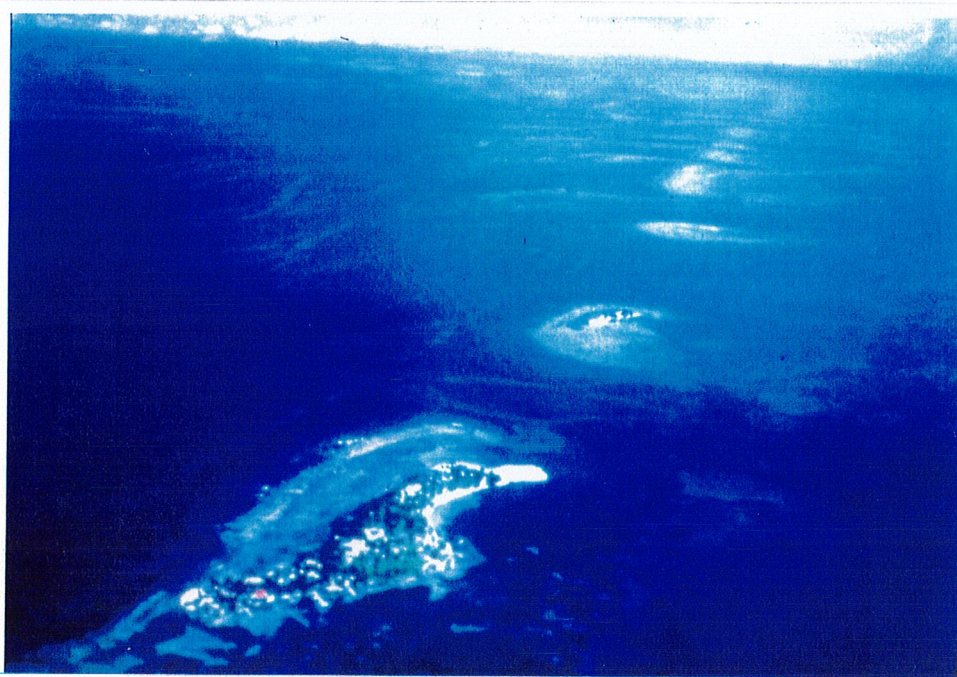


UNIVERSITY OF BRISTOL CORAL CAY EXPEDITION

Report on an expedition to Belize, Summer 1993.

BELIZE



Overview

What is the University Of Bristol Coral Cay Expedition 1993 (UBCCE'93)

Members:

Julian Thomas
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We, a group of four students from Bristol University, agreed to work as self funded volunteers, for and with Coral Cay Conservation (CCC, see below) on a scientific expedition between June and September 1993. All data collected by us during this time was to be made mutually accessible, and of a comparable format. After the period of the research on the islands we were due to travel on the mainland, through Belize and Guatemala, for a further two weeks, prior to returning home.

What is Coral Cay Conservation?

Coral Cay Conservation is an independent company set up in response to a request by the Belizian government. It's purpose being to organise and co-ordinate a long running scientific examination of the Belize Barrier Reef, using volunteers from the UK and Belize. Training forms an integral part of the work of CCC, not only for the expedition volunteers, but also through a scholarship scheme with the University of Belize. As a net result of the work of Coral Cay, the public awareness of the natural environment in Belize has increased dramatically, allowing wide ranging conservation measures to be undertaken by the government of Belize, and by CCC itself. These include the establishment of three major marine nature reserves, on the areas surveyed by CCC, and the production of numerous habitat reserves on the mainland itself.

In 1992 CCC won the 'International Maritime Environmental Award' from the World Underwater Federation, and at the time of writing they have just been approved for an award from the Darwin Initiative for the protection of species. CCC has also recently received Charitable status.

Introduction

"Coral reefs are very important, not just as an underwater tropical rain forest but as a habitat for a vast number of plants and animals.....(These) work together, removing carbon dioxide from the environment and releasing oxygen into the atmosphere.....Coral Cay Conservation expeditions are putting a finger on the pulse of coral reef management in Belize."

David Bellamy, President of CCC.

With the increase in tourism development, the need to expand the fisheries base, the expansion of coastal agriculture and the growth in navigational use, to name just a few activities, it is clear that the coastal zone of Belize is under pressure from competing uses. A plan is therefore critical to accommodate the various uses and to ensure the steady progress of development in a sustainable manner, whilst preserving the biodiversity of the coastal and marine region.

Purpose of the expedition:

- 1) To undertake surveys on the Belize Barrier Reef that will provide baseline data for the classification of remote sensed images of the Sapodilla Cays and a basis for management plans for the sustainable use of its resources.
- 2) To assess the accuracy and precision of data collected by inexperienced volunteers. This allows us to alter the survey techniques for future use, and included an assessment of the accuracy of species identification, the use of abundance scales, inter-surveyor variations and temporal changes of accuracy associated with increased surveyor experience.

Throughout July of 1993 we successfully surveyed 47 separate transects of the barrier reef system at the Sapodilla Cays. These surveys included a topographical representation of the sea bed, and an assessment of the relative abundance of all of the major reef species.

The precision of the volunteer's abundance ratings was tested in August by randomly selecting pairs of survey forms of fixed transects dived repeatedly over a period of three weeks and performing a rank correlation on them. The correlation results were highly significant and of moderate strength (>0.60), indicating a high level of accuracy in the data recorded.

Belize

The Geography:

Belize, formerly British Honduras, is a recently independent nation within the British Commonwealth. It has an area of 22,963 km², bordered in the north by Mexico, in the west by Guatemala and in the east by the Caribbean sea. A well developed barrier reef system lies a few km out from the coast, stretching 257 km from the Sapodilla Cays in the south to the Mexican border in the north. There is a map showing the arrangement of the Cays around Belize on Figure 1. Hunting Cay, where we were during the first month of the expedition is situated on the furthest southern tip of the Sapodilla Cays, whilst South Water Cay is situated between Tobacco Cay and Carrie Bow Cay, out from the South Shelf Lagoon.

Mangrove swamps border the majority of the mainland, protection it from erosion from tropical storms and hurricanes. Between the mainland and the Cays is a stretch of shallow, calm waters forming the lagoon. The lagoon is itself protected by the reef system and the series of Cays formed there. At several sites along the coast and in the lagoon are small patches of very deep water (up to 100 meters in some places, as compared to the 20 meter depth of the lagoon). These sites are the blue holes, formed by fresh water erosion during geological periods of seas level change. Now flooded, they provide major wildlife refuges, and as tourist attractions they are not only a source of income, but also a potential source of environmental damage.

The actual profile of the reef system as it rises up to the Cays is shown on Figure 2. The outer drop off is the furthest point of the reef, and in some places it descends down to 4000m in the Caribbean trench. Deposits of dead coral have built up over centuries at the top of the trench wall. This has resulted in the formation of the ridge, separating the inner and outer drop-off. This declines to the debris filled sand gully. There is a steady slope up from this to the reef crest, the highest point on the reef (which at some points can be permanently above water). This slope forms the outer and inner fore reef. The highest point of the reef itself is the reef crest, and from this the shallow back reef leads up to the Cay, or island.

The Climate.

The dry season runs from March to the end of May and can lead to severe water shortage on the Cays. The rainy season runs from June to October, during which time the coast is exposed to some of the worst of the Caribbean hurricanes and tropical storms. Annual rainfall rarely exceeds 1780mm and winds are from the east for most of the year. Tides are rarely more than 0.3m over the coral atolls, but may reach 0.6m in the lagoon and along the mainland. This can create strong water currents between the reef islands, and helps refresh the calm waters of the lagoon. The characteristics of the water vary seasonally in response to changes in the climate (for example increases in temperature, and decreased rainfall can increase the concentrations of solutes and salts in the water). In general, however, the fluctuations are only slight, and the water temperature and

salinity remain relatively constant year round (usually around 25-29°C and 36ppt respectively). These conditions are ideal for coral growth, and combined with the clear waters (filtered through the mangrove systems), high levels of sunlight (ideal for symbiotic algae), high water temperature, high mineral concentrations, a constant supply of well oxygenated water and a firm substrate at less than 20m depth, make the coast of Belize ideal to support a high diversity reef system.

Figure 1: Reefs and Cays of the Belize Barrier Reef.

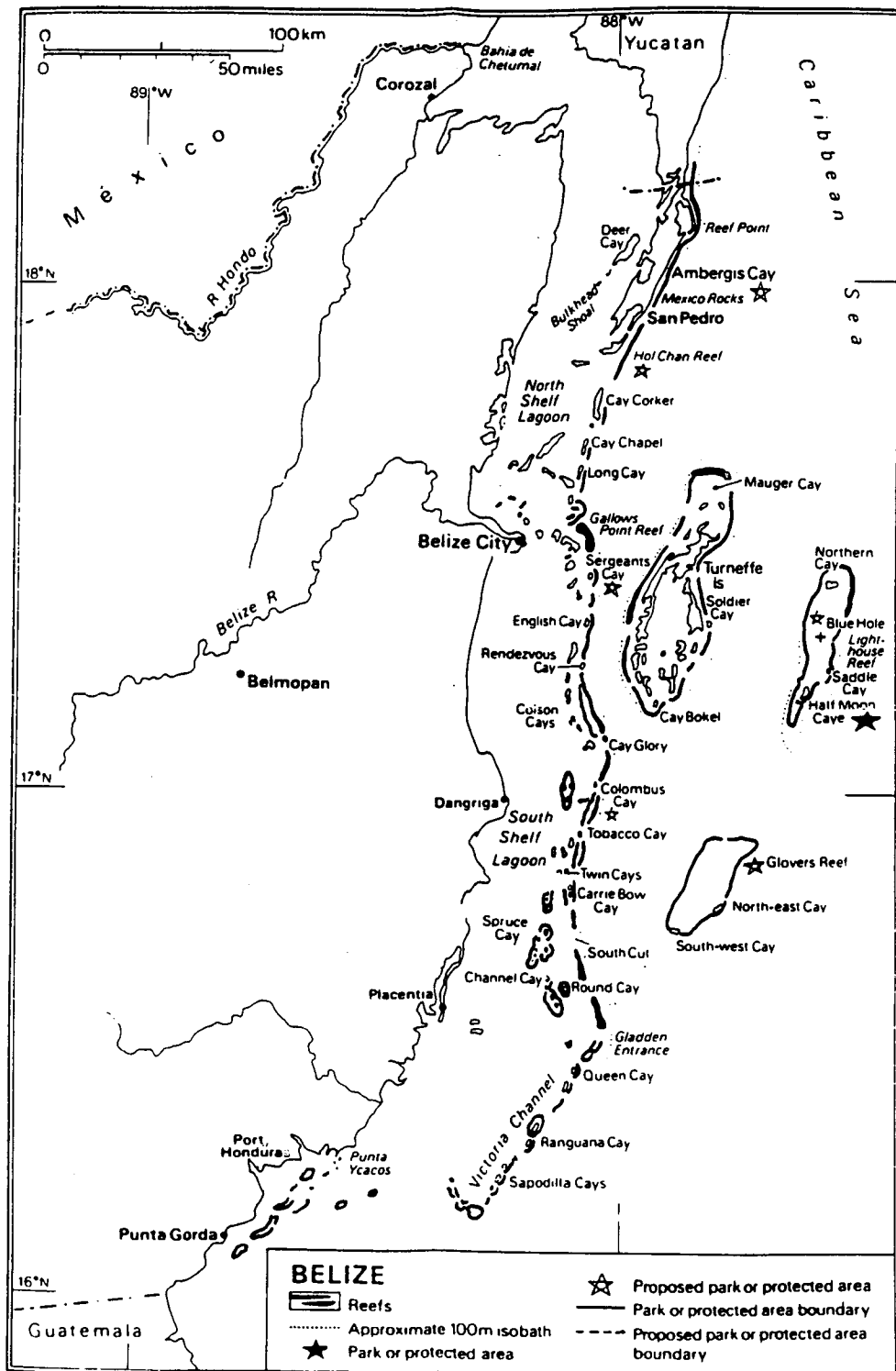
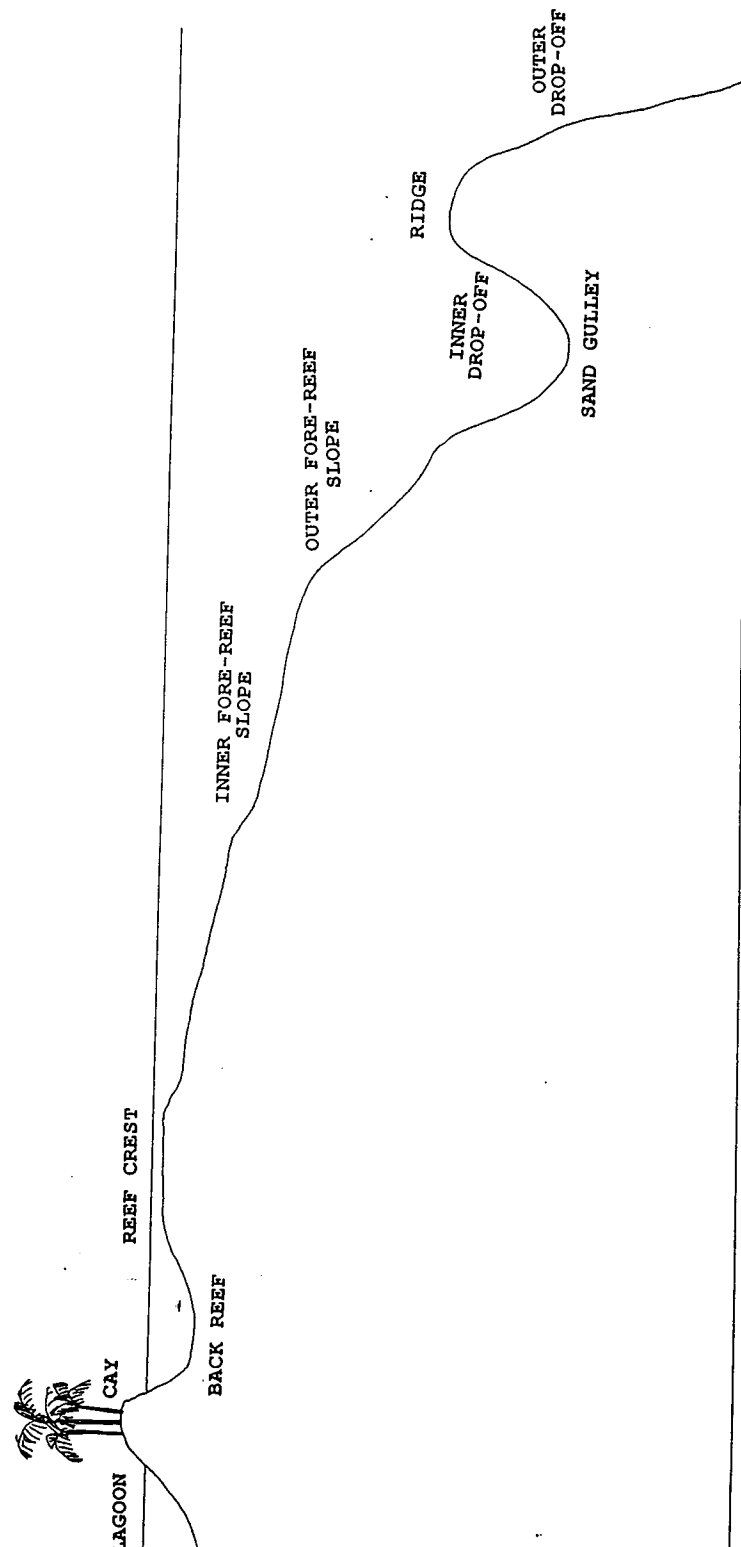


Figure 2: Generalised reef profile plus area terminology.



Environmental Dangers to the Reef:

1. Fisheries.

There is a long history of reef use by the people of Belize; It is known that Maya Indians used the Cays between 300BC and 900AD and today the reef ecosystem is extremely important to the well-being of the fishing industry although the economic potential of the reef resources has yet to be fully realised. Fishing is the only industry totally owned and managed by Belizians. A system of co-operatives was set up in the 1960's and by 1985 they employed 700 fisherman with 450 boats. Spiny lobster, conch, grouper and snapper are the main catches with lobster accounting for 60-70% of the value of all fisheries exports. There is one small scale aquarium fish collector who operates in the mid-northern section of the barrier reef, under licence from the Fisheries Department.

2. Tourism:

There is a growing tourist industry in Belize, based mainly on Ambergris Cay in the north. It is, however, rapidly spreading southwards, attracted by the pristine condition of the reef and palm covered Cays found there. The government of Belize is very aware of the need to establish firm management plans for the protection of the reef system. The government, in association with the Belize Audobon Society and the Belize Centre for Environmental Studies has already established the Hol Chan Marine Reserve and the Half Moon Cay Natural Monument as marine nature reserves, however, more has to be done. It is recognised that baseline studies must be carried out and similar reserves established in the southern part of the reef prior to the establishment of tourism in this region. Funds however are extremely limited and the government must rely on volunteers like ourselves working in conjunction with organisations such as Coral Cay Conservation to undertake such work.

3. Water Quality:

Coral reefs need clear water to survive. Corals (there are 49 species of Scleractinian fauna known in the Belizian waters, 39 of which are Hermatypic or reef building) feed by filtering particulate matter from the water, and also obtain some nourishment in the form of solutes provided by symbiotic algae living within their bodies. The algae require sunlight to survive, and this requires clear water. The run-off from the mainland Belize is typically a dark colour, and is rich in nutrients and silt. Before this water reaches the reef it is filtered by a series of mangrove swamps, first at the land-sea interface, and second at a series of mangrove Cays between the lagoon and the sand Cays. These mangroves also act as nursery grounds for some of the reef dwelling fish. Continual exploitation of the coastline and mangrove forests by man removes this filtering mechanism and results in the total destruction of the ecosystem.

4. Endangered Species:

Loggerhead *Caretta caretta*, Hawksbill *Eretmochelys imbricata* and Green Turtles *Chelonia mydas* nest on offshore cays and along the shoreline of southern Belize. Mans presence seems primarily responsible for the absence of turtles from suitable nesting beaches in the north, and mans invasion into the south may spread this problem. Numerous species of sharks, including the Hammerhead, Bull, and Nurse sharks, once common in the waters of Belize are now in danger from sport fishing, scare hunting, and indiscriminate netting. Similar fate awaits the many dolphin species, notably *Tursiops truncatus*, *Stenella plagiodon* and *Steno bradanensis* which are still relatively common in the coastal waters. The Caribbean Manatee *Trichechus manatus* is found along the shore and on some offshore Cays, though it is at risk from collisions with passing boat traffic. The American Crocodile *Crocodyles acutus* and possibly Morolet's Crocodile *C. Moreletti* occur on some parts of the coast and on offshore Cays, especially in areas with protected lagoons. Despite government legislation, their numbers are still diminishing at an increasing rate due to hunting. Many seabirds nest in Belize including the Magnificent Frigate bird *Fregata magnificens*, Red-footed Booby *Sula sula*, Brown Pelican *Pelecanus occidentalis*, Sooty Tern *Sterna fuscata* and Brown Noddy *Anous stolidus*.

What is being done about this?

The barrier reef has received the concentrated attention of scientists only within the past two decades. The first investigations focusing on the Cays and reefs were undertaken by a Cambridge Expedition in 1959-1960, when 40 Cays were mapped and the reefs described. Subsequent studies treated a wide variety of subjects. In 1972 the Smithsonian institute established a field laboratory at Carrie Bow Cay and since then most work has concentrated on this area. South Water Cay at the southern tip of Tobacco Reef, 2km North of Carrie Bow Cay, is a site used for teaching and research by the Smithsonian Institution and has been the site used by Coral Cay Conservation as a centre for conservation operations in Belize from 1990.

Coral Cay Conservation:

Coral Cay Conservation (CCC) is staffed by six full time employees, but is otherwise run entirely by volunteers. CCC have the scientific resources and expertise to provide the governments of developing countries such as Belize with data to assist in important management plans for the countries marine resources. Each year a multinational workforce of over 300 volunteers carry out underwater surveys of the unique marine resources in Belize to obtain baseline information in preparation for the establishment of proposed marine reserves.

Since 1990, CCC has been undertaking comprehensive surveys of the marine resources in a 180km² area surrounding South Water Cay. This area has the potential for attracting large

numbers of tourists in the near future and has been recommended as the site for one of Belize's largest marine reserves. The area encompasses a range of marine habitats including sand and mangrove Cays. Seagrass beds, patch reefs, and expansive sections of uninterrupted barrier reef found in this area are representative of the whole barrier reef system. Initial surveys of the marine resources within the proposed boundaries of the South Water Cay Marine Reserve are complete, and the Coastal Zone Management Unit has asked CCC to extend these surveys to encompass a further 300km² area of reefs and lagoons immediately south of the proposed boundaries.

CCC has also assisted with surveys of marine resources at other locations within the geographical range of the Belize reef, including those surrounding Laughing Bird Cay and the Sapodilla Cays. These are areas under severe threat from tourist related activities, and are already showing signs of degradation. In 1991, CCC undertook preliminary surveys in both locations, and since January 1992 has sent teams of researchers to Hunting Cay to continue surveys in this area. The government of Belize is anxious that these studies be carried out and have agreed to continue working with Coral Cay Conservation in other parts of the Belize Reef now that management plans for the reserves at South Water Cay and the Sapodilla Cays have been drafted.

UBCCE'93:

In September of 1992 a group of four biology students from Bristol University approached Coral Cay Conservation to offer their services on the July/August 1993 expedition to Belize. Like other university groups we were recognised as having a background in biological sciences and sport diving that would play a valuable part in the expedition.

The existence of CCC is important for biologists with an interest in marine studies since the logistics of organising an underwater scientific expedition in a foreign country are extremely complex and the funds hard to raise. We were thus able to gain first class experience in marine survey techniques using up to date equipment under the guidance of highly experienced marine scientists without the fear of the whole expedition collapsing due to a last minute technical or political hitch. We have consequently gained confidence and knowledge that will enable us to contribute to marine conservation in the future.

Working with teams of other volunteer divers under the guidance of qualified marine scientists we undertook surveys of areas of the Belize Barrier Reef (notably the Sapodilla Cays) that have been identified as "critical habitats" by the Belize Centre for Environmental Studies, with the aim of providing data upon which coherent resource management plans can be structured. Thanks to the expertise and guidance given to us by CCC the expedition ran very smoothly and much was achieved.

UBCCE'93. expedition members:Alexandra Lord

BSc (hons) zoology. Joint president of BIOSOC (with Julian). PADI (Professional Association of Diving Instructors) Advanced Open Water Diver, and a BSAC (British Sub-Aqua Club) Diveleader. Alex logged about eighty dives and "an incredible tan" during this expedition. She is famous for being able to produce 101 amazing culinary delights from a tin of spam, a bottle of worcester sauce and some onions.

Elizabeth Cook

BSc (hons) zoology. Secretary of BIOSOC, vice-president of the university sub-aqua club, BSAC Diveleader and RYA Level 2 Boat handler. Liz scored higher than everyone else on the marine identification tests we were given and was a subject of much discussion among the young men of the British Forces after saying "I'll do anything for a jar of marmite".

Julian Thomas

BSc (hons) zoology. Joint president of BIOSOC (with Alex). A PADI qualified Advanced Open Water Diver, RYA Level 2 Boat handler and BSAC Diveleader. He is an active member of the WWF and the expeditions society. A self confessed poseur Julian enjoyed pushing the Coral Cay boats to their limits for that extra "pose factor", with the essential "Biker-Chick" at the helm. He is famous for never smiling when *posing* for a photograph.

Simon Williams

BSc (hons) zoology. A BSAC Diveleader and RYA Level 2 Boat handler. Never one to let a bit of wind foul the atmosphere, Simon was made "entertainment's officer" for those days when the weather was too bad to dive (Generally indicated by the horizontally flying palm trees). His "spectacular" and generally disastrous wind surfing antics were legendary, drawing an audience even from the local fishermen.

Survey Techniques

Methods

Baseline biological studies are imperative to preparing well-informed management initiatives. The baseline data is gathered by identifying biological habitats and describing them in terms of topography and species present. Survey methods are based on those recommended by the Marine Nature Conservation Review Team (MNCR) of the Joint Nature Conservation Committee. The MNCR was established in 1987 to survey the entire British coast for conservation purposes and their techniques have been carefully refined to collect data in an accurate and consistent manner. Modification of the technique to suit a tropical environment have been made by CCC and have been validated for accuracy and precision during our expedition (Mumby 1993).

MNCR surveys fall into three phases which are hierarchical in the quantity of data collected and the level of scientific expertise required by the surveyor:

Phase 1: These surveys provide general information on the location and extent of major physical and biological characteristics and can be undertaken by non-specialist volunteers under the supervision of a marine biologist.

Phase 2: These surveys are undertaken to describe the range of habitats and communities of conspicuous species. Phase 2 surveys are more detailed than phase one surveys and therefore a smaller area is covered. The work is carried out by experienced surveyors who have a knowledge of the species likely to be encountered in a particular area and will identify subtle differences in community structure within habitats. Abundance scales of 0-5 are used in such surveys.

Phase 3: These surveys are yet more detailed, and are normally carried out for particular habitats in areas established as marine reserves. Surveys of this kind attempt to give an exact numeric value for species abundance.

CCC aimed to survey the marine environment of the Belize Barrier Reef using volunteers, most of whom have limited marine biological experience. Thus surveys were designed to encompass phases 1 and 2 accepting that volunteers would have to be trained prior to undertaking survey work.

Survey teams consisted of four divers. One to carry out a physical assessment (mapping), one to record fish, one to record corals and sponges, and one to record algae and other invertebrates. In addition the fish recorder takes representative photographs of the habitat surveyed.

Data is recorded on specially designed survey forms. A 'physical recording form' is used to map the site and a 'biological recording form' contains a species list that also allows the surveyor to enter an abundance rating per species. To ensure consistency and standardisation, data was collected on standard recording forms developed by CCC. This is essential to ensure that data can be easily analysed both spatially and temporally.

Training programme.

In order to effectively use the CCC marine survey methods (CCCMSM) all of us had to undergo a comprehensive training course in marine life identification and marine survey skills. The course syllabus includes:

1. Identification of marine organisms: fish, corals and other marine invertebrates, mangroves, seagrass and algae;
2. Training in marine survey techniques: assessment of biological cover and topographical features, fish census surveys;
3. Aspects of relevant ecological issues :species interactions; taxonomy; classification; physiology.
4. Consideration of current coastal zone management issues and practises: requirements for an integrated approach, importance of coastal habitats, baseline- and resource-mapping (including use of Global Positioning Systems GPS. and Global Information Systems GIS.), buffer zone management.

The course is designed to run over a seven day period with an optional eighth day to cover more advanced aspects of coastal zone ecology and management.

Barrier reef surveys.

On the Sapodilla Cays surveys were conducted at intervals of 500m starting at Seal Cay and working eastwards back towards Ragged Cay, then north towards Hunting Cay. Each survey was planned beforehand and its starting position was designated by its latitude and longitude. The coxswain used these positions to take the divers to the site (using the onboard GPS to navigate to within an accuracy of a few meters). The boat used for surveys on our expedition was an 8 metre skiff powered by twin 40hp Yamaha outboards (called Boat 1).

On the outer drop-off a depth of thirty metres was found using a hand held depth meter. Because of the remoteness of these expeditions thirty metres was considered the maximum working depth for surveys. Maximum working dive times were limited according to the depth and

were worked out from BSAC 1988 decompression tables to give a very large safety margin. A safety stop of three minutes at six metres was compulsory for every dive carried out. This was standard practise throughout the expedition and was designed to eliminate the risks of decompression sickness that might occur as a result of diving twice a day, six days in every week. (The nearest decompression chamber was in Miami). The dive profiles for survey dives are summarised in table 1.

Table 1: Examples of dive profiles used on the surveys.

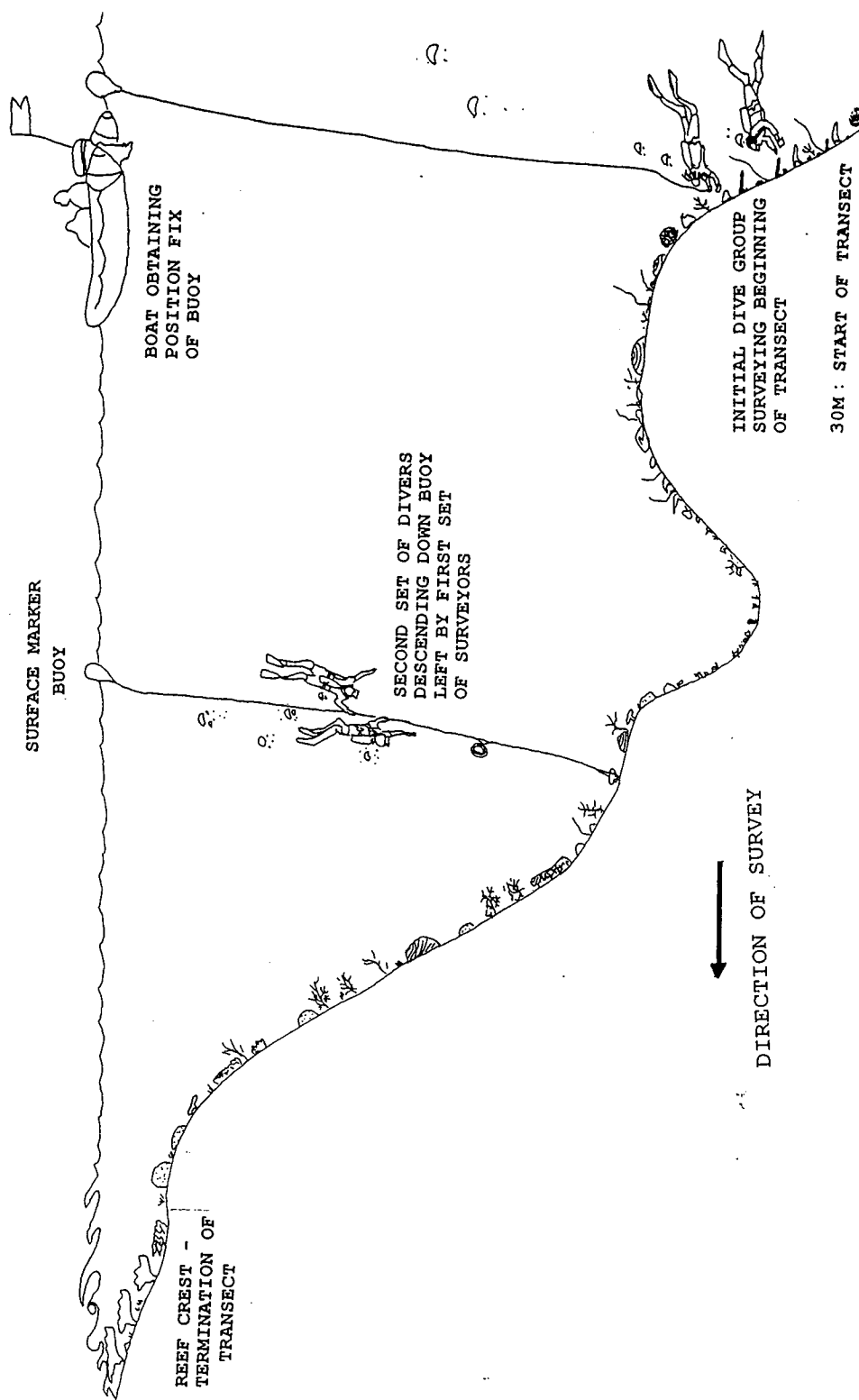
Depth (M)	Dive time (Min)	Stop time (Mins at 6M).	Time to surface	Total time
10	27	3	1	31
12	27	3	1	31
15	27	3	1	31
18	27	3	1	31
21	27	3	1	31
24	26	3	1	30
27	24	3	1	28
30	17	3	1	21

Note: This table assumes that this is the first dive of the day, and that there is no excess residual nitrogen in the body from dives made in the previous day.

At the start of the transect divers were put into the sea. The divers carried with them a brightly coloured buoy attached to thirty plus metres of rope. This, as well as acting as a surface marker buoy (SMB) throughout the dive, allowed the coxswain to take a GPS fix on the start of the survey. The divers indicated this by pulling the buoy hard three times with the rope at the start and pausing long enough for a fix to be made. Divers then proceed along a pre-arranged compass bearing carrying out the survey as they go. At the end of the dive time the buoy was tied to a piece of dead coral or rock, the line laying vertical, and the position of the buoy fixed once the divers had ascended.

The next set of divers continue the transect taking the buoy with them and continuing as before. This continues until the water becomes too shallow to survey without causing harm to the coral. Thus position fixes could not be taken for the final position of many transects. This survey technique can be summarised in the diagram on Figure 3, which shows the dive survey from the beginning of the transect at 30m, to the end at the reef crest.

Figure 3: Methods employed in diving surveys.



During the dive, certain tasks were completed:

- a) **Physical collection:** This includes data regarding topography, site impression, depths and distances etc. A measure of environmental degradation (coral damage, litter etc.) was also recorded.
- b) **Biological data collection:** this included more detailed data on each site, substratum cover and abundance at species level of the most easily identifiable organisms including corals, micro algae, fish and larger invertebrates.
- c) **Photography and Fish identification:** On each of the survey dives one member of the group was responsible for taking survey photos. The photographs taken were on standard 35mm film using a Nikonos V camera with standard lens. Shots consisted of panoramic views of the immediate area in front of the survey team, in the direction of travel. One or two shots were taken as representation of each habitat. The frame numbers and a brief description of each frame were recorded on the physical form. Photography is intended to accompany the biological and physical forms as a useful tool in clarifying the surveys. The photographer also surveyed the major fish species present.

Each transect was divided up into habitats at the discretion of the divers involved, who would communicate with each other underwater in deciding this. For instance, if a dive traversed a dense coral reef, a sand gully and a gently sloping seagrass bed, three habitats would be recorded, each one treated as a different site. (Sometimes communication would break-down underwater leading to much heated discussion on land!!). On returning to base camp, the data collected was recorded onto survey forms: 1 physical form per dive and 1 biological form per habitat.

The use of global positioning systems (GPS) in the surveys.

A crucial element of the survey work carried out is the accurate determination of transect co-ordinates or 'position fixes'. Before the GPS systems became readily available, positions were fixed using a compass, generating a position by triangulation between visible reference points. The use of GPS systems has eliminated much inaccuracy inherent in this method. On this expedition we had the use of Raystar GPS systems.

GPS involves the use of a receiver fixed to the boat that communicates with satellites orbiting 10,900 nautical miles above the earth. The receiver uses the position of the satellites overhead to establish its own position. There are usually at least four satellites overhead, and this is the minimum recommended requirement for accurate positioning to be undertaken. The US Department of Defence purposely reduces the accuracy of the system (to prevent others using it during war) by adding extra 'noise' to the commercially available code. In addition the 'noise' quality, the position fix varies according to the relevant position of the satellites. An indication of

this 'satellite status' is given by the Horizontal Dilution of Precision (HDOP), and this was recorded on all surveys according to a scale of 1 to >3 (1 being very good). Our surveys were abandoned (or usually postponed) if the HDOP reading was less than 2.

Work carried out previously has tested the accuracy of the systems used, concluding that, with a 95% confidence interval, the mean position fix lies within an area of radius 5-25m (Mumby 1992). To gain a very accurate position fix, a differential GPS system, which refers to a permanently fixed land based GPS can be used. This records any variation between the boat and land based readings, then adjusts the readings accordingly. Using this method an accuracy of 0.5m can be obtained, but this system was not available for use during our expedition period.

Data processing.

Information in the field is transferred to the fisheries department in Belize where it is incorporated into a Geographical Information System (GIS) computer database specifically designed to handle this type of data. With this database the abundance and distribution of any species or assemblage of species, can be ascertained along with any physical parameter, such as depth limits or substratum type.

With GIS baseline information can be processed to the stage where, with the socio-economic factors taken into consideration, a zoning rationale can be devised by the Belizean Coastal Zone Management Unit. Using the results from their surveys around South Water Cay CCC has drafted a management plan for the proposed marine reserve, as indicated on the map of the proposed South Water Cay Marine Reserve.

The data set for the area around South Water Cay has been used to complete the first two stages of the management plan (i.e. description and evaluation of the marine resources). Descriptions, distributions and evaluation of the key community species of both the flora and fauna have been made along with community classification. Initial signs of natural and human induced impacts have also been ascertained. The management plan for the area of the Sapodilla Cays surveyed during July is currently being drafted by CCC in their London office.

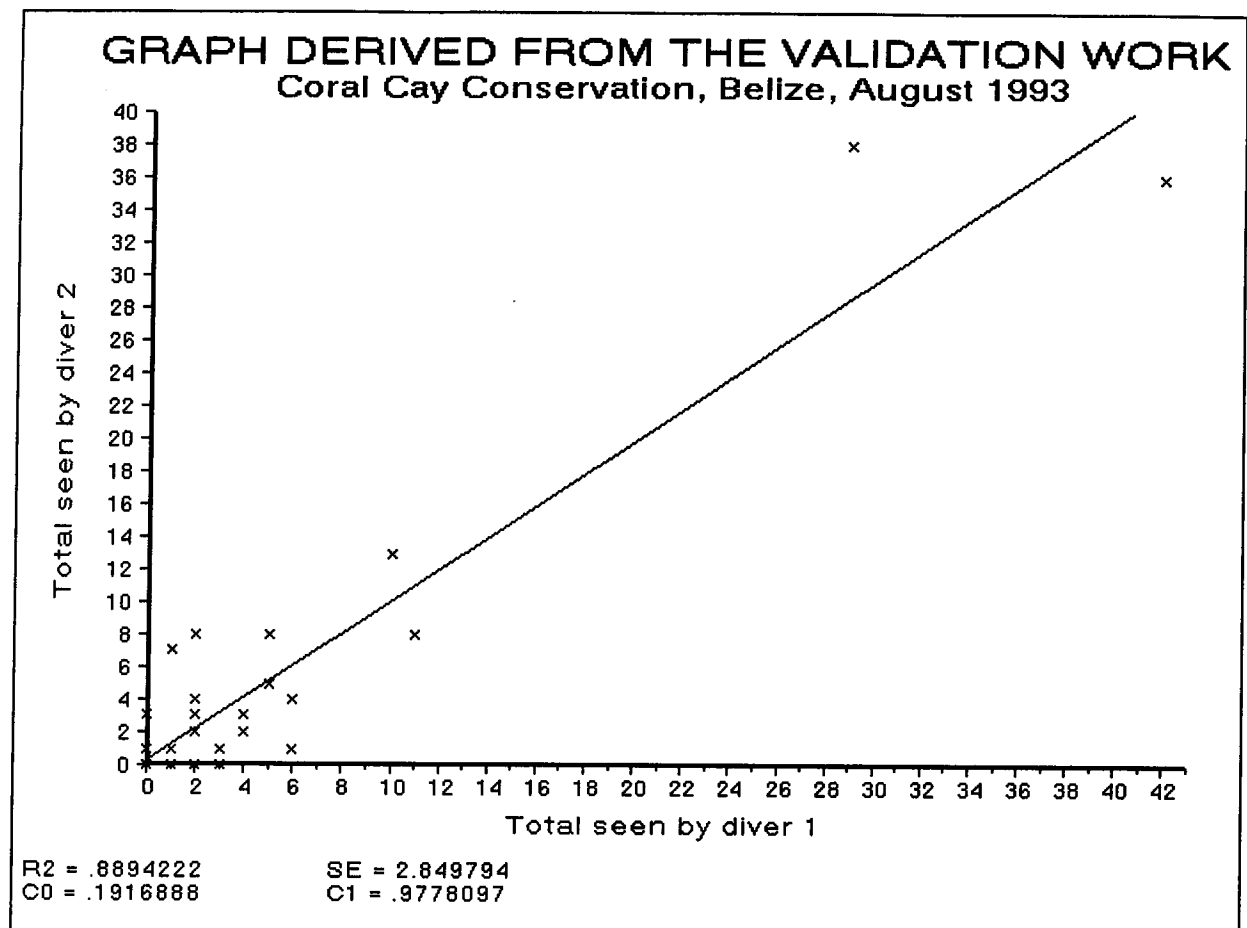
Validation assessment.

An accurate species inventory forms the basis on which a site can be assessed for its conservation status or importance. Not only will a species inventory reveal the presence (or lack) of rare or commercial species, it will also qualitatively describe the biological community and make for a fundamental measurement of biodiversity.

During our stay at South Water Cay a detailed programme of assessment was undertaken to estimate the accuracy of species identification, the correct use of abundance scales, inter-surveyor variation and temporal changes in accuracy associated with increased fish survey experience over time.

A series of 100m transect lines were laid in a north-south direction on the barrier reef east of South Water Cay. A team of three divers, each covering a different group of reef fish (Bottom dwellers, Mid-ocean pelagic, others), swam along the 100m transect and counted each individual of each species of fish in their group that they came across within 5m either side of the line. Each diving group repeated the survey several times and thus ended up with several sets of 'identical' surveys, which could be analysed for variations. The results were filled in on a fish survey form especially compiled by CCC and all the results were then down loaded into a computer where a regression analysis was used to compare consistency within and between groups of divers. Results (Figure 4) show that the correlation between divers is highly significant and of 'moderate strength' (i.e. there is a strong similarity in the results obtained between surveyors, and with the same surveyor over time). The validation report was presented by Pete Mumby, the scientific co-ordinator of CCC, at the First European meeting of the Society for Reef studies in Vienna, December 16th-20th 1993.

Figure 4: Results of the Validation Survey.



The Expedition

Our expedition left London on June 25th 1993 and landed in Belize city on June 28th after an overnight stay in Houston, Texas. We rendezvoused with other volunteers at Gatwick London and in Belize City. There were about thirty volunteers overall since working groups of divers were to be located at two different islands in the Cays (Hunting and Southwater Cays). In Belize City we also met our expedition leader, Mr Tony Read. Tony, a retired builder, is a PADI diving instructor with many years experience at the Adventure Divers Dive Centre in North London. He was appointed by CCC on account of his management experience and, due to the success of the Summer 1993 expedition, has since been employed as a full time member of staff for CCC. Our first day and night in Belize City gave us a chance to acclimatise to the tropical heat, to look around Belize City and get some sleep before catching the early morning bus to Dangriga in the south where we were to meet the boats that would take us to South Water Cay.

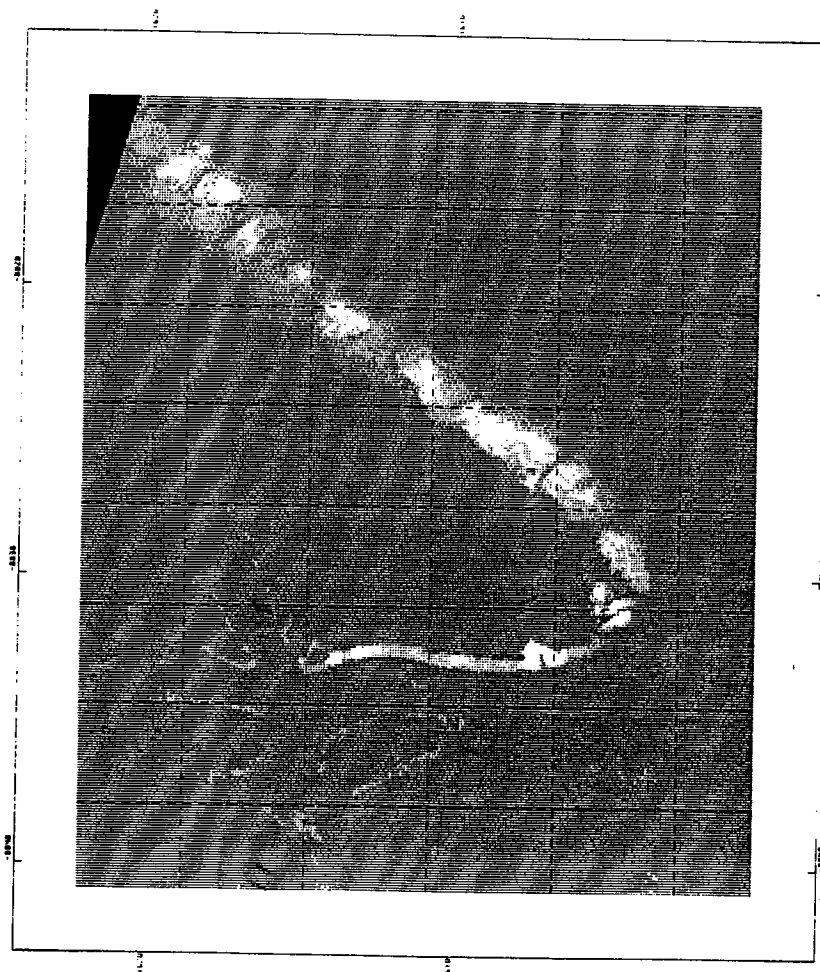
The move from South Water Cay to The Sapodillas.

The next day in Dangriga we met up with Pete Mumby scientific co-ordinator for CCC and John Whitworth, our leader to be on the satellite expedition to Hunting Cay. We then made a boat crossing out to the Cays. The prevailing easterlies at this time of year are very strong and the short steep waves encountered in the lagoon made for a very bumpy crossing and soaked everything through. We soon arrived at Southwater Cay. Southwater Cay (SWC) is a very pretty island about two thirds of a kilometre long and about a hundred metres across at its widest point. Once covered in mangrove like many islands it is now planted with coconut palms. The northern end of the island is the site of much development by hotels. Accommodation for the tourist here is very expensive. Cutting down the mangroves on the northern end of the island has led to erosion which has washed the beaches away (and potentially driven the tourists away too). CCC were based on the southern third of the island, in an old hut 'The Nuns Retreat'. The big white wooden building was indeed once a nuns retreat, but they kicked the habit and it is now leased from the owners (Pelican Beech Resort) by CCC. The mangroves here are fully grown providing much shelter for wildlife. Toilets are of the composting variety (*Clivus Multrum*!) which makes good sense since waste can eventually be dug out and burnt with minimal risk of fouling the air (or health {or environment}). Our first night on the island was spent on the floor of the dining room. The next morning we were given food, and were briefed on what to expect of the forthcoming expedition to the Sapodilla Cays (the Southernmost point of the reef system). Some of us couldn't resist a snorkel on the patch reef at the southern end of the island and we got our first taste of the remarkable diversity of Caribbean reef fauna.

Our next move was to get ourselves to Hunting Cay (Figures 5 and 6) where we were to survey and set up camp for a series of future working parties due to move in the months after we had left. This was a logistic nightmare. The amount of gear we had to load up and take down was phenomenal and the boats we had at our disposal were rather small. We decided to charter a local boat that would allow us to transfer enough fuel and supplies along with our camping and diving equipment down to the Sapodillas. We were recommended a boat called the *Dolce II*. The boat was fine, but the American skipper was far from being a reasonable chap. He was in fact a bit of a Hemingway "boats, beer and wife beating" character who, it seemed, would sooner fight than talk,

and his not at all charming wife seemed always keen to accompany him. They vented all their frustration upon us (verbally) when they smashed their prop on trying to approach our dock on South Water Cay, and when the weather delayed our activities for a few days (the wind blew harder than ever) the skipper blamed *us* for costing him work. After sleeping on the floor of the house for four nights and managing a few dives on sheltered parts of the reef, we eventually got the all clear from the weather and we motored our dive boats down through the lagoon. The *Dolce II* on the other hand took a route for a boat with a deeper keel and met us there. On our arrival we saw the *Dolce II* moored on the western side of the island. To our utter disbelief the skipper and his wife were in the process of dumping all our kit into the sea!! Luckily for us the marines that were stationed on the island had deployed a boat to pick everything up and take it to the shore. Fortunately nothing was damaged (except our impression of American ex-patriots). We were not unhappy to bid farewell to the *Dolce II*. Two months later we saw her again, stuck on a sand bank in Belize City. How we cheered.

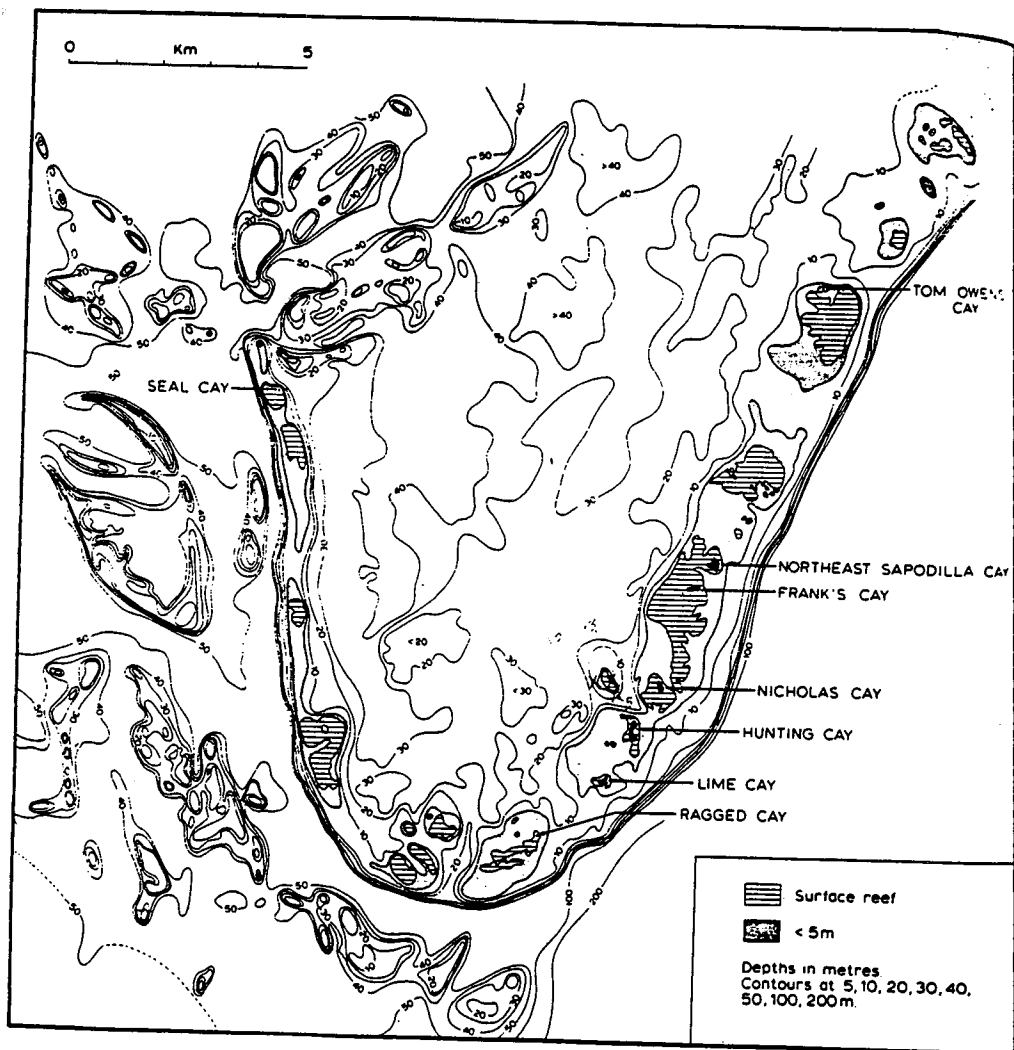
Figure 5: Remote sensing image of the Sapodilla Cays.



Our first impression of Hunting Cay was of an idyllic tropical paradise. The island was very small and covered with dense vegetation consisting mainly of coconut trees and mangrove. Life abounded. Frigate birds soared overhead, humming birds flitted around and lizards skittered across our path. The island has a lighthouse and a small group of buildings located at the western point occupied by a family of fishermen and a troop of six Royal Marines who are deployed on the island to monitor Guatemalan shipping (and De-fizz, it being an alcohol free zone for the marines).

The effects of increasing tourism on these remote islands was apparent by the presence of litter and the remnants of camp fires made by weekend trippers from Guatemala. It is ironic that this outpost, which is strategic in defending Belize from the threat of its unstable neighbour, is in fact invaded by Guatemalans every weekend. These ones however as well as having to apply for a permit to visit the island, sport Bermuda shorts and sun hats rather than military hardware and war, and it seems that enjoyment is the only thing on their minds.

Figure 6: The Reefs and Cays of the Sapodillas.



The Hunting Cay team.

Kate Ellis: A marine biology student at Bangor University. Also interested in other types of *marine* life (cryptic symbiosis in khakis).

Jo Caley: Another marine biologist from Bangor. A Lancashire lass who worked a lot on her tan as well as this project.

Richard Husselbee: Another Bangor person very enthusiastic about marine biology and diving in general. The first of us to swim with a 'real live dolphin'.

John Whitworth: Expedition leader on this satellite expedition. A 27 year old ex-forces commercial diver from Portsmouth, more than cut out for the rough life on Hunting Cay. His favourite saying was "there are no problems, only solutions" (How we lived by that!).

Jeanette: Science officer for the Hunting cay expedition, and expedition leader for Hunting cay during the month after we left.

Pete Mumby: 'Batfish Mumbies Boy', in charge of the science training in front of CCC, returned to Southwater Cay after the first week.

Jon Yearsley: A computer expert and a diver with previous experience in the Cays.

Andy Clifton: Another computer whizz and experienced diver employed by the police force.

Paul Clifton: Elder brother to Andy. An experienced diver also employed by the police. A real comedian!

Rachel Eitel: A 22 year old engineer from Ireland. She could fix anything!! A motivator whom we couldn't have done without.

Danuta Kokanowscha: Who unfortunately was off diving for most of the expedition due to a rather nasty bite to her leg.

Dan Preddy: Living proof that you can have a coconut fall on you from 100 feet and still survive. Dan is still the man.

Liz Cook; Alexandra Lord; Julian Thomas; Simon Williams: All 'UBCCE'93'.

Pete and Sue: The inseparable snogging Neanderthals.

The Marines: Being an alcohol free island they seemed to join us every evening. Bully for us. At least it proved entertaining watching the sharking attempts.

Dildo: The Hunting Cay dog, and mascot for the expedition, named for obvious reasons which I don't care to go into at the moment.

Life on Hunting Cay.

Our first week on Hunting Cay consisted of the training course on marine identification, ecology and survey techniques. For this we had the company of Pete Mumby who slept on the floor of the equipment tent. He lectured us on the ecology of the Sapodillas and the organisms we were likely to encounter. We carried out dives to familiarise ourselves with the area, the organisms encountered, and with the techniques used in boat handling and diving surveys. Despite the idyllic appearance of the island life on Hunting Cay could be tough. The first night on Hunting Cay was a disaster. After the hassle with the *Dolce II* we had to set up camp. Only the male contingency of the expedition had arrived on the Thursday night, and to top that we had to set up camp in one of the worst tropical depressions you could imagine. We managed, and the other half of the expedition arrived early the next morning to find us sodden, and the camp strewn with Belikin bottles (the only way we could make it through the storm was to anchor ourselves down with empty beer bottles, the full ones just didn't seem to work).

The accommodation consisted of a single ex-army tent designed for 8 (and sleeping 14). Anyone sleeping next to the door of the tent was in danger of a soaking, as Simon found out on numerous occasions. Pitching a tent on a small island was not without its consequences for nature. We disrupted the nocturnal foraging habits of some very large terrestrial crabs (identification unknown) which would run around in the tent spreading havoc and sleepless nights for the squeamish (who invariably thought they were spiders). Along with the resident wildlife a pack of stray dogs inhabit the islands and, probably as a result of the free offerings put out after meals, adopted us as their masters. One in particular (affectionately named 'Dildo' by the girls!?) took it upon itself to announce the presence of any strangers that turned up in the vicinity of our tent. On particularly stormy nights they shared our tent.

Food was fresh for as long as it would last. A bag of potatoes, some cabbages, carrots and water melon. Everything else was tinned, spam being a staple part of the diet. For some reason, known only to those residents of SWC that did our shopping for us, we also had five gallons of Worcester Sauce.

The toilets consisted of two wooden cubicles at the end of a rickety pier and hygiene was maintained with soap and sea water. The odd tropical downpour provided a bonus in the form of a freshwater shower, although suds law dictated that covering oneself in soap during a downpour calls for a very abrupt end to it! This was later used to our advantage as if the weather ever became too bad to dive, all you had to do was a quick shampoo and shave, and the weather would be bright again.

Insect bites became infected very easily. Danuta had such a bad infection that she was taken prematurely back up to SWC where it could be better cared for, though she was off diving for over half of her three month stay. Mosquitoes weren't the trouble so much as sand flies. These mm long flies would bite without you knowing it, and for the main active agent for the transmission of sleeping sickness in the tropics.

Radio contact was maintained regularly with Belize City and with South Water Cay. This involved climbing a long way up the lighthouse ladder at a predetermined time every morning and night (despite the weather) and holding an aerial while John W tried to get the latest news and

weather forecast. We split into teams and were assigned a rota of responsibilities according to the day. These were 'day group', 'dive group' and 'bar group'. Day group cooked, dive group pumped bottles, fuelled boats and readied them for diving and bar group had a day off (well, made sure that everybody was rationed the correct amount of soft drinks or alcohol, dealt with the incinerator, and lounged around in the hammock). On top of all this we had to carry out surveys and make sure that the data was documented correctly for transfer onto the database. Jeanette worked long and hard to make sure the data was accurate and consistent (and bossed us around accordingly). Over the next two weeks we completed surveys most of the way along the barrier reef from Seal Cay east to Ragged Cay.

The diversity of marine life was incredible and the reef pristine and untouched. This was our first real impression of the barrier reef and later it was interesting to compare the diversity and abundance of species in the south to those in the north. The lack of boat traffic in the south was apparent and this was reflected in the abundance of some of the commercial species such as lobster and conch. What we noticed later on was a lack of abundance of other species of fish in the Sapodillas compared with the area around South Water Cay. On the other hand certain rarer species such as Spotted Drum were seen on nearly every dive at Hunting Cay. Maybe due to lack of competition from other species these are able to thrive.

The underwater visibility in the Sapodillas was not as good as that around SWC and we speculated that it may have been this factor which kept fish out of our range of vision. There certainly appeared to be plentiful fish on the shallow parts of the reef amongst the elk horn and ribbon coral. Visibility may have been affected by the flooded rivers in Honduras. Debris is not filtered out because there are no mangrove swamps between the Cays and the mainland on this part of the reef. Certainly the reef profile in the Sapodillas is unlike that surrounding SWC. The sand gully and outer ridge (see reef profile) are not features here.

During our stay we became acquainted with Stanley, a Belizean fisherman and resident of Hunting Cay, who knew more about the reef than anyone. He had the uncanny ability to snorkel (without fins) down to depths of twenty metres (much to the surprise of our divers!) and on days when we weren't surveying he took us out to other sites along the reef. This included the wreck of a 16th century Spanish Galleon which is lying very heavily disguised as a coral reef, in six metres of water in the lagoon about 10km North of the Sapodillas. The shape of two large cannons and an anchor can be clearly seen but the rest is broken beyond recognition. Stanley knows of several similar wrecks along the coast. They are extremely hard to find and only an expert like Stanley can locate them every time. We asked him about treasure but he just smiled. I guess if he knew, it would be gone.

Another feature of life on the island were the British forces. They were pleased to see us since we provided some alternative company and they liked talking diving. A helicopter would land on the island twice a week (Fridays and Tuesdays usually), negotiating an impossibly small gap in a group of palms. This brought in fresh troops for a weeks stint on the island (and it provided us with the odd luxury such as a packet of Pringles).

The move to Southwater Cay.

At the end of our third week it was time to leave the base at Hunting Cay and head off back to South Water Cay where we planned to spend a week fixing boats and engines and preparing for our next project, the verification study. On the return journey we were escorted for a while by a pod of spotted dolphins which leapt in the wake of our boats. One picture will always be clear in my mind as our boats cruised at a fast pace alongside each other. John Whitworth coxing Boat 1 with a hangover and a cigarette hanging from his mouth and three dolphins airborne at the bow of the boat. Both ends of the 'health and beauty spectrum'.....

After four hours of heavy travelling we arrived at our destination. Southwater Cay is situated towards the centre of the barrier reef system. The island itself is divided into three sections. At one end is a small, and very exclusive hotel, from which the majority of the pollution and reef damage in the area can be traced. In the middle is a university based centre for 'educating' rich American kids about the reef system, and for whom we presented a number of talks and discussions. At the other end is Coral Cay Conservation. The CCC base consisted of two large joined wooden buildings, representing a work area, kitchens, dinning-rooms, dorms, workshop, and stores area.

Maintenance week.

The first night back on Southwater Cay consisted of a party to bid farewell to those volunteers that were heading off home. They left us with terrible hangovers and a week to wait for another group of volunteers that would take part in the verification study. During this week we fibreglass boats, fixed compressor sheds, fixed the roof and guttering, suffered the olfactory hell of fixing the drainage valve on the composting toilet, and attempted genocide on the islands cockroach and rat populations. All this was done under the watchful eye of John Ridley, the director of CCC, who had joined us on the island for the week. As a reward for our efforts we were allowed to plan recreational dives off of the outer drop off and to Glovers Reef a coral atoll further out east into the Caribbean sea. This was an exceptional site, the drop off spectacular and the sea crystal clear. It was here that we first swam with a pod of bottle nose dolphins (circled whistling and clicking, and seemingly amused at our clumsy movements), and really began to appreciate the beauty of the Belizian reef system.

Validation month.

The next group of volunteers turned up looking very pale and a little apprehensive. They soon settled in and we got to work on the validation surveys. Our leader on this leg of the expedition was Tony Read and our scientific officer Anna Haigh a 28 year old marine biologist. The survey techniques were very different from those previously carried out by us on Hunting Cay. We dived in the same groups of three, on the same sites continually, and as a result became very familiar with certain areas of reef and even became acquainted with individual fish. Because of our previous experience we were assigned as group leaders. Julian, Simon and Liz did a lot of boat

handling and became very good at navigating their way around the reefs, positioning their boats perfectly for putting in and picking up divers.

The diving conditions at South Water Cay was very different from that which we had experienced at Hunting Cay. The increased concentration of surrounding mangroves, and the reduction in the circulation of the water meant that the water was very much more clear. Visibility on some dives reach over 40m (compared with a measly 25m max at Hunting Cay). This was tied in with a great wealth of certain economically important fish species.

During one particular week of survey work, the weather turned bad. A hurricane was predicted to hit our island within a few days, and with constant radio contact with the army at Belize City (Airport Camp), we formulated an evacuation procedure. Fortunately the hurricane collapsed and we were left with a tropical storm of great ferocity (horizontally flying palm fronds were visible on some occasions). This did however have its good points. We replenished our water supplies, and had several fresh water showers. It also meant that when we were once again in diving condition we were able to witness one of the greatest concentrations of fish on the reef imaginable. The fish it seemed had sheltered from the weather in the deeper waters, and were now coming to the reef to feed. This included a great increase in the number of rare species sighted, and Julian was lucky enough to have a close encounter with a Hammerhead shark.

At the end of our second month we said good-bye to the island, and to the friends we had made there, for what we thought was the last time. We got a lift onto the mainland, and travelled into Belize and Guatemala. After a week of travelling we were invited back to the island for a further week, to train the next group of volunteers. This task we accepted with glee, and had nothing to do with our running out of money.

The Final Week.

The final week of the expedition was quite possibly one of the most enjoyable of the trip. As we were the only truly experienced expedition members there, we had the responsibility of teaching and training all the new volunteers on the ways of the world (something which Simon took quite literally). We had to explain the ins and outs of the island, the do's and don'ts of the expedition, and what the typical routine consisted of. Added to this, we had to teach them the names of all the fish species, all the algae, all the invertebrates, and all the coral species. On top of this we had to organise the diving for everyone, take people snorkelling to become acquainted with the environment, and still continue our surveying. This was all in addition to the normal chores of the island.

As it was our last week on the Cays we all pulled as hard as we could and put every effort into getting the most that we could out of being there, whilst having as much fun as we could. We managed this with flying colours, with late night beach parties every night, and achieving more work than ever before.

We had now been on the expedition for the full 2.5 months. It was time to leave. It would be an underestimate to say that there was a lump in our throats as our boat pulled away from the cabana and we waved our farewells to the friends on the island. We decide that we couldn't face the bus journey back so we booked a flight on a 10 seater light aircraft to Belize International. The flight was a fitting good-bye to a brilliant expedition, and we all fell silent as the plane rose above the coastline. You could clearly make out the shapes of the Cays and the barrier reef behind as we flew over it. We landed at Belize City at 09.00, and were met by 'Spanish' a local taxi driver who

works for Coral Cay on the side. We were soon in the air again having met a few more friends who had also been travelling for the past two weeks. Before we knew it we were in Houston airport and running between terminals trying to catch our connection back to London. We arrived in London at 10.00 on Saturday 4th September, tired, and very homesick for the islands.

Plans for the future.

Management Plan.

CCC have already completed the work necessary for the establishment of management plans for the South Water Cay marine reserve (Shown in Figure 7). The resource map was generated on GIS from the CCC survey data at the Lands Information Centre, Ministry of Natural Resources, in Belmopan.

Earlier in 1993 the University College of Belize (UCB) signed a working agreement with CCC which states that both organisations will collaborate towards the development of a Marine Research Centre on Calabash Cay the. This will be of regional and international importance.

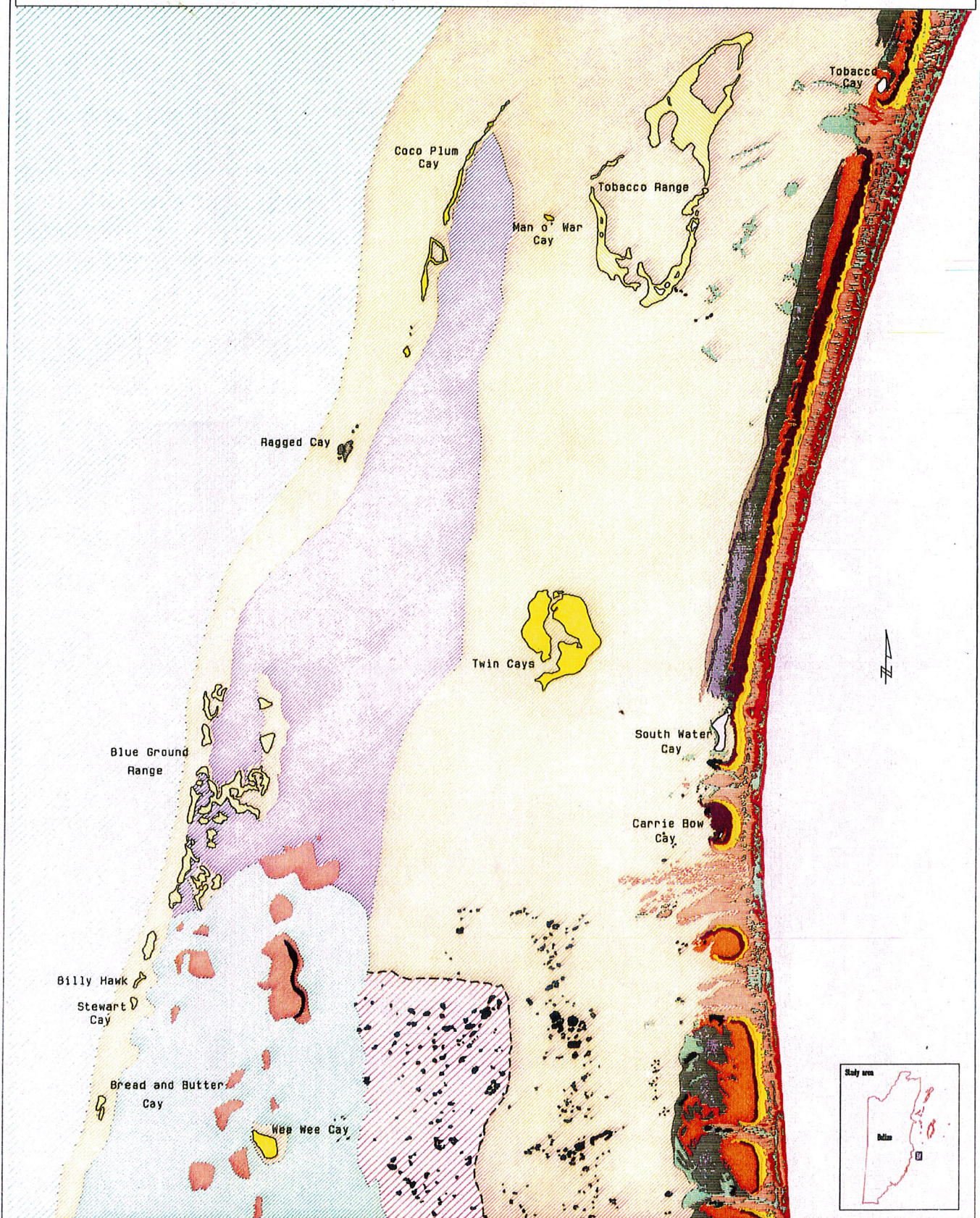
Research programmes at the MRC will encompass four main areas:

- 1) Data collection, compilation and assimilation in support of the development of a management plan for Turneffe.
- 2) Research to support Belizian government ministerial directives.
- 3) Research to support the UCB marine studies programme.
- 4) Collaborative research with foreign institutions.

Turneffe is the largest of Belize's offshore atolls with an area of approximately 205 square miles. The atoll is comprised of numerous sand and mangrove Cays and a complex central lagoon system, and is bounded by an extensive fringing coral reef. Turneffe supports several important bird nesting sites and a population of rare saltwater crocodile, dolphin and manatee are also present. Turneffe has traditionally been a major fishing ground and is a renowned sport fishing area. The establishment of the MRC at Turneffe is considered timely since there is an urgent need to address environmental issues relating to the imminent development of Turneffe for tourism and other activities.

PROPOSED SOUTH WATER CAY MARINE RESERVE

Marine and Terrestrial Habitats



Reef Habitats

- Halophytic zone (sand)
- Porites / algae / seagrass
- Turbinaria and Porites on carbonate pavement
- Coral rubble and Acropora on carbonate pavement
- Acropora reef
- Agaricia/Acropora/Millepora reef
- Gorgonian rich Montastrea reef
- Montastrea reef
- Sand
- Patch reef

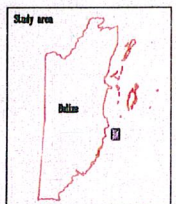
Terrestrial Habitats

- Vegetated sand
- Vegetated shingle
- Mangrove cay with dry sand areas
- Mangrove range

Lagoon Habitats

- Mixed seagrasses and algae
- Algae dominated (Penicillus & Udotea spp.)
- Broad coverage
- Algae dominated (Penicillus & Udotea spp.)
- Sparse coverage
- Thalassia and algae
- Broad coverage
- Sand bores and Lobophora
- Sand bores

Scale 1:30,000



CCC joint universities expedition to Bacalar Chico.

So much progress has been made by the CZMU of the Belize government and by CCC that in September 1993 CCC received notice from the EEC that it would receive funding for its work on the Bacalar Chico Marine Reserve which is to be undertaken from 1994 onward. This project will see collaboration between CCC, the International Tropical Conservation Foundation (ITCF), the International Union for the Conservation of Nature (IUCN) and students with an appropriate background from different universities. Bacalar Chico is a small area by the country's northern border with Mexico. It consists of a diverse range of marine and terrestrial habitats and is home to some of Central America's rarest fauna and flora (Jaguar, Manatee, Turtle and Crocodile). It is the only site in the world in which a barrier reef converges onto the continental mainland. CCC would like to recruit students undertaking studies/research in subjects related to environmental conservation e.g. biology, geography. Students will acquire comprehensive experience in tropical marine ecology, marine life identification, field survey techniques and the experience of working in a large research team. This joint universities expedition will run between July and September 1994 and we of the 1993 Bristol University CCC expedition are actively encouraging as many Bristol students as possible to apply for this expedition. We feel that it is really important for people to take part in the conservation work that desperately needs to be done so that the world's resources are managed in a sustainable manner. To further this campaign we have invited Pete Mumby the scientific co-ordinator of CCC to visit Bristol University and talk of the work being done by CCC. The talk is scheduled for March 1st 1994. Further details will be posted to all parties nearer the date.

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President: David Bellamy.

Honorary President: Jonathan Porritt.

Patrons: Field Marshall Sir John Chapple, GCB CBE (President Zoology society of London).

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Prof. Stewart Sutherland (Vice Chancellor, University of London).

Prof. Eric Sutherland (Vice Chancellor, University of Wales).

Prof. Struther Arnott (Vice Chancellor, University of St. Andrews).

Brigadier Richard Lamb MBE (Chief of Staff, UNFICYP).

Brigadier Christopher Elliot (Commander, British forces, Belize).

Derek Ellerby (Chairman British Sub-Aqua Club, BSAC).

Mike Holbrook (National Diving Officer, BSAC).

Dr. Nic Flemming (Science Advisor, CMAS).

Christian Ide (President CMAS).

Directors: Peter Raines

Jonathan Ridley.

Report written by **Julian Thomas** and **Simon Williams**, on behalf of UBCCE'93.