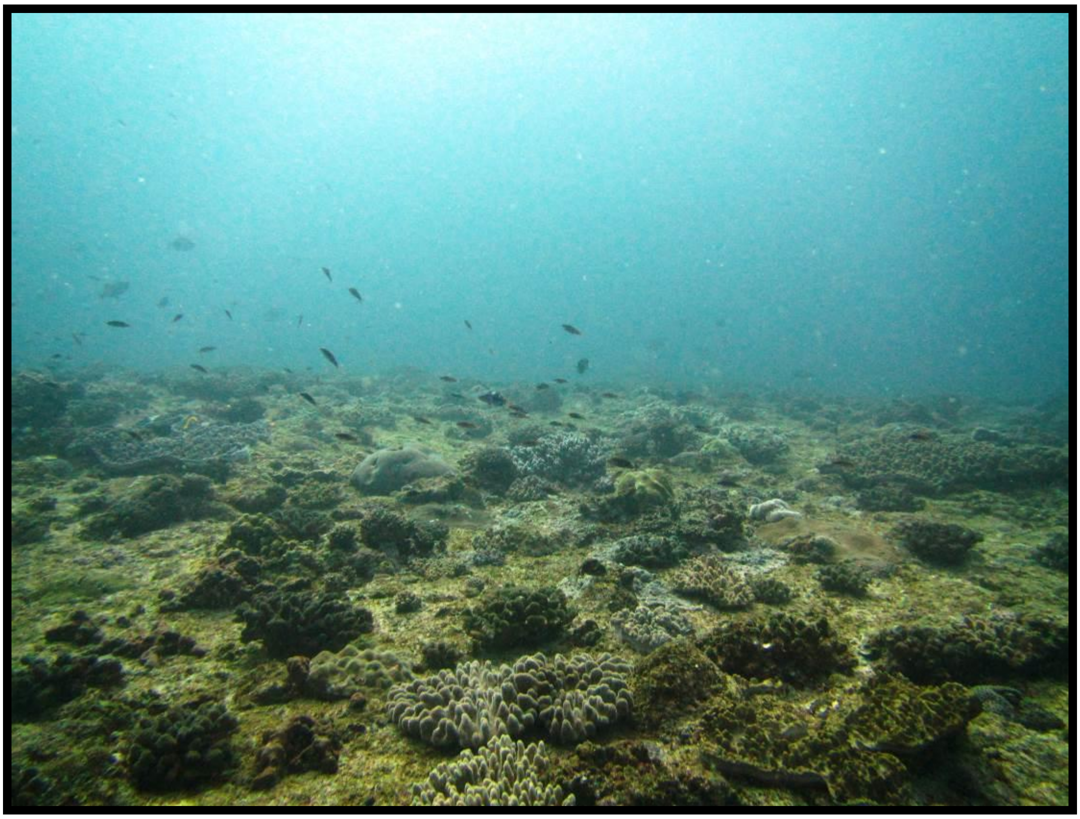

(Photo: Raquel Fernandes, CTV)

ORI Unpublished Report No. 323

RESULTS OF A BENTHIC SURVEY OF BAIXO SÃO JOÃO, PONTA DO OURO PARTIAL MARINE RESERVE, SOUTHERN MOZAMBIQUE

2015

OCEANOGRAPHIC RESEARCH INSTITUTE

Compiled for:	**Ponta do Ouro Partial Marine Reserve**
Funded by:	**Peace Parks Foundation**
Compiled by: **Michael H Schleyer**	**Oceanographic Research Institute**

The ORI Unpublished Report Series is intended to document various activities of the Oceanographic Research Institute. This is the research department of the South African Association for Marine Biological Research.

Oceanographic Research Institute
P.O. Box 10712
Marine Parade, 4056
Durban, KwaZulu-Natal, South Africa
Tel: +27 31 3288222
Fax: +27 31 3288188
Web site: www.ori.org.za

Title:	Results of a benthic survey of Baixo São João, Ponta do Ouro Partial Marine Reserve, Southern Mozambique
Creator:	M.H. Schleyer
Funding Agency:	Peace Parks Foundation
Keywords:	coral reefs, benthic surveys, coral cover, MPA
Description:	Baixo São João is a rocky massif in the northern section of the Ponta do Ouro Partial Marine Reserve, southern Mozambique. A benthic survey was conducted on the reef in July 2015 to investigate the merits of protecting it within a sanctuary. This involved point intercept analysis of photo-quadrat transects recorded in the northern, central and southern parts of the reef on the reef top and its inshore and offshore slopes. The coral community on the reef proved to be relatively rich and uniform within all reef zones, but with no unique or over-vulnerable species. Hard corals were predominant with a mean cover of 32.3%; the mean cover of soft corals was 12.8%. Little coral damage was evident and, despite not having any special attributes, the reef would warrant protection based on the following premises: It is remote, rendering human interference unlikely; it is located offshore in deeper water, protecting it from many of the potential effects of climate change; it could provide a coral breeding refuge for replenishment of more southern reefs; and it would provide a useful reference site for baseline and comparative studies. Furthermore, it is close to the ranger post at Milibangalala which could facilitate compliance.
Document Status	Final
Date Issued:	20 August 2015
Report Type:	Unpublished consultancy report
Latest Version	ORI_Unpub_Rep_323.doc
Language:	English
Coverage:	Ponta do Ouro Partial Marine Reserve, southern Mozambique
Distribution:	ORI Library, author, Peace Parks Foundation and Ponta do Ouro Partial Marine Reserve
Citation:	SCHLEYER, M.H. 2015. Results of a benthic survey of Baixo São João, Ponta do Ouro Partial Marine Reserve, Southern Mozambique. Oceanographic Research Institute, Durban: 10 pp. (ORI Unpublished Report 323).

Contents

EXECUTIVE SUMMARY

Baixo São João is a rocky massif in the northern section of the Ponta do Ouro Partial Marine Reserve, southern Mozambique. A benthic survey was conducted on the reef in July 2015 to investigate the merits of protecting it within a sanctuary. This involved point intercept analysis of photo-quadrat transects recorded in the northern, central and southern parts of the reef on the reef top and its inshore and offshore slopes. The coral community on the reef proved to be relatively rich and uniform within all reef zones, but with no unique or over-vulnerable species. Hard corals were predominant with a mean cover of 32.3%; the mean cover of soft corals was 12.8%. Little coral damage was evident and, despite not having any special attributes, the reef would warrant protection based on the following premises: It is remote, rendering human interference unlikely; it is located offshore in deeper water, protecting it from many of the potential effects of climate change; it could provide a coral breeding refuge for replenishment of more southern reefs; and it would provide a useful reference site for baseline and comparative studies. Furthermore, it is close to the ranger post at Milibangalala which could facilitate compliance.

1. INTRODUCTION

Coral reefs are declining globally and this is attributed to a variety of human-related disturbances (Wilkinson 2008). Such reefs are rich in biodiversity making them a focal point for fishing, tourism and scuba diving. This renders them valuable as an economic resource to local communities and recreational stakeholders.

Baixo São João lies in the northern section of the Ponta Do Ouro Partial Marine Reserve, just south of Inhaca Island. It was superficially surveyed when the development potential of the southern Mozambique coast was assessed in 1996, at which time the mean benthic cover was visually estimated to be 33% (Robertson et al., 1996). More recent visits by scientists indicated that this has improved, resulting in this project to investigate whether the reef warrants protection within a sanctuary as it is remote and thus not subjected to much human interference.

2. METHODS

2.1 STUDY SITE

Baixo São João is a rocky massif lying approximately 4 km off the southern Mozambican coast between ~26.351°S -26.363°S at ~32.974°E. It appears similar in structure to the reefs known as Baixo Danae north of Inhaca Island and Aliwal Shoal south of Durban in KwaZulu-Natal. These consist of dune rock known as aeolianite, derived from beach dunes that fossilised prior to the most recent rise in sea levels (Ramsay, 1996). Baixo São João thus runs parallel to the coast and is a large reef with a smaller side-branch bifurcating from its southern base (Fig. 1). It is just over 1 km long, is ~400 m wide at the widest point, and rises from a depth of ~30 m at its periphery to 12 m at its crest.

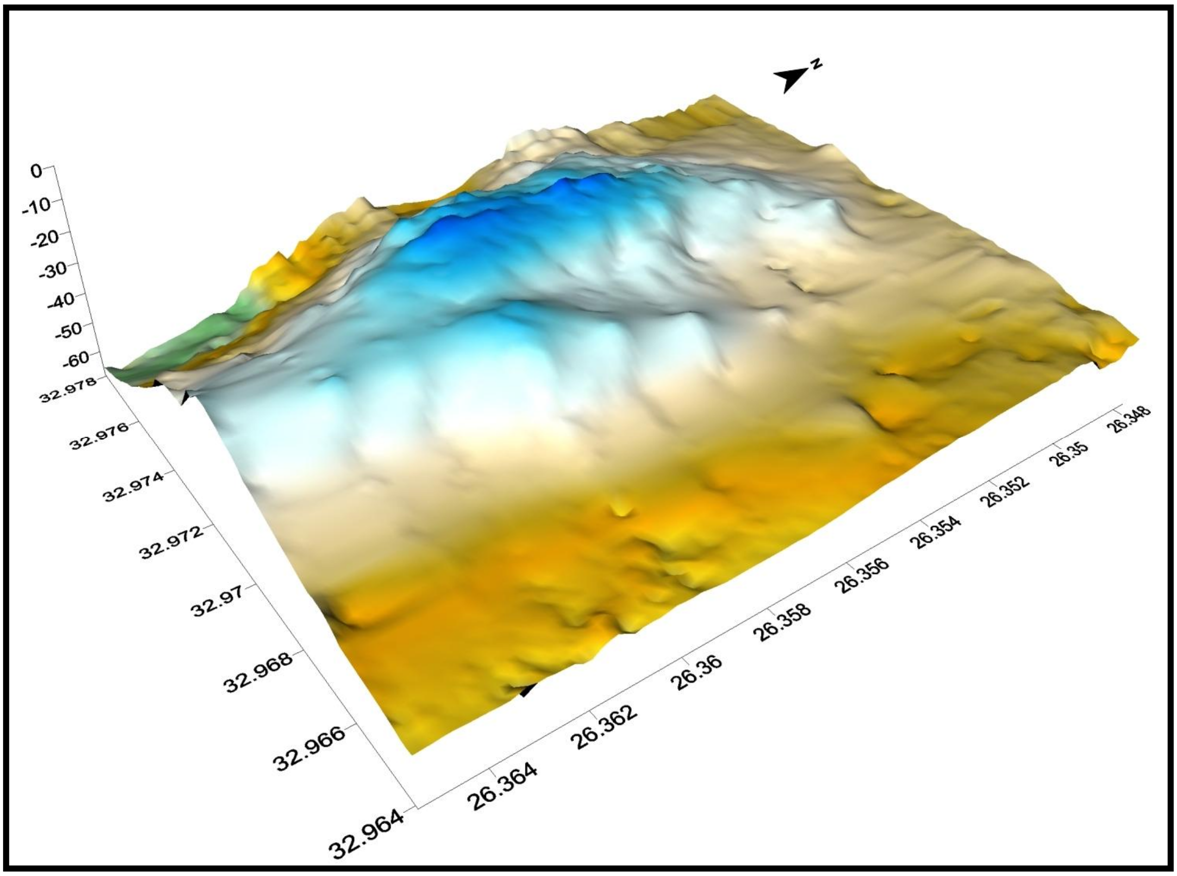

Fig. 1. Bathymetry and coordinates for Baixo São João. (Source: Marcos Pereira, CTV)

2.2 SURVEY METHODS

The reef surveys were undertaken on 24 and 25 July 2015 using SCUBA and a digital camera in an underwater housing. Transects were recorded within bathymetric and physiognomic zones for laboratory analysis, these being in the northern, central and southern (N, C, S) parts of the reef on the reef top and its inshore and offshore slopes (T, I, O). The photographs were taken while swimming with the camera held at right angles to the reef face at a distance of 93 cm, the latter being regulated by a spacer bar attached to the camera housing. The area photographed in each camera frame was thus constant, being 0.32 m^2, and the distance between each photograph was 2-4 m, this being dictated by a pause in the camera recording system. The path of the transects was tracked using a floating GPS.

2.3 DATA ANALYSIS

Data were extracted from the reef transects employing a point-intercept technique in which the photographic images, or photo-quadrats, were screened on a computer as JPEG images using Coral Point Count with Excel extensions (CPCe) software (http://www.nova.edu/ocean/cpce/). The biota or substrata underlying ten randomly-placed points were recorded to at least genus level, where possible. The number of intercepts in each category was considered to be directly proportional to the planar area covered by that category (Carleton & Done, 1995); percentage cover could therefore be calculated using the CPCe software. This yielded information on the community structure of the benthos at the sampling sites and the untransformed data were subsequently subjected to similarity analysis using Primer (http://www.primer-e.com/).

4. RESULTS

A total number of 721 photographs were recorded within eight transects (Table 1). More were planned but severely inclement weather prevented their execution. Low underwater visibility also made identification of the benthos beyond genus dubious in many cases and data were thus only extracted and analysed to the generic level.

Table 1. List of transects undertaken on Baixo São João and the number of photo-quadrats recorded in each. N, C and S denote the north, central and south regions; I, T, and O denote the inner slope, reef top and outer slope respectively.

	Reef zone							
	NI	NT	NO	CT	CO	SI	ST	SO
N	53	150	80	54	90	88	184	22
Depth (m)	15-23	12-15	15-20	12-18	18-26	14-18	12-14	15-22

In structure, the reef itself was not rugose and offered little topographic variation to the life it harboured and supported (Frontispiece and Fig. 2). Results of CPCe analysis of the photo-quadrats (Table 2) revealed that the mean (±SD) algal cover (17.5±16.5%), primarily in the form of algal turf and coralline encrustations, was high on the reef. Hard corals were predominant with a mean cover of 32.3±25.3%; the mean cover of soft corals was 12.8±21.9%. *Montipora* (13.5±19.2%), *Astreopora* (5.7±14.2%), *Pocillopora* (3.6±7.8%) and *Acropora* (3.0±9.3%) were the most abundant hard corals and *Sinularia* (8.8±20.0%) the most abundant soft coral. Substrata devoid of living material (e.g. bare reef, sand, old dead coral) comprised 34.3±21.1% of the reef surface. Indeed, much of the surface of the reef was lightly coated with sand. Little coral damage, disease or mortality was observed on the reef (pers. obs. and DC in Table 2). The calculated means yielded high standard deviations; these were indicative of the relatively low sampling intensity imposed by the inclement weather and logistical constraints, as well as patchiness in the distribution of the benthos.

Further analysis of the CPCe data within the different reef zones revealed fine nuances in the differential abundance of the major biota (Table 3). Multiple dimensional analysis of these data showed that the reef top results were similar, as were those collected on the inner reef slopes; the results for the outer reef slopes were divergent (Fig. 3). Differences in the abundance of biota that seemed responsible for this divergence were *Alveopora*, *Montipora*, *Sinularia* and the algae (Table 4). Nevertheless, the levels of similarity between all the reef zones were high (Table 5).

Finally, apart from the biota listed in Table 3, a few other organisms were encountered amongst the benthos on Baixo São João. These were the sea cucumber *Holothuria nobilis*, the giant anemone *Heteractis magnifica* and the hard coral *Goniopora*. While sponges were grouped together in the analyses, *Theonella* was notably abundant and *Jaspis* and *Callyspongia* were also encountered.

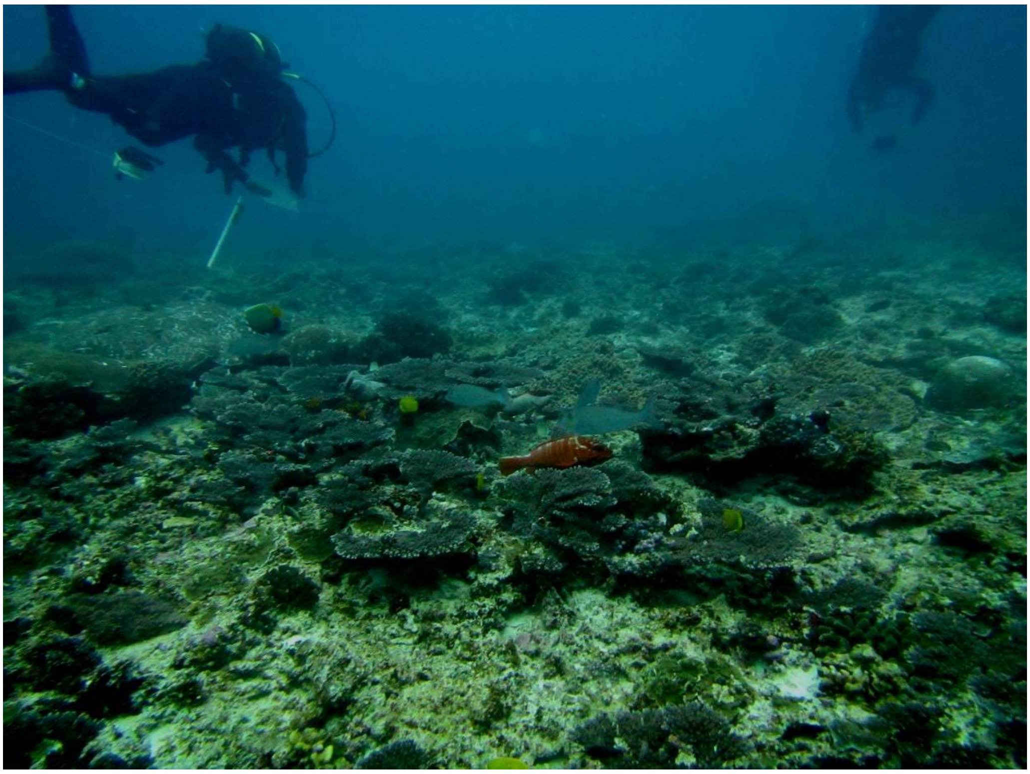

Fig. 2. View of Baixo São João showing its relatively flat profile. (Photo: Raquel Fernandes, CTV)

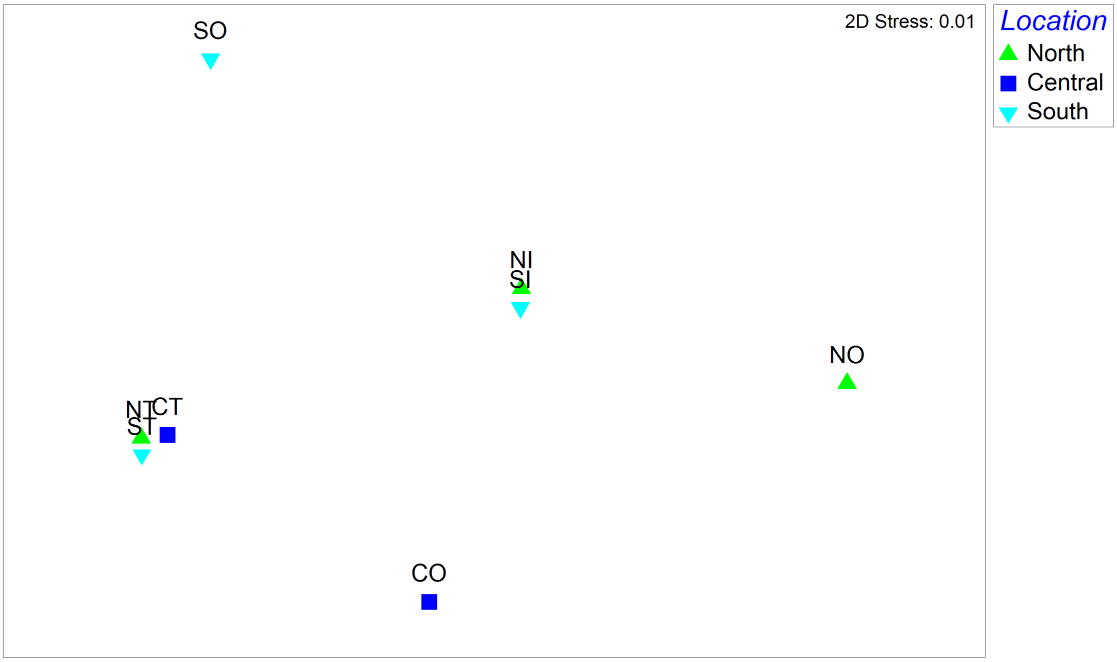

Fig. 3. Multi-dimensional analysis of the CPCE results from transects in the different reef zones on Baixo São João. N, C and S denote the north, central and south regions; I, T, and O denote the inner slope, reef top and outer slope respectively.

Table 2. List of living biota and non-living substrata recorded in photo-quadrats on Baixo São João with their percentage cover (±SD). Information in bold is referred to in the text.

CATEGORIES	% cover	SD	CATEGORIES	% cover	SD
Hard coral			**Soft coral**		
Acanthastrea	0.4	2.8	*Lobophytum*	1.1	6.9
Acropora	**3.0**	9.3	*Rumphella*	<0.1	1.5
Alveopora	1.5	10.4	*Sarcophyton*	1.1	6.7
Astreopora	**5.8**	**14.2**	***Sinularia***	**8.8**	**20.0**
Coscinaraea	<0.1	0.6	*Stereonephthya*	<0.1	0.6
Cyphastrea	<0.1	0.4	*Tubipora*	<0.1	1.1
Echinopora	1.1	7.0	**Other Cnidaria**		
Favia	0.4	2.3	Corallomorpharia	<0.1	0.4
Favites	0.7	3.6	**Bivalves**		
Fungia	<0.1	0.4	*Tridacna*	<0.1	0.8
Galaxea	<0.1	0.8	**Macroalgae**		
Goniastrea	0.2	1.9	Macroalgae	**0.1**	**1.1**
Goniopora	<0.1	0.4	*Padina*	**<0.1**	**0.4**
Gyrosmilia	<0.1	0.8	Turf	**14.6**	**15.5**
Hydnophora	<0.1	0.8	**Other live**		
Leptoria	<0.1	0.8	*Diplosoma*	0.2	2.2
Montastrea	<0.1	0.4	*Diadema*	0.1	1.0
Montipora	**13.5**	19.2	Sea urchin	<0.1	0.8
Mycedium	<0.1	0.4	Sponges	0.4	3.3
Other poritids	<0.1	0.8	**Dead coral (DC)**		
Oulophyllia	0.2	1.9	DC + algae	**0.1**	**1.5**
Platygyra	0.8	4.1	Old DC	**0.8**	**3.0**
Pocillopora	**3.6**	7.8	Recent DC	**0.6**	**2.5**
Porites	1.3	7.3	**Coralline Algae**		
Psammocora	<0.1	0.4	Coralline algae	2.7	0.8
Turbinaria	<0.1	0.8	**Bare reef, sand,**		
Other faviids	0.4	2.3	Bare reef	**21.4**	**17.4**
Soft coral			Rubble	**6.9**	**12.3**
Anthelia	0.8	3.4	Sand	**5.3**	**10.1**
Cladiella	0.9	5.0	**Unknown**		
Dendronephthya	<0.1	0.8	Unknown	1.0	2.7

Table 3. Results of CPCe analysis of data extracted from the photo-quadrats recorded on Baixo São João; only the first 15 records are presented. N, C and S denote the north, central and south regions; I, T, and O denote the inner slope, reef top and outer slope respectively; numbers in parentheses after the transect codes are the number of genera recorded in the photo-quadrats.

NO (18)		**NT (29)**		**NI (23)**		**CO (33)**		**CT (24)**		**SI (25)**		**ST (28)**		**SO (14)**	
Taxon	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**
Algae	36	*Montipora*	27	Algae	34	Algae	27	Algae	26	Algae	38	*Sinularia*	23	*Montipora*	36
Alveopora	23	Algae	21	*Astreopora*	20	*Montipora*	18	*Montipora*	24	*Astreopora*	19	*Montipora*	23	Algae	34
Astreopora	16	*Sinularia*	13	*Montipora*	17	*Sinularia*	13	*Sinularia*	13	*Montipora*	18	*Algae*	23	Sponges	7
Montipora	6	*Acropora*	9	*Acropora*	4	*Astreopora*	11	*Pocillopora*	7	*Sinularia*	6	*Pocillopora*	8	*Acropora*	7
Sinularia	6	*Pocillopora*	6	*Echinopora*	4	*Porites*	7	*Acropora*	6	*Pocillopora*	3	*Acropora*	6	*Pocillopora*	4
Pocillopora	4	*Astreopora*	4	*Porites*	4	*Echinopora*	6	*Astreopora*	4	*Acropora*	2	*Astreopora*	5	*Astreopora*	2
Porites	3	*Sarcophyton*	3	*Sinularia*	3	*Sarcophyton*	3	*Cladiella*	4	*Anthelia*	2	*Lobophytum*	2	*Favia*	2
Sarcophyton	2	*Lobophytum*	3	*Pocillopora*	3	*Lobophytum*	2	*Favites*	2	*Favites*	2	*Anthelia*	1	*Goniastrea*	2
Platygyra	1	*Cladiella*	3	Other faviids	2	*Pocillopora*	2	*Platygyra*	2	*Sarcophyton*	1	*Acanthastrea*	1	*Porites*	2
Favites	1	*Platygyra*	2	*Favites*	1	*Cladiella*	2	*Porites*	2	*Platygyra*	1	*Cladiella*	1	*Sinularia*	2
Echinopora	<1	*Porites*	1	Other	1	*Anthelia*	1	Other faviids	2	*Porites*	1	*Sarcophyton*	<1	*Favites*	<1
Lobophytum	<1	*Anthelia*	1	*Platygyra*	1	*Favites*	1	*Lobophytum*	2	*Echinopora*	<1	*Echinopora*	<1	*Montastrea*	<1
Anthelia	<1	*Echinopora*	1	*Alveopora*	<1	*Oulophyllia*	1	*Echinopora*	1	*Diplosoma*	<1	*Platygyra*	<1	*Platygyra*	<1
Acanthastrea	<1	*Favia*	1	*Goniastrea*	<1	*Favia*	<1	Other	<1	Other faviids	<1	Sponges	<1	*Sarcophyton*	<1

Table 4. Results of CPCe analysis of the Baixo São João data grouped according to their separation by MDS analysis; only the first 15 records are presented. N, C and S denote the north, central and south regions; I, T, and O denote the inner slope, reef top and outer slope respectively. Information in bold is referred to in the text.

Reef top		Inner reef		Outer reef					
				N		Outer		S	
Taxon	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**	**Taxon**	**%**
Montipora	25	Algae	36	**Algae**	**36**	**Algae**	**27**	***Montipora***	**36**
Algae	23	*Astreopora*	19	***Alveopora***	**23**	***Montipora***	**18**	**Algae**	**34**
Sinularia	16	*Montipora*	17	*Astreopora*	16	***Sinularia***	**13**	Sponges	7
Pocillopora	7	*Sinularia*	5	***Montipora***	**6**	*Astreopora*	11	*Acropora*	6
Acropora	7	*Acropora*	3	***Sinularia***	**5**	*Porites*	7	*Pocillopora*	4
Astreopora	4	*Pocillopora*	3	*Pocillopora*	4	*Echinopora*	6	*Astreopora*	2
Cladiella	3	*Echinopora*	2	*Porites*	3	*Sarcophyton*	3	*Favia*	2
Lobophytum	2	*Porites*	2	*Sarcophyton*	2	*Lobophytum*	2	*Goniastrea*	2
Platygyra	2	*Favites*	2	*Platygyra*	1	*Pocillopora*	2	*Porites*	2
Sarcophyton	1	*Anthelia*	1	*Favites*	1	*Cladiella*	2	***Sinularia***	**2**
Favites	1	Other faviids	1	*Echinopora*	<1	*Anthelia*	1	*Favites*	<1
Porites	1	*Platygyra*	1	*Lobophytum*	<1	*Favites*	1	*Montastrea*	<1
Echinopora	1	Other	<1	*Anthelia*	<1	*Oulophyllia*	1	*Platygyra*	<1
Anthelia	1	*Sarcophyton*	<1	*Acanthastrea*	<1	*Favia*	<1	*Sarcophyton*	<1

Table 5. Levels of similarity between the different reef zones on Baixo São João generated by Primer SIMPER analysis. N, C and S denote the north, central and south regions; I, T, and O denote the inner slope, reef top and outer slope respectively.

	NO	**NT**	**NI**	**CO**	**CT**	**SI**	**ST**
NT	48.14						
NI	69.70	60.46					
CO	59.12	73.26	72.99				
CT	51.98	86.43	68.71	74.09			
SI	72.18	64.25	84.57	73.35	67.95		
ST	47.67	83.25	60.90	71.13	83.16	64.01	
SO	51.73	67.49	66.38	56.92	68.94	64.92	63.21

5. DISCUSSION

While Baixo São João is a massive underwater structure, the reef itself is fairly low in profile and offers relatively little topographical variation to the life it harbours and supports. Two quantitative assessments of the benthos have been undertaken: the present study and that of Robertson et al. (1996). It is apparent that the coral cover has changed between these surveys and is presently higher (45%) than it was in 1996 (33%). Furthermore, the most abundant hard coral genera on the reef (*Acropora*, *Astreopora*, *Montipora*, *Pocillopora*) are known for their rapid growth. Thus, it is possible that the coral abundance on Baixo São João varies with fluctuations in the populations of these genera. Since the reef topography is low, such fluctuations may be caused by high turbulence, high turbidity and substantial sand movement. Evidence for this can be found in the strong currents that flow over the reef, the widespread distribution of sediment on its surface, and the absence of fragile coral genera. Examples of these amongst the hard corals would be *Blastomussa*, *Leptoseris*, *Seriatopora*, *Stylophora* and certain fungiids; and amongst the soft corals, *Heteroxenia* and *Xenia*. These are relatively common on more sheltered reefs in the region.

Reefs immediately to the south and closer inshore have higher coral cover and diversity. Cover ≥65% has been recorded at Techobanine (Pereira, 2003) and on South African reefs (Schleyer, 2000), 55 genera being recorded on the latter compared to the 34 genera on Baixo São João. While a greater diversity of corals would undoubtedly be found on Baixo São João with more extensive study, it must be borne in mind that the variety of habitat on this reef is limited. Furthermore, environmental conditions on the reef would preclude its colonisation by the aforementioned fragile genera.

Based on these facts, Baixo São João would thus seem to have little merit that would warrant its protection within a sanctuary. However, other factors must be considered. Baixo Danae, some 50 km to the north, is similar in many respects to Baixo São João, but is more accessible and is heavily dived and fished (unpublished data). Aliwal Shoal, in turn, lies 500 km further south and is thus below the latitudinal limits for extensive coral growth. It falls within a marine protected area but is heavily dived and was largely 'fished out' before it received protection (Olbers et al., 2009). Baixo São João thus has unique attributes within the region. Its coral communities, although not as rich as those on some inshore reefs, are in good condition. The reef is remote and manifested little damage during the survey: it appears to be naturally protected from human disturbance. It is also located offshore in deeper water, which will protect it to some extent from the coastward drift of warmer water associated with climate change; this should give it a measure of protection from coral bleaching (Graham et al., 2015). Corals on deeper reefs of this nature are also known to be more fecund (Holstein et al., 2015) and Baixo São João could provide a coral breeding refuge for replenishment of more southern reefs. Another fact to consider is that it is close to the ranger post at Milibangalala which could facilitate compliance if it were proclaimed a sanctuary. Finally, it would provide a useful reference site for baseline and comparative studies if protected. This may seem a mundane reason for its protection but the value of such sites is often not appreciated. Too often it is difficult to establish whether changes in environments used by humans are attributable to anthropogenic disturbance or natural events; sites such as Baixo São João could provide decisive evidence in this regard if protected.

In conclusion, there certainly is a case for the protection of Baixo São João within a sanctuary.

6. ACKNOWLEDGEMENTS

This study was funded by the Peace Parks Foundation. Field support was provided by Mark Eardley and the other survey participants; logistical support was provided by the Ponta do Ouro Partial Marine Reserve and Anvil Bay Lodge at Chemucane. Oceana Diving kindly provided diving equipment for the expedition and Dr Sean Porter undertook the data analyses with Primer.

7. REFERENCES

OLBERS, J.M., CELLIERS, L., SCHLEYER, M.H. 2009. Zonation of benthic communities on the subtropical Aliwal Shoal, Durban, KwaZulu-Natal, South Africa. African Zoology 44: 8-23.

CARLETON, J.H., DONE, T.J. 1995. Quantitative video sampling of coral reef benthos: Large-scale application. Coral reefs 14:35-46.

GRAHAM, N.A.J., JENNINGS, S., MACNEIL, M.A., MOUILLOT, D., WILSON, S.K. 2015 Predicting climate-driven regime shifts versus rebound potential in coral reefs. Nature 518: 94–97.

HOLSTEIN, D.M., SMITH, T.B., GYORY, J., PARIS, C.B. 2015. Fertile fathoms: Deep reproductive refugia for threatened shallow corals. Scientific Reports 5: 12407; doi: 10.1038/srep12407.

PEREIRA, M.A.M. 2003. Recreational SCUBA diving and reef conservation in southern Mozambique. MSc thesis, University of Natal, 109 pp.

SCHLEYER, M.H. 2000. South African coral communities. In: McCLANAHAN, T., SHEPPARD, C. & OBURA, D., eds. Coral reefs of the Indian Ocean: Their ecology and conservation. Oxford University Press, New York, pp 83-105.

RAMSAY, P.J. 1996. Quaternary marine geology of the Sodwana Bay continental shelf, northern KwaZulu-Natal. Bulletin of the Geological Survey of South Africa (117): 1-86.

ROBERTSON, W.D., SCHLEYER, M.H., FIELDING, P.J., TOMALIN, B.J., BECKLEY, L.E., FENNESSY, S.T., VAN DER ELST, R.P., BANDEIRA, S., MACIA, A. & GOVE, D. 1996. Inshore marine resources and associated opportunities for development of the coast of southern Mozambique: Ponta Do Oura to Cabo de Santa Maria. Unpublished Report. Oceanographic Research Institute (130): 1-51.

WILKINSON, C. (ed.) 2008. Status of Coral Reefs of the World: 2008. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia, 298 pp.