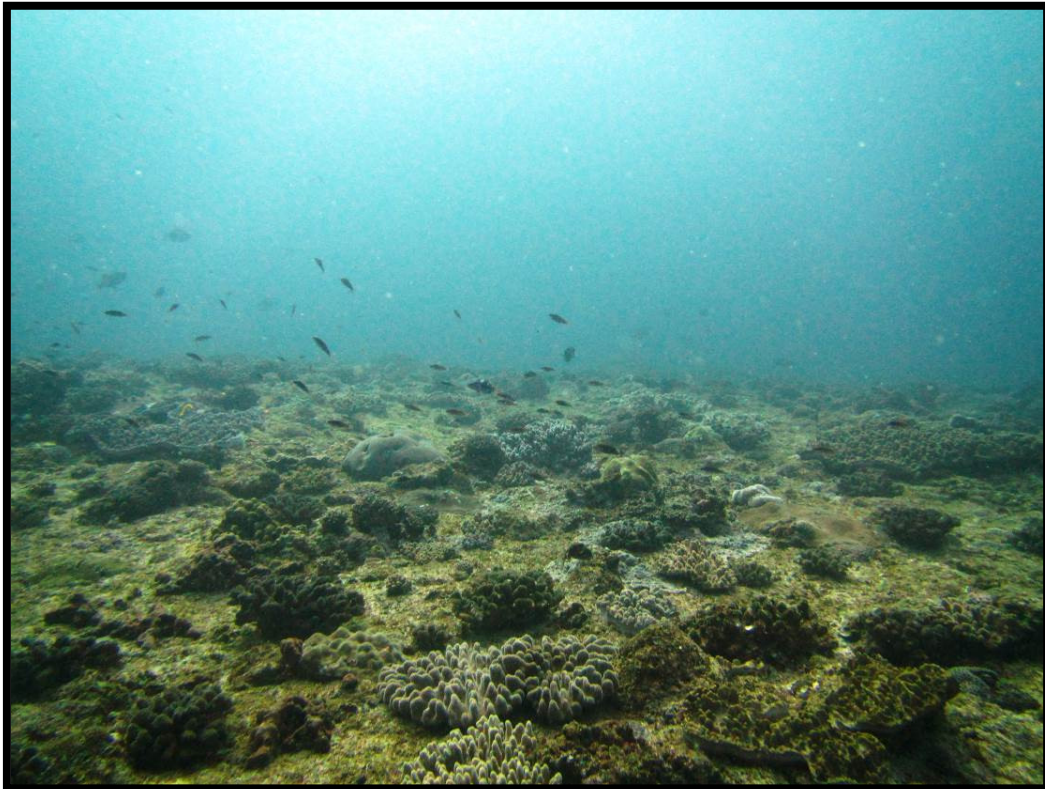


**AN ASSESSMENT OF THE CORAL AND FISH COMMUNITIES AT  
BAIXO SÃO JOÃO, PONTA DO OURO PARTIAL MARINE RESERVE**



**Relatório de Investigação N°7**

**Por**

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and  
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**Centro Terra Viva - Estudos e Advocacia Ambiental  
Ouro**

**Reserva Marinha Parcial da Ponta do**

e

O Centro Terra Viva (CTV) e a Reserva Marinha Parcial da Ponta do Ouro (RMPPPO), assinaram em Setembro de 2013 um Memorando de Entendimento (MdE) com vista ao desenvolvimento de actividades relacionadas com investigação e monitoria de espécies e ecossistemas na RMPPPO, promovendo a sua protecção e conservação. A presente publicação resulta de actividades desenvolvidas no âmbito deste MdE.

*Centro Terra Viva (CTV) and the Ponta do Ouro Partial Marine Reserve (POPMR) have established in September 2013 a Memorandum of Understanding (MoU) in order to develop several activities related to research and monitoring of species and ecosystems within the POPMR, promoting their protection and conservation. The present publication is a result of activities undertaken under the MoU.*

#### **Citação Sugerida:**

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**Cover:** Typical view of Baixo São João, with high coral cover and relative relatively flat profile. Photo: Raquel Fernandes.

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## ABSTRACT

Baixo São João is a rocky massif in the northern section of the Ponta do Ouro Partial Marine Reserve, southern Mozambique. A benthic and fish 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. Semi-quantitative, visual techniques were used to superficially describe the fish community. 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%. A total of 97 species of reef fish, in 30 families, were observed. Relatively large specimens (>30 cm) were common, including species of commercial importance, as well as top predators such as the potato bass (*Epinephelus tukula*) and several species of sharks and rays, which gives a good indication of the status of the fish fauna. Little coral damage was evident and, despite not having any special attributes, the reef would warrant protection based on the following premises: i) it is remote, rendering human interference unlikely; ii) 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 iii) 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.

## RESUMO

O Baixo São João é um maciço rochoso localizado na secção norte da Reserva Marinha Parcial da Ponta do Ouro, sul de Moçambique. Um estudo das comunidades bentónicas e ictiológicas foi conduzido em Julho de 2015 para investigar o mérito de se elevar o estatuto de protecção do recife, num santuário. Este envolveu a análise de intercepção de pontos em transectos de foto-quadratos registados nas zonas sul, centro e norte do recife, incluindo a zona topo, e declives interiores e exteriores. Técnicas visuais semi-quantitativas foram usadas para descrever superficialmente as comunidades ictiológicas. A comunidade de coral mostrou-se relativamente rica e uniforme em todas as zonas do recife, mas sem nenhuma espécie única ou especialmente vulnerável. Os corais duros dominaram com uma cobertura média de 32.3%; a cobertura média dos corais moles foi de 12.8%. Um total de 97 espécies de peixes de recife, em 30 famílias, foram observadas. Exemplos de tamanho relativamente grande (>30 cm) eram comuns incluindo espécies de interesse comercial, além de predadores de topo como a garoupa batata (*Epinephelus tukula*) e várias espécies de tubarões e raias, o que dá uma boa indicação do estado de conservação da ictiofauna. Muito poucos danos aos corais foram observados e, apesar de não possuir atributos especiais, o recife necessita de protecção adicional, baseado em: i) está localizado numa zona remota, com pouca interferência humana; ii) está localizado relativamente longe da costa em águas profundas, o que o protege de muitos potenciais efeitos das mudanças climáticas; poderá providenciar um refúgio de reprodução de coral para a repopulação de recifes localizados mais a Sul; e iii) poderá servir de base de referência, muito útil para estudos comparativos futuros. Adicionalmente, está localizado perto do posto de fiscalização de Milibangalala, o que poderá facilitar o seu controlo.

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## 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. MATERIALS AND METHODS

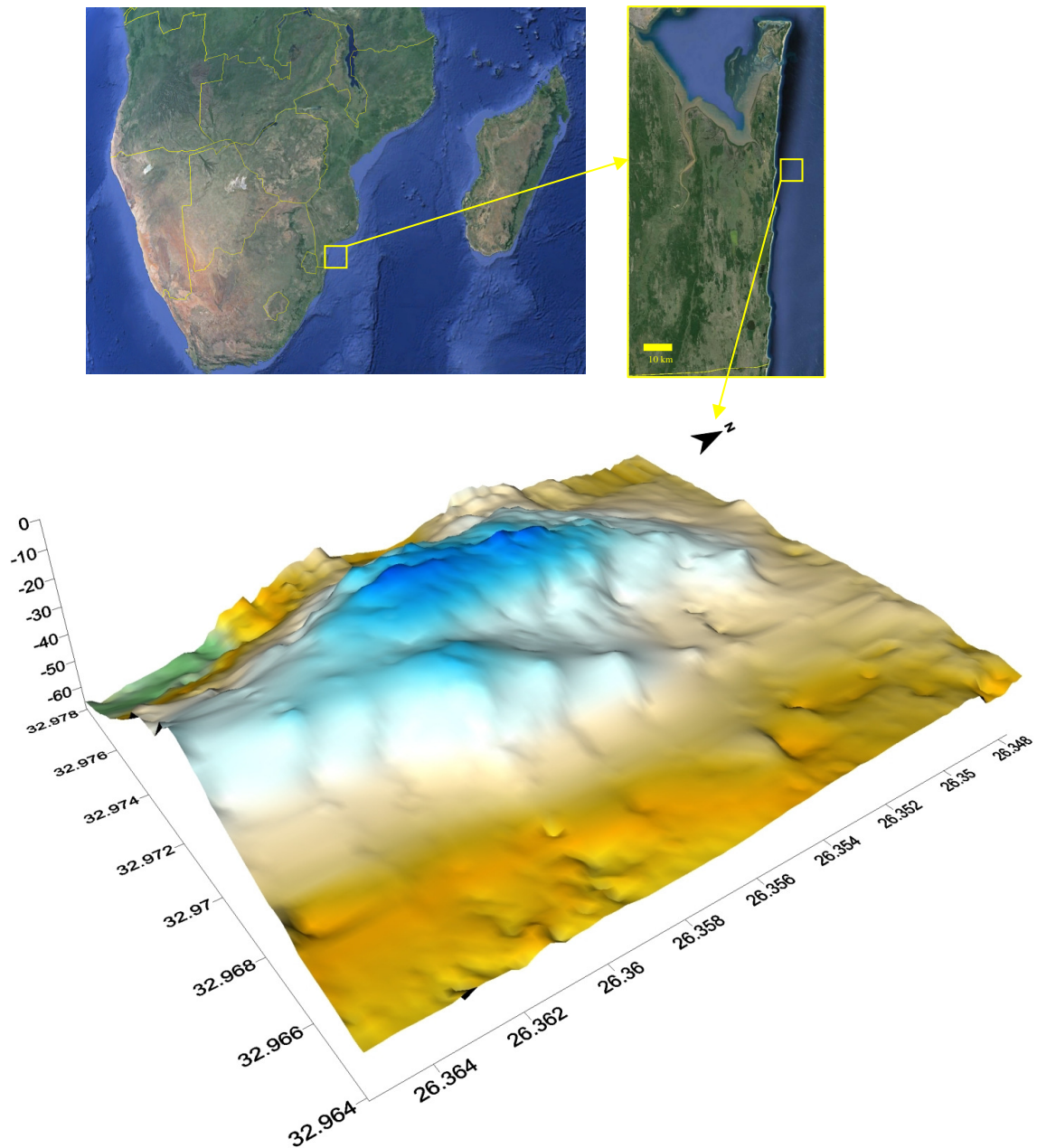
### 2.1. Study Area

Baixo São João is a rocky massif lying approximately 4 km off the southern Mozambican coast between  $\sim 26.351^{\circ}\text{S}$  -  $26.363^{\circ}\text{S}$  at  $\sim 32.974^{\circ}\text{E}$ . 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 (Figure 1). It is just over 1 km long, is  $\sim 400$  m wide at the widest point, and rises from a depth of  $\sim 30$  m at its periphery to 12 m at its crest.

### 2.2. Data Collection

Data was collected from 22 to 25 July 2015. The preliminary bathymetry study was conducted using a GPS/fishfinder combo (Garmin GPSMap 441s), before the reef surveys. Using a pre-determined grid that was superimposed on existing nautical charts, data on depth and geographical coordinates were collected along the reef and analysed using Surf 12 software, according to the methodology described by Heyman et al. (2007). The tridimensional reef structure representation (Figure 1), was then used to, determine the locations of the benthic surveys.

Reef surveys were conducted 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  $0.32\text{ m}^2$ , and the distance between each photograph was 2-4 m, this being dictated by a pause in the camera recording system (Nikon Coolpix 4800). The path of the transects was tracked using a floating GPS (Garmin eTrex). Fish communities were assessed visually, using a semi-quantitative method for abundance, whereas the species observed were assigned to three categories: presents ( $< 5$  individuals), common (6-10) and abundant ( $> 10$ ).



*Figure 1. Location, bathymetry and coordinates for Baixo São João., Reserva Marinha Parcial da Ponta do Ouro.*

### 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>; Kohler & Gill, 2006). 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>).



### 3. RESULTADOS

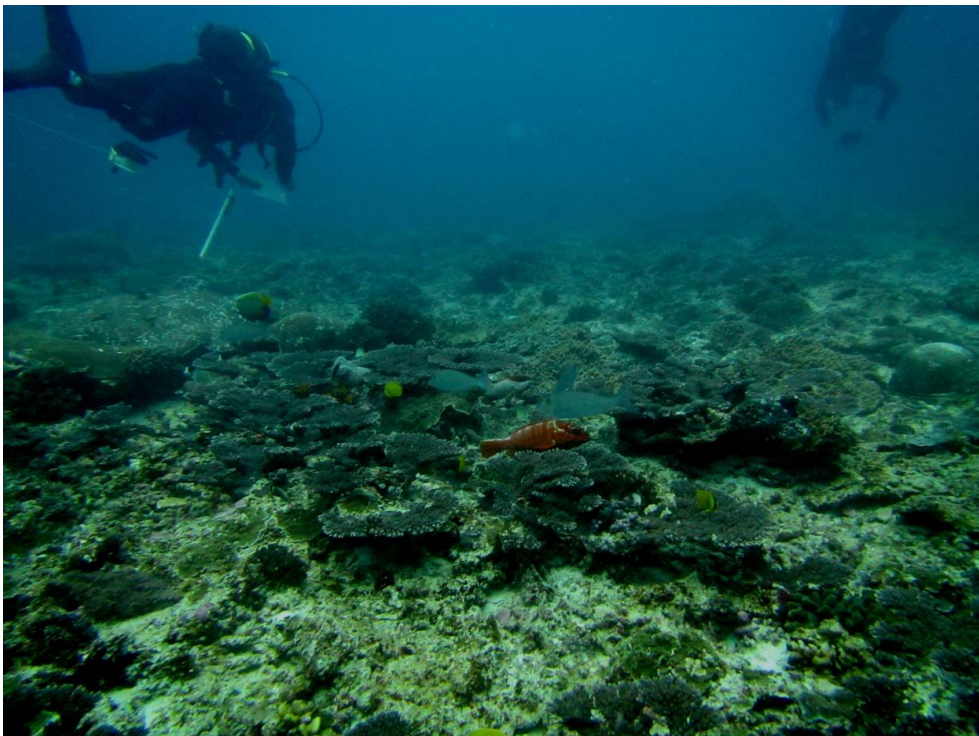
#### 3.1. Coral Communities

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
Nº	53	150	80	54	90	88	184	22
Dept (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 Figure 2). Results of CPCe analysis of the photo-quadrats (Table 2) revealed that the mean ( $\pm$ SD) algal cover ( $17.5\pm 16.5\%$ ), primarily in the form of algal turf and coralline encrustations, was high on the reef. Hard corals were predominant with a mean cover of  $32.3\pm 25.3\%$ ; the mean cover of soft corals was  $12.8\pm 21.9\%$ . *Montipora* ( $13.5\pm 19.2\%$ ), *Astreopora* ( $5.7\pm 14.2\%$ ), *Pocillopora* ( $3.6\pm 7.8\%$ ) and *Acropora* ( $3.0\pm 9.3\%$ ) were the most abundant hard corals and *Sinularia* ( $8.8\pm 20.0\%$ ) the most abundant soft coral. Substrata devoid of living material (e.g. bare reef, sand, old dead coral) comprised  $34.3\pm 21.1\%$  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).

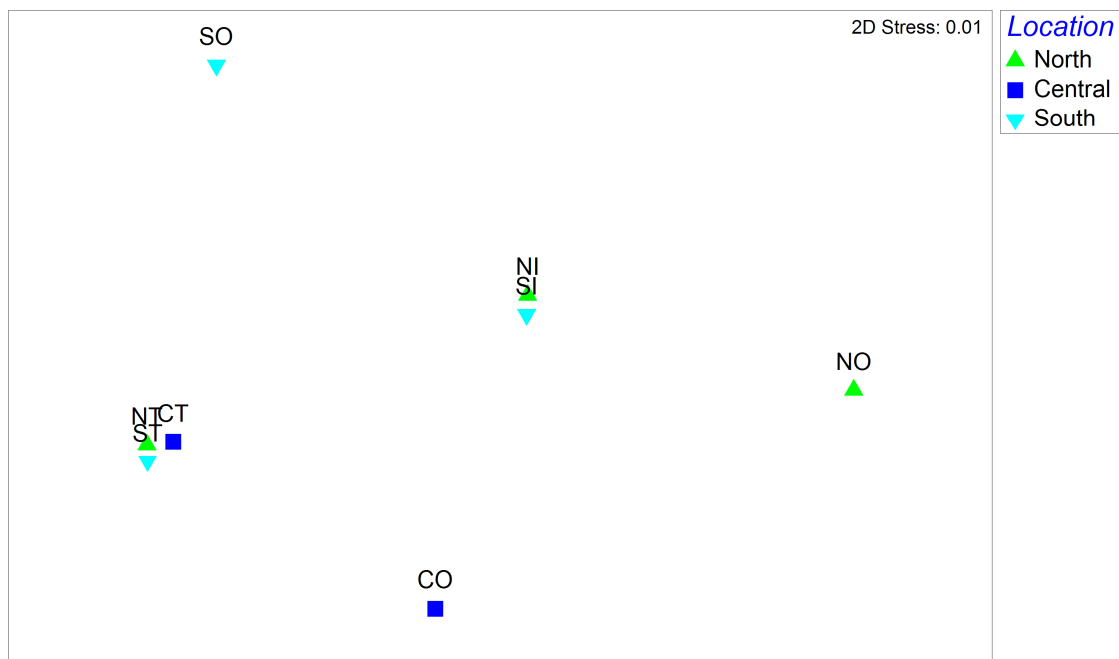


**Figure 2.** View of Baixo São João showing its relatively flat profile. (Photo: Raquel Fernandes, CTV).

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.



**Figure 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 ( $\pm$ SD). Information in bold is referred to in the text.

CATEGORIES	% cover	SD	CATEGORIES	% cover	SD
<b>Hard coral</b>			<b>Soft coral (cont.)</b>		
<i>Acanthastrea</i>	0.4	2.8	<i>Lobophytum</i>	1.1	6.9
<b><i>Acropora</i></b>	<b>3.0</b>	9.3	<i>Rumphella</i>	<0.1	1.5
<i>Alveopora</i>	1.5	10.4	<i>Sarcophyton</i>	1.1	6.7
<b><i>Astreopora</i></b>	<b>5.8</b>	<b>14.2</b>	<b><i>Sinularia</i></b>	<b>8.8</b>	<b>20.0</b>
<i>Coscinaraea</i>	<0.1	0.6	<i>Stereonephthya</i>	<0.1	0.6
<i>Cyphastrea</i>	<0.1	0.4	<i>Tubipora</i>	<0.1	1.1
<i>Echinopora</i>	1.1	7.0	<b>Other Cnidaria</b>		
<i>Favia</i>	0.4	2.3	Corallomorpharia	<0.1	0.4
<i>Favites</i>	0.7	3.6	<b>Bivalves</b>		
<i>Fungia</i>	<0.1	0.4	<i>Tridacna</i>	<0.1	0.8
<i>Galaxea</i>	<0.1	0.8	<b>Macroalgae</b>		
<i>Goniastrea</i>	0.2	1.9	Macroalgae	<b>0.1</b>	<b>1.1</b>
<i>Goniopora</i>	<0.1	0.4	<i>Padina</i>	<b>&lt;0.1</b>	<b>0.4</b>
<i>Gyrosmlia</i>	<0.1	0.8	Turf	<b>14.6</b>	<b>15.5</b>
<i>Hydnophora</i>	<0.1	0.8	<b>Other live</b>		
<i>Leptoria</i>	<0.1	0.8	<i>Diplosoma</i>	0.2	2.2
<i>Montastrea</i>	<0.1	0.4	<i>Diadema</i>	0.1	1.0
<b><i>Montipora</i></b>	<b>13.5</b>	19.2	Sea urchin	<0.1	0.8
<i>Mycedium</i>	<0.1	0.4	Sponges	0.4	3.3
Other poritids	<0.1	0.8	<b>Dead coral (DC)</b>		
<i>Oulophyllia</i>	0.2	1.9	DC + algae	<b>0.1</b>	<b>1.5</b>
<i>Platygyra</i>	0.8	4.1	Old DC	<b>0.8</b>	<b>3.0</b>
<b><i>Pocillopora</i></b>	<b>3.6</b>	7.8	Recent DC	<b>0.6</b>	<b>2.5</b>
<i>Porites</i>	1.3	7.3	<b>Coralline Algae</b>		
<i>Psammocora</i>	<0.1	0.4	Coralline algae	2.7	0.8
<i>Turbinaria</i>	<0.1	0.8	<b>Bare reef, sand,</b>		
Other faviids	0.4	2.3	Bare reef	<b>21.4</b>	<b>17.4</b>
<b>Soft coral</b>			Rubble	<b>6.9</b>	<b>12.3</b>
<i>Anthelia</i>	0.8	3.4	Sand	<b>5.3</b>	<b>10.1</b>
<i>Cladiella</i>	0.9	5.0	<b>Unknown</b>		
<i>Dendronephthya</i>	<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	<i>Montipora</i>	27	Algae	34	Algae	27	Algae	26	Algae	38	<i>Sinularia</i>	23	<i>Montipora</i>	36
<i>Alveopora</i>	23	Algae	21	<i>Astreopora</i>	20	<i>Montipora</i>	18	<i>Montipora</i>	24	<i>Astreopora</i>	19	<i>Montipora</i>	23	Algae	34
<i>Astreopora</i>	16	<i>Sinularia</i>	13	<i>Montipora</i>	17	<i>Sinularia</i>	13	<i>Sinularia</i>	13	<i>Montipora</i>	18	Algae	23	Sponges	7
<i>Montipora</i>	6	<i>Acropora</i>	9	<i>Acropora</i>	4	<i>Astreopora</i>	11	<i>Pocillopora</i>	7	<i>Sinularia</i>	6	<i>Pocillopora</i>	8	<i>Acropora</i>	7
<i>Sinularia</i>	6	<i>Pocillopora</i>	6	<i>Echinopora</i>	4	<i>Porites</i>	7	<i>Acropora</i>	6	<i>Pocillopora</i>	3	<i>Acropora</i>	6	<i>Pocillopora</i>	4
<i>Pocillopora</i>	4	<i>Astreopora</i>	4	<i>Porites</i>	4	<i>Echinopora</i>	6	<i>Astreopora</i>	4	<i>Acropora</i>	2	<i>Astreopora</i>	5	<i>Astreopora</i>	2
<i>Porites</i>	3	<i>Sarcophyton</i>	3	<i>Sinularia</i>	3	<i>Sarcophyton</i>	3	<i>Cladiella</i>	4	<i>Anthelia</i>	2	<i>Lobophytum</i>	2	<i>Favia</i>	2
<i>Sarcophyton</i>	2	<i>Lobophytum</i>	3	<i>Pocillopora</i>	3	<i>Lobophytum</i>	2	<i>Favites</i>	2	<i>Favites</i>	2	<i>Anthelia</i>	1	<i>Goniastrea</i>	2
<i>Platygyra</i>	1	<i>Cladiella</i>	3	Other faviids	2	<i>Pocillopora</i>	2	<i>Platygyra</i>	2	<i>Sarcophyton</i>	1	<i>Acanthastrea</i>	1	<i>Porites</i>	2
<i>Favites</i>	1	<i>Platygyra</i>	2	<i>Favites</i>	1	<i>Cladiella</i>	2	<i>Porites</i>	2	<i>Platygyra</i>	1	<i>Cladiella</i>	1	<i>Sinularia</i>	2
<i>Echinopora</i>	<1	<i>Porites</i>	1	Other	1	<i>Anthelia</i>	1	Other faviids	2	<i>Porites</i>	1	<i>Sarcophyton</i>	<1	<i>Favites</i>	<1
<i>Lobophytum</i>	<1	<i>Anthelia</i>	1	<i>Platygyra</i>	1	<i>Favites</i>	1	<i>Lobophytum</i>	2	<i>Echinopora</i>	<1	<i>Echinopora</i>	<1	<i>Montastrea</i>	<1
<i>Anthelia</i>	<1	<i>Echinopora</i>	1	<i>Alveopora</i>	<1	<i>Oulophyllia</i>	1	<i>Echinopora</i>	1	<i>Diplosoma</i>	<1	<i>Platygyra</i>	<1	<i>Platygyra</i>	<1
<i>Acanthastrea</i>	<1	<i>Favia</i>	1	<i>Goniastrea</i>	<1	<i>Favia</i>	<1	Other	<1	Other faviids	<1	Sponges	<1	<i>Sarcophyton</i>	<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	%
<i>Montipora</i>	25	Algae	36	<b>Algae</b>	<b>36</b>	<b>Algae</b>	<b>27</b>	<b>Montipora</b>	<b>36</b>
<i>Algae</i>	23	<i>Astreopora</i>	19	<i>Alveopora</i>	<b>23</b>	<i>Montipora</i>	<b>18</b>	<b>Algae</b>	<b>34</b>
<i>Sinularia</i>	16	<i>Montipora</i>	17	<i>Astreopora</i>	16	<i>Sinularia</i>	<b>13</b>	Sponges	7
<i>Pocillopora</i>	7	<i>Sinularia</i>	5	<b>Montipora</b>	<b>6</b>	<i>Astreopora</i>	11	<i>Acropora</i>	6
<i>Acropora</i>	7	<i>Acropora</i>	3	<i>Sinularia</i>	<b>5</b>	<i>Porites</i>	7	<i>Pocillopora</i>	4
<i>Astreopora</i>	4	<i>Pocillopora</i>	3	<i>Pocillopora</i>	4	<i>Echinopora</i>	6	<i>Astreopora</i>	2
<i>Cladiella</i>	3	<i>Echinopora</i>	2	<i>Porites</i>	3	<i>Sarcophyton</i>	3	<i>Favia</i>	2
<i>Lobophytum</i>	2	<i>Porites</i>	2	<i>Sarcophyton</i>	2	<i>Lobophytum</i>	2	<i>Goniastrea</i>	2
<i>Platygyra</i>	2	<i>Favites</i>	2	<i>Platygyra</i>	1	<i>Pocillopora</i>	2	<i>Porites</i>	2
<i>Sarcophyton</i>	1	<i>Anthelia</i>	1	<i>Favites</i>	1	<i>Cladiella</i>	2	<b><i>Sinularia</i></b>	<b>2</b>
<i>Favites</i>	1	Other faviids	1	<i>Echinopora</i>	<1	<i>Anthelia</i>	1	<i>Favites</i>	<1
<i>Porites</i>	1	<i>Platygyra</i>	1	<i>Lobophytum</i>	<1	<i>Favites</i>	1	<i>Montastrea</i>	<1
<i>Echinopora</i>	1	Other	<1	<i>Anthelia</i>	<1	<i>Oulophyllia</i>	1	<i>Platygyra</i>	<1
<i>Anthelia</i>	1	<i>Sarcophyton</i>	<1	<i>Acanthastrea</i>	<1	<i>Favia</i>	<1	<i>Sarcophyton</i>	<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.

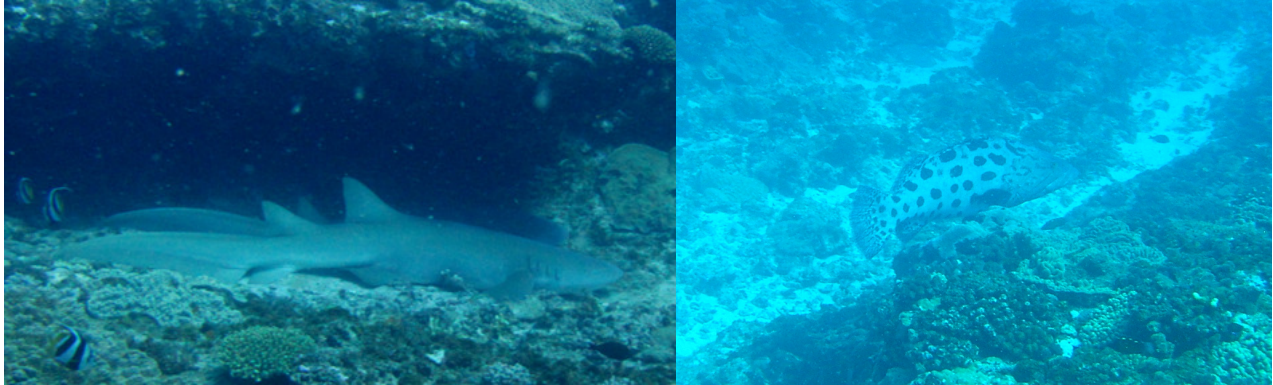
	NO	NT	NI	CO	CT	SI	ST
NT	48.14						
NI	69.70	60.46					
CO	59.12	73.26	72.99				
CT	51.98	86.43	68.71	74.09			
SI	72.18	64.25	84.57	73.35	67.95		
ST	47.67	83.25	60.90	71.13	83.16	64.01	
SO	51.73	67.49	66.38	56.92	68.94	64.92	63.21

### 3.2. Fish Communities

A total of 97 reef fish species, in 30 families, were observed (Annex 1). The great majority (64.9% or 63 species), were present in low abundance (less than five individuals per dive), 14 species were assigned as common and 20 species as abundant. The relatively low number of species observed reflects the poor sampling coverage, which was dictated by unfavourable logistical and weather conditions. The ichthyofauna of Baixo São João is primarily composed of Indo-Pacific species, where the most speciose families proved to be Labridae, Chaetodontidae and Acanthuridae with respectively 15, 12 and eight species (Table 6). Large sized specimens (>30 cm) were commonly observed, species of commercial importance as well as top predators such as the potato bass (*Epinephelus tukula*) and several species of rays and sharks (Figure 4), which gives a good indication of the conservation status of the fish fauna.

**Table 6.** Most speciose fish families at Baixo São João.

Family	Nr especies
Labridae	15
Chaetodontidae	12
Acanthuridae	8
Pomacentridae	7
Serranidae	7
Balistidae	6
Pomacanthidae	5



**Figure 4.** Top predators [*Nebrius ferrugineus* (right) and *Epinephelus tukula* (left)] observed at Baixo São João. Photos: Raquel Fernandes e Marcos Pereira.

#### 4. 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  $\geq 65\%$  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 fished (Pereira & van der Elst, 2014) and dived (unpublished data; pers. obs.). 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.

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## 7. ANNEXES

### Annex 1. Relative abundance of ref fish observed at Baixo São João. + = present (1-5 individuals); ++ common (6-10) and +++ abundant (+10).

#### Acanthuridae

*Acanthurus leucosternon* +  
*Acanthurus mata* +  
*Acanthurus tennentii* +  
*Acanthurus thompsoni* +  
*Ctenochaetus strigosus* +  
*Naso hexacanthus* +++  
*Naso lituratus* +  
*Paracanthurus hepatus* +

#### Aulostomidae

*Aulostomos chinensis* +

#### Balistidae

*Balistapus undulatus* +  
*Balistoides conspicillum* +  
*Odonus niger* +++  
*Sufflamen bursa* +  
*Sufflamen chrysopterus* +  
*Xanthichthys auromarginatus* +

#### Caesionidae

*Caesio caerulea* ++  
*Caesio xanthonota* +++

#### Carangidae

*Caranx melampygus* +

#### Carcharhinidae

*Carcharhinus amblyrhynchus* +  
*Carcharhinus melanopterus* +

#### Chaetodontidae

*Chaetodon auriga* +  
*Chaetodon guttatissimus* ++  
*Chaetodon kleinii* +++  
*Chaetodon lineolatus* +  
*Chaetodon lunula* +++  
*Chaetodon madagaskariensis* ++  
*Chaetodon meyeri* ++  
*Chaetodon unimaculatus* +++  
*Chaetodon vagabundus* +++  
*Forcipiger flavissimus* ++  
*Hemitaurichthys zoster* +++  
*Heniochus acuminatus* ++

#### Cirrhitidae

*Cirrhitichthys oxycephalus* +++  
*Paracirrhites arcatus* +  
*Paracirrhites forsteri* ++

#### Dasyatidae

*Himantura gerrardi* +  
*Taeniura melanospilos* +

#### Ginglymostomatidae

*Nebrius ferrugineus* +

#### Gobiidae

*Nemateleotris magnifica* +

#### Grammistidae

*Grammistes sexlineatus* +

#### Haemulidae

*Plectorhinchus flavomaculatus* ++  
*Plectorhinchus playfairi* +

#### Holocentridae

*Sargocentron caudimaculatum* ++  
*Sargocentron diadema* +

#### Istiophoridae

*Istiophorus platypterus* +

#### Labridae

*Anampses caeruleopunctatus* +  
*Anampses meleagrides* ++  
*Bodianus bilunulatus* +++  
*Bodianus diana* +  
*Cirrhilabrus exquisitus* +  
*Coris caudimacula* +++  
*Coris formosa* +  
*Halichoeres hortulanus* +  
*Hemigymnus fasciatus* +  
*Labroides bicolor* +  
*Labroides dimidiatus* +++  
*Novaculichthys taeniourus* +  
*Scarus ghobban* +++  
*Scarus rubroviolaceus* +++  
*Thalassoma hebraicum* +

#### Lethrinidae

*Lethrinus lentjan* +++  
*Lethrinus nebulosus* +++

#### Lutjanidae

*Aprion virescens* +  
*Paracaesio sordida* +

#### Monacanthidae

*Cantherines pardalis* +

**Mullidae**

*Parupneus bifasciatus* ++  
*Parupneus cyclostomus* +  
*Parupneus rubescens* +

**Muraenidae**

*Gymnothorax favagineus* +  
*Gymnothorax javanicus* +

**Pinguipedidae**

*Parapercis punctulata* ++

**Pomacanthidae**

*Apolemichthys trimaculatus* +  
*Centropyge acanthops*+++  
*Centropyge multispinis*+++  
*Pomacanthus imperator*+  
*Pomacanthus rhomboides*+

**Pomacentridae**

*Amphiprion allardi* +  
*Chromis dimidiata* +++  
*Chromis lepidolepis* +  
*Chromis nigrura* +  
*Dascyllus trimaculatus* ++  
*Plectroglyphidodon leucozonus* +

*Pomacentrus caeruleus* ++

**Pseudochromidae**

*Pseudochromis dutoiti* +

**Scombridae**

*Scomberomorus commerson* +

**Serranidae**

*Aethaloperca rogaa* +  
*Anthias squamipinnis* +++  
*Cephalopholis miniata* +  
*Epinephelus fasciatus* +  
*Epinephelus tukula* +  
*Variola louti* +  
*Settleback coral rockcod* +

**Sparidae**

*Diplodus cervinus hottentotus* +

**Tetraodontidae**

*Arothron nigropunctatus* +  
*Canthigaster valentini* +

**Zanclidae**

*Zanclus canescens* +