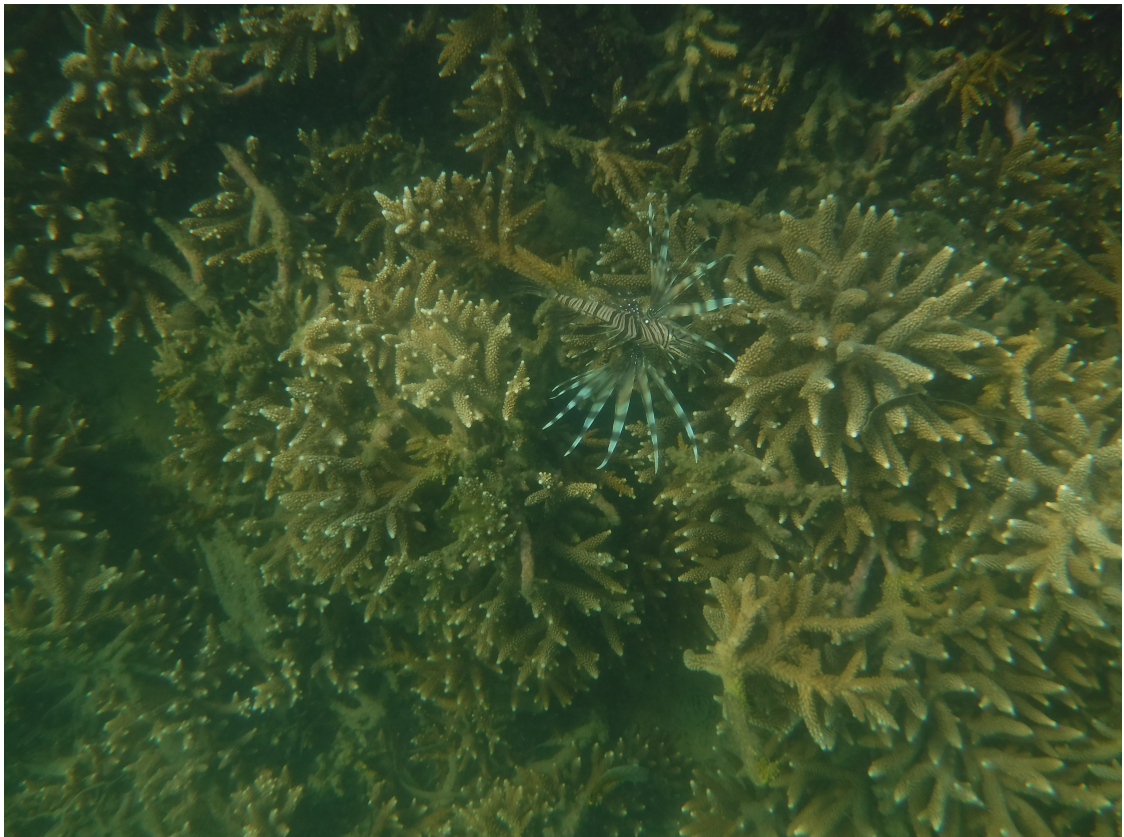


REEF MONITORING IN THE MAPUTO NATIONAL PARK: NORTHERN SECTION REEFS 2019 - 2022



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Centro Terra Viva (CTV) and the formerly known Ponta do Ouro Partial Marine Reserve (POPMPR), now declared the Maputo National Park (PNAM), 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 to contribute to the management, protection and conservation. The present publication is a result of activities undertaken under this MoU.

O Centro Terra Viva (CTV) e a ex-Reserva Marinha Parcial da Ponta do Ouro (RMPPPO), actual Parque Nacional do Maputo (PNAM), 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 ex-RMPPPO, actual PNAM, contribuindo para a sua gestão, protecção e conservação. A presente publicação resulta de actividades desenvolvidas no âmbito deste MdE.

Suggested citation

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Photographs

Lion fish, *Pterois miles*, on hard branching corals, *Acropora spp.*, at Ponta Torres reef, Inhaca Island (Cristina Louro)

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ACRONYMS, ABBREVIATIONS & UNITS

ANAC	National Administration of Conservation Areas
cm	centimeters
COTS	crown-of-thorns starfish
GPS	Global Positioning System
m	meters
MNAP	Maputo National Park
MoU	Memorandum of Understanding
POP MR	Ponta do Ouro Partial Marine Reserve
PPF	Peace Parks Foundation
SCUBA	Self-Contained Underwater Breathing Apparatus
SD	Standard Deviation
WGS	World Geodetic System

ABSTRACT

The report presents the results of the data collected during the March/April 2019 and April 2022 reef benthic and fish monitoring at the northern section reefs, Barreira Vermelha and Ponta Torres, in the Maputo National Park (PNAM). Between this period, Barreira Vermelha reef maintained the total live coral coverage, approximately 72%, whilst Ponta Torres reef showed an increase from 38% (2019) to 59% (2022). The coral community was dominated by the hard branching corals, *Acropora*, at both reefs. The fish community was dominated by typical coral reef fish species (e.g. *Acanthuridae*, *Chaetodontidae*, *Labridae* and *Pomacentridae*), ranging from small (1-15 cm) to medium (16-30 cm) in size, at both reefs. Commercially valuable species were found as present (1-5 individuals) and abundant (>10 individuals) at the Ponta Torres reef. Overall, the lack of predator fish species, like the *Serranidae* and the presence of the crown-of-thorns star fish (*Acanthaster mauritiensis*) at Ponta Torres is of great concern as these are two great indicators of the fragile health of these reefs. As recommended in previous reports, it is necessary and urgent, continuous patrols and enforcement of law, at these sanctuary reefs.

RESUMO

O relatório apresenta os resultados dos dados colectados durante Março/Abril 2019 e Abril 2022 referentes à monitoria das comunidades bentónicas e ictiológicas dos recifes da secção norte, Barreira Vermelha e Ponta Torres, do Parque Nacional do Maputo. Entre este período, o recife da Barreira Vermelha manteve a cobertura total de coral vivo (aproximadamente 72%), enquanto que o recife da Ponta Torres apresentou um aumento de 38% (2019) para 59% (2022). Nestes recifes, a comunidade de coral foi dominada pelo coral duro ramificado, comumente conhecido como *Acropora*. A comunidade da ictiofauna, destes mesmos recifes, foi dominada por espécies típicas de recife de coral (e.g. *Acanthuridae*, *Chaetodontidae*, *Labridae* and *Pomacentridae*), variando em tamanho, entre pequeno (1-15 cm) e médio (16 a 30 cm). Espécies de valor comercial foram encontradas como presentes (1-5 indivíduos) e abundantes (>10 indivíduos) no recife da Ponta Torres. No geral, em ambos os recifes, a ausência de espécies de peixe predadoras (e.g. *Serranidae*) e a presença da estrela do mar coroa-de espinhos (*Acanthaster mauritiensis*) no recife da Ponta Torres é de preocupar pois são dois grandes indicadores da saúde frágil deste recifes. Como recomendado previamente, é necessário, e urgente, a realização de monitorias contínuas e da aplicação da lei, nestes santuários.

1. INTRODUCTION

The reef monitoring programme on the eastern shores was established in 2011 (Pereira & Videira, 2011), after the proclamation of the Ponta do Ouro Partial Marine Reserve (POMPR) in 2009, building upon reef surveys that were conducted in 1996 (Robertson *et al.*, 1995) and 2002 (Pereira, 2003). In 2019, the reef monitoring programme extended to the western shores of the now declared Maputo National Park (MNAP) as part of the Memorandum of Understanding (MoU) signed between the National Administration for Conservation Areas (ANAC) and Centro Terra Viva (CTV) in 2013, and further cemented by the MoU signed in 2016 with the same government entity. The report presents the results of the second monitoring exercise on the MNAP's northern section reefs, which main purpose is to assess the conservation status of the reefs' benthic and fishing communities.

2. METHODOLOGY

2.1. Study Area

MNAP is located in southern Mozambique, along the south-eastern coast of Maputo Province and is part of two coastal districts: the Matutuine District and the Municipal District of KaNyaka. The marine component of the park has a total surface area of 678 km² and it stretches from the high water mark, following the contour of the base of the coastal dunes, to 3 nautical miles into the Indian Ocean and 1 nautical mile into Maputo Bay (Figure 1; DNAC, 2011).

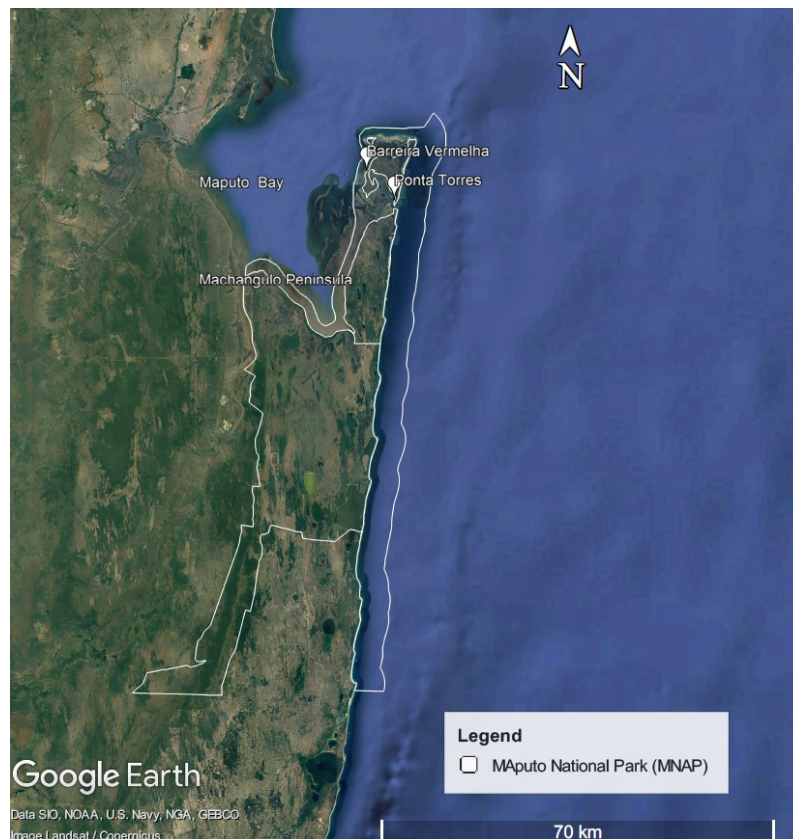


Figure 1. Geographical location of MNAP's northern section reefs, Barreira Vermelha and Ponta Torres. Source: Google Earth 2022

The geographical limits encompass the border with South Africa, in the south, to Cabo da Inhaca, in the north, following through to the Maputo river mouth. MNAP's marine component encompasses the sandy beaches, sand and mudflats, including the inshore reefs and surrounding waters of Inhaca and Portuguese Islands (DNAC, 2011). The MNAP's northern section reefs, Barreira Vermelha and Ponta Torres, located at Inhaca Island (Table 1; Figure 1) have been thoroughly described by Kalk (1995), Pereira (2000), Schleyer & Pereira (2014).

Table 1. Geographical location of the MNAP's northern section reefs during the 2022 monitoring period.

Reef	GPS Coordinates (WGS84)		Attributes
Barreira Vermelha (BV)	S26°01.110	E32°54.055	Inshore fringing reef. Depth: 1-5 m
Ponta Torres (PT)	S26°03.890	E32°57.245	Inshore fringing reef. Depth: 1-3 m

2.2. Reef Benthic Communities

The benthic communities were documented by a SCUBA diver using a high-resolution, underwater digital imagery. 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 distance between each photograph was 2 - 4 meters, this being dictated by a pause in the camera recording system (Nikon Coolpix 4800). The area photographed in each photo-quadrat was approximately 0.3 m² and the distance between each photo-transect was at least 10 metres. Each transect was composed of approximately 30 to 50 photo-quadrats. A total of 10 transects were made, comprised of 316 photo-quadrats (Table 2).

Table 2. Sampling effort for the reef benthic communities monitoring at the at the MNAP's northern section reefs during the 2022 monitoring period.

Reef	Date Surveyed	Transects	Photo-quadrats	Data points
Barreira Vermelha	22 April 2022	5	153	1 202
Ponta Torres	22 April 2022	5	163	1 300
Total		10	316	2 502

The data were extracted from the photo-quadrats using the point-intercept technique, where the images in JPEG format were analysed through the software CPCe 4.1 (Kohler & Gill, 2006). Eight randomly located points were superimposed on each image and the benthic category underneath each point identified to lowest possible taxonomic level. The morphological categories proposed by English *et al.* (1994) were used. A total of 2 502 random data points were analysed (Table 2).

2.3. Reef Fish Communities

The reef fish communities were monitored through direct observation and photography, using a Go-Pro camera. The monitory consists in assessing fish abundance, through the indicative grouping of fish species as present (0 to 5 individuals), common (5 to 10 individuals) and abundant (10 or more individuals) and size classes through the registering of small (<15 cm), medium (16 – 30 cm) and large (> 31 cm). Fish species identification was made with the support of relevant literature (Lieske & Myers, 1999; King & Fraser, 2014).

3. RESULTS

3.1. Reef Benthic Communities

3.1.1. Current trend: 2019 - 2022

At Barreira Vermelha, between 2019 and 2022, the percent cover of the coral category suffered decrease, whilst at Ponta Torres, the percent coral cover increased (Table 3). At Barreira Vermelha it is important to highlight the presence of macroalgae (23.7%). At Ponta Torres, the other invertebrates category was comprised by sea cucumbers (*Stichopus* spp. and *Holothuria* spp.) and sea stars (*Linckia* spp.), including the crown-of-thorns-starfish (CoTs; *Acanthaster mauritiensis*). Still at this reef, the sand, rock, algae and rubble category, although the second largest category, showed a decrease.

Table 3. Percentage cover (\pm SD) of the main reef benthic and coral categories at the MNAP's northern section reefs during the 2019 and 2022 monitoring periods.

Benthic categories	Barreira Vermelha		Ponta Torres	
	2019	2022	2019	2022
Coral	80.8 (\pm 7.3)	73.1 (\pm 12.2)	67.8 (\pm 30.1)	77.4 (\pm 18.1)
Macroalgae	6.4 (\pm 3.5)	23.7 (\pm 10.0)	1.0 (\pm 0.5)	5.7 (\pm 5.6)
Coralline algae	4.3 (\pm 3.1)	0.6 (\pm 0.8)	0.1 (\pm 0.3)	0.0 (\pm 0.0)
Molluscs	0.4 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)
Ascidians	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)
Other invertebrates	1.9 (\pm 4.1)	0.0 (\pm 0.0)	0.3 (\pm 0.5)	3.2 (\pm 4.8)
Sand, rock&algae, rubble	6.2 (\pm 3.4)	2.7 (\pm 3.7)	30.9 (\pm 30.1)	13.5 (\pm 18.4)

Coral categories	Barreira Vermelha		Ponta Torres	
	2019	2022	2019	2022
Branching hard coral	58.9 (\pm 13.2)	33.9 (\pm 20.1)	37.6 (\pm 34.6)	58.5 (\pm 43.3)
Digitate hard coral	0.0 (\pm 0.0)	23.1 (\pm 12.5)	0.0 (\pm 0.0)	1.2 (\pm 1.7)
Encrusting hard coral	3.6 (\pm 3.3)	3.8 (\pm 5.5)	0.1 (\pm 0.3)	0.0 (\pm 0.0)
Foliose hard coral	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.2 (\pm 0.6)	0.0 (\pm 0.0)
Free living coral	0.0 (\pm 0.1)	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)
Massive hard coral	3.3 (\pm 4.3)	0.3 (\pm 0.4)	17.8 (\pm 11.9)	17.6 (\pm 24.7)
Submassive hard coral	0.0 (\pm 0.0)	3.2 (\pm 5.4)	2.0 (\pm 3.8)	0.0 (\pm 0.0)
Tabular hard coral	5.6 (\pm 4.3)	8.3 (\pm 6.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)
Total hard coral	71.4 (\pm 12.2)	72.5 (\pm 7.7)	57.7 (\pm 24.1)	77.4 (\pm 15.0)
Soft coral	0.5 (\pm 0.9)	0.0 (\pm 0.0)	0.2 (\pm 0.7)	0.0 (\pm 0.0)
Fire coral	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)	0.0 (\pm 0.0)
Unidentified corals	0.1 (\pm 0.2)	0.0 (\pm 0.0)	0.2 (\pm 0.3)	0.0 (\pm 0.0)
Total live coral	72.0 (\pm 12.4)	72.5 (\pm 7.7)	57.9 (\pm 23.8)	77.4 (\pm 15.0)
Dead coral with algae	8.8 (\pm 8.4)	0.0 (\pm 0.0)	0.2 (\pm 0.3)	0.0 (\pm 0.0)
Recently dead coral	0.0 (\pm 0.0)	0.6 (\pm 0.7)	0.0 (\pm 0.0)	0.1 (\pm 0.2)

Overall, between the 2019 and 2022 monitoring period, Barreira Vermelha maintained the total live coral coverage (72%), whilst Ponta Torres showed considerable increase from 38% to 59%, respectively (Table 3). In terms of coral growth categories, Barreira Vermelha showed a decrease in cover of the branching hard coral, whilst at Ponta Torres there was a considerable increase. The digitate hard coral is the second most

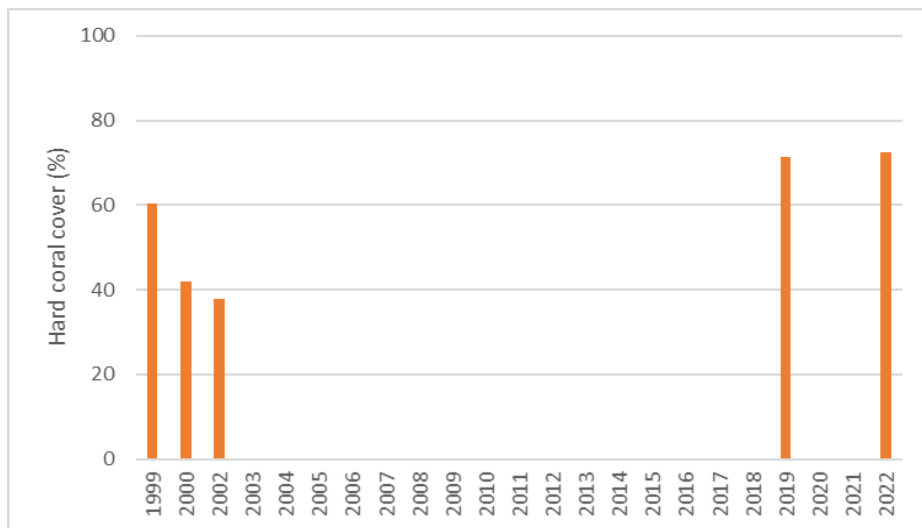
common category at Barreira Vermelha. The massive hard coral has been the second most common category for both monitoring periods (18%).

In terms of coral genera cover, during the same monitoring period, at Barreira Vermelha and Ponta Torres, the main genera found was *Acropora*. Barreira Vermelha maintained the percent coral cover between 62.9 (2019) and 63.8% (2022), whilst Ponta Torres it increased from 36.4% (2019) to 49.6% (2022; Annex 1).

3.1.2. Historical trend: 1999 – 2022

The monitoring of the northern section reefs began in 1999 as part of Mozambique’s National Coral Reef Monitoring Programme. However, there was a data gap of approximately 16 years. Within the last four years (2019 and 2022) there seems, as highlighted by Pereira *et al.* (2021), a steady increase in hard coral cover in both the Barreira Vermelha (71.4% and 72.5%, respectively) and Ponta Torres (57.7% and 77.4%, respectively) reefs (Figure 2).

(A) Barreira Vermelha



(B) Ponta Torres

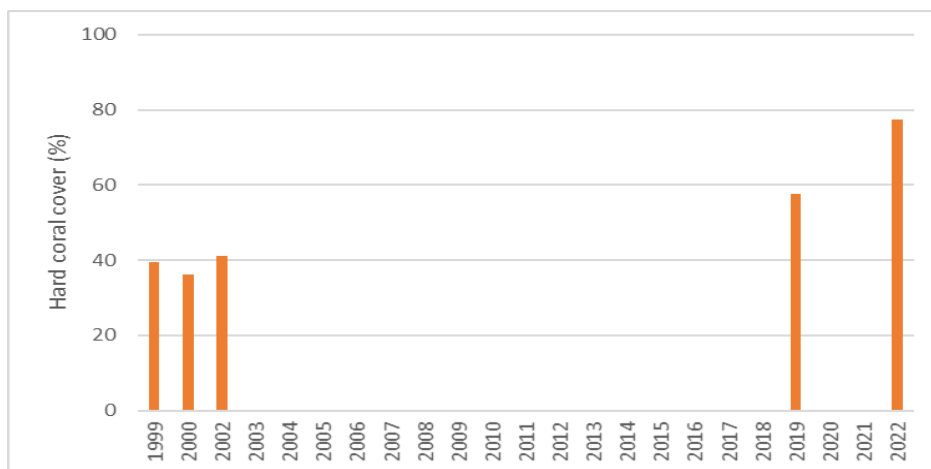


Figure 2. Historical trend of total hard coral cover at the MNAP’s northern section reefs: (A) Barreira Vermelha; (B) Ponta Torres. Data compiled from Costa (2003), Motta *et al.* (2000), Pereira *et al.* (2003; 2019; 2021), Rodrigues *et al.* (1999).

3.2. Reef Fish Communities

3.2.1. Specific Composition

In 2022, a total of 47 species belonging to 16 families were identified at Barreira Vermelha and Ponta Torres reefs (Table 4). When compared to 2019, the numbers of species and families identified were less due to the constraints found, mainly the poor water visibility at Barreira Vermelha (<1 meter) and the receding tide at Ponta Torres. For the 2019 and 2022 monitoring periods, the cumulative number of species identified in these reefs was of 104 (28 families), which accounts for 31.8.% of the total species compiled by Schleyer & Pereira (2014; n=327). The cumulative species list for the PNAM's northern section reefs is found Annex 2.

Table 4. Specific composition of the fish community of Barreira Vermelha (BV) and Ponta Torres (PT), MNAP's northern section reefs, during the 2019 and 2022 monitoring periods.

Family	Number of species (n)								
	2019			2022			2019 & 2022		
	BV	PT	All	BV	PT	All	BV	PT	All
Acanthuridae	7	3	9	3	7	9	9	9	14
Balistidae	1	1	2	-	-	-	1	1	2
Blennidae	-	3	3	-	-	-	-	3	3
Caesionidae	1	1	2	-	-	-	1	1	2
Chaetodontidae	12	10	16	6	6	10	14	12	16
Cirrhitidae	1	-	1	-	1	1	1	1	1
Ephippidae	-	1	1	-	-	-	-	1	1
Gobiidae	-	1	1	-	-	-	-	1	1
Haemulidae	2	-	2	-	1	1	2	1	3
Holocentridae	2	-	2	-	-	-	2	-	2
Labridae	4	4	7	4	4	6	6	5	9
Lethrinidae	-	1	1	-	-	-	-	1	1
Lutjanidae	4	5	8	-	2	2	4	5	8
Monochantidae	-	-	-	-	1	1	-	1	1
Mugilidae	-	1	1	-	-	-	-	1	1
Mullidae	2	3	5	-	2	2	2	4	5
Nemipteridae	1	1	1	-	1	1	1	1	1
Ostracidae	1	1	2	-	1	-	1	2	3
Plotosidae	-	-	-	-	1	1	-	1	1
Pomacentridae	8	8	11	3	4	7	10	9	14
Pomachantidae	2	-	2	-	-	-	2	1	2
Scaridae	2	1	3	1	1	2	3	1	4
Scorpaenidae	-	-	-	-	1	1	-	1	1
Serranidae	2	3	4	-	-	-	2	3	4
Siganidae	-	1	1	-	1	1	-	1	1
Synodontidae	-	1	1	-	-	-	-	1	1
Tetraodontidae	-	1	1	-	-	-	-	1	1
Zanclidae	1	1	1	-	1	1	1	1	1
Total species (n)	54	53	88	17	35	47	62	69	104
Total families (n)	17	22	25	5	16	16	17	27	28

3.2.2. Relative Occurrence and Size Classes

In the 2022 monitoring period, at Barreira Vermelha reef, in terms of species relative occurrence, the abundant category (>10 individuals) was the highest (47.1%) followed by the present category (1-5 individuals) with 35.3% of the total species identified (**Table 5**). Both categories were comprised by species of the same families Acanthuridae, Chaetodontidae and Labridae. At the Ponta Torres reef, in the same year, the present category was the highest category (57.1%), followed by the abundant category, with 25.7% of the total species identified (**Table 5**). The present category was comprised by typical coral reef fish families such as Acanthuridae, Chaetodontidae, Cirrhitidae, Labridae and Zanclidae families (**Table 6**). The abundant category included the Acanthuridae and Pomacentridae families and the commercially valuable species of the Lutjanidae, Scaridae and Siganidae families (**Table 8**). In both reefs, Barreira Vermelha and Ponta Torres, no predator fish species were observed (e.g. Serranidae), as it was described by Pereira et al. (2021)

Table 5. Relative occurrence (%) of fish species at Barreira Vermelha (BV) and Ponta Torres (PT) reefs, MNAP's northern section reefs, during the 2019 and 2022 monitoring periods (n = number of species).

Relative occurrence (%)	Barreira Vermelha		Ponta Torres	
	2019	2022	2019	2022
Present (1-5 individuals)	61.1% (n=33)	35.3% (n=06)	60.4% (n=32)	57.1% (n=20)
Common (6-10 individuals)	14.8% (n=08)	17.6% (n=03)	20.8% (n=11)	14.3% (n=05)
Abundant (>10 individuals)	24.1% (n=13)	47.1% (n=08)	18.9% (n=10)	25.7% (n=09)

With regards to the fish species size classes, at Barreira Vermelha reef, the sizes of the species categorized as present (e.g. *Acanthurus leucosteron*, *Chaetodon auriga* and *C. lineolatus*) were in its great majority of medium size (16-30 cm; Table 6). Still at Barreira Vermelha, the species categorized as abundant ranged, in its great majority, from small to large and were comprised by the species *A. nigrofuscus*, *A. triostegos*, *C. lunula*, *C. trifascialis* and *C. trifasciatus* (Table 8). At Ponta Torres reef, the species categorized as present were also, in its great majority, of medium size, and were comprised mainly by typical reef species, with the exception of *Plectorhincus gaterinus* (Haemulidae) and *Parupeneus macronemus* (Mullidae) which were of large size (> 31 cm; Table 6). At Ponta Torres, the species categorized as abundant varied from small to medium, and which, apart from the characteristic reef fish species, are also found the commercially important species, namely *Lutjanus fulviflamma*, *Scarus ghoban* and *Siganus sutor* (Table 8).

4. CONCLUDING REMARKS

Within the last two monitoring periods, 2019 and 2022, the reef benthic communities of Barreira Vermelha and Ponta Torres reefs showed to be in good condition, especially in terms of hard coral cover. The reef fish community, although in the last monitoring period did not show a diverse species composition due to the environmental conditions encountered, is still lacking the presence of predator group, the rockcods, which is greatly concerning. The above mentioned findings were also supported by Marcos *et al.* (2021). Nonetheless, two concerning factors in these reefs were the presence of the crown-of-thorns starfish (COTS, *Acanthaster mauritiensis*) in the Ponta Torres reef which was not recorded in 2019 (Pereira *et al.* 2021), and the presence of discarded fishing line on the reefs as result of the illegal fishing pressure on these reefs.

Table 6. Present species category (1 -5 individuals) and their size classes (Small - S <15 cm; Medium – M = 16-30 cm; Large – L > 31 cm) of the fish communities of Barreira Vermelha and Ponta Torres reef, Inhaca Island, MNAP's northern section reefs, April 2022.

Family	Species	Barreira Vermelha			Ponta Torres		
		Size Classes			Size Classes		
		S (<15cm)	M (16-30cm)	L (>31 cm)	S (<15cm)	M (16-30cm)	L (>31 cm)
Acanthuridae	<i>Acanthurus leucosteron</i>		x				
	<i>Acanthurus thompsoni</i>					x	
	<i>Ctenochaetus biontatus</i>					x	
	<i>Zebрасoma scopas</i>				x		
Chaetodontidae	<i>Chaetodon auriga</i>	x	x		x		
	<i>Chaetodon falcula</i>					x	
	<i>Chaetodon guttatisimus</i>					x	
	<i>Chaetodon lineolatus</i>	x	x				
	<i>Chaetodon xanthocephalus</i>					x	
Cirrhitidae	<i>Paracirrhites forsteri</i>					x	
Haemulidae	<i>Plectorhincus gaterinus</i>						x
Labridae	<i>Halichoeres scapularis</i>					x	
	<i>Gomphosus caeruleus</i>		x			x	
	<i>Labroides dimidiatus</i>		x		x		
	<i>Thalassoma hardwicke</i>		x				
	<i>Thalassoma lunare</i>					x	
	<i>Lutjanus kasmira</i>					x	
Monochantidae	<i>Amanses scopas</i>					x	
Mullidae	<i>Parupeneus macronemus</i>						x
Nemipteridae	<i>Scolopsis ghanam</i>					x	
Ostraciidae	<i>Canthigaster valentini</i>				x		
	<i>Dascyllus trimaculatus</i>					x	
	<i>Pomacentrus caeruleus</i>				x		
Zanclidae	<i>Zanclus cornutus</i>					x	

Table 7. Common species category (6-10 individuals) and their size classes (S<15 cm; M = 16-30 cm; L> 31 cm) of the fish communities of Barreira Vermelha and Ponta Torres reef, Inhaca Island, MNAP's northern section reefs, April 2022.

Family	Species	Barreira Vermelha			Ponta Torres		
		Size Classes			Size Classes		
		S (<15cm)	M (16-30cm)	L (>31 cm)	S (<15cm)	M (16-30cm)	L (>31 cm)
	<i>Acanthurus sp.</i>	x					
	<i>Acanthurus tennentii</i>						x
Chaetodontidae	<i>Chaetodon lunula</i>						
	<i>Chaetodon kleinii</i>				x	x	
	<i>Chaetodon lineolatus</i>					x	
Mullidae	<i>Mulloidichthys flavolineatus</i>					x	
Pomacentridae	<i>Chromis fieldi</i>	x					
	<i>Chromis sp.</i>	x					

Table 8. Abundant species category (>10 individuals) and their size classes (S<15 cm; M = 16-30 cm; L> 31 cm) of the fish communities of Barreira Vermelha and Ponta Torres reef, Inhaca Island, MNAP's northern section reefs, April 2022.

Family	Species	Barreira Vermelha			Ponta Torres		
		Size Classes			Size Classes		
		S (<15cm)	M (16-30cm)	L (>31 cm)	S (<15cm)	M (16-30cm)	L (>31 cm)
Acanthuridae	<i>Acanthurus nigrofuscus</i>	x	x		x	x	
	<i>Acanthurus sp.</i>	x	x				
	<i>Acanthurus triostegus</i>				x	x	
Chaetodontidae	<i>Chaetodon lunula</i>	x	x				
	<i>Chaetodon trifascialis</i>	x	x				
	<i>Chaetodon trifasciatus</i>	x	x				
	<i>Heniochus monoceros</i>		x				
Labridae	<i>Halichoeres sp.</i>	x					
Lutjanidae	<i>Lutjanus fulviflamma</i>				x	x	
Pomacentridae	<i>Abudefduf vaigiensis</i>				x	x	
	<i>Chromis viridis</i>				x		
	<i>Plectroglyphidodon lacrymatus</i>	x					
Scaridae	<i>Scarus ghoban</i>				x	x	
Scorpionidae	<i>Plotosus lineatus</i>				x	x	
Siganidae	<i>Siganus sutor</i>				x	x	

5. RECOMMENDATIONS

As per the main findings it is recommended the following: (1) the strict enforcement through continuous patrolling of the Barreira Vermelha and Ponta Torres reefs, as these are also important sanctuaries which require maximum protection against illegal and potentially harmful fishing and diving practices; (2) the annual COTS monitoring and control prevention in the Ponta Torres reef; and (3) improve the monitoring protocol of the reef fish communities.

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8. ANNEXES

Annex 1. Percentage cover (\pm SD) of coral genera identified at MNAP's northern section reefs, Barreira Vermelha and Ponta Torres, during the 2019 and 2022 monitoring periods. % trans = percentage of the genera within the transect; % coral = percentage of the genera within corals only. SD = standard deviation. * Information to be made available.

Genera	Barreira Vermelha								Ponta Torres							
	2019				2022				2019				2022			
	% tran	SD	% coral*	SD*	% tran	SD	% coral	SD	% tran	SD	% coral*	SD*	% tran	SD	% coral	SD
<i>Acanthastrea</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Acropora</i>	62.9	14.6			63.8	13.8	87.3	12.8	36.4	35.4			59.6	42.1	69.6	43.4
<i>Alveopora</i>	0.0	0.0			0.0	0.0	0.0	0.0	1.4	3.8			0.0	0.0	0.0	0.0
<i>Astreopora</i>	0.3	0.6			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Cespitularia</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Cladiela</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Dendronephthya</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Diploastrea</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Dipsastraea</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Echinopora</i>	0.1	0.2			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Favites</i>	0.0	0.0			2.0	4.5	2.7	6.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Fungiid</i>	2.1	3.1			0.0	0.0	0.0	0.0	0.1	0.1			0.0	0.0	0.0	0.0
<i>Galaxea</i>	0.1	0.3			0.0	0.0	0.0	0.0	0.0	0.1			0.0	0.0	0.0	0.0
<i>Gardineroseris</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			3.0	6.7	5.4	12.0
<i>Goniastrea</i>	0.0	0.0			0.1	0.2	0.1	0.2	0.1	0.3			0.0	0.0	0.0	0.0
<i>Goniopora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Gorgonian</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Hydnophora</i>	0.0	0.0			0.0	0.0	0.0	0.0	1.4	3.8			0.0	0.0	0.0	0.0
<i>Leptoseris</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Lobophyllia</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Lobophytum</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Merulina</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Montipora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Mycedium</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Nephthiid</i>	0.7	1.1			0.0	0.0	0.0	0.0	0.1	0.1			0.0	0.0	0.0	0.0
<i>Oxypora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Pachyseris</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0

Genera	Barreira Vermelha								Ponta Torres							
	2019				2022				2019				2022			
	% tran	SD	% coral*	SD*	% tran	SD	% coral	SD	% tran	SD	% coral*	SD*	% tran	SD	% coral	SD
<i>Pavona</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Platygyra</i>	0.0	0.1			0.3	0.7	0.4	1.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Plesiastrea</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.2	0.6			0.0	0.0	0.0	0.0
<i>Pocillopora</i>	0.7	0.8			1.9	2.9	2.6	3.9	0.0	0.0			0.3	0.5	0.5	0.8
<i>Porites</i>	0.0	0.0			3.3	5.4	4.0	6.4	0.0	0.0			14.7	20.1	24.5	33.7
<i>Rhytisma</i>	2.1	1.7			0.0	0.0	0.0	0.0	1.1	1.3			0.0	0.0	0.0	0.0
<i>Rumphella</i>	2.1	3.4			0.0	0.0	0.0	0.0	16.6	11.5			0.0	0.0	0.0	0.0
<i>Sarcophyton</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Seriatopora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Sinularia</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Stylophora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.2	0.7			0.0	0.0	0.0	0.0
<i>Tubipora</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Turbinaria</i>	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
<i>Xeniid</i>	0.5	0.9			0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0

Annex 2. Cumulative species list of the fish community identified in Maputo Bay and surrounding areas (Adapted from Schleyer & Pereira, 2014). Taxonomy follows Froese & Pauly (2021), WoRMS (2022) e King & Fraser (2014).

Acanthuridae

Acanthurus blochii
Acanthurus dussumieri
Acanthurus leucosternon
Acanthurus lineatus
Acanthurus mata
Acanthurus nigricauda
Acanthurus nigrofuscus
Acanthurus tennentii
Acanthurus thompsoni
Acanthurus triostegus
Acanthurus xanthopterus
Ctenochaetus binotatus
Ctenochaetus striatus
Ctenochaetus strigosus
Ctenochaetus truncatus
Naso annulatus
Naso brevirostris
Naso hexacanthus
Naso lituratus
Naso unicornis
Paracanthurus hepatus
Zebrassoma scopas
Zebrassoma desjardini
Zebrassoma veliferum

Apogonidae

Apogon aereus
Apogon fraenatus
Apogon kallopterus
Apogon angustatus
Apogon cookii
Apogon semiornatus
Cheilodipterus lineatus

Aulostomidae

Aulostomos chinensis

Balistidae

Balistapus undulatus
Balistoides conspicillum
Balistoides viridescens
Melichthys indicus
Melichthys niger
Odonus niger
Pseudobalistes flavimarginatus
Pseudobalistes fuscus
Rhinechanthus rectangulus
Sufflamen bursa
Sufflamen chrysopteron
Sufflamen fraenatus

Belontiidae

Thylosurus crocodilus crocodilus

Blenniidae

Antennablennius australis
Cirripectes castaneus
Exallias brevis
Parapercis hexophthalma
Parapercis punctulata
Plagiotremus rhinorhynchus
Plagiotremus tapeinosoma

Caesionidae

Caesio caeruleaureus
Caesio xanthonota
Caesio xanthalytos

Carangidae

Alectis indicus
Carangoides fulvoguttatus
Caranx ignobilis
Caranx melampygus
Caranx sexfasciatus
Elagatis bipinnulata
Gnathanodon speciosus
Pseudocaranx dentex
Scomberoides commersonianus
Seriola dumerili
Trachinotus africanus

Carcharhinidae

Carcharhinus brevespina
Carcharhinus leucas
Carcharhinus melanopterus
Carcharhinus wheeleri
Eugomphodus taurus
Galeocerdo cuvier
Triaenodon obesus

Chaetodontidae

Chaetodon auriga
Chaetodon blackburnii
Chaetodon falcata
Chaetodon guttatissimus
Chaetodon interruptus
Chaetodon kleinii
Chaetodon lineolatus
Chaetodon lunula
Chaetodon madagaskariensis
Chaetodon melannotus
Chaetodon meyeri

Chaetodon trifascialis

Chaetodon trifasciatus
Chaetodon vagabundus
Chaetodon xanthocephalus
Chaetodon zanzibariensis
Forcipiger flavissimus
Hemitaurichthys zoster
Heniochus acuminatus
Heniochus diphreutes
Heniochus monoceros

Cirrhitidae

Cirrhichthys oxycephalus
Paracirrhites arcatus
Paracirrhites forsteri

Congridae

Conger cinereus cinereus

Coryphaenidae

Coryphaena hippurus

Dasyatidae

Dasyatis kuhlii
Himantura uarnak
Rhinobatus leucospilus
Taeniura melanospilos
Torpedo fuscomaculata
Torpedo sinuspersici

Diodontidae

Diodon hystrix
Diodon liturosus
Lophodiodon calori

Echeneidae

Echeneis naucrates

Ephippidae

Platax orbicularis
Platax teira
Tripteron orbis

Fistularidae

Fistularia commersonii

Gerreidae

Gerres acinaces

Gobiidae

Cryptocentrus cryptocentrus

Gobiodon rivulatus
Istigobius decoratus
Nemateleotris magnifica
Paragobiodon modestus
Valenciennesa strigata

Haemulidae

Plectorhinchus flavomaculatus
Plectorhinchus gaterinus
Plectorhinchus gibbosus
Plectorhinchus plagiodesmus
Plectorhinchus playfairi
Plectorhinchus sordidus

Holocentridae

Myripristis adusta
Myripristis kuntzei
Myripristis murdjan
Neoniphon sammara
Sargocentron caudimaculatum
Sargocentron diadema
Sargocentron spiniferum

Istiophoridae

Makaira indica
Istiophorus platypterus
Tetrapturus audax

Kyphosidae

Kyphosus bigibbus
Kyphosus cinarensis
Kyphosus vaigiensis

Labridae

Anampses caeruleopunctatus
Anampses meleagrides
Bodianus axillaris
Bodianus diana
Cheilinus fasciatus
Cheilinus trilobatus
Coris ayyula
Coris caudimacula
Coris formosa
Coris gaimard
Gomphosus caeruleus
Halichoeres cosmetus
Halichoeres hortulanus
Halichoeres lapillus
Halichoeres marginatus
Halichoeres nebulosus
Halichoeres scapularis
Hemigymnus fasciatus
Hemigymnus melapterus
Hologymnosus doliatus
Labroides bicolor
Labroides dimidiatus
Pseudocheilinus hexataenia

Stethojulis albovittata
Stethojulis interrupta
Sthethojulis strigiventer
Thalassoma hardwicke
Thalassoma hebraicum
Thalassoma lunare

Lethrinidae

Gnathodentex aureolineatus
Gymnocranius griseus
Lethrinus crocineus
Lethrinus harak
Lethrinus lentjan
Lethrinus mahsena
Lethrinus microdon
Lethrinus nebulosus
Lethrinus sanguineus
Lethrinus variegatus
Monotaxis grandoculis

Lutjanidae

Aphareus rutilans
Aprion virescens
Lutjanus argentimaculatus
Lutjanus bohar
Lutjanus bengalensis
Lutjanus ehrenbergii
Lutjanus fulviflamma
Lutjanus gibbus
Lutjanus kasmira
Lutjanus lutjanus
Lutjanus monostigma
Lutjanus rivulatus
Lutjanus russellii
Lutjanus sanguineus
Lutjanus sebae
Macolor niger

Mobulidae

Manta diabolus

Monacanthidae

Amanses scopas
Cantherines pardalis

Monodactylidae

Monodactylus argenteus

Mugilidae

Liza macrolepis
Mugil cephalus
Valamugil buchanani

Mullidae

Mulloidichthys vanicolensis
Mulloidichthys flavolineatus
Parupeneus barberinus

Parupeneus bifasciatus
Parupeneus cyclostomus
Parupeneus indicus
Parupeneus macronema
Parupeneus rubescens

Muraenidae

Echidna nebulosa
Echidna polyzona
Gymnomuraena zebra
Gymnothorax eurostrus
Gymnothorax favagineus
Gymnothorax flavimarginatus
Siderea grisea

Nemipteridae

Parascalopsis eriomma
Scolopsis vosmeri
Scolopsis ghanam

Orectolobidae

Stegostoma fasciatum

Ostraciidae

Cantherhines pardalis
Canthigaster valentini
Ostracion cubicus
Ostracion meleagris

Pempheridae

Pempheris adusta
Pempheris schwenkii

Pinguipedidae

Paraperis hexophthalma

Platycephalidae

Papilloculiceps longiceps
Platycephalus indicus

Pleuronectidae

Samariscus triocellatus

Pomacanthidae

Apolemichthys trimaculatus
Centropyge acanthops
Centropyge bispinosus
Centropyge multispinis
Pomacanthus imperator
Pomacanthus rhomboides
Pomacanthus semicirculatus
Pomacanthus rhomboides

Pomacentridae

Abudefduf natalensis
Abudefduf sordidus
Abudefduf sparoides

Abudefduf vaigiensis
Amphiprion akallopisos
Amphiprion allardi
Chromis caerulea
Chromis dasygenys
Chromis fieldi
Chromis lepidolepis
Chromis nigrura
Chromis ternatensis
Chromis viridis
Chromis weberi
Chrysiptera annulata
Chrysiptera unimaculata
Dascyllus aruanus
Dascyllus carneus
Dascyllus trimaculatus
Neopomacentrus cyanomos
Plectroglyphidodon dickii
Plectroglyphidodon lacrymatus
Plectroglyphidodon leucozonus
Pomacentrus caeruleus
Pomacentrus pavo
Pomacentrus trichourus

Pseudochromidae

Pseudochromis dutoiti
Pseudochromis natalensis
Pseudochromis tauberæ

Rhincodontidae

Rhincodon typus

Rhinobatidae

Rhynchobatus ancylostoma

Scaridae

Calotomus spinidens
Scarus ghobban
Scarus rubroviolaceus
Scarus sordidus

Scombridae

Acanthocybium solandre
Euthynnus affinis
Gymnosarda unicolor
Katsuwonus pelamis
Sarda orientalis
Scomberomorus commerson
Scomberomorus plurilineatus
Thunnus albacares

Scorpaenidae

Pterois antennata
Pterois miles
Pterois mombasæ
Scorpaenopsis diabolus

Scorpaenopsis gibbosa
Scorpaenopsis oxycephala
Scorpaenopsis venosa
Sebastapistes cyanostigma
Synanceia verrucosa

Serranidae

Aethaloperca rogae
Cephalopholis argus
Cephalopholis boenack
Cephalopholis miniata
Epinephelus caeruleopunctatus
Epinephelus fasciatus
Epinephelus flavocaeruleus
Epinephelus fuscoguttatus
Epinephelus guaza
Epinephelus lanceolatus
Epinephelus longispinis
Epinephelus malabaricus
Epinephelus merra
Epinephelus tauvina
Epinephelus tukula
Plectropomus aerulatus
Plectropomus punctatus
Pseudanthias squamipinnis
Grammisetes sexlineatus

Siganidae

Siganus sutor

Sparidae

Argyrops filamentosus
Aegyrops spinifer
Acanthopagrus bifasciatus
Cheimerius núfar
Chrysoblephus puniceus
Diplodus cervinus hottentotus
Diplodus sargus capensis
Lithognathus mormyrus
Polysteganus coeruleopunctatus
Polysteganus praeorbitalis
Rhabdosargus sarba
Rhabdosargus thorpe

Sphyraenidae

Sphyraena barracuda
Sphyraena jello

Sphyrnidae

Sphyrna mokarran

Synodontidae

Saurida gracilis
Synodus dermatogenys
Atherinomorus lacunosus

Tetraodontidae

Arothron hispidus
Arothron meleagris
Arothron nigropunctatus
Arothron stellatus
Canthigaster ambionensis
Canthigaster bennetti
Canthigaster solandri
Canthigaster valentini

Zanclidae

Zanclus cornutus

