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Composition and ecological aspects of the fish assemblage of the Marine Protected Area APA Baía das Tartarugas, southeastern Brazil

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Abstract: Understanding biodiversity and ecological patterns is a key step for the protection and sustainable use of natural resources. Located in the shore of the city of Vitória (Brazil), the Environmental Protected Area (APA in the Brazilian legislation) Baía das Tartarugas is a Marine Protected Area that lies in a biogeographic transitional zone, and presents a high diversity of marine habitats. Here we provide the first checklist of the ichthyofauna of the APA Baía das Tartarugas and its surroundings, analyzing aspects of fish geographic distribution, trophic structure, and habitat use patterns. We found 278 fish species belonging to 78 families occurring in the studied region. Regarding reef fishes, the region harbors 31.8% of all species recorded in the Brazilian Province, including 20 Brazilian endemics. According to the IUCN and the Brazilian red list, 12 species are classified as endangered (VU, EN or CR). Along with several environmental disturbances registered inside and around the APA, our results highlight the biological importance of the region and the need of a management plan that promotes both the mitigation of harmful activities and the sustainable use of the local resources.

Key words: Biodiversity, Brazilian Province, conservation, ichthyofauna, marine area.

Composição e aspectos ecológicos da assembleia de peixes da área marinha protegida APA Baía das Tartarugas, sudeste do Brasil. Resumo: Entender a biodiversidade e os padrões ecológicos é um passo importante para a proteção e uso sustentável dos recursos naturais. Localizada na costa da cidade de Vitória (Brasil), a Área de Proteção Ambiental (APA) Baía das Tartarugas é uma Área Marinha Protegida que se encontra em uma zona de transição biogeográfica, e apresenta uma alta diversidade de habitats marinhos. Aqui, apresentamos a primeira lista de espécies da ictiofauna da APA Baía das Tartarugas e seus arredores, analisando aspectos da distribuição geográfica dos peixes, estrutura trófica, e padrões de uso dos habitats. Encontramos 278 espécies pertencentes a 78 famílias ocorrendo na região. Em relação aos peixes recifais, a região abriga 31.8% das espécies registradas na província brasileira, incluindo 20 espécies endêmicas do Brasil. De acordo com a IUCN e a lista vermelha brasileira, 12 espécies são classificadas como ameaçadas de extinção (VU, EN ou CR). Junto com diversos distúrbios ambientais registrados dentro e ao redor da APA, nossos resultados evidenciam a importância biológica da região e a necessidade de um plano de manejo que promova a mitigação das atividades nocivas e o uso sustentável dos recursos locais.
Palavras-chave: biodiversidade, Província Brasileira, conservação, ictiofauna, área marinha.

Introduction

The increase of studies about the Brazilian marine ichthyofauna has revealed a great diversity, high endemism rates and distinct assemblages distributed along a large continental coast (8500 km)

and around oceanic islands (Floeter & Gasparini 2000, Rocha 2003). The regional endemism contributed to define Brazil as a zoogeographic province with unique ecological and evolutionary patterns of fish assemblages, harboring a secondary biodiversity center in the Atlantic Ocean (Floeter *et al.* 2008, Joyeux *et al.* 2001, Pinheiro *et al.* 2018). The knowledge about the diversity, biology, and ecology of fishes in the state of Espírito Santo, located on the central coast of Brazil, has also increased. For instance, recent studies were conducted in islands (Floeter *et al.* 2007, Pinheiro *et al.* 2015a), tidepools (Macieira & Joyeux 2011, Pimentel *et al.* 2018), estuaries and mangroves (Chagas *et al.* 2006, Joyeux *et al.* 2004, Pimentel & Joyeux 2010), seamounts (Guabiroba *et al.* 2020, Pinheiro *et al.* 2015b), and on mesophotic coral ecosystems (Simon *et al.* 2016). However, many areas are still under-investigated, like the shore of the city of Vitória, capital of the Espírito Santo state, where ichthyofaunal studies remain scarce (Helmer & Perrone 1991).

The regional and local-scale biodiversity knowledge represents a starting point to more complex studies in ecology and conservation (Agardy 2000, Floeter *et al.* 2006). For instance, the understanding of species richness levels and species distribution along the Brazilian coast has allowed researchers to model priority areas for Marine Protected Areas (MPAs) (Magris *et al.* 2020, Vilar *et al.* 2017). MPAs are key tools for marine ecosystems protection (Magris *et al.* 2013, McLeod *et al.* 2009), especially when they present no-take zones (Edgar *et al.* 2014).

Established in 2018, the Environmental Protected Area (APA) Baía das Tartarugas, an MPA ranked as IUCN category VI, is located in Vitória, Espírito Santo. Despite Espírito Santo having one of the richest reef fish assemblages of the Brazilian Province (Pinheiro *et al.* 2018), there is still a lack of knowledge about the fish diversity in the APA Baía das Tartarugas. Thus, to improve the comprehension about the fish biodiversity of this area, this study provides the first checklist of fish species of the Baía das Tartarugas and surroundings, exploring aspects of fish trophic composition, geographic range, habitat occupation, conservation status, and main threats in the region. Considering the early stages of the MPA and the absence of a management plan, this research aims to contribute with data and recommendations toward the conservation and sustainability of Baía das Tartarugas' region.

Materials and Methods

Study area: The study area is located in the state of Espírito Santo, southeastern Brazil, encompassing the MPA APA Baía das Tartarugas and adjacent environments (Fig. 1). This category of Nature Conservation Unit (UC) is considered of Sustainable Use by the National System of Nature Conservation Units (NSNCU) of Brazil, aiming the compatibility of the nature conservation and the sustainable use of its resources, regulating the occupation process and protecting the biological diversity. The Environmental Protected Area (APA) has biotic and abiotic factors, as well as cultural and aesthetic values, that are key for human welfare (Brasil 2004). The APA Baía das Tartarugas, in Vitória city, was created by the municipal decree No. 17.342 in 2018, and includes 1685.47 hectares. Also, it prohibits any type of alteration that could either compromise the environment and the local biota or that are not allowed by the management plan, which is still under development (PMV 2018).

The area is situated in the central coast of Espírito Santo (Fig. 1), which features a transitional zone, with tropical influence northwards and subtropical waters southwards. For instance, the state represents the boundary between coral reef ecosystems, which predominate to the north, and rocky reefs ecosystems, most found to the south (Floeter *et al.* 2001). Thus, the state hosts one of the most diverse marine fish fauna of Brazil (Pinheiro *et al.* 2018).

The study area, represented by the MPA APA Baía das Tartarugas and its adjacent area, harbors a diversity of habitats and ecosystems (Figs. 1 and 2). The northern edge of the MPA is characterized by beaches and subtidal zones with patches of laterite substrate, which form tidepools and rocky reefs habitats (Figs. 1 and 2). Inside and southern to the MPA, there are sandy beaches, soft bottoms habitats, and many islands and islets, that compose a range of rocky ecosystems, with reefs and tide pools (Figs. 1 and 2). Entering to the inner portions of the bay, western to the MPA's border, there is an estuarine area fed by tributary rivers, flowing to the sea through a main channel (Figs. 1 and 2). Although the high diversity of habitats, the study area encompasses three highly urbanized cities: Serra, Vila Velha, and Vitória (Fig. 1), and consequently, presents environmental disturbances, such as sewage

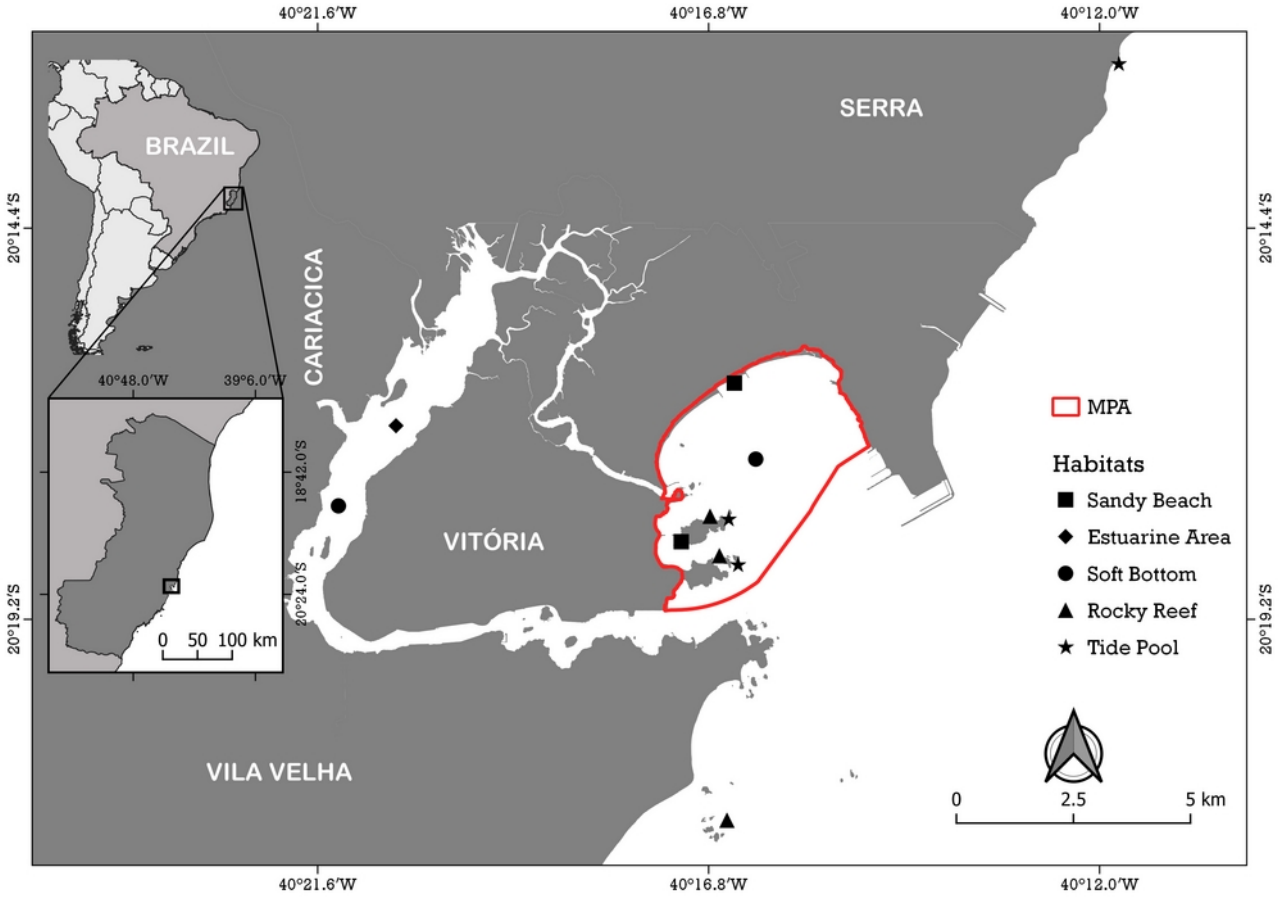

Figure 1. Map of the region of the APA Baía das Tartarugas. Symbols represent the sampling locations and the respective habitat. The red line are the limits of the APA.

Figure 2 (previous page). The variety of habitats found in the APA Baía das Tartarugas. (A) Rocky shore and reefs of the APA Baía das Tartarugas. (B) Intertidal zones with the presence of tide pools. (C) Mangrove and estuarine area. (D) Landscape of Baía das Tartarugas, with rocky shores, soft bottoms and sandy beaches.

discharge, habitat loss, and dredging. Moreover, as most coastal localities in Brazil, fishing is a socially and economically important activity, but also one of the main threats for the local fish biodiversity.

Database: The fish biodiversity database results from an extensive compilation of 1) literature (scientific articles, short communications in conferences, and monographs; Supplementary material Table S1), 2) records from scientific collections, photos and videos of the region, and 3) authors' personal observations. Fish family names follow Fricke, R., Eschmeyer, W. N. & Fong, J. D. (2021) and are presented in phylogenetic order. Species names follow Eschmeyer and Fong (2015), and are presented in alphabetical order within the families. Considering recent taxonomic revisions, Epinephelidae is presented apart from Serranidae, and Scarinae is allocated within Labridae (Westneat & Alfaro 2005, Craig *et al.* 2011). Species traits (depth category, conservation status, geographic range, mobility type, size category, spawning mode, trophic guild, and use of brackish waters) were compiled from the literature (Fishbase 2021, Ferreira *et al.* 2004, IUCN 2021, ICMBio/MMA 2018. Pinheiro *et al.* 2018, Quimbayo *et al.* 2021) (Supplementary material Table S2).

The following information (modified from Luiz *et al*. 2008 and Pinheiro *et al*. 2015) is presented in the Table I:

Trophic guild: obtained from the literature (Fishbase 2021, Ferreira *et al*. 2004), where: CAR = Carnivores (eat a variety of mobile organisms, including invertebrates and fishes), MIF = Mobile invertebrate feeders (feed primarily on small benthic mobile invertebrates like mollusks, crustaceans, worms, etc. associated to the hard- or nearby soft-substrate), OMN = Omnivores (feed on variety of organisms, including animal and vegetal), PIS = Piscivores (feed only or mostly on live fishes), PLK = Planktivores (feed primarily on macro- and micro-zooplankton), ROVH = Roving herbivores (non-territorial, large herbivores which includes in their diet a rich mass of detritus, turf algae and macroalgae), SIF = Sessile invertebrate feeders (feeds on an array of sessile benthic invertebrates like cnidarians, bryozoans, ascidians and sponges that are most associated to hard substrata), and TERH = Territorial herbivores (with a diet composed mainly by turf algae farmed within a vigorously defended territory).

Threat: species registered in fishing activities or in red lists of endangered species, where: PF = species caught by professional fishing activities; RF = species caught by recreational fishing activities; EN = species considered endangered (at risk of extinction, present in the Brazilian list of endangered species; MMA 2014); RO = species considered at risk of over-exploitation (present in the Brazilian list of over-exploited species; IBAMA 2003a, 2003b); IU = species evaluated and considered threatened by the IUCN red list (Critically Endangered, Endangered or Vulnerable); DD = data deficient by IUCN evaluation; DDB = data deficient by the Brazilian evaluation; NR= species not at risk (those not considered to be threatened by red lists and weren't caught by any fishing activity).

Habitats: the place where the species was collected or sighted. The figure 1 highlights where these places are, and specify which habitat they are. BEA = Sandy beaches (sand and gravel composing the substrate), EST = Estuarine area (unconsolidated substrate and brackish water), RR = Rocky reefs (rocky substrate around islands and reefs; due high faunal similarity between inshore and offshore reefs, they were considered a single habitat in the analyses), SB = Soft bottom (substrate composed primarily by mud, sand and bioclastic material), TP = Tide pools (pools formed around islands and rocky shores, influenced by tide regimes). Additionally, species were grouped as habitat specialists (occurring in one habitat), intermediate generalists (two habitats), and generalists (three to five habitats) (Supplementary material Table S2).

Geographic range: Br = Brazilian endemic, CT = circumtropical, SWA = Southwestern Atlantic, TA = Trans-Atlantic, WA = Western Atlantic, and EP = Eastern Pacific.

Record type: how the species was recorded by the authors, where: COL = Collected, MUS = Museum voucher, LIT = Literature, PHO = Photograph, and SIG = Sighting. A list of the voucher ID of specimens deposited in museum collections is provided in the Supplementary material Table S2.

Statistical analysis: A cluster analysis (complete linkage method) of the five habitats was performed

Table I. List of fish species of the APA Baía das Tartarugas and surroundings. Trophic guild (CAR, carnivores; MIF, mobile invertebrate feeders; OMN, omnivores; PIS, piscivores; PLK, planktivores; ROVH, roving herbivores; SIF, sessile invertebrate feeders; TERH, territorial herbivores. Threat (DDB, data deficient by ICMBio evaluations; DD, data deficient by IUCN evaluation; EN, Brazilian red list 2018; IU, IUCN red list; NR, not at risk; PF, professional fishing; RF, recreational fishing). Habitat (BEA, sandy beaches; EST, estuarine zone; RR, rocky reefs; SB, soft bottom; TP, tide pools). Geographic range (Br, Brazilian endemic; CT, circumtropical; SWA, Southwestern Atlantic; TA, Trans-Atlantic; WA, Western Atlantic; EP, Eastern Pacific. Record type (COL, Collected; LIT, Literature; MUS, Museum voucher; PHO, Photograph; SIG, Sighting).

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
CARCHARHINIDAE					
Rhizoprionodon porosus (Poeyi, 1861)	CAR	DDB	BEA	WA	MUS
NARCINIDAE					
Narcine brasiliensis (Olfers, 1831)	CAR	DDB, PF	RR, SB	WA	MUS
RHINOBATIDAE					
Pseudobatos percellens (Walbaum, 1792)	MIF	DDB, PF	SB	TA	LIT
Zapteryx brevirostris (Muller & Henle, 1841)	MIF	EN, IU, PF	BEA	WA	COL, MUS
RAJIDAE					
Rioraja agassizii (Müller & Henle, 1841)	CAR	NR	SB	SWA	LIT
DASYATIDAE					
Hypanus guttatus (Bloch & Schneider, 1801)	MIF	PF, RF	RR	WA	LIT
MYLIOBATIDAE					
Aetobatus narinari (Euphrasen, 1790)	CAR	DDB, PF	BEA, RR	CT	COL, LIT, MUS
RHINOPTERIDAE					
Rhinoptera bonasus (Mitchill, 1815)	MIF	PF	SB	WA	PHO, SIG
MOBULIDAE					
Mobula hypostoma (Bancroft, 1831)	PLK	EN, IU	RR, SB	TA	MUS
ELOPIDAE					
Elops smithi McBride, Rocha, Ruiz-Carus & Bo wen 2010	CAR	PF, RF	BEA, SB	WA	MUS
ALBULIDAE					
Albula vulpes (Linnaeus, 1758)	MIF	RF	BEA, EST, RR, SB	CT	LIT, MUS
MURAENIDAE					
Gymnothorax funebris Ranzani, 1840	CAR	DDB, RF	EST, RR, SB, TP	WA	MUS
Gymnothorax moringa (Cuvier, 1829)	CAR	DDB, RF	RR, TP	TA	LIT
Gymnothorax ocellatus Agassiz, 1831	CAR	DDB, PF	EST, SB	WA	COL, MUS
Gymnothorax vicinus (Casteiau, 1855)	CAR	DDB, RF	RR, TP	TA	LIT
OPHICHTHIDAE					
Ahlia egmontis (Jordan, 1884)	MIF	NR	RR, TP	WA	LIT, MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Echiophis intertinctus (Richardson, 1848)	MIF	NR	RR	WA	SIG
Myrichthys breviceps (Richardson, 1848)	MIF	NR	RR	WA	LIT
Myrichthys ocellatus (Lesueur, 1825)	MIF	NR	RR, TP	WA	COL, LIT, MUS
Myrophis punctatus Lütken, 1852	MIF	NR	BEA, EST, SB	WA	MUS
Ophichthus gomesii (Castelau, 1855)	MIF	PF	RR	WA	LIT
Ophichthus cylindroideus (Ranzani 1839)	MIF	NR	RR	WA	SIG
Ophichthus ophis (Linnaeus, 1758)	MIF	RF	BEA, RR	TA	LIT, MUS
MURAENOSOCIDAE					
Cynoponticus savanna Bancroft, 1831	CAR	NR	SB	WA	MUS
CONGRIDAE					
Ariosoma opisthophthalma (Ranzani,1840)	CAR	NR	BEA	Br	MUS
Conger triporiceps Kanazawa, 1958	CAR	DDB	TP	WA	LIT
CLUPEIDAE					
Brevoortia pectinata (Jenyns, 1842)	PLK	NR	BEA	SWA	LIT
Harengula clupeola (Cuvier, 1829)	PLK	PF	BEA, RR	WA	MUS
Harengula jaguana Poey, 1865	PLK	NR	TP	WA	LIT
Lile piquitinga (Schreiner & Miranda-Ribeiro, 1903)	PLK	NR	BEA, EST, RR, SB	WA	COL, MUS
Opisthonema oglinum (Lesueur, 1818)	PLK	NR	SB	WA	MUS
Sardinella brasiliensis (Steindachner, 1789)	PLK	DDB, PF, RO	BEA, RR, SB	WA	MUS
ENGRAULIDAE					
Anchoa filifera (Fowler, 1915)	PLK	PF	BEA	WA	MUS
Anchoa januraria (Valenciennes, 1848)	PLK	NR	BEA	WA	LIT
Anchoa lyolepis (Evermann & Marsh, 1902)	PLK	NR	BEA, RR, SB	WA	MUS
Anchoa marinii Hildebrande, 1943	PLK	NR	RR	WA	LIT
Anchoa spinifera (Valenciennes, 1848)	PLK	PF	BEA, SB	EP + WA	MUS
Anchoa tricolor (Agassiz, 1829)	PLK	PF	BEA, SB	SWA	MUS
Anchovia clupeoides (Swainson, 1839)	PLK	NR	BEA, EST, RR, SB	WA	MUS
Anchoviella brevirostris (Günther, 1868)	PLK	NR	BEA	SWA	MUS
Anchoviella cayennensis (Cuvier, 1828)	PLK	NR	BEA	WA	LIT
Anchoviella lepidentostole (Fowler, 1911)	PLK	PF	BEA, EST, SB	WA	MUS
Cetengraulis edentulus (Cuvier, 1829)	PLK	PF	BEA, EST, RR, SB	WA	MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Lycengraulis grossidens (Agassiz, 1829)	CAR	PF	BEA, RR	WA	MUS
PRISTIGASTERIDAE					
Chirocentrodon bleekerianus (Poey, 1867)	OMN	PF	BEA, EST, SB	WA	MUS
Odontognathus mucronatus Lacépède, 1800	PLK	PF	SB	SWA	MUS
Pellona harroweri (Fowler, 1917)	MIF	PF	RR, SB	WA	MUS
ARIIDAE					
Genidens genidens (Cuvier 1829)	CAR	NR	SB	SWA	SIG
Notarius grandicassis (Valenciennes,1840)	CAR	PF	SB	SWA	LIT
CLHOROPHTHALMIDAE					
Chlorophthalmus agassizi Bonaparte, 1840	MIF	NR	SB	CT	LIT
SYNODONTIDAE					
Saurida brasiliensis Norman, 1935	PIS	NR	SB	WA	COL, MUS
Synodus foetens (Linnaeus, 1766)	CAR	NR	BEA, EST, RR, SB	WA	MUS
HOLOCENTRIDAE					
Holocentrus adscencionis (Osbeck, 1765)	MIF	RF	RR, TP	TA	COL, LIT, MUS
OPHIDIIDAE					
Ophidion holbrookii Putnam, 1874	MIF	EN	SB	WA	MUS
Raneya brasiliensis (Kaup, 1856)	MIF	NR	SB	WA	MUS
BATRACHOIDIDAE					
Porichthys porosissimus (Valenciennes, 1837)	CAR	NR	SB	SWA	LIT
STROMATEIDAE					
Peprilus xanthurus (Quoy & Gaimard, 1825)	CAR	PF	BEA	WA	MUS
POMATOMIDAE					
Pomatomus saltatrix (Linnaeus, 1766)	CAR	PF, RF, RO	BEA, RR	CT	LIT
TRICHIURIDAE					
Trichiurus lepturus Linnaeus, 1758	CAR	PF	BEA, EST, SB	CT	COL, MUS
FISTULARIDAE					
Fistularia petimba Lacépède, 1803	CAR	NR	BEA, RR	CT	MUS
Fistularia tabacaria Linneaus, 1758	PIS	NR	BEA, RR	TA	LIT
SYNGNATHIDAE					
Bryx dunckeri (Metzelaar, 1919)	MIF	NR	BEA	WA	MUS
Hippocampus erectus (Perry, 1810)	MIF	EN, IU	BEA	WA	MUS
Hippocampus reidi Ginsburg, 1933	MIF	EN	BEA, EST, RR, SB	WA	MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Micrognathus crinitus (Jenyns, 1842)	MIF	NR	RR, TP	WA	COL, MUS
Microphis cf. *lineatus* (Kaup, 1856)	MIF	NR	BEA, TP	WA	LIT, MUS
Syngnathus scovelli (Evermann & Kendall, 1896)	MIF	NR	BEA	WA	COL, MUS
Syngnathus pelagicus Linnaeus, 1758	PLK	PF	RR, SB	WA	MUS
DACTYLOPTERIDAE					
Dactylopterus volitans (Linnaeus, 1758)	MIF	PF, RF	BEA, EST, RR, SB	TA	MUS
ELEOTRIDAE					
Eleotris pisonis (Gmelin, 1789)	CAR	NR	BEA, EST	SWA	COL, MUS
Guavina guavina (Valenciennes, 1837)	CAR	NR	BEA, EST	WA	MUS
GOBIIDAE					
Awaous tajasica (Lichtenstein, 1822)	OMN	NR	BEA	SWA	COL, MUS
Bathygobius geminatus (Tornabene, Baldwin & Pezold, 2010)	CAR	NR	RR, TP	WA	COL, MUS
Bathygobius soporator (Valenciennes, 1837)	CAR	NR	BEA, EST, RR, SB, TP	TA	COL, MUS
Coryphopterus glaucofraenum Gill, 1863	MIF	NR	RR	WA	COL, LIT, MUS
Ctenogobius boleosoma (Jordan & Gilbert, 1882)	MIF	NR	BEA, EST, RR, TP	WA	COL, MUS
Ctenogobius smaragdus (Valenciennes, 1837)	MIF	NR	EST, SB, TP	WA	COL, MUS
Ctenogobius stigmaticus (Poey, 1860)	MIF	NR	EST, SB	WA	LIT
Evorthodus lyricus (Girard, 1858)	OMN	NR	EST, SB	WA	MUS
Gobionellus oceanicus (Pallas, 1770)	CAR	NR	EST, SB	WA	MUS
Gobionellus stomatus Starks, 1913	MIF	NR	EST, SB	Br	MUS
Gobiosoma alfiei Joyeux & Macieira 2015	MIF	NR	RR, TP	Br	MUS
Lythrypnus brasiliensis (Greenfield, 1988)	MIF	NR	TP	Br	MUS
Lythrypnus nesiotes Böhlke & Robins, 1960	MIF	NR	TP	WA	MUS
Microgobius meeki Evermann & Marsh, 1899	MIF	NR	EST, SB	WA	MUS
MICRODESMIDAE					
Microdesmus bahianus Dawson, 1973	MIF	NR	TP	WA	LIT
CENTROPOMIDAE					
Centropomus parallelus Poey, 1860	CAR	NR	EST, SB	WA	LIT, MUS
Centropomus undecimalis (Bloch, 1792)	CAR	PF, RF	BEA, EST, SB	WA	LIT, MUS
SPHYRAENIDAE					
Sphyraena barracuda (Edwards, 1771)	PIS	NR	SB	CT	LIT

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Sphyraena guachancho Cuvier, 1829	PIS	PF	SB	SWA	LIT
POLYNEMIDAE					
Polydactylus oligodon (Gunther, 1860)	OMN	PF, RF	BEA	WA	MUS
Polydactylus virginicus (Linnaeus, 1758)	OMN	PF, RF	BEA, RR, SB	WA	COL, MUS
CARANGIDAE					
Carangoides bartholomaei Cuvier, 1833	PIS	PF, RF	BEA, RR, TP	WA	LIT
Carangoides crysos (Mitchill, 1815)	PIS	PF, RF	RR, SB	TA	MUS
Caranx hippos (Linnaeus, 1766)	PIS	PF, RF	BEA, RR	TA	LIT, MUS
Caranx latus Agassiz, 1831	PIS	PF, RF	BEA, EST, RR, SB	TA	LIT, MUS
Chloroscombrus chrysurus (Linnaeus, 1776)	PLK	PF, RF	BEA, EST, RR, SB	TA	COL, MUS
Oligoplites palometa (Cuvier, 1833)	CAR	PF	BEA	WA	LIT
Oligoplites saliens (Bloch, 1793)	CAR	PF, RF	BEA, RR	WA	LIT, MUS
Oligoplites saurus (Bloch & Schnerider, 1801)	CAR	PF	BEA	EP + WA	MUS
Selar crumenophthalmus (Bloch, 1793)	PLK	NR	RR	CT	LIT
Selene brownii (Cuvier 1816)	CAR	PF	SB	WA	MUS
Selene setapinnis (Mitchill, 1815)	CAR	PF	BEA, SB	WA	COL, LIT, MUS
Selene vomer (Linnaeus, 1758)	CAR	PF, RF	BEA, EST, RR, SB	WA	MUS
Trachinotus carolinus (Linnaeus, 1766)	MIF	PF, RF	BEA, RR	WA	COL, MUS
Trachinotus falcatus (Linnaeus, 1758)	MIF	PF, RF	BEA, RR	WA	COL, MUS
Trachinotus goodei (Jordan & Evermann, 1896)	MIF	PF, RF	BEA, RR	WA	MUS
Trachurus lathami Nichols, 1920	MIF	NR	BEA	WA	LIT
RACHYCENTRIDAE					
Rachycentron canadum (Linnaeus, 1766)	CAR	NR	BEA	CT	MUS
BOTHIDAE					
Bothus lunatus (Linnaeus, 1758)	MIF	NR	BEA	TA	LIT
Bothus ocellatus (Agassiz, 1831)	MIF	PF	SB	WA	MUS
PARALICHTHYDAE					
Citharichthys arenaceus Evermann & Marsh, 1900	MIF	NR	BEA, EST, SB	WA	COL, MUS
Citharichthys macrops Dresel, 1885	MIF	PF	BEA, EST, SB	WA	MUS
Citharichthys spilopterus Gunther, 1862	MIF	PF	BEA, EST, SB	WA	MUS
Etropus crossotus Jordan & Gilbert, 1882	MIF	NR	BEA, EST, SB	EP + WA	COL, MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Etropus longimanus Norman, 1933	MIF	NR	EST, SB	SWA	COL, MUS
Paralichthys brasiliensis (Ranzani, 1842)	MIF	RF	BEA, EST, SB	SWA	MUS
Paralichthys cf. *orbignyanus* (Valenciennes, 1839)	MIF	DDB	SB	SWA	MUS
Syacium micrurum Ranzani, 1842	MIF	PF	BEA, SB	WA	MUS
Syacium papillosum (Linnaeus, 1758)	MIF	PF	SB	TA	MUS
ACHIRIDAE					
Achirus declivis Chabanaud, 1940	CAR	PF	EST, SB	WA	MUS
Achirus lineatus Linnaeus, 1758	CAR	PF	EST, SB	WA	MUS
Catathyridium garmani (Jordan, 1889)	OMN	NR	EST, SB	SWA	LIT, MUS
Trinectes microphthalmus (Chabanaud, 1928)	MIF	NR	BEA, EST, SB	SWA	LIT, MUS
Trinectes paulistanus (Miranda-Ribeiro, 1915)	MIF	NR	BEA, EST, SB	WA	LIT, MUS
CYNOGLOSSIDAE					
Symphurus diomedianus (Goode & Bean, 1885)	MIF	PF	EST, SB	WA	MUS
Symphurus jenynsi Evermann & Kendall, 1906	MIF	NR	SB	SWA	LIT
Symphurus tessellatus (Quoy & Gaimard, 1824)	MIF	PF	EST, SB	WA	MUS
Symphurus plagusia (Bloch & Schneider, 1801)	MIF	PF	BEA, SB	WA	COL, MUS
ATHERINOPSIDAE					
Atherinella brasiliensis (Quoy & Gaimard, 1825)	OMN	NR	BEA, RR, TP	SWA	COL, MUS
Odontesthes bonariensis (Valenciennes, 1835)	PLK	NR	BEA	SWA	MUS
BELONIDAE					
Strongylura timucu (Walbaum, 1792)	PIS	NR	BEA, RR, TP	WA	LIT
Tylosurus acus (Lacépède, 1803)	PIS	PF	BEA, RR	CT	MUS
HEMIRAMPHIDAE					
Hemiramphus brasiliensis (Linnaeus, 1758)	OMN	PF	BEA, RR	TA	MUS
Hyporhamphus roberti (Valenciennes, 1847)	PIS	NR	BEA, RR	EP + WA	LIT
Hyporhamphus unifasciatus (Ranzani, 1842)	OMN	NR	BEA, RR	WA	LIT, MUS
MUGILIDAE					
Mugil curema Valenciennes, 1836	ROVH	DDB, PF	BEA, EST, RR, SB, TP	CT	MUS
Mugil gaimardianus Desmarest, 1831	ROVH	PF	BEA	WA	MUS
Mugil liza Valenciennes, 1836	ROVH	PF, RF, RO	EST, SB	WA	MUS
GOBIESOCIDAE					
Acyrtops beryllinus (Hildebrand & Gisburg, 1927)	MIF	NR	BEA, RR, TP	WA	LIT, MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Gobiesox barbatulus Starks, 1913	MIF	NR	BEA	WA	COL, MUS
Tomicodon australis (Briggs, 1955)	MIF	NR	RR, TP	Br	COL, LIT, MUS
LABRISOMIDAE					
Gobioclinus kalisherae (Jordan, 1904)	MIF	NR	RR	WA	LIT
Labrisomus cricota (Sazima, Gasparini & Moura, 2002)	MIF	NR	RR, TP	Br	MUS
Labrisomus nuchipinnis (Quoy & Gaimard, 1824)	MIF	RF	BEA, RR, TP	TA	COL, LIT, MUS
Malacoctenus delalandii (Valenciennes, 1836)	MIF	NR	BEA, RR, TP	WA	COL, LIT, MUS
Malacoctenus zaluari Carvalho-Filho, Gasparini & Sazima 2020	MIF	NR	RR, TP	Br	COL, LIT, MUS
Paraclinus arcanus (Guimarães & Bacellar, 2002)	MIF	NR	RR, TP	Br	MUS
Paraclinus fasciatus (Steindachner, 1876)	MIF	NR	RR	WA	LIT
Paraclinus rubicundus (Starks, 1913)	MIF	NR	TP	Br	MUS
Starksia brasiliensis (Gilbert, 1900)	MIF	NR	RR, TP	Br	MUS
DACTYLOSCOPIDAE					
Dactyloscopus tridigitatus (Gill, 1859)	MIF	NR	TP	WA	MUS
Gillellus greyae Kanazawa, 1952	MIF	NR	TP	WA	LIT, MUS
BLENNIIDAE					
Lupinoblennius paivai (Pinto, 1958)	MIF	NR	EST	Br	MUS
Parablennius pilicornis (Cuvier, 1829)	OMN	NR	RR, TP	TA	COL, MUS
Parablennius marmoreus (Poey 1876)	OMN	NR	RR, TP	WA	SIG
Scartella cristata (Linnaeus, 1758)	ROVH	NR	RR, TP	CT	MUS
LOBOTIDAE					
Lobotes surinamensis (Bloch, 1790)	CAR	NR	SB	CT	COL, MUS
POMACANTHIDAE					
Holacanthus ciliaris (Linneaus, 1758)	SIF	DDB	RR	WA	LIT, MUS
Pomacanthus arcuatus (Linnaeus, 1758)	SIF	NR	RR	WA	COL, MUS
Pomacanthus paru (Bloch, 1787)	SIF	DDB, RF	RR, TP	WA	LIT, MUS
CHAETODONTIDAE					
Chaetodon sedentarius Poey, 1860	SIF	NR	RR	WA	LIT
Chaetodon striatus Linnaeus, 1758	SIF	NR	EST, RR, SB, TP	WA	COL, MUS
EPHIPPIDAE					
Chaetodipterus faber (Broussonet, 1782)	CAR	PF, RF	BEA, EST, RR, SB	WA	MUS
ACANTHURIDAE					
Acanthurus bahianus Castelnau, 1855	ROVH	PF, RF	RR, TP	WA	COL, MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Acanthurus chirurgus (Bloch, 1787)	ROVH	PF, RF	BEA, RR, TP	TA	COL, LIT, MUS
Acanthurus coeruleus Bloch & Schneider, 1801	ROVH	RF	RR, TP	WA	LIT
ANTENNARIDAE					
Antennarius striatus (Shaw, 1794)	CAR	NR	RR, SB	CT	LIT
OGCOCEPHALIDAE					
Ogcocephalus notatus (Valenciennes, 1837)	MIF	NR	RR	WA	LIT
Ogcocephalus vespertilio (Linnaeus, 1758)	MIF	PF	EST, RR, SB	WA	MUS
DIODONTIDAE					
Chilomycterus antillarum Jordan & Rutter, 1897	SIF	NR	BEA, RR	WA	MUS
Chilomycterus spinosus (Linnaeus, 1758)	SIF	PF, RF	BEA, EST, SB	WA	MUS
Diodon hystrix Linnaeus, 1758	SIF	NR	BEA	CT	MUS
TETRAODONTIDAE					
Canthigaster figueiredoi Moura & Castro, 2002	OMN	NR	RR	WA	LIT
Lagocephalus laevigatus (Linnaeus, 1758)	CAR	PF, RF	BEA, EST, RR, SB	TA	MUS
Sphoeroides greeleyi (Gilbert, 1900)	MIF	PF	BEA, EST, RR, SB, TP	WA	COL, MUS
Sphoeroides spengleri (Bloch, 1785)	MIF	RF	BEA, EST, RR, SB, TP	WA	MUS
Sphoeroides testudineus (Linnaeus, 1758)	MIF	DDB, PF	EST, SB	WA	COL, MUS
OSTRACIIDAE					
Acanthostracion polygonius (Poey, 1876)	OMN	NR	BEA, EST, SB	WA	LIT
Acanthostracion quadricornis (Linnaeus, 1758)	OMN	PF	BEA, EST, SB	WA	LIT
MONACANTHIDAE					
Aluterus monoceros (Linnaeus, 1758)	OMN	NR	BEA	CT	LIT, SIG
Cantherhines pullus (Ranzani, 1842)	OMN	NR	RR	TA	LIT
Monacanthus ciliatus (Mitchill, 1818)	OMN	NR	BEA	TA	LIT, MUS
Stephanolepis hispidus (Linnaeus, 1766)	OMN	PF	RR, SB	TA	MUS
BALISTIDAE					
Balistes vetula Linnaeus, 1758	MIF	PF, RF	RR	TA	LIT
KYPHOSIDAE					
Kyphosus sectratrix (Linneaus, 1765)	ROVH	PF, RF	BEA, RR, TP	CT	LIT
PEMPHERIDAE					
Pempheris schomburgkii (Müller &. Troschel, 1848)	PLK	NR	RR	WA	COL, MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
SERRANIDAE					
Alphestes alfer (Bloch, 1793)	CAR	NR	BEA, SB	WA	MUS
Diplectrum formosum (Linnaeus, 1766)	CAR	PF, RF	SB	WA	MUS
Diplectrum radiale (Quoy & Gaimard, 1824)	CAR	NR	EST, SB	WA	COL, MUS
EPINEPHELIDAE					
Cephalopholis fulva (Linnaeus, 1758)*	CAR	PF	BEA	WA	LIT
Epinephelus itajara (Osbeck, 1771)	CAR	EN, IU, PF, RF	EST, RR	TA	LIT, MUS
Hyporthodus niveatus (Valenciennes, 1828)	CAR	IU	SB	WA	LIT
Mycteroperca acutirostris (Valenciennes, 1828)	PIS	PF	RR	WA	MUS
Mycteroperca bonaci (Poey, 1860)	PIS	EN, PF, RF	BEA, EST, RR, SB	WA	MUS
Mycteroperca interstitialis (Poey, 1860)	PIS	NR	RR	WA	LIT
Rypticus randalli (Courtenay, 1967)	CAR	NR	SB	WA	MUS
Rypticus subbifrenatus Gill, 1861	CAR	NR	TP	TA	LIT
GRAMMATIDAE					
Gramma brasiliensis Sazima, Gasparini & Moura, 1998*	PLK	PF	RR	Br	LIT
APOGONIDAE					
Apogon americanus Castelnau, 1855	PLK	NR	TP	Br	MUS
Apogon pseudomaculatus Longley, 1932	PLK	NR	TP	TA	MUS
Astrapogon puncticulatus (Poey, 1867)	PLK	NR	RR	WA	COL, MUS
Phaeoptyx pigmentaria (Poey, 1860)	PLK	NR	RR, TP	TA	COL, MUS
LUTJANIDAE					
Lutjanus analis (Cuvier, 1828)	CAR	PF, RF, RO	BEA, EST, RR, SB	WA	MUS
Lutjanus cyanopterus (Cuvier, 1828)	CAR	EN, IU, PF	BEA	WA	LIT
Lutjanus jocu (Bloch & Schneider, 1801)	CAR	PF, RF	BEA, EST, RR, SB, TP	WA	COL, MUS
Lutjanus synagris (Linnaeus, 1758)	CAR	PF, RF	BEA, EST, RR, SB	WA	COL, MUS
Ocyurus chrysurus (Bloch, 1791)	CAR	PF, RO	BEA, RR	WA	MUS
GERREIDAE					
Diapterus auratus Ranzani, 1840	MIF	PF	EST, SB	WA	COL, MUS
Diapterus rhombeus (Cuvier, 1829)	MIF	NR	BEA, EST, SB	WA	COL, MUS
Eucinostomus argenteus Baird & Girard, 1855	MIF	PF	BEA,	EP + WA	MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Eucinostomus gula (Cuvier,1830)	MIF	NR	EST, RR, SB BEA, EST, RR, SB	WA	MUS
Eucinostomus lefroyi (Cuvier, 1830)	MIF	PF	BEA, EST, RR, SB	WA	LIT
Eugerres brasilianus (Bleeker, 1863)	MIF	RF	SB	WA	LIT
HAEMULIDAE					
Anisotremus surinamensis (Bloch, 1791)	MIF	DDB, RF	RR	WA	MUS
Anisotremus virginicus (Linnaeus, 1758)	MIF	PF, RF	TP	WA	MUS
Boridia grossidens Cuvier, 1830	MIF	RF	SB	SWA	COL, MUS
Conodon nobilis (Linnaeus, 1758)	CAR	PF, RF	BEA, RR, SB	WA	COL, MUS
Genyatremus luteus (Bloch 1790)	MIF	NR	EST, SB	WA	PHO, SIG
Haemulon aurolineatum (Lienneaus, 1758)	MIF	PF	BEA, RR	WA	COL, LIT, MUS
Haemulon parra (Desmarest, 1823)	MIF	PF, RF	BEA	WA	MUS
Haemulon plumieri (Lacépède, 1802)	MIF	DDB, PF, RF	RR, TP	WA	COL, LIT, MUS
Haemulon atlanticus Carvalho, Marceniuk, Oliveira & Wosiacki, 2020	MIF	PF, RF	BEA, RR, TP	WA	COL, MUS
Haemulopsis corvinaeformis Steindachener, 1830	OMN	NR	TP	WA	LIT
Orthopristis ruber (Cuvier, 1830)	MIF	PF, RF	BEA, EST, SB	WA	MUS
Orthopristis scapularis Fowler 1915	MIF	NR	BEA, EST, SB	WA	SIG
Paranisotremus moricandi (Ranzani, 1842)	MIF	RF	RR, SB, TP	WA	MUS
Pomadasys ramosus (Poey, 1860)	CAR	NR	BEA	WA	MUS
Ronchiscus crocro (Cuvier, 1830)	CAR	NR	BEA, EST, RR, SB	WA	MUS
SPARIDAE					
Archosargus probatocephalus (Walbaum, 1792)	MIF	DDB, RF	BEA, EST, RR, SB	WA	MUS
Archosargus rhomboidalis (Linnaeus, 1758)	OMN	PF, RF	BEA, EST, RR, SB	WA	MUS
Calamus penna (Valenciennes, 1830)	MIF	PF	BEA, SB	WA	MUS
Diplodus argenteus (Valenciennes, 1830)	OMN	PF, RF	RR	WA	COL, MUS
SCIAENIDAE					
Bairdiella goeldi Marceniuk, Molina, Caires, Rotundo, Wosiacki & Oliveira, 2019	CAR	NR	BEA, EST, SB	Br	MUS
Ctenosciaena gracilicirrhus (Metzelaar, 1919)	MIF	PF	SB	WA	MUS

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Cynoscion jamaicensis (Vaillant & Bocourt, 1883)	CAR	PF	SB	WA	MUS
Cynoscion leiarchus (Cuvier, 1830)	CAR	PF	EST, SB	WA	MUS
Cynoscion microlepidotus (Cuvier, 1830)	CAR	PF	EST, SB	WA	MUS
Cynoscion striatus (Cuvier, 1829)	CAR	PF	SB	SWA	LIT
Cynoscion virescens (Cuvier, 1830)	CAR	PF	SB	WA	MUS
Isopisthus parvipinnis (Cuvier, 1830)	MIF	PF	SB	WA	MUS
Larimus breviceps (Cuvier, 1830)	MIF	PF	BEA, EST, SB	WA	COL, MUS
Macrodon ancylodon (Bloch & Schneider, 1801)	CAR	PF, RO	SB	WA	MUS
Menticirrhus martinicensis (Cuvier, 1830)	MIF	DDB, PF, RF	BEA, RR, SB	WA	MUS
Menticirrhus cuiaranensis Marceniuk, Caires, Rotundo, Dantas Cerqueira, Siccha-Ramirez, Wosiacki & Oliveira, 2020	MIF	DDB, PF, RF	BEA, RR, SB	WA	COL, MUS
Micropogonias furnieri (Desmarest, 1823)	MIF	PF, RF, RO	BEA, EST, RR, SB	WA	MUS
Nebris microps Cuvier, 1830	MIF	PF	SB	WA	LIT
Odontoscion dentex (Cuvier, 1830)	CAR	NR	RR	WA	COL, MUS
Ophioscion punctatissimus Meek & Hildebrand, 1925	MIF	DDB	BEA, EST, SB	WA	MUS
Paralonchurus brasiliensis (Steindachner, 1875)		PF, RF	BEA, RR, SB	WA	LIT, MUS
Pareques acuminatus (Bloch & Schneider, 1801)	CAR	DDB	BEA, RR	WA	COL, LIT, MUS
Stellifer brasiliensis (Schultz, 1945)	MIF	PF	SB	SWA	MUS
Stellifer rastrifer (Jordan, 1889)	MIF	PF, RF	BEA, SB	WA	MUS
Stellifer stellifer (Bloch, 1790)	MIF	RF	BEA	WA	LIT, MUS
Stellifer naso (Jordan, 1889)	MIF	PF	SB	WA	LIT
Umbrina coroides Cuvier, 1830	MIF	PF, RF	BEA, RR	WA	MUS
MULLIDAE					
Pseudopneus maculatus (Bloch, 1793)	MIF	PF, RF	BEA, RR, SB, TP	WA	COL, MUS
Upeneus parvus (Poey, 1853)	MIF	NR	RR, SB	WA	COL, MUS
POMACENTRIDAE					
Abudefduf saxatilis (Linnaeus, 1758)	OMN	RF	RR, TP	CT	LIT, MUS
Azurina multilineata (Guichenot, 1853)	PLK	NR	RR	TA	LIT
Stegastes fuscus (Cuvier, 1830)	TERH	NR	RR	Br	LIT
Stegastes pictus (Castelnau, 1855)*	TERH	NR	RR	SWA	LIT
Stegastes variabilis (Castelau, 1855)	TERH	NR	RR, TP	WA	LIT, MUS
LABRIDAE					
Bodianus rufus (Linnaeus, 1758)	MIF	RF	RR	WA	LIT

Family and Species	Trophic guild	Threat	Habitat	Geographic range	Record type
Doratonotus megalepis Gunther, 1862	MIF	NR	RR, TP	TA	LIT
Halichoeres brasiliensis (Bloch, 1791)	MIF	DD	RR	Br	MUS
Halichoeres penrosei Starks, 1913	MIF	NR	RR, TP	Br	LIT
Halichoeres poeyi (Steindachner, 1867)	MIF	RF	BEA, RR, TP	Wa	COL, LIT, MUS
SACARINAE					
Cryptotomus roseus Cope, 1871*	ROVH	NR	RR	WA	LIT
Nicholsina usta (Valenciennes, 1839)	ROVH	NR	BEA, RR	WA	LIT, MUS
Scarus trispinosus (Valenciennes, 1840)**	ROVH	EN, IU, RF	RR	Br	MUS
Sparisoma amplum (Ranzani, 1841)	ROVH	PF	SB, TP	Br	MUS
Sparisoma axillare (Steindachner, 1878)	ROVH	EN, PF, RF, DD	EST, RR, SB, TP	Br	MUS
Sparisoma radians (Valenciennes, 1840)	ROVH	NR	RR	WA	LIT
URANOSCOPIDAE					
Astroscopus y-graecum (Cuvier, 1829)	CAR	NR	BEA, RR	WA	MUS
SCORPAENIDAE					
Scorpaena brasiliensis Cuvier, 1829	CAR	NR	EST, RR, SB	TA	MUS
Scorpaena plumieri Bloch, 1789	CAR	NR	BEA, EST, RR, SB, TP	WA	MUS
TRIGLIDAE					
Prionotus punctatus (Bloch, 1797)	MIF	PF	BEA, EST, RR, SB	WA	COL, MUS

*Registered only in the adjecent area of the APA Baía das Tartarugas
** Misidentified as S. guacamaia in Helmer & Perrone 1991

using a binary distance similarity matrix derived from the species presence/absence database to compare the similarity among the five habitats. Analyses were made with R version 4.0.2 (R Core Team, 2020) using the package "pvclust". Chi-squared tests were used to verify whether the relative richness of trophic guilds at each habitat differed from the overall assemblage. This analysis was also performed to compare the relative richness of both trophic guilds and habitat among the three categories of habitat occupation (specialists, intermediate generalists, and generalists). The influence of ecological and biological traits (independent variables) on the species composition of the five habitats (presence/absence data, dependent variable) was analyzed through generalized linear mixed models (GLMM). Thus, it was assumed a binomial distribution for the response variable (absence = 0 and presence = 1), and an appropriate logit link function for the predictor variables (Zuur *et al.* 2009). To consider the non-independence of species due phylogenetic relationships, the taxon (genus nested within family) was used as a random effect. Thus, we can generalize to the entire fauna other variables attributed to the overall 'fixed' effects, once the nested random variation is represented as taxon-level differences in families and genera around it (Pinheiro & Bates 2000). The backward stepwise procedure was adopted for model selection, in which the fixed-effect terms that weren't significant ($p > 0.05$) were sequentially removed from the full

model, until only significant variables remained (Zuur *et al.* 2009). This approach has been used in studies interested in fish biogeography (Luiz *et al.* 2012, 2015, Pinheiro *et al.* 2018). Analyses with GLMMs were fitted using the function 'glmer' in the package lme4 (Bates *et al.* 2015) of software R (R Core Team 2020).

Results

General Aspects: A total of 278 species belonging to 186 genera within 78 families was recorded in the APA Baía das Tartarugas (MPA) and adjacent areas (Table I). Among the 31 orders registered, Perciformes represents 33.1% of the total species, followed by Carangiformes (10.1%), Clupeiformes (7.6%), and Gobiiformes (6.1%) (Table I). The most species-rich family is Sciaenidae (23 species), followed by Carangidae with 16 species, and Haemulidae and Gobiidae with 14 species each. The richest genus is *Anchoa* (6 species), followed by *Cynoscion*, *Lutjanus*, *Stellifer*, *Gymnothorax*, *Eucinostomus*, *Symphurus*, and *Haemulon*, all having five species each (Table I).

Regarding the geographic distribution, most species are widely distributed, with 65.1% (181 species) occurring along the Western Atlantic (WA) (Table I). Transatlantic (TA) species represent 11.5% (32) of the total fish fauna, while Circumtropical (CT) fishes account for 6.5% (18) (Table I). The taxa found exclusively in the Southwestern Atlantic (SWA) sum 8.0% (23), and Brazilian endemic species (Br) constitute 7.2% (20) of the total species (Table I). The species found in Eastern Pacific and Western Atlantic (EP + WA) represents 1.4% (4) (Table I).

The trophic structure is composed predominantly of mobile invertebrate feeders (42.8%) and carnivores (25.9%), followed by planktivores (10.8%), omnivores (7.6%), roving herbivores (5.0%), piscivores (4.0%), sessile invertebrate feeders (2.9%) and territorial herbivores (1.1%) (Fig. 3A). According to the IUCN red list, eight species are classified as Vulnerable (VU) or Endangered (EN): *Epinephelus itajara* (VU), *Hippocampus erectus* (VU), *Hyporthodus niveatus* (VU), *Lupinoblennius paivai* (EN), *Lutjanus cyanopterus* (VU), *Mobula hypostoma* (EN), *Scarus trispinosus* (EN) and *Zapteryx brevisrostris* (VU) (Table I). Regarding the Brazilian red list (IBAMA 2014), eleven species are classified as Vulnerable (VU), Endangered (EN), or Critically Endangered (CR): *E. itajara* (CR), *Hippocampus erectus* (VU), *H. reidi* (VU), *L. cyanopterus* (VU), *M. hypostoma* (VU), *Mycteroperca bonaci* (VU), *Ophidion holbrooki* (CR), *S. trispinosus* (EN), *Sparisoma axillare* (VU) and *Z. brevirostris* (VU) (Table I). Among the species, 42% and 24% were registered respectively in professional and recreational fishing activities in the region, including six of the endangered species mentioned above (*E. itajara, L. cyanopterus, M. bonaci, S. trispinosus, S. axillare and Z. brevirostris*) (Table I).

Assemblage composition among habitats: Considering the fish assemblage composition among habitats, 145 (52.2%) species were recorded in rocky reefs, 33 species considered exclusives to this habitat; 139 (50%) species were recorded in soft bottom habitats, 35 exclusives; 134 (48.2%) were recorded in sandy beaches, being 29 exclusives; 82 (29.5%) species were recorded in estuarine habitats, 1 exclusive; 63 species (22.7%) occurred in tide pools, 13 exclusives (Fig. 3B). We also observed that inshore and offshore reefs (Fig. 1) are very similar, with only three species exclusively recorded in the latter (Table I). The cluster analysis shows a high similarity between rocky reefs and sandy beaches, as well as between estuarine habitats and soft bottom, while the tide pool formed a distinct group (Supplementary material Figure S1). The richest family in rocky reefs and in sandy beaches was Carangidae with 11 and 13 species respectively. Sciaenidae dominated the soft bottom habitats with 19 species, while Gobiidae is in greater numbers in estuarine habitats with 8 species. In the tide pools, Gobiidae and Labrisomidae were the richest families, both with 7 species.

Most species are habitat specialists (39.9%) in the study area, followed by intermediate generalists (32.4%) and generalists (27.7%). Specialist species present a distinct distribution pattern among habitats compared to intermediate generalists and generalists (Chi-squared Test, $p<0.05$) (Figs. 4A-4C). The overall trophic structure of the assemblage is not different from any habitat (Chi-squared Test, $p<0.05$) (Fig. 5), nor among groups of specialist and generalist fishes (Chi-squared Test, $p<0.05$) (Figs. 4D-4F).

Most important species traits characterizing species composition among habitats are mobility, depth range, brackish water occurrence, and trophic guild (Table II). Roving and sedentary mobility are positively related with estuarine area (Table II). Piscivorous and herbivorous fishes are positively related with rocky reefs, while the brackish water dependency is negatively related to rocky reefs

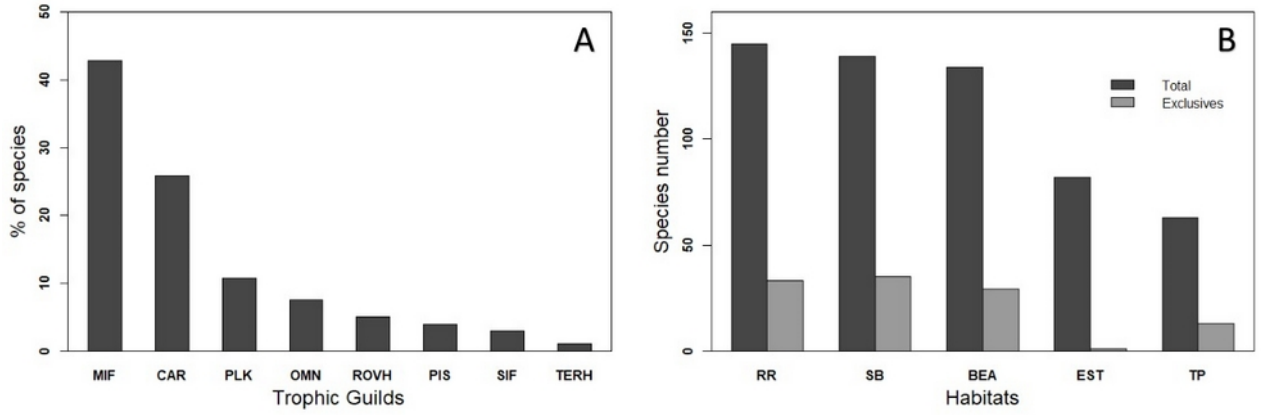

Figure 3. (A) Percentage contribution of each trophic guild to the overall species number. CAR, carnivores; MIF, mobile invertebrate feeders; OMN, omnivores; PIS, piscivores; PLK, planktivores; ROVH, roving herbivores; SIF, sessile invertebrate feeders; TERH, territorial herbivores. (B) Number of species in the habitats and the number of exclusive fishes in each habitat. BEA, sandy beaches; EST, estuarine zone; RR, rocky reefs; SB, soft bottom; TP, tide pools.

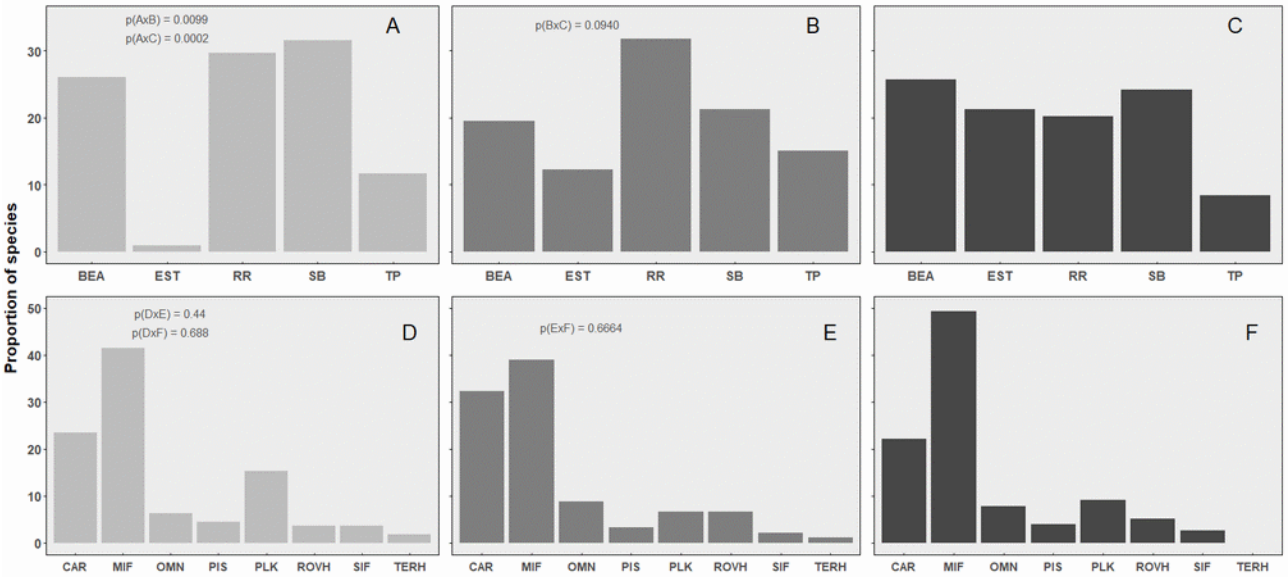

Figure 4. Relative richness of the habitat specialists (A, D), intermediate generalists (B, E), and generalists (C, F) fishes in each habitat (A-C) and trophic guilds (D-F). Results of Chi-squared test comparing the three habitat specialization categories are displayed. BEA, sandy beaches; EST, estuarine area; RR, rocky reefs; SB, soft bottom; TP, tide pools. CAR, carnivores; MIF, mobile invertebrate feeders; OMN, omnivores; PIS, piscivores; PLK, planktivores; ROVH, roving herbivores; SIF, sessile invertebrate feeders; TERH, territorial herbivores.

(Table II). The sedentary trait is negatively related to sandy beaches, while the brackish water dependency is positively related (Table II). Both shallow and very shallow depth categories are negatively related to soft bottom, and the brackish water dependency is positively related (Table II). About the tide pools, the high mobility and very deep fishes, as well as the brackish water dependency, are negatively related, while the sedentary mobility is positively related (Table II).

Discussion

Here we present APA Baía das Tartarugas as one of the species richest localities in the Espírito Santo state, presenting a higher fish diversity than localities from the northern and southern coast of the state (Pinheiro *et al.* 2015, Simon *et al.* 2016). The high richness of fish species shown corresponds with previous studies that indicate the state as harboring one of the richest reef fish assemblage on the Brazilian coast (Floeter *et al.* 2001, Pinheiro *et al.* 2018). For instance, our study area harbors 31.8% of the reef fishes recorded in Brazil (233 of 733), and

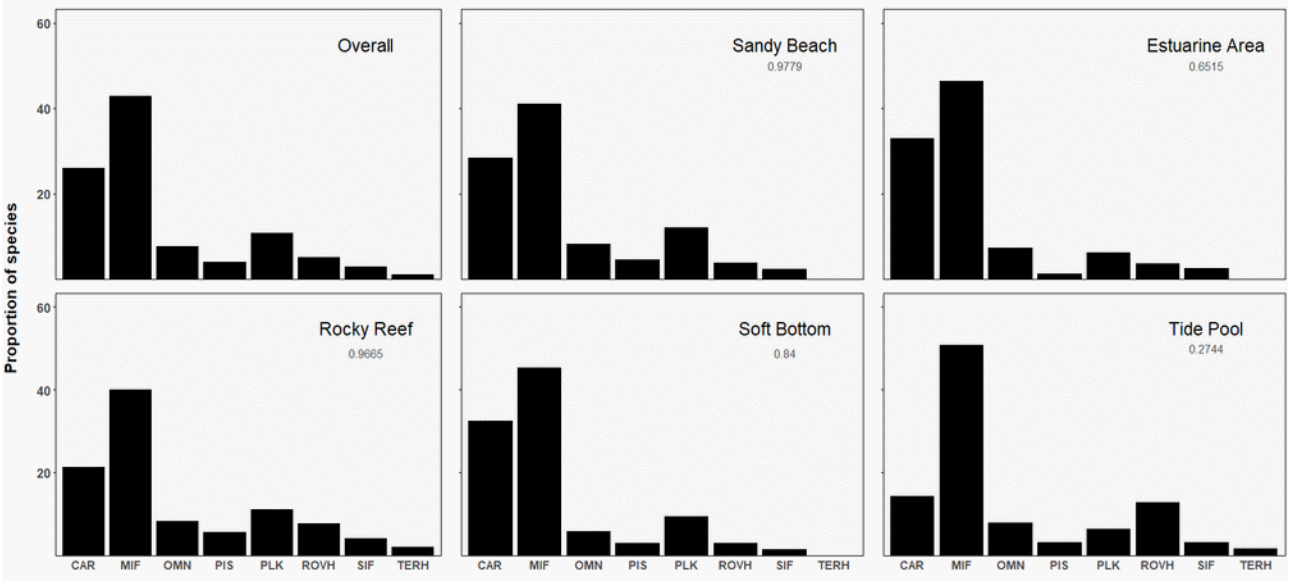

Figure 5. Relative richness of the trophic guilds in the overall checklist and in each habitat. Results of Chi-squared test comparing the trophic guild structure of each habitat against the overall assemblage are displayed. CAR, carnivores; MIF, mobile invertebrate feeders; OMN, omnivores; PIS, piscivores; PLK, planktivores; ROVH, roving herbivores; SIF, sessile invertebrate feeders; TERH, territorial herbivores.

11.5% of the endemic ones (20 of 174). This region also contributes significantly to the diversity of other Brazilian marine fauna groups, such as Gastropods (Barroso et al. 2016). This pattern could be associated with the mosaic of regional and small-scale environmental features that compose the region. Besides being situated in a transitional zone between tropical and subtropical waters (Martins *et al.* 2007, Schmid *et al.* 1995), which fuels the fish diversity with some degree of faunal overlap, the study area also represents the ecotone of coral reef and rocky reef ecosystems (Floeter *et al.* 2001). These characteristics, associated with the high local diversity of habitats found in Vitória, especially inside and adjacent to the APA Baía das Tartarugas, possibly explain the high richness observed. The richest families showed here correspond to the same families found in other localities studied in the Espírito Santo (Macieira & Joyeux 2011, Pinheiro *et al.* 2011, 2015) and Brazil (Pinheiro *et al.* 2015, 2018, Vilar *et al.* 2013), evidence of a pattern that characterizes the Brazilian Province.

The fish trophic composition of APA Baía das Tartarugas follows patterns found by Ferreira *et al*. (2004) and Floeter *et al*. (2004), in which mobile invertebrate feeders and carnivores predominate in the central coast of Brazil, with less fishes that eat low-energy resources (*i.e.*, algae, seagrasses, and detritus). Interestingly, the relative richness of trophic guilds among the habitats does not show differences from the overall assemblage, suggesting similar assembly rules, large-scale drivers operating in the assemblages composition (Bellwood & Hughes 2001). This result is corroborated by the trophic guild composition of habitat specialists and generalists, which also do not show differences. Moreover, most species are habitat generalists (60.1%), enhancing the connection among the habitats. This notable uniformity of trophic guilds among habitats and fish categories could be associated with local environmental conditions and ecological characteristics of the fishes. The study area, despite their habitat diversity, has some degree of homogeneity in ecological parameters (e.g. water turbidity and temperature), and also proximity between habitats, what form an environmental mosaic that could promote connectivity among assemblages. Furthermore, estuaries and mangroves have historically been recognized as nursery areas for several fish species, including many found on reefs (Moura *et al.* 2011, Nagelkerken *et al.* 2000). Such process promotes migration of species among the habitats.

However, conversely to the similarities regarding trophic composition, specialist fishes are distributed differently among habitats compared to generalist fishes. This may be associated with the

Table II. Significant variables obtained from de generalized linear mixed- effect models of the species traits on the habitats composition. ROV, roving; HMO, high mobility; SED, sedentary;PIS, piscivore; ROVH, roving herbivore; SHALL, shallow; VSHALL, very shallow; VDEEP, very deep.

Habitat	Variable	Estimate	Std. Error	z value	p value
Estuarine Area	Mobility: ROV	2.1612	0.8367	2.583	0.0098
	Mobility: SED	2.6868	1.0436	2.575	0.0100
Rocky Reef	Trophic guild: PIS	2.3192	1.1630	1.994	0.0461
	Trophic guild: ROVH	2.7870	1.3109	2.126	0.0335
	Brackish	-1.1065	0.4618	-2.396	0.0166
Sandy Beach	Mobility: SED	-1.8593	0.7244	-2.567	0.0103
	Brackish	1.6577	0.3840	4.317	<0.0001
Soft Bottom	Depth category: SHALL	-2.45445	1.07565	-2.282	0.0225
	Depth category: VSHALL	-3.14310	1.23229E+05	-2.551	0.0108
	Brackish	3.34570	0.84112	3.978	<0.0001
Tide Pool	Mobility: HMO	-2.0889	0.8359	-2.499	0.0125
	Mobility: SED	2.0089	0.8233	2.440	0.0147
	Depth category: VDEEP	-2.0912	0.7560	-2.766	0.0057
	Brackish	-1.4486	0.4751	-3.049	0.0023

fact that the physical and oceanographic characteristics of the habitats could drive the presence of fishes with specific ecological traits, as shown in our analyses (Table II). For instance, sedentary fishes are associated with tide pools, a habitat that promote the presence of bottom dweller and cryptic species (Macieira & Joyeux 2011), opposed to the sandy beaches, which are habitats with high influence of wave and currents, with the presence of more mobile fishes, such as carangids and engraulids. Yet, both sedentary and roving fishes are positively associated with estuarine areas, as they offer resources for a variety of species that come from other environments (Nagelkerken *et al.* 2000), also presenting complex microhabitats within the mangroves, hosting many gobiids. Rocky reefs, on the other hand, provide food source for herbivorous fishes (Ferreira *et al.* 2004, Mendes *et al.* 2015), explaining their association, while the use of brackish water was inversely related to this habitat. However, the dependency of reef fishes on estuaries and mangroves is well known (Nagelkerken *et al.* 2002), so this negative relation could be possibly explained by the presence of specialists and strictly reef dweller fishes, such as some labrisomids, labrids and apogonids.

Apart from the endemic and endangered reef fish species, the APA Baía das Tartarugas receives many juveniles of green turtles (*Chelonia mydas*) (Santos *et al.* 2011), hosts several seabirds species (Efe 2004), and some marine mammals could be sighted, such as the Guiana dolphin (*Sotalia guianensis*), and more distantly the humpback whale (*Megaptera novaeangliae*), which transits close to the limits of the APA in the southern hemisphere winter. These attributes highlight the biological importance of the region. Moreover, the APA Baía das Tartarugas is surrounded by an estuarine complex, with the main channel being formed by the Santa Maria da Vitória River and some tributary rivers, such as the Bubu River, Marinho River, Itanguá River, Aribiri River, and the Canal da Costa River. However, all of these rivers receive daily a large amount of urban and industrial sewage (Jesus *et al.* 2004, Joyeux *et al.* 2004), which is driven to the APA. In addition, other anthropogenic disturbances are easily identified inside and around the APA (Fig. 6), such as port activities, dredging, plastic pollution, and trawling. All these environmental problems are extremely harmful, especially because the region is characterized as a nursery area, which is used by species targeted by fisheries and also classified as endangered (Fig. 7)

Figure 6. The main threats and anthropogenic disturbances present in the APA Baía das Tartarugas. (A) Sewage discharge. (B) Plastic and microplastic pollution. (C) Specimens collected for ornamental trade or souvenirs. (D) Landfills and dredging, activities that were common inside and surroundings of the area that comprises the APA in the last four decades. (E) Proximity to high port activity. (F) Trawling inside nursery areas.

and Brazilian endemic reef fishes (Fig. 8). This scenario is not different from other urbanized localities in Brazil and worldwide (Pinheiro *et al.* 2019). The marine realm has historically been suffering from different anthropogenic pressures (Gasparini *et al.* 2005, Guabiroba *et al.* 2020, Hughes *et al.* 2009), and as in the study area, the most affected regions are the closest to shore (Pinheiro *et al.* 2019). Nevertheless, there are several successful cases of environmental planning (Magris *et al.* 2017, Vilar *et al.* 2020) and conservation initiatives that bring hope and optimism (Pinheiro *et al.* 2019). Here, the recently created APA Baía das Tartarugas has a great potential to promote both biodiversity conservation and sustainable development of coastal activities. Its biodiversity, which includes charismatic species such as parrotfishes, groupers and rays (*e.g.*, *Rhinoptera bonasus*), could be promoted for increasing the ecotourism in Vitória, involving activities such as SCUBA diving, underwater photography, and catch-and-release fishing. However, the MPA needs a management plan, which we recommend including no-take zones

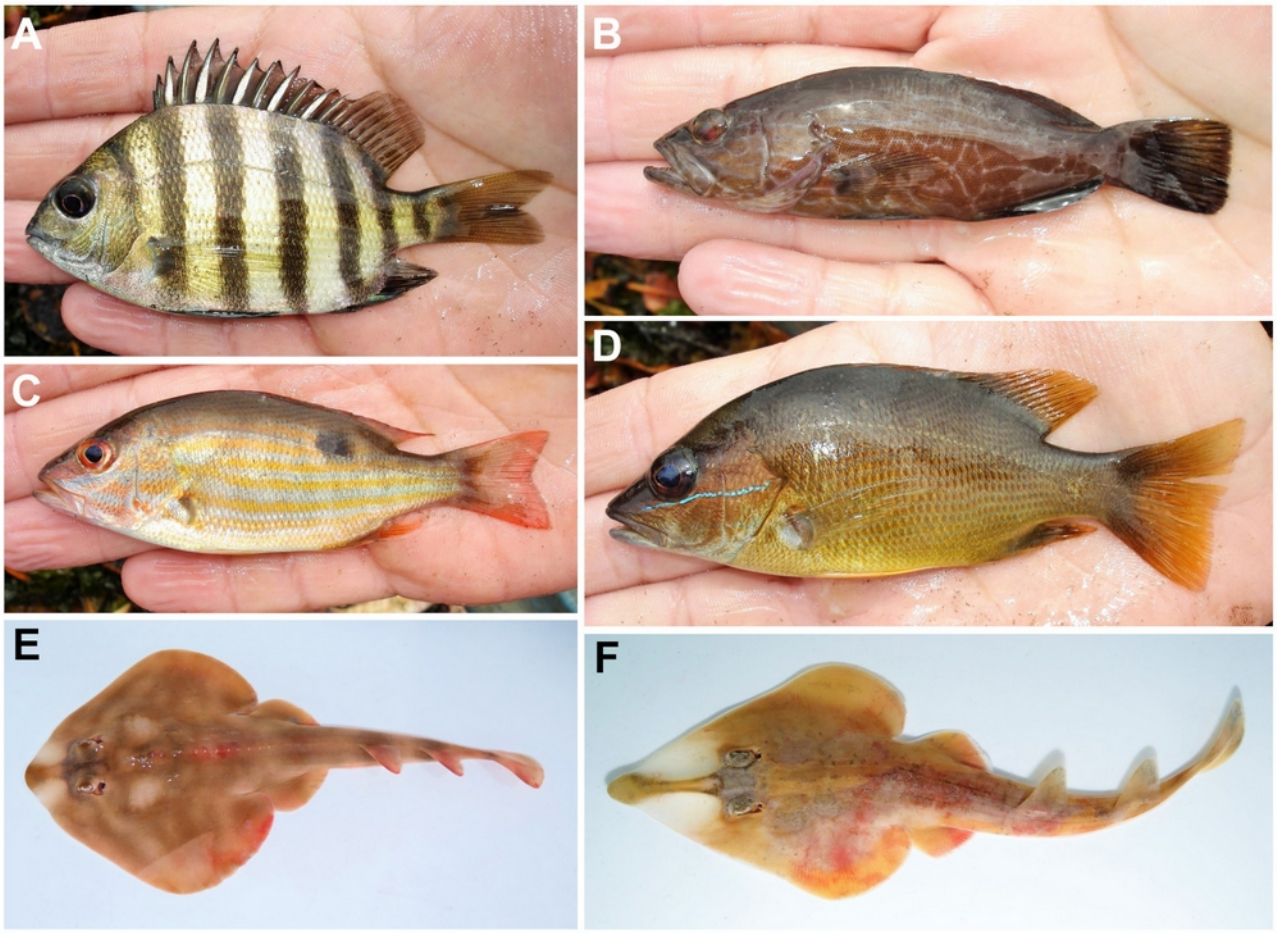

Figure 7. Juveniles of key species found in the study area. These species are abundant in the region, targeted by fishing, or classified as endangered. (A) *Archosargus probatocephalus*. (B) *Mycteroperca bonaci*. (C) *Lutjanus synagris.* (D) *Lutjanus jocu.* (E) *Zapteryx brevirostris.* (F) *Pseudobatos percellens*. Photos: JLG.

encompassing 30% of its area, and enforcement, especially to the protection of endangered species. Furthermore, in the city of Vitória there is another protected area called MES Ilha do Lameirão, which encompass 891.83 ha of estuarine and mangrove area. The conservation of MES Ilha do Lameirão, which is connected through the estuarine complex with the APA Baía das Tartarugas, and represents a nursery area for many fishes, would benefit the local marine biodiversity. The creation of no-take zones and fisheries management should be considered as a priority action by the MPA managers and decision makers, since it is an extremely efficient tool for biodiversity and resources preservation (Edgar *et al.* 2014). Potentially harmful activities, as unmanaged gillnet fishing, trawling and pollution, should be controlled in the MPA and its adjacencies. These recommendations have the potential to contribute to the recovery and sustainable development of the APA Baía das Tartarugas and the activities that depend on its resources.

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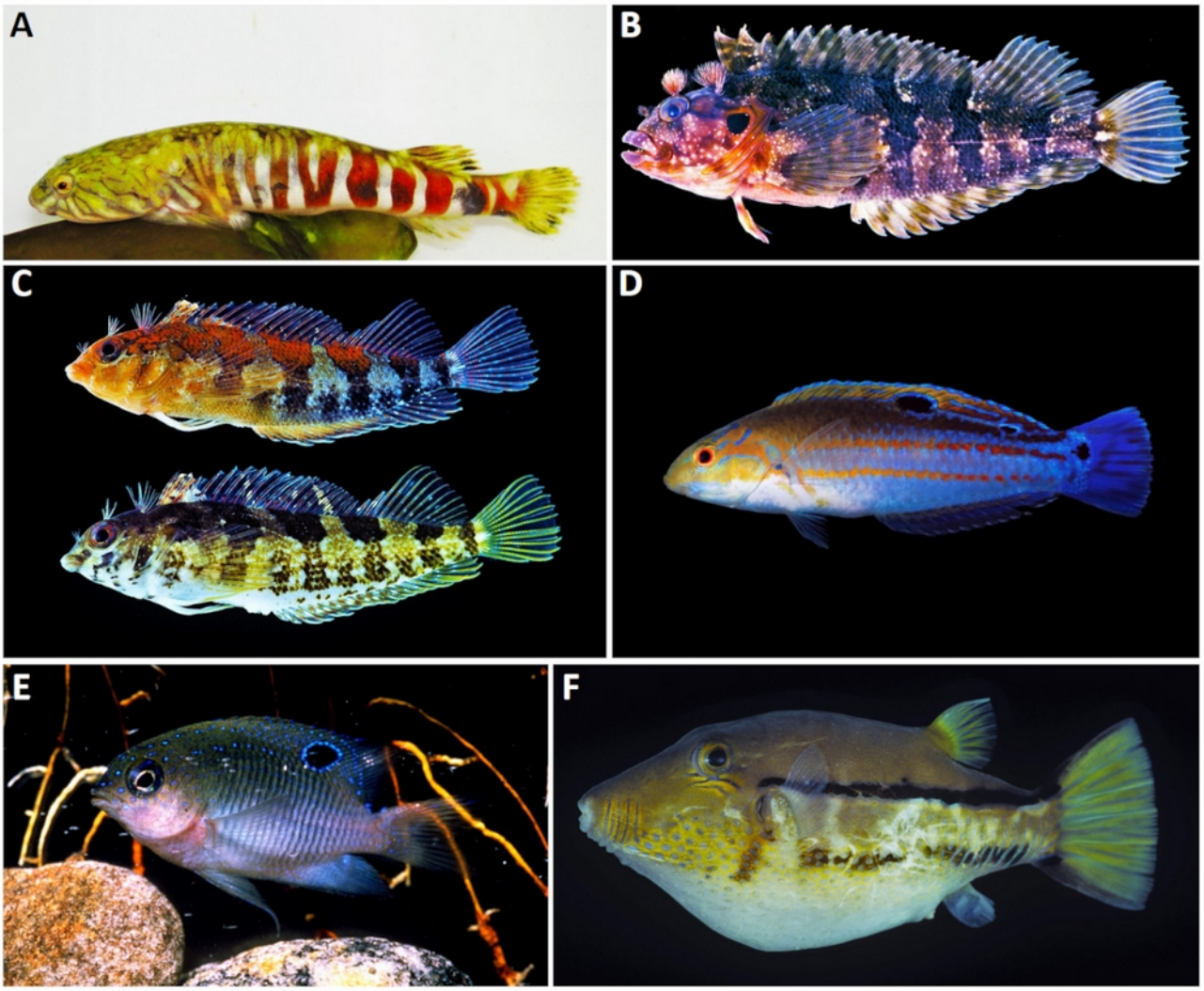

Figure 8. Some of the Brazilian endemic reef fish species that occur at the APA Baía das Tartarugas. (A) *Tomicodon australis*. (B) *Labrisomus cricota*. (C) Male and female of *Malacoctenus zaluari*. (D) Juvenile of *Halichoeres brasiliensis*. (E) Juvenile of *Stegastes fuscus*. (F) *Canthigaster figueiredoi*. Photos: JLG.

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Ethical statement

Ethical regulations do not apply. This investigation involved neither collection of individuals nor biological samples taken from fish.

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Composition and ecological aspects of the fish assemblage of the Marine Protected Area APA Baía das Tartarugas, southeastern Brazil

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Supplementarymaterial
Tables S1 and S2
Figure S1

Table S1. List of scientific articles, short communications in congress and monographs which were used to compose the checklist and were not cited in the main text

ALMEIDA, Reinaldo Pavan de. **A FAUNA ACOMPANHANTE DO CAMARÃO SETE BARBAS NA PESCA ARTESANAL COM ARRASTO DE PORTAS NA REGIÃO COSTEIRA ADJACENTE A PRAIA MOLE E CARAPEBUS - ESPIRITO SANTO, BRASIL**. 2004. 53 f. TCC (Graduação) - Curso de Oceanografia, Universidade Federal do Espírito Santo, Vitória, 2004.
ARAUJO, Marcio Francisco de. **Avaliação bio-ecológica, tecnológica e sócio-econômica do Sistema Pesqueiro de Itapoã, Vila Velha – ES**. 2006. 83 f. TCC (Graduação) - Curso de Oceanografia, Departamento de Ecologia e Recursos Naturais, Universidade Federal do Espírito Santo, VitÓria, 2006
ARAUJO, Ciro C. V. de; ROSA, Daniel de M.; FERNANDES, Joelson M.; RIPOLI, Leandro V.; KROHLING, Werther. Composição e estrutura da comunidade de peixes de uma praia arenosa da Ilha do Frade, Vitória, Espírito Santo. **Iheringia. Série Zoologia**, [s.l.], v. 98, n. 1, p. 129-135, mar. 2008. FapUNIFESP (SciELO). http://dx.doi.org/10.1590/s0073-47212008000100016.
CHIAPPANI, Luiz Henrique Bastos. **CARACTERIZAÇÃO E AVALIAÇÃO DA ATIVIDADE DE PESCA AMADORA DE ARREMESSO NA PRAIA DE CAMBURI, VITÓRIA – ES.** 2006. 51 f. Monografia (Graduação) - Curso de Oceanografia, Departamento de Ecologia e Recursos Naturais, Universidade Federal do Espírito

Santo, Vitória, 2006.

GASPARINI, J. L. 2017. Peixes dos recifes e das ilhas de Vitória e adjacências – Espírito Santo, Brasil. FAUNA – Editora, Estudos e Projetos LTDA / Gráfica GSA. Vitória. 200 p. ilust.

HELMER, José Luiz; PERRONE, Edson Campos. COMPOSIÇÃO PRELIMINAR DA ICTIOFAUNA DO LITORAL DA ILHA DO FRADE, VITÓRIA, ESPÍRITO SANTO. **Revista de Cultura**: UFES, Vitória, v. 16, n. 44/45, p. 69-78, jun. 1991.

LAFFRANCHI NETO, Rudá Mário. **VARIAÇÃO ESPAÇO-TEMPORAL DA ICTIOFAUNA SOB O IMPACTO DE DERROCAGEM NA BAÍA DE VITÓRIA/ES**. 2013. 72 f. TCC (Graduação) - Curso de Ciências Biológicas, Faculdade CatÓlica Salesiana do EspÍrito Santo, VitÓria, 2013.

NETTO, Ricardo de Freitas; KROHLING, Werther; ROCHA, Mariana Bicalho; BENEDITTO, Ana Paula Madeira di. PRODUÇÃO PESQUEIRA NO TRIÊNIO 2003-2005 PELA COOPERATIVA DE PESCA DE VILA VELHA, ESPÍRITO SANTO, SUDESTE DO BRASIL. **Boletim do Instituto de Pesca.** São Paulo, p. 663-673. jun. 2009.

ZAMPROGNO, Claudio. **DISTRIBUIÇÃO E HÁBITOS ALIMENTARES DOS PEIXES NA ZONA ENTREMARÉS DE RECIFES ROCHOSOS DA PRAIA DE MANGUINHOS, ESPÍRITO SANTO**. 1989. 176 f. Dissertação (Mestrado) - Curso de Biologia, Instituto de Biologia, Universidade Estadual de Campinas, Campinas, 1989.

Table S2. List of fish species of the APA Baía das Tartarugas and adjacent areas and their traits used in the GLMM analyses, as well the voucher number of the specimens deposited in museum collections. Depth category (VSHALL, fishes that occupy the range from 0 to 10 meters of the water column; SHALL, fishes that occupy the range from 10 to 25 meters of the water column; MID, fishes that occupy the range from 25 to 50 meters of the water column; DEEP, fishes that occupy the range from 50 to 100 meters of the water column; VDEEP, fishes that occupy the range from 100 or more meters of water column. Size category (SMALL, fishes that measure 0 to 10 centimeters in SL; MEDSMALL, fishes that measure 10 to 25 centimeters in SL; MED, fishes that measure 25 to 50 centimeters in SL; LARGE, fishes that measure 50 or more centimeters in SL. Mobility (SED, sedendatry fishes; ROV, roving fishes; HMO, high mobility fishes). Spawning type (BAL, balistid type; BRO, brooded egg; DEG, dermersal egg; DNP, demersal egg without pelagic phase; LIV, live birth; PAD, semipelagic to pelagic adults; PEL, pelagic eggs; UNK, unknown. Brackish (1, occurrence in brackish water; 0 ausent in brackish water)

Species	Depth category	Size category	Mobility	Spawning type	Brackish	Voucher ID
Abudefduf saxatilis	SHALL	MEDSMALL	ROV	DEG	0	CIUFES 130242, 131473, 131676, 131682
Acanthostracion polygonius	DEEP	MED	ROV	BAL	1	
Acanthostracion quadricornis	DEEP	LARGE	ROV	BAL	1	
Acanthurus bahianus	DEEP	MED	ROV	PEL	0	CIUFES 130001, 130007, 2279
Acanthurus chirurgus	DEEP	MED	ROV	PEL	0	CIUFES 130005, 130009, 130011, 130012, 130013, 2280
Acanthurus coeruleus	DEEP	MED	ROV	PEL	0	
Achirus declivis	MID	MEDSMALL	SED	PEL	1	CIUFES 130191
Achirus lineatus	SHALL	MEDSMALL	SED	PEL	1	CIUFES 130183 , 130185
Acyrtops beryllinus	SHALL	SMALL	SED	DEG	0	CIUFES 130851
Aetobatus narinari	DEEP	LARGE	HMO	LIV	1	CIUFES 823
Ahlia egmontis	SHALL	MED	ROV	PEL	0	CIUFES 130271, 625
Albula vulpes	DEEP	LARGE	ROV	PEL	1	CIUFES 130014, 130015, 1692, 1985, 2864, 556, 640, 643
Alphestes alfer	MID	MED	ROV	PEL	0	CIUFES 1790
Anchoa filifera	MID	MEDSMALL	HMO	PEL	1	CIUFES 130813
Anchoa januraria	MID	SMALL	HMO	PEL	1	
Anchoa lyolepis	MID	MEDSMALL	HMO	PEL	0	CIUFES 1837, 880
Anchoa marinii	SHALL	MEDSMALL	HMO	PEL	0	
Anchoa spinifera	DEEP	MEDSMALL	HMO	PEL	1	CIUFES 130809, 130810
Anchoa tricolor	MID	MEDSMALL	HMO	PEL	1	CIUFES 707
Anchovia clupeoides	MID	MED	HMO	PEL	1	CIUFES 130807, 1519, 2878, 678 812,

Anchoviella brevirostris	MID	SMALL	HMO	PEL	1	CIUFES 1986
Anchoviella cayennensis	SHALL	MEDSMALL	HMO	PEL	1	
Anchoviella lepidentostole	MID	MEDSMALL	HMO	PEL	1	CIUFES 546
Anisotremus surinamensis	DEEP	LARGE	ROV	PEL	0	CIUFES 131456, 131725
Anisotremus virginicus	MID	MED	ROV	PEL	0	CIUFES 131667
Antennarius striatus	VDEEP	MEDSMALL	SED	PEL	1	
Apogon americanus	DEEP	MEDSMALL	SED	BRO	0	CIUFES 130019, 130035, 130235
Apogon pseudomaculatus	DEEP	SMALL	SED	BRO	0	CIUFES 131315
Archosargus probatocephalus	MID	LARGE	ROV	PEL	1	CIUFES 130287, 131642, 2860, 817, 821
Archosargus rhomboidalis	MID	MED	ROV	PEL	1	CIUFES 130946, 2871, 624
Ariosoma opisthophthalma	VDEEP	MED	SED	PEL	0	CIUFES 130629
Astrapogon puncticulatus	DEEP	SMALL	SED	BRO	0	CIUFES 131407
Astroscopus y-graecum	DEEP	MED	ROV	DEG	0	CIUFES 131645
Atherinella brasiliensis	VSHALL	MEDSMALL	ROV	PEL	1	CIUFES 130653, 130657, 131249, 1734, 2862
Awaous tajasica	SHALL	MEDSMALL	SED	DEG	1	CIUFES 2942
Bairdiella goeldi	MID	MED	ROV	PEL	1	CIUFES 131626, 551, 601, 636, 717
Balistes vetula	VDEEP	MED	ROV	BAL	0	
Bathygobius geminatus	VSHALL	SMALL	SED	DEG	1	CIUFES 2281, 3188
Bathygobius soporator	SHALL	MEDSMALL	SED	DEG	1	CIUFES 130328, 130364, 130470, 130477, 130482, 130483, 130487, 130497, 131257, 1680, 1681, 2985, 361, 674, 691
Bodianus rufus	DEEP	MED	ROV	PEL	0	
Boridia grossidens	DEEP	MED	ROV	PEL	0	CIUFES 131662, 1949
Bothus lunatus	VDEEP	MED	ROV	PEL	0	
Bothus ocellatus	VDEEP	MEDSMALL	ROV	PEL	0	CIUFES 130317
Brevoortia pectinata	VSHALL	MED	HMO	PEL	1	
Bryx dunckeri	SHALL	SMALL	SED	LIV	1	CIUFES 131033
Calamus penna	DEEP	MED	ROV	PEL	0	CIUFES 130450, 130947, 2861
Cantherhines pullus	DEEP	MEDSMALL	ROV	BAL	0	

Canthigaster figueiredoi	DEEP	MEDSMALL	ROV	BAL	0	
Carangoides bartholomaei	DEEP	LARGE	HMO	PAD	0	
Carangoides crysos	DEEP	LARGE	HMO	PAD	1	CIUFES 130790
Caranx hippos	VDEEP	LARGE	HMO	PAD	1	CIUFES 130797
Caranx latus	VDEEP	LARGE	HMO	PAD	1	CIUFES 1295, 130769, 130800, 1522, 548, 709
Catathyridium garmani		MEDSMALL	SED	PEL	1	CIUFES 130195, 559
Centropomus parallelus	VSHALL	LARGE	HMO	PEL	1	CIUFES 257, 514
Centropomus undecimalis	SHALL	LARGE	HMO	PEL	1	CIUFES 637
Cephalopholis fulva	VDEEP	LARGE	ROV	PEL	0	
Cetengraulis edentulus	MID	MEDSMALL	HMO	PEL	1	CIUFES 130814, 130815, 705, 831, 832
Chaetodipterus faber	VDEEP	MED	ROV	PEL	1	CIUFES 1294, 130818, 1848, 2865
Chaetodon sedentarius	DEEP	MEDSMALL	ROV	PEL	0	
Chaetodon striatus	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 130764, 704, 665
Chilomycterus antillarum	MID	MED	ROV	PEL	0	CIUFES 1667
Chilomycterus spinosus	VDEEP	MEDSMALL	ROV	PEL	1	CIUFES 130649, 130651, 679
Chirocentrodon bleekerianus	DEEP	MEDSMALL	HMO	PEL	1	CIUFES 130610, 1520, 1720, 437
Chlorophthalmus agassizi	VDEEP	MED		PEL	1	
Chloroscombrus chrysurus	DEEP	MED	HMO	PAD	1	CIUFES 130767, 130780, 130785, 131351, 1626, 1852, 595, 697, 789
Chromis multilineata	DEEP	MEDSMALL	ROV	DEG	0	
Citharichthys arenaceus	VDEEP	MEDSMALL	ROV	PEL	1	CIUFES 130912, 130913, 130926, 130931, 1406, 2847, 680
Citharichthys macrops	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 130866, 517, 787
Citharichthys spilopterus	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 130542, 130572, 130584, 130585, 130593, 131665, 715, 837, 887
Conger triporiceps	DEEP	LARGE	SED	PEL	0	
Conodon nobilis	DEEP	MED	ROV	PEL	0	CIUFES 131758, 1778, 689
Coryphopterus glaucofraenum	SHALL	SMALL	SED	DEG	0	CIUFES 1679
Cryptotomus roseus	DEEP	MEDSMALL	ROV	PEL	0	
Ctenogobius boleosoma	VSHALL	SMALL	SED	DEG	1	CIUFES 130203, 130207, 130485, 130492, 383, 600, 673

Ctenogobius smaragdus	VSHALL	MEDSMALL	SED	DEG	1	CIUFES 130490, 2989, 380, 605
Ctenogobius stigmaticus	VSHALL	SMALL	SED	DEG	1	
Ctenosciaena gracilicirrhus	VDEEP	MEDSMALL	ROV	PEL	0	CIUFES 131724
Cynoponticus savanna	DEEP	LARGE	ROV	PEL	1	CIUFES 130276
Cynoscion jamaicensis	DEEP	MED	ROV	PEL	1	CIUFES 446
Cynoscion leiarchus	MID	LARGE	ROV	PEL	1	CIUFES 1523, 402, 692, 888
Cynoscion microlepidotus	MID	LARGE	ROV	PEL	1	CIUFES 445
Cynoscion striatus	DEEP	LARGE	ROV	PEL	0	
Cynoscion virescens	DEEP	LARGE	ROV	PEL	1	CIUFES 687
Dactylopterus volitans	DEEP	MED	ROV	BRO	1	CIUFES 130623, 1535
Dactyloscopus tridigitatus	DEEP	MED	ROV	BRO	0	CIUFES 130343, 130625, 130626, 130985, 1670
Diapterus auratus	VSHALL	MED	ROV	PEL	1	CIUFES 130837, 1503, 1532, 712, 818
Diapterus rhombeus	DEEP	MED	ROV	PEL	1	CIUFES 1832, 889
Diapterus rhombeus	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 598
Diodon hystrix	MID	LARGE	ROV	PEL	0	CIUFES 130043
Diplectrum formosum	DEEP	MED	ROV	PEL	0	CIUFES 131529, 131563, 131749, 628
Diplectrum radiale	DEEP	MED	ROV	PEL	1	CIUFES 1521, 1862, 1864, 502
Diplodus argenteus	MID	MED	ROV	PEL	0	CIUFES 130312
Doratonotus megalepis	SHALL	SMALL	ROV	PEL	0	
Echiophis intertinctus	DEEP	LARGE	ROV	PEL	0	
Eleotris pisonis	VSHALL	MEDSMALL	SED	PEL	1	CIUFES 1376, 390
Elops smithi	MID	LARGE	HMO	PEL	1	CIUFES 846
Epinephelus itajara	VDEEP	LARGE	ROV	PEL	1	CIUFES 131480
Etropus crossotus	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 130356, 130357, 130358, 130925, 1524, 1801
Etropus longimanus	VDEEP	MEDSMALL	ROV	PEL	1	CIUFES 1820
Eucinostomus gula	DEEP	MEDSMALL	ROV	PEL	1	CIUFES 703
Eucinostomus lefroyi	VSHALL	MEDSMALL	ROV	PEL	1	
Eucinostomus melanopterus	SHALL	MED	ROV	PEL	1	CIUFES 130827, 130829, 131036, 1830

Eugerres brasilianus	SHALL	MED	ROV	PEL	1	
Evorthodus lyricus	VSHALL	MEDSMALL	SED	DEG	1	CIUFES 386
Fistularia petimba	VDEEP	LARGE	ROV	PEL	1	CIUFES 130821, 2849
Fistularia tabacaria	VDEEP	LARGE	ROV	PEL	1	
Genidens genidens	SHALL	MED	ROV	PEL	1	
Genyatremus luteus	MID	MED	ROV	PEL	1	
Gillellus greyae	SHALL	SMALL	SED	BRO	0	CIUFES 130349, 130627, 130628, 130986, 2966
Gobioclinus kalisherae	SHALL	SMALL	SED	DEG	0	
Gobiesox barbatulus	SHALL	SMALL	SED	DEG	0	CIUFES 130849, 130850, 130854, 1368, 1405
Gobionellus oceanicus	MID	MEDSMALL	SED	DEG	1	CIUFES 130549, 384, 512, 520, 593, 594
Gobionellus stomatus		MEDSMALL	SED	DEG	1	CIUFES 430, 501
Gobiosoma alfiei	VSHALL	SMALL	SED	DEG	0	CIUFES 646
Gramma brasiliensis	MID	SMALL	SED	BRO	0	
Guavina guavina	VSHALL	MED	SED	PEL	1	CIUFES 130449, 130451, 130540, 130999, 602
Gymnothorax funebris	DEEP	LARGE	ROV	PEL	1	CIUFES 131501, 389
Gymnothorax moringa	VDEEP	LARGE	ROV	PEL	0	
Gymnothorax ocellatus	VDEEP	LARGE	ROV	PEL	1	CIUFES 1745, 519
Gymnothorax vicinus	VDEEP	LARGE	ROV	PEL	0	
Haemulon aff. *plumieri*	DEEP	MED	ROV	PEL	0	CIUFES 131576, 131640, 588
Haemulon atlanticus	MID	MED	ROV	PEL	0	CIUFES 130121, 131487, 131556, 2853, 590
Haemulon aurolineatum	DEEP	MEDSMALL	ROV	PEL	0	CIUFES 131345
Haemulon parra	DEEP	MED	ROV	PEL	0	CIUFES 131714, 2872
Haemulopsis corvinaeformis	MID	MEDSMALL	ROV	PEL	1	
Halichoeres penrosei	DEEP	MEDSMALL	ROV	PEL	0	
Halichoeres poeyi	DEEP	MEDSMALL	ROV	PEL	0	CIUFES 130283, 130894, 130895, 130896, 130899, 130902, 130906, 131346, 131347
Halichoeres brasiliensis	DEEP	MEDSMALL	ROV	PEL	0	CIUFES 130898, 130904
Harengula clupeola	MID	MEDSMALL	HMO	PEL	1	CIUFES 2863
Harengula jaguana	SHALL	MEDSMALL	HMO	PEL	1	

Hemiramphus brasiliensis	VSHALL	LARGE	ROV	PEL	0	CIUFES 2851
Hippocampus reidi	DEEP	MEDSMALL	SED	LIV	1	CIUFES 131679, 1483, 1628, 2845, 2964, 611, 91
Hippocampus erectus	DEEP	MEDSMALL	SED	LIV	0	CIUFES 131228, 131679, 1483, 1628, 2845, 2964, 611, 91
Holacanthus ciliaris	VDEEP	MED	ROV	PEL	0	CIUFES 130058
Holecentrus adscencionis	VDEEP	MED	ROV	PEL	0	CIUFES 130860, 1719, 518, 587
Hypanus guttatus	MID	LARGE	ROV	LIV	0	
Hyporhamphus roberti	VSHALL	MED	ROV	PEL	1	
Hyporhamphus unifasciatus	VSHALL	MED	ROV	PEL	1	CIUFES 647
Hyporthodus niveatus	VDEEP	LARGE	ROV	PEL	0	
Isopisthus parvipinnis	MID	MEDSMALL	ROV	PEL	1	CIUFES 131551, 409, 771
Kyphosus sectratrix	DEEP	LARGE	ROV	PEL	0	
Labrisomus nuchipinnis	VSHALL	MEDSMALL	SED	DEG	0	CIUFES 130939, 130940, 130942, 130945, 3186
Labrisomus cricota	VSHALL	SMALL	SED	DEG	0	CIUFES 987
Lagocephalus laevigatus	VDEEP	LARGE	ROV	BAL	1	CIUFES 131699, 499, 516
Larimus breviceps	DEEP	MED	ROV	PEL	1	CIUFES 131611, 131675, 1809
Lile piquitinga	MID	MEDSMALL	HMO	PEL	1	CIUFES 130980
Lobotes surinamensis	DEEP	LARGE	ROV	PEL	1	CIUFES 2118
Lupinoblennius paivai	VSHALL	SMALL	SED	DEG	1	CIUFES 2115
Lutjanus analis	DEEP	LARGE	ROV	PEL	1	CIUFES 130965, 816, 820
Lutjanus cyanopterus	DEEP	LARGE	ROV	PEL	1	
Lutjanus jocu	DEEP	LARGE	ROV	PEL	1	CIUFES 130963, 130967, 131229, 255, 258, 2858, 661
Lutjanus synagris	VDEEP	LARGE	ROV	PEL	1	CIUFES 130953, 130957, 131250, 2591, 2876, 667, 819, 822
Lycengraulis grossidens	MID	MEDSMALL	HMO	PEL	1	CIUFES 130803, 130804, 130805, 130816, 547, 716
Lythrypnus nesiotes	DEEP	SMALL	SED	DEG	0	CIUFES 130298
Lythrypnus brasiliensis	DEEP	SMALL	SED	DEG	0	CIUFES 2278
Macrodon ancylodon	DEEP	MED	ROV	PEL	1	CIUFES 131462, 131681, 408, 631, 688

Malacoctenus delalandii	SHALL	SMALL	SED	DEG	0	CIUFES 130327, 130934, 130936, 130941, 591
Malacoctenus zaluari	MID	SMALL	SED	DEG	0	CIUFES 1648
Menticirrhus cuiaranensis	SHALL	MEDSMALL	ROV	PEL	1	CIUFES 1825, 407
Menticirrhus martinicensis	MID	MEDSMALL	ROV	PEL	1	CIUFES 2868
Microdesmus bahianus	VSHALL	MEDSMALL	SED	DEG	0	
Microgobius meeki	MID	SMALL	SED	DEG	1	CIUFES 698
Microphis lineatus	VSHALL	MEDSMALL	SED	LIV	1	CIUFES 131035
Micropogonias furnieri	DEEP	LARGE	ROV	PEL	1	CIUFES 513
Mobula hypostoma	DEEP	LARGE	HMO	LIV	0	CIUFES 3430
Monacanthus ciliatus	MID	MEDSMALL	ROV	BAL	0	CIUFES 2842
Mugil curema	SHALL	LARGE	ROV	PEL	1	CIUFES 130284, 403
Mugil gaimardianus		LARGE	ROV	PEL	0	CIUFES 131065, 131066
Mugil liza	SHALL	LARGE	ROV	PEL	1	CIUFES 131069
Mycteroperca acutirostris	DEEP	LARGE	ROV	PEL	0	CIUFES 131763
Mycteroperca bonaci	VDEEP	LARGE	ROV	PEL	1	CIUFES 2870, 400
Mycteroperca interstitialis	MID	MEDSMALL	SED	PEL	0	CIUFES 315
Myrichthys breviceps	MID	LARGE	ROV	PEL	1	
Myrichthys ocellatus	MID	LARGE	ROV	PEL	0	CIUFES 131137, 1769
Myrophis punctatus	DEEP	MED	ROV	PEL	1	CIUFES 2852
Narcine brasiliensis	VDEEP	LARGE	ROV	LIV	0	CIUFES 393, 3759
Nebris microps	MID	MED	ROV	PEL	1	
Nicholsina usta	MID	MEDSMALL	ROV	PEL	0	CIUFES 131050
Notarius grandicassis	MID	LARGE	ROV	PEL	1	
Ocyurus chrysurus	VDEEP	LARGE	ROV	PEL	0	CIUFES 130949, 476, 589
Odontesthes bonariensis		MED	ROV	PEL	1	CIUFES 545, 553
Odontognathus mucronatus	MID	MEDSMALL	HMO	PEL	1	CIUFES 130614
Odontoscion dentex	MID	MED	ROV	PEL	0	CIUFES 1699

Ogcocephalus notatus	VDEEP	MEDSMALL	SED	UNK	0	
Ogcocephalus vespertilio	VDEEP	MED	SED	UNK	1	CIUFES 130042, 626
Oligoplites palometa	MID	MED	HMO	PAD	1	
Oligoplites saliens	MID	MED	HMO	PAD	1	CIUFES 130777, 130783, 130784, 555
Oligoplites saurus	MID	MED	HMO	PAD	0	CIUFES 130775, 2875
Ophichthus cylindroideus	MID	LARGE	ROV	PEL	0	
Ophichthus gomesii	VDEEP	LARGE	ROV	PEL	0	???? CIUFES 1727
Ophichthus ophis	DEEP	LARGE	ROV	PEL	0	CIUFES 131290
Ophidion holbrookii	DEEP	MED	ROV	PEL	0	CIUFES 131134
Ophioscion punctatissimus	MID	MEDSMALL	ROV	PEL	1	CIUFES 131523, 1834, 406
Opisthonema oglinum	VSHALL	MED	HMO	PEL	0	CIUFES 130611, 130617
Orthopristis ruber	DEEP	MED	ROV	PEL	1	CIUFES 131668, 618
Orthopristis scapularis	DEEP	MED	ROV	PEL	1	
Parablennius pilicornis	SHALL	SMALL	SED	DEG	0	CIUFES 131041, 1632
Parablennius marmoreus	VSHALL	SMALL	SED	DEG	0	Gaspa
Paraclinus fasciatus	VSHALL	SMALL	SED	DEG	0	
Paraclinus arcanus	VSHALL	SMALL	SED	DEG	0	CIUFES 130938, 645
Paraclinus rubicundus	SHALL	SMALL	SED	DEG	0	CIUFES 130299
Paralichthys brasiliensis	MID	LARGE	ROV	PEL	1	CIUFES 1632, 2848, 815
Paralichthys cf. *orbignyanus*	MID	MED	ROV	PEL	1	CIUFES 130566
Paralonchurus brasiliensis	MID	MED	ROV	PEL	1	CIUFES 131614, 1823, 2867, 405
Paranisotremus moricandi	MID	MEDSMALL	ROV	PEL	0	CIUFES 131535, 130165
Pareques acuminatus	DEEP	MEDSMALL	SED	PEL	0	CIUFES 130297, 486
Pellona harroweri	MID	MEDSMALL	HMO	PEL	1	CIUFES 130608, 130609, 130612, 130615
Pempheris schomburgkii	MID	MEDSMALL	SED	PEL	0	CIUFES 1836
Peprilus xanthurus	VDEEP	MED	ROV	LIV	1	CIUFES 131599, 1533, 654
Phaeoptyx pigmentaria	DEEP	SMALL	SED	BRO	0	CIUFES 131405
Polydactylus oligodon	SHALL	MED	ROV	PEL	1	CIUFES 2879, 623, 810

Polydactylus virginicus	DEEP	MED	ROV	PEL	1	CIUFES 131677, 131783, 1805, 622, 811
Pomacanthus arcuatus	MID	LARGE	ROV	PEL	0	CIUFES 131360, 1761
Pomacanthus paru	DEEP	MED	ROV	PEL	0	CIUFES 131489
Pomadasys ramosus		MED	ROV	PEL	1	CIUFES 131732, 2877
Pomatomus saltatrix	VDEEP	LARGE	HMO	PEL	1	
Porichthys porosissimus	VDEEP	MED	SED	DNP	0	
Prionotus punctatus	VDEEP	MED	ROV	PEL	1	CIUFES 130951, 131716, 1802, 2843, 521, 627, 722
Pseudobatos percellens	VDEEP	LARGE	ROV	LIV	0	
Pseudopneus maculatus	DEEP	MED	ROV	PEL	0	CIUFES 131350, 131659, 131769, 1751
Rachycentron canadum	VDEEP	LARGE	HMO	PEL	1	CIUFES 131620
Raneya brasiliensis	VDEEP	MED	ROV	PEL	0	CIUFES 130044
Rhinoptera bonasus	VDEEP	LARGE	HMO	LIV	1	
Rhizoprionodon porosus	VDEEP	LARGE	HMO	LIV	1	CIUFES 2812
Rioraja agassizii	VDEEP	MED	ROV	LIV	0	
Ronchiscus crocro	VDEEP	MED	ROV	PEL	1	CIUFES 131660, 391, 515
Rypticus subbifrenatus	MID	LARGE	SED	PEL	0	
Rypticus randalli	SHALL	MEDSMALL	SED	PEL	0	CIUFES 130855
Sardinella brasiliensis	VSHALL	MEDSMALL	HMO	PEL	1	CIUFES 130619, 130620, 130621, 131256
Saurida brasiliensis	VDEEP	MEDSMALL	ROV	PEL	0	CIUFES 131040
Scartella cristata	VSHALL	SMALL	SED	DEG	0	CIUFES 130564
Scarus trispinosus	MID	MED	ROV	PEL	1	CIUFES 131619
Scorpaena brasiliensis	DEEP	MED	SED	PEL	1	CIUFES 131575, 131689, 496, 613
Scorpaena plumieri	DEEP	MED	SED	PEL	1	CIUFES 130308, 131585, 2854, 575, 603, 604, 617, 641
Selar crumenophthalmus	VDEEP	MED	HMO	PAD	0	
Selene brownii	DEEP	MED	HMO	PAD	0	CIUFES 3225
Selene setapinnis	DEEP	LARGE	HMO	PAD	1	CIUFES 1859
Selene vomer	DEEP	MED	HMO	PAD	1	CIUFES 130798, 2846, 550, 701, 702, 894
Sparisoma axillare	MID	MED	ROV	PEL	1	CIUFES 619

Sparisoma radians	SHALL	MEDSMALL	ROV	PEL	0	
Sparisoma amplum	DEEP	MED	ROV	PEL	0	CIUFES 130948, 131705
Sphoeroides greeleyi	SHALL	MEDSMALL	ROV	BAL	1	CIUFES 130041, 130339, 130340, 130341, 130342, 130411, 131252, 1654, 2841, 500, 676
Sphoeroides spengleri	DEEP	MED	ROV	BAL	1	CIUFES 130371, 130541, 2840, 664, 668, 706
Sphoeroides testudineus	MID	MED	ROV	BAL	1	CIUFES 130413, 1389, 1655, 256, 2839, 599, 884
Sphyraena barracuda	DEEP	LARGE	HMO	PEL	1	
Sphyraena guachancho	DEEP	LARGE	HMO	PEL	1	
Starksia brasiliensis	SHALL	SMALL	SED	DEG	0	CIUFES 130072
Stegastes fuscus	DEEP	MEDSMALL	SED	DEG	0	
Stegastes pictus	DEEP	SMALL	SED	DEG	0	
Stegastes variabilis	MID	MEDSMALL	SED	DEG	0	CIUFES 131534
Stellifer brasiliensi		MEDSMALL	ROV	PEL	0	CIUFES 1534, 772
Stellifer naso	MID	MEDSMALL	ROV	PEL	1	
Stellifer rastrifer	MID	MED	ROV	PEL	1	CIUFES 130164, 131527, 2873, 552
Stellifer stellifer	MID	MEDSMALL	ROV	PEL	1	CIUFES 131628
Stephanolepis hispidus	VDEEP	MED	ROV	BAL	0	CIUFES 130748
Strongylura timucu	VSHALL	LARGE	HMO	PEL	1	
Syacium papillosum	VDEEP	MED	ROV	PEL	0	CIUFES 886
Syacium micrurum	VDEEP	MED	ROV	PEL	0	CIUFES 130355, 130395, 130439, 130499, 130543, 130911
Symphurus diomedianus	VDEEP	MEDSMALL	SED	PEL	1	CIUFES 130149, 130641
Symphurus jenynsi	VDEEP	MED	SED	PEL	0	
Symphurus plagusia	VDEEP	MEDSMALL	SED	PEL	1	CIUFES 130633, 130639, 130642, 1776
Symphurus tessellatus	DEEP	MEDSMALL	SED	PEL	1	CIUFES 704, 708, 784
Syngnathus pelagicus	DEEP	MEDSMALL	SED	LIV	0	CIUFES 130372
Syngnathus scovelli	VSHALL	MEDSMALL	SED	BRO	1	CIUFES 2850, 2959, 557
Synodus foetens	VDEEP	MED	ROV	PEL	1	CIUFES 131664, 131686, 825, 826
Tomicodon australis	VSHALL	SMALL	SED	DEG	0	CIUFES 130853, 131058, 1709, 1359, 2929, 2931

Trachinotus carolinus	DEEP	LARGE	HMO	PAD	1	CIUFES 130779, 1796, 549
Trachinotus falcatus	DEEP	LARGE	HMO	PAD	1	CIUFES 130778, 131255, 1721, 1811, 1988, 2859
Trachinotus goodei	MID	MED	HMO	PAD	0	CIUFES 1296, 651
Trachurus lathami	VDEEP	MED	HMO	PAD	0	
Trichiurus lepturus	VDEEP	LARGE	HMO	PEL	1	CIUFES 131517, 1814, 401, 610
Trinectes microphthalmus	MID	SMALL	SED	PEL	1	CIUFES 130184, 711, 719, 827
Trinectes paulistanus	VSHALL	MEDSMALL	SED	PEL	1	CIUFES 130190, 130555, 130556, 776, 829, 833, 836, 130554
Tylosurus acus	VSHALL	LARGE	HMO	PEL	0	CIUFES 130558
Umbrina coroides	SHALL	MED	ROV	PEL	1	CIUFES 655
Upeneus parvus	VDEEP	MED	ROV	PEL	0	CIUFES 131349
Zapteryx brevirostris	VDEEP	LARGE	ROV	LIV	0	CIUFES 394, 397, 824

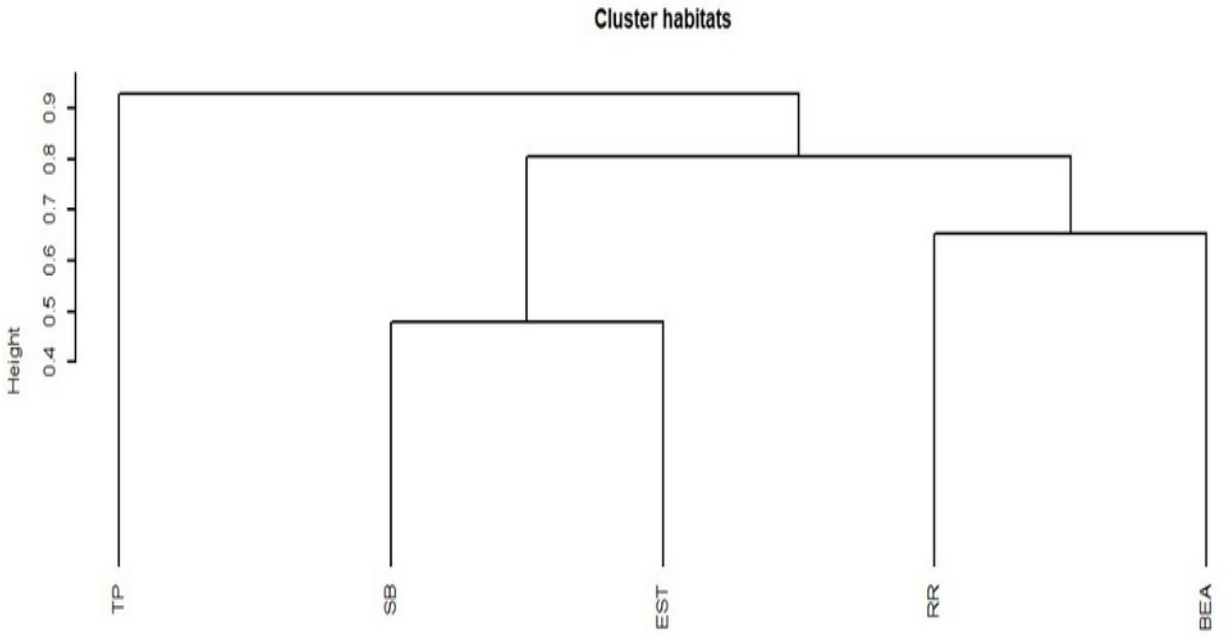

Figure S1. Cluster analysis of habitats similarity of the APA Baía das Tartarugas and the adjacent area. BEA, sandy beaches; EST, estuarine zone; RR, rocky reefs; SB, soft bottom; TP, tide pools.