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Reef fishes of the Anchieta Island State Park, Southwestern Atlantic, Brazil

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Abstract: This paper presents a checklist of the reef fish fauna of the Anchieta Island State Park, a no-take zone in which no extractive activities are allowed, in Ubatuba, Southeastern Brazil. Data was obtained between 2011 and 2013, mainly through underwater observations with snorkelling and SCUBA, and secondarily using scientific fishing (trawling). Published and unpublished data were also verified and compiled. A total of 103 reef fish species, distributed in 78 genus and 50 families was recorded. Haemulidae was the richest family (n=7 species), followed by Epinephelidae (n=6), Pomacentridae, Carangidae and Tetraodontidae (n= 4 each). *Haemulon* was also the most speciose genera (n=5), followed by *Stegastes*, *Acanthurus* and *Mycteroperca* (n=3 each). Sixty-nine species (67%) are included in global and regional Red Lists. Twenty-five species (24.2%) are within the categories Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near-Threathened (NT). The network of Marine Protected Areas in Southeastern Brazil is still incipient, and the considerable number of threatened species in the Anchieta Island State Park clearly indicates the importance of the study area for the conservation of coastal and reef fishes.

Key words: *rocky reefs; species richness; scientific diving; ichthyology; conservation.*

Peixes recifais do Parque Estadual da Ilha Anchieta, Sudoeste do Atlântico, Brasil

Resumo: Este artigo apresenta uma lista de espécies de peixes recifais do Parque Estadual da Ilha Anchieta, uma área na qual nenhuma atividade extrativista é permitida, em Ubatuba, Sudeste do Brasil. Os dados foram coletados entre 2011 e 2013, principalmente por observações subaquáticas com o uso de mergulhos livres e autônomos e, secundariamente, através de pescaria científica (arrasto). Dados publicados e não publicados também foram verificados e compilados. Foram registradas 103 espécies de peixes recifais distribuídas em 78 gêneros e 50 famílias. Haemulidae foi a família com maior número de espécies (n=7 espécies), seguida por Epinephelidae (n=6), Pomacentridae, Carangidae e Tetraodontidae (n=4 cada). Os gêneros com maior número de espécies foram *Haemulon* (n=5) e *Stegastes*¸ *Acanthurus* e *Mycteroperca* (n=3 cada). Sessenta e nove espécies (67%) estão inclusas em listas vermelhas de espécies ameaçadas globais e regionais. Vinte e cinco espécies (24,2%) são classificadas nas categorias Criticamente em Perigo (CR), Em Perigo (EN), Vulnerável (VU) e Quase Ameaçadas (NT). A rede de Áreas Marinhas Protegidas no Sudeste do Brasil ainda é incipiente e o considerável número de espécies ameaçadas no Parque Estadual da Ilha Anchieta indica claramente a importância da área de estudo para a conservação de peixes recifais e costeiros.

Palavras-chave: *recifes rochosos; riqueza de espécies; mergulho científico; ictiologia; conservação.*

Introduction

In Brazil, coralline and sandstone reefs occur in the Northern, Northeastern and Central coast from the Amazon River mouth south to the Doce River mouth, off Espírito Santo State (~19º50'S) (Moura et al. 2013, 2016, Pinheiro et al. 2015a), while rocky reefs predominate in the subtropical portion of the coast, southwards to Rio Grande do Sul State (~32º30'S), as well as in the three oceanic archipelagos (Ferreira et al. 2001, 2004, Krajewski & Floeter 2011, Magalhães et al. 2015). The physical complexity of coralline and rocky reefs is associated to a remarkably high diversity of fish and several other groups, which overcomes that of any other aquatic habitat (Reaka-Kudla 1997, Spalding et al. 2001).

Reefs increase shelter and provide feeding habitats for a broad taxonomic spectrum of fishes with specific morphological and functional adaptations, the so-called reef fishes (Luckhurst & Luckhurst 1978, Alvarez-Filip et al. 2009, Ménard et al. 2012, Nunes et al. 2015).

Because the Southeastern Brazilian coast is located in a tropical and subtropical transition zone (Floeter et al. 2001), the region's rocky reefs often present higher local (alpha) diversity of reef fishes than coralline reefs (e.g. Moura & Francini-Filho 2005, Gibran & Moura 2012), and may be considered biodiversity hotspots, akin to "marginal" areas of other biogeographic regions (Aburto-Oropeza & Balart 2001, Sala et al. 2012). The Brazilian coralline reef area represent 0.4% of global reef area, with 20% of reef fishes endemism, which represent a priority in conservation (Moura 2003, Moura & Francini-Filho 2005, Gibran & Moura 2012).

Information about fish assemblages associated to Brazilian subtropical rocky reefs steadily increased in the last two decades (e.g. Luiz Jr. & Floeter 2004, Bonaldo et al. 2005, Floeter et al. 2006, Luiz Jr. et al. 2008, Gibran & Moura 2012, Teixeira-Neves et al. 2015, Neves et al. 2016). However, major geographic gaps still remain along this broad (~2,000 km) and highly threatened (e.g. Gibran & Moura 2012) extension of the coast, where the country´s population is concentrated within less than 100 km from shoreline (IBGE 2016) with several multiple and interacting environmental stressors (pollution, harbors, tourism and fishing) are observed. Such information gaps are particularly relevant for the ongoing development of management plans for the large multiple-use Marine Protected Areas (MPAs) that have been established along most of coast of the State of São Paulo.

Fish faunal assessments in the north coast of São Paulo are concentrated on demersal species associated to unconsolidated substrates (e.g. Cunningham 1983, Nonato et al. 1983, Braga & Goitein 1984, Rocha et al. 2010). Only two reef fish assessments were carried out in the vicinity of the Anchieta Island State Park (AISP), the protected area focused by the present study. One of these studies tested the use of artificial reefs for habitat restoration (Cunningham & Saul, 2004) and the other was focused on cleaning symbiosis, involving 35 fish species (Sazima et al. 2000). Here, we provide a checklist of teleosts and elasmobranchs of the AISP and comment upon the known distribution and conservation status of the recorded species. The information provided herein fill a relevant gap about local reef fish communities and contribute to the future management plans of the AISP and MPAs around.

Material and Methods

1. Study area

Sampling was carried out between 2011 and 2013 in the AISP, municipality of Ubatuba, northern coast of São Paulo (23°31'-23°34'S, 45°02'-45°05'W) (Figure 1). The AISP was created in 1977 by the State Government (Decree 9,629, March 29 1977), covering the terrestrial part of the island. In 1983, a fishing ban perimeter with 17.37 km^2 was established around the AISP (Portaria SUDEPE 56, November 10 1983). This perimeter is relatively well enforced, due to the considerable movement of people who visit the park. In addition, the park's own security guards carry out frequent inspections around the island. Anchieta Island is separated from the mainland by a narrow (0.5 km) and relatively deep (33 m) channel. Its shoreline is predominantly granitic, with the exception of a 1.5 km length sandy beach in its northern, shallower and less exposed side. Depths reach up to 37 m around the island, with a benthic mosaic encompassing sandy, gravel and rocky bottom (Guillaumon et al. 1989).

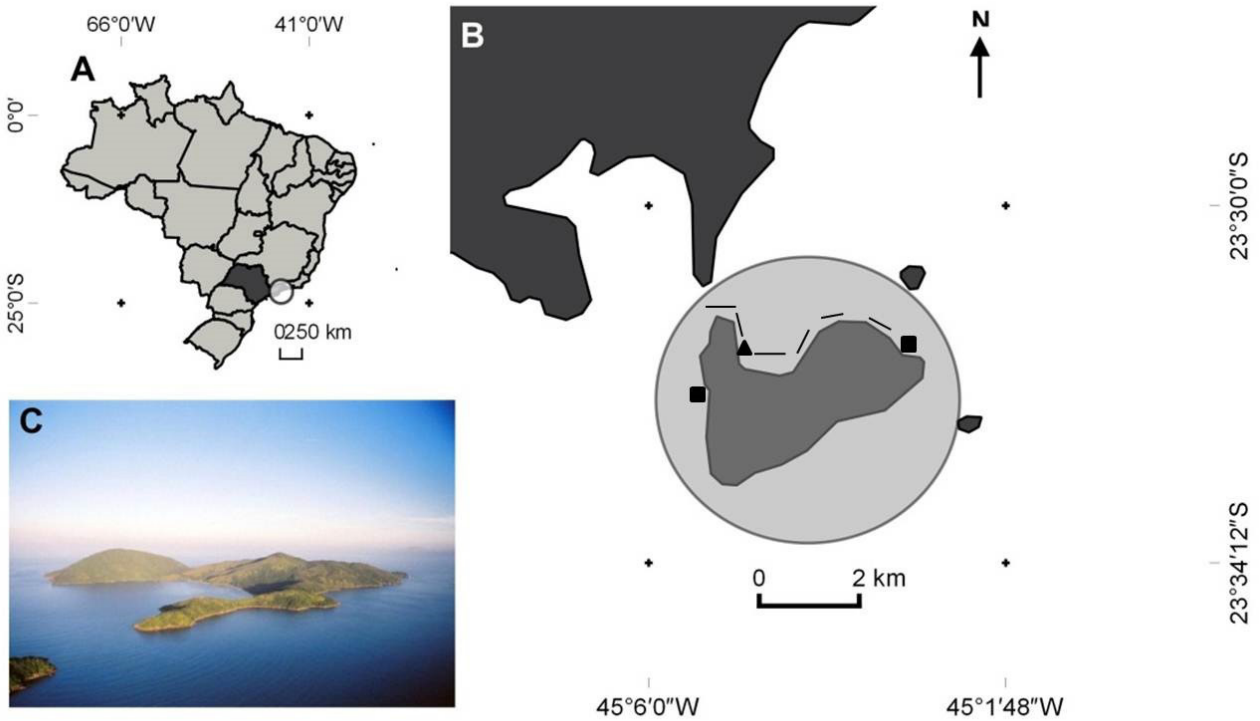

Figure 1. Study area, (A) Brazil in grey, São Paulo State in black and north coast of São Paulo inside the circle; (B) Anchieta Island inside the circle with the points of data collect: specific for this work (squares), Cunningham & Saul 2004 (triangle) and the area of bottom trawling (lines); (C) photograph of the Anchieta Island (credits: http://www.ambiente.sp.gov.br/parque-ilha-anchieta/galeria-de-fotos/).

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2. Data collection

The checklist was compiled from snorkelling and SCUBA observations, scientific bottom trawling operations (research permit – SISBIO nº 32352-3), as well as from published (e.g. Sazima et al. 2000 and Cunningham & Saul 2004) and unpublished data (e.g. museum records – ZUEC). In total, 142 hours were spent on dives: (i) 20 hours with snorkelling and SCUBA for this work; (ii) 42 hours by Sazima et al. (2000); and (iii) 80 hours by Cunningham & Saul (2004). Dives were concentrated in the south and east sides of the island (i.e. South Beach and East Beach), and inside Palmas Bay, a cove in the west face of the island with depths of up to 12 m. All the reef fish observed during the dives were noted and, eventually, divers searched for cryptic species beneath crevices and rocks. Considering the different samplings, dives were carried over a depth range of 2-17 meters (for more details see Sazima et al. 2000 and Cunningham & Saul 2004). Twelve bottom trawls of 12 minutes each were carried out around the island, in the sand substrate adjacent to the rocky reefs, between 10 and 16 m depths. The trawl had 25mm of mesh size, three meters height and 7 meters length.

Identifications were based on Menezes & Figueiredo (1980, 1985), Figueiredo & Menezes (1978, 1980, 2000), and Humann & DeLoach (2002). The species were organized alphabetically within families, following Betancur-R et al. (2014) for teleosts, Rosa & Gadig (2014) for sharks and Last et al. (2016) for rays. Reef fish were considered as species that spend most of their time associated with consolidate substrates, and that commonly use these habitats for feeding, shelter or reproduction, including nektonic species (cf. Luiz Jr. et al. 2008). Geographical distributions followed Luiz Jr. et al. (2008), where: CT, Circumtropical; SE, Southeastern Brazil (endemic from between 20 - 27° S); TA, Trans-Atlantic (both sides of the Atlantic); WA, Western Atlantic (Northern and Southwestern Atlantic); BR, Brazilian Province endemic; SCa, Southern Caribbean (Venezuela, Trinidad and Tobago and other nearby islands); Pat, Patagonian (primarily occurring in temperate rocky reefs south to Argentina); EA, Eastern Atlantic. Conservation status were based on the International Red List of threatened species (IUCN – International Union for Conservation of Nature), the National Endangered Fauna – Fish and Aquatic Invertebrates (MMA – Ministério do Meio Ambiente) and on the São Paulo State List of threatened species (SMA – Secretaria do Meio Ambiente). Although the classification "Near Threatened (NT) is often not considered a threatened species, we have decided to include it because species in this category may be considered threatened in the near future.

As non-lethal methods were primarily adopted, "voucher-specimens" were stored as videos and photos in the ichthyological collection "Victor Sadowsky – UNESP Registro" (SADUNESP#0001). Specimens collected during past surveys (e.g. Sazima et al. 2000) were also deposited at the Museu de Zoologia/Universidade Estadual de Campinas - ZUEC Coleção de Peixes/Fish Collection.

Results

A total of 103 species belonging to 78 genera and 49 families were recorded (Table 1), comprising 16 elasmobranchs and 87 actinopterygians. Haemulidae (n=7 species; 6.7%) and Epinephelidae (n=6; 5.8%) were the richest families. *Haemulon* (n=5 species) was the most speciose genus, followed by *Stegastes*, *Acanthurus* and *Mycteroperca* (n=3 each). With almost 90% of the geographic range classifications, the species classified as Western Atlantic, Trans-Atlantic and Circumtropical were dominant (56%, 17% and 14% respectively) (Figure 2).

Sixty-nine species (67%) had their conservation status evaluated in at least one geographic scale, with 25 included within categories Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near-Threathened (NT) (Table 1), eight of these species are represented in Figure 3. Highlighting some species that are highly targeted by fisheries, we had most from the Epinephelidae family, such as *Epinephelus marginatus*, *E. morio*, *Hyporthodus niveatus* and *Mycteroperca bonaci*, and some taxa of Lutjanidae like *Lujanus analis*.

Table 1 – Checklist of the reef fish species recorded at the Anchieta Island State Park. Geographic Range: CT, Circumtropical; SE, Southeastern Brazil; TA, Trans-Atlantic; WA, Western Atlantic; BR, Brazilian province; SCa, Southern Caribbean; Pat, Patagonian; EA, Eastern Atlantic. Main Threats: OF, Overfishing; BC, Bycatch; AT, Aquarium Trade. IUCN: CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern. BRAZIL: CR, Critically Endangered; VU, Vulnerable; SÃO PAULO STATE: NT, Near Threatened; NMA, Need Management Action; DD, Deficient Data. Record type: VIS, Visually (underwater observation); CTF, Scientific Fisheries; UND, Unpublished Data (Sazima et al.); REP, Reports (O.B.F. Gadig); PHO, Photographic Record; LIT, Literature (Sazima et al., 2000; Cunningham & Saul, 2004); MUS, Museum Vaucher (ZUEC).

FAMILY and *Species*	Geographic Range	Main Threat	IUCN	Brazil	São Paulo state	Record type
CARCHARHINIDAE						
Carcharhinus brevipinna (Müller & Henle, 1839)	CT	OF, BC	NT	-	NMA	REP
Galeocerdo cuvier (Péron & LeSueur, 1822)	CT	OF, BC	NT	-	DD	UND
SPHYRNIDAE						
Sphyrna lewini (Griffith & Smith, 1834)	CT	OF, BC	EN	CR	NMA	REP
RHINOBATIDAE						
Pseudobatos horkelii Müller & Henle, 1841	SE	BC	CR	CR	NMA	CTF
Pseudobatos percellens (Walbaum, 1792)	TA	BC	NT	-	NMA	CTF
Zapteryx brevirostris (Müller & Henle, 1841)	SE	BC	VU	VU	NMA	CTF
NARCINIDAE						
Narcine brasiliensis (von Olfers, 1831)	CT	BC	DD	-	DD	VIS, PHO
DASYATIDAE						
Dasyatis hypostigma Santos & Carvalho, 2004	SE	BC	DD	-	DD	VIS, CTF
Hypanus americanus (Hildebrand & Schroeder, 1928)	WA	BC	DD	-	DD	REP
Hypanus guttatus (Bloch & Scheider, 1801)	WA	BC	DD	-	DD	REP
GYMNURIDAE						
Gymnura altavela (Linnaeus, 1758)	TA	BC	VU	CR	DD	VIS, CTF
MYLIOBATIDAE						
Aetobatus narinari (Euphrasen, 1790)	CT	OF, BC	NT	-	DD	VIS, UND, REP

Table 1 – Continued**...**

FAMILY and *Species*	Geographic Range	Main Threat	IUCN	Brazil	São Paulo state	Record type
RHINOPTERIDAE						
Rhinoptera brasiliensis Müller, 1836	SE	OF, BC	EN	-	NMA	REP
Rhinoptera bonasus (Mitchill, 1815)	TA	OF, BC	NT	-	NMA	REP
MOBULIDAE						
Mobula hypostoma (Bancroft, 1831)	CT	OF, BC	DD	VU	NMA	REP
Mobula thurstoni (Lloyd, 1908)	CT	OF, BC	NT	VU	NT	REP
MURAENIDAE						
Gymnothorax funebris Ranzani, 1839	WA	-	LC	-	-	UND
Gymnothorax ocellatus Agassiz, 1831	WA	-	LC	-	-	VIS, CTF
CLUPEIDAE						
Harengula clupeola (Cuvier, 1829)	WA	-	-	-	DD	UND, MUS
SYNODONTIDAE						
Synodus foetens (Linnaeus, 1766)	WA	-	-	-	-	UND, LIT
HOLOCENTRIDAE						
Holocentrus adscensionis (Osbeck, 1765)	TA	-	-	-	-	UND, VIS
Myripristis jacobus Cuvier, 1829	TA	-	-	-	-	UND
APOGONIDAE						
Apogon americanus Castelnau, 1855	BR	-	-	-	-	UND, MUS
Apogon pseudomaculatus Longley, 1932	TA	-	LC	-	-	UND
Astrapogon puncticulatus (Poey, 1867)	WA	-	LC	-	-	UND, MUS
ELEOTRIDAE						
Eleotris pisonis (Gmelin, 1789)	WA	-	LC	-	-	UND, MUS
GOBIIDAE						
Awaous tajasica (Lichtenstein, 1822)	BR	-	-	-	-	UND, MUS
Coryphopterus glaucofraenum Gill, 1863	WA	-	LC	-	-	UND, VIS
Elacatinus figaro Sazima, Moura & Rosa, 1997	BR	AT	-	VU	NMA	LIT, VIS, MUS
AULOSTOMIDAE						
Aulostomus maculatus Valenciennes, 1841	WA	-	-	-	-	VIS
FISTULARIDAE						
Fistularia tabacaria Linnaeus, 1758	TA	-	-	-	-	LIT
DACTYLOPTERIDAE						
Dactylopterus volitans (Linnaeus, 1758)	TA	-	-	-	-	VIS
MULLIDAE						
Pseudupeneus maculatus (Bloch, 1793)	WA	-	-	-	DD	UND, VIS, LIT
CENTROPOMIDAE						
Centropomus parallelus Poey, 1860	WA	OF	LC	-	NT	VIS, MUS
Centropomus undecimalis (Bloch, 1792)	WA	OF	LC	-	NT	VIS
CARANGIDAE						
Carangoides crysos (Mitchill, 1815)	TA	OF	LC	-	-	UND, MUS
Caranx latus Agassiz, 1831	TA	OF	-	-	-	UND, MUS
Pseudocaranx dentex (Bloch & Schneider, 1801)	CT	-	-	-	-	VIS, PHO
Trachinotus goodei Jordan & Evermann, 1896	WA	-	LC	-	-	UND
PARALICHTHYIDAE						
Syacium sp.	-	-	-	-	-	VIS
POMACENTRIDAE						
Abudefduf saxatilis (Linnaeus, 1758)	CT	-	-	-	-	UND, VIS, LIT
Chromis multilineata (Guichenot, 1853)	TA	-	-	-	-	UND, VIS, LIT
Stegastes fuscus (Cuvier, 1830)	BR	-	LC	-	-	UND, VIS, LIT
Stegastes pictus (Castelnau, 1855)	BR+SCa	-	-	-	-	UND, VIS
Stegastes variabilis (Castelnau, 1855)	WA	-	-	-	-	UND, VIS, PHO
HEMIRAMPHIDAE						
Hyporhamphus sp.	-	-	-	-		UND, MUS
MUGILIDAE						
Mugil curema Valenciennes, 1836	CT	OF	LC	-	DD	UND, LIT, MUS
Mugil liza Valenciennes 1836	WA	OF	DD	-	NMA	VIS
BLENIIDAE						
Parablennius marmoreus (Poey, 1876)	WA	-	LC	-	-	VIS, PHO
Parablennius pilicornis (Cuvier, 1829)	TA	-	LC	-	-	UND
Scartella cristata (Linnaeus, 1758)	CT	-	LC	-	-	UND

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Table 1 – Continued...

FAMILY and *Species*	Geographic Range	Main Threat	IUCN	Brazil	São Paulo state	Record type
LABRISOMIDAE						
Labrisomus nuchipinnis (Quoy & Gaimardi, 1824)	TA	-	LC	-	-	UND
Malacoctenus delalandii (Valenciennes, 1836)	WA	-	LC	-	-	UND
GERREIDAE						
Diapterus rhombeus (Cuvier, 1829)	WA	-	LC	-	-	LIT, MUS
Eucinostomus melanopterus (Bleeker, 1863)	TA	-	LC	-	-	UND, MUS
HAEMULIDAE						
Anisotremus surinamensis (Bloch, 1791)	WA	OF	-	-	-	UND, VIS, LIT
Anisotremus virginicus (Linnaeus, 1758)	WA	-	-	-	-	UND, VIS, PHO, LIT
Haemulon aurolineatum Cuvier, 1830	WA	-	-	-	-	UND, LIT, MUS
Haemulon chrysargyreum Günther, 1859	WA	-	-	-	-	VIS
Haemulon parra (Desmarest, 1823)	WA	-	-	-	-	VIS, PHO
Haemulon plumierii (Lacepède, 1801)	WA	-	-	-	-	UND, LIT
Haemulon steindachneri (Jordan & Gilbert, 1882)	WA	-	LC	-	-	UND, VIS, PHO, LIT
LUTJANIDAE						
Lutjanus analis (Cuvier, 1828)	WA	OF	VU		NMA	VIS, PHO, LIT
Lutjanus synagris (Linnaeus, 1758)	WA	OF	-	-	-	LIT, MUS
Ocyurus chrysurus (Bloch, 1791)	WA	-	-		NMA	UND
POMACANTHIDAE						
Holacanthus tricolor (Bloch, 1795)	WA	AT	LC	-	NT	UND, VIS, LIT
Pomacanthus paru (Bloch, 1787)	WA	AT	LC	-	NT	UND, VIS, LIT
PRIACANTHIDAE						
Heteropriacanthus cruentatus (Lacepède, 1801)	CT	-	-	-	-	VIS, PHO
Priacanthus arenatus Cuvier, 1829	TA	-	-	-	-	VIS
SCIAENIDAE						
Menticirrhus littoralis (Holbrook, 1847)	WA	OF	LC	-	NT	UND
Odontoscion dentex (Cuvier, 1830)	WA	-	LC	-	DD	UND
Pareques acuminatus (Bloch & Schneider, 1801)	WA	-	LC	-	-	UND, VIS
LABRIDAE						
Bodianus rufus (Linnaeus, 1758)	WA	-	LC	-	-	UND, LIT
Cryptotomus roseus Cope, 1871	WA	-	LC	-	-	LIT
Halichoeres poeyi (Steindachner, 1867)	WA	-	LC	-	-	UND, VIS, PHO, LIT
Scarus taeniopterus Lesson, 1829	WA	OF	LC	-	-	LIT
Sparisoma axillare (Steindachner, 1878)	BR	OF	DD	VU	NMA	VIS
LOBOTIDAE						
Lobotes surinamensis (Bloch, 1790)	CT	-	-	-	DD	UND, MUS
EPHIPPIDAE						
Chaetodipterus faber (Broussonet, 1782)	WA	-	-	-	-	VIS, PHO
SPARIDAE						
Diplodus argenteus (Valenciennes, 1830)	WA	-	LC	-	-	UND, LIT
CHAETODONTIDAE						
Chaetodon striatus Linnaeus, 1758	WA	AT	LC	-	-	UND, VIS, LIT
OGCOCEPHALIDAE						
Ogcocephalus vespertilio (Linnaeus, 1758)	WA	-	-	-	-	UND, VIS
DIODONTIDAE						
Chilomycterus spinosus spinosus (Linnaeus, 1758)	WA	-	-	-	DD	VIS
TETRAODONTIDAE						
Canthigaster figueiredoi Moura & Castro, 2002	BR+SCa	AT	LC	-	-	VIS
Canthigaster rostrata (Bloch, 1786)	WA	AT	LC	-	-	UND, LIT
Sphoeroides greeleyi Gilbert, 1900	WA	-	LC	-	DD	UND
Sphoeroides spengleri (Bloch, 1785)	WA	-	LC	-	DD	UND
MONACANTHIDAE						
Aluterus scriptus (Osbeck, 1765)	CT	-	-	-	-	UND
Stephanolepis setifer (Bennett, 1831)	WA	-	-	-	-	UND
ACANTHURIDAE						
Acanthurus bahianus Castelnau, 1855	WA	AT	LC	-	-	UND, VIS, LIT
Acanthurus coeruleus Bloch & Schneider, 1801	WA	AT	LC	-	-	UND, VIS, LIT
Acanthurus chirurgus (Bloch, 1787)	TA	AT	LC	-	-	UND, VIS, LIT

Table 1 – Continued...

FAMILY and *Species*	Geographic Range	Main Threat	IUCN	Brazil	São Paulo state	Record type
PEMPHERIDIDAE						
Pempheris schomburgkii Muller & Troschel, 1848	WA	-	-	-	-	UND
KYPHOSIDAE						
Kyphosus sp.	TA	-	-	-	-	UND, MUS
SERRANIDAE						
Serranus baldwini (Evermann & Marsh, 1899)	WA	-	LC	-	-	UND
Serranus flaviventris (Cuvier, 1829)	WA	-	LC	-	-	UND
EPINEPHELIDAE						
Epinephelus marginatus (Lowe, 1834)	SE+Pat+EA	OF	EN	VU	NMA	UND, VIS, LIT
Epinephelus morio (Valenciennes, 1828)	WA	OF	NT	VU	NMA	UND, VIS, LIT
Hyporthodus niveatus (Valenciennes, 1828)	WA	OF	VU	VU	NMA	UND, PHO
Mycteroperca acutirostris (Velenciennes, 1828)	WA	OF	LC	-	-	VIS, PHO, LIT
Mycteroperca bonaci (Poey, 1860)	WA	OF	NT	VU	NMA	UND
Mycteroperca interstitialis (Poey, 1860)	WA	OF	VU	VU	NMA	UND, VIS, PHO
SCORPAENIDAE						
Scorpaena plumieri Bloch, 1789	WA+CA	-	-	-	-	VIS

*Voucher used as reference: *Harengula clupeola* ZUEC-PIS 3019, 3035; *Apogon americanus* ZUEC-PIS 2709; *Astrapogon puncticulatus* ZUEC-PIS 2710, 2711; *Eleotronis pisonis* ZUEC-PIS 2728, 3009, 3127; *Awaous tajasica* ZUEC-PIS 2731, 3008; *Elacatinus figaro* ZUEC-PIS 2703, 2724, 2725, 2726, 2727, 2816, 2817, 3012; *Centropomus parallelus* ZUEC-PIS 3017, 4334; *Carangoides crysos* ZUEC-PIS 2754, 2900, 2901; *Caranx latus* ZUEC-PIS 2902, 2903; *Hyporhamphus* sp. ZUEC-PIS 2911, 2912; *Mugil curema* ZUEC-PIS 2729, 3001, 3002, 3016; *Diapterus rhombeus* ZUEC-PIS 2904; *Eucinostomus melanopterus* ZUEC-PIS 2913, 3000, 3010, 8012; *Haemulon aurolineatum* ZUEC-PIS 2914, 2915, 2916, 2917, 3022; *Lutjanus synagris* ZUEC-PIS 2929, 2930, 2931; *Lobotes surinamensis* ZUEC-PIS 2715; *Kyphosus* sp. ZUEC-PIS 2896;

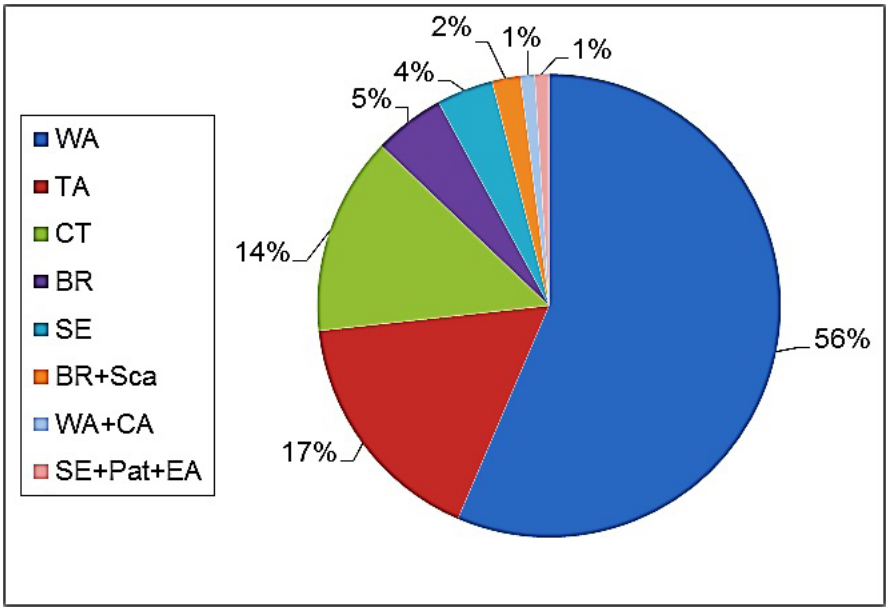

Figure 2. Geographic distribution of the species recorded at Anchieta Island State Park: WA, Western Atlantic (Northern and Southern West Atlantic); TA, Trans-Atlantic (both sides of the Atlantic); CT, Circumtropical; BR, Brazilian Province; SE, Southeastern Brazil (20- 27° S); ; SCa, Southern Caribbean (Venezuela, Trinidad and Tobago and other neighboring islands); CA, Central Atlantic; Pat, Patagonian (primarily in temperate rocky reefs south to Argentina); EA, Eastern Atlantic.

Discussion

We provide a checklist of 103 reef fishes that occur in the AISP, 77 of which appearing for the first time in the literature for this area. Seventeen (22%) species refer to elasmobranchs which, due to specific habits and extremely reduced abundance, are only rarely recorded in faunal surveys, especially using visual census. The fact that several elasmobranchs were recorded by consulting experts, highlight the importance of secondary unpublished data. The use of BRUVS (Baited Remoted Underwater Video Stations) was also particularly relevant, once this tool allows recording species that often remain unseen by divers, such as elasmobranchs. Its use along the Brazilian coast is recent, but preliminary results have shown great potential to record sharks and rays in reef environments (Rolim et al. 2017). For instance, we recorded comparatively more reef fish species than other surveys conducted in nearby areas, i.e. 106 species in Gibran & Moura (2012) and 67 species in Teixeira-Neves et al. (2015).

Biogeographic affinities of the AISP reef fish fauna are similar to those recorded in other similar assessments carried out in Southeastern Brazil (Luiz Jr. et al. 2008, Daros et al. 2012, Pinheiro et al. 2015b), with most species being widely ranging across the Western Atlantic (WA). Anchieta

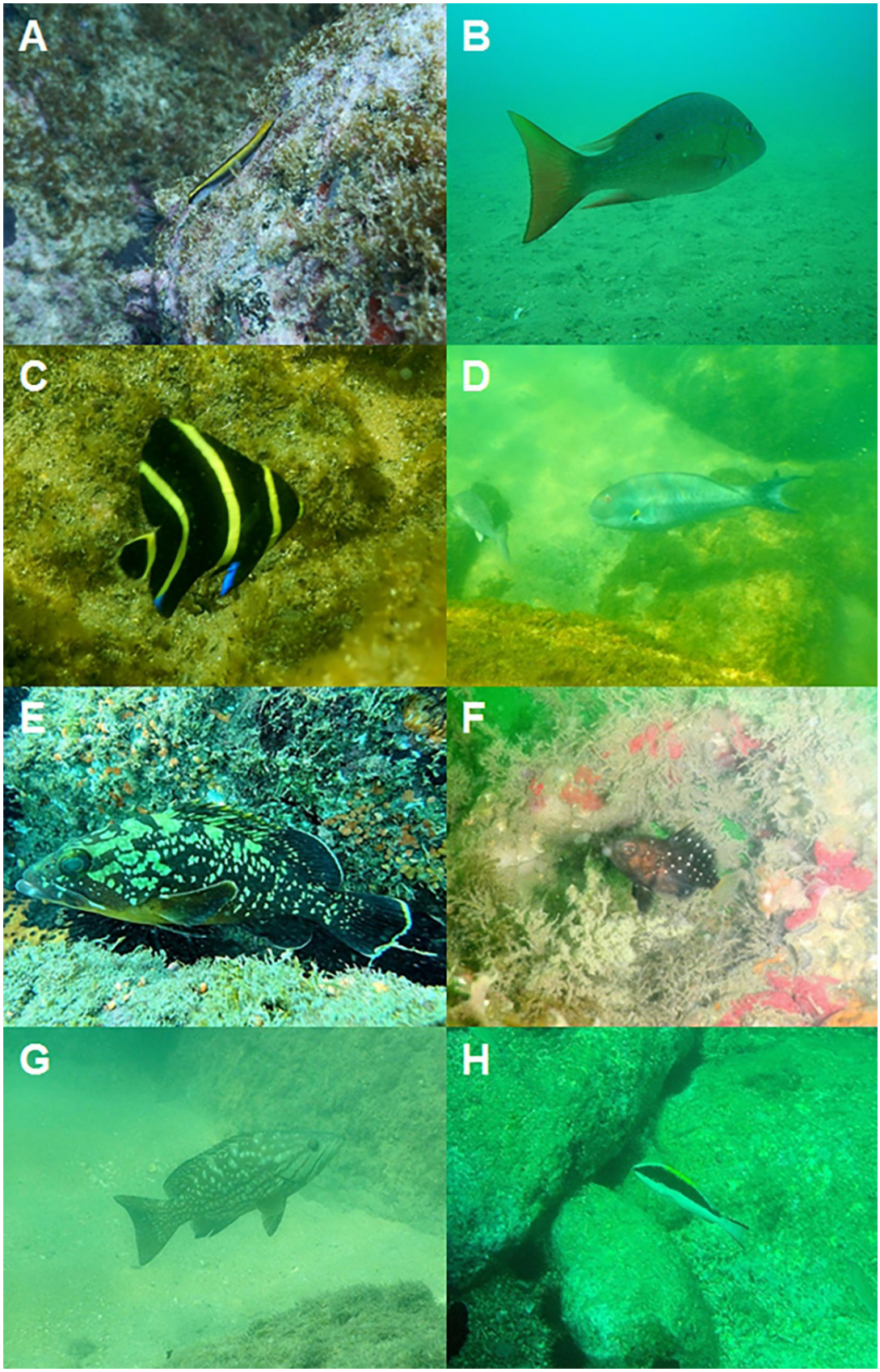

Figure 3. Some species included within threatened categories that were recovered on the AISP. A, *Elacatinus figaro* Sazima, Moura & Rosa, 1997 (<2cm); B, *Lutjanus analis* (Cuvier, 1828); C, *Pomacanthus paru* (Bloch, 1787) (juvenile) (2-10cm); D, *Sparisoma axillare* (Steindachner, 1878) (terminal phase) (>30cm); E, *Epinephelus marginatus* (Lowe, 1834); F, *Hyporthodus niveatus* (Valenciennes, 1828) (juvenile) (2-10cm); G, *Mycteroperca acutirostris* (Valenciennes, 1828); H, *Mycteroperca interstitialis* (Poey, 1860) (juvenile) (2-10cm).

Island is a coastal site largely dominated by the warm and less saline (due to riverine inflow) Coastal Water (CW), as well as by the warm (>18ºC) and saline water from the south-flowing Brazil Current (BC) (Matsuura 1986). Luiz Jr. et al. (2008) pointed out the importance of the BC to provide a proper water temperature and larval input to the subtropical rocky reefs, explaining the large amount of tropical reef fishes in this subtropical area. In addition, the region is affected by upwellings of the cold (8-18ºC) South Atlantic Central Water (SACW) during the austral summer and spring (Matsuura 1986). Such frequent cold water intrusions, as well as the relatively wide depth range of the AISP, account for the presence of several reef fishes with subtropical and temperate affinities (Floeter et al. 2001, Luiz Jr. et al. 2008, Gibran & Moura 2012, Pinheiro et al. 2015b). Furthermore, the high structural complexity of rocky shores (Ferreira et al. 2001, Dominici-Arosema & Wolf 2006, Gibran & Moura 2012, Teixeira-Neves et al. 2015) and the broad depth range of coastal islands (Pereira-Filho et al. 2011, Gibran & Moura 2012, Teixeira-Neves et al. 2015), as well as the proximity to large estuaries and the protected status of the AISP, are responsible for the relatively high richness of fishes recorded herein.

Overfishing and bycatch are the main stressors operating over 85% of the endangered species recorded at AISP, which mostly include mesopredators (i.e. medium to large size carnivores) such as groupers (*E. marginatus*, *E. morio*, *M. acutirostris* and *M. bonaci*), and large herbivorous like *S. axillare* (Floeter et al. 2006, Francini-Filho & Moura 2008, Teixeira-Neves et al. 2015). These species are targeted by both professional and recreational fisheries, including spearfishing, which is poorly regulated and monitored in Brazil (Nunes et al. 2012; Freire et al. 2016). Most of the species of elasmobranchs recorded (64.7%) are either CR, EN, VU or NT, e.g. *Sphyrna lewini*, *Pseudobatos horkelii* and *Rhinoptera brasiliensis*, and its population status is more critical than that of actinopterygians. With extremely reduced populations, elasmobranchs are curently captured mostly as bycatch (Rosa & Gadig 2014), and therefore deserve specific mitigation measures directed to fisheries targeting other resources (especially longlines, gillnets and trawls). Among actinopterygians, it is remarkable that 83.3% of the recorded epinephelids (groupers) are either CR, EN, VU or NT. Besides being protogynous hermaphrodites, epinephelids are slow-growing and long-living species with late maturity (Andrade et al. 2003, Mitcheson et al. 2008, Reñones et al. 2010), being thus highly vulnerable to fishery.

The protected status of the marine perimeter of AISP is well justified by its relatively high fish richness and concentration of threathened species. However, the population status of these species and the reef fish community structure are still poorly known (e.g. Sazima et al. 2000), impeding a thorough assessment of long-term of population viability and the potential of AISP to outsource unprotected areas in the vicinities (e.g. Floeter et al. 2006, Francini-Filho & Moura 2008). For instance, it is unclear whether the current no-take zoning at the regional level is sufficient to ensure long term biodiversity persistence and fisheries sustainability, as stated in the objectives of the State MPA network under development along the São Paulo coast.

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Authors Contributions

Gabriel Raposo Silva de Souza – Substantial contribution to the idea and design of the work, contribution to data collection, contribution in the analysis and interpretation of data and contribution in the writing of the work.

Otto B. F. Gadig – contribution to data collection, contribution in the analysis and interpretation of data and contribution in the writing of the work.

Fábio dos Santos Motta – Contribution to data collection, contribution in the analysis and interpretation of data, contribution in the writing of the work and contribution in critical review adding intellectual content.

Rodrigo Leão de Moura – Contribution to data collection, contribution in the analysis and interpretation of data, contribution in the writing of the work and contribution in critical review adding intellectual content.

Ronaldo Bastos Francini-Filho - Contribution to data collection, contribution in the analysis and interpretation of data, contribution in the writing of the work and contribution in critical review adding intellectual content..

Domingos Garrone Neto – Substantial contribution to the idea and design of the work, contribution to data collection, contribution in the analysis and interpretation of data and contribution in the writing of the work.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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