from other sources (please provide an estimate for each funding source)?

This is difficult to apportion since each of the other donors listed in 8.3. had a different focus for their funding which overlapped to some extent with the aims of marine management plan work. For example:

Fundación Charles Darwin para las Islas Galápagos - core funding for CDRS including the salary component £50,000 stated in 8.2.

USAID - marine biodiversity surveys prior to this DI project plus funding for boats and computers.

WWF & GEF - core funding for CDRS including the stakeholder participation/conflict resolution initiated and guided by Pipa Heyerling, CDRS.

The Packard Foundation - Galapagos fisheries monitoring of catch and effort

8.5. To what extent is work begun by the project likely to be continued in the future (if this is relevant - some projects may come to a natural end at completion)? This is more likely to be relevant for research-based projects.

The marine management plan has been produced and agreed so there is a natural end to the the project. However the plan requires routine monitoring of the marine environment particularly the abundance of commercial fish stocks (particularly lobsters and sea cucumbers) in order to set quotas and seasons.

Dr Rodrigo Bustamante, former head of marine research CDRS, has been awarded a US Pew Foundation Fellowship which will enable him to continue his biodiversity work in Galapagos for 2 months each year (2000-2003) as well as fund fieldwork and the salary of an

Ecuadorian assistant at CDRS.

8.6. Has the project acted as a catalyst for other projects/initiatives in the host country? Is it likely to do so in the future?
Yes., see 8.4. and 8.5.

9. Outcomes in the Absence of Darwin Funding
9.1. Had Darwin funding been unavailable for the project, what would have been the most likely outcome:
The project would have proceeded with other funding (see 8.3.) but would have a very small marine research component. Without extensive quantitative marine biodiversity data it would have been more difficult to argue for the allocation of no-take zones around the archipelago.

9.2. Had this project not been undertaken, how would the users/beneficiaries of the project have met their requirements? Would other organisations/ initiatives have been able to meet their needs (at least to some extent)?
See 9.1.

10. Key Points

10.1. What would you identify as the key success factors of this project?

(i) Dr Rodrigo Bustamante, head of marine research CDRS, my opposite number whose enthusiasm and hard work drove the project in Galapagos.

(ii) Good email communications.

10.2. What were the main problems/difficulties encountered by the project?
Nothing major, including civil unrest and overthrow of government (see 6.3.). Propellor fell off the survey boat in a remote part of the archipelago during one survey, but were rescued by patrol boat.

10.3. What are the key lessons to be drawn from the experience of this project?

The need for good reliable communications (email) and a collaborator who is prepared respond quickly to messages.
The project paid for 1 month/yr of the coordinator's (Dr Collins)time to cover the field work period only. A further month each year was taken for preparation and post fieldwork matters. Project co-ordination took up a further month each year. This extra time (6 man months) was effectively paid for from other research contracts.

The once a year visits maintained a degree of contact but a useful strategy has proved to be sending students between these annual visits and post-project to provide direct feed-back and enhance continuity of presence in Galapagos. Much of the time in Galapagos was spent away at sea leaving only a limited time for discussions with workers at CDRS.

10.4. Does the experience of this project imply a need to review arrangements for developing and managing projects funded as part of this Initiative?
No.

11. Project Contacts

(name, current address, tel/fax number, e-mail address), for the following:

11.1. UK project leader

Dr Ken Collins
School of Ocean and Earth Science
University of Southampton
Southampton Oceanography Centre
Southampton SO14 3ZH

11.2. Host country project leader/co-ordinator (and other key people involved in the project at the host country collaborating institute)

Dr Rob Benstead-Smith (Director)
director@fcdarwin.org.ec
Dr Graham Edgar (Head of Marine Research)
gedgar@fcdarwin.org.ec
Charles Darwin Research Station / Estacion Cientifica Charles Darwin
Puerto Ayora, Santa Cruz
Galapagos
Ecuador

Dr Rodrigo Bustamante (Former head of marine conservation CDRS)
CSIRO Marine Laboratories
Brisbane
Queensland
Australia

11.3. *'End users' for the output produced by the project in the host country*

Ecuadorian government,
National Park Service - Galapagos National Park Service
Galapagos Participatory Management Group:
Galapagos National Park Service
Charles Darwin Research Station
Local government authorities
Navy
Fisheries representatives
Tourist industry representatives

11.4. Project trainees/students

(i) Ecuador

Hernan Vargas (ornithologist CDRS) & Priscilla Martinez (deputy marine conservation, CDRS) GIS training UK
Luis Vinuzezza, Camillo Martinez, Veronica Torral, Jymmy Penaherrera, Juan Carlos Ricaurte - biological field survey training.

(ii) UK

MSc Oceanography research projects:
Stephanie Watkins, visited CDRS summer 1999
Stuart Banks, visited CDRS summer 2000
BSc Oceanography research projects:

Sophie Cullington
Mathew Marshall
Isabell Lee-Elliot
Kirsty Nash

11.5. Other project beneficiaries

11.6. Other key players involved in the funding/operation/utilisation of the project.
Galapagos Conservation Trust, UK funded travel costs for UK postgraduates (Stephanie Watkins and Stuart Banks) to CDRS.

12. Documentation Produced by the Project

(i) Galapagos Marine Management Plan (2000)

(ii) Papers and reports:

Watkins, S.P. (1998) The use and problems with using remotely sensed, and biological data within a geographical information management system for the coastal management of the Galapagos Islands. MSc dissertation, School of Ocean and Earth Science, University of Southampton, 39pp. + figs.

Jennings, S., Bustamante, R.H., Collins, K.J. and Mallinson, J.J. (1998). Reef fish behaviour during a total solar eclipse at Pinta Island, Galápagos. Journal of Fish Biology. **53**, 683-686.

Jennings, S., Bustamante, R.H., Collins, K.J. and Mallinson, J.J. (1999). Reef fish behaviour during a total solar eclipse at Pinta Island. Noticias de Galápagos. **60**: 9-10.

Collins, K.J. (1999) Darwin Initiative updates: underwater research. Galapagos Conservation Trust, Galapagos News **7**, 6-8.

Marshall.M. (1999) A comparison of SeaWIFs and in-situ chlorophyll from the Galapagos region. BSc dissertation, School of Ocean and Earth Science, University of Southampton, 47pp. + appendices.

Cullington, S. (1999) Zonation of macrofauna within the Galapagos marine reserve. BSc dissertation, School of Ocean and Earth Science, University of Southampton, 39pp. + appendices.

Banks.S.A. (1999) The use of AVHRR data in determining sea surface temperature zonation across the Galapagos Marine Reserve. MSc dissertation, School of Ocean and Earth Science, University of Southampton, 46pp.

Bustamante, R, Collins, K.J. and Bensted-Smith, R. (2000). Biodiversity Conservation in the Galápagos Marine Reserve. Proceedings of the Symposium, Science for Conservation in Galápagos, 15th April 1998, Institut Royal des Science Naturelles de Belgique, Brussels Bulletin de l'Institut Royal des Science Naturelles de Belgique **70**(supplement),31-38

Mallinson, J.J., Baldock, B.L. and Collins, K.J. (2000) Divers guidance notes to ground cover organisms of the Galapagos archipelago. Report to CDRS, 31pp.

Hickman, C.P. and Zimmerman, T.L. (2000) A field guide to Crustaceans of Galapagos. Galapagos Marine Life Series , Sugar Spring Press, Lexington Virginia, 156pp.

Lee-Elliott, I. (2000) Zonation of macrofauna within the Galapagos Marine Reserve. BSc dissertation, School of Ocean and Earth Science, University of Southampton, 58pp.

Nash, K. (2001) Carbon and oxygen isotope composition of the sea urchin, *Eucidaris thoursii*. BSc dissertation, School of Ocean and Earth Science, University of Southampton,

Collins, K.J., Bustamante, R.H. and Benstead-Smith, R. (in press) The Galapagos marine reserve. Proceedings Ist International Workshop on Marine Reserves, Spain, 1999. Edited by Ministerio de Agricultura, Pesca y Alimentación,.

Calder, D.R., Mallinson, J.J., Collins K.J. and Hickman, C.P. (in prep.) Additions to the hydroids (Cnidaria: Hydrozoa) of the Galápagos, with a checklist of species from the islands. Journal of Natural History.

Hickman, C.P, et al. (in prep) A field guide to sessile organisms of the Galapagos. Galapagos Marine Life Series , Sugar Spring Press, Lexington Virginia.

Bustamante, R, and Collins, K.J.(in prep) Biogeography of the Galapagos.