Regeneration Rates of Coral Communities Roatán Honduras - Final Report to the Darwin Initiative for the Survival of Species.

-Prepared by-

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1. Darwin Project Information

Project title	*Regeneration rates of coral communities in Roatán, Honduras*
Country(ies)	*Honduras*
Contractor	*Coral Cay Conservation*
Project Reference No.	*162/11/017*
Grant Value	*31,000*
Start/Finishing dates	*April 2002 – 2004* Revised: April 2003 - 2005
Reporting period	*April 2003 - 2004*

2. Project Background/Rationale

The Bay Islands stretch in an arc between 29 and 56 km north of the Atlantic coast of Honduras. The archipelago sits on the Bonacca ridge which is an extension of the Sierra Omoa mountains and bordering them to the North is the Bartlett trench (5191m deep).

Roatán is the largest and most developed destination for tourism of the Bay Islands. It is approximately 40 km long and 3 km wide. An almost continuous barrier and fringing reef stretches along the northern coastline 0.5 km offshore. A full review of the coastal zone of Honduras can be found in Harborne et al. (2001)[1].

The importance of the coral reefs around Roatán (Honduras) and the biodiversity they support is undeniable, both from a socioeconomic and a biological standpoint. The fringing reefs around the island are the key stone of an ever expanding dive tourism industry, they supply a primary source of protein to the islands inhabitants through coastal fisheries and provide a natural protection from coastal erosion. The Bay Islands, of which Roatán is the largest, form the southern extent of the Meso-American Barrier Reef (MBRS) System and support an enormous wealth of biodiversity that may be vital to he connectivity of the MBRS system as a whole.

[1] Harborne, A.R., D. Afzal and M.J. Andrews. 2001. Honduras: Caribbean coast. *Marine Pollution Bulletin* 42(12): 1221-1235.

Working in collaboration with Government agencies, Honduran universities and Island based Non-governmental organisations; Coral Cay Conservation has been in the Bay Islands since 1999 with the aims to:

- Undertake a systematic and detailed survey of the marine resources of the Bay Islands
- Continue and expand monitoring programmes;
- Provide SCUBA and scientific training;
- Provide research opportunities for Honduran project counterparts;
- Establish conservation education opportunities for local communities.
- Establish an environmental database at UNAH for the Bay Islands;

From 1999 to 2000 CCC undertook surveys on the Island of Utila, the completion of which allowed the project to extend geographically to a survey bases on Roatán. CCC completed survey work on the south-east coast of Roatán after spending 18 months on the south shore. The CCC base is currently located on the north-west coast of Roatan.

During analysis of the preliminary survey work conducted on the north shore reefs of Roatán, it was recognised that one of the key factors influencing the long term viability of these coral reef and most other MBRS systems would be the regeneration rates of coral communities and the effect of spatial competition from macroalgae.

Across the Caribbean and throughout the Mesoamerican barrier reef, hard coral cover has declined dramatically in the last thirty years, with a corresponding increase in macroalgal dominance. The cause of this change has been attributed to a range of factors including pollution, coral disease, successive hurricanes and the reduction in herbivore abundance due to over-fishing, however the true cause and how the interrelation of different factors influence this phase shift is not clearly understood.

Phase shifts to macroalgal dominance are not only detrimental to the biodiversity of the reef ecosystem, but cause a decrease in the economic value of the resource in terms of the abundance of commercially viable fish the reef can support and the loss of aesthetic attraction for tourism.
One area of importance in the context of coral reef recovery, which to date has been largely unstudied, is competition between macroalgae and juvenile corals and the limitation to coral recruitment caused by space pre-emption of macroalgae.

For coral populations to persist (or recover) adult colonies must survive and reproduce and the larvae produced settle and grow to reach fecundity. As coral cover declines the total abundance of larvae produced will also decrease and therefore the successful recruitment of juveniles to the adult population becomes vital for sustaining the population.

Successful recruitment requires suitable free space and for that space to be unoccupied for a duration long enough for juvenile corals to become competitively viable against spatial competitors. Knowing the duration that available space on a reef is free from competition in addition to the likely outcomes of competition between juvenile corals and macroalgae, enables a prediction to be made on the probability of survival for coral recruits over time.
The main Honduran project partners of CCC the Ministry of Tourism's 'Bay Islands Environmental Management Project' (Programa Manejo Ambiental Islas de la Bahia; PMAIB) were very keen to have this additional scientific output from their collaboration with CCC as this information could then be incorporated into management models for sustainable coastal development and would provide a new analysis tool for reef management in addition to the primary survey data provided by CCC's baseline surveys.

The grant from the Darwin initiative directly enabled this question to be addressed and the "Regeneration rates of coral communities in Roatán, Honduras" project was initiated

3. Project Summary

- To train Hondurans in reef survey techniques and research methodologies to perpetuate the monitoring of their marine environment.

- To incorporate data on coral algal competition and the temporal/spatial dynamics of free space on coral reefs into coastal zone management strategies for Roatán

- To re-train Roatanians away from environmentally damaging practices towards environmentally sustainable employment

- To provide reef ecology educational packages for use in local schools and for other targeted groups

Some changes to the original project outputs, personnel and scientific focus were proposed and accepted by the Darwin Secretariat in the April 2003 annual report, and a further change in personnel made in the October 2003. A summary of the changes are given below:

Changes in Personnel

Original Personnel List	Final Personnel List
♦Alistair Harborne	♦Alistair Harborne - Project supervisor
♦3 consecutive Project scientists	♦3 consecutive Project scientists
	♦Stephen Box – Field co-ordinator
	♦Dr Pete Mumby – PhD supervisor
	♦Ryan Walker – Project supervisor, CCC- UK

Changes to Honduran Project Counterparts

Original Counterparts	Final Project Counterparts
Programa Manejo Ambiental Islas de la Bahia (PMAIB)	PMAIB
Universidad Nacional Autonoma de Honduras (UNAH)	UNAH
Bay Islands Conservation Association (BICA)	Native Bay Islands Professionals and Labourers Association (NABIPLA)
	Universidad Jose Cecilio del Valle (JCV)

Counterpart Biannual Training Commitments

Original Training Commitments	Proposed Training Commitments
5 UNAH students	5 UNAH or JCV students
5 BICA students	2 PMAIB staff or nominees
	3 NABIPLA nominees
	2 UNAH students (800 hr interns)

Summaries of the most relevant Articles to this Darwin Projects

Article 7

Identification and Monitoring

Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities which have adverse effects; maintain and organise relevant data.

Article 8

In-situ Conservation

Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources.

4. Scientific, Training, and Technical Assessment

Steve Box conducted two inter-related experiments on coral growth and algal patch dynamics using assistance from International CCC volunteers and trained Honduran counterparts.

4.1 Experiment One

Title:

The effect of macroalgal overgrowth on the growth rate and survival of coral recruits

Objectives:

- To measure the effect of overgrowth by macroalgae on the growth rate and survival of coral recruits
- To ascertain the relative importance of abrasion and shading by macroalgae on coral recruits

- To determine whether the size of the coral recruit is an important determinant on the outcome of macroalgal overgrowth

4.1.1 Methodology:

Sixty coral recruits of *Agaricia sp*. in the size range of 10 ±2mm were found in around 8m of water on patch reefs at the north-west end of Roatán. The depth, surrounding benthic cover and the angle of substratum around the recruits were recorded. The recruits were randomly assigned one of six treatments to randomise the possible effect of depth, orientation and surrounding benthos on the experiment.

	Treatments					
	Treatment	Algae cleared around recruit	Caged with single level cage	Dictyota added around recruit[1]	Synthetic algae added around recruit[2]	Synthetic shading Algae added to top of cage[3]
1	No Cage Control	✓				
2	Cage control	✓	✓			
3	Algal addition	✓	✓	✓		
4	Synthetic Abrasion	✓	✓		✓	
5	Synthetic shading cage control	✓	✓			✓
6	Synthetic shading	✓	✓			✓

[1,2,3] See explanation below

The cages were constructed from 1.5cm square PVC mesh with a total height of 5cm and a diameter of 10.5cm. The design of the cages was cylindrical as apposed to square because the corners of small square cages may compound the effect of decreased flow.

Cages were secured to the substratum by nails pinned to a peripheral skirt, with the nails being covered by a plastic sheath and sealed with epoxy to prevent any leaching of iron into the surrounding water. The top mesh of the cage was

hinged to allow access for cleaning and photography, without having to remove the entire cage.

Notes on treatment methodology:

1 - Dictyota added around recruit

Algae were added around the coral recruit using the original algal "Doughnut" method. Each Doughnut was made from 3.5g (Wet Weight) *Dictyota pulchella* placed in nylon mesh tube and shaped to form a ring, secured using 0.5mm nylon monofilament. This weight of algae is the average maximum density of *D. pulchella* in a circle of 10.5cm diameter (the size of the cages).

The algae were collected from the same reef as the experiment and the wet weight measured in a laboratory. Rings were constructed and maintained in an aquarium until required to enable the algae to grow through the mesh sufficiently before being added to the cages.

The Doughnuts were tied using monofilament to the inside of the cages to prevent the mesh coming into contact with the recruit itself; in addition it provided a degree of protection against being displaced by storm action.

2 - Synthetic algae added around recruit

$10cm^2$ thin, clear polythene sheets were cut into 0.2cm strips (an approximate width of large Dictyota fronds). Each sheet was then bunched up and tied at a central point to form a loose leaf arrangement of radiating fronds. This constituted 1 pseudo algae. In cage treatments requiring synthetic abrasion addition, 4 of these units were tied to the inside of the cages so that the fronds touched the periphery, but did not cover the recruit.

Each unit was tied with nylon line and evenly spaced around the cage depending on the specific topography upon which the recruit was growing and the location of the recruit within the cage.

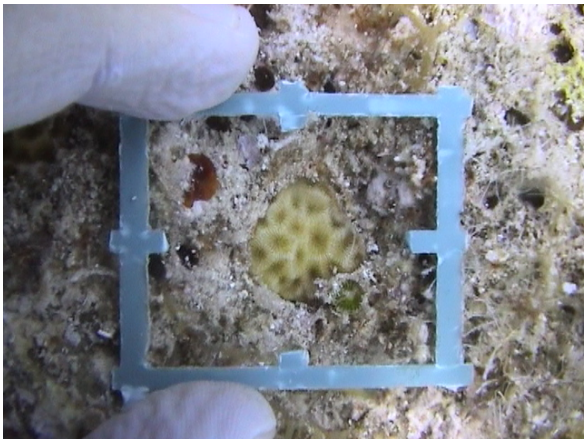
3 - Synthetic shading Algae added to top of cage

The reduction in Photosynthetically Active Radiation (PAR) caused by *Dictyota pulchella* directly overgrowing a coral recruit was measured using a PAR sensor. This reduction of PAR was replicated using a synthetic dark plastic material that caused the same level of irradiance reduction. This material was clumped using the same method as for abrading synthetic algae and attached to top of the "Synthetic Shading Treatment" cages.

Because the cage material itself also caused some level of PAR reduction on the recruit, a second synthetic material was found that matched the level of PAR reduction caused by Dictyota overgrowth minus the level of PAR reduction caused by the cage shading effect.
This material therefore gave the same level of PAR reduction that overgrowth causes without the additional influence on shading of the cage. This material was added to the top of the cages called "Synthetic Shading Cage Control"

4.1.2 Sampling:

The recruits were digitally photographed every two weeks with a 33mm x 33mm quadrate placed around the coral for scaling.



Using software written by researchers from the Marine Spatial Ecology Labs at Exeter University the exact size of the recruit (to 1mm^2) was calculated from the digital image.

4.2 Experiment Two

Title:

The spatial and temporal dynamics of shallow tropical benthic marine algae

Objective:

- To map the spatial changes in algal patch area and vertical height over time
- To measure the effect of substratum orientation on algal assemblage composition and spatial dynamics
- To calculate the spatial and temporal availability of bare substratum in the presence and absence of herbivory

4.2.1 Methodology:

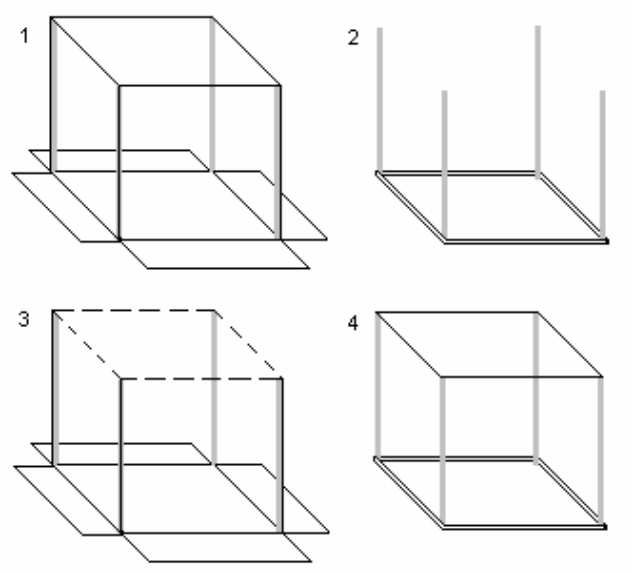
25cm x 25cm quadrates were marked using corner stakes on both vertical and horizontal dead *Montastrea annularis* containing one of four species of macroalgae (see table below)

Algal Patch Type	Orientation of surface
Dictyota pulchella	Horizontal
Dictyota menstrualis	Vertical
Lobophora variegata	Vertical
Halimeda copiosa	Vertical
Control - All Algae Cleared	Vertical
Control - All Algae Cleared	Horizontal

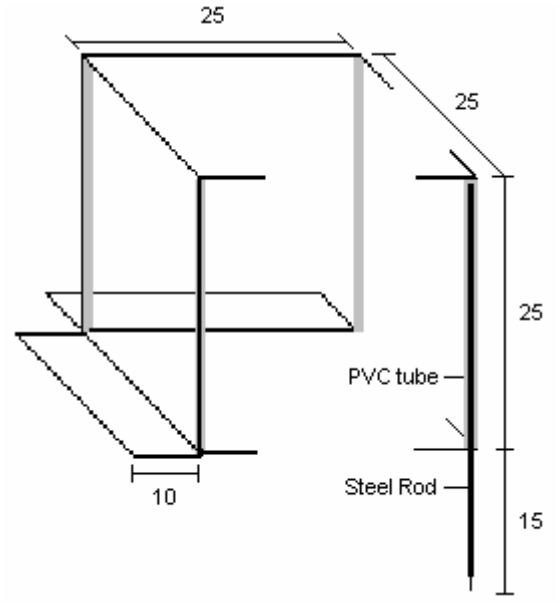
All patches of algae were approximately the same initial size within species (about 10cm diameter), with their size being estimated by eye during set-up. Once the suitable substratum/algal sites had been found their depths and orientations were recorded. They were then randomly assigned one of four treatments with the number of replicates varying depending on the treatment (see below).

	Full Cage (1)	No Cage (2)	Sides Only (3)	Top Only (2)	Total
Number of Replicates	6	4	2	2	14
Total number of plots	36	24	12	12	84

Diagrammatic representation of treatments:

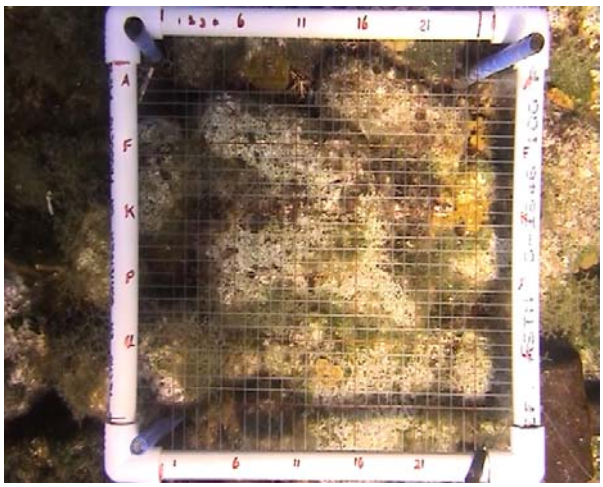


Cage Design:



(measurements in cm – not drawn to scale)

For all treatments steel bars were driven into the substratum at each corner of a 25cm x 25cm square, with the bars protruding above the substratum by 25cm. The bars were covered by a 1/16th inch rubber tubing to prevent leaching of any metallic ions into the surrounding sea water. Cages were constructed from 1.5cm square PVC mesh, heat bonded into a cube. The cages were 25cm high and slightly larger than 25cm^2 to fit over the rubber-clad steel corner posts. A skirt around the edge of the cage prevented herbivores penetrating under the cage and aided in fixing the cages into position.



4.2.2 Sampling:

Each plot was sampled using a quadrate

enclosing a 25cm x 25cm grid of 1cm squares made of nylon monofilament. The quadrate was laid over the corner posts (any cages being lifted off first) to ensure that the position of the quadrate was exactly the same upon repeat sampling. The entire quadrate was videoed from vertically above using digital video, then each section of the quadrate was videoed in a "close up" of 5cm bands, to facilitate the accurate identification of benthic algae in each $1cm^2$ Identification of the substratum cover in each square (using the categories below) was conducted via video analysis and the area cover of algal patches measured using specially developed software.
All algae occurring in the quadrats were identified as far as possible. The quadrates were videoed each month and the change in benthic algal assemblage and spatial dynamics of free space calculated.

Herbivore survey:

Surveys of macro-herbivores (fish and urchins) were conducted every month at the study site using the following parameters:

Herbivore	Transect size	Depth	Replicates	Species Recorded	Data recorded
Urchins	0.5m x 30m	8m ±2	15	Longspine *Diadema antillarum* Rockboring *Echinometra lucunter* Reef *Echinometra viridis*	The total number and average size of each species
Fish	4m x 30m	8m ±2	15	All species of Parrotfish, All species of Surgeon fish,	The total abundance in each family. Fish length estimates of each species

Results of both experiments:

4.2.3 Preliminary Results

There is to date a very large amount of data in the form of digital images and video on growth rates and algal patch dynamics which is currently under analysis. Unfortunately the data set collected from these two experiments is currently incomplete due to unforeseen problems associated with severe storms on the North shore of Roatán during October 2003 - March 2004.

These storms prevented sampling of the cages, disturbed and destroyed some of the recruit replicates and affected the algal patch quadrates and has disrupted the timeline of continuous data collection integral to this research.

As the data set is incomplete and the results consequently inconclusive, CCC-UK in consultation with Dr Pete Mumby and Steve Box, from Exeter University, have decided to fund the continued collection of data on coral growth and algal patch dynamics over the following twelve months to yield the originally proposed quantity of data over a continuous timeline.
CCC has decided to solely fund this continued research and after the further period of data collation these experiments will realise their full potential when analysed in conjunction with the existing data set.

It is hoped that when the entire data is disseminated along it will constitute around six peer review papers for publication in relevant journals, and a PhD thesis. In addition the data could form a part of a computer model on algal patch dynamics and reef regeneration rates, which could be used in the design of coastal zone management plans for the reefs of the Bay Islands and the MBRS. This will greatly add to the existing CCC baseline data and could prove to be a valuable management tool for the in-country project partners PMAIB.

The Darwin initiative will receive copies of, and credit for, these outputs as they occur.

The training, education and capacity building programs of this project have overall been a huge success. Although the training was originally targeted only at university students and staff or nominees from two of our local project partners, other training and educational programmes were devised during the lifetime of this project to better fit the needs of the stakeholders and to fit in around the prior commitments of the people requiring training.

The unforeseen difficulties our project partners encountered in recruiting all the candidates to fill the spaces that CCC could offer was the major problem encountered during the training phase of this project.

This was due to a combination of factors including;

- Difficulties in timetabling the residential training programmes, to avoid the rainy season, but coincide with the semester breaks of the Universities and not conflict with other University commitments of the students.
- There was also a small language problem in that the science and SCUB A training were conducted in English so only English speaking students could attend the residential courses.
- In addition there was often a lack of commitment from some of the local nominees from the project partner NABIPLA, who signed on to the training courses then failed to make the time available to complete the training programs they committed to.

However, in consultation with our project partners' new ways of training selected groups of stakeholders were established. Shortened training programmes and educational packages were devised so that a greater number of people, in many more stakeholder groups, were given reef awareness and environmental education. The greater diversity of stakeholders that CCC, in conjunction with the project partners, managed to train and educate and the flexibility of all involved in the realignment of training and educational goals in respect to original difficulties is a truly great success for this project.

The main training program and the additional educational workshop contents are outlined below.

4.3 Reef Awareness Residential Training Course

The Darwin Initiative funds directly enabled the establishment of "Coral Cay Conservation Reef Awareness Awards" which are scholarship programmes offered to Honduran nationals aimed at providing students with technical and scientific skills that will benefit them in their chosen career. During 2003 & 2004, students from Universidad Nacional Autonoma de Honduras (UNAH) participated in 4-week training schemes or for 3 month internships.

Students undertook SCUBA diving training to PADI Advanced Open Water level certification and could continue to gain further diving qualifications if desired. Participants then followed an intensive two week science "skills development programme" (SDP) involving a series of lectures and written tests, species identification dives and snorkels, and a number of in-water validation exercises supervised by experienced CCC science staff. The primary aim of the lecture programme was to give individuals the ability to discern the specific identification characteristics and relevant

biological attributes of the species that they would encounter during their diving surveys. These species include key indicator species for reef health, diversity and signs of environmental pollution or degradation. Survey skills were also taught so that these students could then survey the reefs of Roatán in the future.

A large amount of emphasis was placed on coral reef biology and ecology and in particular specific factors posing a threat to the coral reefs surrounding the Bay Islands. Details of this training timetable and content are outlined below. On successful completion of the training program students then participated in the collection of survey data which is incorporated into the CCC data set for use in habitat mapping and the designation of marine protected areas in conjunction with PMAIB.

Week 1 – start of SDP: ***Expedition Skills Training***

	Friday	Saturday	Sunday No diving	Monday	Tuesday	Wednesday	Thursday	Friday
⇦ AM		**Lecture 3** ►Dangerous marine animals **Safety briefings** **Practical** ►Scuba kit allocation ►PADI AOW Elective Dive: PPB with new diver volunteers. ►Rescue Diver mods 1&2	**Expedition Camp Duties** **Lecture 5** ►Into to the biology and ID of marine plants and algae	**Lecture 6** ►Intro to the Cnidaria - biology and taxonomy **Practical 2** ►PADI AOW Elective Dive: PPB (6m) with new diver volunteers with brief Reef Orientation – Cnidaria & Algae	**Lecture 8i** ►Hard coral ID – target groups 1 **Lecture 8ii** ►Hard coral ID – target groups 2 **Practical 4** ►Hard coral targets ID (scuba-18m / snorkel)	**Lecture 10** ►Intro to fish biology, ecology & identification **Lecture 11** ►Main Fish families **Practical 5** ►Fish ID – Families (scuba 18m/snorkel) **Review** ►Fish ID – Families	**Lecture 12ii** ►Fish ID – target species 2 **Practical 7** ►Fish ID – target species 2 (scuba-18m) **Review** ►Fish ID – target species 2	**Lecture 13i** ►Invert. ID 1 **Lecture 13ii** ►Invert. ID 2 **Practical 9** ►Invert. ID (scuba-18m) **Review** ►Invert. ID
⇦ PM	**Orientation** ►Welcome & tour of facilities ►Expedition life & duties ►General health & safety ►CCC rules & regulations	**Review** ►Expedition Skills Development Programme schedule **Lecture 4** ►Intro to coral reef ecology **Practical** ►Orientation dive	**Practical 1** ► Marine plants & algae ID (snorkel) ►Specimen ID – reference collections **Review** Marine plants and algae	**Lecture 7** ►Intro to hard corals - biology and life-forms **Practical 3** ►ID – Cnidaria groups and hard coral life-forms (scuba- 16m / snorkel) **Review** ►Cnidaria & hard coral life forms	**Lecture 9** ►Soft corals and sponges – biology and ID **Practical 5** ►Hard/soft coral and sponges ID (scuba – 16m / snorkel) **Review** ►Hard/soft coral and sponges ID	**Lecture 12i** ►Fish ID – target species 1 **Practical 6** ►Fish ID – target species (scuba 16m) **Review** ►Fish ID – target species 1	**Practical 8** ►Fish ID – families and target species (scuba-18m/snorkel) **Review** ►Fish ID – target species	**Review** ►ID – coral, fish, inverts & algae **Practical Exam** ► Hard and soft coral ID –coral trail (scuba-16m/ snorkel)
EVE	**Lecture 1** ►Country Brief, Local culture and customs **Lecture 2** ►In-Country Partners and Project Background	**Review** ►Expedition Skills Development Programme schedule	**Review quiz** ►CCC health & safety regulations ►CCC dive standards ►Emergency procedures ►Local culture & customs	**Revision** ►Marine plants and algae **Examination** ►Marine Plants and algae (spot samples/slides)	**Revision** ►Hard and soft corals **Examination** Hard and soft Coral ID	**Review** ►Fish ID (pictionary) **Revision** ►Fish families and targets 1 ID	**Revision** ►Fish families and target species ID. **Examination** ►Fish ID	**Revision** ► Invertebrate ID (slides) **Lecture 14** ►Ropes & knots **Self-revision** ►ID – coral, fish, inverts & algae

Week 2 - ***CCC Skills Development Programme (continued.)***

	Saturday	Sunday No diving	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday end of training
⇦ AM	**Review** ►ID – inverts & algae **ID skills evaluation** ►Inverts & algae (scuba 18m / snorkel) **Review** ►CCC dive standards ►PADI tables & quiz ►Boat safety ►Boat marshalling	**Lecture 16** ►Intro to CCC Reef Survey forms, habitat classifications and use of Abundance Scales **Practical 11** ►Practice CCC reef survey 2 (snorkel) ►Data entry onto CCC forms	**Lecture 19** ►Intro to GPS **Practical 14** ►Practice CCC Baseline Survey 3 dive (scuba 18 m) Followed by data entry on to survey forms **Review** ►GPS & knots	**Practical 16** ►Practice Reef Check Survey 2 - fish - (scuba 18 m) Followed by Data entry onto CCC Reef Check forms **Review** ► Reef Check Belt survey - fish	**Lecture 22** ►CCC data validation **Review** Benthic categories ID **Skills validation** ►Benthic line - Baseline and Reef Check (scuba-18m) **Review** Benthic validation assessment	**Review** ►CCC Reef Survey technique (baseline) **Practical 13** ►Practice CCC Reef Survey 3 (scuba 18m) ►Data entry onto CCC forms	**Practical 13** ►Practice CCC Baseline Survey dive ►Data entry onto CCC forms **Validation retake if required** **ID skills in water evaluation if required** (coral / inverts)	**Survey dive + data collation**
⇦ PM	**Lecture 15** ►Intro to CCC Baseline Reef Survey Technique **Practical 10** ►CCC Baseline Survey methods (dry run) ►CCC Baseline Survey practice 1 (scuba-16m) **Review** ►CCC Reef Survey technique (baseline)	**Practical 12** ►Practice CCC Reef Survey 3 (snorkel) **Review** ►CCC Reef Survey technique (baseline) **Lecture 17** ►Data entry to CCC computer database – (groups of 4)	**Lecture 20** ►Reef Check Intro & Survey Method **Practical 15** ►RC Practise Survey – Dry Run – fish, inverts and benthic ►RC Practise Survey 1 – line point (snorkel) Data entry on to CCC Reef Check survey forms and computer – benthic	**Practical 17** ►Practice Reef Check Survey 2 -Belt inverts (scuba 16 m) Followed by data entry onto CCC Reef Check forms CCC Reef Check data entry on to computer – fish, inverts (groups of 4). **Review** ►Reef Check Belt survey - inverts	**Review** Reef Fish ID **Skills validation** ►Fish (scuba-10m) **Review** ►Validation assessment	**PADI EFR*** ►Mods **Skills validation** ►Retakes if required (fish or benthic**)** **Review** ►Validation Assessment ►Practice CCC Baseline Survey dive ►CCC data entry on to forms	**PADI EFR*** ►Mods **Practical 14** ►Practice CCC Baseline Survey dive ►Data entry onto CCC forms **Validation retake if required** **ID skills in water evaluation if required** (coral / inverts)	**Survey dive + data collation** **Safety brief** ►Night-diving procedures
EVE	**Revision** ►Invertebrate ID (slides) **Examination** ►Invertebrate ID	**Lecture 18** ►CCC data: analysis & use **ID skills evaluation** ►Re-takes if required	**Review** Reef Check line point – survey results **ID skills evaluation** ►Re-takes if required	**Lecture 21** ►Other survey methods: **ID skills evaluation** ►Re-takes if required	**Advanced lecture 1** ►Conservation of coastal and marine habitats (mangrove / seagrass / reefs)	**Advanced lecture 4** ►Threats to Reefs 1 **Retakes of ID tests if required** **Data entry** - database	**Advanced lecture 7** ►Global and regional coral reef initiatives **Data entry** - database	**Data entry** – database Optional night dive

In addition to the 4-weeks scholarship programme, an alternative two week internship was offered to students from Universidad Jose Cecilio del Valle (JCV) in Tegucigalpa and older students from the local bi-lingual school on Roatán. Students participated in SCUBA training to PADI Advanced Open Water and followed a shortened version of the science development program given above.

Students from both UNAH and JCV were able to obtain course accreditation at their respective Universities as a result of participation in the Coral Cay Reef Awareness Scheme.

Total number of students trained: 14

The development of reef awareness days targeted at school children was the first of a number of initiatives established to meet the additional training and educational remit of this project.
School children from local schools on Roatán aged from 10 - 15 visiting the base in groups of 15 benefited from coral education workshops. Using a half-day training programme, tailored to the age and abilities of the group, pupils listened to talks and played interactive games aimed at educating and inspiring local children about coral reefs and their importance to the livelihood of the Bay Islanders. Groups were also given the opportunity to go snorkelling with experienced reef surveyors and take guided boat trips over the reef systems.

Total number of school children educated: 150.

With tourism being one of the most important industries for the Bay Islands and cruise ship tourism currently expanding faster than land-based tourism, it was thought to be extremely important to target this stakeholder group with reef awareness education. However, reaching the cruise ship passengers directly (of which an estimated 150,000 will visit Roatán in 2004) was not deemed possible, or suitable, so another approach was used. In collaboration with The *Native Bay Islanders Professionals and Labourers Association* (NABIPLA) the local tour guides who escort the cruise ship passengers around Roatán were contacted. An educational program was devised so that the information about coral reefs could be easily incorporated in to the tour guides' talks and presentations that they gave to the visiting cruise ship passengers.

The educational workshops focused on simple coral reef biology and ecology - the "facts and fictions", identification of commercially important species, the "do's and don'ts" of reef

tourism and highlighting the importance of coral reefs both in terms of preservation of biodiversity and potential economic and social benefit towards the host country.

Total Tour guides trained: 96

During February 2004, CCC provided technical assistance and support during the development and provision of a workshop for local teacher-trainers, covering material that could then be integrated into the environmental education curriculum in schools throughout the Bay Islands. The workshop was a joint venture between Coral Cay Conservation, the main project partner *Projecto Manejo Ambiental de las Islas de la Bahia* (PMAIB) and the Department for Education in the Bay Islands.

To accommodate the bi-lingual nature of many schools around the Bay Islands, the workshop was divided into Spanish and English sessions and lecture materials were produced in both languages. The training schedule is outlined below and the course material included in the appendix.

	DAY ONE	**DAY TWO**
Morning	L1: Coastal & marine Habitats (CCC)	L5: Environmental problems around the Bay Islands (PMAIB)
	L2: Introduction to coral biology (CCC)	L6: Management strategies (PMAIB)
	L3: Threats to the reefs (CCC)	L7: The use of habitat maps and their importance in coastal zone management (PMAIB)
Afternoon	L4: Fish biology and fisheries (CCC)	Discussion and problem solving activities
	Practical Session: Snorkelling	Practical session; Snorkelling
		Summary of Workshop and conclusions (CCC & PMAIB)

Total teacher trainers: 40

Summary of Training and Educational Achievements

Target Group	Training program	Number trained
University students from Tegucigalpa	Reef species ID and Survey skills - residential course	14
Roatán School Children	Reef Awareness Days	150
Roatán Cruise Ship Tour Guides	Basic Coral Reef Education	96
Bay Islands Teacher Trainers	Environmental Education for incorporation into national curriculum	40
	TOTAL	**300**

5. Project Impacts

The numbers of people reached though the various training and education programmes organised by CCC during this project, speak for themselves as evidence of the accomplishment of this project's purpose. Through education, the level of awareness on current issues affecting reef biodiversity have been dramatically increased at many levels across diverse stakeholder groups. Through specialised and targeted training, the capacity for future surveying and monitoring of the reefs of the Bay Islands has been significantly increased. In addition the unique and on-going research that was conducted on the reefs of Roatán will deliver some original and highly relevant results from experiments never before conducted in the field of tropical marine biology. The results will be able to be incorporated into management models on reef regeneration rates and start to answer some of the key questions still unanswered on the processes affecting coral growth and reef survival. A true achievement is that this project will not stop solely because the Darwin funding phase is drawing to a close. Through the dedication and support of Coral Cay Conservation and it's continuing work in Roatán, not only will the specialised research carry on to fulfil it's full long term potential under the guidance of some of the UK's leading tropical marine biologists, but the training and education will continue on new stakeholder groups in different communities of Roatán. Coral Cay Conservation through it commitment to coral reef restoration and protection has agreed to fund the remaining portion of the research to continue the work that has to date had such positive results.

The difficulties encountered by the project have ironically resulted in the some of the greatest achievement of them all. Through the tenacity and commitment of all involved both in the UK and in-country counterparts to overcome training problems, expand and include new sectors of the community, factor against adverse weather conditions and other logistical problems

beyond their control yet still deliver a training and education legacy of the highest calibre in addition to excellent data on the reef systems of Roatán and targeted research on coral algal competition is truly a great achievement.

The research on coral growth and algal patch dynamics has shown that there could be a serious threat posed to the coral reefs of Roatán; The continued increase in algal spatial dominance. Initial results indicate that space pre-emption by macroalgae can seriously affect the likely hood of coral settlement and the effect of shading and abrasion by macro algae inhibits the growth of juvenile corals compounding the problem of juvenile corals reaching a size large enough to recruit into the adult reproducing population.

Over time this situation could result in the severe degradation of the reef systems as whilst adult corals suffer mortality (whether the result of natural or anthropogenic factors) there are fewer younger coral colonies to replace them, thus the coral cover will continue to decline. As colony size is often a factor in successful coral reproduction this scenario could get worse over time as the population of reproducing adult colonies declines further, decreasing further the available coral recruits. This original research has highlighted the problem for the project partners for the first time. As more information is gathered combined with the long term outputs of the research including a predictive model, the integrated coastal zone managers of the Bay Islands can try to reduce the impact of macroalgae on reef health. For example these strategies could be based on evidence that macro herbivores are fundamental in maintaining free space for settlement and thus management plans which conserve them should be paramount for the future. In addition strategies that protect the adult population from further degradation and could possibly be beneficial to algal growth such as terrigenous runoff, sewage discharge and dredging should be avoided and controlled. The management plans for the bay islands are being compiled by CCC's in-country project partners and this data will definitely be instrumental in assisting this goal and provide concrete evidence to support any plans that are initiated for example funding the construction of sewage treatment facilities.

The successful results of the environmental education and local capacity building component of the project were very unique to the area. The student scholarship-training program enabled 14 undergraduate students form the National University, in Tegucigalpa to be trained in SCUBA diving and marine identification and survey techniques. Most scholars returned to university to continue with there studies, but one notable exception was recent Biology graduate, Victoria

Flores. Victoria demonstrated the practical and transferable nature of the training she had received by securing paid employment with a local environmental management and conservation NGO working within the Bay Islands.

Positive impacts created by the project include forging links between CCC, PMIAB and the National University. CCC has donated a PC and a complete set of the baseline data collected by CCC for the reefs of the Bay Islands for students to work with and practice data analysis techniques. Over 300 local people have benefited from direct training from the project (see table above). Indicators of success for such educational and out reach work are very difficult of measure. But, the teacher training workshop, where teachers form Roatan were trained in delivering a new environmental education component to their curriculum was judged a success by those teachers and CCC staff involved. The CCC trainers have been asked to replicate the workshops for similar groups of teachers on the two other main islands of Utila and Guanaja. Over 150 children were trained through Reef Awareness days, again success is very difficult to establish at this very early stage, but anecdotal evidence to the awareness rising within the local community could be seen on occasions. For example, several local children attracted the attention of CCC personnel when local fishers were excavating turtles eggs from a local beach. All of the children expressed their concern for what was happening to the nest and that the disturbance and excavation was “wrong”.

6. Project Outputs

Additional achieved out puts were the teacher training workshops used to take secondary school teachers within the Bay islands through a new curriculum in environmental education, enabling them to disseminate the information to students. An environmental awareness and threats poster in Spanish – *La Vida en los arrecifes de Coral,* was produced through a grant from the UK Foreign and Commonwealth Office, and used in Darwin funded education programs and workshops. This out put has been successfully disseminated through out other regions of Mesoamerica, Spain, and Spanish speaking communities within the United States, as an education tool used in schools, and aquariums (pictured below).

Partly archived outputs include a Reef Algal model which will be completed with the next 12 months through additional funding from CCC, and will be used by PMAIB as a management tool. A video containing digital footage of the local reefs will also be produced through additional funding by CCC, and be used as a training tool by PMIAB and UNAH, for improving surveyors ID skills.

7. Project Expenditure

8. Project Operation and Partnerships

8.1 Main In-Country Project Partners

- Universidad Nacional Autonoma de Honduras (UNAH)
- Proyecto de Manejo Ambiental des las Islas de la Bahia (PMAIB)
- Native Bay Islanders Professionals and Labourers Association (NBIPLA)

PMAIB were the main partners involved in biodiversity issues, being the government agency in charge of environmental planning and management agency for the Bay Islands. For this project their role involved utilising the primary data provided by CCC and assisting in compiling targeted training and education programmes. The role of UNAH was primarily to select students for training programmes and to use the raw and analysed data provided by CCC in the courses of the university degree programmes for biological science and environmental management.

NBIPLA had no real role in biodiversity issues with the exception of raising awareness of reef protection in the local community in conjunction with CCC education programmes. The

only plans that were modified in response to local consultation were the initial training targets, to take in account the new needs of the project partners. These changes are outlined in "**Training and capacity building activities".**

CCC maintains a strong presence in Roatán continuing it's commitment to provide resources to help sustain and alleviate poverty through the protection, restoration and management of coral reefs. It continues to work closely with all the project partners in this project, expanding the training programmes and continuing the research initiated through the help of this Darwin Initiative grant. Local partners have continued their involvement and commitment to the biodiversity strategy process. Currently there is only a limited role for the private sector in the furtherance of this project. The main role of the private sector should be to understand the long term problems facing the reef systems of Roatán and the impact that their degradation will have on the socio-economics and livelihoods of the Bay Islands.

9. Monitoring and Evaluation, Lesson learning

The training and education programmes were monitored and evaluated by CCC staff at head office thorough weekly reports written by field project staff and by submitting full itineraries and details of the programmes in advance. In addition in depth consultation with each project partner group to specifically tailor them and after the event to receive feedback and comments to continually improve future programmes.

The research was monitored by Dr Pete Mumby through reports written by Steve Box and by yearly reports submitted for external evaluation to the University of Exeter. A visit to Roatán was also made by Dr Mumby during December 2003 to evaluate at first hand the progress made on the research objectives and oversee any changes to the methodology due to the weather problems being experienced at the time.

10. Darwin Identity:

Although CCC is a well known conservation organisation, the identity of the Darwin Initiative project within the Coral Cay framework was not over shadowed by this. However PMAIB is funded by a World Bank, GEF grant, for some of its environmental work including the construction of sewage treatment works on Roatán. Within this context the Darwin Initiative may have been over shadowed. That being said, in terms of the training and research that were completed, the Darwin grant was instrumental and widely acknowledged for its fundamental

role as a key piece in the “bigger picture”.

11. Leverage

A $5,000 (US) development grant was secured by the UK Foreign and Commonwealth Office (FCO). This funding was used to design and print 5,000 copies of the Spanish “life on the coral reef poster”. This education tool is designed to be used in schools and highlights the biodiversity on coral reefs in the Mesoamerican region, and the impending treats facing these fragile environments.

During the course of the Darwin project approximately 450 paying volunteers participated in the CCC Project Bay Islands, a percentage of the expedition fees paid by volunteers has been channelled in the Darwin environmental education projects.

12. Sustainability and Legacy

The most sustainable legacy of the project was the training of 14 Honduran students from UHAH, in marine identification and survey techniques. As this training will form the basis of managers of the future. The 40 teachers trained during the bi-lingual teacher training workshops will also be a sustainable component of the project as they will be training the children of the Bay Islands in environmental awareness for years to come.

The coral algal interaction survey component of the project is still incomplete and is being independently funded by CCC. CCC will continue its baseline survey work in the far eastern end of the island, plus its community environmental education program in this region, thus ensuring sustainability and legacy of the work that was funded by this Darwin project. CCC is currently preparing a bid to attempt secure Darwin funding for a fisheries management project on Roatan beginning in 2005.

13. Post-Project Follow up Activities

N/A.

14. Value for money

The report out lines the success of the project in terms of the amount of successful out reach and environmental education programs conducted. Direct success and therefore value for money is very hard to gauge over a relatively short period of time. But, as mentioned in other sections of this report the training of one scholar form UNHA, enabling her to gain employment within the conservation sector within the Bay Islands should be regarded as a direct successful result for the project. The work undertaken with the local teachers and tour guides, should be considered a success as the education program is so wide ranging in terms of the volume of potential people the teachers and tour guides will come into contact with, and therefore disseminate the information they have been taught.

15.Author(s) / Date

Steve Box 27/07/04
Ryan Walker
Jacqui Taylor

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

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	**Project %**	**Article Description**
6. General Measures for Conservation & Sustainable Use	25	The project has contributed to the knowledge of algae and coral recruit interaction within the Caribbean, thus providing data and information enabling coral reef managers in the region a better chance at managing coral reefs and associated resources. An important issue as anthropogenic and natural disturbances appear to be causing a shift in hard coral to algal dominance upon reefs throughout the wider Caribbean. The training of students from two host country universities and various local stakeholders will ensure the project has left a legacy of sustainability, and the one going nature of the work will continue this legacy.
7. Identification and Monitoring	5	The project has implemented a two year monitoring program of algal/coral interactions within the reefs of Roatan, Honduras.
8. In-situ Conservation	10	The results of the algal/coral interaction work, can be used in aiding coastal mangers and decision makers (i.e. PMIAB) when considering the sighting of Marine Protected Areas. The effects of algae can be assed on areas of reef supporting high hard coral cover.
9. Ex-situ Conservation	10	Ex-situ conservation measures can be facilitated by using data to establish regional treats facing coral reefs in the Caribbean.
10. Sustainable Use of Components of Biological Diversity	5	The results of this work can be used to demonstrate that management policies such as local fisheries management practices and waste water treatment issues need to be addressed, as anthropogenic stresses are contributing to the algal phase shifts within Caribbean reefs.
11. Incentive Measures	5	Data resulting from the project can be used to demonstrate the incentive of environmental sustainability. For example demonstrating the incentives gained in the form of a healthy reef environment by managing local reef fisheries sustainably.
12. Research and Training	15	14 Honduran students were trained to SCUBA dive to PADI Advanced Open Water level, and trained in marine taxonomy and survey techniques.
13. Public Education and Awareness	15	150 local school children form Roatan attended the “Reef awareness” training days. 96 local cruse ship tour guides attended reef tourism and environmental awareness workshops.
14. Impact Assessment and Minimizing Adverse Impacts		N/A
15. Access to Genetic Resources		N/A
16. Access to and Transfer of Technology		N/A
17. Exchange of Information	10	All of CCCs results are made available for all host country project partner organisations. Results are also made freely available via the CCC website and can be downloaded to be used by other institutions, NGOs and members of the public.
19. Bio-safety Protocol		N/A
Total %	**100%**	**Check % = total 100**

17. Appendix II Outputs

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

Code	Total to date (reduce box)	Detail (←expand box)
Training Outputs		* to be submitted
1a	Number of people to submit PhD thesis	1*
1b	Number of PhD qualifications obtained	
2	Number of Masters qualifications obtained	
3	Number of other qualifications obtained	
4a	Number of undergraduate students receiving training	14
4b	Number of training weeks provided to undergraduate students	77 (person weeks)
4c	Number of postgraduate students receiving training (not 1-3 above)	
4d	Number of training weeks for postgraduate students	
5	Number of people receiving other forms of **long-term** (>1yr) training not leading to formal qualification(i.e not categories 1-4 above)	
6a	Number of people receiving other forms of **short-term** education/training (i.e not categories 1-5 above)	286
6b	Number of training weeks not leading to formal qualification	29
7	Number of types of training materials produced for use by host country(s)	4 (2 still in progress)
Research Outputs		
8	Number of weeks spent by UK project staff on project work in host country(s)	104
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (s)	
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	
11b	Number of papers published or accepted for publication elsewhere	
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country	
13a	Number of species reference collections established and handed over to host country(s)	
13b	Number of species reference collections enhanced and handed over to host country(s)	

Dissemination Outputs		
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	1
14b	Number of conferences/seminars/ workshops **attended** at which findings from Darwin project work will be presented/ disseminated.	1
15a	Number of national press releases or publicity articles in host country(s)	
15b	Number of local press releases or publicity articles in host country(s)	
15c	Number of national press releases or publicity articles in UK	
15d	Number of local press releases or publicity articles in UK	
16a	Number of issues of newsletters produced in the host country(s)	
16b	Estimated circulation of each newsletter in the host country(s)	
16c	Estimated circulation of each newsletter in the UK	
17a	Number of dissemination networks established	
17b	Number of dissemination networks enhanced or extended	
18a	Number of national TV programmes/features in host country(s)	
18b	Number of national TV programme/features in the UK	
18c	Number of local TV programme/features in host country	
18d	Number of local TV programme features in the UK	
19a	Number of national radio interviews/features in host country(s)	
19b	Number of national radio interviews/features in the UK	
19c	Number of local radio interviews/features in host country (s)	
19d	Number of local radio interviews/features in the UK	
Physical Outputs		
20	Estimated value (£s) of physical assets handed over to host country(s)	
21	Number of permanent educational/training/research facilities or organisation established	
22	Number of permanent field plots established	
23	Value of additional resources raised for project	

18. Appendix III: Publications

Provide full details of all publications and material that can be publicly accessed. Details will be recorded on the Darwin Monitoring Website Publications Database.

Mark (*) all publications and other material that you have included with this report

Type * ***(e.g. journal paper, book, manual, CD)***	**Detail** ***(e.g. title, authors, journal, year, pages)***	**Publishers** ***(name, city)***	**Available from** ***(e.g. contact address, email address, website)***	**Cost £**
Poster	La Vida en los Arrecifes de Coral – life on the coral reef.	Coral Cay Conservation, London.	Coral Cay Conservation, 125 High street Colliers Wood, London SW19 2JG	Free
Lectures and power points	Reef education in English and Spanish for teacher training workshops	Coral Cay Conservation, London.	Coral Cay Conservation, 125 High street Colliers Wood, London SW19 2JG	Free
Reef algal model (still in progress)		Coral Cay Conservation, London.	Coral Cay Conservation, 125 High street Colliers Wood, London SW19 2JG	Free
Reef ID digital Images and video		Coral Cay Conservation, London.	Coral Cay Conservation, 125 High street Colliers Wood, London SW19 2JG	Free
Progress Report	Coral Cay Conservation Project Bay Islands Summary report September – May 2004. *A quantitative summary of baseline surveys, Reef Check results and the community based environmental education program.*	Coral Cay Conservation, London.	Coral Cay Conservation, 125 High street Colliers Wood, London SW19 2JG	Free

19. Appendix IV: Darwin Contacts

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

Project Title	Regeneration rates of coral communities in Roatan, Honduras.
Ref. No.	162/11/017
UK Leader Details	
Name	Ryan Walker
Role within Darwin Project	UK project supervisor
Address	**Coral Cay Conservation** The Tower 13th Floor 125 High Street London, SW19 2JG
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	
Role within Darwin Project	
Address	
Phone	
Fax	
Email	
Partner 1	
Name	Enoc Burgos Bennett
Organisation	**Programa Manejo Ambiental Lslas de la Bahia**
Website address	
Role within Darwin Project	Coordinator of Natural Resources for PMAIB – main project partner
Address	Edifico Banffaa, French Harbour, Roatan, isles de la Baia, Hopnduras, CA.
Fax	
Email	
Partner 2 (if relevant)	
Name	Prof. Becky Myton
Organisation	**National Autonomous University of Honduras (UNAH)**
Role within Darwin Project	Head of Biology Department UNAH – from where most of the Darwin scholarship trainees are based.
Address	National Autonomous University of Honduras (UNAH) Biology Department Apartado Postal 2718 Tegucigalpa, Honduras
Fax	
Email	