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

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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 (\textit{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.

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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 43°35'W - 42°09'W; 23°01'S - 22°09'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 40m²-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, Bannertot (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).
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 brasiliensis (Cuvier, 1828) under Athiadiidae (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*, Moraes et al., 2013*, Monteiro-Neto et al., 2013*, Amorim, Monteiro-Neto, 2016*, Garcia et al., 2018*, Bertoncini et al., 2019*, Araujo et al., 2020*, Hauser-Davis et al., 2021*.

| Family and species | IUCN | ICMBio | Observed sites | Record type |
|--------------------|------|--------|----------------|-------------|
| GINGLYMOSTOMATIDAE  |      |        |                |             |
| Ginglymostoma cirratum (Bonnaterre, 1788) | DD | VU | MCA | SIG *² |
| RHINCODONTIDAE      |      |        |                |             |
| Rhinodon typus Smith, 1828 † | EN | VU | MCA | SIG |
| LAMNIDAE            |      |        |                |             |
| Isurus oxyrinchus Rafinesque, 1810 | EN | NT | Z7 / Z13 | FIS*² |
| CARCHARHINIDAE      |      |        |                |             |
| Carcharhinus brevipinna (Valenciennes, 1839) | NT | DD | Z7 / Z13 | FIS*² |
| Carcharhinus falciformis (Bibron, 1839) | VU | NT | Z7 | FIS*² |
| Rhizoprionodon lalandii (Valenciennes, 1839) | DD | NT | Z13 | FIS*² |
| GALEOCERDONIDAE     |      |        |                |             |
| Galeocerdo cuvier (Péron & Lesueur, 1822) | NT | NT | Z13 | FIS*² |
| SYPYRHINIDAE        |      |        |                |             |
| Sphyrna lewini (Griffith & Smith, 1834) | CR | CR | Z7 / Z13 | FIS*² |
| Sphyrna zygaena (Linnaeus, 1758) | VU | CR | Z7 / Z13 | FIS*² |
| HEXANCHIDAE         |      |        |                |             |
| Notorynchus cepedianus (Péron, 1807) † | DD | CR | Z13 | FIS |
| SQUATINIDAE         |      |        |                |             |
| Squatina guggenheim Marini, 1936 | EN | CR | Z7 & Z13 | FIS*² |
| NARCINIDAE          |      |        |                |             |
| Narcine brasiliensis (Olfers, 1831) | DD | DD | TA / Z13 | SRV / FIS*² |
| RAJIDAE             |      |        |                |             |
| Atlantoraja cyclopheora (Regan, 1903) | VU | NT | MUS | MUS*³ |
| Atlantoraja castelnaui (Miranda Ribeiro, 1907) | EN | EN | Z7 / Z13 | FIS*² |
| Rioraja agassizii (Müller & Henle, 1841) | VU | EN | MUS / Z13 | MUS*³ / FIS*² |
| RHINOBATIDAE        |      |        |                |             |
| Pseudobatos horkellii (Müller & Henle, 1841) | CR | CR | Z7 / Z13 | FIS*² |
| Pseudobatos percellens (Walbaum, 1792) | NT | DD | MCA / Z13 | SRV / FIS*² |
| TRYGONORRHINIDAE    |      |        |                |             |
| Zapteryx brevirostris (Müller & Henle, 1841) | NT | DD | TA / MCA / MA / Z13 / MUS | UVC / MUS*³ / FIS*² |
| DASYATIDAE          |      |        |                |             |
| Dasysphyra hypostigma Santos & Carvalho, 2004 | DD | DD | Z13 | FIS*³ |
| Hypanus americanus (Hildebrand & Schroeder, 1928) | DD | DD | MCA / MA / RI / Z13 | UVC / SRV / FIS*² |
| Hypanus guttatus (Bloch & Schneider, 1801) | DD | LC | Z13 | FIS*² |
| Hypanus say (Lesueur, 1817) | LC | DD | Z13 | FIS*² |
| Pteroplatytrygon violacea (Bonaparte, 1832) | LC | DD | Z13 | FIS*² |
| GYMNRUIDAE          |      |        |                |             |
| Gymnura altavela (Linnaeus, 1758) | VU | CR | TA / MCA / MA / Z13 | UVC / FIS*³ |
| MYLIOBATIDAE        |      |        |                |             |
| Aerobatus marinari (Euphrasen, 1790) | NT | DD | TA / MCA / MA / RI | UVC / SRV / LIT*¹,² |
| 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*² |
| ELOPIDAE            |      |        |                |             |
| Elops saurus Linnaeus, 1766 | LC | NE | Z13 | FIS*² |
### Table 1 (Continued)

| Family          | Genus and Species | Status | Location | Remarks          |
|-----------------|-------------------|--------|----------|------------------|
| **Albulidae**   | *Albula vulpes*   | NT     | DD       | Z13 FIS²         |
| **Muraenidae**  | *Gymnothorax funebris* | LC     | DD       | MCA SIG / LIT¹   |
|                 | *Gymnothorax moringa* | LC     | DD       | TA / MCA / MA / RI UVC / SRV / SIG¹ |
|                 | *Gymnothorax ocellatus* | LC     | DD       | Z13 FIS²         |
|                 | *Gymnothorax vicinus* | LC     | DD       | TA / MCA / MA / RI UVC / SIG³ |
|                 | *Muraena retifera* | LC     | LC       | TA / MCA UVC / SIG³ |
| **Ophichthidae**| *Ahlia egmontis* | LC     | LC       | MCA / RI UVC / SIG³ |
|                 | *Myrichthys breviceps* | LC     | LC       | MCA UVC / LIT¹   |
|                 | *Myrichthys ocellatus* | LC     | LC       | TA / MCA / MA / RI UVC / LIT³ |
|                 | *Ophichthus ophis* | LC     | LC       | TA / MCA UVC / LIT³ |
| **Congridae**   | *Conger orbignianus* | LC     | DD       | MUS MUS³         |
| **Clupeidae**   | *Brevoortia aurea* | LC     | LC       | Z13 FIS²         |
|                 | *Harengula clupeola* | LC     | LC       | TA / MCA / MA SRV / SIG³ |
|                 | *Opisthonema oglinum* | LC     | LC       | MCA / MA / Z13 UVC / FIS² / SIG³ |
| **Aridae**      | *Genidens barbus* | NE     | EN       | CI3 / Z13 UVC / FIS² |
| **Synodontidae**| *Synodus foetens* | LC     | LC       | MCA LIT³³         |
|                 | *Synodus intermedius* | LC     | LC       | TA / MCA / MA RI LIT⁴⁴⁴ / UVC |
|                 | *Synodus synodus* | DD     | DD       | MCA / Z13 UVC / FIS² |
| **Lampridae**   | *Lampris guttatus* | LC     | LC       | Z13 FIS         |
| **Merlucciidae**| *Merluccius hubsi* | NE     | NT       | Z13 FIS²         |
| **Gadidae**     | *Urophycis brasiliensis* | NE     | NT       | Z13 FIS²         |
| **Holocentridae**| *Holocentrus ascensionis* | LC     | LC       | TA / MCA / MA / RI / CI / Z13 UVC / SRV / LIT⁴⁴⁴ / FIS² |
|                 | *Myripristis jacobus* | LC     | LC       | TA / MCA / MA / RI UVC / SRV / LIT¹ |
|                 | *Plectropops retropinensis* | LC     | LC       | MCA / MA UVC / LIT⁴² |
|                 | *Sargocentron bulisi* | LC     | LC       | MCA / MA SIG⁴⁵ / UVC |
| **Batrachoididae** | *Porichthys porosissimus* | NE     | LC       | MCA / MA / Z13 / MUS UVC / LIT² / MUS³ / FIS⁴ |
| **Gobidae**     | *Coryphopterus glaucofraenum* | LC     | LC       | TA / MCA / MA / RI / CI UVC / LIT¹ |
|                 | *Ctenogobius saepepallens* | LC     | LC       | TA / MCA / MA / RI / CI MA / MUS UVC / LIT¹ |
|                 | *Eucaturus figaro* | NE     | VU       | TA / MCA / MA / RI / CI UVC / SRV / LIT¹ |
|                 | *Gnatholepis thompsoni* | LC     | LC       | MCA UVC / SIG⁴³ |
|                 | *Gobulus myersi* | NE     | LC       | TA UVC         |
| **Apoxogonidae**| *Apogon pseudomaculatus* | LC     | LC       | MCA / MA UVC / LIT³⁴ |
|                 | *Phaeoptyx pigmentaria* | LC     | LC       | Not Available SIG³⁵ |
| **Ptereleotridae** | *Ptereleotris randalli* | LC     | LC       | TA UVC / SRV / SIG⁵ |
| **Gempylidae**  | *Thysites lepidopodea* | NE     | LC       | Z13 FIS²         |
TABLE 1 | (Continued)

| FAMILY                | SPECIES                                                                 | STATUS | RISK | KEEPCODE | IUCN CATEGORY | CODE |
|-----------------------|-------------------------------------------------------------------------|--------|------|----------|----------------|------|

**POMATOMIDAE**

*Pomatomus saltatrix* (Linnaeus, 1766) VU NT MCA / Z13 SRV / FIS²

**SCOMBRIDAE**

*Euthynnus alletteratus* (Rafinesque, 1810) LC LC MCA / MA UVC / LIT⁴

*Sarda sarda* (Bloch, 1793) † LC LC MCA SIG

*Scamber colias* Gmelin, 1789 LC LC Z13 FIS⁴

*Scobiomeronus brasiliensis* Collette, Russo & Zavala-Camin, 1978 LC LC MCA / Z13 SIG / FIS⁴

**STROMATEIDAE**

*Pepripus paru* (Linnaeus, 1758) LC LC Z13 FIS²

**TRICHIURIDAE**

*Trichiurus lepturus* Linnaeus, 1758 DD LC MCA / Z13 SIG² / FIS²

**FISTULARIIDAE**

*Fistularia petimba* Lacepède, 1803 LC LC MCA / Z13 SIG / FIS²

*Fistularia tabacaria* Linnaeus, 1758 LC LC TA / MCA / MA UVC / SRV / SIG²

**SYNGNATHIDAE**

*Halicampus crinitus* (Jenyns, 1842) † LC LC TA / MCA / MA / CI UVC / SRV / SIG²

*Hippocampus erectus* Perry, 1810 VU VU Not Available LIT⁵

*Hippocampus patagonicus* Piacentino & Luzzatto, 2004 † VU VU MCA SIG

*Hippocampus reidi* Ginsburg, 1933 NT VU TA / MCA / MA UVC / SIG²

**CALLIONYMIDAE**

*Callionymus bairdi* Jordan, 1888 LC LC TA / MCA / MA UVC / SIG³

**MULLIDAE**

*Mullus argentinae* Hubs & Marini, 1933 LC LC Z13 FIS²

*Mullolidichthys martincus* (Cuvier, 1829) † LC LC MCA / MA UVC

*Pseudupeneus maculatus* (Bloch, 1793) LC LC TA / MCA / MA / RI / CI / Z13 UVC / SRV / SIG² / FIS²

**DACTYLOPTERIDAE**

*Dactylopterus volitans* (Linnaeus, 1758) LC LC TA / MCA / MA / CI / Z13 UVC / SRV / FIS²

**BLENNIIDAE**

*Emblemariopsis signifer* (Ginsburg, 1942) LC LC TA / MCA / MA / RI / CI UVC / LIT²

**LABRISOMIDAE**

*Labrisomus delalandii* (Valenciennes, 1836) LC LC TA / MCA / MA / RI / CI UVC / LIT²

*Paraclinus spectator* Guimarães & Bacellar, 2002 Ψ LC LC TA / MCA UVC / SIG⁴

*Starksia brasiliensis* (Gilbert, 1900) Ψ LC LC TA SIG / LIT³

**BELONIDAE**

*Strongylura* spp. van Hasselt, 1824 LC LC TA / MCA / RI UVC / SIG³

*Strongylura marina* (Walbaum, 1792) LC LC TA / MCA / RI UVC / SIG³

*Tylosurus spp.* LC LC TA / MCA / RI UVC / SIG³

*Mugil liza* Valenciennes, 1836 DD NT TA / MCA / MA / CI / Z13 UVC / SRV / FIS²

**OPISTHOGNATHIDAE**

*Opistognathus vicinus* Smith-Vaniz, Tornabene & Macieira, 2018 † Ψ NE NE RI / MA UVC
### Table 1 (Continued)

| Family               | Species                                                                 | Status | Population | Conservation | IUCN Range | Source | Notes |
|----------------------|-------------------------------------------------------------------------|--------|------------|--------------|------------|--------|-------|
| 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 *†*                                       | NE     | LC         | MCA / RI       | UVC / SRV / LIT*1 |
|                      | *Chromis vanbeebereae* McFarland, Baldwin, Robertson, Rocha & Tornabene, 2020 *†* | NE     | NE         | MCA           | UVC |
|                      | *Stegastes fuscus* (Linnaeus, 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              | UVC / SRV / LIT*1 |
| CARANGIDAE           | *Caranx cryos* (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*1 |
|                      | *Decapterus macarellus* (Cuvier, 1833) *†*                             | LC     | LC         | TA / CI                      | UVC |
|                      | *Decapterus punctatus* (Cuvier, 1829) *†*                               | LC     | LC         | MCA                      | UVC |
|                      | *Oligopilus* 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 / Z13      | UVC / SRV / FIS*3 |
|                      | *Seler 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 dumerilii* (Risso, 1810)                                       | NT     | LC         | MCA / Z13                   | SIG*2 / FIS*3 |
|                      | *Seriola lalandii* Valenciennes, 1833                                   | LC     | LC         | TA / MCA / Z13               | UVC / SIG*2 / FIS*2 |
|                      | *Seriola rivoliana* Valenciennes, 1833                                  | LC     | LC         | TA / MCA / MA / RI / Z13     | 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* (Poeys, 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            | *Xiphius gladius* Linnaeus, 1758 *†*                                    | LC     | NT         | TA                      | FIS |
| BOTHIDAE             | *Bothus ocellatus* (Agassiz, 1831)                                      | LC     | LC         | TA / MCA / MA / RI / Z13   | UVC / SRV / FIS*2 |
| PARALICHTHYIDAE      | *Cycloptera 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 micrurrum* 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)

| FAMILY | SPECIES | COMMON NAME | STATUS | LOCATION | ACQUISITION | CONSERVATION |
|--------|---------|-------------|--------|----------|-------------|--------------|
| Sphyraenidae | Sphyraena guachancho | Cuvier, 1829 | LC | LC | Not Available | FIS*3 |
| | Sphyraena tere | 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*4 / 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*2 / 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*2 / FIS*2 |
| | Mycteroperca acutirostris | (Valenciennes, 1828) | LC | DD | TA / MCA / MA / RI / CI / Z13 | SRV / UVC / SIG*2 / 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*2 / FIS*2 |
| | Mycteroperca microlepis | (Goode & Bean, 1879) | VU | DD | Z13 | FIS*2 |
| | Paranthias furcifer | (Valenciennes, 1828) | LC | NE | TA / RI | UVC / SIG*4 |
| Serranidae | Dipselcrum formosum | (Linnaeus, 1766) | LC | LC | MCA / MA / RI / CI | UVC / SRV / SIG*2 |
| | Dipselcrum 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*4 |
| | Ripticus bistrispinus | (Mitchill, 1818) | LC | LC | TA / MCA / MA / RI | UVC / SIG*4 |
| | Ripticus saponaceus | (Bloch & Schneider, 1801) | LC | LC | MCA / MA / RI / MUS | UVC / SIG*4 / MUS*5 |
| | Serranus atrobranchus | (Cuvier, 1829) | LC | LC | MCA / MA / RI | UVC / SIG*2 |
| | Serranus baldwinei | (Evermann & Marsh, 1889) | LC | LC | MCA / MA / RI | UVC / SIG*1 |
| | Serranus flaviventris | (Cuvier, 1829) | LC | LC | MCA | SIG*2 |
| Antheridiidae | Acanthistius brasiliatus | (Cuvier, 1828) | DD | LC | TA / MCA / MA / RI | UVC / SRV / SIG*2 |
| Percophidae | Percophis brasiliensis | (Quoy & Gaimard, 1825) | NE | LC | Z13 | FIS*2 |
| Triglididae | Prionotus punctatus | (Bloch, 1793) | LC | LC | MA / Z13 | UVC / FIS*2 |
| Scorpaenidae | Pontinus corallinus | Miranda Ribeiro, 1903 | NE | DD | MUS | MUS*3 |
| | Scorpaena brasiliensis | Cuvier, 1829 | LC | LC | MCA | UVC / SIG*2 |
| | Scorpaena unum | Meek & Hildebrand, 1928 | LC | LC | TA / MCA / MA / RI / Z13 | UVC / SIG*4 / FIS*4 |
| | Scorpaena plumieri | Bloch, 1789 | LC | LC | MCA / MA / RI / Z13 | UVC / SIG*4 / FIS*4 |
| | Scorpaenodes caribbaeus | Meek & Hildebrand, 1928 | LC | LC | MCA | SIG*2 |
| | Scorpaenodes trachysurus | (Metzelaar, 1919) | LC | LC | MCA | UVC / SIG*3 |
| Kyporidae | Kyphosus sectatrix | (Linnaeus, 1758) | LC | NE | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / SIG*2 / FIS*2 |
| | Kyphosus vaigiensis | (Quoy & Gaimard, 1825) | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*2 |
| Labridae | Bodianus pulchellus | (Poey, 1860) | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*2 |
| | Bodianus rufus | (Linnaeus, 1758) | LC | LC | TA / MCA / MA / RI | UVC / SRV / SIG*2 |
| | Clepticus brasiliensis | Heiser, Moura & Robertson, 2000 | LC | LC | MCA | UVC / SRV / SIG*2 |
| | Cryptotomus roseus | Cope, 1871 | LC | LC | TA / MCA / MA / CI | UVC / SRV / SIG*2 |
| | Doratonotus megalops | Günter, 1862 | LC | LC | RI | UVC / SIG*2 |
| | Halichoeres brasilienis | (Bloch, 1791) | DD | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*2 |
| | Halichoeres dimidiatus | (Agassiz, 1831) | LC | LC | TA / MCA / MA / RI | UVC / SIG*2 |
| | Halichoeres poeyi | Starks, 1867 | LC | LC | MA | UVC |
| | Halichoeres poeyi | (Steindachner, 1867) | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*2 |
| | Halichoeres sazimai | Luiz, Ferreira & Rocha, 2009 | NE | LC | MCA / MA / RI | UVC / SRV / SIG*2 |
| | Nicholsina ustata | (Valenciennes, 1840) | LC | LC | MCA / MA | UVC / SRV / SIG*3 |
| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Scarus trispinosus | Scarus | Valenciennes, 1840 | DD | VU | MCA | SIG*4 / FIS*3 |
| Scarus zelindae | Scarus | Moura, Figueiredo & Sazima, 2001 | DD | VU | MCA | SIG*4 / FIS*3 |
| Sparisoma amplum | Sparisoma | Ranzani, 1841 | LC | NT | TA / MCA | UVC / SIG*2 |
| Sparisoma axillare | Sparisoma | Steindachner, 1878 | DD | VU | TA / MCA / MA / RI | UVC / SRV / SIG*4 |
| Sparisoma frondosum | Sparisoma | Agassiz, 1831 | DD | VU | TA / MCA / MA / RI / Z13 | UVC / SRV / SIG*1 / FIS*2 |
| Sparisoma radians | Sparisoma | Valenciennes, 1840 | LC | LC | MCA / MA | SIG*2 |
| Sparisoma tuipiranga | Sparisoma | Gasparini, Joyeux & Floeter, 2003 | LC | LC | TA / MCA / MA / RI | UVC / SRV / SIG*1 |
| Thalassoma noronhanum | Thalassoma | Bouleger, 1890 | Ψ | LC | TA / MCA / MA / RI | UVC / SRV / SIG*2 |
| Xyrichtys novacula | Xyrichtys | Linnaeus, 1758 | LC | LC | MA | UVC / SIG*4 |
| Xyrichtys splendens | Xyrichtys | Castelnau, 1858 | LC | LC | MA | UVC |

**URANOSCOPIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA |
|---------|-------|--------|--------|---------------|-------|-----|----|
| Astroscopus ygraecum | Astroscopus | Cuvier, 1829 | LC | LC | Z13 | FIS*4 |

**PINGUIPEDIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Pinguipes brasilianus | Pinguipes | Cuvier, 1829 | NE | LC | TA / MCA / MA / RI | UVC / SRV / FIS*3 |
| Pseudopercis numida | Pseudopercis | Miranda Ribeiro, 1903 | LC | NT | Not Available | FIS*3 |

**PEMPHERIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA |
|---------|-------|--------|--------|---------------|-------|-----|----|
| Pempheris schomburgkii | Pempheris | Müller & Troschel, 1848 | LC | LC | TA / MCA / MA / RI / CI / MUS | UVC / SRV / SIG*1 / MUS*3 |

**ACANTHURIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Acanthurus bahianus | Acanthurus | Castelnau, 1855 | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*1 |
| Acanthurus chirurgus | Acanthurus | Bloch, 1787 | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*1 |
| Acanthurus coeruleus | Acanthurus | Bloch & Schneider, 1801 | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / SIG*1 |

**GERREIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Diapterus rhombeus | Diapterus | Cuvier, 1829 | LC | LC | Z13 | FIS*4 |
| Eucinostomus gula | Eucinostomus | Quoy & Guaimard, 1824 | LC | LC | RI / CI | UVC / SRV / LIT*3 |

**EPHIPPIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Chaetodipterus faber | Chaetodipterus | Broussonet, 1782 | LC | LC | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / FIS*2 |

**HAEMULIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA | RI | CI | Z13 | UVC | SRV | FIS* |
|---------|-------|--------|--------|---------------|-------|-----|----|----|----|-----|-----|-----|-------|
| Anisotremus surimamensis | Anisotremus | Bloch, 1791 | DD | DD | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / FIS*2 |
| Anisotremus virginicus | Anisotremus | Linnaeus, 1758 | LC | LC | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / FIS*2 |
| Haemulon aurorelineatum | Haemulon | Cuvier, 1830 | LC | LC | TA / MCA / MA / RI / CI | UVC / SRV / FIS*3 |
| Haemulon plumieri | Haemulon | Lacépede, 1801 | LC | DD | MCA / MA / RI | SIG*1 / FIS*3 |
| Haemulon steindachneri | Haemulon | Jordan & Gilbert, 1882 | LC | LC | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / SIG*2 |
| Orthopristis rubra | Orthopristis | Cuvier, 1830 | LC | LC | TA / MCA / MA / RI / CI / Z13 | UVC / SRV / FIS*2 |
| Paranisotremus moricandi | Paranisotremus | Ranzani, 1842 | LC | LC | Z13 | SIG*3, FIS*3 |
| Pomadasys ramosus | Pomadasys | Poe, 1860 | NE | LC | Z13 | FIS |

**SCIAENIDAE**

| Species | Genus | Author | Status | IUCN Category | Source | MCA | MA |
|---------|-------|--------|--------|---------------|-------|-----|----|
| Cynoscion acoupa | Cynoscion | Lacepède, 1801 | VU | LC | Z13 | FIS*4 |
| Cynoscion guatucupa | Cynoscion | Cuvier, 1830 | LC | LC | Z13 | FIS*4 |
| Cynoscion jamaicensis | Cynoscion | Vaillant & Bocourt, 1883 | LC | LC | Z13 | FIS*4 |
| Cynoscion microlepidotus | Cynoscion | Cuvier, 1830 | LC | LC | Z13 | FIS*4 |
| Cynoscion virens | Cynoscion | Cuvier, 1830 | LC | LC | Z13 | FIS*4 |
| Eques lanceolatus | Eques | Linnaeus, 1758 | LC | LC | MCA | SIG*4 |
| Larimus breviceps | Larimus | Cuvier, 1830 | LC | LC | Z13 | FIS*2 |
| Menticirrhus americanus | Menticirrhus | Linnaeus, 1758 | LC | DD | Z13 | FIS*2 |
| Micropogonias furnieri | Micropogonias | Desmarest, 1823 | LC | LC | Z13 | FIS*2 |
| Odontoscion dentex | Odontoscion | Cuvier, 1830 | LC | LC | MCA / RI | UVC / SRV / SIG*1 |
| Paralunchonculus brutus | Paralunchonculus | Steinadacher, 1875 | LC | LC | Z13 | FIS*2 |
| Pareques acuminatus | Pareques | Bloch & Schneider, 1801 | LC | DD | TA / MCA / MA / RI / CI | UVC / SRV / SIG*4 |
| Pogonias cromis | Pogonias | Linnaeus, 1766 | LC | EN | Z13 | FIS*2 |
| Stellifer rastrifer | Stellifer | Jordan, 1889 | LC | LC | Z13 | FIS*4 |
**TABLE 1** (Continued)

| Common Name | Code | Status | Threat Action | Remarks |
|-------------|------|--------|---------------|---------|
| **LUTJANIDAE** | | | | |
| Umbrina canosai | LC | LC | Z13 | FIS*2 |
| 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*9 |
| Lutjanus synagris (Linnaeus, 1758) | NT | NT | Z13 | FIS*2 |
| Ocyrus chrysurus (Bloch, 1791) | DD | NT | MCA | SIG*4 / FIS*3 |
| Rhomboploites 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 |
| **CHAEHODONTIDAE** | | | | |
| 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*1 |
| 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*1 |
| 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*5 |
| 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 monoceros (Linnaeus, 1758) | LC | NT | MCA / MA / RI / Z13 | SRV / FIS*2 |
| Aluterus scriptus (Osbeck, 1765) | LC | LC | TA | SRV / SIG*5 |
| 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 |
sweeping 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 rocky reefs: 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 brasilensis, 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 rocky reefs: A. *Hippocampus reidi*, B. *Callionymus bairdi*, C. *Haemulon plumieri*, D. *Sargocentron bullisi*, E. *Chromis flavicauda*, F. *Pronotogrammus martinicensis*, G. *Centropyge aurantonotus*, and H. *Bodianus rufus*. 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.
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 8** | *Heniochus acuminatus*. A. The SRV frame recorded on MAR 2019 at Redonda Island, inside of the MPA, close to *Acanthus 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.
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*
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The authors declare no competing interests.

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