



*Aldabra Marine Programme  
Phase III:*

## **Extending the Survey Eastward**

**Ben Stobart, Raymond Buckley, Nigel Downing, Martin Callow,  
Larry LeClair and Kristian Teleki**







## **Phase III**

# **Extending the Survey Eastward**

February 2002

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Mushroom-like islet – “champignon”

Bras Grande Poche



Mangrove/lagoon border

## **Executive Summary**

In February 2002 the Aldabra Marine Programme successfully completed the third annual survey in the long term monitoring of the corals and reef fishes of Aldabra Atoll. All eight outer reef sites and three lagoonal sites were revisited. A survey was also completed on the exposed southeast reef of Aldabra, and the monitoring programme was further extended eastwards to the islands of Assumption, Astove and St. Pierre.

At Aldabra, with some exceptions, the coral community continues to show signs of recovery following the 1998 El Niño event. The fish population appears healthy. At Assumption, Astove and St. Pierre, the coral fauna is similar to that on Aldabra, with the exception of Astove that has very high live coral cover in shallow water and poor coral cover in deeper water. While fish diversity is lower at these three new sites, the overall density is comparable to that found at Aldabra.

Coral tagging and recruitment research continued at Aldabra, and was also carried out at Assumption, Astove and St. Pierre. Recruit numbers at Aldabra remained high in 2002 with very few changes. Levels were similar at the other islands, with the exception of Astove that had very low numbers of recruits. Almost all corals tagged in February 2001 were relocated and measured providing the first data on coral growth and mortality for Aldabra. In addition echinoderm surveys were completed at the three new locations.

Temperature data loggers, deployed in 2001, failed to perform due to design defects, and although additional data loggers were deployed, it is unlikely that they will yield reliable results.

The first aerial survey of the lagoon was completed as a preliminary assessment of the feasibility of continuing such work.

## Introduction

In 1997-1998 a severe El Niño Southern Oscillation in the Pacific lead to a significant incursion of warm water into the Indian Ocean (Teleki *et al.* 1998). Average sea surface temperatures (SSTs) increased beyond the tolerance of many corals. As a result widespread coral death was reported in many coral reef areas.

Among the reefs exposed to these elevated temperatures were those of the large raised atoll of Aldabra in the southern Seychelles. A Cambridge University expedition surveyed Aldabra in 1998 and reported some 40% of all outer reef scleractinians to be recently bleached or dead (Spencer *et al.* 2000).

In response to this widespread coral death, the Aldabra Marine Programme (AMP) was formed with the express purpose of monitoring, over the long-term, the outcome of the perturbation, and measuring the recovery of the reef community. The first expedition (Phase I) visited the atoll in November 1999. Seven permanent underwater survey sites were set up at various locations on the north and western outer reef. Baseline data was obtained on the diversity and abundance of both corals and fishes at two depths at each site (Teleki *et al.* 1999<sup>a</sup>).

In February 2001 a second survey (Phase II) was completed at the original sites, and four more permanent survey sites were established, three of them inside the lagoon. In addition, a coral recruitment study was completed at each of the eleven permanent survey sites. An echinoderm survey was carried out at selected locations. Underwater data loggers, capable of recording temperatures at regular intervals over extended periods were deployed at various depths both inside and outside the lagoon (Stobart *et al.* 2001). AMP reports are available online at [www.aldabra.org](http://www.aldabra.org).

This report covers the results of the third survey in this extended study of the Aldabra reef, in February 2002. Once again all previous permanent sites were resurveyed. The scope was also increased by establishing further survey locations on two other reefs in the Aldabra group, Assomption and Astove, and St. Pierre in the Farquhar group.

## **The 2002 Aldabra Marine Programme Phase III**

Phase III of the Aldabra Marine Programme took place between 31<sup>st</sup> January and the 19<sup>th</sup> February 2002.

The main objectives were to:

- Repeat the coral and fish transects at the eleven permanent survey sites established at Aldabra between 1999 and 2001;
- Survey an area of reef on the exposed southeastern coast of Aldabra;
- Re-measure corals tagged at selected sites at Aldabra in 2001, and tag more corals where possible;
- Establish new permanent monitoring survey sites at three islands, Assomption, Astove and St. Pierre, east of Aldabra;
- Conduct coral recruitment quadrats at all survey sites at Aldabra, Assomption, Astove and St. Pierre;
- Survey Echinoderm populations at Assomption, Astove and St. Pierre;
- Download temperature loggers deployed at Aldabra in 2001 and deploy new loggers at selected sites;
- Deploy temperature data loggers at Assomption, Astove and St. Pierre.

The secondary objectives of this phase were to:

- Mark all permanent 50m transects with lead core line;
- Continue training Seychellois rangers in marine survey techniques;
- Survey the reef habitats around Assomption, Astove and St. Pierre.

## **Location information**

### ***Aldabra Atoll***

Aldabra Atoll (9°24' S, 46°20' E), Southern Seychelles Islands Group, is one of the world's largest raised coral atolls (34km long, maximum 14.5km wide, area 155km<sup>2</sup>). It is located 1150km southwest of Mahé, Republic of Seychelles, and 426km north of Madagascar (Figures 1 and 2). For further information on Aldabra see [www.aldabra.org](http://www.aldabra.org).

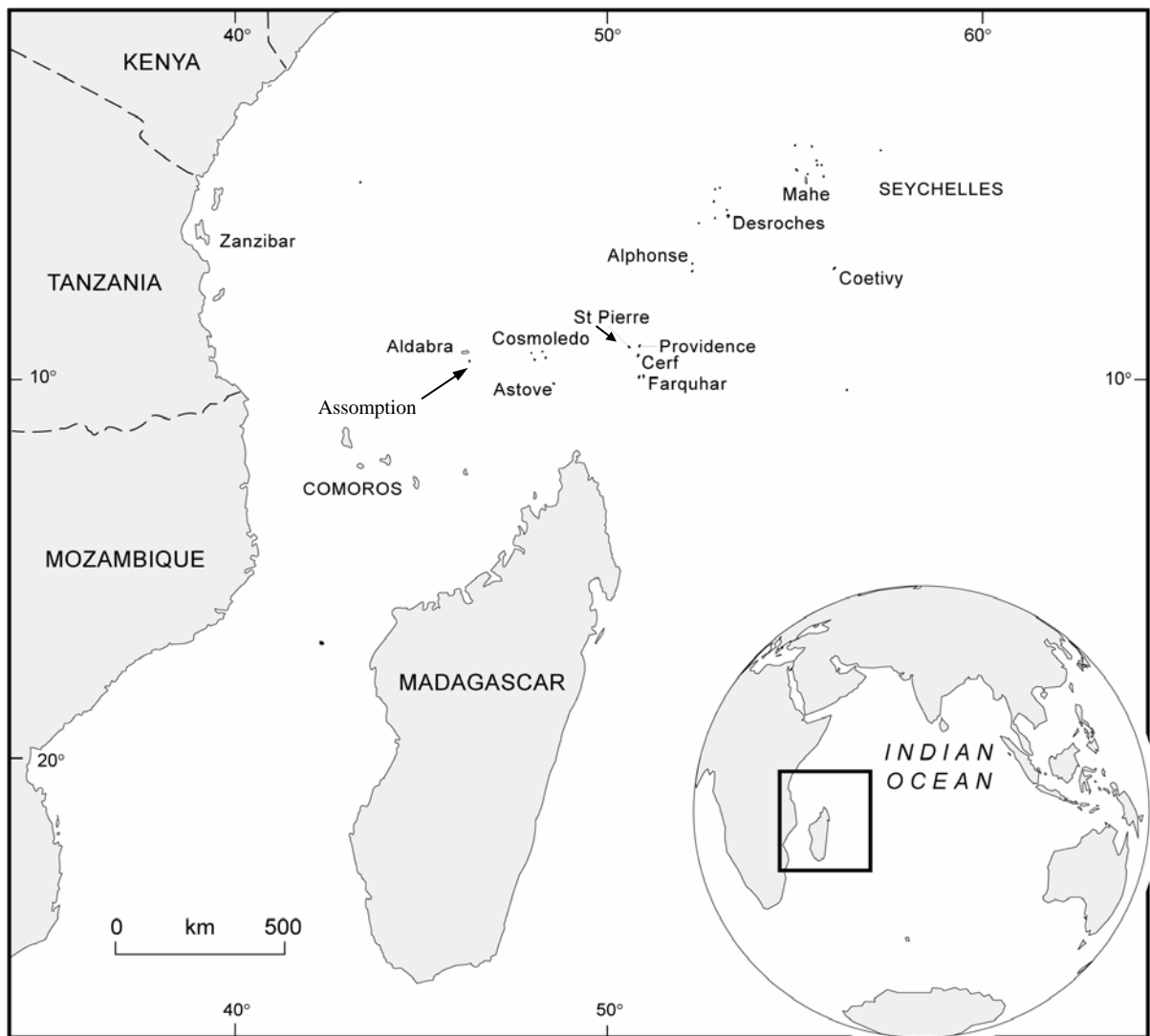


Figure 1. Location of AMP sites in the Western Indian Ocean.

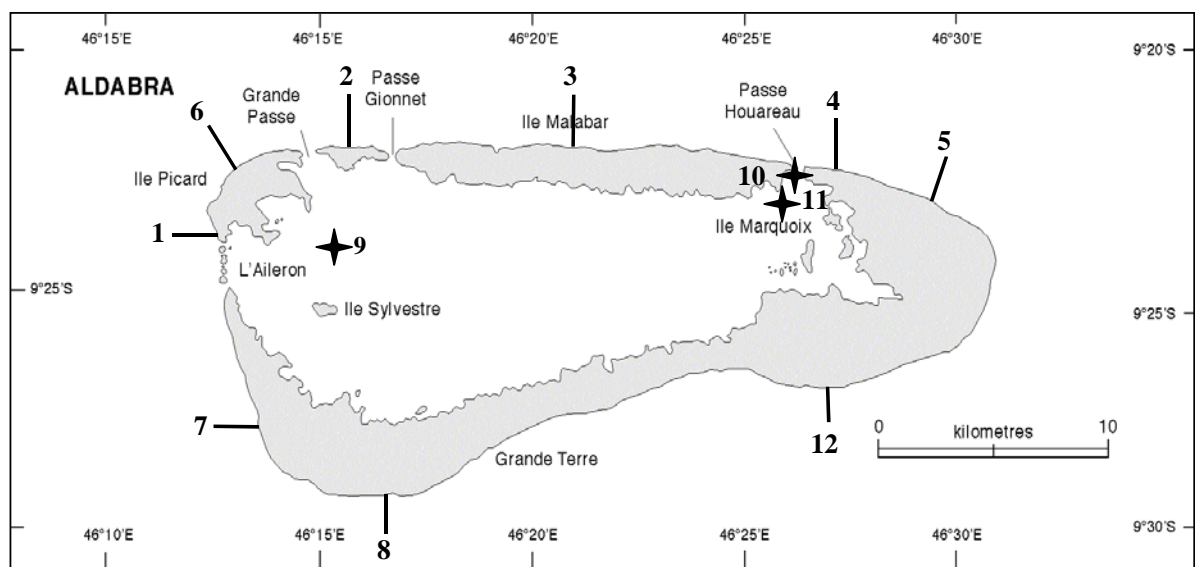


Figure 2. Aldabra Atoll with Aldabra Marine Programme monitoring sites.



### ***Assomption***

Assomption island is situated approximately 37km south of the eastern tip of Aldabra ( 9°43' S, 46°31' E )(Figures 1 and 3). This raised coral island has a mostly gently shelving rocky coastline, with the exception of the western coast that has an almost uninterrupted sandy beach that extends for approximately five kilometres. There is a large shelf extending out to sea on the eastern side of the island and a very steep drop close to shore on the western side. Assomption is largely flat (see photo below), and due to the devastating effect of guano mining which lasted until 1983, is dominated by expanses of bare rock and caves, and is sparsely covered with low scrub (Stoddart 1970). Two large sand dunes are prominent on the south eastern coast of the island, one of them reaching 32m high. There is a concrete runway that runs from between the two sand dunes on the south east to the permanently manned settlement which is situated on the more sheltered western side of the island. The settlement is surrounded by *Casuarina* trees and there is an abandoned coconut palm plantation just south of it.



Aerial view of Assomption.

### ***Astove***

Astove lies 1056km from Mahé and approximately 185km ESE of Aldabra (10°04' S, 47°44' E; Figures 1 and 3). Astove is a raised coral island with a substantial shallow lagoon (approximately 4.5 x 2 kilometres) opening to the sea through a single narrow channel on the south coast (Figure 3). The exposed eastern side of the island is dominated by low scrub and mangroves on the lagoon side, while the western side is quite highly vegetated. On the western side there is an abandoned copra plantation and an apparently healthy population of giant tortoises (Pers. obs.). Astove is no longer inhabited but it was once exploited for guano mining, and more recently for the production of cotton, sisal, maize and copra (Pavard 2000). There is an abandoned settlement on the western coast and a grass airstrip on the north east point of the island. Astove has a gently shelving rocky coastline to the east, an undercut coastline on the southwestern coast and a 3km long sand beach on the north west coast. The shelf slopes gently out to sea on the east side of Astove, but there is a dramatic cliff on the west side that drops sheer to about 100m and continues to drop steeply to over 2000m. The cliff starts directly at the end of the 300m wide tidal flat from barely 6m deep and has many caves.

### ***St. Pierre***

St. Pierre is approximately 704km from Mahé and 500km ENE from Aldabra (09°20' S, 50°44' E; Figures 1 and 3). St. Pierre is a small (approximately 1.2 x 2 km) raised coral island. Guano was mined here between 1906 and 1972 converting a once densely forested island of *Pisonia*, to the current barren pitted landscape (Piggot 1969, Stoddart 1967). The western third of the island is now densely forested by *Casuarina*. St. Pierre is virtually inaccessible from the sea due to a steep undercut fossil coral shoreline that is only broken at one point. Here there is a small inlet (approx. 5m wide) to a sandy bottomed cove. There is a derelict jetty and settlement on the north west shore that would only be accessible by boat in the calmest of weather. Like all the other islands surveyed St. Pierre has a gently sloping seabed on the exposed south eastern coast and a steep drop off on the north west.



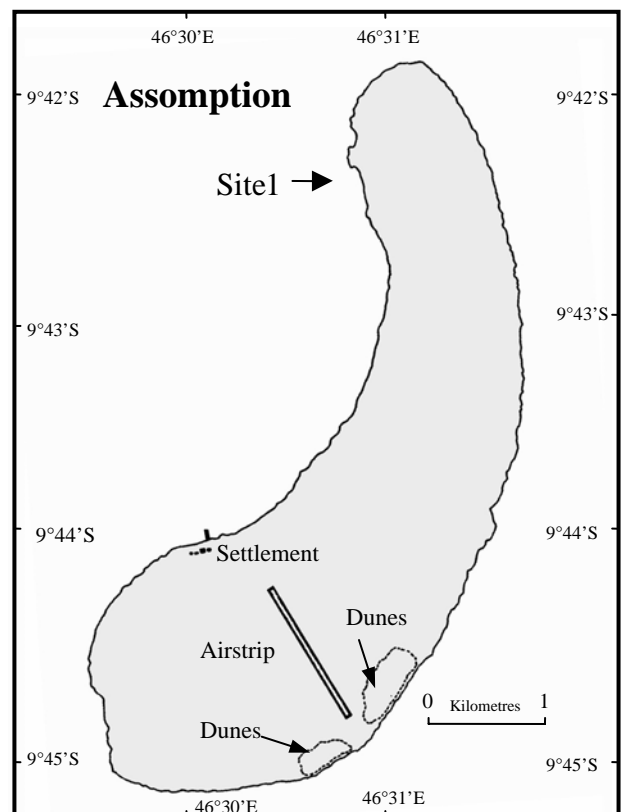
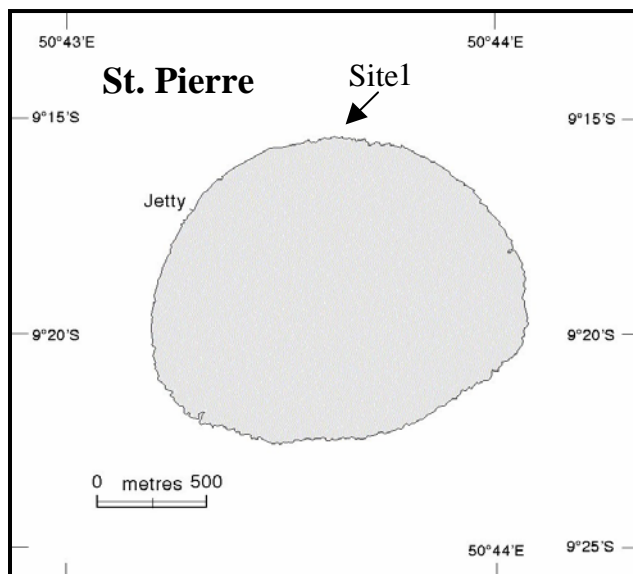
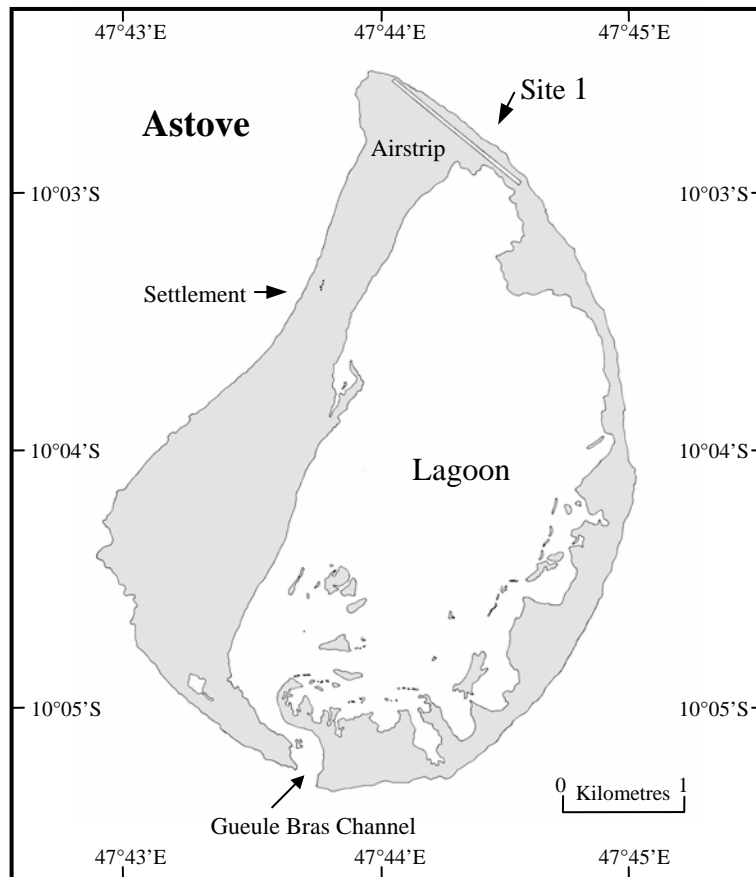


Figure 3. Astove, Assomption and St. Pierre site locations.

# Methodology

## Coral and Fish Transects

The procedures used in the 2002 AMP survey to locate and mark permanent survey sites, and the methods used to quantify corals and fishes on the transects, replicated those used in AMP Phase I (Teleki *et al.* 1999<sup>a</sup>) and AMP Phase II (Stobart *et al.* 2001).

In 2002 one additional site (Site 12, see Figure 2) was established on the SE coast of Aldabra not far from the Lion wreck ( 9°27'S, 46°27'E ). The site was selected because little is known about the SE coast due to the difficulty of access for most of the year caused by high exposure to prevailing weather. At Site 12 tapes were extended (total 155m) from 6m to 29m depth, and a primary video transect was conducted. The site was not permanently marked as returning from year to year would not be practical, and consequently secondary video transects were not carried out as for other sites around Aldabra. Primary video transects are filmed about 1m from the substrate and provide a record of the reef appearance for future reference. Depth was recorded at approximately five meter intervals along the tape and used to calculate the reef profile. The video was also used to determine which organisms were most abundant at each depth.

The scope of the 2002 expedition was also expanded by setting up permanent survey sites at three other islands, Assomption south of Aldabra, and Astove and St. Pierre, SE and ENE of Aldabra, respectively (Figure 1). These sites were chosen for comparison due to their increasing distance from Aldabra and their reduced protection from fishing. Furthermore, very little is known about the marine life surrounding Assomption and Astove. St. Pierre was surveyed by Teleki *et al.* (1999<sup>b</sup>) immediately after the bleaching in 1998 when they observed large stands of very bleached coral. It was of particular interest to return to this site and determine how much of the coral had died, and whether recovery was taking place.

One permanent monitoring site was established at each of these islands (see Figure 3). Sites at Assomption and Astove were chosen for good coral cover on the sheltered northern and northeastern coasts respectively, comparable to the majority of sites at Aldabra. Site selection was made after an extensive survey carried out by moving along the coast in a boat and periodically snorkelling to determine reef appearance. Sites of interest were noted and their

locations fixed by GPS. The site at St. Pierre was on the northern coast and had been surveyed in 1998 and 1999. Permanent monitoring sites at these three locations were established using the same methods employed on Aldabra (see Teleki *et al.* 1999<sup>a</sup> and Stobart *et al.* 2001). Primary transects were also run vertically up the reef at each of these sites.

In 2001 the positions of several 50m transects were permanently marked along the depth contour with lead core line. This increased survey efficiency by removing the need to lay tapes prior to surveys, thus reducing bottom time, and permanently marking the route taken for the coral video and fish transects to improve survey consistency. Permanent lines also made site relocation easier, and reduced disruption to the site before counting fish. Inspection of lead core line in 2002 revealed that, as expected, it had remained in place and had been bonded to the reef by calcareous algae and coral. New lead core line was therefore deployed at all stations around Aldabra. Due to short supply, lead core line was only deployed at 10m depth at Assomption, Astove and St. Pierre, and will be deployed at 20m during the 2003 expedition.

## **Coral Recruitment and Tagging**

In 2002 coral recruits were monitored at all sites using 4m by 1m quadrats as in 2001. Following analysis in 2001 the number of quadrats per site was reduced from up to eight randomly positioned quadrats to an optimum of six. This decision was made based on precision graphs where precision for increasing numbers of quadrats was estimated as:

$$\frac{\sqrt{\text{Variance } A_1 \dots A_x / n (A_1 \dots A_x)}}{\text{Mean } A_1 \dots A_x}$$

Quadrat surveys at six meters were not possible at any outer reef sites due to adverse weather conditions generating heavy swells, with the exception of Site 6 where a few quadrats were counted.

During AMP Phase III, coral growth and survivorship for recruits tagged in 2001 was estimated at four permanent survey sites (Sites 1, 3, 6 and 7). Coral recruits tagged in 2001 were relocated, measured and a video still was taken of each one. Where time allowed (Site 1 at 20m, Sites 7 and 6 at 6m) ten new recruits were found and tagged with numbered perspex

tags of a different colour to the previous year. Tag relocation proved to be very time consuming as most were fully encrusted with calcareous algae or *Xenia* sp. after a year on site. Where possible new tags were attached using long cable ties as the protruding ends proved quite easy to locate even when encrusted.

The same tagging method was also used at the new Astove site to monitor twenty *Acropora* sp. colonies at 10m depth. Astove was unusual in having an area of surviving *Acropora*, including some large plate colonies. These have almost all died at the other locations. It was therefore considered important to monitor these colonies which will become a reference in the event of future warm water events. The greatest length and breadth was recorded for all tagged colonies at Astove.

### Echinoderm Transects

During AMP Phase III, quantitative surveys of urchin abundance were conducted at Astove, Assumption and St. Pierre. All sites were on the outer reef (Figure 3), and located directly adjacent to the coral and reef fish monitoring sites. A total of 8 survey dives were made. For logistical reasons all surveys were made during daylight hours. The presence of the coral predator *Acanthaster planci* (Crown of Thorns) was also noted at these sites, and qualitative observations of urchins and *A. planci* were made at a number of adjacent locations. Prior to the surveys, training in survey methodology was conducted and practised by team members.

For comparative purposes, a similar method to that employed by Engelhardt (2001) was utilised for the urchin surveys. Transect depths varied between sites due to the heterogeneous reef profiles (Table 1). Typically, the start and end depths were comparable to those surveyed by Callow *et al.* 2001 at Aldabra Atoll (4.8m – 24.3m).

AMP Transect #	Start and end depths (m) at 3 sites		
	Assumption	Astove	St. Pierre
T1 start	6.4	8.8	10.5
T1 end	13.7	21.5	17.6
T2 start	6.5	9.5	7
T2 end	18.8	20.5	16

Table 1. Urchin transect starting and ending depths at Assumption, Astove and St. Pierre.

Following the method of Engelhardt (2001), the three ‘target’ urchins, *Diadema setosum*, *D. savigni* and *Echinometra mathaei*, were selected for this study, although ‘non-target’ urchins were recorded if observed within the survey area. Species were identified *in-situ*.

Mean species counts per 125m<sup>2</sup> (n=2) were calculated ( $\pm$  Standard Deviation, SD), per site, for ‘target’ and ‘non-target’ urchin species. In addition, pooled urchin taxa density counts were compiled per site. Black spined urchin (BSU) index values were assigned, as an indicator of the potential threat to post-settlement coral survivorship, using pooled ‘target’ urchin counts (*D. setosum*, *D. savigni* and *E. mathaei*). BSU index values were based upon Engelhardt (2001; Table 2). An index value of ‘3’ (30.5 - 47.5 individuals per 125m<sup>2</sup>) indicates the maximum sustainable density of urchins (Engelhardt 2001). The additional index classification category of ‘bio-eroding’ was developed to encompass the three ‘target’ species as well as *Echinostrephus molaris*, a bio-erosive species (Bak 1994, 1990) not found around the inner granitic Seychelles Islands.

<b>BSU Index value</b>	<b>BSU Density rating (abundance)</b>	<b>Criteria for visual assessment of respective density categories as mean BSU per 125m<sup>2</sup></b>
<b>1</b>	<b>Very low</b>	<b><math>\leq 12.5</math></b>
<b>2</b>	<b>Low</b>	<b>13-30</b>
<b>3</b>	<b>Moderate</b>	<b>30.5-47.5</b>
<b>4</b>	<b>High</b>	<b>48-62.5</b>
<b>5</b>	<b>Very high</b>	<b>&gt;62.5</b>

Table 2. Black spined urchin (BSU) Index Value (adapted from Engelhardt 2001).

## Temperature Data Loggers

One of the main objectives of the AMP Phase II research in February 2001 was to establish a series of *in-situ* water temperature recorders at Aldabra Atoll to collect the first long-term temperature data at this location. The Optic StowAway Temp temperature data logger, manufactured by Onset Computer Corporation, USA, was selected for this objective based on the following specifications: a recording range of -35°C to +75°C, an accuracy of  $\pm 0.5^\circ\text{C}$ , a

32K data storage capacity, a 10-year battery life, and programmable for a selected recording interval. During the Aldabra Marine Programme Phase II ten temperature loggers were deployed on the outer reef and in the lagoon at Aldabra.

The plan for 2002 was to retrieve and download the temperature loggers deployed in Phase II, redeploy them in the original locations, and to deploy a further 10 temperature data loggers at 10m and 20m depths on the outer reefs at Aldabra, Assomption, St. Pierre and Astove. Onset Computer Corporation supplied five refurbished loggers to replace one logger that was reported to have failed at Passe Dubois as well as any other loggers that might have failed. Onset also supplied two prototype HOBO Water Temp Pro temperature data loggers for testing.

All of the data loggers deployed in 2002 were programmed to record temperatures at 30 minute intervals, starting at 17:00 hours on the day of deployment. Following the AMP Phase II protocols, the loggers were placed in 23 cm by 10 cm diameter circular cages made from 1.5 cm mesh Vexar plastic, to avoid damage from fish grazing on any encrusting algae and invertebrates. These cages were attached to the rebar transect stakes with cable ties. The temperature loggers were programmed, and the records were downloaded from retrieved loggers, using BoxCar Pro 4 computer software.



Blacktipped grouper – *Epinephelus fasciatus*.





Spinner dolphin – *Stenella longirostris* – is common around Aldabra. Photo Roberto Sozzani.



Bluestriped snapper – *Lutjanus kasmira*.

# Results

## New Permanent AMP Survey Sites Established in 2002

### Aldabra Site 12

The general profile of Aldabra Site 12 is shown in Figure 4. The SE coast of Aldabra is subject to high wave action most of the year and this is clearly evident in the structure and composition of the reef at this location. The fringing reef along the coast is dominated by calcareous algae and scoured coral rock. At 6m depth the seabed is rocky with occasional coral colonies such as *Porites* (both massive and branching), *Millepora*, soft corals such as *Lobophyton* and *Sinularia*, and faviids. Between 10 and 20m coral abundance is greater but still occurring as isolated colonies. Species such as *Porites*, *Acropora robusta*, *Acropora (isopora)*, *Pocillopora* and faviids were prominent between these depths along with soft coral species such as *Sinularia*. Massive *Porites* colonies and faviids were the most abundant corals between 20 and 28m. *Halimeda* was the dominant alga from 6m down to the end of the reef at 28m. Below this depth the reef ends and is replaced by a gently sloping rubble bottom with occasional sand patches.

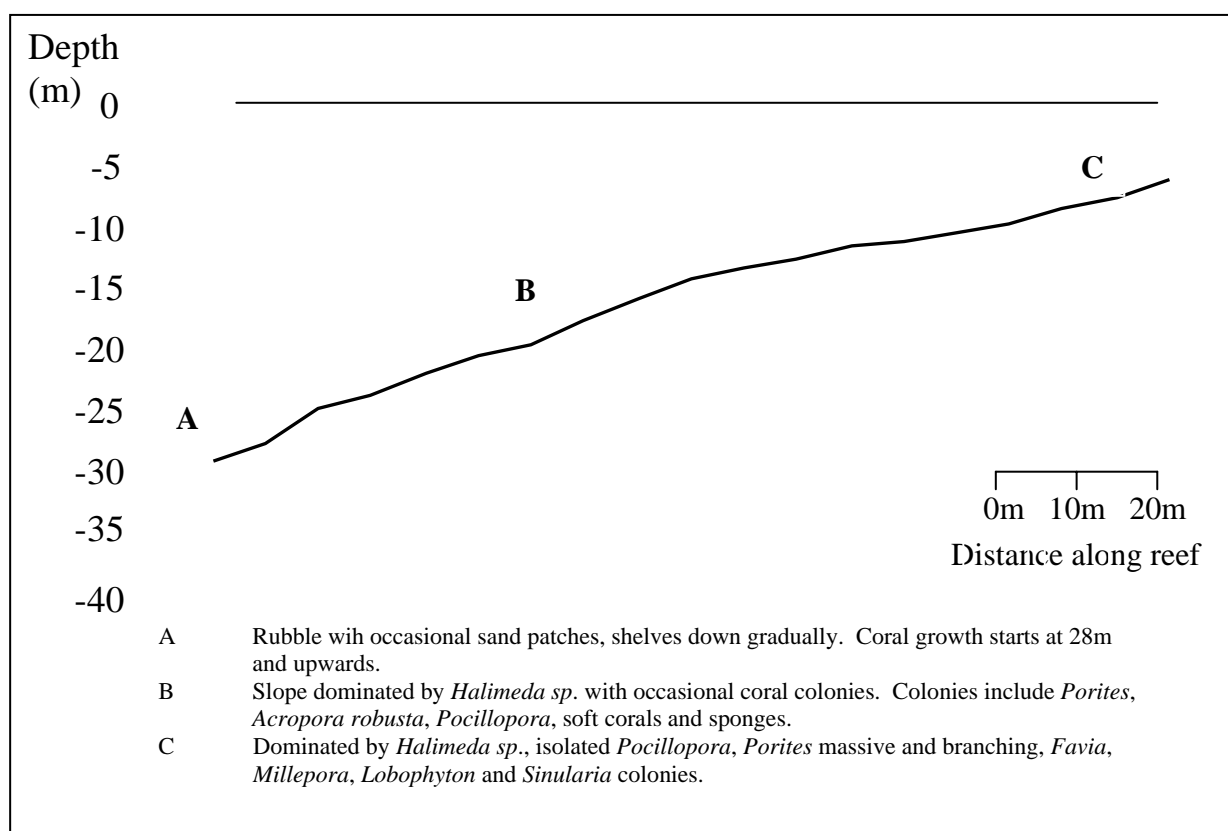


Figure 4. Reef profile for Site 12 with corresponding coral species composition.



## Assumption

The general profile for the Assumption site is shown in Figure 5. The site is situated on the north western tip of the island and sheltered from prevailing south easterly winds. The sea bed shelves gently for about 200m from the shore to a depth of about 10 m, after which there is a very steep drop down to a sandy shelf at approximately 40m. The shallow reef at the Assumption site has very large stands of dead branching corals (mostly *Heliopora coerulea*) that were almost certainly killed by the 1998 bleaching event. Massive *Porites* and *Lobophyllia* colonies are also present and either completely dead, or more typically dead on the top and still alive around the edges. Moving towards the reef edge at about 12m there is more live coral and the reef is dominated by *Lobophyllia*, *Goniastrea*, *Porites*, *Pocillopora* and *Turbinaria*. At this depth there is still evidence of high coral mortality. Below 18m there are more live corals, dominated by *Goniastrea*, *Lobophyllia*, *Porites* branching and massive, *Turbinaria* and soft corals. It is noteworthy that *Physogyra lichtensteini*, the dominant species at depths between 10 and 30m at Aldabra, less than 30 miles away, is not abundant at Assumption. This is perhaps not surprising as *P. lichtensteini* is a species associated with turbid water (Veron 2000), and Assumption waters are clearer than those around Aldabra due to the absence of a lagoon.

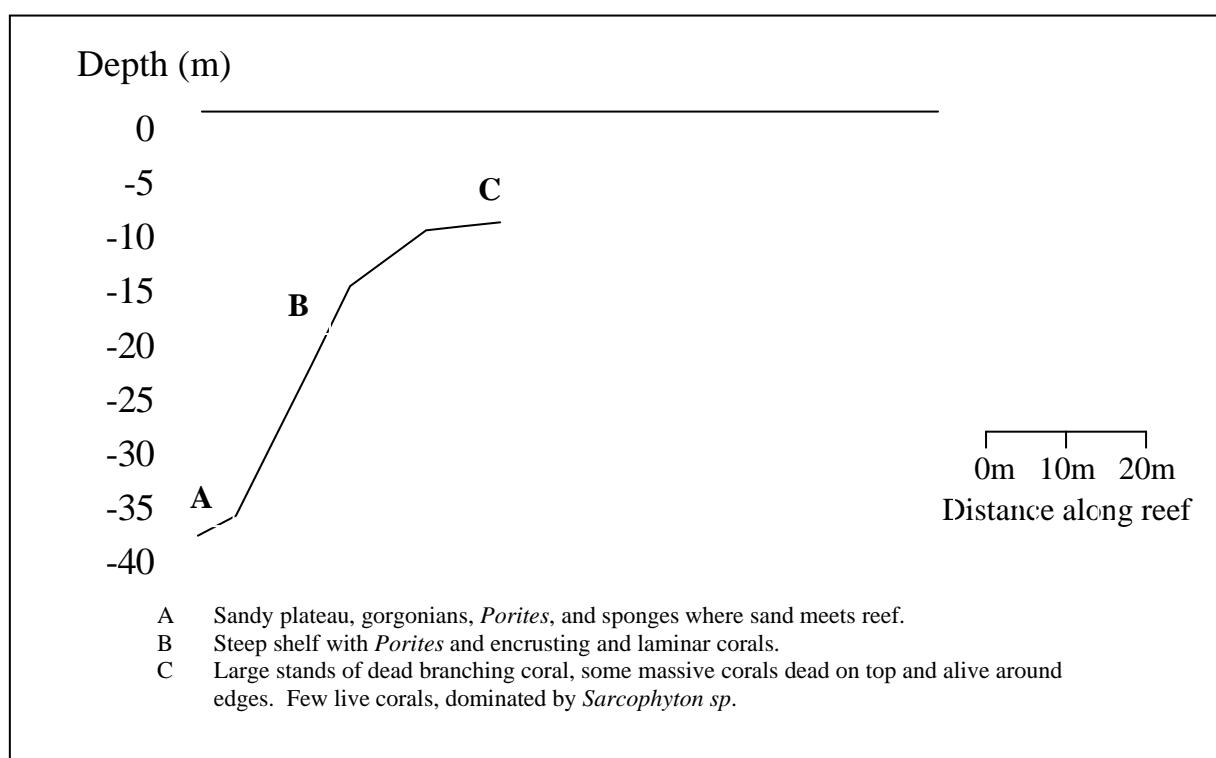


Figure 5. Reef profile for Assumption with corresponding coral species composition.

## Astove

The general profile of the Astove site is shown in Figure 6. Situated on the north eastern coast, the site was chosen after surveying a long stretch of this coast up to the northernmost point of Astove (see Figure 3). Coral growth at this site is abundant in spite of being open to long-shore wave action during the southeast monsoon. A reef outcrop about 500 metres down the coast probably provides some shelter from wave action. Coral cover at Astove is good below 10m. Above this there is a heavily scoured shelf on which the dominant corals are *Porites*, *Pocillopora*, faviids and soft corals such as *Lobophyton* and *Sinularia*, and sponges. The reef crest at about 12m has abundant coral growth and many surge channels. Most striking was the presence of live *Acropora* plate and branching corals that are so rare at other sites. There is also evidence that coral growth was even more extensive before the bleaching as there are many dead plate and massive colonies. The reef slopes steeply from the crest with a solid coral rock base down to 20m depth followed by a less stable sand and rubble substrate. From about 15m down there is abundant growth of *Caulerpa* sp. that becomes the dominant species below 25m. A deep dive revealed this species was still completely coating the seabed below 65m. It was also present in similar amounts down the steep western drop-off.

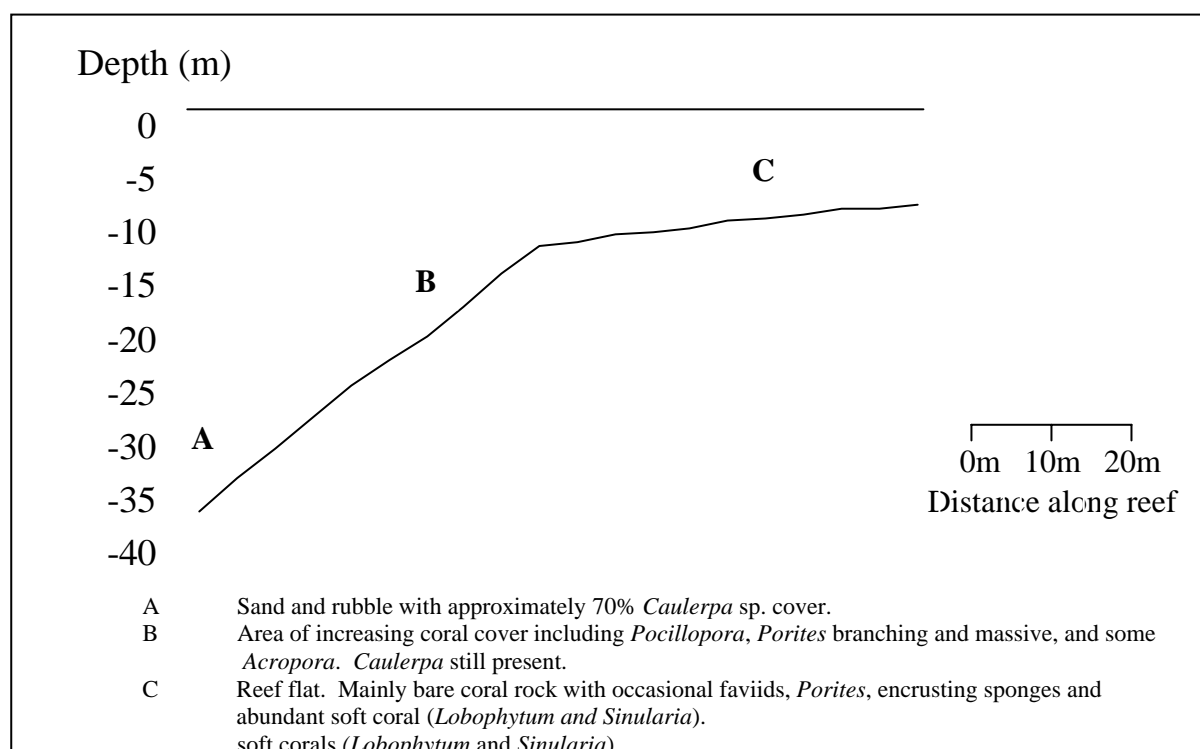


Figure 6. Reef profile for Astove with corresponding coral species composition.

### ***St. Pierre***

The general profile of the St. Pierre site is shown in Figure 7. The site lies directly adjacent to a large sand patch that extends from the coast to the reef edge and beyond. At this site a shallow shelf extends approximately 200m from the shore to 10m depth from which it then drops steeply to a second shelf below 40m. Evidence of dead coral is very striking between 8 and 15m depth. There are abundant remains of large plate *Acropora*, massive *Porites*, *Goniastrea*, and large stands of dead branching coral. Interestingly there is a very large *Pavona* sp. colony (approx. 10m long by 6m wide) at 12m depth that survived the bleaching unscathed, and elsewhere at this site *Pavona* colonies seem to have survived undamaged. Even more striking is the large amount of *Pocillopora eydouxi* recruits that form an almost monospecific stand between these depths. In deeper water there are also large numbers of dead plate colonies, but live coral cover is better and dominated by *Podabacia*, *Pocillopora* and *Porites*. Below 30m coral cover decreases and *Tubastrea micrantha* colonies and small gorgonians become dominant.

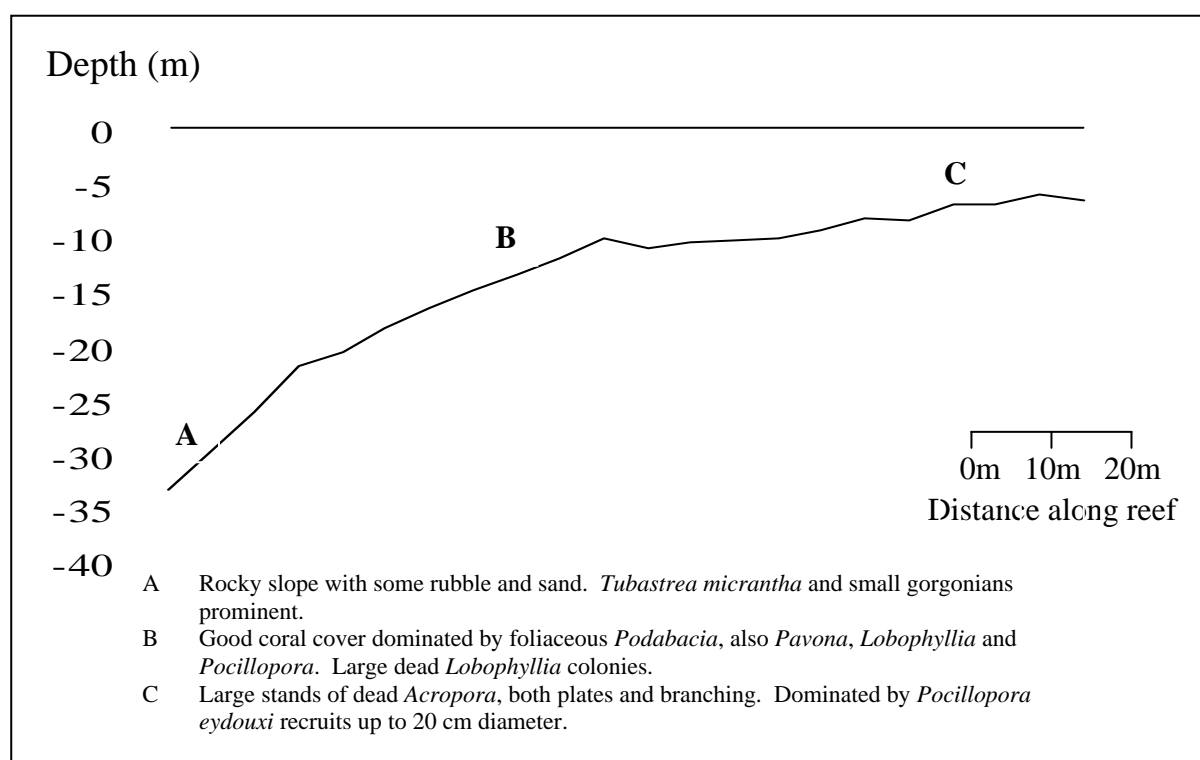


Figure 7. Reef profile for St. Pierre with corresponding coral species composition.