



**Darwin Initiative
Annual Report**



The Effect of Macroalgal Overgrowth on the Growth Rate and Survival of Coral Recruits

Roatan, Honduras

May 2003

Darwin Initiative for the Survival of Species

Annual Report

1. Darwin Project Information

Project title	The effect of macroalgal overgrowth on the growth rate and survival of coral recruits (<i>Previously – Regeneration rates of coral communities in Roatan, Honduras</i>)
Country(ies)	<i>Honduras (Roatan)</i>
Contractor	<i>PMAIB (Programa Manejo Ambiental Islas de la Bahia)</i>
Project Reference No.	<i>162/11/017</i>
Grant Value	<i>£ 17,500</i>
Start/Finishing dates	<i>April 2002 for 2 years</i>
Reporting period	<i>April 2002-2003</i>

2. Project Background

The spatial dominance of benthic organisms on Caribbean Coral reefs has undergone a significant change over the last thirty years. Hard coral cover has declined dramatically with a corresponding increase in macroalgal dominance. This phenomenon has been reported Caribbean wide and been termed a “phase shift”. The cause of this phase shift has been much debated in the literature with anthropogenic impacts including over fishing, eutrophication and increased sedimentation proposed, in addition to “natural” phenomena such as an extinction event of urchins, coral disease and successive hurricanes. The perpetuation of phase shifts and the continuing dominance of macroalgae have raised the further questions as to whether the dominance of macroalgae is the result or the cause of coral decline and whether corals are able to effectively compete for space under the current ecological conditions on Caribbean reefs .

The importance of coral reefs and the biodiversity they support is undeniable, both from a socioeconomic and a biological standpoint. Phase shifts to macroalgal dominance may not only be 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 and the aesthetic attraction for tourism. Therefore key management questions are also concerned with what is perpetuating phase shifts and limiting the recovery of hard coral and how can management aid the reversal of macroalgal dominance?

Previous investigations have focused on the result of spatial competitions between adult coral and macroalgae and the external influences that affect these outcomes, such as herbivory or ambient nutrient concentrations. Few studies however have looked at the actual mechanisms of these interactions and have been limited mainly to anecdotal observations rather than experimental manipulation. 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 for settlement and for that space to be unoccupied for a period of time long enough for juvenile corals to become competitively viable against spatial competitors.

In algal dominated assemblages free space can be generated by disturbances such as herbivory and reduced by colonisation or lateral growth. The availability of free space may therefore be spatially constant over time as a proportion of overall area, but the location of that free space may be temporally variable. Consequently, ascertaining the proportion of algal cover and free space at discrete time intervals may yield consistent values for abundance, but will not determine whether the areas are in the same or different positions. For assessing the likelihood of successful coral recruitment to an area, knowing the duration that available space is free from competition and not just the total area at a given time is required. In addition knowing the likely outcomes of competition with macroalgae across different size classes of coral recruits enables a prediction to be made on the survival probability of coral recruits over time.

This study will investigate the mechanisms of macroalgal competition on coral recruits and their effect on the growth and survival of coral across a range size classes. In addition the spatial and temporal flux of benthic algal patches in the presence or absence of herbivory over timescales relevant to coral growth will be studied.

The results of these two parallel investigations may elucidate the limitations on coral recruitment caused by macroalgae and this information could then be incorporated into models on spatial dynamics of benthic assemblages and hard coral populations. From a reef management perspective this study may provide important insights into the role of herbivores in maintaining free space and the possibility of aiding coral reef regeneration through reef management strategies.

The fieldwork will be located at the Coral Cay Conservation project base on Roatán, Honduras and will be conducted continuously between the end of April 2003 and August 2004.

3. Project Objectives

To be able to examine the spatial and temporal patterns of algal patches and to monitor growth rates of juvenile corals, a sustained period of fieldwork is required. The ability to conduct the fieldwork of this study in one continuous period provides the research with an advantage rare in ecological studies, in that data can be collected at a small temporal resolution (days - weeks) but over a large temporal scale (months - years). However, due to the significant proportion of fieldwork involved, one initial aim for this study was to carefully plan the logistics of being in the field for that period of time and ensure that the experimental design was well structured prior to departure, with contingency plans discussed in case of unforeseen complications.

Objectives of the fieldwork

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

Aims of the study

- To incorporate the data on juvenile coral growth and survival into coral population models
- To use the data on algal patch dynamics to model the availability of free space on coral reefs
- To model the likely recruitment success of corals over time on algal dominated reefs and the impact of macro-herbivores on this process.
- To assess the management implications of the results in terms of strategies to promote coral recruitment.

4. Progress

- A full literature review of the subject area has been conducted with a paper currently in preparation on the mechanisms by which hard corals spatially compete and their structural and morphological limitations in competitions with algae.
- A preliminary trip to Honduras was made in February 2003 to look into the logistical considerations of conducting the research on Roatán. In addition, contacts were made with other individuals and groups working on, or concerned with, the coral reefs in the area and collaboration on field studies and the sharing of resources proposed.

These groups include:

- ◆ The Environmental Management Program of the Bay Islands (PMAIB), which is a government body
- ◆ The Institute of Marine Sciences on Roatán; A non governmental organisation

- ◆ The University of Honduras, which although based on the mainland has PhD students who conduct their research on Roatán.
 - ◆ The Native Bay Islanders Professional and Labourers Association (NABIPLA), another N.G.O
 - ◆ The commercial diving community
 - ◆ Local stakeholders and governing bodies
- Through the network of contacts made during the trip logistical assistance in the form of office and laboratory facilities has been agreed and in addition local knowledge and information on the reefs around Roatán and the environmental conditions which affect them has been provided. In return targeted lectures on general coral reef ecology and conservation will be given to interested parties and the progress of the research disseminated to organisations providing assistance.
 - A detailed methodology and study plan has been formulated for the field experiments in addition to a database template. All survey techniques were developed either from the standard operating procedure of the Australian Institute for Marine Science (AIMS) manual or from previous research methodologies in addition to information gathered from the preliminary trip.

These techniques include:

- Caging individual coral recruits and manipulating macroalgal abundance and direct contact with the coral within the cage,
- Placing permanent quadrats on specific algal patches growing on different substratum types and excluding macro-herbivores from some of these patches using exclusion cages
- Utilising underwater digital photography and specially designed image analysis software for monitoring coral growth rates and substratum cover
- Visual surveys of fish and urchin abundance

The cages were specially designed for this experiment using non-metallic materials (as metal ions may influence algal growth). All the cages will be manufactured at the project base using a combination of local and imported materials.

- The study was only initiated in December 2002 so no data have so far been collected. However the planning and review process is now complete and data collection will commence from May 2003.
- All of year 2 will be spent in Honduras conducting fieldwork. Once the experiments are set up each month will follow a similar schedule, outlined below:

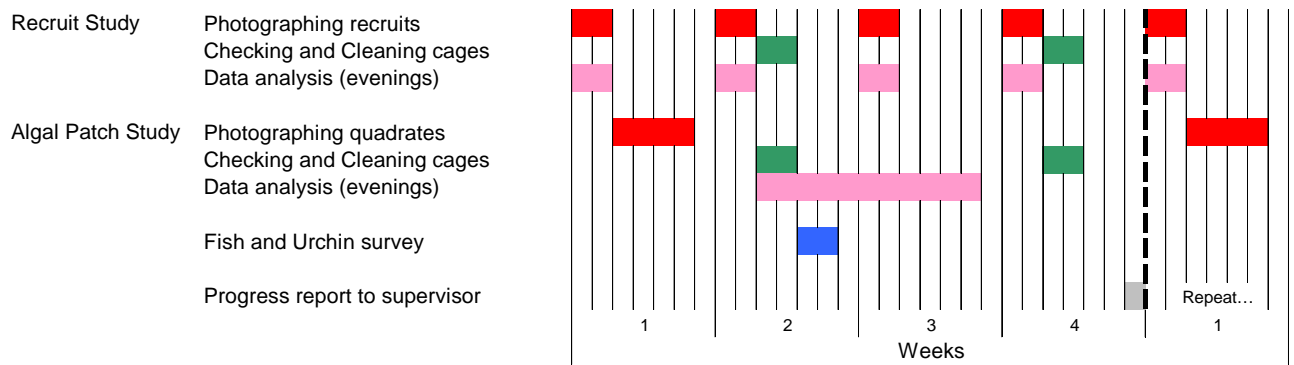


Figure 1. Proposed monthly schedule for fieldwork

- All the data collection will be conducted on SCUBA, the schedule is therefore designed to be flexible to take into account the variability in weather conditions and other factors that may influence the ability to dive.
- Although the data set will not be complete until the completion of the study, some of the experiments could produce interesting “stand alone” data within the first year. Therefore in year two of the study it may be feasible to submit for publication the first paper from this fieldwork.

5. Partnerships

- Important developments have occurred between Coral Cay Conservation and host country partners
 - The Bay Islands Conservation Association, CCC’s main project partner, has experienced severe financial difficulties in the last year. This has had a negative affect on its involvement with conservation matters on the island of Roatan.
 - In March 2003, CCC renewed its Memorandum of Agreement with PMAIB (Environmental Management of the Bay Islands), a governmental unit that forms part of the Ministry of Tourism. This MoA was signed by Prof. David Bellamy (CCC President) and Thierry de Pierrefeu (Minister of Tourism). PMAIB is currently CCC’s main project partner.
 - In the last few month, CCC has established strong links with NABIPLA (Native Bay Islanders Professional and Labourers Association). Members of CCC staff have given numerous presentations to members of NABIPLA, who represent various groups within the community. Shortly, CCC will be conducting a reef awareness workshop for tourist guides and taxi drivers on Roatan.
 - In March 2003, CCC re-launched its scholarship programme. Since 1998, CCC had offered numerous scholarships to students from the Universidad Nacional Autónoma de Honduras (UNAH). The March 2003 launch aimed at expanding the scholarship programme to a greater number of candidates. CCC’s scholarship awards are twofold:
 - CCC Reef Awareness Awards

Short scholarship courses providing training in SCUBA diving (to PADI Advanced Open Water certification) and general reef awareness and appreciation.

- CCC Reef Conservation Awards

Four-week intensive residential scholarship course providing SCUBA training and certification under the “CCC Skills Development Training Programme”.

These awards have recently been granted to students from UNAH, the Universidad Jose Cecilio del Valle and the Universidad Tecnologica (Tegucigalpa), the Bi-lingual School (Roatan), members of the local government in Roatan, PMAIB, BICA, NABIPLA and the local divemasters.

- CCC continues to run open days for young school children, including orientation courses in marine ecology, snorkelling trips and boat trips with an underwater viewer for less experienced swimmers.

6. Impact and Sustainability

- As the project has a strong scientific foundation, the interest it raises is only limited to a number of groups such as PMAIB and Honduran university students.
- However, a great amount of work is been conducted to promote the importance of coral reef conservation on a community level. Posters and leaflets have been produced and distributed in Roatan. The islands local community is a lot more aware of CCC’s presence and purpose.
- On a National level, university participation has increased significantly with the involvement of three universities in Tegucigalpa: UNAH, Universidad Jose Cecilio del Valle and UNITEC. CCC is also currently consolidating links with the first university in Roatan, which is about to open its doors to students.

7. Outputs, Outcomes and Dissemination

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

Code No.	Quantity	Description
1A	1	Steve Box (Project Leader)
4A	17	10 UNAH, 6 JCV, 1 UNITEC undergraduate students
4B	4	2 weeks training course followed by fieldwork
4C	1	1 postgraduate from UNAH
7	2	Poster (1) and leaflet (1)
8	52	Project Leader (52 weeks); Project scientist (8 weeks)
10	1	Synthesis of existing material to produce project identification guide.
12A	1	Database will be handed over to project partners, PMAIB
13A	1	Database and reference collection for juvenile corals
16A		Under revision
18C		Links with local television network (Channel 19) have been established for feature on the project
19C		Links with local radio station have been established for feature on the project

- In the original proposal, field work was set to commence in July 2002 with the previous three months used for project planning. By December 2003 all field work was meant to have been completed and counterpart training accomplished.

The funding for the first year of the project from the Darwin Initiative did not reach CCC until September 2002. This meant that the project could not be initiated following the original timetable.

- CCC decided to re-assign the study to Mr Steve Box, who was recruited in September 2002. Originally, much of the research was to be undertaken and co-ordinated by a number of CCC Project Scientists. The Project Scientist's term of employment with CCC is six months. We considered that Steve Box would be more suited to carry out this project over a two-year period and assure its continuity.

8. Project Expenditure

The initial delay in obtaining the money to progress with the project and the subsequent project partner difficulties has delayed the progress of the project during the first year. However CCC is now in a very good position to actively proceed.

All planning and project consolidation is complete and Stephen Box will be in Roatán from the end of April 2003 until August 2004.

The budget re-alignments that have been made to take into account the new project outline are detailed below along with the expenditure to date. The remaining budget for year one will be spent when the training program commences from May 2003, therefore the next installment of the Darwin grant (year 2) will be necessary as planned to facilitate the smooth implementation of the training and research schedule.

Table 3: Project expenditure during the reporting period

9. Monitoring, Evaluation and Lessons

See attached document

10. Author(s) / Date

Steve Box

Lucy Gallagher

21.05.2003