Rocky reef fish biodiversity and conservation in a Brazilian Hope Spot region

Correspondence:
Áthila A. Bertoncini
athilapeixe@gmail.com

Augusto A. Machado[1,2], Fernando C. de Moraes[2], Aline A. Aguiar[2], Mauricio Hostim-Silva[1], Luciano N. Santos[3,4] and Áthila A. Bertoncini[2,4,5]

Coastal islands of Grande Rio, located south Rio de Janeiro and Maricá cities have been under multiple anthropogenic impacts. Despite these problems, these insular systems shelter a high diversity of fish species. Reef fishes are essential components of tropical marine coastal communities, also providing food and income for millions of people around the world. In this work, we generated an updated checklist from Cagarras Islands Natural Monument and surrounding areas based on fisheries data, literature records and multiple sampling techniques, including the Submersible Rotating Video technique, used for the first time in Brazil. We present an inventory of 282 fish species representing 91 different families, with 21 new records for the study area, including a non-native species (*Heniochus acuminatus*). In addition, our results show a moderate endemism level for the Brazilian province (approximately 6.0%), while 10.5% of species are assigned to one of IUCN's threatened categories. Our efforts show the fish biodiversity scenario and their distribution on coastal islands more than 10 years after the Cagarras Islands Natural Monument establishment, reinforcing the importance of monitoring research programs for the management of this Marine Protected Area and surrounding waters, that play a key role for artisanal fisheries.

Keywords: Checklist, Marine Protected Areas, Non-destructive techniques, Richness, South Atlantic.

Submitted May 14, 2022
Accepted August 23, 2022
by Osmar Luiz
Epub October 14, 2022

Online version ISSN 1982-0224
Print version ISSN 1679-6225

Neotrop. Ichthyol.
vol. 20, no. 3, Maringá 2022

1 Programa de Pós-Graduação em Oceanografia Ambiental (PPGOAM), Universidade Federal do Espírito Santo, Vitória, ES, Brazil. (AAM) augustoa.machado91@gmail.com, (MHS) mhostim@gmail.com.

2 Projeto Ilhas do Rio, Instituto Mar Adentro. Rio de Janeiro, RJ, Brazil. (FCM) fmoraes@maradentro.org.br, (AAA) alineaguiar@maradentro.org.br.

3 Programa de Pós-graduação em Ciências Biológicas (Biodiversidade Neotropical), Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, RJ, Brazil. (LNS) luciano.lep@gmail.com.

4 Programa de Pós-Graduação em Ecoturismo e Conservação (PPGEC), Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, RJ, Brazil.

5 Programa de Pós-Graduação em Ecologia (POSECO), Universidade Federal de Santa Catarina (UFSC), Florianópolis, SC, Brazil. (AAB) athilapeixe@gmail.com (corresponding author).

As ilhas costeiras do Grande Rio, ao sul das cidades do Rio de Janeiro e Maricá, têm sofrido múltiplos impactos antrópicos. Apesar destes problemas, esses sistemas insulares abrigam uma grande diversidade de espécies de peixes. Os peixes recifais são componentes essenciais das comunidades costeiras marinhas tropicais, fornecendo alimento e fonte de renda para milhões de pessoas em todo o mundo. Neste trabalho, geramos uma lista de verificação atualizada do Monumento Natural das Ilhas Cagarras e áreas do entorno com base em dados de pesca, registros da literatura e múltiplas técnicas de amostragem, incluindo a técnica de vídeo rotacional subaquático usada pela primeira vez no Brasil. Apresentamos um inventário de 282 espécies de peixes representando 91 famílias, com 21 novos registros para área de estudo, incluindo uma espécie não nativa (*Heniochus acuminatus*). Além disso, nossos resultados mostram um nível de endemismo moderado da província brasileira (aproximadamente 6,0%), sendo 10,5% das espécies classificadas em uma das categorias ameaçadas da IUCN. Nossos esforços mostram o cenário da biodiversidade de peixes e sua distribuição nas ilhas costeiras mais de 10 anos após o estabelecimento do Monumento Natural das Ilhas Cagarras, reforçando a importância de programas de pesquisa de monitoramento para a gestão desta Área Marinha Protegida e suas águas adjacentes, que desempenham papel fundamental para a pesca artesanal.

Palavras-chave: Áreas Marinhas Protegidas, Atlântico Sul, Lista de espécies, Riqueza, Técnicas não-destrutivas.

INTRODUCTION

Rocky reefs are among the most important marine ecosystems in the world, due to their importance in providing livelihood services for millions of people, such as fishing, medicinal compounds, and tourism (Pereira, Soares-Gomes, 2009; Laport *et al*., 2016; Riofrío-Lazo *et al*., 2022). Despite all their importance, many forms of life that inhabit rocky shore ecosystems are critically endangered by human actions (Benedetti-Cecchi *et al*., 2001; Pereira, Soares-Gomes, 2009; Mendez *et al*., 2019). Coastal development, urbanization and overfishing are amongst the main activities that exert pressure on coastal marine ecosystems (Elliott, 2014; Alves *et al*., 2019; Figueroa-Pico *et al*., 2021), currently occurring so fast that they generally surpass our ability to understand the surrounding ecosystem functioning. In order to reduce these impacts caused by human activities, Marine Protected Areas (MPAs) have been created as an important management tool, aiming to provide protection for local marine biodiversity (Lester *et al*., 2009; Miller, Russ, 2014), especially minimizing impacts on fish assemblages and improving/preserving the essential habitats on which species depend (Gaines *et al*., 2010; Sciberras *et al*., 2015).

As reef environments, reef fishes are important components of tropical marine communities, serving as food and income source for millions of people (Munro, 1996; Pauly *et al*., 2002; Nelson *et al*., 2016). In Brazil, reef fish communities are distributed along the coast, from off the mouth of the Amazon River, and the Manuel Luiz reefs (Northern Brazil) to coastal regions of Santa Catarina State in Southern Brazil (Rocha, Rosa, 2001; Hostim-Silva *et al*., 2005; Moura *et al*., 2016), including oceanic islands (Quimbayo *et al*., 2019; Pinheiro *et al*., 2020). However, the rocky shore ichthyofauna on coastal regions has been under increasing human pressure, ranging from the degradation by pollution, to extractive activities, such as fishing (recreational and commercial), which can lead some species to high extinction risks (Quaas *et al*., 2019). Additionally, the introduction/arrival of invasive species can pose a significant threat to local biodiversity, and may cause changes in the structure of communities, resulting in the exclusion of native species (Ruiz *et al*., 1997; Bax *et al*., 2003). These facts contribute to the reduction of the environment quality, directly impacting the associated ichthyofauna, which demands a better understanding of the dynamics of the reef fish communities in these regions, especially within MPAs.

Along the Southeastern Brazilian coastline, the complex structure of rocky reefs is associated with a valuable diversity of fish species and other organisms, even overcoming the number of species present on other marine ecosystems (Floeter *et al*., 2004; Souza *et al*., 2018). The Grande Rio region shelters our studied islands. They are precisely located from the Guanabara Bay entrance to both sides of the E-W coastline orientation, encompassing Rio de Janeiro and Maricá municipalities, in Southeastern Brazil. These islands and surrounding waters shelter a high biodiversity of marine and terrestrial fauna and flora, and even stand out as a singular archeological site, being commonly visited by tourists, fishermen, military activities, and the general public (details in Moraes *et al*., 2013; Bertoncini *et al*., 2019). Part of these islands form an important Marine Protected Area (MPA) in Rio de Janeiro City, The Cagarras Islands Natural Monument (MONA Cagarras). Despite its importance and proximity to a highly populated Brazilian metropolis, the ichthyofauna of these coastal islands and surrounding waters are still poorly known. Nonetheless, MONA Cagarras, together with its surrounding areas (including Rasa and Cotunduba islands) was, in 2021, recognized as a Hope Spot for conservation of marine biodiversity by the international nonprofit organization Mission Blue.

The survey of biodiversity appears as a key tool in studies of fish communities (Mora *et al*., 2008; Guabiroba *et al*., 2020; Pereira *et al*., 2021). Non-destructive techniques have been widely employed in marine ecosystems, especially in MPAs (Andradi-Brown *et al*., 2016; Bayley *et al*., 2019; Quaas *et al*., 2019, Schmid *et al*., 2020). The Underwater Visual Census (UVC) is frequently used in ecological studies of reef fish communities (Chaves, Monteiro-Neto, 2009; Daros *et al*., 2018; Motta *et al*., 2021; Pereira *et al*., 2021), allowing the identification of species and the monitoring of the behavior of organisms that especially, are not affected by the presence of divers (Sale, 1997; Beck *et al*., 2014). In parallel, the evolution of non-destructive techniques through remote videos, have been employed as important complementary tools, to carry out more accurate sampling of the ichthyofauna (Mallet, Pelletier, 2014; Koenig, Stallings, 2015; Pimentel *et al*., 2020; Pinheiro *et al*., 2020; Rolim *et al*., 2022). Such instruments allow to estimate the abundance and diversity of reef fishes, providing relevant information on the health of local marine communities, with minimum impacts.

In the present work, we revisited and updated the checklist of fish species from Rio de Janeiro coastal islands and surrounding waters, based on a decade of field surveys, published scientific articles and fisheries records. In addition, we report the first record of the non-native species *Heniochus acuminatus* (Linnaeus, 1758) in Rio de

Janeiro. Furthermore, we provide data of species richness on several coastal islands and surroundings by different sampling methods, improving the knowledge on the marine fish species of the state of Rio de Janeiro.

MATERIAL AND METHODS

Sampling sites. The present study was conducted at the coastal islands of Rio de Janeiro and Maricá cities (between 43º35'W – 42º09'W; 23º01'S – 22º09'S) (Fig. 1): from West to East, Tijucas Archipelago is located 1.7 km off Barra da Tijuca Beach and comprises Pontuda, Alfavaca, and Meio Islands; the Cagarras Archipelago is about 4 km southwards off Ipanema Beach, formed by Palmas, Cagarra, Comprida islands plus Filhote da Cagarra Islet; and along with Redonda Island and Filhote da Redonda Islet, which lie 4 km southwards the Cagarra Archipelago, they form the Cagarras Islands Natural Monument, a no-take MPA created in 2010 to protect the local biodiversity, which boundaries includes the marine area 10 m from the rockyshore of each island. Further East lies Rasa Island, while Cotunduba Island is located at the entrance of Guanabara Bay. Further East, Maricás Archipelago is spread 3.5 km from the Maricá coast and is formed by Maricá and Crioula islands and two small islets.

Data source. The updated checklist of marine fishes presented herein was produced through non-destructive methods: (I) 696 Underwater Visual Censuses (UVC) were carried out using 40m^2-belt transects by two scientific divers in all of the three archipelagos and Cotunduba Island, between 2011 and 2022, at shallow waters (<10 m) and deeper waters (>11 to 25 m); (II) 468 Submersible Rotating Videos (SRV) were obtained at three different areas on shallow (<10 m) and deep (>10 m) strata (117 hours of video); Additionally, (III) fish occurrence records were compiled from previously published scientific papers and books (*e.g.*, Rangel *et al*., 2007; Moraes *et al*., 2013; Monteiro-Neto *et al*., 2013; Aguiar *et al*., 2015; Amorim, Monteiro-Neto, 2016; Garcia *et al*., 2018; Bertoncini *et al*., 2019; Araujo *et al*., 2020; Hauser-Davis *et al*., 2021); (IV) Data were also compiled from fishery landing monitoring and personal communication with Z13 and Z7 Fishermen Colonies, providing much of the species that inhabit soft bottoms, once they have fishing grounds in the surroundings of the islands. Finally, (V) Underwater Sighting Data (approx. 603 hours of scientific diving) and sightings by colleagues and volunteers *in situ* were considered in the present work.

Submersible Rotating Videos (SRV). The SRV system (Fig. 2), developed by Koenig, Stallings (2015), is an innovative rotational underwater video technique, and consists of a stainless-steel frame with an engine inside (2 rpm) and a camera of high resolution attached (*e.g.*, GoPro). This technique simulates the renowned stationary census technique, developed by Bohnsack, Bannerot (1986) and excludes the potential influence of the diver on the behavior of fishes. From each deployment, a 15-minute-video was recorded, and then after analyzed using the VLC multimedia player (http://www.videolan.org/vlc/index.html).

Data analysis. The species were identified based on Figueiredo, Menezes (2000), Humann, Deloach (2014), Hostim-Silva *et al.* (2005), Bertoncini *et al.* (2019), and consultancy to experts. The families were ordered according to Dornburg, Near (2021)

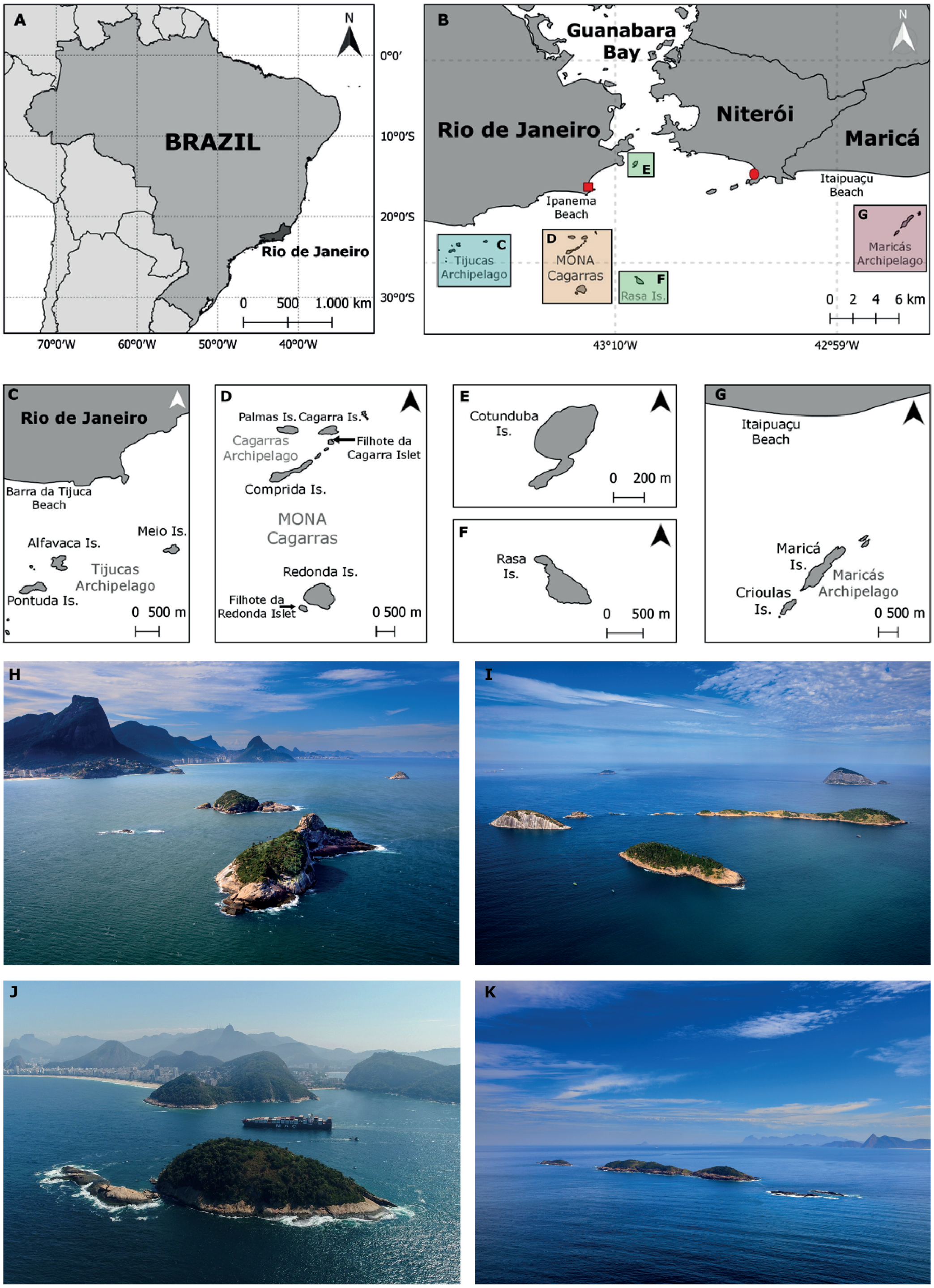

FIGURE 1 | Maps and photographs of the study area (Coastal Islands of Rio de Janeiro metropolitan region). **A.** The State of Rio de Janeiro in Southeast Brazil; **B.** The Guanabara Bay and the archipelagos/islands along the southern coast, Z13 fishermen's colony (red square) and Z7 fishermen's colony (red circle); **C.** Tijucas Archipelago; **D.** Cagarras Archipelago and Redonda Island and Filhote da Redonda Islet forming the MONA Cagarras MPA; **E.** Cotunduba Island; **F.** Rasa Island; **G.** Maricás Archipelago; **H.** Aerial view from West of the Tijucas Archipelago; **I.** Aerial view from Northwest of MONA Cagarras, depicting Rasa Island in the far background; **J.** Aerial view from Southeast of Cotunduba Island; **K.** Aerial view from East of the Maricás Archipelago. Credits: Augusto A. Machado (**A-G**); Áthila A. Bertoncini (**H, I, K**); Fred Cunha (**J**).

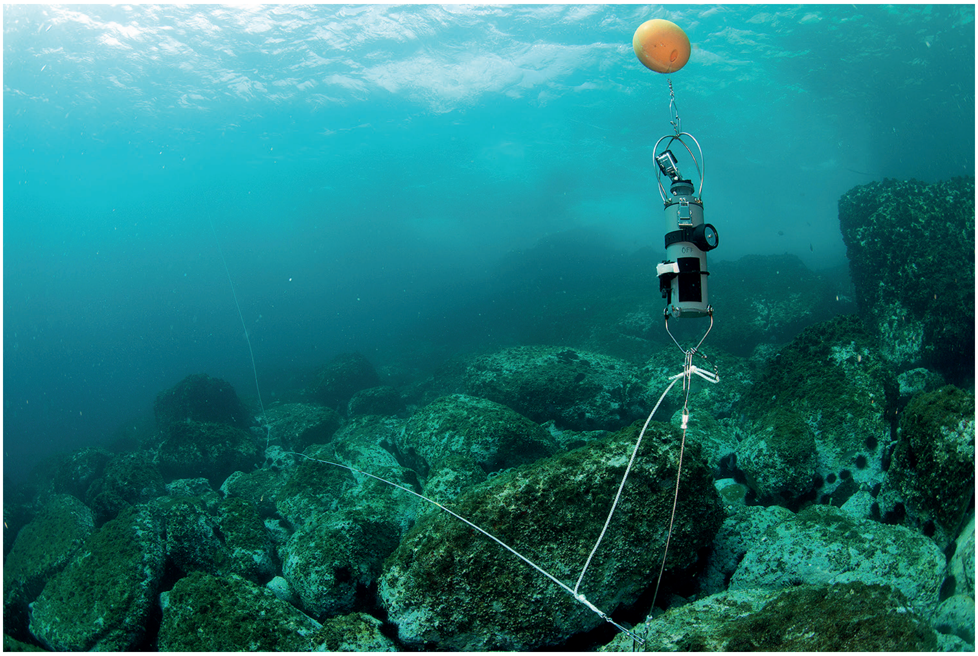

FIGURE 2 | Submersible Rotating Videos “SRV” in operation on Redonda Island. Photo: Áthila A. Bertoncini.

and species were arranged in alphabetic order inside each family. The IUCN Red List of threatened species and the Brazilian environmental agency, Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) – Red list of Brazilian Fauna Threatened of Extinction were addressed to classify the conservation status of each species (ICMBio, 2018; IUCN, 2020). The sites where the species were reported are presented here and the records of species not observed by this study are referenced. Data analyses were performed using Software R (R Development Core Team, 2020) and maps were elaborated through QGIS 3.16 (QGIS Development Team, 2022).

RESULTS

Fish database. The annotated checklist includes 282 fish species, belonging to 192 genera and 91 families cataloged at the coastal Islands of Rio de Janeiro and surrounding waters, including soft bottom habitats (Tab. 1). It is important to note in Tab. 1 that phylogenetic updates are considered for recent changes in families, *i.e.*, *Galeocerdo cuvier* (Péron & Lesueur, 1822) under Galeocerdonidae (Ebert *et al.*, 2021), *Zapteryx brevirostris* (Müller & Henle, 1841) under Trygonorrhinidae (Last *et al.*, 2016), *Acanthistius brasilianus* (Cuvier, 1828) under Anthiadidae (Dornburg, Near, 2021; Anderson, 2018); and genus, *i.e.*, from *Equetus* (*lanceolatus*) (Linnaeus, 1758) to *Eques Bloch*, 1793 (Parenti, 2020); and from *Chromis* (*multilineata*) (Guichenot, 1853) to *Azurina* Jordan & McGregor, 1898 (Tang *et al.*, 2021).

From this total, 176 (62.4%) species were observed during Projeto Ilhas do Rio fieldwork surveys. Among the species listed herein: 102 (36.2%) were observed in SRV videos, 160 (56.7%) species were recorded by UVC, being 86 (30.5%) registered in both

TABLE 1 | Fish species observed in Coastal Islands of Rio de Janeiro arranged according to Dornburg, Near (2021). Observed sites: Tijucas Archipelago = TA; Cagarras Islands Natural Monument = MCA; Maricás Archipelago = MA; Rasa Island = RI; Cotunduba Island = CI; Conservation Status (IUCN/ICMBio): CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, and NE = Not Evaluated. Record type: SIG = Sighted, LIT = Literature; FIS = Fishery (Fishermen's colony and spearfishing), MUS = Museum Voucher, SRV= Submersible Rotating Video and UVC = Underwater Visual Census. † New Records for the area. # Exotic species, Ψ Brazilian endemic species; Rangel *et al*., 2007*[1], Moraes *et al*., 2013*[2], Monteiro-Neto *et al*., 2013*[3], Amorim, Monteiro-Neto, 2016*[4], Garcia *et al*., 2018*[5], Bertoncini *et al*., 2019*[6], Araujo *et al*., 2020*[7], Hauser-Davis *et al*., 2021*[8].

Family and species	IUCN	ICMBio	Observed sites	Record type
GINGLYMOSTOMATIDAE				
Ginglymostoma cirratum (Bonnaterre, 1788)	DD	VU	MCA	SIG *[2]
RHINCODONTIDAE				
Rhincodon typus Smith, 1828 †	EN	VU	MCA	SIG
LAMNIDAE				
Isurus oxyrinchus Rafinesque, 1810	EN	NT	Z7 / Z13	FIS*[7]
CARCHARHINIDAE				
Carcharhinus brevipinna (Valenciennes, 1839)	NT	DD	Z7 / Z13	FIS*[7]
Carcharhinus falciformis (Bibron, 1839)	VU	NT	Z7	FIS*[7]
Rhizoprionodon lalandii (Valenciennes, 1839)	DD	NT	Z13	FIS*[7]
GALEOCERDONIDAE				
Galeocerdo cuvier (Péron & Lesueur, 1822)	NT	NT	Z13	FIS*[7]
SPHYRNIDAE				
Sphyrna lewini (Griffith & Smith, 1834)	CR	CR	Z7 / Z13	FIS*[7]
Sphyrna zygaena (Linnaeus, 1758)	VU	CR	Z7 / Z13	FIS*[7]
HEXANCHIDAE				
Notorynchus cepedianus (Péron, 1807) †	DD	CR	Z13	FIS
SQUATINIDAE				
Squatina guggenheim Marini, 1936	EN	CR	Z7 & Z13	FIS*[6]
NARCINIDAE				
Narcine brasiliensis (Olfers, 1831)	DD	DD	TA / Z13	SRV/ FIS*[7]
RAJIDAE				
Atlantoraja cyclophora (Regan, 1903)	VU	NT	MUS	MUS*[3]
Atlantoraja castelnaui (Miranda Ribeiro, 1907)	EN	EN	Z7 / Z13	FIS*[6]
Rioraja agassizii (Müller & Henle, 1841)	VU	EN	MUS / Z13	MUS*[3]/FIS*[7]
RHINOBATIDAE				
Pseudobatos horkelii (Müller & Henle, 1841)	CR	CR	Z7 / Z13	FIS*[6]
Pseudobatos percellens (Walbaum, 1792)	NT	DD	MCA / Z13	SRV / FIS*[7]
TRYGONORRHINIDAE				
Zapteryx brevirostris (Müller & Henle, 1841)	NT	DD	TA / MCA / MA / Z13 / MUS	UVC / MUS*[3]/FIS*[7]
DASYATIDAE				
Dasyatis hypostigma Santos & Carvalho, 2004	DD	DD	Z13	FIS*[3]
Hypanus americanus (Hildebrand & Schroeder, 1928)	DD	DD	MCA / MA / RI / Z13	UVC / SRV / FIS*[7]
Hypanus guttatus (Bloch & Schneider, 1801)	DD	LC	Z13	FIS*[7]
Hypanus say (Lesueur, 1817)	LC	DD	Z13	FIS*[4]
Pteroplatytrygon violacea (Bonaparte, 1832)	LC	DD	Z13	FIS*[7]
GYMNURIDAE				
Gymnura altavela (Linnaeus, 1758)	VU	CR	TA / MCA / MA / Z13	UVC / FIS*[3]
MYLIOBATIDAE				
Aetobatus narinari (Euphrasen, 1790)	NT	DD	TA / MCA / MA / RI	UVC/ SRV/ LIT*[1,3]
Myliobatis freminvillei Lesueur, 1824	DD	EN	MCA / RI	UVC/ SRV/ SIG*[3]
RHINOPTERIDAE				
Rhinoptera bonasus (Mitchill, 1815) †	VU	VU	MCA	UVC
MOBULIDAE				
Mobula mobular (Bonnaterre, 1788)	EN	VU	Z13	FIS*[8]
ELOPIDAE				
Elops saurus Linnaeus, 1766	LC	NE	Z13	FIS*[2]

➡

TABLE 1 | (Continued)

ALBULIDAE				
Albula vulpes (Linnaeus, 1758)	NT	DD	Z13	FIS*[2]
MURAENIDAE				
Gymnothorax funebris Ranzani, 1839	LC	DD	MCA	SIG / LIT*[1]
Gymnothorax moringa (Cuvier, 1829)	LC	DD	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
Gymnothorax ocellatus Agassiz, 1831	LC	DD	Z13	FIS*[2]
Gymnothorax vicinus (Castelnau, 1855)	LC	DD	TA / MCA / MA / RI	UVC / SIG*[3]
Muraena retifera Goode & Bean, 1882	LC	LC	TA / MCA / MA / RI / CI	UVC / SIG*[3]
OPHICHTHIDAE				
Ahlia egmontis (Jordan, 1884)	LC	LC	MCA / RI	UVC / SIG*[3]
Myrichthys breviceps (Richardson, 1848)	LC	LC	MCA	UVC / LIT*[1]
Myrichthys ocellatus (Lesueur, 1825)	LC	LC	TA / MCA / MA / RI	UVC / LIT*[3]
Ophichthus ophis (Linnaeus, 1758)	LC	LC	TA / MCA	UVC / LIT*[3]
CONGRIDAE				
Conger orbignianus Valenciennes, 1837	LC	DD	MUS	MUS*[3]
CLUPEIDAE				
Brevoortia aurea (Spix & Agassiz, 1829)	LC	LC	Z13	FIS*[2]
Harengula clupeola (Cuvier, 1829)	LC	LC	TA / MCA / MA	SRV / SIG*[3]
Opisthonema oglinum (Lesueur, 1818)	LC	LC	MCA / MA / Z13	UVC / FIS*[2] / SIG*[3]
Sardinella brasiliensis (Steindachner, 1879)	DD	DD	MCA / Z13	UVC / FIS*[2]
ARIIDAE				
Genidens barbus (Lacepède, 1803)	NE	EN	CI3 / Z13	UVC / FIS*[2]
SYNODONTIDAE				
Synodus foetens (Linnaeus, 1766)	LC	LC	MCA	LIT*[2,3]
Synodus intermedius (Spix & Agassiz, 1829)	LC	LC	TA / MCA / MA / RI	LIT*[1]/UVC
Synodus synodus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Trachinocephalus myops (Foster, 1801)	LC	LC	MUS	MUS*[3]
LAMPRIDAE				
Lampris guttatus (Brünnich, 1788) †	LC	LC	Z13	FIS
MERLUCCIIDAE				
Merluccius hubbsi Marini, 1933	NE	NT	Z13	FIS*[2]
GADIDAE				
Urophycis brasiliensis (Kaup, 1858)	NE	NT	Z13	FIS*[2]
HOLOCENTRIDAE				
Holocentrus adscensionis (Osbeck, 1765)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / LIT*[1]/ FIS*[2]
Myripristis jacobus Cuvier, 1829	LC	LC	TA / MCA / MA / RI	UVC / SRV / LIT*[1]
Plectrypops retrospinis (Guichenot, 1853)	LC	LC	MCA / MA	UVC / LIT*[2]
Sargocentron bullisi (Woods, 1955)	LC	LC	MCA / MA	SIG*[3]/UVC
BATRACHOIDIDAE				
Porichthys porosissimus (Cuvier, 1829)	NE	LC	MCA / MA / Z13 / MUS	UVC / LIT*[2]/ MUS*[3] / FIS*[2]
GOBIIDAE				
Coryphopterus glaucofraenum Gill, 1863	LC	LC	TA / MCA / MA / RI / CI	UVC / LIT*[1]
Ctenogobius saepepallens (Gilbert & Randall, 1968) †	LC	LC	MA	UVC
Elacatinus figaro Sazima, Moura & Rosa, 1997 Ψ	NE	VU	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Gnatholepis thompsoni Jordan, 1904	LC	LC	MCA	UVC / SIG*[6]
Gobulus myersi Ginsburg, 1939 †	LC	NE	TA	UVC
APOGONIDAE				
Apogon pseudomaculatus Longley, 1932	LC	LC	MCA / MA	UVC / LIT*[2]
Phaeoptyx pigmentaria (Poey, 1860)	LC	LC	Not Available	SIG*[3]
PTERELEOTRIDAE				
Ptereleotris randalli Gasparini, Rocha & Floeter, 2001	LC	LC	TA	UVC / SRV / SIG*[3]
GEMPYLIDAE				
Thyrsites lepidopodea (Cuvier, 1832)	NE	LC	Z13	FIS*[2]

TABLE 1 | (Continued)

POMATOMIDAE				
Pomatomus saltatrix (Linnaeus, 1766)	VU	NT	MCA / Z13	SRV / FIS*[2]
SCOMBRIDAE				
Euthynnus alletteratus (Rafinesque, 1810)	LC	LC	MCA / MA	UVC / LIT*[6]
Sarda sarda (Bloch, 1793) †	LC	LC	MCA	SIG
Scomber colias Gmelin, 1789	LC	LC	Z13	FIS*[4]
Scomberomorus brasiliensis Collette, Russo & Zavala-Camin, 1978	LC	LC	MCA / Z13	SIG / FIS*[4]
STROMATEIDAE				
Peprilus paru (Linnaeus, 1758)	LC	LC	Z13	FIS*[2]
TRICHIURIDAE				
Trichiurus lepturus Linnaeus, 1758	DD	LC	MCA / Z13	SIG*[2]/ FIS*[2]
FISTULARIIDAE				
Fistularia petimba Lacepède, 1803	LC	LC	MCA / Z13	SIG / FIS*[2]
Fistularia tabacaria Linnaeus, 1758	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
SYNGNATHIDAE				
Halicampus crinitus (Jenyns, 1842) †	LC	LC	RI	UVC
Hippocampus erectus Perry, 1810	VU	VU	Not Available	LIT*[3]
Hippocampus patagonicus Piacentino & Luzzatto, 2004 †	VU	VU	MCA	SIG
Hippocampus reidi Ginsburg, 1933	NT	VU	TA / MCA / MA	UVC / SIG*[1]
CALLIONYMIDAE				
Callionymus bairdi Jordan, 1888	LC	LC	TA / MCA / MA	UVC / SIG*[3]
MULLIDAE				
Mullus argentinae Hubbs & Marini, 1933	LC	LC	Z13	FIS*[2]
Mulloidichthys martinicus (Cuvier, 1829) †	LC	LC	MCA / MA	UVC
Pseudupeneus maculatus (Bloch, 1793)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC/SRV/ SIG*[1] /FIS*[2]
DACTYLOPTERIDAE				
Dactylopterus volitans (Linnaeus, 1758)	LC	LC	TA / MCA / MA / CI / Z13	UVC / SRV / FIS*[2]
BLENNIIDAE				
Hypleurochilus fissicornis (Quoy & Gaimard, 1824)	LC	LC	TA / MCA / MA / RI / CI	UVC / LIT*[1]
Hypsoblennius invemar Smith-Vaniz & Acero P., 1980	LC	LC	TA / MCA / RI	UVC / LIT*[1]
Parablennius marmoreus (Poey, 1876)	LC	LC	TA / MCA / MA / RI / CI	UVC / LIT*[1]
Parablennius pilicornis (Cuvier, 1829)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Scartella cristata (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
CHAENOPSIDAE				
Emblemariopsis signifer (Ginsburg, 1942)	LC	LC	TA / MCA / MA / RI / CI	UVC / LIT*[1]
LABRISOMIDAE				
Gobioclinus kalisherae (Jordan, 1904)	LC	LC	TA / MCA / RI	UVC / SIG*[3]
Labrisomus cricota Sazima, Gasparini & Moura, 2002	LC	LC	Not Available	LIT*[1]
Labrisomus nuchipinnis (Quoy & Gaimard, 1824)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Malacoctenus triangulatus Springer, 1959	LC	LC	Not Available	LIT*[1]
Malacoctenus delalandii (Valenciennes, 1836)	LC	LC	TA / MCA / MA / RI	UVC / LIT*[1]
Paraclinus spectator Guimarães & Bacellar, 2002 Ψ	LC	LC	TA / MCA	UVC / SIG*[6]
Starksia brasiliensis (Gilbert, 1900) Ψ	LC	LC	TA	SIG / LIT*[3]
BELONIDAE				
Strongylura spp. van Hasselt, 1824	LC	LC	Not Available	LIT*[1]
Strongylura marina (Walbaum, 1792)	LC	LC	Z13	FIS*[3]
Tylosurus spp.	LC	LC	RI	UVC / SIG*[3]
Tylosurus acus (Lacepède, 1803)	LC	LC	Z13	FIS*[2]
MUGILIDAE				
Mugil curema Valenciennes, 1836	LC	DD	MCA / Z13	SIG*[2] / FIS*[2]
Mugil liza Valenciennes, 1836	DD	NT	TA / MCA / MA / CI / Z13	UVC / SRV / FIS*[2]
OPISTOGNATHIDAE				
Opistognathus vicinus Smith-Vaniz, Tornabene & Macieira, 2018 † Ψ	NE	NE	RI / MA	UVC

TABLE 1 | (Continued)

POMACENTRIDAE				
Abudefduf saxatilis (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV /LIT*[1]/ FIS*[2]
Azurina multilineata (Guichenot, 1853)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Chromis flavicauda (Günther, 1880)	DD	LC	MCA	UVC / LIT*[2]
Chromis jubauna Moura, 1995 Ψ	NE	LC	MCA / RI	UVC / SRV / LIT*[1]
Chromis vanbebberae McFarland, Baldwin, Robertson, Rocha & Tornabene, 2020 †	NE	NE	MCA	UVC
Stegastes fuscus (Cuvier, 1830)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
Stegastes pictus (Castelnau, 1855)	NE	LC	TA / MCA / MA / RI	UVC / SRV / LIT*[1]
Stegastes variabilis (Castelnau, 1855)	NE	LC	TA / MCA / MA / RI / CI	UVC / SRV / LIT*[1]
CARANGIDAE				
Caranx crysos (Mitchill, 1815)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS*[3]
Caranx hippos (Linnaeus, 1766)	LC	LC	Not Available	SIG*[3] / FIS*[3]
Caranx latus Agassiz, 1831	LC	LC	TA / MCA / MA / RI	UVC / SRV / LIT*[2]
Caranx ruber (Bloch, 1793)	LC	LC	TA / MCA / MA / RI	UVC / SRV / FIS*[3]
Chloroscombrus chrysurus (Linnaeus, 1766)	LC	LC	MCA / Z13	SIG / FIS*[2]
Decapterus macarellus (Cuvier, 1833) †	LC	LC	TA / CI	UVC
Decapterus punctatus (Cuvier, 1829) †	LC	LC	MCA	UVC
Oligoplites spp.	LC	LC	Z13	FIS*[2]
Parona signata (Jenyns, 1841)	LC	LC	Z13	FIS*[2]
Pseudocaranx dentex (Bloch & Schneider, 1801)	LC	LC	TA / MCA / MA / RI	UVC / SRV / FIS*[3]
Selar crumenophthalmus (Bloch, 1793)	LC	LC	MCA	SIG / FIS*[3]
Selene setapinnis (Mitchill, 1815)	LC	LC	MCA / Z13	SIG / FIS*[2]
Selene vomer (Linnaeus, 1758)	LC	LC	MCA / Z13	SRV / FIS*[2]
Seriola dumerili (Risso, 1810)	NT	LC	MCA / Z13	SIG*[2]/ FIS*[3]
Seriola lalandi Valenciennes, 1833	LC	LC	TA / MCA / Z13	UVC / SIG*[2] / FIS*[2]
Seriola rivoliana Valenciennes, 1833	LC	LC	TA / MCA / MA / RI	UVC / FIS*[3]
Trachinotus carolinus (Linnaeus, 1766)	LC	LC	Z13	FIS*[2]
Trachinotus falcatus (Linnaeus, 1758)	LC	LC	CI3 / Z13	SIG / FIS*[3]
Trachinotus goodei Jordan & Evermann, 1896	LC	LC	MCA / Z13	SRV / FIS*[2]
Trachinotus marginatus Cuvier, 1832	LC	LC	MCA	SIG*[2] / FIS*[3]
Trachurus lathami Nichols, 1920	LC	LC	MCA / RI / Z13	UVC / FIS*[2]
Uraspis secunda (Poey, 1860)	LC	LC	MCA / Z13	UVC / FIS*[2]
CORYPHAENIDAE				
Coryphaena hippurus Linnaeus, 1758	LC	LC	TA / MCA	UVC / FIS*[2]
ECHENEIDAE				
Echeneis naucrates Linnaeus 1758	LC	LC	TA / MCA / MA / Z13	UVC / SRV / FIS*[2]
RACHYCENTRIDAE				
Rachycentron canadum (Linnaeus, 1766) †	LC	LC	CI	SRV
XIPHIIDAE				
Xiphias gladius Linnaeus, 1758 †	LC	NT	TA	FIS
BOTHIDAE				
Bothus ocellatus (Agassiz, 1831)	LC	LC	TA / MCA / MA / RI / Z13	UVC / SRV / FIS*[2]
PARALICHTHYIDAE				
Cyclopsetta fimbriata (Goode & Bean, 1885)	LC	LC	MCA	SIG
Paralichthys orbignyanus (Valenciennes, 1839)	DD	DD	Z13	FIS*[2]
Paralichthys patagonicus Jordan, 1889	VU	NT	Z13	FIS*[2]
Syacium micrurum Ranzani, 1842	LC	LC	Z13	FIS*[4]
Syacium papillosum (Linnaeus, 1758)	LC	LC	/ Z13	SIG / FIS*[2]
CENTROPOMIDAE				
Centropomus parallelus Poey, 1860 †	LC	LC	TA	SRV
Centropomus undecimalis (Bloch, 1792)	LC	LC	TA / MCA / CI / Z13	SRV / SIG*[3] / FIS*[4]
POLYNEMIDAE				
Polydactylus virginicus (Linnaeus, 1758)	LC	LC	Z13	FIS*[2]

TABLE 1 | (Continued)

SPHYRAENIDAE				
Sphyraena guachancho Cuvier, 1829	LC	LC	Not Available	FIS*[3]
Sphyraena tome Fowler, 1903	NE	DD	TA / MCA / MA / CI	UVC / SRV / SIG*[2]
EPINEPHELIDAE				
Cephalopholis fulva (Linnaeus, 1758)	LC	LC	MCA	SIG*[3]
Cephalopholis taeniops (Valenciennes, 1828)	LC	NE	MCA	SIG*[5]/ MUS*[5]
Epinephelus itajara (Lichtenstein, 1822)	VU	CR	MCA	SIG*[2]
Epinephelus marginatus (Lowe, 1834)	VU	VU	TA / MCA / MA / RI / CI / Z13	UVC / SIG*[1]/ FIS*[2]
Epinephelus morio (Valenciennes, 1828)	VU	VU	MCA	SIG / FIS*[3]
Hyporthodus niveatus (Valenciennes, 1828)	VU	VU	TA / MCA / MA / RI / Z13	UVC / SIG*[1] / FIS*[2]
Mycteroperca acutirostris (Valenciennes, 1828)	LC	DD	TA / MCA / MA / RI / CI / Z13	SRV / UVC / SIG*[1] / FIS*[2]
Mycteroperca bonaci (Poey, 1860)	NT	VU	TA / MCA / MA / Z13	UVC / SRV / FIS*[2]
Mycteroperca interstitialis (Poey, 1860)	VU	VU	MCA	SRV / SIG*[1]/ FIS*[2]
Mycteroperca microlepis (Goode & Bean, 1879)	VU	DD	Z13	FIS*[2]
Paranthias furcifer (Valenciennes, 1828)	LC	NE	TA / RI	UVC / SIG*[1]
SERRANIDAE				
Diplectrum formosum (Linnaeus, 1766)	LC	LC	MCA / MA / RI / CI	UVC / SRV / SIG*[2]
Diplectrum radiale (Quoy & Gaimard, 1824)	LC	LC	MCA / MA / RI / CI	UVC / SRV / SIG*[3]
Dules auriga Cuvier, 1829	NE	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[2]
Pronotogrammus martinicensis (Guichenot, 1868)	LC	LC	MCA	SIG*[3]
Rypticus bistrispinus (Mitchill, 1818)	LC	LC	TA / MCA / MA / RI	UVC / SIG*[1]
Rypticus saponaceus (Bloch & Schneider, 1801)	LC	LC	MCA / MA / RI / MUS	UVC / SIG*[1] / MUS*[3]
Serranus atrobranchus (Cuvier, 1829)	LC	LC	MCA / RI	UVC / SIG*[2]
Serranus baldwini (Evermann & Marsh, 1889)	LC	LC	TA / MCA / MA / RI	UVC / SIG*[1]
Serranus flaviventris (Cuvier, 1829)	LC	LC	MCA	SIG*[2]
ANTHIADIDAE				
Acanthistius brasilianus (Cuvier, 1828)	DD	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
PERCOPHIDAE				
Percophis brasiliensis Quoy & Gaimard, 1825	NE	LC	Z13	FIS*[2]
TRIGLIDAE				
Prionotus punctatus (Bloch, 1793)	LC	LC	MA / Z13	UVC / FIS*[2]
SCORPAENIDAE				
Pontinus corallinus Miranda Ribeiro, 1903 Ψ	NE	DD	MUS	MUS*[3]
Scorpaena brasiliensis Cuvier, 1829	LC	LC	MCA	UVC / SIG*[1]
Scorpaena isthmensis Meek & Hildebrand, 1928	LC	LC	TA / MCA / MA / RI / Z13	UVC / SIG*[1] / FIS*[4]
Scorpaena plumieri Bloch, 1789	LC	LC	TA / MCA / MA / RI / Z13	UVC / SIG*[1] / FIS*[2]
Scorpaenodes caribbaeus (Meek & Hildebrand, 1928)	LC	LC	MCA	SIG*[2]
Scorpaenodes tredecimspinosus (Metzelaar, 1919)	LC	LC	MCA	UVC / SIG*[3]
KYPHOSIDAE				
Kyphosus sectatrix (Linnaeus, 1758)	LC	NE	TA / MCA / MA / RI / CI / Z13	UVC/ SRV / SIG*[1]/FIS*[2]
Kyphosus vaigiensis (Quoy & Gaimard, 1825)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[6]
LABRIDAE				
Bodianus pulchellus (Poey, 1860)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Bodianus rufus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
Clepticus brasiliensis Heiser, Moura & Robertson, 2000 Ψ	LC	LC	MCA / RI	UVC / SRV / SIG*[1]
Cryptotomus roseus Cope, 1871	LC	LC	TA / MCA / MA / CI	UVC / SRV / SIG*[2]
Doratonotus megalepis Günther, 1862	LC	LC	RI	UVC / SIG*[3]
Halichoeres brasiliensis (Bloch, 1791) Ψ	DD	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Halichoeres dimidiatus (Agassiz, 1831)	LC	LC	TA / MCA / MA / RI	UVC / SIG*[1]
Halichoeres penrosei Starks, 1913 Ψ	LC	LC	MA	UVC
Halichoeres poeyi (Steindachner, 1867)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Halichoeres sazimai Luiz, Ferreira & Rocha, 2009 Ψ	NE	LC	MCA / MA / RI	UVC / SRV / SIG*[1]
Nicholsina usta (Valenciennes, 1840)	LC	LC	MCA / MA	UVC / SRV / SIG*[3]

TABLE 1 | (Continued)

Scarus trispinosus Valenciennes, 1840	EN	EN	MCA / MA	SIG*[2]/ FIS*[3]
Scarus zelindae Moura, Figueiredo & Sazima, 2001	DD	VU	MCA	SIG*[2]/ FIS*[3]
Sparisoma amplum (Ranzani, 1841)	LC	NT	TA / MCA	UVC / SIG*[2]
Sparisoma axillare (Steindachner, 1878)	DD	VU	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
Sparisoma frondosum (Agassiz, 1831)	DD	VU	TA / MCA / MA / RI / Z13	UVC / SRV/ SIG*[1] / FIS*[2]
Sparisoma radians (Valenciennes, 1840)	LC	LC	MCA / MA	SIG*[2]
Sparisoma tuiupiranga Gasparini, Joyeux & Floeter, 2003	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
Thalassoma noronhanum (Boulenger, 1890) Ψ	LC	LC	MCA	UVC / SIG*[2]
Xyrichtys novacula (Linnaeus, 1758)	LC	LC	MA	UVC / SIG*[6]
Xyrichtys splendens Castelnau, 1855 †	LC	LC	MA	UVC
URANOSCOPIDAE				
Astroscopus ygraecum (Cuvier, 1829)	LC	LC	Z13	FIS*[4]
PINGUIPEDIDAE				
Pinguipes brasilianus Cuvier, 1829	NE	LC	TA / MCA / MA / RI	UVC / SRV / FIS*[3]
Pseudopercis numida Miranda Ribeiro, 1903	LC	NT	Not Available	FIS*[3]
PEMPHERIDAE				
Pempheris schomburgkii Müller & Troschel, 1848	LC	LC	TA / MCA / MA / RI / CI / MUS	UVC / SRV / SIG*[1] / MUS*[3]
ACANTHURIDAE				
Acanthurus bahianus Castelnau, 1855	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[1]
Acanthurus chirurgus (Bloch, 1787)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[1]
Acanthurus coeruleus Bloch & Schneider, 1801	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[1]
GERREIDAE				
Diapterus rhombeus (Cuvier, 1829)	LC	LC	Z13	FIS*[4]
Eucinostomus gula (Quoy & Guaimard, 1824)	LC	LC	RI / CI	UVC / SRV / LIT*[3]
EPHIPPIDAE				
Chaetodipterus faber (Broussonet, 1782)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS*[2]
HAEMULIDAE				
Anisotremus surinamensis (Bloch, 1791)	DD	DD	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS *[2]
Anisotremus virginicus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS *[2]
Haemulon aurolineatum Cuvier, 1830	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / FIS *[3]
Haemulon plumierii (Lacèpede, 1801)	LC	DD	MCA / MA / RI	SIG*[1] / FIS*[3]
Haemulon steindachneri (Jordan & Gilbert, 1882)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / SIG *[2]
Orthopristis rubra (Cuvier, 1830)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS *[2]
Paranisotremus moricandi (Ranzani, 1842)	LC	LC	Z13	SIG*[3], FIS*[3]
Pomadasys ramosus (Poey, 1860) †	NE	LC	Z13	FIS
SCIAENIDAE				
Cynoscion acoupa (Lacepède, 1801)	VU	LC	Z13	FIS*[2]
Cynoscion guatucupa (Cuvier, 1830)	LC	LC	Z13	FIS*[2]
Cynoscion jamaicensis (Vaillant & Bocourt, 1883)	LC	LC	Z13	FIS*[2]
Cynoscion microlepidotus (Cuvier, 1830)	LC	LC	Z13	FIS*[2]
Cynoscion virescens (Cuvier, 1830)	LC	LC	Z13	FIS*[2]
Eques lanceolatus (Linnaeus, 1758)	LC	LC	MCA	SIG*[2]
Larimus breviceps Cuvier, 1830	LC	LC	Z13	FIS*[2]
Menticirrhus americanus (Linnaeus, 1758)	LC	DD	Z13	FIS*[2]
Micropogonias furnieri (Desmarest, 1823)	LC	LC	Z13	FIS*[2]
Odontoscion dentex (Cuvier, 1830)	LC	LC	MCA / RI	UVC / SRV / SIG *[1]
Paralonchurus brasiliensis (Steindachner, 1875)	LC	LC	Z13	FIS*[2]
Pareques acuminatus (Bloch & Schneider, 1801)	LC	DD	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[1]
Pogonias cromis (Linnaeus, 1766)	LC	EN	Z13	FIS*[2]
Stellifer rastrifer (Jordan, 1889)	LC	LC	Z13	FIS*[4]

TABLE 1 | (Continued)

Umbrina canosai Berg, 1895	LC	LC	Z13	FIS*[2]
LUTJANIDAE				
Lutjanus analis (Cuvier, 1828)	NT	NT	MCA / Z13	SRV / FIS *[2]
Lutjanus cyanopterus (Cuvier, 1828)	VU	VU	Z13	FIS *[2]
Lutjanus jocu (Bloch & Schneider, 1801)	DD	NT	TA / MUS	UVC / MUS*[3]
Lutjanus synagris (Linnaeus, 1758)	NT	NT	Z13	FIS *[2]
Ocyurus chrysurus (Bloch, 1791)	DD	NT	MCA	SIG*[1]/ FIS*[3]
Rhomboplites aurorubens (Cuvier, 1829)	VU	NT	Z13	FIS *[2]
MALACANTHIDAE				
Malacanthus plumieri (Bloch, 1786)	LC	LC	TA / MA	UVC / SRV / SIG *[3]
POMACANTHIDAE				
Centropyge aurantonotus Burgess, 1974	LC	DD	MCA / RI	UVC / SIG *[1]
Holacanthus ciliaris (Linnaeus, 1758)	LC	DD	TA / MCA / MA / RI	UVC / SRV / SIG *[1]
Holacanthus tricolor (Bloch, 1795)	LC	DD	MCA	UVC / SIG *[1]
Pomacanthus arcuatus (Linnaeus, 1758)	LC	DD	MCA	UVC / SIG *[1]
Pomacanthus paru (Bloch, 1787)	LC	DD	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[1]
CHAETODONTIDAE				
Chaetodon sedentarius Poey, 1860	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG *[1]
Chaetodon striatus Linnaeus, 1758	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG *[1]
Heniochus acuminatus (Linnaeus, 1758) # †	LC	NE	MCA	SRV / SIG
Prognathodes brasiliensis Burgess, 2001	LC	LC	MCA / MA	UVC / SRV / SIG *[2]
Prognathodes guyanensis (Durand, 1960)	LC	LC	MCA / MA / RI	UVC / SIG *[1]
SPARIDAE				
Archosargus probatocephalus (Walbaum, 1792)	LC	DD	Z13	FIS*[2]
Archosargus rhomboidalis (Linnaeus, 1758)	LC	LC	Not Available	FIS*[3]
Calamus penna (Valenciennes, 1830)	LC	LC	MCA / CI / Z13	UVC / FIS*[2]
Calamus pennatula Guichenot, 1868	LC	LC	TA / MCA / MA / RI	UVC / SRV / FIS *[3]
Diplodus argenteus (Valenciennes, 1830)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS *[2]
Pagrus pagrus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / Z13	UVC / SRV / FIS *[2]
PRIACANTHIDAE				
Heteropriacanthus cruentatus (Lacepède, 1801)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / FIS*[3]
Priacanthus arenatus Cuvier, 1829	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC / SRV / FIS*[2]
ANTENNARIIDAE				
Antennarius multiocellatus (Valenciennes, 1837)	LC	DD	MCA	SIG*[2]
Antennarius striatus (Shaw, 1794)	LC	DD	MUS	MUS*[3]
LOPHIIDAE				
Lophius gastrophysus Miranda Ribeiro, 1915	LC	NT	Z13	FIS*[2]
OGCOCEPHALIDAE				
Ogcocephalus vespertilio (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI	UVC / FIS *[3]
BALISTIDAE				
Balistes capriscus Gmelin, 1789	VU	NT	TA / MA / Z13	SRV / FIS*[2]
Balistes vetula Linnaeus, 1758	NT	NT	TA / MCA / Z13	UVC / SRV / FIS*[2]
DIODONTIDAE				
Chilomycterus reticulatus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[6]
Chilomycterus spinosus (Linnaeus, 1758)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Diodon hystrix Linnaeus, 1758	LC	LC	MCA / MA	UVC / SIG*[1]
MOLIDAE				
Mola mola (Linnaeus, 1758) †	VU	LC	MCA	SIG
MONACANTHIDAE				
Aluterus monocerus (Linnaeus, 1758)	LC	NT	MCA / MA / RI / Z13	SRV / FIS*[2]
Aluterus scriptus (Osbeck, 1765)	LC	LC	TA	SRV / SIG*[3]
Cantherhines macrocerus (Hollard, 1853)	LC	LC	TA / MCA / MA / RI	UVC / SRV / SIG*[1]
Cantherhines pullus (Ranzani, 1842)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]

TABLE 1 | (Continued)

Stephanolepis hispida (Linnaeus, 1766)	LC	LC	TA / MCA / MA / RI / CI / Z13	UVC/SRV/ SIG*[1] /FIS*[2]
OSTRACIIDAE				
Acanthostracion polygonius Poey, 1876	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG *[2]
Acanthostracion quadricornis (Linnaeus, 1758)	LC	LC	TA / MCA	UVC / SIG *[2]
Lactophrys trigonus (Linnaeus, 1758)	LC	LC	MCA	SIG*[1]
TETRAODONTIDAE				
Canthigaster figueiredoi Moura & Castro, 2002	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Lagocephalus laevigatus (Linnaeus, 1766)	LC	LC	MA / Z13	SRV / FIS*[2]
Sphoeroides greeleyi Gilbert, 1900	LC	LC	MCA / MA / CI	UVC / LIT*[3]
Sphoeroides spengleri (Bloch, 1785)	LC	LC	TA / MCA / MA / RI / CI	UVC / SRV / SIG*[1]
Sphoeroides testudineus (Linnaeus, 1758)	LC	DD	CI	UVC / SIG*[1]

sampling techniques. In addition, 16 (5.6%) species were only observed by SRV, while 73 (25.9%) species were exclusively observed through UVC. Lastly, 149 (52.8%) species were recorded in spearfishing/ artisanal fisheries', being 63 (22.3%) exclusive.

The fish inventory contains 254 (90.1%) species of Osteichthyes and 28 (9.9%) Chondrichthyes. Carangidae was the richest family with 22 species, followed by Labridae with 21 fish species, Sciaenidae (14), Epinephelidae (11), Serranidae (9), Haemulidae and Pomacentridae (8), and Labrisomidae with 7 species (Fig. 3). The most common genera were *Halichoeres* Rüppell, 1835, *Sparisoma* Swainson, 1839, and *Cynoscion* Gill, 1861 with five species each, followed by *Gymnothorax* Bloch, 1795, *Mycteroperca* Gill, 1862, *Caranx* Lacepède, 1801, *Lutjanus* Bloch, 1790, and *Trachinotus* Lacepède, 1801, with four species each. In addition, this study revealed 21 new records of fish species, as follows: *Rhincodon typus*, *Notorynchus cepedianus*, *Rhinoptera bonasus*), *Lampris guttatus*, *Ctenogobius saepepallens*, *Gobulus myersi*, *Hippocampus patagonicus*, *Halicampus crinitus*), *Mulloidichthys martinicus*, *Opistognathus vicinus*, *Chromis vanbebberae*, *Decapterus macarellus*, *Decapterus punctatus*), *Sarda sarda*, *Rachycentron canadum*, *Xiphias gladius*, *Pomadasys ramosus*, *Centropomus parallelus*, *Xyrichtys splendens*, *Mola mola*), and last but not the least, *Heniochus acuminatus*, an exotic fish species herein reported in MONA Cagarras (see † in Tab. 1).

The three most common elasmobranch species were *Gymnura altavela*, *Myliobatis freminvillei*, and *Z. brevirostris* (Figs. 4A,B,C). The Fig. 4 (D,E) brings two new records *S. sarda* and *C. vanbebberae*, and the most common species in the Archipelagos, which were *D. argenteus*, *C. pullus*, and *H. aurolineatum* (Figs. 4 F,G,H).

Yet, rare species recorded in situ are depicted in Fig. 5, *Thalassoma noronhanum*, *Paranthias furcifer*, *X. splendens.* Yet, rare species recorded in situ are depicted in Fig. 5, *T. noronhanum*, *P. furcifer*, *X. splendens*, *C. brasiliensis*, *E. lanceolatus*, *U. secunda*, *S. zelindae*, and *P. randalli*, and in Fig. 6, *Hippocampus reidi*, *Callionymus bairdi*, *Haemulon plumierii*, *Sargocentron bullisi*, *Chromis flavicauda*, *Pronotogrammus martinicensis*, *Centropyge aurantonotus*, and *Bodianus rufus*. Finally, the rare cryptic species *Gobulus myersi*, and *Paraclinus spectator* are depicted in Fig. 7.

Exotic fish record. Among the fishes listed, the SRV recorded an exotic species, originally widespread throughout the Indo-Pacific Ocean, from East Africa and Persian Gulf to the Society Islands, north to southern Japan, south to Lord Howe Island and throughout Micronesia. *Heniochus acuminatus*, commonly known as Longfin Bannerfish,

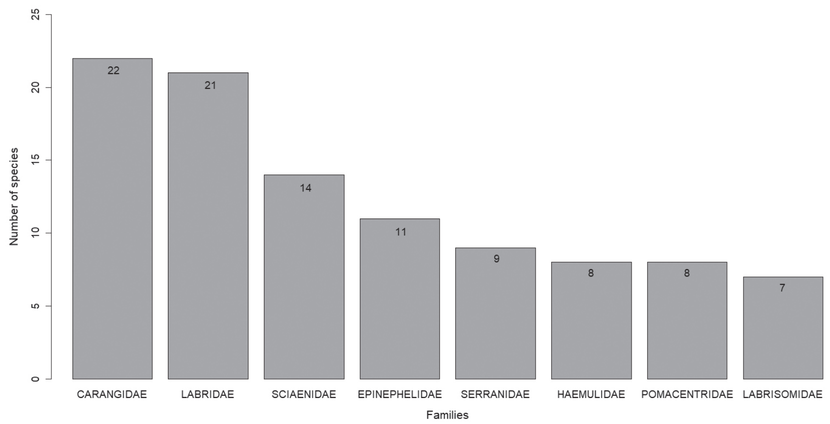

FIGURE 3 | The richest families reported along the coastal islands and surrounding waters of Rio de Janeiro metropolitan region, Brazil.

FIGURE 4 | Elasmobranchs commonly observed on Rio de Janeiro coastal islands rockyreefs: **A.** *Gymnura altavela*, **B.** *Myliobatis freminvillei*, and **C.** *Zapteryx brevirostris*; new records **D.** *Sarda sarda* and **E.** *Chromis vanbebberae*; and the most common species: **F.** *Diplodus argenteus*, **G.** *Cantherhines pullus*, and **H.** *Haemulon aurolineatum*. Photos: Augusto A. Machado (**A–B**), Suzana Guimarães (**D**), Áthila A. Bertoncini (**C, E–H**).

FIGURE 5 | Rare fish species recorded on Rio de Janeiro coastal islands rocky reefs: **A.** *Thalassoma noronhanum*, **B.** *Paranthias furcifer*, **C.** *Xyrichtys splendens*, **D.** *Clepticus brasiliensis*, **E.** *Eques lanceolatus*, **F.** *Uraspis secunda*, **G.** *Scarus zelindae* and **H.** *Ptereleotris randalli*. Photos: Áthila A. Bertoncini (**A–B**, **E–H**), Augusto A. Machado (**C, D**).

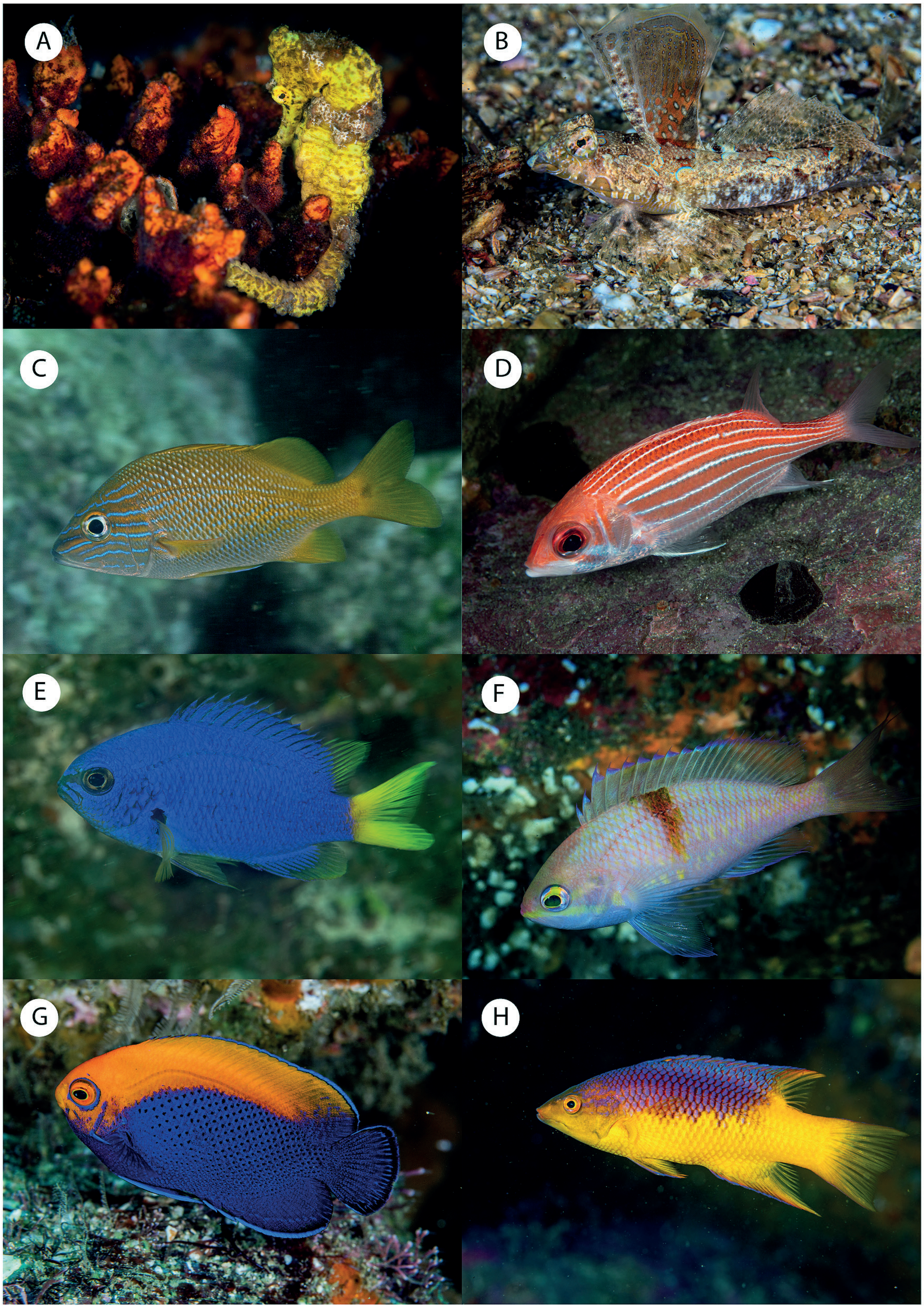

FIGURE 6 | Rare fish species recorded on Rio de Janeiro coastal islands rockyreefs: **A.** *Hippocampus reidi*, **B.** *Callionymus bairdi*, **C.** *Haemulon plumierii*, **D.** *Sargocentron bullisi*, **E.** *Chromis flavicauda*, **F.** *Pronotogrammus martinicensis*, **G.** *Centropyge aurantonotus*, and **H.** *Bodianus rufus*. Photos: Áthila A. Bertoncini.

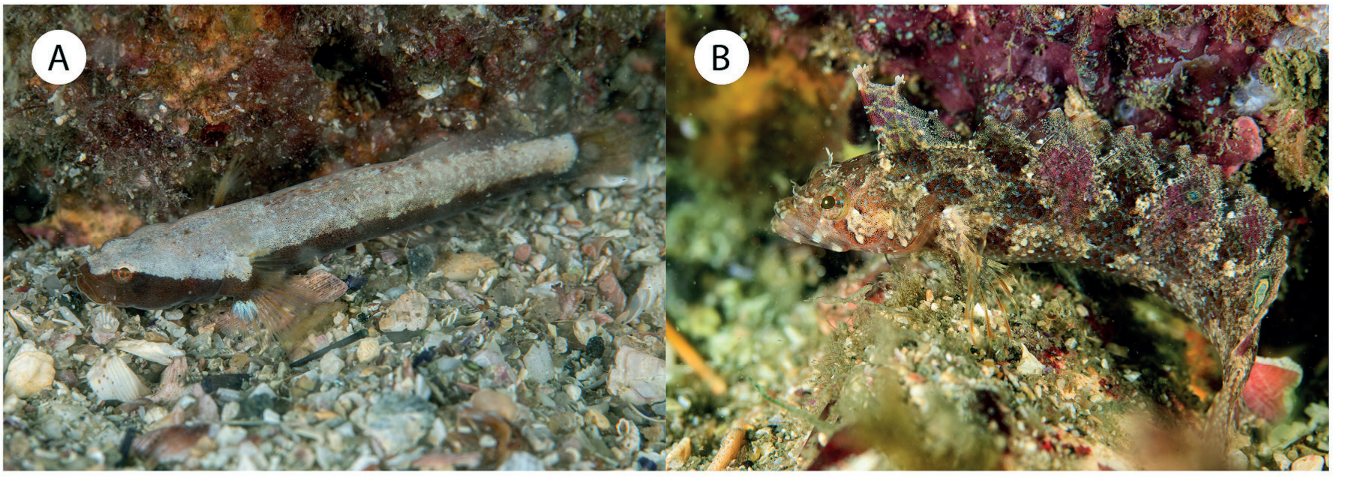

FIGURE 7 | Two cryptic species observed at a particular gravel bottom at Tijucas Archipelago. **A.** *Gobulus myersi* (new record) and *Paraclinus spectator*. Photos: Áthila A. Bertoncini.

was observed in Redonda Island at 8 meters deep. A single individual was sighted at a sampling video (Fig. 8A and in the video **S1**) in March 2019 swimming over the rocky reef covered by turf algae, among native fish species (*i.e.*, *Acanthurus bahianus*, *Acanthurus chirurgus* among others) and in February 2022, it was again observed at the same location (Suzana Guimarães, Projeto Ilhas do Rio researcher) at the same location, and on April 2022 by the authors (Fig. 8B). This species is easily identified observing its color pattern, white body with a pair of black bands, yellow truncate caudal fin, and dorsal fin spine especially long (Randall, 1995; Adelir-Alves *et al*., 2018; Froese, Pauly, 2022).

Conservation status. The fish species of coastal islands and surroundings were categorized following IUCN and ICMBio Red lists of threatened species (Fig. 9). According to IUCN, approximately 71.28% of species are assigned as Least Concern (LC), 7.45% are Data Deficient (DD), 4.26% Near Threatened (NT), and 6.74% Not Evaluated (NE). A total of 10.3% are considered threatened, being 7.45% assigned as Vulnerable (VU), 2.13% Endangered (EN) and 0.71% as Critically Endangered (CR). In parallel, the Brazilian red list (ICMBio, 2018) considers 66.31% of the species as LC, 12.41% are DD, 7.8% NT, and 2.84% are NE. Threatened species account to 10.6%, where 6.03% are VU, 2.13% EN, and 2.48% CR.

Fish richness along Rio de Janeiro and Maricás coastal islands. The richness from coastal islands of Rio de Janeiro and surroundings were widely represented through different sampling techniques (Tab. 1). We present the numbers of species recorded per archipelago, disregarding the number of islands sampled in each archipelago, where Cagarras Islands Natural Monument presented 181 fish species, with 58 exclusive species. In the Maricás Archipelago, 120 fish species, being six exclusives, whereas 115 species were recorded in Tijucas Archipelago, with 11 exclusive records (Fig. 10). In addition, samples from Rasa Island provided 108 records and in Cotunduba island, which is located within the Paisagem Carioca Municipal Natural Park – at the entrance to Guanabara Bay – 62 fish species were recorded.

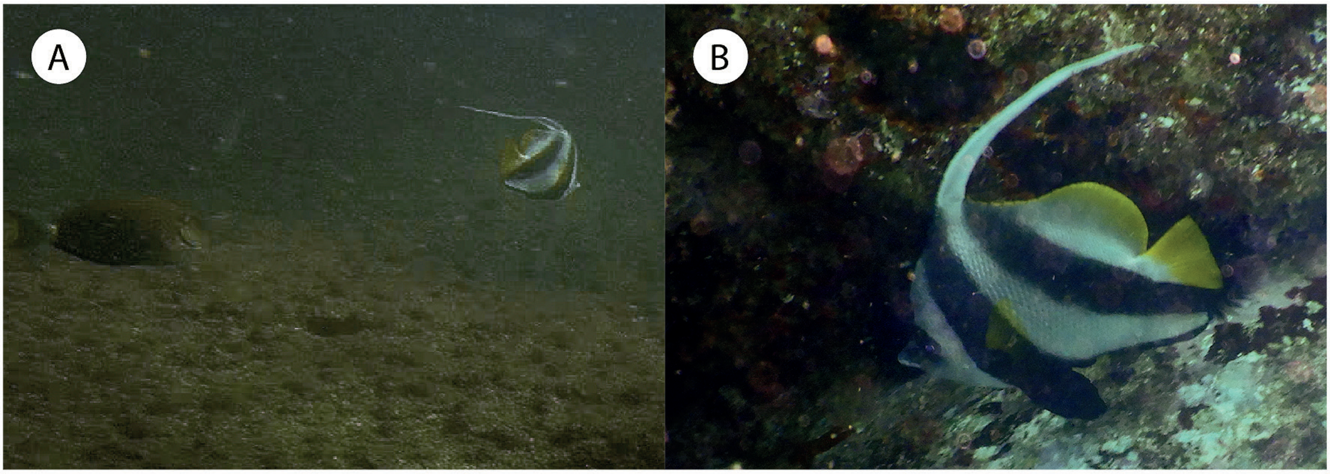

FIGURE 8 | *Heniochus acuminatus*. **A.** The SRV frame recorded on MAR 2019 at Redonda Island, inside of the MPA, close to *Acanthurus bahianus*; **B.** *H. acuminatus* photographed in April 2022 (photo by Augusto A. Machado).

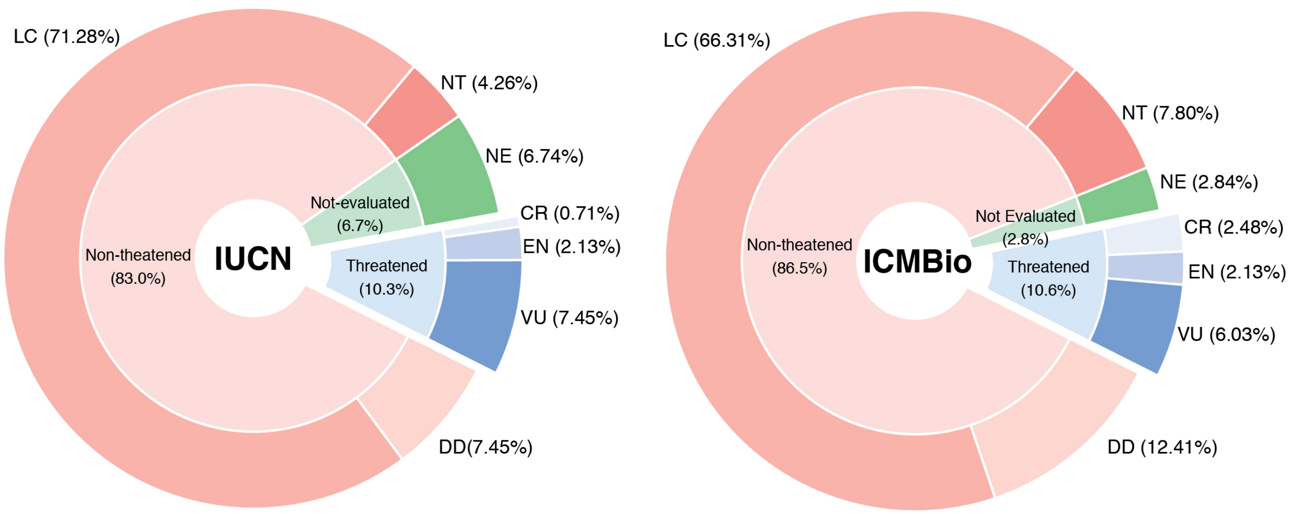

FIGURE 9 | Doughnut chart showing the assigned categories (%) of threatened fish species according to the IUCN and the Brazilian (ICMBio, 2018) red lists. CR = Critically Endangered, DD = Data Deficient, EN = Endangered, LC = Least Concern, NE = Not Evaluated, NT = Near Threatened, VU = Vulnerable.

We assessed the number of reef fish occurring simultaneously among archipelagos. The MONA Cagarras (MCA) and Maricás Archipelago presented the highest number of species in common with 112 fish species, representing 39.8% of total, that can be seen in both areas, followed by 102 species in MONA Cagarras and Tijucas Archipelago (36.3%), Maricás and Tijucas Archipelago with 93 species (approximately 33.1%) and finally only 91 or 32.4% species that can be seen in the three archipelagos (Fig. 10).

New records. This study provides 21 new records never reported for these archipelagos, occurring along the coasts of Rio de Janeiro and Maricá cities (Fig. 1). Among the sampled areas, four new occurrences were reported in the Tijucas

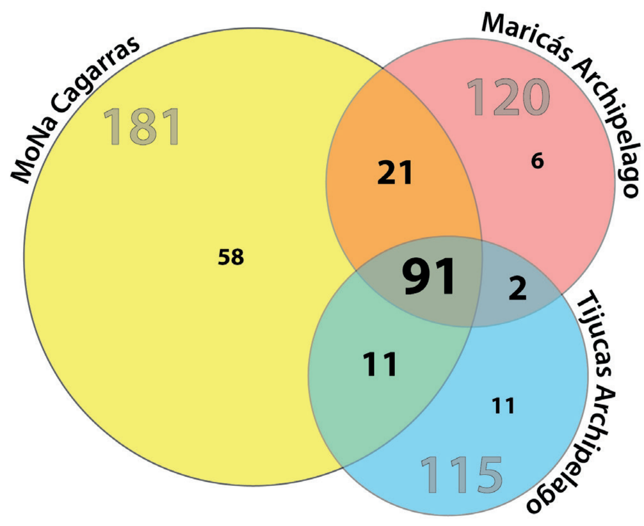

FIGURE 10 | Venn diagram representing exclusive and shared species richness recorded in the study areas: large-bold-grey numbers are the total number of species in each area; small numbers represent exclusive species in each area; medium size numbers represent the share between/among areas.

Archipelago: *Xiphias gladius* by spearfishing close to the islands, *D. macarellus* (UVC), *C. parallelus* (SRV), and *G. myersi* (UVC, Fig. 7A). The MONA Cagarras presented the greatest number of new records: *M. mola* was sighted on board close to Cagarra Island, while *D. punctatus* was observed by UVC in Comprida Island. Redonda Island provided the following new records: *Rhincodon typus* sighted on board within the MONA Cagarras Island ring, *R. bonasus*, *C. vanbebberae* (Fig. 4E), and *M. martinicus* by UVC, *S. sarda* (Fig. 4D) was sighted by Ilhas do Rio associated researchers, *H. patagonicus* was detected through fishing activities in the surroundings of the MPA and the non-native species *H. acuminatus* registered by SRV, within of the MPA. Additionally, *O. vicinus* was observed on Rasa Island inside its sand burrow and *H. crinitus* was seen amongst the gravel bottom. The samples performed on Cotunduba Island, at the entrance of Guanabara Bay, provided records of *R. canadum* by SRV and *D. macarellus* (UVC), while Maricás Archipelago contributed with three new records from UVC: *X. splendens*, *M. martinicus* and *C. saepepallens*. Finally, at the Z13 Fishermen colony, which fishing grounds are in the vicinity of the MONA Cagarras, three records were provided: *N. cepedianus*, *P. ramosus*, and *L. guttatus*.

DISCUSSION

In order to carry out scientific research and survey of marine species biodiversity, the Ilhas do Rio Project started in 2011 to improve knowledge, developing a huge effort in the biodiversity assessment in the Coastal Islands of Rio de Janeiro, specially, the then recently created MPA, MONA Cagarras. Since then, SCUBA diving surveys, documenting the rich biodiversity have been carried out to provide basic knowledge to build up public policies, such as the MPA's Management Plan and to enhance the knowledge of the surrounding islands.

To assess fish species richness and reduce impacts, non-destructive techniques have been employed, providing relevant scientific results with minimal environmental disturbance. The use of complementary sampling techniques, especially UVC and SRV, was essential to achieve the important new records (n = 12) of species never recorded before in this study, such as the Green razorfish, *X. splendens* (Maricá Islands) (Fig. 5C); and the collaboration of Ilhas do Rio associated researchers (n = 2), that *in situ* reported the Sunfish, *M. mola*, and the Atlantic bonito, *S. sarda* (Fig. 4D).

Also, the important long-lasting relationship of researchers from Ilhas do Rio Project and the fishermen colony, provided unique records (n = 4), such as the offshore Opah, *L. guttatus*; the Broadnose sevengill shark (*N. cepedianus*), that was reported by fishing data at Z13 fishermen colony from Copacabana, Rio de Janeiro. We had 63 species (22.3%) being provided by fishermen, which is similar with the reported by Pinheiro *et al.* (2015), where out of the 221 recorded species, 26% were exclusively provided by fishermen. In addition, the spearfishing activity recorded the Broadbill swordfish (*X. gladius*) and the Patagonian seahorse (*H. patagonicus*) was caught by bottom trawling. It is paramount to develop a good relationship and share the knowledge with fishermen in order to receive new records for the studies sites.

The submersible rotating video system (SRVs) proved to be of great power in detecting species, such as the exotic Longfin Bannerfish, *H. acuminatus*, first observed by this method, in a site often visited by researchers at Redonda Island. We emphasize the importance of using multiples and complementary techniques in fish biodiversity survey studies.

The inventory herein brings a combination of different observational and fisheries records, allowing the scientific assessment of rocky reefs and the surrounding pelagic and soft-bottom environments from Coastal islands of Rio de Janeiro and Maricá, contributing thus to improve conservation and management efforts in a broader area. Our observations provided 282 fish records and 21 new species, including an exotic species, representing a significant increase (over 7.6%) in the checklist, considering previous studies in these Islands (Monteiro-Neto *et al*., 2013, Bertoncini *et al*., 2019). Marine coastal areas are known as important habitats for fish communities (Kume *et al*., 2021), thus recognizing the attributes of fish communities for future comparisons is likely to have consequences for the provision of ecosystem services such as fisheries and tourism (Chong-Seng *et al*., 2012), mainly in areas with a moderate-rate of endemic species like the Rio de Janeiro and Maricá coastal islands, circa 6%, and with circa 10.5% of the species in a threatened category according to IUCN and ICMBio.

These coastal islands are known to host a high diversity of terrestrial and marine species like seabirds, fishes, corals, and other organisms (for details, see Moraes *et al*., 2013; Bertoncini *et al*., 2019). Our study contributes to the update and improvement in the knowledge about fish biodiversity in each archipelago and surrounding areas. Data revealed the greatest fish richness within the Cagarras Islands Natural Monument, comprising about the 64.2% (181 spp.) (Fig. 10) of the total fish species encountered in Coastal islands of Rio de Janeiro and Maricá cities, showing the importance of this MPA for the conservation of fish species.

Long-term monitoring efforts are widely needed in coastal islands in order to better understand the structure of fish communities and the ecological relationships of this vertebrate group with other organisms. In addition, fish monitoring data provide important information for coastal management, to protect marine resources and efforts to assess MPA effectiveness (Jentoft *et al*., 2007; Melià *et al*., 2020). Previous studies have indicated that MPAs are appropriate places for, in addition to preserving biodiversity, recovering exploited stocks (Roberts *et al*., 2001; Halpern, 2003), especially considering that most of the studied area is subject to recreational and artisanal fisheries. It is important to highlight that the MONA Cagarras, together with its surrounding areas (including Rasa and Cotunduba islands) was, in 2021, recognized as a Hope Spot for conservation of marine biodiversity by the international nonprofit organization Mission Blue (www.mission-blue.org/hope-spots).

However, this international recognition along with the national protection such as the "Natural Monument" category, bring the spotlight to these islands, but alone they will not save nor guarantee the protection of the reef fish fauna. It is important to rethink the design and limits of the MPA, in order to provide a proper protection for deeper rocky reefs, once the MPA limits of 10m from the island's coast leave much of these areas unprotected.

The presence of exotic species such as the *H. acuminatus*, and *Cephalopholis taeniops* (Valenciennes, 1828) – previously collected in 2006 (Garcia *et al*., 2018) within MONA Cagarras, calls the attention for the management and conservation of this important area. In Brazil, there is no evidence of successful invasion of the Longfin Bannerfish. The first report occurred in 1999 from Armação dos Búzios, Rio de Janeiro State (Moura, 2000), while in 2013 it was recorded at Laje de Santos, São Paulo State (Luiz *et al*., 2014), and in 2017 it was sighted in a shipwreck in South Brazil (Paraná) (Adelir-Alves *et al*., 2018). According to Luiz *et al.* (2014) there are two possible hypotheses for the introduction in Brazil: an aquarium release or long-distance natural dispersal from the Indian-Ocean. We suspect that the former hypothesis might be the case once this species is commonly traded by aquarists in the metropolis of Rio de Janeiro. Nevertheless, *H. acuminatus* is a planktivorous species and its occurrence is unlikely to cause significant impacts in the ecosystem's health.

Additionally, the detection of alien species such as the Azores Chromis, *Chromis limbata* (Valenciennes, 183) (Leite *et al*., 2009; Anderson *et al*., 2017), and the Toadfish, *Opsanus beta* (Goode & Bean, 1880), both established in some Brazilian estuaries (Cordeiro *et al*., 2020) warns about the need to prevent the arrival and establishment of other exotic species, such as the lionfish (*Pterois* spp.) which has recently been continuously recorded in the Brazilian offshore island of Fernando de Noronha, and in coastal fisheries in North Brazil (Luiz *et al*., 2021). In the Caribbean Sea, the lionfish invasion caused several impacts due to the voracious generalist predatory behavior, while depicting exponential increases in its abundance without significant natural predatory control (Côté *et al*., 2013; Samhouri, Stier, 2021). The introduction of non-native species through human vectors is globally acknowledged to represent a major threat to biodiversity and ecosystem health (Sutherland *et al*., 2010), and, according to IOC-UNESCO (2022) it is critical to understand multiple ocean stressors and target efforts at minimizing their impacts to lessen the cumulative pressure on the resilience and health of marine life.

Besides the exotic fish species, the presence of other invasive species along Brazilian reef environments, specially composing the bottom community, such as cnidarians, *e.g*., *Stereonephthya* sp. (Ferreira, 2003), *Sarcothelia* sp. (Xeniidae), and *Briareum* *hamrum* (Gohar, 1948) (Briareidae) (Menezes *et al*., 2022) and the Sun coral (*Tubastraea* spp.), already established in the study area (Silva *et al*., 2022), may cause negative impacts on rocky reef fish communities (Miranda *et al*., 2018), being studied (AAM, work in progress) in Rio de Janeiro's archipelagos.

Coastal islands from Rio de Janeiro and Maricá cities are close to large urban centers (7 million people live around Guanabara Bay) and suffer a great influence of marine pollution (Guanabara Bay and Ipanema Sewage Outfall), unmanaged tourism, ornamental fish trade, illegal and unregulated fishing practices, and marine exotic species (ICMBio, 2020). In order to understand how these impacts may influence the health of fish communities, this background knowledge about biodiversity and their ecological relationships is paramount. In this context, long-term monitoring programs are crucial to assist MPA managers in the development of preventive plans for biodiversity conservation of this area, that shelters one of the Brazilian hope spots.

ACKNOWLEDGMENTS

We thank Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) for research permits (SISBio 74219–1). Part of the results were granted through Ilhas do Rio Project sponsored by Petrobras (2011–2019) and by AIEP and JGP (2020–2022). Doctoral scholarship was granted to AAM by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) through Programa de Pós-Graduação em Oceanografia Ambiental-UFES. AAB benefited from a Postdoctoral scholarship from CAPES/PNPD (23102.004667/2014–42) and CNPq/PDS (160133/2018–1). We also thank Dr. Liliane Lodi for the Ocean sunfish sighting reports and Dr. Suzana Guimarães for the Longfin Bannerfish records, Carlos Augusto Rangel for support in field campaigns, Alfredo Carvalho-Filho and Cláudio L. S. Sampaio for the help in identification of species. We would like to thank Manasi Rebouças and Z13 fishermen's colony for their invaluable records and long lasting partnership; and finally the field support from Caio Salles (Projeto Verde Mar), Luiz "Cação", Welington Vieira, Eduardo Licurci and Wagner Rodrigues from Mergulho Carioca.

REFERENCES

- **Adelir-Alves J, Soeth M, Braga RR, Spach HL.** Non-native reef fishes in the Southwest Atlantic Ocean: a recent record of *Heniochus acuminatus* (Linnaeus, 1758) (Perciformes, Chaetodontidae) and biological aspects of *Chromis limbata* (Valenciennes, 1833) (Perciformes, Pomacentridae). Check List. 2018; 14(2):379–85. https://doi.org/10.15560/14.2.379
- **Aguiar A, Bertoncini ÁA, Moraes FC, editors.** Ilhas do Rio. 1 ed. Rio de Janeiro: Mar Adentro; 2015.
- **Alves F, Canning-Clode J, Ribeiro C, Gestoso I, Kaufmann M.** Local benthic assemblages in shallow rocky reefs find refuge in a marine protected area at Madeira Island. J Coast Conserv. 2019; 23:373–83. https://doi.org/10.1007/s11852-018-0669-y
- **Amorim RB, Monteiro-Neto C.** Marine protected area and the spatial distribution of the gill net fishery in Copacabana, Rio de Janeiro, RJ, Brazil. Braz J Biol. 2016; 76(1):1–09. http://dx.doi.org/10.1590/1519-6984.06614

- **Anderson AB, Salas EM, Rocha LA, Floeter SR.** The recent colonization of south Brazil by the Azores chromis *Chromis limbata*. J Fish Biol. 2017; 91(2):558–73. https://doi.org/10.1111/jfb.13363
- **Anderson WDJr.** Annotated checklist of anthiadine fishes (Percoidei: Serranidae). Zootaxa. 2018; 4475(1):1–62. https://doi.org/10.11646/zootaxa.4475.1.1
- **Andradi-Brown DA, Macaya-Solis C, Exton DA, Gress E, Wright G, Rogers AD.** Assessing Caribbean shallow and mesophotic reef fish communities using baited-remote underwater video (BRUV) and diver-operated video (DOV) survey techniques. PLoS ONE. 2016; 11(12):e0168235. https://doi.org/10.1371/journal.pone.0168235
- **Araujo NLF, Lopes CA, Brito VB, Santos LN, Barbosa-Filho MLV, Amaral CRL *et al*.** Artisanally landed elasmobranchs along the coast of Rio de Janeiro, Brazil. Bol Lab Hidrobiol. 2020; 30(1):33–53. http://dx.doi.org/10.18764/1981-6421e2020.4
- **Bax N, Williamson A, Aguero M, Gonzalez E, Geeves W.** Marine invasive alien species: a threat to global biodiversity. Mar Policy. 2003; 27(4):313–23. https://doi.org/10.1016/S0308-597X(03)00041-1
- **Bayley DTI, Mogg OMA, Purvis A, Koldewey HJ.** Evaluating the efficacy of small-scale marine protected areas for preserving reef health: A case study applying emerging monitoring technology. Aquat Conserv: Mar Freshw Ecosyst. 2019; 29 29(12):2026–44. https://doi.org/10.1002/aqc.3215
- **Beck HJ, Feary DA, Figueira WF, Booth DJ.** Assessing range shifts of tropical reef fishes: A comparison of belt transect and roaming underwater visual census methods. Bull Mar Sci. 2014; 90(2):705–21. https://doi.org/10.5343/bms.2013.1055
- **Benedetti-Cecchi L, Pannacciulli F, Bulleri F, Moschella PS, Airoldi L, Relini G, Cinelli F.** Predicting the consequences of anthropogenic disturbance: large-scale effects of loss of canopy algae on rocky shores. Mar Ecol Prog Ser. 2001; 214:137–50. https://doi.org/10.3354/meps214137
- **Bertoncini AA, Moraes FC, Borgonha M, Aguiar A, Duarte B, editors.** Marine biodiversity and diving guide to the islands of Rio. Rio de Janeiro: Museu Nacional, Série Livros 65; 2019.
- **Bohnsack JA, Bannerot SP.** A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NOAA Technical Report NMFS [Internet]. Washington; 1986. Available from: https://repository.library.noaa.gov/view/noaa/1005
- **Chaves LCT, Monteiro-Neto C.** Comparative analysis of rocky reef fish community structure in coastal islands of south-eastern Brazil. J Mar Biol Assoc UK. 2009; 89(3):609–19. https://doi.org/10.1017/S0025315408002695
- **Chong-Seng KM, Mannering TD, Pratchett MS, Bellwood DR, Graham NAJ.** The influence of coral reef benthic condition on associated fish assemblages. PLoS ONE. 2012; 7(8):e42167. https://doi.org/10.1371/journal.pone.0042167
- **Cordeiro BD, Bertoncini AA, Abrunhosa FE, Corona LS, Araújo FG, Santos LN.** First report of the non-native gulf toadfish *Opsanus beta* (Goode, Bean, 1880) on the coast of Rio de Janeiro – Brazil. Bioinvasions Rec. 2020; 9(2):279–86. Available from: https://www.reabic.net/journals/bir/2020/2/BIR_2020_Cordeiro_etal.pdf
- **Côté IM, Green SJ, Hixon MA.** Predatory fish invaders: Insights from Indo-Pacific lionfish in the western Atlantic and Caribbean. Biol Conserv. 2013; 164:50–61. https://doi.org/10.1016/j.biocon.2013.04.014
- **Daros FA, Bueno LS, Soeth M, Bertoncini AA, Hostim-Silva M, Spach HL.** Rocky reef fish assemblage structure in coastal islands of southern Brazil. Lat Am J Aquat Res. 2018; 46(1):197–211. http://dx.doi.org/10.3856/vol46-issue1-fulltext-19
- **Dornburg A, Near TJ.** The emerging phylogenetic perspective on the evolution of Actinopterygian fishes. Annu Rev Ecol Evol Syst. 2021; 52:427–52. https://doi.org/10.1146/annurev-ecolsys-122120-122554
- **Ebert DA, Dando M, Fowler S, editors.** Sharks of the world - A complete guide, Wild Nature Press, Plymounth, UK. 2021.

- **Elliott M.** Integrated marine science and management: Wading through the morass. Mar Pollut Bull. 2014; 86(1–2):1–04. http://dx.doi.org/10.1016/j.marpolbul.2014.07.026
- **Ferreira CEL.** Non-indigenous corals at marginal sites. Coral Reefs. 2003; 22:498. https://doi.org/10.1007/s00338-003-0328-z
- **Figueiredo JL, Menezes NA.** Manual de peixes marinhos do sudeste do Brasil VI. Teleostei. 5 ed. São Paulo: Museu de Zoologia da Universidade de São Paulo; 2000.
- **Figueroa-Pico J, Tortosa FS, Carpio AJ.** Natural and anthropogenic-induced stressors affecting the composition of fish communities on the rocky reefs of Ecuador. Mar Pollut Bull. 2021; 164:112018. https://doi.org/10.1016/j.marpolbul.2021.112018
- **Floeter SR, Ferreira CEL, Dominici-Arosemena A, Zalmon IR.** Latitudinal gradients in Atlantic reef fish communities: trophic structure and spatial use patterns. J Fish Biol. 2004; 64(6):1680–99. https://doi.org/10.1111/j.0022-1112.2004.00428.x
- **Froese R, Pauly D.** FishBase. World Wide Web electronic publication, version (02/2022) [Internet]. Available from: https://www.fishbase.de/summary/5588
- **Gaines SD, White C, Carr MH, Palumbi SR.** Designing marine reserve networks for both conservation and fisheries management. Proc Natl Acad Sci USA. 2010; 107(43):18286–93. https://doi.org/10.1073/pnas.0906473107
- **Garcia LC, Moreira CR, Carvalho-Filho A.** First record of African hind, *Cephalopholis taeniops* (Valenciennes, 1828) (Perciformes, Epinephelidae) in the South-western Atlantic. Check List. 2018; 14(6):961–65. https://doi.org/10.15560/14.6.961
- **Guabiroba HC, Pimentel CR, Macieira MR, Cardozo-Ferreira GC, Teixeira JB, Gasparini JL *et al*.** New records of fishes for the Vitória-Trindade Chain, southwestern Atlantic. Check List. 2020; 16(3):699–705. https://doi.org/10.15560/16.3.699
- **Halpern BS.** The impact of marine reserves: Do reserves work and does reserve size matter? Ecol Appl. 2003; 13(1):117–37. https://doi.org/10.1890/1051-0761(2003)013[0117:TIOMRD]2.0.CO;2
- **Hauser-Davis RA, Amorim-Lopes C, Araujo NLF, Rebouças M, Gomes RA, Rocha RCC *et al*.** On mobulid rays and metals: Metal content for the first *Mobula mobular* record for the state of Rio de Janeiro, Brazil and a review on metal ecotoxicology assessments for the Manta and *Mobula* genera. Mar Pollut Bull. 2021; 168:112472. https://doi.org/10.1016/j.marpolbul.2021.112472
- **Hostim-Silva M, Andrade AB, Machado LF, Gerhardinger LC, Daros FA, Barreiros JP *et al*.** Peixes de Costão Rochoso de Santa Catarina: Arvoredo. Itajaí: Universidade do Vale do Itajaí; 2005.
- **Humann P, Deloach N.** Reef fish identification - Florida Caribbean Bahamas. 4 ed. Florida: New World Publications; 2014.
- **Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).** Livro vermelho da fauna brasileira ameaçada de extinção: Volume VI – Peixes. In: Instituto Chico Mendes de Conservação da Biodiversidade, organizers. Livro vermelho da fauna brasileira ameaçada de extinção. Brasília: ICMBio/MMA; 2018. Available from: https://www.gov.br/icmbio/pt-br/centrais-de-conteudo/publicacoes/publicacoes-diversas/livro_vermelho_2018_vol6.pdf
- **Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).** Plano de manejo do monumento natural do arquipélago das Ilhas Cagarras. Brasília, DF; 2020. Available from: http://www.femerj.org/wp-content/uploads/plano_manejo_mona_arquipelago_das_ilhas_cagarras.pdf
- **Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO).** Multiple ocean stressors: A scientific summary for policy makers. In: Boyd PW, Dupont S, Isensee K, editors [Internet]. Paris, France, UNESCO (IOC Information Series, 1404); 2022. http://dx.doi.org/10.25607/OBP-1724
- **International Union for Conservation of Nature (IUCN).** The IUCN Red List of Threatened Species; 2021 [Internet]. Available from: https://www.iucnredlist.org

- **Jentoft S, Van Son TC, Bjørkan M.** Marine protected areas: A governance system analysis. Hum Ecol. 2007; 35:611–22. https://doi.org/10.1007/s10745-007-9125-6
- **Koenig CC, Stallings CD.** A new compact rotating video system for rapid survey of reef fish populations. Bull Mar Sci. 2015; 91(3):365–73. http://dx.doi.org/10.5343/bms.2015.1010
- **Kume M, Lavergne E, Ahn H, Terashima Y, Kadowaki K, Ye F *et al*.** Factors structuring estuarine and coastal fish communities across Japan using environmental DNA metabarcoding, Ecol Indic. 2021; 121:107216. https://doi.org/10.1016/j.ecolind.2020.107216
- **Laport MS, Pontes PVM, Santos DS, Santos-Gandelman JF, Muricy G, Bauwens M *et al*.** Antibiotic resistance genes detected in the marine sponge *Petromica citrina* from Brazilian coast. Braz J Microbiol. 2016; 47(3):617–20. https://doi.org/10.1016/j.bjm.2016.04.016
- **Last PR, Séret B, Naylor GJP.** A new species of guitarfish, *Rhinobatos borneensis* sp. nov. with a redefinition of the family-level classification in the order Rhinopristiformes (Chondrichthyes: Batoidea). Zootaxa. 2016; 4117(4):451–75. https://doi.org/10.11646/zootaxa.4117.4.1
- **Leite JR, Bertoncini ÁA, Bueno L, Daros F, Adelir-Alves J, Hostim-Silva M.** The occurrence of Azores *Chromis*, *Chromis limbata* in the south-western Atlantic. J Mar Biol Assoc UK. 2009; 2:e145. https://doi.org/10.1017/S1755267209990637
- **Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD *et al*.** Biological effects within no-take marine reserves: a global synthesis. Mar Ecol Prog Ser. 2009; 384:33–46. https://doi.org/10.3354/meps08029
- **Luiz OJ, Comin EJ, Madin JS.** Far away from home: the occurrence of the Indo-Pacific bannerfish *Heniochus acuminatus* (Pisces: Chaetodontidae) in the Atlantic. Bull Mar Sci. 2014; 90(2):741–44. https://doi.org/10.5343/bms.2013.1046
- **Luiz OJ, Santos WCR, Marceniuk AP, Rocha LA, Floeter SR, Buck CE *et al*.** Multiple lionfish (*Pterois* spp.) new occurrences along the Brazilian coast confirm the invasion pathway into the Southwestern Atlantic. Biol Invasions. 2021; 23:3013–19. https://doi.org/10.1007/s10530-021-02575-8
- **Mallet D, Pelletier D.** Underwater video techniques for observing coastal marine biodiversity: A review of sixty years of publications (1952-2012). Fish Res. 2014; 154:44–62. https://doi.org/10.1016/j.fishres.2014.01.019
- **Melià P, Casagrandi R, Di Franco A, Guidetti P, Gatto M.** Protection reveals density-dependent dynamics in fish populations: A case study in the central Mediterranean. PLoS ONE. 2020; 15(2):e0228604. https://doi.org/10.1371/journal.pone.0228604
- **Mendez MM, Livore JP, Bigatti G.** Interaction of natural and anthropogenic stressors on rocky shores: community resistance to trampling. Mar Eco Prog Ser. 2019; 631:117–26. https://doi.org/10.3354/meps13144
- **Menezes NM, McFadden CS, Miranda RJ, Nunes JACC, Lolis L, Barros F *et al*.** New non-native ornamental octocorals threatening a South-west Atlantic reef. J Mar Biol Assoc UK. 2022; 101(6):911–17. https://doi.org/10.1017/S0025315421000849
- **Miller KI, Russ GR.** Studies of no-take marine reserves: Methods for differentiating reserve and habitat effects. Ocean Coast Manage. 2014; 96:51–60. https://doi.org/10.1016/j.ocecoaman.2014.05.003
- **Miranda RJ, Nunes JACC, Mariano-Neto E, Sippo JZ, Barros F.** Do invasive corals alter coral reef processes? An empirical approach evaluating reef fish trophic interactions. Mar Environ Res. 2018; 138:19–27. https://doi.org/10.1016/j.marenvres.2018.03.013
- **Monteiro-Neto C, Bertoncini AA, Chaves LCT, Noguchi R, Mendonça-Neto JP, Rangel CA.** Checklist of marine fish from coastal islands of Rio de Janeiro, with remarks on marine conservation. Mar Biodivers Rec. 2013; 6:1–13. http://dx.doi.org/10.1017/S1755267213000973
- **Mora C, Tittensor DP, Myers RA.** The completeness of taxonomic inventories for describing the global diversity and distribution of marine fishes. P Roy Soc B-Biol Sci. 2008; 275(1631):149–55. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2596190/

- **Moraes FC, Bertoncini ÁA, Aguiar A., editors.** História, Ppesquisa e Biodiversidade do Monumento Natural das Ilhas Cagarras. 1 ed. Rio de Janeiro: Mar Adentro; 2013.
- **Motta FS, Moura RL, Neves LM, Souza GRS, Gibran FZ, Francini CL *et al*.** Effects of marine protected areas under different management regimes in a hot spot of biodiversity and cumulative impacts from SW Atlantic. Reg Stud Mar Sci. 2021; 47:101951. https://doi.org/10.1016/j.rsma.2021.101951
- **Moura RL.** Non-indigenous reef fishes in the southwestern Atlantic. In: Abstracts of the 9th International Coral Reef Symposium, Bali, Indonesia. 2000.
- **Moura RL, Amado-Filho GM, Moraes FC, Brasileiro PS, Salomon PS, Mahiques MM *et al*.** An extensive reef system at the Amazon River mouth. Sci Adv. 2016; 2(4):e1501252. https://www.science.org/doi/10.1126/sciadv.1501252
- **Nelson JS, Grande TC, Wilson MV, editors.** Fishes of the World, Hoboken, NJ: Wiley; 2016.
- **Munro JL.** The scope of tropical reef fisheries and their management. Reef Fisheries. 1996; 20:1–14. https://doi.org/10.1007/978-94-015-8779-2_1
- **Parenti P.** An annotated checklist of fishes of the family Sciaenidae. J Animal Divers. 2020; 2(1):1–92. https://doi.org/10.29252/JAD.2020.2.1.1
- **Pauly D, Christensen V, Guénette S, Pitcher TJ, Sumaila UR, Walters CJ *et al*.** Towards sustainability in world fisheries. Nature. 2002; 418:689–95. https://doi.org/10.1038/nature01017
- **Pereira PHC, Côrtes LGF, Lima GV, Gomes E, Pontes AVF, Mattos F *et al*.** Reef fishes biodiversity and conservation at the largest Brazilian coastal Marine Protected Area (MPA Costa dos Corais). Neotrop Ichthyol. 2021; 19(4):e210071. https://doi.org/10.1590/1982-0224-2021-0071
- **Pereira RC, Soares-Gomes A, editors.** Biologia marinha. Rio de Janeiro, Interciência; 2009.
- **Pimentel CR, Andrades R, Ferreira CEL, Gadig OBF, Harvey ES, Joyeux J-C *et al*.** BRUVS reveal locally extinct shark and the way for shark monitoring in Brazilian oceanic islands. J Fish Biol. 2020; 96(2):539–42. https://doi.org/10.1111/jfb.14228
- **Pinheiro HT, Madureira JMC, Joyeux J-C, Martins AS.** Fish diversity of a southwestern Atlantic coastal island: aspects of distribution and conservation in a marine zoogeographical boundary. 2015; Check List 11(2):1–17. https://doi.org/10.15560/11.2.1615
- **Pinheiro HT, Macena BCL, Francini-Filho RB, Ferreira CEL, Albuquerque FV, Bezerra NPA *et al*.** Fish biodiversity of Saint Peter and Saint Paul's Archipelago, Mid-Atlantic Ridge, Brazil: new records and a species database. J Fish Biol. 2020; 97(4):1143–53. https://doi.org/10.1111/jfb.14484
- **QGIS Development Team.** QGIS Geographic Information System. Open Source Geospatial Foundation Project, 3.16 version; 2022. Available from: http://qgis.osgeo.org
- **Quaas Z, Harasti D, Gaston TF, Platell ME, Fulton CJ.** Influence of habitat condition on shallow rocky reef fish community structure around islands and headlands of a temperate marine protected area. Mar Eco Prog Ser. 2019; 626:1–13. https://doi.org/10.3354/meps13091
- **Quimbayo JP, Dias MS, Kulbicki M, Mendes TC, Lamb RW, Johnson AF *et al*.** Determinants of reef fish assemblages in tropical Oceanic islands. Ecography. 2019; 42(1):77–87. https://doi.org/10.1111/ecog.03506
- **R Development Core Team.** R: The R project for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2020. Available from: https://www.r-project.org/
- **Randall JE, editor.** Coastal fishes of Oman. Bathurst, Australia: Crawford House Publishing; 1995.
- **Rangel CA, Chaves LCT, Monteiro-Neto C.** Baseline assessment of the reef fish assemblage from Cagarras Archipelago, Rio de Janeiro, southeastern Brazil. Braz J Oceanogr. 2007; 55(1):7–17. https://doi.org/10.1590/S1679-87592007000100002
- **Riofrío-Lazo M, Zetina-Rejón MJ, Vaca-Pita L, Murillo-Posada JC, Páez-Rosas D.** Fish diversity patterns along coastal habitats of the southeastern Galapagos archipelago and their relationship with environmental variables. Sci Rep. 2022; 12:3604. https://doi.org/10.1038/s41598-022-07601-w

- **Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R.** Effects of marine reserves on adjacent fisheries. Science. 2001; 294(5548):1920–23. https://doi.org/10.1126/science.294.5548.1920
- **Rocha LA, Rosa IL.** Baseline assessment of reef fish assemblages of Parcel Manuel Luiz Marine State Park, Maranhão, north-east Brazil. J Fish Biol. 2001; 58(4):985–98. https://doi.org/10.1111/j.1095-8649.2001.tb00549.x
- **Rolim FA, Rodrigues PFC, Langlois T, Neves LM, Gadid OBF.** A comparison of stereo-videos and visual census methods for assessing subtropical rocky reef fish assemblage. Environ Biol Fish. 2022; 105:413–29. https://doi.org/10.1007/s10641-022-01240-w
- **Ruiz GM, Carlton JT, Grosholz ED, Hines AH.** Global invasions of marine and estuarine habitats by non-indigenous species: Mechanisms, extent, and consequences. Am Zool. 1997; 37(6):621–32. https://doi.org/10.1093/icb/37.6.621
- **Sale PF.** Visual census of fish: How well do we see what is there? In: Lessios HA, MacIntyre IG, editors. Proc Int Cor Reef Symp 2. Balboa, Smithsonian Tropical Research Institute: 1997.
- **Samhouri JF, Stier AC.** Ecological impacts of an invasive mesopredator do not differ from those of a native mesopredator: lionfish in Caribbean Panama. Coral Reefs. 2021; 40:1593–600. https://doi.org/10.1007/s00338-021-02132-8
- **Schmid K, Silva FRM, Santos BJV, Bezerra NPA, Garla RC, Giarrizzo T.** First fish fauna assessment in the Fernando de Noronha Archipelago with BRUVS: Species catalog with underwater imagery. Biota Neotrop. 2020; 20(4):e20201014. https://doi.org/10.1590/1676-0611-BN-2020-1014
- **Sciberras M, Jenkins SR, Mant R, Kaiser MJ, Hawkins SJ, Pullin AS.** Evaluating the relative conservation value of fully and partially protected marine areas. Fish Fish. 2015; 16(1):58–77. https://doi.org/10.1111/faf.12044
- **Silva MS, Moraes FC, Batista D, Bahia RG, Bertoncini AA, Machado AA *et al*.** Distribution, population structure and settlement preference of *Tubastraea* spp. (Cnidaria: Scleractinia) on rocky shores of the Cagarras Islands Natural Monument and surroundings, Rio de Janeiro, Brazil. Reg Stud Mar Sci. 2022; 52:102245. https://doi.org/10.1016/j.rsma.2022.102245
- **Souza GRS, Gadig OBF, Motta FS, Moura RL, Francini-Filho RB, Garrone-Neto D.** Reef fishes of the Anchieta Island State Park, Southwestern Atlantic, Brazil. Biota Neotrop. 2018; 18(1):e20170380. https://doi.org/10.1590/1676-0611-bn-2017-0380
- **Sutherland WJ, Clout M, Côté IM, Daszak P, Depledge MH, Fellman L *et al*.** A horizon scan of global conservation issues for 2010. Trends Ecol Evol. 2010; 25(1):1–07. https://doi.org/10.1016/j.tree.2009.10.003
- **Tang KL, Stiassny MLJ, Mayden RL, DeSalle R.** Systematics of damselfishes. Ichthyol Herpetol. 2021; 109(1):258–318. https://doi.org/10.1643/i2020105

AUTHORS' CONTRIBUTION

Augusto A. Machado: Conceptualization, Formal analysis, Investigation, Methodology, Writing-original draft, Writing-review and editing.

Fernando C. de Moraes: Writing-original draft, Writing-review and editing.

Aline A. Aguiar: Funding acquisition, Project administration, Writing-original draft, Writing-review and editing.

Mauricio Hostim-Silva: Supervision, Writing-original draft, Writing-review and editing.

Luciano N. Santos: Writing-original draft, Writing-review and editing.

Áthila A. Bertoncini: Conceptualization, Formal analysis, Methodology, Project administration, Writing-original draft, Writing-review and editing.

Neotropical Ichthyology

OPEN ACCESS

Official Journal of the
Sociedade Brasileira de Ictiologia

ETHICAL STATEMENT

Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) for research permits (SISBio 74219–1).

COMPETING INTERESTS

The authors declare no competing interests.

HOW TO CITE THIS ARTICLE

- **Machado AA, Moraes FC, Aguiar AA, Hostim-Silva M, Santos LN, Bertoncini AA.** Rocky reef fish biodiversity and conservation in a Brazilian Hope Spot region. Neotrop Ichthyol. 2022; 20(3):e220032. https://doi.org/10.1590/1982-0224-2022-0032